Beyond Pesticides: Encouraging the Use of Integrated Pest Management in California

Pesticides are currently recognized as potentially harmful to the environment and human health. For this reason, use of alternatives to pesticides should be encouraged whenever possible. There are a number of things which can be done to encourage the use of alternative pest control methods in California. Several alternatives are considered in this article.

Pesticides are the predominant method of insect control used in the United States today. In the long run, however, exclusive use of chemicals to control pests is not a reasonable solution to the pest problem. Since insects develop resistance to chemicals, the exclusive use of pesticides eventually becomes counter-productive. More important, the widespread use of pesticides endangers both human health and the environment.[1] The National Academy of Sciences, an institution which has conducted numerous studies on pest control, warned in 1975 that unless alternatives to the use of chemicals are developed quickly and applied, agriculture in the United States will begin to suffer a reduction in productivity.[2] Thus it is imperative that other pest control methods be developed.

Most critics of pesticides concede that it is impossible to outlaw pesti-

1. Because of problems with persistence, bio-magnification and toxicity, *see* text accompanying notes 1-6 *infra*, many chemicals have disturbing implications for both the environment and human health. U.S. DEP'T OF HEALTH, EDUCATION AND WELFARE, REPORT OF THE SECRETARY'S COMMISSION ON PESTICIDES AND THEIR RELATIONSHIP TO ENVIRONMENTAL HEALTH 4 (1969) (hereinafter cited as MRAK REPORT). See also R. CARSON, SILENT SPRING (1st ed. 1962); COUNCIL ON ENVIRONMENTAL QUALITY, INTEGRATED PEST MANAGEMENT (1972); ENVIRONMENTAL PROTECTION AGENCY, THE EFFECTS OF AGRICULTURAL PESTICIDES IN THE AQUATIC ENVIRONMENT IRRIGATED CROPLANDS (1972); F. GRAHAM, SINCE SILENT SPRING (1970); NATIONAL ACADEMY OF SCIENCES, CONTEMPORARY PEST CONTROL PRACTICES AND PROSPECTS (1975) (hereinafter cited as CONTEMPORARY PEST CONTROL); R. RUDD, PESTICIDES AND THE LIVING LANDSCAPE (1st ed. 1964); RODGERS, THE PERSISTENT PROBLEM OF PERSISTENT PESTICIDES: A LESSON IN ENVIRONMENTAL LAW, 70 Colum. L. Rev. 567 (1970); PESTICIDES IN THE ENVIRONMENT (R. White-Stevens ed. 1971).

2. 259 NATURE 440 (1976) (untitled news item).

cides totally.[3] Their primary concern is the use of broad-spectrum pesticides, which kill not just the target insect but many different species. Broad spectrum chemicals destroy competitors, predators, and parasites of the target pest that otherwise operate as a natural control system. Furthermore, insects that were controlled naturally before application of the pesticide may increase in number after application.[4] A once innocuous insect then becomes a pest, creating a secondary pest outbreak.

Another concern of critics is the persistence of chemicals in the environment. Some pesticides do not break down, but retain their chemical identity in the environment and enter the food chain of human-beings and wildlife. When used extensively, as pesticides currently are, chemical concentrations build up in the food chain so that life at the top of the chain, including human beings, ingests an inordinate amount of them.[5] Governmental concern with the effects of broad-spectrum pesticides and their widespread use is not new in California. In 1971, the California Legislature declared that the official policy of the state was to protect the environment from harmful pesticides by prohibiting, regulating or controlling uses of such pesticides.[6] In 1972, the legislature expanded state policy to include the encouragement of alternate pest management systems that use biological and cultural controls.[7] Despite such legislative encouragement, however, little action has been taken to develop alternate techniques. The state has ignored, for the most part, significant developments in the field of pest control known as Integrated Pest Management (IPM).[8] IPM is a strategy which uses a combination of pest control methods, rather than just one. An IPM program maximizes natural controls by using cultural methods, such as tilling or alternating crops, to prevent build-up of pests.[9] Insect concentrations and natural

3. *See* PEST CONTROL: BIOLOGICAL, PHYSICAL, AND SELECTED CHEMICAL METHODS (W. Kilgore & R. Doutt eds. 1967); INTEGRATED PEST MANAGEMENT (J. Apple & R. Smith eds. 1976); CONTEMPORARY PEST CONTROL, *supra* note 1; COUNCIL ON ENVIRONMENTAL QUALITY, *supra* note 1.

4. COUNCIL ON ENVIRONMENTAL QUALITY, *supra* note 1, at 6.

5. *Id.* at 4. Since chemicals may be toxic (poisonous), teratogenic (causing birth defects), carcinogenic, or mutagenic, chemical concentration is of extreme concern for health reasons. *Id.* at 5.

6. CAL. FOOD AND AGRIC. CODE § 11501 (West Cum. Supp. 1978). The California Agriculture Code was renamed the California Food and Agriculture Code by 1972 Cal. Stats. 468.

7. *Id.* § 11501(f):

> The purposes of this division are as follows . . . to encourage the development and implementation of pest management systems, stressing application of biological and cultural pest control techniques with selective pesticides when necessary to achieve acceptable levels of control with the least possible harm to nontarget organisms and the environment.

8. Interview with Mary Louise Flint, Cal. Dep't of Food and Agric., (Sept. 16, 1977); *Accord*, Petition of Environmental Defense Fund to Richard Rominger, Director, Cal. Dep't of Food and Agric. (by Phone) (1977).

9. COUNCIL ON ENVIRONMENTAL QUALITY, *supra* note 1, at 10.

controls (*e.g.*, natural predators of the target pest) are monitored to determine the need for further measures.[10] When pest levels reach a point where economic damage to the crop is threatened (the pest threshhold), IPM uses the most appropriate technique to control the pest, which can include chemicals.[11] The obvious advantage of a successful IPM program is the reduced threat to health and the environment. The disadvantages are economic, according to some growers, who are reluctant to risk loss of profit to benefit the environment. Both growers and pesticide manufacturers are interested in maximum profits and at this point see no reason to change their methods for the unknown. Thus, although IPM programs are being used successfully in California by some growers, the impact of such programs on the total amount of pesticides being used in the state is small.

To maximize grower use of available IPM techniques, California needs to provide incentives to growers. The state must not delay implementation of its stated policy to encourage alternative pest controls until a major disaster necessitates such action.[12] The purpose of this article is to suggest a specific program that will ensure that the state meets the goals of decreased pesticide use and utilization of available alternative pest technologies. The first section documents the growing public awareness of the need for development of alternative control methods. The second section explores the stages of development of the various alternative technologies and their application. The third section assesses the reasons, both official and private, why alternative pest control methods have not progressed in accordance with the intention of section 11501 of the California Food and Agriculture Code, which the legislature enacted in 1972. The final section proposes specific remedial actions that the state can take to encourage widespread use of alternative technologies.

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10. *Id.*

11. *Id.*

12. The Environmental Defense Fund, a citizen's group, took action to force the Cal. Dep't of Food and Agric. to comply with the law. The Environmental Defense Fund petitioned the Director of the Dep't of Food and Agric. in accordance with § 11426 of the CAL. GOVT. CODE, which provides that "any interested person may petition a state agency requesting the adoption or repeal of a regulation as provided in this article." The petition requested the Director to use his statutory authority to pass regulations requiring improved monitoring and reporting of pest control practices and encourage use of Integrated Pest Management (IPM). The petition stated that the proposed regulation is necessary because IPM techniques now are being almost wholly ignored, though available and economical for many crop-pest combinations. *See* Environmental Defense Fund petition to Richard Rominger, Director of Cal. Dep't of Food and Agric. (1977) (unpublished manuscript available at Cal. Dep't of Food and Agric.) The petition also says that one reason for the failure of growers to take advantage of IPM is the lack of knowledge at the field level. *Id.* at 4.

I. PESTICIDE RISK AND THE CURRENT STATE OF THE LAW

The hazards associated with the exclusive use of chemicals to control pests first came to public attention with the publication in 1962 of Rachel Carson's *Silent Spring*.[13] *Silent Spring* did not advocate the banning of pesticides as a form of pest control, but suggested careful consideration of the effects of such chemicals on human beings and wildlife so that informed decisions could be made regarding their use.

In the years following the publication of *Silent Spring*, more information became available about the hazards associated with the use of chemicals in agriculture. It became increasingly apparent that the government should weigh the benefits of using pesticides against their present and potential risks.[14] Accordingly, a number of studies were conducted by government commissions and agencies on pesticide risk.[15] These studies fall into two groups, (1) those that focus on the hazards of pesticides and (2) those that recommend alternative control measures.[16]

The studies that focused on the hazards of pesticides were concerned with both their effect on the environment and their effect on human health.[17] In some instances, life forms were endangered because of certain persistent pesticides.[18] Pesticides were shown to have possible deleterious effects on human health, since tests on animals showed several compounds might cause tumors.[19] Demands were made to determine what levels of pesticide content in food, water and air were safe.[20]

Other studies advocated the use of available alternative pest control

13. R. CARSON, SILENT SPRING (1962). This book became the center of a wide-ranging controversy over the use of agricultural chemicals which still continues to some extent, although many of Miss Carson's fears have been proven to have firm foundation. *See, e.g.*, E. GRAHAM, SINCE SILENT SPRING (1970).

14. MRAK REPORT, *supra* note 1, at 5.

15. *See generally* CONTEMPORARY PEST CONTROL, *supra* note 1; COUNCIL ON ENVIRONMENTAL QUALITY, *supra* note 1; ENVIRONMENTAL PROTECTION AGENCY, INCENTIVES FOR RESEARCH AND DEVELOPMENT IN PEST CONTROL (1976); ENVIRONMENTAL PROTECTION AGENCY, EVALUATION OF THE POSSIBLE IMPACT OF PESTICIDE LEGISLATION ON R & D ACTIVITIES OF PESTICIDE MANUFACTURERS (1975); GOVERNOR EDMUND BROWN'S COMMITTEE ON PESTICIDE REVIEW, REPORT ON PESTICIDES IN CALIFORNIA (1965); MRAK REPORT, *supra* note 1; M. Li and W. Kilgore, The Significance of Pesticides from Irrigated Agriculture in California (1977) (unpublished report to the California State Water Resources Control Board).

