PN-AB5-861 7415

Consortium for International Crop Protection

4321 Hartwick Road, Suite 404, College Park, Maryland 20740 USA
Telephone: (301) 403-4223 ☐ Cable: CONSORTICP
Telex: 5106013963 ☐ FAX: (301) 403-4226

AN ENVIRONMENTAL ASSESSMENT OF PEST MANAGEMENT PRACTICS AND PESTICIDE USE IN EL SALVADOR

Team Composition:

Heriberto Arreaga, Universidad of San Carlos, Guatemala
Filmore Bender, University of Maryland
Mary Louise Higgins, S&T/FENR, A.I.D./W, Team Leader
David Kauck, Tropical Science Center
J. Bruce Mann, University of Miami

Completed under Contract No. DAN-4142-C-00-5122-00 with the Consortium for International Crop Protection (CICP)

January 5, 1989

INTEGRATED PEST MANAGEMENT
AND
ENVIRONMENTAL PROTECTION
PROJECT

Contract No.
DAN-4142-C-00-5122-00
Project No. 936-4142

Member Institutions University of California, Cornell University, University of Florida, University of Hawaii, University of Illinois, University of Maryland, University of Miami, University of Minnesota, North Carolina State University, Oregon State University, University of Puerto Rico, Purdue University, Texas A & M University, United States Department of Agriculture

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ACRONYMS

ABC	ADMINISTRACION DE BIENESTAR CAMPESINO
A.I.D.	AGENCY FOR INTERNATIONAL DEVELOPMENT
APA	ASOSCIACION DE PROVEEDORES AGRICOLAS
BCR	BANCO CENTRAL DE RESERVA
BFA	BANCO DE FOMENTO AGROPECUARIO
CABEI	CENTRAL AMERICAN BANK FOR ECONOMIC INTEGRATION
CATIE	CENTRO AGRONOMICO DE TECNOLOGIA DE INVESTIGACIONES Y ENSEÑANZA
CDG	CENTRO DE DESARROLLO GANADERO
CDP	CENTRO DESARROLLO PESQUERO
CENREN	CENTRO NACIONAL DE RECURSOS NATURALES
CENTA	CENTRO DE TECNOLOGIA AGRICOLA
CICP	CONSORTIUM FOR INTERNATIONAL CROP PROTECTION
CIP	CONTROL INTEGRADA DE PLAGAS
COPAL	COOPERATIVA ALGODONERA SALVADORENA
DDA	DIRECCION DE DEFENSA AGROPECUARIA
DIVAGRO	DIVERSIFICACION AGRICOLA
EA	ENVIRONMENTAL ASSESSMENT
ENA	ESCUELA NACIONAL DE AGRICULTURA
EPA	ENVIRONMENTAL PROTECTION AGENCY
FDA	FOOD AND DRUG ADMINISTRATION OF THE U.S.
FAO	FOOD AND AGRICULTURE ORGANIZATION OF THE U.N.
FEDECREDITO	FEDERACION DE CAJAS DE CREDITO
FINATA	FINANCIERA NACIONAL DE TIERRAS AGRICOLAS
FUSADES	FUNDACION SALVADORENA PARA EL DESARROLLO ECONOMICO Y SOCIAL

GOES	GOVERNMENT OF EL SALVADOR
GR	GERENCIA REGIONAL
GTZ	GERMAN TECHNICAL ASSISTANCE AGENCY
ICI	INTERMEDIATE CREDIT INSTITUTIONS
IPM	INTEGRATED PEST MANAGEMENT
ISIC	INSTITUTO SALVADORENO DE INVESTIGACION DEL CAFE
INCAFE	INSTITUTO NACIONAL DEL CAFE
IDB	INTERAMERICAN DEVELOPMENT BANK
ISTA	INSTITUTO SALVADORENO DE TRANSFORMACION AGRARIA
MAG	MINISTEERIO DE AGRICULTURA Y GANADERIA
MIPLAN	MINISTERIO DE PLANIFICACION Y COORDINACION DEL DESARROLLO ECONOMICO Y SOCIAL
MIP	MANEJO INTEGRADO DE PLAGAS
ORD	OFFICE OF RURAL DEVELOPMENT
PFI	PARTICIPATING FINANCIAL INSTITUTION
ROCAP	REGIONAL OFFICE FOR CENTRAL AMERICA AND PANAMA
S&T/FENR	BUREAU FOR SCIENCE AND TECHNOLOGY/OFFICE OF FORESTRY ENVIRONMENT AND NATURAL RESOURCES
WHO	WORLD HEALTH ORGANIZATION

