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9. ABSTRACT

This document addresses the problems and progress of information systems as related mainly to non-chemical methods of pest control, and discusses some of the major problems and needs confronting pest control specialists in developing countries. It was found that information about various methods of pest control must be coordinated and consolidated in order to aid pest management programs in developing countries; computer-based data bases and their services offer tremendous potential for this. Scientific societes, information centers, and organizations assisting these developing countries must provide immediate solutions to the most pressing needs in information gathering and dissemination. To begin solving these needs, it is recommended that an international information project center for alternative methods of pest control be formed. It is mandatory that the institution selected to coordinate the project has a wide range of inter-disciplinary programs in pest management, and a staff of highly knowledgeable pest management scientists in these disciplines to utilize the various pest control methods in the developing countries.

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INFORMATION SYSTEMS

FOR ALTERNATIVE METHODS OF PEST CONTROL

With emphasis on problems and needs
of crop protection specialists
in developing countries

by

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This document synthesizes the ideas and assistance of a great many workers in the fields of information systems science, computer science and the biological sciences involved in crop protection and pest management. Information systems technology is currently witnessing a revolution in new approaches, and its application to the agricultural and biological sciences is in a continual state of flux. Consequently, it simply is not possible to obtain supportive information backed up with concrete data which will answer many questions regarding the present acceptability and the future direction of information systems as related to pest management. It was thus necessary for us to draw heavily from the unpublished data of, and personal communications with, experts in the field.

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TABLE OF CONTENTS

	Page
SUMMARY AND RECOMMENDATIONS	1
INTRODUCTION	5
PROBLEMS OF ACCESS TO PEST MANAGEMENT LITERATURE	8
ORGANIZED EFFORTS TO IMPROVE INFORMATION RETRIEVAL AND EXCHANGE	11
MACHINE-READABLE DATA BASES AND SERVICES	15
APPENDIX A. Some Data Bases of Particular Value to Crop Protection Specialists	21
APPENDIX B. Experimental Evaluation of Data Bases Related to Crop Protection	28
APPENDIX C. Recent Actions Taken to Assist Entomologists with Their Literature Searching Needs. .	37
REFERENCES CITED	40

SUMMARY AND RECOMMENDATIONS

This document addresses the problems and progress of information systems as related mainly to non-chemical methods of pest control and discusses some of the major problems and needs confronting pest control specialists in developing countries. Several of the special problems in information handling are treated by individual topic in the appendixes included herein.

Due to lack of formal training in, and exposure to library science and its techniques in literature searching, and also due to restrictions on the time that can be spent in information searching, most pest control specialists are very ineffective at retrieving publications and other written information related to their field. This has become an extremely crucial problem for crop protection specialists working in developing countries who rarely have access to modern library facilities. And, the problem can only be expected to worsen in the future as the numbers of new journals, books and other written documents continue to increase at an astronomical rate. Furthermore, there is the growing problem of accessing "current awareness" information pertaining to on-going research projects in areas related to the specialist's work.

There have been several major efforts in the past decade to coordinate and consolidate at an international level the whole of the information activities in the agricultural sciences which are reviewed herein. The future of these efforts is presently not too certain, however, and no one effort has adequately addressed the immediate information needs related to crop pest management programs in developing countries.

There are a great many currently active and planned electronic computer or "machine-readable" data bases (over 120 in all fields; 10 to 15 of immediate value to crop protection specialists) accessible via computer facilities at most modern libraries and certain information brokerages (refer to Appendix A for a discussion of data bases of particular value to crop protection specialists). These offer good potentialities as a means to more rapid access of published and current-awareness, non-published information and to supplement (and perhaps eliminate, in special cases) "manual" information searches. However, little is presently known of their specific coverage proficiencies for accessing information on integrated pest control in general or on non-chemical controls in particular. Only a few assessments have been made, for example, to ascertain the best single base, or the best two or three in combination, to obtain information most frequently demanded by crop protection specialists assigned to a particular crop or crop-pest complex. This is no easy chore either, since the best information source(s) to answer a specific query of one of these crop protection specialists may not be the best source(s) for a companion specialist, i.e., individualistic

demands and "tastes" complicate procedures of assessment. There is no substitute for the skilled information specialist in the given scientific discipline or sub-discipline, as a means to judge the adequacy or inadequacy of a data base; moreover, the tests themselves must be made against good "standards" or "yardsticks" and these must be selected with care and experienced judgment.

It was found herein from our own independent "yardstick" evaluations that of three presumed-to-be appropriate data bases queried for literature on the greenbug, Schizaphis graminum (Rondani), back to 1972, one base (BIOSIS Previews) provided 30 citations not provided by the other two, while the other two provided only 21 (CAIN) and 3 (CA Condensates), respectively, of such unique citations (refer to Appendix B for procedure and results of these evaluations). For a different scientific area, the results would undoubtedly be different.

Another problem in using electronically stored data bases is their limitation to the most recent years of publication (their coverage is normally only 3-5 years). Furthermore, the crop protection specialist in a developing country does not commonly have the facilities to access these data bases, nor the familiarity with proper query terminology and techniques. The costs involved for each prospective scientist to proceed on his own would be most costly and wasteful in any event.

These points which describe the problems posed in gaining access to the necessary scientific information, with respect even to well developed countries having strong scientific staff and libraries in the respective pest control disciplines, are aggravated many times over for the developing countries. Workers in pest management in these countries, in the absence of knowledge suggesting other possibilities, lean naturally on the most obvious tactic -- use of a chemical pesticide. To assess the information concerning other adequate strategies and tactics is a must if this reliance on the single tactic of chemical control is to be lessened substantially.

Beyond this, there are also other problems that, although commonly confronting even those pest control specialities housed near modern library facilities of the developed countries, are especially crucial problems which prevent effective access to literature and other information in developing countries. Some of these major problems are discussed, and a review is included from some of the recent actions which have been taken to solve these problems (refer to Appendix C).

The most effective way to deal with all these very serious problems confronting the information requirements of pest control specialists of developing countries will be through the concerted, unselfish efforts of developed countries who become committed to the cause of effecting better methods of disseminating useful pest control information to specialists of these developing countries. Without this help it is doubtful that information on the best control

technology of the developed world and of good programs in the developing world will reach those who need it.

Needs and Recommendations

1. Unless a new and major effort is undertaken to coordinate and consolidate the whole spectrum of activities of information gathering and dissemination related to alternative methods of pest control, programs of pest management in the developing countries will suffer from inadequate access to literature and unnecessary duplication and costs in accessing it; they will thus be unnecessarily delayed in meeting intended objectives.

2. Such pest management programs require not only good coordination, consolidation and management but rapid access to developments in various countries participating in the programs and in other world areas as well. This requires close attention and collaboration of many scientists, institutions and organizations.

3. Computer-based data bases and their services offer tremendous potential in this coordination and consolidation. However, many of these bases and services, especially those designed to meet the needs of developing countries, are currently in the experimental phase; and several years will be required before their potential is ever realized. Other computer-based services, while currently available to developed countries, are not available to, and probably cannot be afforded by many developing countries.

4. Scientific societies, information centers and organizations involved in providing assistance to these developing countries should take a more sincere interest and active role in providing immediate solutions to the most pressing needs in information gathering and dissemination. Efforts should be made to form consortia which embrace the participation of fraternal societies of a broad segment of the agricultural and biological sciences as a mechanism toward improving communication and a more common ground for assisting developing countries with their information needs.

We recommend that immediate actions be taken to address these pressing needs:

a. The formation of an international information project center for alternative methods of pest control. This center would consist of a network of participants from both developed and underdeveloped countries to assist in searching, collating and disseminating information. However, the principal responsibilities in all areas, and in coordination as well as dissemination and information referral, would be centrally headquartered at one institution. This institution would require access to an exceptionally strong and modern library facility staffed with information science specialists

having expertise in computer-based retrieval systems and adequate computer facilities for the development of an information system to meet specific needs of the project. Also, it is mandatory that the institution selected to coordinate the project has a wide range of on-going interdisciplinary programs in pest management and a staff of highly knowledgeable pest management scientists in the several relevant disciplines, and that they be keenly interested in developing programs utilizing alternative methods of pest control in the underdeveloped countries for which the international information project would serve a unifying and catalytic role. These scientists must have had broad collaborative working experiences with scientists of and in developing pest management programs in the underdeveloped world and familiarity with the information needs of these programs.