16. *See* note 15 *supra*.

17. MRAK REPORT, *supra* note 1, at 5. *See also* COUNCIL ON ENVIRONMENTAL QUALITY, *supra* note 1, at 11. This study found that U.S. production of synthetic organic insecticides, herbicides and fungicides had risen from 300,000 pounds in 1950 to 1 million in 1970. By 1972, nearly 1,000 chemicals in over 32,000 pesticide products were registered for use. The report estimated that 230 insect species, half of which were of agricultural importance, had developed resistance to various insecticides and that total resistance was perilously near in some important U.S. pests. *Id.* at 5-6.

18. MRAK REPORT, *supra* note 1, at 9.

19. *Id.* at 10.

20. *Id.* at 12.

methods[21] and recommended intensive research to develop more appropriate technologies.[22] Research on alternative approaches to pest control has been limited.[23] Studies found that private industry cannot be counted on to pursue alternative control for three reasons.[24] First, alternative pest control methods are more costly to develop than competitive products such as broad-spectrum pesticides. Second, the potential market for alternative controls is smaller than the market for a broad-spectrum pesticide. Third, lack of adequate storage, patent protection and user acceptance for alternative pest control remain problems. For these reasons, several studies concluded that government support or subsidization of alternative pest control approaches is necessary.[25]

California officially has recognized that state action is needed to encourage the use and development of alternatives to pesticides since 1965, when a governor's report recommended that less hazardous control measures should receive high priority attention.[26] The report suggested that the state establish a continuing program to identify and conduct research necessary for the development of less hazardous pest control methods.[27] The law has not, however, kept pace with the recommendations of the various studies, including the governor's report. Instead, the major thrust of both state and national legislatures has been

21. For a short list of studies, *see generally* B. BEIRNE, PEST MANAGEMENT (1966); P. DEBACH, BIOLOGICAL CONTROL BY NATURAL ENEMIES (1974); INTEGRATED PEST MANAGEMENT (1976); PEST CONTROL BIOLOGICAL, PHYSICAL, AND SELECTED CHEMICAL METHODS (R. Doutt and W. Kilgore eds. 1967); THE BIOLOGICAL IMPACT OF PESTICIDES IN THE ENVIRONMENT (Gillett ed. 1970); BIOLOGICAL CONTROL (C. Huffaker ed. 1971); BIOLOGICAL CONTROL (R. van den Bosch and P. Messenger eds. 1973); M. Flint and R. van den Bosch, A Source Book on IPM (1976) (unpublished report supported by grant to the International Center for Integrated and Biological Control of the University of California, by the Dep't of Health, Education, and Welfare). *See also* note 15 *supra* for a list of government studies.

22. *See, e.g.*, CONTEMPORARY PEST CONTROL, *supra* note 1, at 2.

23. ENVIRONMENTAL PROTECTION AGENCY, EVALUATION OF THE POSSIBLE IMPACT OF PESTICIDE LEGISLATION ON RESEARCH AND DEVELOPMENT ACTIVITIES OF PESTICIDE MANUFACTURERS 3 (1975).

24. *Id.* at 4-5.

25. *See* COUNCIL ON ENVIRONMENTAL QUALITY, *supra* note 1, at 11; ENVIRONMENTAL PROTECTION AGENCY, *supra* note 23, at 52, 111; and MRAK REPORT, *supra* note 1, at 28.

Another study, ENVIRONMENTAL PROTECTION AGENCY, INCENTIVES FOR RESEARCH AND DEVELOPMENT IN PEST CONTROL (1976), also recommended that government encourage the use of IPM where economical and effective in meeting user needs and increase information and training in all areas of pest management. *Id.* at 9-10.

President Carter reiterated the same general theme of encouraging alternative pest control methods in his message to Congress on May 23, 1977. The President advocated the development of new IPM techniques to protect the environment whenever possible from harmful substances. *See* 1977 PEST CONTROL 47.

26. GOVERNOR EDMUND BROWN'S COMMITTEE ON PESTICIDE REVIEW, REPORT ON PESTICIDES IN CALIFORNIA 116 (1965).

27. *Id.* at 17.

the regulation of pesticide use.[28] California has two sets of laws dealing with pest control. One is part of the California Food and Agriculture Code[29] and the other is a set of regulations for the California Environmental Quality Act (CEQA).[30]

The emphasis of the California Food and Agriculture Code's division on pest control operations is restricting the use of pesticides rather than assisting and encouraging alternative pest control methods. The Code, however, mandates state encouragement and implementation of pest management systems which utilize biological and cultural pest control approaches.[31] Although the Code expressly gives the Director of the California Department of Food and Agriculture (hereinafter Department of Agriculture) the discretion to cancel or refuse registration of any pesticide for which there is a reasonably effective alternative that is less destructive to the environment,[32] the Director has not yet exercised such discretion. The Director of the Department of Agriculture has failed to promulgate regulations to enforce the law.[33] Thus, the state actually has done little to encourage the use of alternative pest control in California.

In addition to the provisions in the California Food and Agriculture Code, CEQA[34] states that the long-term protection of the environment shall be the guiding criterion in making public decisions. Governmental agencies must consider environmental factors, as well as economic and technical factors, in evaluating any proposed action and alternatives to

28. For example, the Federal Insecticide, Fungicide, and Rodenticide Act of June 25, 1947, ch. 125, §§ 2-313, 61 Stats. 163-172 (7 U.S.C. §§ 135-135k), amended and superseded by 7 U.S.C. §§ 136-136y (1976) (hereinafter FIFRA), provided consumer protection against misbranded and adulterated pesticides. The amendment to FIFRA, the 1972 Federal Environmental Protection Control Act (FEPCA) (current version at 7 U.S.C. §§ 136-136y (1976)), requires registration of chemicals for agricultural use and classifies chemicals for either "general" or "restricted" use. (For a full discussion of the pesticide regulatory system, *see* Comment, *The Regulation of Pesticide Use in California*, this volume.) However, although FEPCA requires the Administrator of the Environmental Protection Agency to give priority to research and development of biologically integrated alternatives to pest control. (*See* 7 U.S.C. § 136r (a) which offers no incentive to producers and applicators to use integrated control techniques and does not require that integrated pest control be used to the fullest extent possible.)

29. CAL. FOOD AND AGRIC. CODE §§ 11401-12500 (West 1968 & Cum. Supp. 1978).

30. CAL. PUBLIC RES. CODE § 21000-27424.5 (West Cum. Supp. 1978).

31. CAL. FOOD AND AGRIC. CODE § 11501(f) (West Cum. Supp. 1978).

32. *Id.* § 12825 (West Cum. Supp. 1978). All pesticides must be registered with the state. *Id.* § 12824.

33. The Director of the Cal. Dep't of Food and Agric. can make regulations to enforce the law. CAL. FOOD AND AGRIC. CODE §§ 11501.5, 12005 (West Cum. Supp. 1978). Having the authority to forbid or regulate the use of environmentally harmful materials, *id.* § 14102, the Director is required to consider the effect of all such materials on the environment. The Director also is required to "initiate, cooperate, and collaborate with the University of California and other state agencies in research designed to reduce and eliminate the use of environmentally harmful materials." *Id.* § 14102.

34. *See* note 30 *supra*.

such action.[35] In 1976 the California Attorney General[36] ruled that CEQA applied to pesticides that require a use permit (generally restricted pesticides).[37] Under this ruling, the use of pesticides requiring a use permit would have had to comply with CEQA regulations,[38] which require the preparation of an environmental impact report if a project has the potential to cause a physical change in the environment. However, the Attorney General also found that an environmental impact report on the whole regulatory system might be sufficient to meet CEQA's requirements. In June 1978 new legislation was passed which exempts the regulation of pesticides from CEQA until 1981 or until a pesticide regulatory program drawn up by the Department of Agriculture is certified by the Secretary of the Resources Agency.[39] The new legislation dilutes the effect which applying CEQA to pesticide use in California would have had. Under CEQA, consideration of feasible non-chemical methods of pest control would have been required as part of the environmental impact report. While the new legislation specifies that the regulations adopted by the administering agency shall require consideration of alternatives and mitigation measures to minimize any significant environmental impact, it is questionable whether this language will have any greater effect on the use of pesticides without regard to feasible alternatives than legislation on the books, such as California Food and Agriculture Code § 11501(f), has had. There will be no case by case determination under the new law as to whether non-chemical alternatives are feasible in a particular situation. Rather, when the Secretary of the Resources Agency issues a blanket certification of a proposed regulatory program, CEQA requirements will be deemed to have been met.

The independent studies and legislative action illustrate a growing awareness of the problems associated with exclusive use of pesticides.

35. CAL. ADMIN. CODE tit. 14, § 15011.

36. 59 OP. ATTY. GEN. 300 (1976).

37. *See* CAL. PUB. RES. CODE § 21002.1 (West Cum. Supp. 1978).

38. *E.g.*, one important CEQA regulation requires the preparation of an environmental impact report if a project has the potential to cause a physical change in the environment. Under the regulations, an environmental impact report must describe direct and indirect effects of the project on the environment for short and long-term periods, as well as any reasonable alternatives to the project. *See* CAL. ADMIN. CODE, tit. 14, § 15143(d). Alternatives should include proposals capable of substantially reducing or eliminating any significant environmental effects, even if such alternatives impede the attainment of project objectives are more costly than the project in question.

39. The legislature enacted AB 3765 in June 1978, in response to the Cal. Attorney General opinion. In addition, the Department of Agriculture prepared a statewide pesticide use plan which was issued in October 1978. The DRAFT REPORT ON ENVIRONMENTAL ASSESSMENT OF PESTICIDE REGULATORY PROGRAMS suggests mitigating measures and alternatives to use of certain restricted pesticides and to the existing regulatory system.