SUMMARY AND RECOMMENDATIONS

There is sufficient evidence from the review of literature and from first hand observations of the study team to state, unequivocally, that serious problems exist regarding the misuse, overuse and unsafe handling of pesticides in El Salvador. On average since 1980, more than 1100 poisonings have resulted in hospital visits each year (Chapter III.C.5.). Of these hospital visits, pesticide poisonings are among the top ten causes of mortality. In reality, the number of pesticide poisonings is almost certainly underenumerated because many cases go unreported and many pesticide related illnesses resemble other problems, e.g. respiratory infections. Over the past 10-15 years, residue levels exceeding allowable tolerances for organocholorines and parathion have been found in water, soil, beef, oils, fruits and vegetables, and human tissue. There have also been a substantial number of cases of pesticide related mortality in domestic and wild animals (Chapter III.C.2 and III.C.3).

If no positive action is taken to correct the situation, it is reasonable to conclude that El Salvador will lose export markets because of pesticide residues, that the environment will continue to be contaminated leading to the potential loss of existing industries (e.g. fish and shrimp), and that pesticide intoxications and related human health problems will continue at their current unacceptably high levels. In fact, there is every likelihood that acute intoxications will increase as organochlorine use declines in favor of organophosphates and carbamates, some of which pose a greater direct threat to human health.

If action is to be taken, it must be taken with full recognition of the problems and obstacles that exist to effecting change. These include the following.

1. Pesticide management problems are widespread and pervasive in the Salvadoran context (Chapter III.B.4 and III.C.2). Pesticides are readily available, even to the poorest farmers, and Salvadoran peasants are accustomed to their use.

2. Despite their familiarity with pesticides, El Salvador's small farmers are often woefully misinformed about proper pest control techniques. Overuse of pesticides, application at inappropriate times, disregard of proper safety precautions, and a lack of awareness of alternative methods of pest control are all common. Poverty and illiteracy contribute to pesticide use problems, making it exceedingly difficult to implement safety measures or to introduce alternative methods of pest control.

3. In recent years, the deterioration of the government's agricultural extension system, which was never adequate to meet the demand for technical assistance, has further inhibited the transfer of alternative pest control technologies.

4. The problem of overuse of pesticides is exacerbated by current banking practices which encourage the use of pesticides without ensuring their safe and effective management (Chapter III.C.2). Banking practices contribute to pesticide use in two ways.

   a. Banks commonly offer bland loans for the purchase of pesticides, but not for alternative pest control measures. This practice amounts to a subsidy for pesticide inputs which oftentimes renders alternative pest control strategies noncompetitive.

   b. Secondly, agricultural lending policies typically require that farmers use a designated portion of their loans for pesticide inputs. One bank, the Banco de Fomento, actually distributes pesticides itself as part of its agricultural lending program. Thus, even if alternative pest control measures are competitively priced, small farmers are not free to use credit to purchase that technology.

5. Crop diversification is being promoted without an accompanying base of knowledge about effective pest management in those crops. Thus, pest control depends on prophylactic use of pesticides based on a calendar schedule rather than on actual pest infestation and threat of economic damage (Chapter III.C.4).