The following disciplines should be strongly represented by the institution chosen to assume the primary functional and fiscal responsibility and coordinative role of the project:

(1) Entomology

(2) Plant pathology

(3) Nematology

(4) Weed control science

(5) Vertebrate pest control

(6) Information science

(7) Computer technology

(8) Systems analysis

b. The responsibilities of this project will be to:

1. Conduct an in-depth study of the whole spectrum of information requirements to meet the short-term and long-term needs of crop pest specialists involved in developing economically and ecologically sound pest management programs in the underdeveloped countries.

2. Determine the <u>immediate</u> needs and take necessary action for improving the gathering and dissemination of information as related to developing pest management programs. Needs for manuals, guides, handbooks, bibliographies and other references to information relevant to these programs should be determined immediately. And it is extremely important too that provisions are made for the coordination, i.e., financing, locating authors and editors,

etc., of the production of new references deemed essential.

3. Develop guidelines for the use and evaluation of available and future machine-readable data bases related to alternative methods of pest control.

4. Develop a worldwide network of specialists who would serve as resource persons to gather and communicate information in their areas of the world and their disciplines to augment existing data files and information concerning current developments.

5. Cooperate with current and future international information systems and services to ensure compatibility of these systems and services as is feasible within the context of the project.

INTRODUCTION

Data gathering and dissemination are mainstream activities of every crop protection and pest management scientist. These activities, in fact, are probably the single most unifying force among the whole universe of scientists. Pest control scientists, and all other scientists as well, depend upon observations as the ultimate source for information. These observations provide the data and other information which usually are disseminated to users who require this information. Information that is most commonly required by users and which is usually provided ultimately by the disseminator is "hard" data or recorded observations. Although direct personal exchange between individuals is usually the best means of communciation, constraints of time, funds and geography limit the frequency of these exchanges. Thus, accessibility to and dissemination of literature contained in or derived from scientific periodicals, monographs, proceedings and other sources and other records, such as file cards or electronic tapes, are the primary modes of communication between scientists. Hence, it is no wonder that the exceptionally rapid growth of scientific and technical information has caused scientists, administrators, scientific organizations and whole countries and governments and the United Nations to become more conscious of the acute need for such communication in the future growth and development of developing countries.

In 1971, an intergovernmental conference was called by the United Nations Educational, Scientific, and Cultural Organization (UNESCO) to review this problem of communication and lack of its awareness among scientists (Caponio and Moran 1975). The participants concluded that the problem might be solved through international

cooperation, and the conference endorsed the principles of and guidelines for such cooperation in the form of UNISIST, a World Science Information System.

International cooperation in the collection and dissemination of information related to agriculture and allied subject areas is, on the whole, unsatisfactory in spite of good progress in international cooperation in certain other fields of science (Caponio and Moran 1975; East 1975). Yet, most countries and organizations recognize that only a sustained and coordinated effort at the international level can ensure the proper collection, processing and dissemination of knowledge pertinent to global agriculture. The awareness of needed improvements in international cooperation in this area has stimulated several long-established agricultural institutions to focus on the idea of establishing an international information system or series of sub-systems for the agricultural sciences.

Information Systems Defined

Information as used here refers to the communication of data, usually by means of a document available in the form of a publication or record (Arnett 1970). Information systems, then, include the bases in which the data are stored, whether these bases be electronic tapes, published bibliographies, books, reviews, etc., or unpublished files of data, and the navigational equipment for locating the data or references to them. Information systems have a dual purpose (Lynch 1974). First, in keeping with their traditional role for bibliographic control, they are used to compile the data bases and to make them available in printed form for direct manual consultation or direct readable form in the case of microfilm storage. Secondly, through information-dissemination centers, which may or may not be identical with the data-base producer, they are used to disseminate the information more directly and selectively to users.

What is Meant by Alternative Methods of Pest Control?

This paper concentrates on information systems related to ecologically oriented control of crop pests, especially by non-pesticidal methods. Alternative methods of control include biological control, host plant resistance and other cultural practices such as habitat management, use of pheromone traps and pheromone manipulation strategies and any other suppression tactic other than conventional insecticides used by itself or integrated with other tactics to effect population control of insects, plant pathogens, weeds, nematodes and other invertebrate or vertebrate pests. Although a larger portion of this document is devoted to information systems pertaining to insects than to other pests, the general problems, approaches and concepts presented appear to be universally the same for all information systems, regardless of the specific pest involved.

This document, which addresses the problems and progress of information systems as related to alternative methods of pest control

and discusses some of the major problems and needs confronting pest control specialists in developing countries, does little more than to introduce a highly complex and dynamic subject. Information science, like the science of pest management, varies greatly in its subject matter, methodology and concepts among information specialists. And the pest management specilists' needs and concepts of information systems are highly varied too. Hence, it is neither our intention nor our mission to analyze and provide solutions for all problems related to information activities in pest management. We simply have limited our effort to (1) the identification of major problems commonly confronting pest management specialists involved in literature searches, and these problems will be confronted also in the more restricted area of alternative methods of pest management; (2) the review of the application, potential and limitations of major literature search systems and services, especially those computer-based systems and services, of relevance to developing pest management; and (3) a discussion of the needs for improved systems and services which allow more rapid or better collation, diffusion and retrieval of information in an international communication network focusing specifically on alternative methods of pest control.

Objectives of this Document

1. Review the information systems commonly used by pest management specialists and their role in meeting the needs of individuals as well as institutions engaged in crop protection.

2. Review some of the problems most common to collection, storage and retrieval of information and discuss current progress to alleviate these problems.

3. Examine some current computer-based information systems related to alternative methods of pest control to determine:

   a. Their data bases.

   b. Their current availability to crop protection specialists.

   c. Comparison in accuracy of retrieval, geographical application and other pertinent features of commonly-used bases.

4. Develop recommendations relevant to needed changes and additional required inputs into items 1, 2, and 3 as required to meet the most pressing, specific information needs of pest management specialists working in developing countries.

The document is primarily limited to a discussion of problems and needs in information handling which confront pest management specialists of agricultural crops. However, these basic problems and needs also confront pest management specialists who work with pests affecting man and animals, and the needs of the latter are no less pressing or any less important.

PROBLEMS OF ACCESS TO PEST MANAGEMENT LITERATURE

The Information Explosion

In spite of lack of agreement among various experts who have compiled data on the magnitude of the world's scientific literature, all of the estimated projections are startling! The total number of scientific journals for the whole of science and technology is thought to be about 26,000. Approximately half or 13,000 of these are related in one way or another to the life sciences. These figures account only for the scientific journals (i.e., serials) of the global library. They omit all books, published and unpublished reports, monographic works, newsletters, scientific society "fliers," and many thousands of other documents. Although Caponio and Moran (1975) estimated that 200,000 new documents related to the whole area of agriculture are currently produced each year, it is doubtful that the actual growth rate can be accurately predicted. As Foote (1972) pointed out, few of the publications and documents having only parochial interest ever find their way into the mainstream of information flow. Nevertheless, in spite of the inaccuracies of available estimates, only the most unaware scientist can fail to appreciate the explosive increase of scientific information in the past ten years. More important is what this explosi will likely produce in the next ten years!

Common Information Handling Practices Concerning Problems of Crop Protection Specialists

Examination of the educational background typical of crop protection specialists might be the single best clue to why information searching presents the difficult task it does to these persons. Most of these specialists come from a highly specialized background in the biological and physical sciences, with only minimal exposure to the typical university's liberal educational curriculum. Some curricula in biology and agriculture require an introductory course in library science or scientific literature. However, most students training as crop protection specialists rarely get more than minimal formal exposure to library science.

Even the rare pest specialist properly trained in library science has to cope with the problems universally common to all information searches. Proper information search in a library demands a great deal of time -- much more than is commonly compatible with the job demands of most pest specialists. Inaccessibility to libraries, and high costs of maintaining personal and sectional unit libraries are other factors prohibiting satisfaction of proper information needs of these specialists. These problems are especially crucial for specialists in underdeveloped countries lacking modern library facilities or budgets with which to create personal or specialty libraries.