Three questions remain to be considered: Are there feasible alternatives which California can encourage? If so, why are they not being encouraged? Should governmental action in California be re-defined and made more specific? The next three sections will focus on these issues.

II. The State of Development of Alternative Pest Control Methods

Integrated pest management uses a combination of pest control technologies to control the target pest. The particular combination of techniques differs according to the type of pest to be controlled and crop conditions. Alternative technologies fall into several categories, which are at varying stages of development. This section will explain the major categories and then explore their application in California agriculture to determine whether or not their use should be mandated more specifically by state law.

A. Biological Control

One of the most frequently used alternative pest control methods is biological control which has played a major role in IPM programs. Natural predators and parasites are introduced into the field to control either endemic pest species or accidentally imported pests.[40] A well known example is the ladybug Vedalia imported from Australia in the nineteenth century, which has been an important pest control device to the California citrus industry for decades.[41] Biological control often works best when used in conjunction with other pest control technologies.[42] When used alone, biological control may permit a certain level of pest damage since results are not always immediate.[43] Despite this drawback, biological control is one of the most promising alternative technologies, especially when it is used as part of an integrated control program. Twenty species of beneficial predators and parasites have offered significant control in the United States.[44] In California, biological control projects alone have resulted in an estimated $200 million savings from reduced need for chemical control and decreased pesticide

40. J. Diekman, C. Djerassi, & C. Shih-Coleman, *Insect Control of the Future: Operation and Policy Aspects*, 186 Science 596, 599 (1974).

41. Council on Environmental Quality, *supra* note 1, at 7.

42. J. Diekman, *supra* note 40.

43. *Id.* While pest damage may not harm the crop in any way except for surface blemishes, this may be economically unacceptable to the grower because buyers have been conditioned to expect cosmetic perfection. As a precaution against surface blemishes and the resulting decreased market value of the crop, growers tend to overuse pesticides. *See also* Environmental Protection Agency, Investigation of the Effects of Food Standards on Pesticide Use ii, iv (Contract 68-01-2602).

44. J. Diekman, *supra* note 40, at 604.

damage in the last forty-five years.[45]

Methods of biological control, however, have not received enough study. The government has sponsored most of the research which has been done, even though industry should have the incentive to do so also. Industry requires much less capital investment to develop biological controls than to develop pesticides, due to the reduction in safety testing and the elimination of residue tolerance determinations.[46] Interest on the part of industry has remained negligible, though, partly because of the lack of patent protection and partly because of the short shelf life of insects.[47]

B. Cultural Controls

Cultural controls, or effective agricultural practices, also can reduce the need for pesticides when properly used. Tilling practices, fertilization, crop sequencing and rotating, harvest procedures and irrigation can be used in more sophisticated ways to achieve pest control. Such practices often are used independently by growers but are even more effective when used as part of an IPM program.[48] Examples of cultural techniques to control pests include planting a few rows of alfalfa between cotton rows to draw away pests from the cotton; early planting of rapidly fruiting crop varieties to reduce damage by the late season pest Heliothis; and interposing soybeans or small grains between corn crops to eliminate rootworm.[49] The use of cultural controls may create some problems for the farmer. The farmer may experience decreased crop yield or find that additional energy must be expended for increased tilling of fields. These costs, however, may be balanced by societal gains such as a cleaner environment or a reduction of energy needed for production of pesticides.[50] Another problem with the use of cultural techniques is the degree to which effectiveness may depend on unification of cultural practices over a wide geographic area. Mechanisms for grower cooperation (such as cooperative pest control districts) therefore may be needed for optimal use of some cultural techniques.[51] Because cultural

45. L. TALLIAN, POLITICS AND PESTICIDES 145 (1975).

46. J. Diekman, *supra* note 40, at 604. The extensive Environmental Protection Agency testing required for pesticides is considerably lessened for biological controls. Due to the nature of biological controls there is no need for residue tolerance testing.

47. *Id.* at 599. Since insects have short life spans, they cannot be kept on a shelf indefinitely as pesticides can.

48. CONTEMPORARY PEST CONTROL, *supra* note 1, at 358.

49. *Id.* at 358-59.

50. CONTEMPORARY PEST CONTROL, *supra* note 1, at 358-359.

The prospect of societal gain, however, is probably of little comfort to the farmer who experiences decreased crop yield or spends more money to till the fields.

51. *Id.* at 361. Pest control districts are devices which have been used to ensure uniformity of pest control practices in a certain geographic area. Growers can establish the

controls involve power practices rather than a product, research has been almost entirely in the public sector.[52] The results of such research must be made known to farmers if they are expected to use such techniques. Presently, however, research findings are not brought to the farmer's attention by advertising campaigns, as in the case of new pesticides. While county extension programs may provide the farmer with some pest control information, news of innovative techniques may not reach the grower if a comprehensive extension program is not developed.

C. Insect Hormones and Pheromones

Insect hormones and pheromones, another category of alternative technology, are chemical compounds which interfere with the pest's biochemistry. Insect behavior is modified by soliciting an inappropriate response or inhibiting an appropriate one.[53] Unlike broad-spectrum pesticides which affect many different organisms, hormones and pheromones affect only a very narrow spectrum of organisms. This selectivity is desirable because beneficial species are not affected and no chemicals are used that might build up in the environment.[54] Pheromones, which are sexual attractants, have been developed to the point of being a viable control method for some pests. Traps using pheromones are being distributed by the United States Department of Agriculture and Zoecon, a California corporation.[55] Since pheromones are an environmentally preferable means of pest control, their use on pests for which they are already an effective control should be encouraged. However, more research in insect biochemistry, physiology and ecology is needed to determine if this control method can be developed for application to more pests. Though environmentally preferable, research and development costs have made the more widespread use of hormones and pheromones unattractive to industry.[56]

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district by vote and set uniform policies. Then the police power of the state can be used for enforcement. Such a device is specifically provided for in § 8541 of the CAL. FOOD & AGRIC. CODE for citrus districts. Such districts may be useful in terms of alternative technologies since one farmer's spraying operation can ruin a neighbor's attempt at biological control.

52. CONTEMPORARY PEST CONTROL, *supra* note 1, at 361.

53. H.H. Shorey and L.K. Gaston, *Pheromones*, in PEST CONTROL: BIOLOGICAL, PHYSICAL, AND SELECTED CHEMICAL METHODS 242 (R. Doutt and W. Kilgore eds. 1967).

54. *Id.* at 263.

55. CONTEMPORARY PEST CONTROL, *supra* note 1, at 342.

56. *Id.* at 341. Research and development costs are as high for a pheromone as for a broad-spectrum pesticide, yet the pheromone has a much smaller potential market because it is so selective.

D. Insect Pathogens

Insect pathogens are another effective pest control alternative that has been used successfully by growers. Insect pathogens are microbial agents which cause disease in the target insect. They have proved to be very practical controls in some instances. For example, control of the Japanese beetle in the eastern United States was established in the 1930's and 40's by use of a bacteria, *Bacillus popilliae*.[57] Currently, *Bacillus thuringiensis* is successfully used to control certain pests.[58]

Viruses have been used informally by growers in the San Joaquin Valley of California by mixing diseased insects with water and spraying the crop.[59] However, only one insect virus has been developed commercially to the point of receiving an experimental use permit from the Environmental Protection Agency.[60] The lack of current research activity by industry in this area seems to be the result of the prohibitive cost of meeting regulatory testing requirements of the Environmental Protection Agency. The potential market for a virus is very selective and therefore not as widely or profitably marketable as a broad-spectrum pesticide.[61]

The Environmental Protection Agency uses testing procedures for viruses that are as stringent as the ones for chemicals. Strict testing requirements are understandable when dealing with viruses, which have reproductive abilities and potentially can be harmful to the public.[62] Unfortunately, the Environmental Protection Agency regulations, because they are so strict, act as a disincentive to the development of alternative technologies such as pathogens.[63] Still, viruses could play a supplemental role in integrated control programs and more research in the area should be encouraged. Presently, public sector research is not extensive enough to compensate for the little being done in the private sector.[64]

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57. CONTEMPORARY PEST CONTROL, *supra* note 1, at 346.
58. *Id.*
59. CONTEMPORARY PEST CONTROL, *supra* note 1, at 347.
60. *Id.* at 348.
61. *Id.* at 347. The cost of meeting regulatory requirements was much lower in the 1950s, when *Bacillus thuringiensis* was developed.
62. *Id.* at 348.
63. CONTEMPORARY PEST CONTROL, *supra* note 1, at 341.
Zoecon's product Altosid, which is based on a juvenile hormone analog, cost Zoecon an estimated $8 million to develop. This is approximately equal to the cost of currently developing a broad-spectrum pesticide which will have a much larger market than a more selective, and therefore environmentally preferable, control technique.
64. *Id.* at 350.