There are a whole variety of actions that can be taken by A.I.D. and other donors, that are both practical and feasible, falling into four major categories: policy change, research, training, and extension. The recommendations that follow emphasize these areas but are presented in order of the first five priority actions that can be taken by the Office of Rural Development, USAID/El Salvador. More detailed suggestions are included within the body of the text.

Recommendation 1: Many of the pesticides that are currently in use are considered Class I chemicals, highly toxic to humans and the environment if the appropriate safety measures are not taken. It is highly unadvisable to permit use of such dangerous chemicals under the conditions in which they are being used, (i.e. frequent application and calendar spraying by farmers who lack adequate protective gear and knowledge of appropriate safety practices).

The first action that should be taken is to distribute broadly less toxic, general use chemicals. A list has been prepared with this environmental assessment. The chemicals are all registered for use and available in El Salvador. Cost differences and efficacy will need to be considered. Some of these comparisons are made in Section III.C.4. Adaptive research will be required to test chemical alternatives and to refine the attached list. Farmers are familiar with the use of certain chemicals, and will continue their use unless additional information is made available and alternatives are offered. Alternatives must be equally effective and comparably priced or they will be undersold by the more toxic chemicals (Chapter III.C.4).

Projects should place a high priority on field trials with safer chemicals if their efficacy is in question. Such field trails could be implemented by FUSADES on their demonstration plots, by the Water Management Project and/or by the CENTA/MIP team. Also CENTA does perform efficacy trials for pesticide registration. If resources could be made available (local currency funds), these trials could be incorporated into their existing activities.

This is part of a short term solution until broader scale training can be implemented, safety equipment can be procured, and IPM technologies can be developed and extended. The list attached to the draft document should not be considered completed or approved until the final document is reviewed and approved. This list will require continual updating.

Recommendation 2: Current exchange rate and credit policies make it exceedingly difficult to promote alternative methods of pest control. The current rate of exchange has resulted in an overvalued currency, and hence encourages the importation of agricultural inputs, including pesticides. Furthermore, the Central Bank, which rations scarce dollar reserves to importers, generally treats the importers of agricultural inputs preferentially. It is recognized that changes in the rate of exchange or the Central Bank's scheme of rationing foreign currency will be implemented for reasons that have nothing to do with pesticide use and handling practices. Other actions, however, could serve to compensate for the negative impacts that these policies have on pesticide imports.

USAID/El Salvador may consider working with Defensa Agropecuaria, Economia Agropecuaria, and the Banco Central de Reserva to encourage the cancellation or restriction of the importation and/or sale of highly toxic chemicals. Alternatively, a quota system or tax could be levied on the more toxic chemicals, thus discouraging their importation for general use. The system needed to implement this policy change already is in place. Quotas on imported agricultural inputs are currently set by the BCR and a sliding scale exists for import fees (ranging from 5-30%). Import fees could also be used to directly support safety and monitoring programs, and IPM. A.I.D. could negotiate changes in these quotas and fees as a condition of further economic support funds or local currency agreements.

Recommendation 3: As noted above, Salvadoran banks currently offer bland loans for the purchase of pesticides, but not for alternative pest control measures. This practice amounts to a subsidy for pesticide inputs. In addition, although credit is made available for pesticide purchases (which oftentimes are an obligatory condition of the loan), the banks have shown little interest in providing credit for safety equipment. The contribution to the economy and to national goals of low interest agricultural credit is beyond the scope of this study. However, credit policy changes could be implemented that would foster safer and more effective use of pesticides. This would include the following changes.

1. General use pesticides that are provided through credit programs should be accompanied by safety equipment such as cotton masks, light weight gloves, rubber boots and cotton overalls, i.e. equipment appropriate to

the Salvadoran context. Farmers should be required to procure safety equipment at a favorable price at the time that pesticides are procured and its use will be part of the loan package. Both the commercial banks and Banco de Fomento have a relatively large staff of agents that regularly visit farmers to monitor their loan portfolio. Loan officers could monitor compliance with this component of the loan during site visits, by reviewing former practices and use of safety equipment and types of pesticides.