Information - Use Patterns

Although the amount of written information on science and technology is astronomic for any one year and the total universe of information is incalculably larger, the amount of this information important to any one crop protection specialist obviously is relatively small. The needs often vary considerably, of course, between any two scientists of the same discipline and usually vary greatly between scientists of different disciplines although the recent trend toward interdisciplinary research has created a common need among the various disciplines engaged in crop protection. Thus, it is difficult to identify the primary or most frequently used sources of information having the greatest demand, and it is virtually impossible to identify all of those sources demanded. Foote (1972) and Reddin and Feinberg (1973) reported on studies of their own and previous studies on the use patterns and information sources of biologists and allied disciplines. The latter authors showed that about one-third of those publications which were categorized as serials (i.e., publications issued in successive parts at regular or irregular intervals) contributed 85% of the total research reports of interest to biologists. Somewhat similar trends of literature use were reported by Diamond (1970) and Kennedy and Parkins (1969) for entomologists and mycologists, respectively.

Perhaps seemingly irrelevant, the information-use patterns of scientists is actually very important in any kind of assessment of the present and future needs for information systems related to alternative methods of pest control. Unless the use patterns of users of specific kinds of information are determined, appropriate information systems cannot be tailored to meet these specific needs. This is an especially significant obstacle confronting the manufacturers of machine-readable data bases, as is discussed in a later section of this document's text and in the attached Appendixes A and B.

While the crop protection specialist's "core" or principal source of literature may be relatively small, the chore of properly searching this literature presents a perplexing problem. More perplexing yet is the problem of searching the "non-core" literature, especially the obscure documents, which often are as valuable to a crop protection specialist as is the core literature. Then there is perhaps the most difficult problem of all: searching the important current unpublished information such as project outlines, reports and other unpublished material. When extrapolated across the international scene, the problem of searching and gaining access to information related to the crop protection specialist's needs becomes extraordinarily large and complex.

Special Problems Confronting Developing Countries

Although most crop protection specialists of the developed world are confronted with the basic problems of lack of familiarity with the library facilities and the limited amount of time they can

devote to information searching, their problems are usually very small when compared to the information problems confronting specialists of the underdeveloped world who rarely have access to modern library facilities. Crop protection specialists of the developing countries often are required to work in remote areas isolated many miles from any library facilities at all, and inadequate modes of communication and transportation to these facilities further hinder their access to information sources. A further hindering factor confronting these specialists is their need for information encompassing more than just one field of pest control. Many of these specialists are required to assume a "hybrid" role dealing with problems of insect control, plant disease control, weed control and control of other crop pests. In other words, the crop protection specialist of a developing country often has to deal with less specialized problems and, thus, requires literature and other written information covering a broader field of pest control. To further complicate matters, this specialist often has to depend on information written in a foreign language and, thus, requires translation which is difficult to obtain.

Below is a list of problems that, although sometimes confronting even those crop protection specialists housed near modern library facilities of the developed world, are especially crucial problems which prevent effective searching of literature and other information in developing countries.

1. Inaccessibility to institutional library facilities and other information documentaries.

2. Budgetary constraints which prevent the creation of specialty libraries and the installation of remote facilities such as computer terminals which connect to data bases available at library facilities or information centers.

3. Inaccessibility to directories, indexes and other guides to the primary and secondary sources of information. (The Entomological Society of America has recently published several references, described in Appendix C of this document, which would appear to be especially helpful in lessening this problem.)

4. Inadequate modes of communication with crop protection specialists in charge of pest control programs in developed countries. (A centralized referral center, to which these specialists could direct inquiries and requests for information needs, seems to be a logical way to deal with this problem.)

5. Lack of time to travel to remote library facilities and budgetary constraints on travel to do so.

6. Unawareness of the services which provide translations of written information from one language to another.

7. The general need for information pertaining to a broad field of pest control rather than one specialized field per se. (Recently, representatives of the Entomological Society of America conferred with representatives of fraternal American societies in plant pathology, weed science, and nematology to discuss the formation of a multidisciplinary pest control consortium. Such a consortium appears to offer a possible vehicle to more effectively deal with this problem.)

The most effective way to deal with the very serious problems confronting the information requirements of crop protection specialists of developing countries will be through the concerted, unselfish efforts of developed countries who become committed to the cause of effecting better methods of disseminating useful crop protection information to specialists of these developing countries. Without this help it is doubtful that information on modern pest control technology of the developed world will reach the developing world for years to come. Thus, unless a major effort is undertaken to coordinate and consolidate the whole spectrum of activities related to information gathering and dissemination, the developing program of pest management will stalemate from unnecessary duplication and cost and, hence, lag in meeting the desired objective. It thus behooves all appropriate scientists and administrators involved in cooperative international pest control to become conscious of the importance of information activities in developing pest management and their consequential effect on the social and economic development of the countries of the developing world.

ORGANIZED EFFORTS TO IMPROVE INFORMATION RETRIEVAL AND EXCHANGE

In the wake of the need for making information more available to the scientist, several major organized efforts have been undertaken in the past 10-12 years at both national and international levels. According to Foote (1972), the father of all broadly-based studies on information handling in the sciences was the report of the Weinberg Panel of the President's Science Advisory Committee (U.S.A.) (Weinberg 1963). The recommendations of this report formed the impetus for concerted action to improve information handling in the sciences. A subsequent report (SATCOM 1969) provided recommendations of the Committee on Scientific and Technical Communication established by the U.S. National Academy of Sciences and Engineering to study information activities in the sciences and technical communities.

The COBSI report (COBSI 1970) of the Council on Biological Science Information has significantly influenced recent actions to be taken in information handling of biological literature such as the study of a system concept for information handling in entomology, completed in 1971 by a committee of the Entomological Society of America (Foote and Hammack 1969; Graham and Foote 1971). This is only one of the many recent organized efforts to effect better

information exchanges among scientists. Most of the major scientific societies in the United States and many public and private institutions as well have committees or task forces assigned to the problems of information handling for their respective disciplines. There are several additional committees addressing the broader interdisciplinary problems. Nevertheless, the task is a monumental one that has not yet been solved for any one discipline, while the interdisciplinary problem is even more formidable.

In the United States alone, in 1968, there were 68 national biological societies, 17 of which were agricultural societies (Frye et al. 1968). This does not include the hundreds of state, regional and interregional professional societies and project organizations, many of which produce conference proceedings and other information related to agriculture. The professional society is by far the principal publisher of the scientific journal. As the scientific journal is the principal source of information, the biological information problem is correspondingly associated with the facility with which the information contained in these journals can be made available to the users. It should be obvious that the societies which produce these journals must adopt a coordinated program and work together to resolve the problems in retrieving the information for their dissemination to users.

On the international front there exists several major organized efforts on improved information handling and coordination among countries. UNISIST (UNESCO/ICSU 1971) was a study report on the feasibility of a world science information system. An intergovernmental conference called in 1971 by the United Nations Educational, Scientific, and Cultural Organization (UNESCO) reviewed the lack of awareness on the part of researchers and scientists of recent developments in all disciplines and concluded that the problem might be solved through international cooperation (Caponio and Moran 1975). UNISIST provided the principles and guidelines for such cooperation adopted by the UNESCO conference. From the basic provisions set forth by UNISIST emerged a series of studies on international systems which led to the establishment of AGRIS, FAO's International Information System for the Agricultural Sciences and Technology (East and Martinelli 1975, and Caponio and Moran 1975). AGRIS probably represents the first major international effort to coordinate and consolidate a spectrum of information activities related to agriculture[1]. Several national and regional agricultural information system concerns are participating in the development of AGRIS'

[1] It should be mentioned that INIS (International Nuclear Information System), a creation of the International Atomic Energy Commission and its member states, and MEDLARS (Medical Literature Analysis and Retrieval System), coordinated by the U.S. National Library of Medicine, Bethesda, Maryland, are both computer-based documentation services whose input is prepared on an internationally decentralized basis which antedate AGRIS by several years (East 1975, East and Martinelli 1975).

centralized computer-based networks (Caponio and Moran 1975). Each network is conceived as a central computer data bank linked with a number of large documentation centers also using computers. Each of these centers is to be linked to a number of smaller local information centers that may or may not use computers. Clients will be able to obtain services from any of these centers depending upon geographic location, communication facilities, and language employed. Issued monthly, AGRINDEX, the first output of AGRIS, is a bibliography of the latest agricultural literature, based on inputs from contributing centers worldwide and data collection and production at AGRIS' coordinating Centre of FAO.