E. Genetic Techniques

Genetic techniques are important forms of pest control which fall into two categories: genetic manipulation of crop resistance to pests and genetic interference with the pest itself. Crops can be bred to be less attractive to pests and thus more resistant. For example, if the skins of fruits are bred to be thicker, it is harder for pests to damage them. An instance of genetic interference is the mass production of a selected phenotype (for example, one which will make off-spring sterile) and their subsequent release into the target pest population.[65]

Resistant crops should play an important role in pest control in the future.[66] A massive study on contemporary pest control by the National Academy of Sciences in 1975 found that use of resistant crop varieties saves the American farmer $1 billion annually.[67] Although more study is needed, research on breeding resistant crop varieties currently is being done by federal research units, state experimental stations and commercial seed companies.[68]

Autolethal techniques, which are similar to genetic interference, have been used successfully in California. Reared insects which are either sterile or have a genetic mutation that is lethal are released at appropriate locations.[69] Effective use requires a situation where the target pest population is low or reduced. Autolethal techniques have promising potential when used in conjunction with other control strategies, but are too small a part of the market to interest private firms in researching them further.[70] However, California has devised a way to encourage use of this technique by imposing a bale tax on cotton to defray a part of the cost of sterile male releases.[71] Autolethal techniques are attractive because there are no environmental or health hazards incident to their use.[72]

The goal of pest control research is to eliminate harm to the environment while providing the grower with an economically feasible pest control strategy. All of the above alternative technologies[73] have been used successfully to control pests and most of them work best when used in combination with one or more other methods. IPM, or the combina-

65. *Id.*
66. *Id.* at 353.
67. *Id.* at 351.
68. *Id.*
69. *Id.* at 355.
70. *Id.* at 357.
71. *Id.*
72. *Id.*
73. The list of alternative technologies here discussed is not exhaustive. There are other areas which are still in the developmental stages that may be viable in the future. *See generally* PEST CONTROL: BIOLOGICAL, PHYSICAL, AND SELECTED CHEMICAL METHODS (R. Doutt and W. Kilgore eds. 1967).

tion of various pest control methods, is currently at a stage where it can be used economically and effectively for some crops. Research is currently being focused on seven major crops: cotton, apples, alfalfa, soybeans, corn, cereals and citrus.[74] The ultimate goal for each crop is a systems approach, in which sophisticated systems, science and computer technology will be combined with traditional integrated control.[75] Integrated pest control programs are being or have been developed in California for the following crops: cotton, alfalfa, citrus, grapes, pears and apples.[76] Since forty-five per cent of the total amount of pesticides used in agriculture is used for cotton, a good integrated control program for this crop alone could reduce substantially the amount of pesticides being used in California.[77] A survey on the profitability of IPM on cotton and citrus in the San Joaquin Valley reveals that IPM reduces pesticide

74. This research is being sponsored by the Environmental Protection Agency, the U.S. Dep't of Agric. project, and the National Science Foundation. The project, which is formally titled "The Principles, Strategies, and Tactics of Pest Population Regulation and Control in Major Crop Eco-systems" is headed by Dr. C. Huffaker of the University of California at Berkeley Biological Control Division. It has focused on developing integrated programs for U.S. crops. Integrated and systems control programs for these crops are at different stages of development. In cotton, losses to insects total $500 million annually, while $150 million is spent on pesticides each year. Research has shown that economic and environmental benefits may be gained by adopting an IPM approach for cotton. Cotton programs are approaching the stage of a sophisticated systems approach, which combines "monitoring, modeling, and management tools into a system of delivery to the pest manager." C. Huffaker and B. Croft, *IPM in the U.S.: Progress and Promise*, 14 ENVT'L HEALTH PERSPECTIVES 167, 169-71 (1976).

Little damage is tolerated for apples because of high cosmetic standards. However, better timing and appraisal of the time to spray have resulted in a substantial reduction in pesticide use. In Washington a 50% reduction in the use of chemicals on apples has been achieved since this program was instituted, and in the eastern U.S. a 20 to 30% reduction. *Id.* at 172.

IPM systems for alfalfa are some of the most advanced in the U.S. This is because alfalfa has one principal pest. Extensive use of chemicals is too expensive for a low-return crop like alfalfa. Also, the philosophy of IPM has been long accepted by alfalfa entomologists. *Id.* at 173.

Despite a complex pest system and a campaign for extensive pesticide application on soybeans by industry, preliminary programs indicate that pesticide use can be cut in half by integrated control with a corresponding increase in profits and improved environmental quality.

In corn, integrated programs have so far relied heavily on genetic resistance of plants, cultural methods and chemicals. Research on a systems approach is at an early stage. *Id.* at 175.

Much research has been done on resistant varieties in cereals in the last ten years. Integrated control programs are being developed today. Considerable success was achieved using biological control of a major cereal pest, the cereal leaf beetle. C. Huffaker and B. Croft, *supra* note 34, at 178.

Biological control of invading citrus pests has enjoyed phenomenal success. The citrus industry in California has a well-developed system of integrated control which combines use of natural enemies with selective, reduced use of pesticides. *Id.* at 178-79.

75. C. HUFFAKER AND B. CROFT, *supra* note 74, at 180.

76. L. TALLIAN, POLITICS AND PESTICIDES 122 (1975).

77. C. Huffaker and B. Croft, *supra* note 74, at 167.

use by one third to two thirds. The difference in the growers' profits between using chemicals exclusively and using an integrated control program was negligible.[78] In addition, an insect monitoring program used on grapes in California eliminated much of the insecticide applications formerly used.[79] Insect monitoring, one aspect of the classic IPM program, continually notes insect concentrations and natural controls to determine the need for further control measures.[80] Monitors carefully note existing pest population levels and apply pesticides only when the pest reaches the level of economic damage to the crop, rather than applying them according to a calendar date. The vineyards also were manipulated to maintain natural enemies of the target pest throughout the year, which improved serious pest control problems that had been chemically induced.[81]

The IPM programs that have been developed show that such programs are environmentally preferable, in terms of reduced pesticide use and health hazard, as well as economically feasible. For IPM to have maximum effect, however, more research is needed to develop IPM programs for a greater number of crop/target pest combinations. Although the alternative technologies are not yet sufficiently developed to serve as the sole means of pest control, their combined use in IPM programs can reduce substantially the use of pesticides in California. Even where good IPM programs have been developed, however, there still may be a problem because "acceptance and utilization by farmers is really the ultimate test as to the utility of any IPM program".[82] Unless the farmer is willing to try or is given incentives to try alternative technologies, the development of integrated control programs cannot be effective.

III. Obstacles to the Development and Use of IPM in California

Despite the general consensus that research programs should be directed toward pest management systems and despite its official policy,[83] California has done little to encourage the development and use of alternative pest technology.[84] The obstacles to full utilization of available

78. D. Hall, The Profitability of IPM: Case Studies for Cotton and Citrus in the San Joaquin Valley 3 (1977).

79. R.L. Doutt and Ray F. Smith, *The Pesticide Syndrome—Diagnosis and Suggested Prophylaxis*, in Biological Control 14 (C. Huffaker ed. 1971).

80. Council on Environmental Quality, *supra* note 1, at 10.

81. *Id.*

82. C. Huffaker and B. Croft, *supra* note 74, at 181.

83. Cal. Food and Agric. Code § 11501(f) (West Cum. Supp. 1978).

84. M. Li and W. Kilgore, *supra* note 15, at 97.

Under Cal. Food and Agric. Code §§ 11501.5 and 12005 the Director of the Cal. Dep't of Agric. has the power to pass regulations to implement the law, but this authority has not been exercised to implement § 11501.

alternative technologies include lack of an adequate research base, the absence of an effective system for delivering new technology and technical assistance to the farmer, growers' attitudes, and food quality standards.

A. The Lack of an Adequate Research Base

The major obstacle to an effective research program is the lack of an overall coordinated approach combining research and practical application.[85] There is no program that links current research with the needs of the California grower and which provides a mechanism for transferring the new technology from the researcher to the grower. Although the Biological Control Unit[86] at the Department of Agriculture has sponsored several small research projects in the past, these have not been part of an overall state plan or even directed toward developing IPM programs.[87]

Another problem is the lack of a state research program. Most of the research in the state has been done by the University of California. University research projects usually are sponsored by federal grants to individual researchers for specific projects, which may or may not concern California's agricultural problems. Some research needs to be done at the state level to ensure a coordinated approach to California's pest control needs.[88]

The lack of coordination and cooperation between the Department of Agriculture and the University of California, however, has been an obstacle to the development of a comprehensive research plan. Most of the research efforts by these public bodies are independent of each other. While the University and the Department both conceive the University's role as researching and developing new pest controls and the Department's role as implementing such research, the two roles have overlapped in application. It is not always easy to tell where research ends and implementation begins. In some cases, the Department of Ag-

85. A. Gregorio, Chairman, Cal. Senate Health and Welfare Committee, Press Release 776-25 at 2 (1976). "No coordinated approach to research exists on the state level in regard to . . . integrated pest management."

86. The Biological Control Unit is now a part of the Division of Pest Management, Environmental Protection and Worker Safety, formed in July 1976.

87. Interview with R. Dunkel, head Biological Control Unit, Division of Pest Management, Environmental Protection and Worker Safety, by phone (Sept. 20, 1977). Although no comprehensive research or use plan has been formulated, the Cal. Dep't of Food and Agric. created a new unit in this area in July 1977, the Division of Pest Management, Environmental Protection and Worker Safety. According to Division Director J. McKenzie, the goals of the new division are as yet undefined. The division is divided into four units: pesticide registrations, enforcement, worker health and safety, and pest management and environmental monitoring.

88. Interview with Mary Louise Flint, Cal. Dep't of Food and Agric., by phone (Sept. 16, 1977).

riculture thought field experimentation was within its role once the basic research was completed by the University, while the University perceived research as carrying over into the field experiments. As a result, conflicts over which body should be doing particular functions have arisen.[89]

Even if the roles of the University of California and the Department of Agriculture in research and development of alternative pest control methods were delineated clearly by legislation, problems still would exist. Using the University as the chief researcher for the State has limitations. For example, assume that a comprehensive state plan for research is established, including priorities for certain research projects. The possibility still exists that no one at the University would be interested in working on the projects given the highest priority by the plan or even on any of the research projects suggested. The state could not order the University to undertake specific research projects without raising the specter of academic freedom. Another possible problem in depending on the University for a planned research program is the lack of proper incentives. The incentives affecting the University researcher differ from those affecting the private industry researcher.[90] Since university researchers may desire quick publication for career advancement purposes, they may be interested in projects that produce immediate results rather than the projects that are most helpful to developing IPM. Thus, despite the presumed neutrality of the university, the researcher's self-interest may prevail over the public interest.