2. In order to accomplish the previous recommendation, it will be necessary to familiarize loan officers in Salvadoran banks with alternative pest control technologies.

   Short courses should also be offered to acting loan officers. Project 0307 (Agrarian Reform Financing) currently is providing training for loan officers through the BCR. It seems likely that short courses on pest control and safe pesticide handling could be integrated into this program at a nominal cost. An illustrative budget is included as Attachment 4. Such a training program should have a monitoring and evaluation component built into it. CICP, under the S&T/AGR project, has developed training materials and conducted similar training courses in other parts of Latin America and the Caribbean.

3. As a result of this training, loan officers should include information on health risks and costs as part of the project risk/benefit analysis conducted for loan requests and when reviewing farm plans. Safe use means a healthier farmer who can more likely pay back on his loan. This training for loan officers, many of whom are agronomists, could be implemented through the contract with Arizona State in the Agrarian Reform Financing Project, as noted above.

4. As long as loans for agricultural inputs are going to be offered on concessionary terms, credit should be made available on terms that are at least as advantageous for biological and mechanical control measures as they are for pesticides.

Recommendation 4. Ultimately decreased pesticide use will require alternatives and options and the development of IPM technologies. IPM should be an explicit component of all future agricultural development projects, including A.I.D. projects, in El Salvador. Pests, and thus pest management, are part and parcel of agricultural production systems. Addressing this problem up front may avoid or at least minimize problems with pesticide use down the road. While a lot can be done with local currency, dollar resources would strengthen activities by providing timely access to necessary technical assistance. IPM should focus on extension where technologies exist and on research where research is needed. Where research is needed, it should be adaptive in nature and designed, developed and implemented with the participation of extensionists and growers. Building national capabilities is the key.

IPM in Nontraditional Exports

IPM Research in nontraditional crops needs to be expanded. FUSADES should support more research activities in IPM through a long-term advisor to coordinate and integrate IPM into their variety trials. Priority areas for research should include some of the following.

1. Resistant crop varieties to virus and fungus infection, development of which is likely to be done at the regional level through any one of the regional agricultural research centers (e.g. CATIE). Research in El Salvador on resistant varieties is likely to be primarily adaptive in nature.

2. Vector biology and control. Vector management is critical in some of the nontraditional crops to reduce disease transmission. Cultural practices and plant resistance, in addition to vector biology and ecology, will be key components of this research.

3. Sampling and monitoring techniques and determination of economic thresholds should be developed to enable moving beyond calendar schedules for the application of pesticides.

4. Development of cultural practices including rotations and intercropping techniques to control pests and diseases.

5. Diagnostics for pests and natural enemies in nontraditional crops.

IPM for Small Farmers

IPM technologies for small farmers will need to have somewhat of a different focus. Emphasis should be placed on IPM in mixed cropping systems and most importantly, on the design of sampling techniques and decision tools that can be used by farmers. The CATIE/MIP team, in coordination with the GTZ project, should look at these issues in determining research priorities. A farming systems approach perhaps will be far more effective for small farmers than a single crop focus. IPM Research for small farmers could develop needed technology for pest management in import substitution crops which are likely to be more manageable for small farmers than will be export crops.

It is recommended that a series of IPM agronomists be hired to work on horticultural crops. Regional IPM centers, which would be comprised of the agronomists and demonstration plots, would undertake research in selected crops. Agronomists would receive training from CENTA and FUSADES specialists, similar to the training now being provided under the Water Management Project. These agronomists could then train other extentionists and farmers through a series of workshops in IPM techniques. Simple issues such as early identification of pests and diseases and the presence of natural enemies could help to reduce pesticide use.

Finally, resources for research are slim in El Salvador. Interest in developing a private research foundation may have certain merits given the current problems with the flow of resources in the government. On the other hand, it could also further cripple what little is being done in the public sector. It is recommended that a research foundation, if established, be used to, in part, promote research to meet the needs of nontraditional crop development while also supporting the focus of the public sector, i.e. to work with smaller growers and IPM in mixed cropping systems. It is strongly recommended that IPM research be a clear priority to be supported by the foundation. This mechanism should be used to identify key pest problems and research needs to implement IPM programs in nontraditional export crops.