Two concurrently developing international systems, AGLINET (Agricultural Libraries Information Network) and CARIS (Current Agricultural Research Information System), are considered instrumental to the development of AGRIS (Caponio and Moran 1975). AGLINET was established within the framework of the International Association of Agricultural Librarians and Documentalists for the purpose of organizing cooperation among agricultural libraries. CARIS is a pilot project covering information handling of nearly 250 agricultural research institutions and stations and over 1500 agricultural research projects in West Africa.

Greater detail was presented here for AGRIS than will be presented for other international concerns engaged in multinational information coordination, because, in theory, AGRIS is presently the only broad-based international agricultural information system that possesses many features which are in congruence with the overall information-handling demands of all crop protection specialists and their organizations. Though the system is in its infancy (first issue of AGRINDEX was in January 1975) and its potential to the user and its impact on other information systems have yet to be determined, it has widespread appeal to agricultural concerns. Several systems designed to increase the availability of information to agriculturalists (e.g., Intredis II Digests which pertains to forest pathology and entomology; and Abstracts on Tropical Agriculture) have complied with format compatibility-requirements established by AGRIS. The reader is referred to East and Martinelli (1975) and Caponio and Moran (1975) and the articles cited in their publications for more information on the evolution, present status and future plans of AGRIS. Appendix A presents a discussion of some of the specific problems which AGRIS must resolve if it is to become fully operational.

Other international developments in increased availability of information in whole or in part relating to alternative methods of pest control include the establishment of IRS (International Referral System for Sources of Environmental Information), a pilot project of UNEP to encourage the worldwide interchange of environmental information (UNEP/EARTHWATCH 1975). GEMS (Global Environmental Monitoring System) is a coordinated effort on the part of Member States, United Nations agencies and UNEP to ensure that data

on environmental variables are collected in a manner necessary for assessing environmental management requirements at the national and international levels (UNEP/GC 1975). ARDA (AID Research and Development Abstracts), an abstract publication of the Agency for International Development, is aimed at assisting dissemination of information related to national development in many countries and contains much information on agriculture.

Space constraints prevent us from discussing the numerous other cooperative efforts to establish coordinated literature-information networks that cut across both national and disciplinary boundaries in agriculture and related fields.

The Organization's Pitfall

A common endorsement among information science experts, who have reported in the Annual Review of Information Science and its fraternal publications, seems to be an inter-organizational, international-collaborative approach for appropriate communication of technical information. However, most of these on-going collaborative efforts are currently in the "organizational chart phase" or are at least several years from fruition. Yerke (1971) described the efforts of most of these organizational information channels as ". . .not very successful." This seems to describe appropriately the organizational information efforts of the Entomological Society of America (ESA), the North American parent society to which more than 7,000 entomologists belong. Through cooperative grants from the National Science Foundation, ESA initiated an in-depth study of needs for improved storage and retrieval of entomological literature and the feasibility of a centralized system concept for information handling (Foote and Hammack 1969; Graham and Foote 1971). After several years of interdisciplinary efforts by entomologists, information scientists and computer specialists, the ESA concluded that the proposed information system center was too expensive, would unnecessarily compete with existing information retrieval systems and would become a financial burden to ESA members. It was decided that ESA would instead cooperate closely with existing information retrieval systems to improve their services to the Society's members. (Appendix C of this document reports on the developments of some of the actions taken by ESA in the course of working toward the proposed center. Although the Center per se was not carried to fruition, several useful side benefits stemmed from the ESA's work in information handling and are discussed in this appendix.)

The destiny of the many proposed or on-going organizational information systems may or may not follow that of ESA's initially proposed system. Hopefully, there will be solutions to the problems of financing and the technical complexities inherent to such systems so that the better ones (i.e., those satisfying user's needs) will be developed and survive. Unfortunately, some of the contrivances of information science may be compared to many other contrivances which have emerged from efforts of "power-hungry" scientists. Some appear to have been conceived from a political or promotional context

rather than real need. The scientific community should employ much caution and prudence in adopting any emerging information system. In a time of dramatic information explosion, scientists cannot support or accept a system where real need is not shown. Crop protection specialists should buy critically for they need the best information system possible if they are to develop a sound pest control technology for developing countries of the world.

MACHINE-READABLE DATA BASES AND SERVICES

The recent upsurge in the complex of information dissemination centers, retrieval service suppliers, data base producers and data communication services has made the computer information systems highly visible. There is every reason to believe that these systems will become even more visible as new information brokerages emerge to expand computerized services to users and as the information dissemination centers gain increased access to storage data. Computer-based information retrieval systems have been in use for years and appear to be having especially wide appeal in the physical and biological sciences.

Space does not permit a detailed review of the concepts, methodology and applications of computer search services related to crop protection. Listed below are a few of the more recent important publications on computer literature searching. They are excellent sources of information on the whole spectrum of computer searching, and their contained bibliographic citations are a good source to information on computer-based systems of value in crop protection and allied fields.

1. Brandhorst and Eckert (1972) - on the history and development of computer information retrieval systems.

2. Gechman (1972) - on machine-readable bibliographic data bases.

3. Houseman (1973) - on the use of data bases for selective dissemination of information.

4. Parkins and Kennedy (1971) - on secondary information services.

5. Summit and Firschein (1974) - on document retrieval systems and techniques.

6. Williams (1974) - on the use of machine-readable data bases.

7. Lynch (1974) - on the specialized application of computer-based information services in science and technology.

8. Lancaster and Fayen (1974) - a major text dealing with on-line computer searching.

A recent bibliography by Foote and Zidar (1975) contains many references to information on computer information retrieval activities in biology and related fields, especially activities in the U.S.A., and the reference above by Summit and Firschein (1974) is a good source relative to other countries.

The material given here on the descriptions and applications of computer information retrieval systems was abstracted from the sources listed above, from commercial brochures and advertising literature or from unpublished information supplied by experts in information science. We borrowed heavily from these sources, and some of the material is given nearly verbatim.

A machine-readable data base will be considered here as any organized set of computer records containing bibliographic or document-related data. These records can be searched by the user to obtain a computer-printed list of bibliographic citations and/or citations and abstracts or other information from records of published material on a given subject or records of on-going research projects, for example.

The terms document retrieval and information searching will be used interchangeably to describe a system capable of retrieving information relating to documents. The retrieved product is usually a representation or surrogate (e.g., title or abstract) of a document required to answer submitted questions.

The process of document retrieval or information searching is called selective dissemination of information (SDI) or current awareness service (CAS) if only records of new publications are searched or if records of on-going or current research projects are searched. Some SDI or CAS services provide information on the most recent articles appearing in scientific journals or other published sources while other such services provide information such as the names of project investigators, objectives, etc., of research projects at universities, federal laboratories or other research institutions.

Retrospective search services, on the other hand, provide information on back volumes of data, i.e., journal articles, books, etc., stored in computer records. The search naturally can be made back only as far as the first volume of information on record.

Retrospective searches are of special interest to crop specialists engaged in areas of alternative pest control in which significant contributions were made many years ago. Unfortunately, few of the available data bases of great interest to these specialists permit retrospective searches further back than 3 to 5 years. Though customized searches of older literature are provided by certain private brokerages, costs for this service are often prohibitive, because to prepare a data base for this service, all back issues of pertinent publications have to be searched manually and appropriate data from them have to be converted to machine-readable form. In some situations, however, costs charged for this service may be justified, especially if the costs for a retrospective search could be shared among several users.

There are two types of information retrieval systems in regard to their interaction with the user: (1) on-line or direct access and (2) off-line or serial search.

On-line or direct-access search systems are those available through a terminal connected directly to computer data bases. The user manipulates the terminal's teletype keyboard or other transmitting apparatus to establish on-line telecommunication with a particular data base. This computer base feeds out printed or other readable information. Often only a few seconds are required to process an inquiry. Lapse between the request and feedback of a large number of bibliographic citations or citations and abstracts may entail only a few minutes. Readable material is fed back either through a cathode ray terminal or other visual-display screen unit(s) or as a hard copy print-out, depending on the terminal employed. Some terminals are equipped with both the visual-display and hard copy features. On-line systems allow the user to interact with data bases to obtain sample outputs, to determine the number of relevant documents stored in the base and to process other queries.