Additionally, since the work usually is contracted out to different researchers within the University on a project-by-project basis, the research team is dissolved at the end of each project.[91] A great pool of knowledge is lost when another project is contracted to an entirely new team of researchers. While a cooperative effort by the Department of Agriculture and the University to devise a comprehensive state plan to which they both agree might be feasible, the Department of Agriculture also should consider the possibility of contracting work on an on-going basis to a private research foundation to eliminate some of the above problems.

Although public entities have not satisfied research needs for agricultural pest control, private industry also has failed to meet these research needs. Only one of the approximately ninety companies engaged in research and marketing of pesticides devotes a substantial amount of research to alternative control methods.[92] Since the market for more

89. Interview with R. Dunkel, *supra* note 87.
90. CONTEMPORARY PEST CONTROL, *supra* note 1, at 151.
91. Interview with R. Dunkel, *supra* note 87.
92. ENVIRONMENTAL PROTECTION AGENCY, EVALUATION OF THE POSSIBLE IMPACT OF PESTICIDE LEGISLATION ON RESEARCH AND DEVELOPMENT ACTIVITIES OF PESTICIDE

selective pesticides at present is smaller than for broad-spectrum pesticides, economic considerations deter industry from researching alternative controls. Another consideration is that the pesticide industry is product-oriented rather than service-oriented. Therefore, industry is not equipped to give growers the continuing technical advice and assistance they need to use alternative control methods.

B. The Need for a Technology Delivery System

In addition to the need for more research, pest control technology must be delivered to farmers as it develops. The delivery of such information requires one-on-one contact between the expert advisor and grower since pest problems vary from field to field as well as from crop to crop. Unfortunately, California has no effective system for transferring the feasible alternative pest technology that now exists to the grower.

One obstacle to an effective delivery system is the lack of enforcement of existing regulation at the county level.[93] The state has not met its asserted goal of maximized use of integrated pest control in part because the state system is inadequately enforced at the county level. The large numbers of applications for restricted pesticide use permits make it impossible for each county commissioner to consider whether nonchemical alternatives would be feasible. Although the commissioner is required to consider whether a non-restricted material or procedure is equally as effective and practical as the restricted material,[94] in practice the agricultural commissioners are not qualified to make decisions as to what would be the best technology.[95]

The chief vehicle for educating the farmer in the past has been extension programs. Traditional extension programs emphasize the distribution of information to the farmer, often in the form of bulletins or classes. Such programs have helped the farmer to become aware of potential pest problems, to identify specific pests and to learn the proper

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MANUFACTURERS 50 (1975). Zoecon, a California corporation, is watched closely by the chemical companies to see if it can successfully market hormonal controls by pursuing a vigorous alternative technology research program.

93. The county agricultural commissioners, under the supervision of the Dep't of Agric., enforce the state regulatory program at the local level. CAL. FOOD AND AGRIC. CODE § 11501.5 (West Cum. Supp. 1978). They oversee the licensing of agricultural pest control advisors, *id.* § 12002; recommendations made by such advisors, *id.* §§ 12004, 12973; damage reports from pesticides, *id.* § 11761; and issue permits for application of restricted materials, *id.* § 14006.5. For a fuller discussion of enforcement of pesticide regulations at the county level, *see* Comment, *The Regulation of Pesticide Use in California*, this volume.

94. CAL. FOOD AND AGRIC. CODE § 14006 (West Cum. Supp. 1978).

95. H. Dunning, *Pests, Poisons, and the Living Law: The Control of Pesticides in California's Imperial Valley*, 2 ECOLOGY L.Q. 683 (1972).

control actions to be taken.[96] However, these programs have involved little evaluation or monitoring of pest levels. Neither the grower nor the county extension agent has the time or training to make complex management decisions based on such factors as climatic conditions, the biology of the pest species or the presence of a population of beneficial insects.[97] For this reason, extension efforts at promoting the use of alternative technologies in California have not been very effective.

In addition to these limited traditional extension programs, the farmer's main source of pest control information is the sales representative of a chemical pesticide company.[98] The sales representatives must be licensed pursuant to Department of Agriculture regulations.[99] The current licensing test primarily requires a knowledge of pesticides, however, with little attention paid to alternative controls.[100] Conflicts of interest also are inherent in using chemical sales representatives as major sources of advice. Consequently, there are no effective, unbiased channels through which growers regularly can receive timely information on pest control, except for independent pest control advisors.

It is unfortunate that many growers rely exclusively on the advice of pesticides sales representatives, since the use of other pest control methods combined with selective use of chemicals can reduce the amounts of pesticide used and result in increased returns per acre.[101] For example, the California Farm Bureau found that cotton, citrus and grape farmers using independent consultant firms reaped increased net profits of twenty-two per cent.[102]

Over the last twenty years, California has seen the growth of independent companies which offer pest management consultant services.[103] The scope of such services covers a wide range. Some only count pests; others pay attention to predators, parasites and crop conditions; a

96. NATIONAL ACADEMY OF SCIENCES, III CONTEMPORARY PEST CONTROL PRACTICES AND PROSPECTS 7 (1975).

97. *Id.*

98. *See* A. Gregorio, *supra* note 85, at 2. "Most pest control advisors licensed by the Dep't of Food and Agric. to prescribe the type and amount of pesticide application, have an interest in pesticide sales since they earn commissions from them."

99. CAL. FOOD AND AGRIC. CODE § 12021 (West Cum. Supp. 1978).

100. Dunning, *supra* note 95, at 684. California Senator Arlen Gregorio sponsored S.B. 669, Cal. Leg. Reg. Sess. (1977) to eliminate the conflict of interest inherent in having pest control advisors who are also pesticide sales representatives. Because of the opposition to the bill by agri-business and the chemical industry and in view of the practical problems presented in filling the gap if sales representatives are eliminated as advisors, the bill currently is being revised.

101. D. Hall, R. Norgaard, & P. True, *The Performance of Independent Pest Management*, 29 CALIFORNIA AGRICULTURE 12 (Oct. 1975). This study found that cotton and citrus growers, the two largest users of pesticides in the U.S., could increase returns per acre by using IPM methods advised by independent consultant firms.

102. COUNCIL ON ENVIRONMENTAL QUALITY, *supra* note 1, at 12.

103. *Id.*

few emphasize total crop management and advise on cultural practices and weed control.[104] Private pest management consultants have helped reduce overuse of pesticides, but only recently have started recommending practices which resemble complex integrated control strategies.[105] Although there are independent consultant companies in every California county where cotton is grown,[106] the impact of independent consultants in reducing the overall chemical use in the state is negligible, perhaps because most small growers see consultant services as risky.[107] Some practices, such as the use of natural enemies, take time to become effective.[108] Also, commercial pest advising firms cannot afford the kind of mass media advertising which the large chemical companies employ to sell their chemical products.[109] Thus, large growers are often the only ones who can take advantage of these services,[110] since small growers cannot afford the cost of independent consultant firms.[111]

There are other factors, however, which indicate that the independent consultant firms are not the answer, in the long run, to the need for a universally available program of technical assistance and advice on integrated controls. First, people hesitate to enter the private consultant business because the work is highly seasonal and it is hard to acquire capital.[112] Most growth in the industry has been gradual, through internal funding.[113] Second, scouts, who are needed by the firms to carry out monitoring of pest levels, are usually students or teachers who are available only seasonally. The firms must be able to trust monitoring personnel, yet it is hard to develop a skilled core of workers.[114] Third, consultants face the risk of suit in case of crop failure. Fourth, the saleability of their service may be threatened since the knowledge they sell can be acquired from independent consultants and used by intelli-

104. D. Hall, *supra* note 101.

105. NATIONAL ACADEMY OF SCIENCES, III CONTEMPORARY PEST CONTROL PRACTICES AND PROSPECTS 27 (1975).

106. D. Hall, *supra* note 101. In 1970, 40% of the cotton acreage in Kern County, 25% in Fresno County, and from 3 to 11% in Kings, Madera, Merced and Tulare Counties was served by independent consultants. In 1971, 9% of the citrus acreage in Kern County and 10% in Fresno County was served by independent consultants.

107. *Id.* at 13. *See also* COUNCIL ON ENVIRONMENTAL QUALITY, *supra* note 1, at 13. Lack of familiarity with IPM leads farmers to fear crop loss if they try new or complex methods of pest control, which might be recommended by independent consultants.

108. COUNCIL ON ENVIRONMENTAL QUALITY, *supra* note 1, at 13.

109. ENVIRONMENTAL PROTECTION AGENCY, I INCENTIVES FOR RESEARCH AND DEVELOPMENT IN PEST CONTROL 73 (1976).

110. The farms of those who use independent consultants in California average 680 acres, which is five times the size of the average farm in the San Joaquin Valley. D. Hall, *supra* note 101, at 13.

111. NATIONAL ACADEMY OF SCIENCES, *supra* note 105, at 73.

112. *Id.* at 28.

113. *Id.*

114. *Id.*

gent farmers, employees and competing pest dealers.[115] Finally, the risk involved in giving advice means the consultant often will take the most conservative approach and will be less willing to advise alternative pest control methods.[116] For these reasons, the independent consultant has not been able to adequately supply up-to-date information and assist the majority of California growers, a task which the government of California has left undone.[117]

C. Growers' Attitudes

Another major obstacle to the use of IPM is the attitude of growers themselves.[118] First, since growers often are motivated by economic interests, they are not likely to take into consideration long-range governmental goals, such as long-term protection of the environment. Aside from economics, the grower is influenced by other factors. For example, many growers simply may be ignorant of pesticide hazard.[119] They may feel that a pesticide used according to directions on the label is safe. In terms of health and environment, in the long run, however, this is not necessarily true.[120]

Growers also are more familiar with the use of pesticides. The farmers' fear of crop loss makes them cautious about experimenting with pest control methods. Even if an IPM program is the most economical pest control method for a particular crop and field situation, the grower still might be swayed to exclusive use of pesticides because they are applied easily and their usually fast results are known to the grower.[121] The pesticide is applied; the next day the bugs are dead. The effects of alternative control strategies are not always so dramatic. IPM programs control pest populations and keep damage to acceptable levels, rather than totally eradicating the pest. In addition, some alternative control methods, such as release of predators of the target pest, may take longer to accomplish control than use of a chemical.