Public sector research could be complemented by establishing a research grants program in the foundation which would be accessible to both the private and public sector. The foundation could also offer research fellowships to university students who are already working with CENTA in the labs and the field. CENTA staff also serve as advisors to students at the various universities. Procurement of resources for the public sector could be done by the foundation, thus avoiding difficulties with the flow of resources.

Recommendation 5: Training in safe pesticide use and alternative pest management techniques, where available should be a part of every agricultural project in El Salvador. This emphasis should be increased in all projects. Listed below are some possible mechanisms to target training needs.

1. Safety training could be provided to bank loan officers as described above, to cooperatives through technical assistance firms working with cooperatives and as part of the phase III land titling. Some support may be provided to APA to provide training to distributors. APA training however, should be expanded to consider proper management of pesticides (e.g. timing and frequency) in addition to safety. Support to APA should be conditioned on developing the short courses in collaboration with an IPM specialist.

2. The support for curriculum development being provided through the Water Management Project and the TA in crop protection is excellent. It is strongly recommended that some of the basic courses for agronomy students be strengthened through this irrigation specialization with the support of the CENTA Control Integrada de Plagas. Another option might be to invite agronomy students to the specialized courses in crop protection as an elective, thereby taking advantage of the strengthened courses. Assistance in teaching and curriculum design may be available from some of the ecologists and agronomists teaching in the universities. These professors could consult on design thereby enabling use of local currencies for technical assistance.

3. IPM should be strengthened as a component of the curriculum at the Escuela Nacional de Agricultura (ENA). The agronomo program should also strengthen its training in ecology and IPM. Ecology courses should focus on agricultural systems, thus providing a background in

ecology that applies directly to the management of agricultural systems. An illustrative curriculum is included as Attachment 5 to the EA.

There is an important need to increase the collaboration and cooperation between ENA and CENTA particularly in the area of crop protection. CENTA has considerably more resources than ENA in terms of labs and library and CENTA could incorporate ENA students into the field research and provide practical experience in experimental methodology for ENA students. Agronomos need to develop a stronger set of tools for problem-solving and assessments (e.g. Rapid Rural Appraisal and Agroecosystems Analysis). Methodology courses could be strengthened. Finally, in many of the courses, there should be greater emphasis on field exercises, particularly within existing entomology and ecology courses. The ENA and CENTA administrations should consider this issue for increased collaboration.

4. Changing the minds of policy-makers is a critical step in effecting institutional changes. A short course for policy makers in GOES, USAID/El Salvador, and those private sector firms involved in the agriculture sector should be developed. The course should be at least two days long and present information regarding current practices and their environmental, economic and human health consequences, including information on alternative pest management strategies, including IPM. The bulk of the course will be spent in the field learning firsthand about the problems posed by pesticide misuse. The S&T/FENR Environmental Planning and Management (EPM) project is exploring possible collaboration with the Organization for Tropical Studies (OTS) in Costa Rica to provide environment and natural resources training for policy makers and NGOs. Action may be possible through this project.

5. <u>CATIE/MIP</u>: Continued support should be given to the CATIE/MIP project. There should be greater emphasis on extension where IPM technologies have been developed. Coordination between GTZ and MIP is critical. Both of their efforts are oriented towards small farmers. This should continue. CATIE/MIP may however focus more on import substitution crops. Emphasis should be placed on developing IPM techniques for small farmers in a farming systems context through applied and adaptive research, working directly with farmers in the development of technologies more so than has been done in the past. MIP, with A.I.D. assistance, should endeavor to increase its linkages with extension and the Gerentes Regionales to garner their support and allegiance.