Off-line or serial-search systems do not give the user direct access to a data base via remote terminal: hence, interactive communication with the data base is not possible. The data base of these search systems is organized as a serial file on magnetic tape. Serial searches entail the examination of each record in a file.

In theory, a machine-readable data base represents an absolute population of machine-readable records containing bibliographic or document-related data from the universe in which the records were taken. In other words, a data base formed from Chemical Abstracts published in 1972-74 would contain records of every publication on "boll weevil pheromone" that the journal cited during that period. In reality, however, it is doubtful that most data bases truly represent absolute coverage. Human error and machine error occurring during the conversion of data to a machine-readable form preclude absolute accuracy.

Our point is that, though some data bases available for information-retrieval services probably are highly accurate, any base may fail to contain some bibliographic or other records of value. And it should be remembered that retrieval of all information desired from even the most accurate data base requires the most sensitive query system. The data-base search technique involves the computer's matching a set of key-words and other input descriptors, decided upon by the user, with the corresponding records in the data base. Each data base may have its own unique query system that only the most experienced user can comprehend.

Other pertinent points that will be dicussed later in greater detail are that any one base is wholly or partially selective, i.e., it is formed from only one journal or a composite of related

information sources. And there is a certain amount of overlap in any two or more data bases from a related field.

The following summary will emphasize features, both good and bad, of computer information retrieval that an individual or an institution of a crop protection specialty may want to consider before substituting computer services for traditional information searches.

1. Demand for services of computer information retrieval systems has come about for several reasons: (a) the services facilitate more rapid speed of searching (several volumes or years at once) and offer the convenience of custom-printed, personalized bibliographic printouts; (b) they allow access to data bases for some information which cannot be obtained from published hard copy and can only be searched by machine; (c) they have the ability to combine in special ways or limit in special ways searches which are exceedingly difficult if not impossible to do manually (many data bases have some features which can only be exploited by machine searches); and (d) because of brokerage advertisement.

2. Retrospective literature searches which scan literature more than five years old are not currently possible for most fields of interest to crop protection specialists. Costs for customized retrospective services are high.

3. Current awareness searches of new literature and unpublished information provide an extremely valuable adjunct to other current awareness techniques. They often provide the only means of getting to information pertaining to on-going research projects.

4. Costs for computer searches vary with the services provided and are subject to change. A discussion of costs of the various computer services available to crop protection specialists is beyond the scope of this document. Such information is obtainable through commercial brokerages and public libraries.

5. No one computer information retrieval system has available any combined data base that represents the whole universe of a given set of information.

6. Some data bases are simpler to use than others, but all require careful scrutiny and experience if their maximum capacity is to be utilized.

7. The future of computer information retrieval systems looks bright but, like most systems, they present some technical, legal, political and human problems. Let us hope that these problems will not block the progress that is currently underway to produce high quality, affordable computer systems that the crop protection specialist can effectively utilize.

Data Bases Related to Pest Control: How many?

Probably one of the most complete lists available on the current data bases of the world is in Williams' (1974) article, "Use of machine-readable data bases." These bases cover a broad category of subjects in the sciences and non-science fields as well. Acronyms and fully spelled-out names are listed for approximately 120 data bases and the organizations responsible for generating them; however, the list is by no means complete. Williams obviously overlooked several data bases, and new bases have appeared since her 1974 article. We have found information for about 20 data bases not listed in her publication and suspect that there are additional ones.

Data bases of great interest to one specialty of crop protection may be limited interest to another. A plant pathologist interested in the biochemical aspects of plant/pathogen interactions might find CA Condensates (data bases formed from records of Chemical Abstracts) highly useful, whereas a field plant pathologist interested in the effects of crop rotation on the dynamics of pathogen populations might find CA Condensates of no substantial value. As earlier noted, all available data bases are selective in the sense that they are formed to meet the needs of a specific, related group of users.

However, probably no data base is so selective as to include only information of interest to a single discipline or a specialty within a discipline. Also, two or more computer data bases often expectedly overlap in the sources (bibliographic abstracts, etc.) from which they are formed. Hence, the problems of too much selectivity, not enough selectivity, and overlap often boggle an inexperienced user who experiments with one data base or a group of bases. This user may find that a composite of data bases must be properly searched to obtain even a reasonable representation of citations on a given subject. This individual, however, has contributed to the problems of selectivity and overlap. Because, as discussed elsewhere herein, data bases cannot be properly fabricated to the user's need unless the user's demands are fully understood. Probably the least known and least understood component of selective dissemination of information systems is the user (Williams 1974).

Space does not permit a discussion herein of all of those machine-readable data bases and computer search services which are partially or wholly related to crop protection and of specific value to crop protection specialists of underdeveloped countries. However, Appendixes A and B of this document are devoted entirely to a discussion of data bases which either have been used frequently by crop protection specialists or are of potential value to these specialists. Appendix A briefly describes the subject matter covered by these data bases and presents additional information which might be of interest to crop protection specialists. Appendix B reports

on an experimental evaluation that we conducted to determine the specific value of Biosis Previews, CA Condensates and CAIN in retrieving information on a selected topic. These three computer data bases are probably the best known and are the most widely used of any of the data bases available to crop protection specialists.

Appendix A

Some Data Bases of Particular Value to Crop Protection Specialists

Table 1A lists 15 data bases (acronyms and full spelling) which cover subject matter having restricted or widespread use to crop protection specialists. We may have inadvertently omitted other pertinent data bases and perhaps have included some which have no value whatsoever to certain specialists. The list does include, however, some of the data bases most frequently sought by entomologists, plant pathologists, weed control specialists, nematologists and other crop protection specialists in the U.S.A. Most of the bases shown in Table 1A have world coverage and are made available to libraries, information centers or information brokerages in other countries. References listed in an article by Summit and Firschein (1974) are good sources for information regarding the availability of these bases and others in countries other than the U.S.A.

When possible, we have listed under the column "Entry-Year Coverage From" the dates in which records were first entered into the files by the data base suppliers; however, the actual publication-year coverage may be broader than shown.

Some of the data bases (e.g., CAIN) provide only bibliographic citations, other (e.g., NTIS) provide both citations and abstracts, while others (e.g., CRIS) provide objectives and project summaries, names of project investigators, etc., for current research in agricultural universities and other institutions. The output (i.e., retrieved information) from a computer-based search may be computer-printed paper sheets, microfiche (a fileable microfilm sheet with many citations), microfilm (photographic record of greatly reduced size) or visual displays on cathode tube screens. The form of the output depends on the computer terminal, which differs between service institutions. Most modern libraries, many research facilities and private firms have terminals on display for demonstration.

AGRIS

The future of AGRIS is of great interest to agriculturalists, worldwide, because it represents the first big international effort to consolidate such a broad spectrum of information activities in the agricultural sciences. This system chances to greatly influence the development of information activities in both developed and under-developed countries. However, participation in the implementation of this system and production of the bibliographic index, AGRINDEX, will require a large investment of resources in different tape formats, methods of literature coverage and altered internal procedures. And this index will offer greatest utility to pest management specialists only if the subject index is adequate; also, AGRIS files and AGRINDEX tapes must be made much more available to

the user (L. C. Farrell, University of California, personal communication). The success of AGRIS, therefore, will depend upon the economic future of participating countries, willingness of these countries to cooperate with one another, various economic and political factors, compatibility with other information systems in agriculture and quality of service that it eventually provides. Hence, the eventual role of AGRIS is to play in improved coordination and dissemination of global agricultural information cannot presently be predicted with a great deal of confidence.

Although AGRIS appears to be successfully developing according to its time schedule, there are a number of serious problems which it has yet to resolve and several others which information dissemination centers will have to face if AGRIS becomes fully operational. Currently, the U.S.A. contribution to AGRIS consists of 500 citations per month drawn from selected journals of this country. Obviously, this represents but a small fraction of the U.S.A. journal literature and completely ignores the other relevant types of publications such as government publications, agricultural experiment station reports, etc.