The lack of training in using alternative technologies also influences the growers' attitudes. Thus, the nature of IPM and alternative technology becomes a deterrent to widespread grower use, since they often in-

115. *Id.* at 29.
116. *Id.*
117. This government study found that if private consultants are to make up a significant proportion of a future pest management delivery mechanism, the government must consider public subsidy or insurance programs to keep the consultant supply high enough. NATIONAL ACADEMY OF SCIENCES, *supra* note 105, at 29.
118. COUNCIL ON ENVIRONMENTAL QUALITY, *supra* note 1, at 12-13.
119. ENVIRONMENTAL PROTECTION AGENCY, I INCENTIVES FOR RESEARCH AND DEVELOPMENT IN PEST CONTROL 75 (1976).
120. For example, pesticides may be persistent, thereby remaining in the soil, and eventually posing problems even though applied in an approved manner.
121. However, fast results may be less of a consideration today since insects are becoming increasingly resistant to chemicals. *See* note 2 *supra*.

volve more sophisticated techniques than chemical applications. Insect levels must be monitored, information on economic thresholds must be available; a trained professional often is needed to determine what is the best control strategy.

D. Food Quality Standards

Extremely strict quality standards for agricultural produce also mitigate against the adoption of IPM or at least prevent its full utilization.[122] Growers are forced by processor, marketer and consumer pressures to produce cosmetically perfect crops. To achieve such a goal, the grower must strive for virtually zero pest levels. For this reason, available IPM programs on oranges, processing tomatoes and cling peaches, which maintain crop quality and yield while reducing pesticide usage up to fifty per cent hardly are used by growers.[123]

Due to the lack of a coordinated research program, the absence of an effective technology delivery system, growers' attitudes and strict food quality standards, development and use of IPM has not progressed very rapidly. Where economic costs of using an integrated control strategy are equal to the cost of using chemicals exclusively, farmers still may opt for straight chemical use because of the comparative ease of the method. Non-chemical or less-chemical alternatives are perceived by individual users as entailing a risk sufficiently greater than continued reliance on chemical controls so as to discourage any shift.[124] Even with the problems encountered with insect resistance to chemicals, farmers need incentives to consider using other pest control strategies. Thus, the state needs to provide some incentive to ensure that environmental and health considerations enter into farmers' pest control decisions. To achieve a significant statewide decrease in the amount of pesticides used on California crops, the state must help the grower by providing unbiased advice as well as technical assistance to implement integrated control programs. The Director of the Department of Agriculture has a duty to provide a system for disseminating up-to-date information on pest control methods to the grower so that an informed decision can be made. Up to the present time, there has been "inadequate demonstration and advertising of the economic advantages of pest management by government agencies in California, despite ample justification in terms of health, safety, and environmental quality."[125]

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122. ENVIRONMENTAL PROTECTION AGENCY, INVESTIGATION OF THE EFFECTS OF FOOD STANDARDS ON PESTICIDE USE ii (Contract 68-01-2602) (principal investigator R. van den Bosch).

123. *Id.*

124. CONTEMPORARY PEST CONTROL, *supra* note 1, at 271.

125. ENVIRONMENTAL PROTECTION AGENCY, EVALUATION OF PEST MANAGEMENT PROJECTS FOR COTTON, PEANUTS AND TOBACCO IN THE U.S. 73 (1975).

IV. Suggestions for State Action to Foster the Use of IPM

California can take several courses to encourage the use of IPM techniques in pest control. First, California can offer various incentives to growers.[126] Second, the Department of Agriculture can pass implementing regulations to attain the goals of environmental protection expressed by the California Legislature. Third and most importantly, the state can develop a coordinated delivery system to provide information and assistance to growers on IPM. This section will explain and evaluate these possibilities, recommending a course of action designed to bring about a significant change in the making of California pest control decisions.

A. Incentives

Under present conditions, growers bear the brunt of the cost of environmental measures.[127] Since the benefits of a healthier environment accrue to all, the costs of achieving that goal should be borne by all. One way to spread the cost is to offer incentives. The theory behind offering incentives is that desirable programs have not been instituted because of unwieldly costs of unreasonable risks but that the removal of these obstacles will encourage the use of environmentally beneficial methods. Among the incentives California could offer directly to growers to encourage use of available alternative technology are (1) indemnification of the grower (direct payments for crop losses); (2) crop insurance; (3)

126. Most incentives which have been proposed to fill the gap created by industry's disinterest in developing alternative pest controls have been envisioned as taking place at the federal level. *See, e.g.*, Environmental Protection Agency, *supra* note 92, which recommends that government-funded research, government-performed research, insurance incentives, research and development loan/pay-back plans, and consumer education to increase the market for alternative pest control be considered by the federal government. However, the report notes that realistically even if incentives were offered to industry it is doubtful that many more would participate in the research and development process on alternative controls because of acceptance, economic and risk factors. *Id.* at 111. If even incentives failed, the responsibility would fall on the government to provide the needed research base. Another report notes that such diversified types of industries are producing pesticides that it is uncertain whether reaction to any government incentive would be uniform. Contemporary Pest Control, *supra* note 1, at 173. A third major study on incentives to industry, Environmental Protection Agency, Incentives for Research and Development in Pest Control (1976) made three main recommendations to increase development of alternative controls by offering incentives to industry. First, they recommended decreasing regulatory hindrances to research and development, which presently are inherent in the Environmental Protection Agency pesticide registration system. Second, they recommended reducing the risk of product development to industry. Third, they recommended lengthening the patent life of products by compensating for the time required for the registration process. *Id.* at 8-9. These incentives, however, also are feasible only if implemented by government at the federal level.

127. L.A. Jones, Insuring Crop and Livestock Losses Caused by Restricted Pesticide Use 1, U.S.D.A.-Economic Research Service # 512 (1973).

bonuses to cover unusual costs incurred in using alternative pest control methods; and (4) tax credits and exemptions.

While commercial applicators of pesticides must possess a written recommendation prepared by a pest control advisor,[128] farmers need not possess any kind of recommendation to apply a pesticide to their own land.[129] Thus, under the present California system there is no way to ensure that a grower even considers using alternative pest controls instead of unrestricted pesticides. An indemnification plan would provide an incentive to the grower to consider alternatives. According to one proposal,[130] the grower registers for the program at the beginning of the season and submits either an alternative pest management plan or signs an agreement to abide by the advice of a pest control specialist (public or private). At the end of the season, upon certification that the grower had satisfied the conditions imposed, the grower would be indemnified for losses suffered due to pest damage.

Although indemnification plans seem to provide the perfect incentive for the grower, the chances that they actually will be instituted are slim. The government would have to assume the entire risk of any out-of-pocket loss[131] as well as dealing with complicated proof problems in determining loss and settling claims.[132] Thus, indemnification will be adopted, if at all, only for a short period and probably would cease once alternative practices were widely adopted.[133]

Crop insurance is an incentive similar to indemnification, except that farmers bear part or all of the risk of loss by paying premiums. A state-sponsored crop insurance program could provide coverage for crop failures which were due to bona-fide failure of pest control methods and not due to poor farming practices or neglect. The theory behind crop insurance is that growers might be willing to use different techniques if they were protected against a possible decrease in earnings.[134] Heavy pesticide applications presently perform this insurance function for many growers.[135] They spend extra money applying large amounts of unneeded pesticides to ensure themselves against crop failure. Crop in-

128. CAL. FOOD AND AGRIC. CODE § 12971 (West Cum. Supp. 1978).
129. *Id.* § 12974.
130. *See* CONTEMPORARY PEST CONTROL, *supra* note 1, at 396.
131. The government would not have to assume the entire risk of loss under a partial indemnification plan. However, the effectiveness of partial indemnification as an incentive is questionable.
132. If the grower used a complex alternative program, indemnification might require a complicated schedule based on a rate of return on the farmer's whole operation, rather than a simple schedule based on past yields and production costs. *See* CONTEMPORARY PEST CONTROL, *supra* note 1, at 396.
133. *Id.* at 397.
134. L.A. JONES, *supra* note 127.
135. CONTEMPORARY PEST CONTROL, *supra* note 1, at 393.

surance, however, might encourage growers to accept what they perceive to be a higher risk in using IPM.

A federal crop insurance program already offers some coverage to eligible growers for crop losses.[136] Since the program limits coverage to seventy-five per cent of production costs, however, there is little incentive for growers to change pest control practices because they still bear a part of any loss that occurs. In addition, to spread the risk of loss and to provide low premiums, such a program needs a large number of participants. Unfortunately, under the federal program only eleven per cent of eligible growers participate.

California could make a crop insurance scheme attractive by offering low premiums and comprehensive coverage, but the plan would require broad-based tax support and extensive grower participation. Before implementing a crop insurance plan, the government would have to research certain aspects of the proposal. The same proof problems in setting up an indemnification plan also exist with crop insurance. In addition, setting insurance rate schedules to reflect loss caused by changed pest control practices might be difficult. Estimation of loss probabilities requires knowledge based on actual experience, but current knowledge is of limited value since it is based on agricultural practices which involve extensive use of pesticides.[137] Thus, research would be necessary to provide a data base for predicting loss probabilities when IPM is the predominant method of pest control.[138] If these problems can be worked out, however, insurance could reduce delay in the diffusion of new technology as well as spread the cost of reducing agricultural pollution. Moreover, a crop insurance plan would be more feasible politically than an indemnification scheme, simply because the cost of the program would be lower since growers contribute through premiums and bear at least a part of the risk of loss.