The above outlined recommendations are considered priorities in terms of the overall impact they may have in directly addressing the pesticide use and pest management problems in El Salvador. Other options should be explored. These target other sectors and attempt to facilitate coordination between the public and private sectors.

Public Health Training and Information Needs

1. A series of training seminars on the proper treatment of intoxications should be offered to health professionals through the Ministerio de Salud. This in fact could be conducted as part of a planned emergency health care training course under the Health Sector Support Project in the Office of Health. The Office of Rural Development should follow up with the health office on this opportunity.

2. Current recommendations on the treatment of different types of intoxications should be compiled, published and distributed to all of the nation's hospitals and clinics. Within those facilities, that information should be easily accessible and prominently displayed.

3. Technical assistance should be given to the Ministry of Health so that health extensionists and rural clinics can provide short courses in safe pesticide handling and first aid in the case of intoxications. At the earliest possible date, pesticide intoxications should become part of the training activities offered to the rural health promoters program. These individuals are widespread and apparently well respected within their community. Again this would require coordination between the health and rural development offices of USAID/El Salvador, but the programs of the Office of Health offers a possible vehicle for implementation.

4. In order to close the data gap, the Ministry of Health should be encouraged to establish a national registry of intoxications. Such a registry should include information on the type of intoxicant, the circumstances of the intoxication, and the socioeconomic characteristics of the victim. Surveys should be administered to the victims by health professionals as part of the treatment process. The training seminars mentioned above would be an appropriate opportunity to distribute questionnaires to health professionals and to train them in interview techniques. A sample questionnaire and protocol is included as Attachment 6 to the EA.

It is important for all of the training activities described above that a monitoring, evaluation and followup component be included. Follow-up visits should be made to evaluate the impact of the training in terms of behavioral and attitudinal changes.

Coordination among sectors is critical. It is recommended that training programs incorporate the participation of health and agriculture professionals and the staff from both ministries. Not only is this important to minimize conflicts between the use of pesticides in public health and agriculture, but activities in both ministries could serve to mutually reinforce one another.

While the team did not have time to explore general educational issues and public awareness, the Office of Rural Development should examine opportunities to support environmental education with local NGOs and the use of radio public service announcements. The Office of Education is

developing a new rural radio program which may present a potential vehicle. It is recommended that the Office of Rural Development explore this possibility. S&T/Education has assisted USAID/Bolivia in a similar effort. Their communications project may be available to provide T.A. in the design of a pesticide safety program for radio.

Illiteracy is a serious impediment to safe use of pesticides. With illiteracy rates as high as 70% in the rural population, current labeling and packaging information is inadequate. APA and Defensa Agropecuaria should endeavor to develop more effective labeling for the illiterate portion of the population (e.g. pictograms in addition to color coding). This may be an appropriate area of collaboration between the USAID/El Salvador Offices of Rural Development and Education.

Data and Monitoring

Availability of data and information is patchy and results largely from specific studies. There is little, if any, continual monitoring of environmental, health and economic impacts of pesticide use. Lack of resources largely limits these activities. Monitoring programs should be put in place and supported in four general areas.

1. Environmental monitoring on impact of pesticides on nontargets (e.g. natural enemies, estuaries and avifauna) and environmental contamination (water and soil) due to pesticide use (i.e. monitoring residue levels). Future focus might be placed on fungicides and metal contamination, where fungicides are increasing in use, and on sensitive areas, both economically (e.g. fisheries) and ecologically (e.g. coastal zones).

2. Human health impacts should be monitored as described above. There is also a need to monitor and evaluate chronic poisoning through acetylcholinesterase (AcCh) levels to identify problem areas and to establish norms for AcCh activity for rural populations. Where sampling has been conducted, levels were depressed in about 40-45% of the population sampled. The norm for these populations and the interaction between the depression of AcCh and health status are unclear.