Furthermore, there is an economic problem for information centers introduced by the existence of multiple systems and data bases. Exploratory work of the Data Systems Application Division, USDA-ARS, for example, indicates that CAB and BIOSIS Previews (discussed below) have far greater retrieval productivity than either AGRIS or CAIN (also discussed below), so the question arises as to what does AGRIS (or CAIN) offer that the first two bases do not. As more bases become available, duplication will become even more critical. Although cooperative effort among the data base producers have been made, there is still a long way to go before the problem will be solved. Meanwhile, dissemination centers will have to deal with increased costs brought about by the duplication as well as user complaints about duplicate citations (H. Burton, USDA-ARS, personal communication).

BIOSIS Previews, CA Condensates, and CAIN

These are probably the best known and the most widely used data bases presently available to crop protection specialists. The BIOSIS Previews data base is formed of citations published in Bioresearch Index and citations to the abstracts published in Biological Abstracts. Both of these references cover a wide field of literature pertaining to the life sciences. They draw from over 8.000 publications with a scope of more than 100 countries. These publications include most of the major scientific periodical journals considered to be "core" literature of entomologists, plant pathologists, nematologists, weed control specialists and other crop protection specialists. In addition, many state and federal experiment station publications, books, dissertations, etc., are included. The data base allows retrospective literature searches of all citations included since 1969.

BIS, a recent service of the Institute of Biology and the British Library, England, will complement the U.K.'s existing information services in agriculture, chemistry and medicine. This service will cover the broad field of biology including the BIOSIS Previews data base.

CA Condensates is an index to world literature covering chemistry, chemical engineering and chemistry aspects of the life sciences. Items covered are books, conference proceedings, scientific journal articles, dissertations, patents and research reports as drawn from the full records of the corresponding issue of Chemical Abstracts. This data base is of special interest to crop protection specialists interested in the chemical aspects of pest control, plants, natural enemies and pest-environment often sought by laboratory and field researchers. In general, however, CA Condensates has less value to crop protection specialists than does BIOSIS Previews of CAIN.

CAIN spans only from 1970 to the present, with monthly updates, and averages over 120,000 additional citations annually. This is the U.S. National Agricultural Library's Cataloging and Indexing data base. The CAIN file provides coverage of worldwide journal and monographic literature on agriculture and related subjects. CAIN tapes are made available to countries outside of the U.S. and are available in many U.S. agricultural libraries, information centers and through private brokerages. However, since the CAIN tape, as compiled by the National Agricultural Library (U.S.A.), does not now include even all USDA publications not to mention other agriculturally related publications by other federal, state and private agencies, there is a serious gap which must be closed before any system can expect to be fully effective (H. Burton, USDA-ARS, personal communication).

CRIS and SSIE

CRIS and SSIE are current awareness data bases which allow access to on-going research project information. CRIS service is available only to contributing agencies and provides annual project reports and other project information such as the names of project co-workers and recent project publications of U.S.-based state and federal agricultural research agencies. SSIE has wider availability than CRIS and it covers information on research projects underway at private institutions which CRIS does not cover. SSIE is available to contributors as well as other interested parties.

CAB Series

These journals published by the Commonwealth Agricultural Bureau are perhaps among the most popular abstracting series used by crop protection specialists:

Review of Applied Entomology -- Series A (agricultural entomology)

Review of Plant Pathology (formerly Review of Applied Mycology)

Helminthological Abstracts -- Series B, Plant Nematology
Horticultural Abstracts

Herbage Abstracts

Field Crop Abstracts

Plant Breeding Abstracts

Weed Abstracts.

Scrivenor (1971) reviews CAB's abstracting and indexing services.

Data bases have been formed from these and other CAB journals but currently are available in the U.S. only through the Agricultural Research Service-USDA. These bases should be of particular interest to crop specialists working with crop protection programs throughout the world. The CAB abstracting journals from which the data bases are formed are an excellent source of information to the world literature dealing with alternative methods of pest control.

The other data bases of Table 1A will not be discussed here; however, sufficient information is included in the Table as to their general intent and their time-span of coverage. Of particular interest to crop protection specialists, confronted with problems of translation, is TRANSDEX, which covers articles translated from the Communist and underdeveloped countries.

TABLE 1A. Examples of, and information on data bases containing subject matter related to crop protection and allied fields. Condensed from publications cited in text, brokerage-supplied material and unpublished data.

Acronym	Data Base and/or Supplier	Entry-Year Coverage From	output Citation and Abstracts (A) or Citation only (C)	Miscellaneous Information
AGRIS	International Information System for Agricultural Sciences and Technology (FAO, Rome)	?	C	Refer text for discussion.
BIOSIS Previews	BioSciences Information Service of Biological Abstracts	1969	C[1/]	One of the best bases for information related to alternative methods of pest control. Worldwide coverage.
BIS	Biological Information Service. Institute of Biology and the British Library (England)	1975	?	Biological Information including BIOSIS data base.
CAB Series	Commonwealth Agricultural Bureaux			Refer to text for discussion
CA Condensates	Chemical Abstract Condensates	Jan 1972		Primarily oriented toward chemistry but is a good source of information on other topics of interest to crop specialists. Worldwide coverage.

TABLE 1A. ntinued

CAIN	Cataloging and indexing data produced by the National Agricultural Library (USA)	Jan 1972	C	Data base is formed from a large percentage of documents received by National Agricultural Library. Worldwide coverage.
CRIS	Current Research Information System. Information regarding current research activities in USA agricultural agencies	Current research projects	Project information	Information from USA-based research projects in agricultural research federal and state facilities. Available only to contributing agencies.
INSPEC Science Abstracts	Science Abstracts. From the Institute of Electrical Engineers (England)	1969	A	Good source for information on computer programming and application. Worldwide, English language only.
INTREDIS-II	Supplement to the International Tree Disease Register (INTREDIS) Information on forest pathology and forest entomology.	?	A	Exploratory system designed to supplement the Forest Technical Information service of the U.S. Forest Service. Compatible with FAO'S-AGRIS FORESTRY.
NTIS	Government-sponsored R and D reports from National Technical Service (USA) Information	1964	A	Technical reports of USA government (federal) research.

TABLE 1A. Continued

PANDEX	Current Index to Scientific Technical Literature	Jan 1970	C	Covers world's major scientific and technical journals.
POLLUTION	Pollution Abstracts	Jan 1970	C	Covers the entire spectrum of pollution including pesticide pollution. Worldwide.
SCISEARCH	Institute for Scientific Information	Apr 1972	C	Covers many journals in the life sciences, including some in animal and plant sciences. Worldwide.
SSIE	Research in progress, from Smithsonian Science Information Exchange (USA)	1974	Project Information	Information on current research projects within USA. Private and governmental activities included.
TRANSDEX	Bibliographic Reference File to the Translation of the United States Joint Publications Research Service (JPRS)	?	A	Covers articles translated from the Communist and so-called undeveloped countries.

1/ Index numbers or reference numbers to the data bases' abstracts are also provided.

Appendix B

Experimental Evaluation of Data Bases Related to Crop Protection

Numerous papers have reported on the evaluation and comparison of specific bibliographic computer data bases for specific classes of users. These studies have employed a number of criteria to assess the performance of the data bases in terms of the user's needs. Williams (1974) reviewed some of these evaluative procedures. She pointed out that the results of one evaluative study are not necessarily transferable to other classes of users, e.g., an evaluation of CA Condensates with respect to its adequacy for an insect toxicologist may have no bearing on its utility to an insect ecologist. Also, the evaluative studies are influenced by both the data base and the search systems used.

This report covers evaluations we made with three data bases that have been commonly used by crop protection specialists. The evaluations were made to determine the data bases' specific value to a restricted class of users. Hence, the results are not necessarily transferable to different classes of users, but should serve, nevertheless, to demonstrate the kinds of information obtained from computer searches and some of the problems that might arise in any computer search.

Procedures

Comparison of BIOSIS Previews, CA Condensates and CAIN

An on-line search of world literature reporting on the greenbug, *Schizaphis graminum* (Rondani), an insect pest of cereal grains, was made with each of these data bases. Lockheed Dialog® Data Bases were accessed by a computer terminal located at the University of California Library, Berkeley, to conduct the searches which were retrospective to 1972, 1972 and 1970, respectively, for BIOSIS Previews, CA Condensates and CAIN.