Another incentive, which could work in conjunction with crop insurance or indemnification, is a bonus to the user of alternative pest controls.[139] Some growers may shy away from learning to use IPM methods because they feel the initial cost is prohibitive. If they were compensated for any costs over and above the cost of using conventional pesticides, however, they would be more likely to try alternative methods. The bonus would not cover crop losses, but would reimburse growers for costs incurred in using the services of independent pest control advisors or for

136. The Federal Crop Insurance Corporation offers some insurance coverage to farmers. *Id.* at 394.

137. CONTEMPORARY PEST CONTROL, *supra* note 1, at 395.

138. The need for research to provide a data base for alternative pest control losses could be eliminated, however, if the government subsidized the insurance. Under such a scheme, a low premium would be set which would bear no relationship to the risk of loss and the government would subsidize losses above the premium amount.

139. J. Diekman, *supra* note 40, at 606.

training courses to learn to use alternative pest technologies. Like indemnification, the bonus would be offered to the grower for only a limited period to take care of initial costs associated with learning to use alternative methods.[140]

A tax credit for the cost of technical advice on IPM could also provide an attractive incentive. Tax credits already are being used to further other environmental objectives in California, on the policy ground that the entire state benefits. For example, a property owner who installs a solar heating system can receive an income tax credit or property tax exemption which in effect subsidizes part of the cost.[141] Similarly, a tax exemption currently is granted for the installation of pollution control equipment in private industry.[142] The same justification behind state sponsorship of solar heating and pollution control through tax exemptions applies to subsidizing growers' use of alternative technologies through tax credits. The public benefits because there is reduced use of harmful pesticides and increased use of environmentally desirable methods.[143]

B. The Legislative/Regulatory Scheme

Besides providing direct incentives to growers to use IPM, California can promote the use of alternative technology by making certain changes in the regulatory scheme.[144] These changes can be made by the passage of new legislation or the adoption of implementing regulations by the Director of the Department of Agriculture.

The Director of the Department of Agriculture has broad powers to adopt rules and regulations to carry out the California Food and Agriculture Code's division[145] on pest control operations.[146] One of the purposes of the division on pest control is to protect the environment by

140. If a bonus system were adopted, proof of authorized expenditures and limitation to certain kinds of expenditures would have to be required under the program.

141. CAL. REVENUE AND TAXATION CODE § 234 (West Cum. Supp. 1978) provides for property tax exemptions for solar heating systems; CAL. REVENUE AND TAXATION CODE § 17052.5 (West Cum. Supp. 1978) provides for tax credits for installation of solar heating systems.

142. *See* CAL. HEALTH AND SAFETY CODE §§ 44500-44563 (West Cum. Supp. 1978). Any bonds or notes used to finance pollution control in private industry are exempt from state and local taxation. *Id.* § 44555.

143. Conversely, a tax on the grower's use of broad-spectrum pesticides might reduce use of such pesticides by forcing growers to use feasible alternatives. However, this kind of disincentive would probably not be very effective "because a tax of the magnitude which would be possible politically seems unlikely to alter use patterns." Dunning, *supra* note 95, at 690.

144. *See* Comment, *The Regulation of Pesticide Use in California*, this volume.

145. CAL. FOOD AND AGRIC. CODE §§ 11401-12500 (West 1977 & West Cum. Supp. 1978).

146. *Id.* § 12005 (West Cum. Supp. 1978).

controlling and regulating harmful pesticides.[147] The Director is required to eliminate from use in the state any pesticide which endangers the environment.[148] To this end, the Director has broad powers to cancel pesticide registrations,[149] suspend operation of facilities[150] or to revoke agricultural pest control advisor licenses.[151] Another purpose of the division on pest control is to issue agricultural pest control permits to competent and responsible licensees under strict control of the Director and the county commissioners,[152] who enforce the regulatory scheme at the county level.[153] Beyond the regulation of pesticides, the Director is required to protect the environment by encouraging the development and implementation of alternative pest management systems, which include use of biological and cultural pest control techniques.[154]

The Director's discretion to promulgate regulations is limited by law to regulations which are consistent with the enabling statute and which are reasonably necessary to effectuate the purpose of the statute.[155] The agency cannot exercise greater discretion than that which is necessary for the fulfillment of the legislature's purposes.[156]

There are several problems in the way the current regulatory system operates. The Director, however, has the power to enact new regulations to solve these problems. First, the county commissioners should be required to meet standards relating to training and competence. Presently the county commissioner, who is charged with overseeing the issuance of permits for restricted pesticides,[157] is not required to meet any training standards. Since the Director has the power to adopt rules to protect the environment and encourage the use of alternative pest control techniques,[158] he or she should have the power to pass regulations detailing standards for appointment of county agricultural commissioners. Since county commissioners are required by law to consider possible alternatives before issuing a permit for a restricted pesticide,[159] they should have expertise in the area of alternative pest control as well as knowledge of pesticides.

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147. *Id.* § 11501(b).
148. *Id.* § 12824.
149. *Id.* § 12825.
150. *Id.* § 11737.
151. *Id.* § 12023.
152. *Id.* § 11501(d).
153. *See* note 93 *supra*.
154. CAL. FOOD AND AGRIC. CODE § 11501(f) (West Cum. Supp. 1978).
155. CAL. GOVT. CODE § 11374 (West 1966).
156. *See* Clean Air Constituency v California State Air Resources Board, 11 Cal. 3d 801, 523 P.2d 617, 114 Cal. Rptr. 577 (1974).
157. CAL. FOOD AND AGRIC. CODE § 14006 (West Cum. Supp. 1978).
158. *See* note 33 *supra*.
159. CAL. FOOD AND AGRIC. CODE § 14006 (West Cum. Supp. 1978).

A second problem in the present system involves the procedure used in issuing permits for restricted pesticides. While the use of restricted pesticides is limited by law to situations where no non-restricted material or procedure is equally effective and practical,[160] in practice the commissioner may lack the information or expertise to determine whether a feasible alternative control strategy exists. Under present law, a commercial applicator needs a written recommendation from a licensed pest control advisor before applying a restricted pesticide.[161]

This written recommendation is not furnished to the county commissioner unless specifically requested, despite the fact that the commissioner must decide whether to issue a permit for the restricted pesticide.[162] Unless the commissioner requests a copy of the written recommendation, he or she has no data concerning the feasibility of an alternative pest control technique. According to a 1977 report by the Department of Agriculture, during the last twelve month reporting period 53,947 restricted materials permits were issued by commissioners, while only 2,062 written advisor recommendations were inspected in making those decisions.[163] In fact, it is customary to issue blanket restricted use permits for an entire season.[164] While the law requires that the written recommendation be furnished only if requested,[165] the Director could pass a regulation requiring that the commissioners automatically request the written recommendation along with each application for a restricted materials permit. Alternatively, the legislature could change the law to require automatic submission of the written recommendation to the commissioner.[166] Another regulation the Director should enact involves a change in the nature of the written recommendation itself. Presently, the data required in the written recommendation is so cursory that even if county commissioners were furnished with a copy, and they had the time to read each recommendation before issuing or denying a permit, it still could not be determined whether a feasible alternative existed.[167] The regulations should require more information on the feasibility of various alternative pest control

160. *Id.*
161. *Id.*
162. *Id.* § 12973.
163. Cal. Dep't of Food and Agric., State Plan for Certification of Pesticide Applicators of Restricted Materials, 42 Fed. Reg. 35,184 (1977).
164. *Id.*
165. *See* note 162 *supra*.
166. However, when this minimal change in the law was proposed to the California legislature recently, *see* A.B. 1652, Cal. Leg. Reg. Sess. (1977), the bill was amended so that the only change now proposed is requiring the pest control advisor's name to be included on the written recommendation.
167. CAL. ADMIN. CODE, tit. 3, § 3123 on written recommendations requires only that the recommendation include: name of the property owner, location of the property, the kind of crop, number of acres to be treated, name of the pest involved, name and dosage

measures and related technical data to be included in the written recommendation, so that the commissioner can make an intelligent decision.[168]

Many pesticides qualify for the Director's list of "exempt materials", which require no permit.[169] Currently, there is no mechanism to ensure that growers and applicators consider alternatives to these "exempt" pesticides. While a regulation requiring a permit for the application of any pesticide might be ideal, in practical terms such a regulation would not work within the present system. The commissioners do not have the time to consider carefully each application for a restricted pesticide permit.[170] Moreover, decisions to apply a pesticide often must be made quickly, so that the application would have to be reviewed with an absolute minimum of delay, perhaps within two to three days. Meaningful consideration of alternatives could not possibly be made within so short a time.[171]

It might be argued that since the commissioners now have difficulty reviewing the few recommendations that currently are submitted with applications for permits, expanding the number required would be pointless. One solution would be for the Director to pass a regulation requiring close inspection and consideration of alternatives of randomly-selected applications.[172] Another solution would be to provide additional personnel at the county level to review the applications. Another change needed to ensure consideration of pest control alternatives is elimination of the conflict of interest inherent in allowing pesticide sales representatives to be licensed as official pest control advisors.[173] Since the Director has broad power to establish requirements for the licensing of pest control advisors,[174] he or she should promulgate a regulation requiring that pest control advisors be unaffiliated with any chemical or pesticide company to ensure that California growers are provided with unbiased advice on pest control methods. Alternatively, the legislature could enact this as a law.[175] The main problem with such a regulation or law is that enough independent advisors probably are not available to take the place of the pesticide salespersons if they were

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of the pesticide recommended, restrictions on harvesting the crop and workers' entry times and a warning of possible damages.

168. The Environmental Defense Fund proposed regulations, *supra* note 12, included a sample written recommendation form that would have expanded the information required to include data regarding the feasibility of using pest control alternatives.

169. CAL. FOOD AND AGRIC. CODE § 14006.7 (West Cum. Supp. 1978).

170. *See* text accompanying notes 93-97 *supra*.

171. *Id.*

172. *See* Environmental Defense Fund proposal, *supra* note 12, at 9.

173. *See* text accompanying notes 98-101 *supra*.