3. Residue levels on foodstuffs in the domestic market. CENTA and Defensa Agropecuaria have identified the budget needs to begin a monitoring program for vegetables in the domestic market (Attachment 7). Assistance could be provided to CENTA as part of existing A.I.D. projects. Resources should be provided in kind for reagents and equipment to avoid complex GOES procurement procedures. In addition, this type of support may fit into some of the IDB supported programs to build laboratory capabilities, at least in terms of the support for infrastructural development.

There is interest coming from many directions to develop a database of pesticides, pests, and crops. This could be a very helpful source of information to keep institutions abreast of changes in the status of

chemicals, to acquire information on alternatives and management options. Such a database would most appropriately be housed at Defensa Agropecuaria, CENTA and FUSADES. This should however, be a regional effort coordinated by ROCAP to assure uniformity and compatibility among systems, allow for periodic updates of information, and to capitalize on the work going on in the region. The database being developed by CABEI on the current software system (LOTUS) is a bit unwieldy. To begin, this should be reviewed as part of the data management activities soon to get underway in the Water Management Project. CABEI may also be available to provide guidance in developing a database. FUSADES should also support this effort and be closely involved since they appear to have far greater computer facilities at their disposal than does CENTA. This database would include guidance on use of pesticides, guidance on interventions (timing, economic thresholds, etc.) and cost implications of alternative pesticides. Information to be covered is included as Attachment 8.

AN ENVIRONMENTAL ASSESSMENT OF PEST MANAGEMENT PRACTICES AND PESTICIDE USE IN EL SALVADOR

I. INTRODUCTION

A. The Need for an Environmental Assessment (EA)

The adverse environmental and human health impacts caused by the misuse and overuse of agricultural chemicals in El Salvador have a long history. Traditional export crops such as cotton have historically accounted for up to 80% of El Salvador's pesticide consumption, and the decade of the 70's was accompanied by large numbers of pesticide poisonings and high levels of pesticide residues in human tissue, mother's milk and beef. While cotton hectarage has decreased, the importation, formulation and use pesticides remain high, and the development of nontraditional commodities for export is leading to a new suite of pest and pesticide management problems and practices.

The Agency for International Development (A.I.D.) is integrally involved in these development efforts in both its public and private sector programs, in which pesticides are procured through intermediate credit institutions (ICI). All A.I.D.-funded pesticide procurement and/or use requires a review of potential health and environmental impacts of the proposed use as outlined in Section 216.3(b)(1), Pesticide Procedures for Project Assistance, from 22 CFR 216, Environmental Procedures for the Agency for International Development. These requirements apply to the procurement of pesticides through ICIs even "when the objective is to assist in the capitalization of the institution or part thereof."

At the very least, these procedures call for the review of certain key factors and the incorporation of mitigations into project programs to minimize adverse human health and environmental impacts and to reduce the reliance on pesticides as the sole means of pest control. Among the factors that should be considered are:

1. EPA registration status of the proposed pesticide use;
2. basis for selection of proposed pesticides;
3. the extent to which the proposed pesticide use is part of an IPM program;
4. the proposed method or methods of application and safety equipment;
5. any acute and long-term toxicological hazards, either human or environmental associated with the proposed pesticide use;
6. the effectiveness of the proposed pesticide use;
7. compatibility with nontarget and target ecosystems;
8. conditions under which pesticides are to be used;
9. availability and effectiveness of alternatives;
10. regulatory capabilities;
11. provisions made for training; and
12. provisions made for monitoring the use and effectiveness of the proposed pesticides.

Each of these issues has been reviewed for USAID/El Salvador's Rural Development Projects which includes three ongoing programs, Water Management (519-0303), Agrarian Reform Financing (519-0307) and Agribusiness Development (517-0327). While USAID/El Salvador is responding to a specific need to review pesticide use and procurement in conformance with 22 CFR 216, there is a larger and more pervasive issue at hand, and that is the constraint that pesticide use, misuse and overuse could pose to current and future development efforts. Misuse may increase the threat to human health and safety. It may also result in high levels of pesticide residues in foods destined for the export and domestic market. Residues could limit access to U.S. markets which have strict quality standards regarding the presence of pesticide residues. New legislation is pending in the U.S. Congress (Dingle Act) that would require producer countries such as El Salvador to demonstrate the ability to monitor pre-export quality standards both with respect to pest incidence and pesticide residues. It is likely under this bill, that the Food and Drug Administration (FDA) will increase its spot checks for pesticide residues for commodities entering the U.S. under this bill, further emphasizing the need for residue levels to remain within the legal range.