Since all recorded bibliographic citations to articles dealing specifically with the greenbug were desired from each data base, descriptors were selected to match up with words commonly used in the articles' titles. The descriptors were greenbug(s), the insect's commonly used scientific name (*Schizaphis graminum*) and a synonym sometimes used (*Toxoptera graminum*), and a common parasite of this insect, *Lysiphlebus testaceipes*. This choice of selective descriptors narrowed the literature search to articles that reported only on the greenbug or the parasite.

Results

A total of 113, 26 and 144 citations were retrieved from the data bases BIOSIS Previews, CA Condensates and CAIN, respectively, and the total computer search time was approximately 18 minutes. Some of the citations retrieved from CAIN were dated as early as 1969, and some from BIOSIS Previews and CA Condensates were dated as early as 1971. However, to facilitate quantitative comparisons of the three data bases, only those citations dated 1972 or later were evaluated (Table 1B).

BIOSIS Previews provided the largest number of 1972-75 citations (92), followed by CAIN (77) and CA Condensates (20). Each data base provided citations dated as recent as April 1975, four months prior to the August 1975 searches. Citations from CAIN represented 24 journals or other publications, and citations from BIOSIS and CA Condensates represented 23 and 9, respectively, journals or other publications. The Journal of Economic Entomology, Environmental Entomology and Annals of the Entomological Society of America, in that order, were the publications appearing most frequently in both the BIOSIS Previews and CAIN citations (Table 2B). These three American journals are the primary journals that American entomologists publish in most frequently. Publications of the Texas Agricultural Experiment Station appeared more frequently than Environmental Entomology in the CA Condensates citations; however, the Journal of Economic Entomology and the Annals of the Entomological Society of America were the first and third, respectively, most common citations retrieved from that data base.

Each data base provided citations of articles from foreign publications. Languages represented for CA Condensates and CAIN citations were specified on the computer print out, but were not specified on the BIOSIS Previews print outs (Table 1B). There was considerable overlap in citations appearing in CA Condensates and BIOSIS Previews (Table 1B). Seventeen or 85% of the 20 citations provided by CA Condensates also were provided by BIOSIS Previews. About 50% of CA Condensates' citations were provided by CAIN. About 73% of CAIN's citations were provided by BIOSIS Previews. The net gain or number of unique citations for BIOSIS Previews, CA Condensates and CAIN was 30, 3 and 21, respectively.

Some users of CAIN have indicated that a given citation may appear two or three times on the print out of one search. This duplication apparently is due to the cataloging and indexing procedure employed at the National Agricultural Library where the data base is produced. This seems to be a problem restricted primarily to citations of monographs or books. Although frequent duplications would add to the expense of a literature search because of the extra citation cost involved, duplication was not a major problem in the present search with CAIN's data base. In fact, only one citation appeared twice, and none appeared three times.

Considering all criteria used in this evaluation, BIOSIS Previews scored more favorably than any data base since it did provide the greatest number of citations and the largest number of citations unique to any one data base. This might have been expected since BIOSIS Previews' data base represents publications containing broader entomological subject matter than CA Condensates' data base. And deeper indexing is normally used to prepare BIOSIS Previews' data base than is used to prepare CAIN's data base. CAIN's indexing is more frequently restricted to words in the titles; whereas BIOSIS Previews' indexing includes descriptors other than just the title words.

Nevertheless, no one of the data bases retrieved all citations of the total pool of citations retrieved on the greenbug. Therefore, a user should weigh the benefits of a more comprehensive search entailing more than one data base against the additional expense required for a multi-data base search. Costs for a two-base search may more than double the costs for a single-base search.

An interesting observation of this study was that the CAIN data base did not provide the citations of a recent manually-prepared bibliography on the greenbug (Walker et al. 1972) which was published in a common American entomological periodical, Bulletin of the Entomological Society of America. This seemed especially strange since both the insect's common and scientific names appeared in the bibliography's title and both corresponded to descriptors used in the CAIN search. Both BIOSIS Previews and CA Condensates provided the citation of this publication, further pointing to the advantages of searches from two or more data bases when seeking more comprehensive bibliographic citations.

Comparison of Citations Provided by CAIN with Citations of a Manually-Prepared Bibliography

The objective of this evaluation was to compare the bibliographic citations provided from the CAIN search described above with citations of a manually-prepared bibliography on greenbug (Walker et al. 1972). This bibliography was chosen as a standard for comparison since it did attempt to include all publications on greenbug appearing in English and did cover two years (1970 and 1971) also covered by CAIN. We have personal knowledge of the literature-search procedures employed in the manually-prepared bibliography. We believe that those procedures were typically of the procedures commonly employed by crop protection specialists who have attempted to assemble other complete bibliographies on a subject or a group of related subjects. These procedures consisted of searching primary publications as well as abstracting journals, bibliographic indexes and other secondary sources of literature. The search was continued until the bibliography was thought to be complete although, as Walker et al. (1972) admitted in their bibliography which was assembled after a period of several years' searching, it is virtually impossible to prepare a truly complete bibliography.

Results

The bibliography of Walker *et al*. (1972) contained 76 citations of articles reporting on greenbug during 1970 and 1971, whereas the CAIN search provided only 48 citations during this same period (Table 3B). Forty-three citations in the bibliography were not retrieved by CAIN, but 15 CAIN citations did not appear in the bibliography. Many of the citations appearing in the bibliography but not retrieved by CAIN were considered to be relevant. Likewise, CAIN provided citations which could be considered relevant but which did not appear in the bibliography. Thirty-three of the citations were common to the bibliography and CAIN.

CAIN's Retrieval of Publication Citations Known for One Author

The objective of this evaluation was to determine the accuracy of a CAIN data-base search in retrieving citations of publications pertaining to cotton insects which had been authored singly or co-authored by D. G. Bottrell whose publication record in this field was known for the search period, 1970-73. The descriptors were selected to correspond to the author's name, co-authors and major words appearing in titles of those publications known for the author.

The CAIN search produced citations to 10 or 77% of the 13 publications which the author was known to have produced by himself or to have produced jointly with other authors during the search period. Two of the articles not cited in the CAIN search probably could be categorized as irrelevant in the sense that they appeared in relatively obscure publications having limited distribution. However, the other article not cited in this search appeared in the publication, Proceedings of the Beltwide Cotton Research Conferences, which has a much wider distribution and greater appeal to many cotton entomologists in the U.S.A. and other countries.

Table 1B. Comparison of BIOSIS Previews, CA Condensates and CAIN outputs of bibliographic citations of publications on the greenbug, Schizaphis graminum (Rondani), appearing in 1972-75.

Output	BIOSIS Previews	CA Condensates	CAIN
No. citations	92	20	77
Most recent citation	Apr. 1975	Apr. 1975	Apr. 1975
No. journals or other publications represented[1/]	23	9	24
No. times same citation appeared, i.e., overlapped, in:			
BIOSIS, CA Condensates	17		
BIOSIS, CAIN	56		
CA Condensates, CAIN		11	
BIOSIS, CA Condensates, CAIN	11		
No. citations unique to one data base	30	3	21
No. times a given citation appeared twice in each data base (i.e., duplication)	0	0	1
Languages represented	English[2/]	Ukrainian (Slavic) Romanian English	Russian Romanian Spanish English

1/ Refer Table 2B for publication list.

2/ BIOSIS Previews represented languages in addition to English but did not specify the names of the languages on the print outs.

Table 2B. Journals and other publications represented in data bases searched for bibliographic citations on the greenbug, Schizaphis graminum (Rondani), 1972-75.