174. CAL. FOOD AND AGRIC. CODE §§ 12005, 12024 (West Cum. Supp. 1978).

175. S.B. 669, Cal. Leg. Reg. Sess. (1977) was proposed but has been sent back to the Senate Health and Welfare Committee.

barred as advisors. Therefore a supplementary program to train new advisors should be mandated concurrent with abolishing pesticide representatives as licensed advisors. A phasing-out period also might be provided to smooth the transition. The cost of such a program would be well justified.

Although policy statements in the law encourage consideration of environmental objectives, specific statutes conflict with this policy. For example, one of the purposes of requiring a permit for application of a restricted pesticide is to ensure that no feasible alternative pest control technique exists.[176] Yet under the California Food and Agriculture Code, a farmer or other non-commercial applicator does not need a written recommendation to get a permit for a restricted pesticide.[177] Thus, issuing permits for restricted pesticides to farmers, the commissioner has no data to call upon to determine whether feasible alternative pest control methods could be used. The legislature should amend the California Food and Agriculture Code to require that all growers submit recommendations along with applications for restricted pesticide permits. Until the legislature enacts such a statutory amendment, the Director cannot pass a regulation requiring all growers to submit recommendations since present statutory law pre-empts such a regulation.

Changes in the present legislative/regulatory scheme are desirable and long overdue. However, the best long-range solution is to structure the way technological pest control decisions are made in the private sector.[178] Changes in the regulatory system would be most effective if enacted in conjunction with a comprehensive program to deliver advice and assistance on pest control use decisions to all growers.

C. Improvement of the Information Delivery System

Comprehensive extension programs would improve significantly the current information delivery system to farmers. A comprehensive extension program promoting the use of integrated control strategies has several advantages which would further the state's goal of ensuring human safety and protection of the environment. One advantage would be that small growers, who may not be able to afford independent consultants, would gain access to professional advice on pest control alternatives. Also, such a program could provide a mechanism for regional cooperation and could assure that professional advice is available to the grower in the short time necessary for making pest control decisions.

176. CAL. FOOD AND AGRIC. CODE § 14006 (West Cum. Supp. 1978).
177. *Id.* § 12974.
178. Dunning, *supra* note 95, at 395.

The current extension program in California emphasizes the distribution of information to farmers, in the form of bulletins and classes. However, the program has not resulted in the widespread acceptance and use of alternative pest control methods. One reason is that farmers depend mainly on pesticide sales representatives for advice.[179] The extension agent may reinforce such dependence since extension agents often are limited in the sophisticated advice they can offer.[180] Another problem with the effectiveness of the present extension service is that there is no fast way to transfer current research to the extension services.[181] Yet according to a 1976 Environmental Protection Agency study on pest control incentives, the county extension program could be the ideal structure to train growers in new control methods.[182] A comprehensive extension program which combines both a coordinated research base and an effective information delivery system is needed.[183] One of the most important benefits of such a system is that growers receive biological and environmental information in a timely fashion, which allows the implementation of ecologically, economically and sociologically acceptable management strategies.[184] Grower acceptance of a similar system in Michigan generally has been good.[185] The reason for the relatively fast acceptance of the new program by Michigan growers probably was that growers already were familiar with the local exten-

179. See note 98 *supra*.

180. *See* note 95 *supra*.

181. ENVIRONMENTAL PROTECTION AGENCY, I INCENTIVES FOR RESEARCH AND DEVELOPMENT IN PEST CONTROL 97 (1976).

182. *Id.* at 96.

183. A similar program which became a three year pilot project was developed at Michigan State University. Begun initially for use on apples, it is now used for a variety of cropping systems. *See* MICHIGAN STATE UNIVERSITY, 3 ON LINE PEST MANAGEMENT 1 (1976).

184. *Id.* at 4.

185. *Id.* at 3.

The structure of Michigan's system consists of (1) a research base at Michigan State University, (2) a data processing center at Michigan State University which incorporates information on regional models, weather, pest identification and alerts, survey information and pesticide registration information, (3) an extension specialist network, which formulates pest control strategies from the collected data to the different areas, and (4) a pest management extension staff, including district and county agents and pest management field assistants. The program operates on a regional basis. Regional offices are equipped with a computer terminal and a code-a-phone, and pest management field assistants are assigned to each region. Also, a number of county agents have access to computer terminals from sources other than the project. Input by growers is usually either through the county agent, the field assistant or by phone. Messages coming over the computer to the grower are disseminated by using taped phone messages and bulletins. Eventually the system should give growers access to direct information through use of a simple, portable communications and data input equipment in the field. A keyboard send-receive terminal (such as the teletype) is used in conjunction with an acoustic coupler and the direct-dialed switched telephone network, B. Croft, J. Howes, S. Welch, *A Computer-Based Extension Pest Management Delivery System*, 5 ENVIRONMENTAL ENTOMOLOGY 21 (1976).

sion service and, thus, with some facets of the new extension program which were carried over from the old, such as informative periodic bulletins. An effort was made to acquaint growers with the new services through advertisement, radio shows and extension bulletins. California would have the same advantage of partial grower familiarity in starting a similar program.

Computerized extension systems have developed in response to the need for drastic alteration in the methods in data collection and delivery back to the user. A computerized information system is designed to deal with the kind of problems with which entomologists have always grappled. Their job has been (1) to collect relevant data about pests and factors such as weather and natural enemies; (2) to integrate the information and determine its significance; and (3) to transmit helpful advice back to the user in the field with a minimum of delay.[186] The need for rapid analysis is magnified with a pest control strategy such as IPM, which requires information in even greater detail before advisors can make a decision. A fully developed computerized extension system could serve agricultural areas on a state or regional basis by providing farmers with sound pest management recommendations based on the current condition of their pest-crop systems.[187]

While traditional extension services emphasize the distribution of information, a computerized system relies on the collection of data from growers. This is the chief mechanism for developing specific pest control strategies for certain regions. The data collected from a certain area is interpreted by experts and the results are available in a short time. Since timing in pest control is crucial, the main advantage of the system is that data is analyzed quickly and the resulting recommendation reaches the grower in time to make a decision.[188]

At present, computerized delivery systems are somewhat ahead of the biological research programs they are designed to distribute. When more information becomes available on alternative pest control methods, computerized delivery systems will be even more effective. However, the system offers many advantages that could be utilized immediately and the structure already would be in place when research advances make realization of the system's full potential possible.

California could initiate a computerized delivery system on one major crop. Starting with one crop would enable those involved to see how the system should work on a smaller scale and also would provide time

186. *Id.* at 20.

187. Pest-crop systems are combinations of a specific pest on a specific crop, which can be controlled by certain strategies. A different pest on the same crop might call for a different control strategy.

188. B. Croft, *supra* note 185, at 21.

for news of its advantages to reach growers through advertising and by word of mouth. Of course, acceptance often depends on results obtained in the initial phases of a program. California should use advertisements at the end of a successful phase of the project, as well as publishing the results to growers, to encourage growers to join the program.

Funding of a comprehensive extension program should not be a problem, at least initially. California can request federal help to begin such a program as a federal pilot project. Michigan's program began as a federal pilot project, but will become state-supported after its third year.[189]

California has several obstacles to overcome in instituting such a program, however. First is the lack of trained personnel. The state must actively seek out trained professionals to run the program and to supplement the personnel in the current extension service. Experts in IPM will be needed both at the county extension level and at the receiving level as data interpreters.

Second, the state must decide who will coordinate and run the program. In Michigan the program was developed voluntarily by Michigan State University with little help from the state Department of Agriculture. However, since the need for the least harmful method of pest control is pressing and it is the state's job to initiate action where health and the environment are concerned, California should consider government sponsorship.

One possibility is for California to use an already existing state agency to set up the program. The newly-formed Division on Pest Management, Environmental Protection and Worker Safety, under the Department of Agriculture, could perform the job. It could attempt to interest the University of California in helping develop such a program. If that failed, it could use independent experts to set up and run the program. Another possibility is for the legislature to create a new state agency or board to handle the program.

Third, California must decide who should provide the research base necessary for the program. If the University is not interested in setting up a unit to provide the data base, California should contract with another research institution to do so, in addition to utilizing current federally-sponsored research as a source.

A final consideration which faces California is the issue of mandatory versus voluntary controls. This issue must be faced in every decision where environmental considerations and the public benefit are weighed against the price to individual liberty. In view of the growing hazards of pesticide usage, should grower participation in an extension program

189. The Michigan system proved so successful that a state plan to continue the system on termination of the federally-sponsored pilot project is being developed. MICHIGAN STATE UNIVERSITY, 3 ON-LINE PEST MANAGEMENT 4 (1976).

providing technical advice on all methods of pest control be mandated? Should all growers be required to seek the advice of a professional pest control advisor, whether in the public or private sector? The purpose of environmental regulation is to ensure that costs are internalized and borne by those who derive the benefits that accrue from the environmentally hazardous activities.[190] Since farmers derive benefit from using harmful pest control materials, it is appropriate that they bear some costs, such as increased regulation. On the other hand, the environmental benefit of tighter regulation of pest control decisions eventually will accrue to the public at large as well and some of the cost should be borne by the public. While the "homocentric logic of self-interest" may lead finally "not to human satisfaction but to loss of humanity,"[191] the ultimate question is what level of restraint on individual liberty will result finally in a society which is no longer free?[192]

CONCLUSION

California should begin the expanded extension program with voluntary grower participation, in conjunction with direct incentives to the grower, such as tax credits or crop insurance. Grower education combined with some of the suggested regulatory reforms should go a long way to ensure that environmental concerns are part of the grower's decision in choosing an appropriate pest control strategy. Should a voluntary program fail, a mandatory system may become necessary.

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190. J. Huffman, *Individual Liberty and Environmental Regulation: Can We Protect People While Preserving the Environment?*, 7 ENV. L. 441, (1976-77).

191. L. Tribe, *Ways Not To Think About Plastic Trees: New Foundations for Environmental Law*, 83 YALE L.J. 1325 (1974).

192. J. Huffman, *supra* note 190, at 435.