Publication[2/]	Frequency of appearance in[1/]: BIOSIS Previews	CA Condensates	CAIN
J. Econ. Entomol.	1	1	1
Environ. Entomol.	2	4	2
Ann. Entomol. Soc. Amer.	3	3	3
Crop Sci.	5	-	4
Tex. Agric. Exp. Stn. (Progr. Rep., Misc. Publ. and other Exp. Stn. publications)	4	2	5
Phytopath.	7	-	6
Bien. Conf. Grain Sorghum Utilization	-	-	7
Plant Dis. Rep.	7	-	7
So. Dak. St. Univ. Ext. Fs.	-	-	7
Khim Sel'sk Khoz	-	-	8
ARS-S U.S. Agric. Res. Serv. So. Reg.	-	-	8
Zashch. Rast. (Kiev.)	-	5	8
Qrt. Serv. Farm Ranch Home, Univ. Nebr. Coll. Agric.-Home-Ec.	-	-	8
Proc. Tall Timbers Conf. Ecol. Anim. Control Habitat Mng.	-	-	8

Table 2B. continued

Publication[2/]	Frequency of appearance in[1/]: BIOSIS Previews	CA Condensates	CAIN
Am. Inst. Cer. Pentru. Prot. Plant	-	-	8
Biull Vses Nauchno Issled Inst Zashch Rast	-	-	8
U.S. Govt. Printing Off.	-	-	8
Leaf. U.S. Dep. Agric.	-	-	8
An. Ser. C Amelior genet Fiziol Teh Agric Inst Cercet Pentru Cereal Plant Teh Fundulea	-	-	8
Colo. Agric. Exp. Sta. Progr. Rep.	-	-	8
Okla. Agric. Exp. Stn. Progr. Rep.	-	-	8
Bull. Entomol. Res.	8	-	8
Wash. Agr. Exp. Circ.	-	-	8
Entomol. Exp. Appl.	8	-	8
Fiziol Technol Agric	6	-	-
Folia Entomol Mex	6	-	-
J. Entomol. Soc. So. Afr.	6	-	-
Ann. Phytopath.	8	-	-
Pol Pismo Entomol	8	-	-
Annat Zool Bot	8	-	-
J. Entomol. Ser. Gen. Entomol.	8	-	-
Rev Chil Entomol	8	-	-

Table 2B. continued

Publication[2/]	Frequency of appearance in[1/]: BIOSIS Previews	CA Condensates	CAIN
Queensl. J. Agric. Anim. Sci.	8	5	-
Ser Poeyana Inst Zool Acad Cienc Cuba	8	-	-
Bull. Entomol. Soc. Amer.	8	-	-
Stud Ceret Biol Ser Bot	8	-	-
J. Kans. Entomol. Soc.	7	-	-
Diss. Abst.	-	4	-
Dopv. Akad. Nauk Ukr. RSR, Ser.	8	5	-
Am. Inst. Cercet. Prot. Plant, Stiinte. Agr. Ser.	-	5	-

1/ A rating of 1 under each data base indicates the publication cited more frequently than any of the others; 2 = second most frequently, etc. A number appearing more than once under a data base indicates a tie between two or more publications.

2/ Publication abbreviations or codens appear as listed on the computer print outs. No attempt was made to modify them to conform to a given standard.

Table 3B. CAIN's retrieval of bibliographic citations of publications on the greenbug, Schizaphis graminum (Rondani), which appeared in a bibliography citing articles published in English, 1970-71.

	Bibliography[1/]	CAIN
Total no. citations in:	76	48
No. citations appearing in bibliography but not retrieved by CAIN	43	
No. citations retrieved by CAIN but not in bibliography		15
No. citations retrieved by CAIN and also appearing in bibliography	33	

1/ Walker *et al*. (1972).

Appendix C

Recent Actions Taken to Assist Entomologists with Their Literature Searching Needs

The Entomological Society of America (ESA), in wake of the growing problems related to storage and retrieval of entomological literature, established a special committee within the Society to deal specifically with these problems. Several important developments emerged from this committee that have contributed significantly toward providing entomologists with improved methods of gaining access to entomological literature. We do not suggest that these developments represent the ideal approach to improved methods of information handling in entomology or any other discipline. Nevertheless, we do believe that these developments, which have proved most useful to insect pest management specialists, could serve as a basic blueprint to improved access to literature in certain other areas of crop protection. Hence, we review here the major developments of the special ESA committee on information storage and retrieval and would encourage members of other scientific societies related in part or in whole to crop protection to consider how they might benefit by taking similar actions. A more complete description of the actions taken by the ESA special committee mentioned above and the developments of this committee are reported by Foote and Hammack (1969) and Graham and Foote (1971).

1. A New Directory of Information Sources

The most pressing need concerning the use of information sources for most entomologists was found to be a description of the products of available information systems (Hammack 1970a). This included (1) descriptions of the scope and nature of information; (2) the information's deliverable form: hard copy, microfilm, microfiche; (3) the products of any given service: citations, informative abstracts, translations; and (4) costs. This composite of information was published as ESAID, Entomological Society of America Information Director, and has found wide acceptance among many entomologists. It contains information which would appear to be of value to other disciplines as well. For example, it describes the services of BIOSIS Previews (Bio Sciences Information Service of Biological Abstracts) which produces abstracts of significant published literature related to biology, including many crop protection fields. While the directory is intended to extend information services to the individual scientist, it could be adopted as an important reference in crop protection laboratories and centers throughout the world. It is not as broad as the National Referral Center's "A Directory of Information Resources in the United States: Biological Sciences" (1972), however, it is a good selective directory to entomological literature and related information housed in government-supported and commercial systems as well as in those systems maintained by universities and individuals.

2. Guide to the Core Literature

Since inquiries into the information-use patterns of entomologists pinpointed serial publications as the core literature of this discipline, the Entomological Society of America took steps to make these publications more visible to its members. The end result was the most complete and up-to-date list and analysis of the serial literature of entomology presently available in a single publication, "The Serial Literature of Entomology" (Hammack 1970b). No entomologist should be without this publication. It includes the titles, abstracting or indexing services covering the publications, costs and other important information on the serial world literature in entomology and also some information on serials of value to other crop protection disciplines. An additive feature which would be of great value to the whole spectrum of crop specialist is the listing of other reference sources to the serial literature.

3. Guides to Secondary Serial Literature

The purpose of most literature searches is to find the primary sources of information, i.e., those sources in which the results of research are first published. Browsing through journals, if done properly, is probably the most effective way to locate the primary publications and also is the most informative. However, browsing becomes an impossible task when seeking all the primary publications in a broad field such as biological control, host plant resistance or cultural control, for example. The so-called secondary literature sources--abstracts, indexes, bibliographies and reviews--are an important adjunct to the primary sources.

A recent adjunt to meet the entomologist's needs is Patrias' (1970) Analysis of Secondary Serial Literature Publications of Interest to Entomologists. The 50 secondary serial publications analyzed in this guide represent the world literature. A high percentage of these publications deal with many phases of crop protection, and the guide is one of the best references available to sources of literature on alternative methods of pest control. It is as an important guide for crop protection specialists housed near the most modern university libraries, and it is truly essential for those who are not.

Other Immediate Steps

The three developments noted above have met certain requirements of the growing needs facing users of entomological literature. If the new services emerging from these developments were utilized fully, the pay-offs would be great, for their use would improve the completeness of a literature search and greatly lessen the time spent searching.

Other developments which have stemmed from efforts of the Entomological Society of America to meet the more specialized information-handling needs of entomologists, worldwide, include the following, with only minimum detail provided for each. (Complete descriptions may be found in Graham and Foote 1971).

4. Preparation of a list of entomological publications (and their sponsors) originating in federal institutions of the U.S.A. and reported in the Monthly Catalog.

5. Preparation of a list of entomological publications (and their sponsors) originating in state institutions of the U.S.A.

6. Compilation of literature having principal value to extension entomologists. This is a useful reference for crop protection specialists engaged in many facets of pest management.

7. Preparation of a list of suppliers of periodicals, microforms and books available in the field of entomology.

8. Preparation of a directory of translators and translation services and a bibliography of translation periodicals. (This reference appears to answer the needs of any crop protection specialist seeking to find out if a particular publication has been translated into the language of interest or where to obtain this translation. This reference should have wide appeal to individuals and institutions engaged in collaborative multinational crop protection programs.)

These references to entomological information are either available now or are planned for the future as soft-bound publications intended for the user's personal library. They currently represent the most up-to-date entomological reference of their kinds.

9. Other specialized developments underway include (1) the preparation of an entomological thesaurus for facilitating improved processing of literature to be stored and for improved guidance to literature retrieval, (2) work toward better entomological glossaries to provide clearer and more standardized definitions as an adjunct to improved indexing, storage and retrieval; and (3) closer working relationships with existing retrieval systems to improve their services to users in entomology.

In addition to those developments which came about as a direct result of actions by the Entomological Society of America, an important peripheral development was the recent publication, Searching Entomological Literature, by Trauger _et al_. (1974), a highly useful guide for entomologists that also contains information relevant to other crop protection specialists.

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