Implementation of safe pesticide use and effective pest management is constrained by several factors. Among these are the increased demands being imposed upon the extension service to provide technical assistance to Phase I cooperatives. Prior to agrarian reform, large producers of cotton, coffee and sugar did not generally rely on technical assistance from the extension service, but rather maintained their own trained agronomists. When these estates became Phase I cooperatives, they immediately needed technical assistance from an extension service that was already overburdened and deteriorating from lack of resources which were being directed towards resolving the civil conflict. Therefore any improvements in current pest control practices must be made in the context of an overextended, understaffed Ministry of Agriculture.

A second problem arises when considering the base of knowledge and experience in the agricultural sector and the nontraditional crop production focus of USAID/El Salvador development efforts. To achieve long-term, stable economic growth, Salvadoran agriculture must diversify, both to expand the economic base beyond traditional exports and to meet some of the food needs of the growing Salvadoran population. Consequently, USAID/ES is implementing development programs which emphasize the production, processing and marketing of nontraditional crops for export potential and vegetables for import substitutions. Some examples include melons, broccoli, okra, sesame, cucumbers, cabbage, tomatoes, carrots and pond produced shrimp. Information concerning the management of these crops - especially with respect to phytosanitary practices - under Salvadoran conditions is limited. Without such information, there is a tendency to rely strictly on pesticides as the only means of pest control and current practices largely depend on prophylactic use of pesticides, applied on a calendar basis. Many are Class I compounds, highly toxic to humans and the environment. This situation can only lead to high production costs, development of resistance and secondary pests, not to mention the adverse health and environmental impacts.

A third problem area in El Salvador stems from the strict reliance on pesticides in traditional crops. El Salvador has a long history of pesticide use. Growers are accustomed to their use. Furthermore, they are readily available and accessible to even the poorest farmers. Their management problems and negative impacts are thus widespread and pervasive in the El Salvadoran context. Poverty and illiteracy further contribute to pesticide use problems, making it exceedingly difficult to assure their safe and effective use.

The fourth problem is related to banking and credit policies which tend to promote and subsidize use of pesticides.

Recommendations on safe use must be accompanied by resources to procure the necessary equipment. Decreased use of pesticides can only be realized through the development and application of IPM technology and alternative pest management practices. If El Salvador is to pursue export-led development in the agricultural sector, it must be able to assure proper pesticide use and cost effective pest management. Therefore, rational integrated pest management (IPM) in horticultural crops needs to be initiated as soon as possible.

B. How the EA was Conducted and Constraints to Implementation

USAID/El Salvador contracted with the Consortium for International Crop Protection (CICP) to conduct an environmental assessment (EA) of three major projects through which pesticides are being procured. In addition, USAID/El Salvador arranged for the assistance of S&T/FENR Environmental Protection Specialist from A.I.D./W to assist in this effort. A total of 14 person-weeks in country was spent from October 17 to November 11, 1988. Follow-on work as outlined by the team should be conducted after November 11, 1988. The team-members included the following:

Heriberto Arreaga	M.D.	M.D.	Univ. of San Carlos, Guat.
Filmore Bender	Economist	Ph.D.	University of Maryland
Mary Louise Higgins	Team Leader	Ph.D.	Entomologist AID/W
David Kauck	Sociologist	Ph.D.	Tropical Science Center
J. Bruce Mann	Chemist	M.S.	University of Miami

All information and conclusions are drawn from selected interviews, site visits, the review of literature available in El Salvador on projects and institutions, and the review of the results of research conducted by local institutions. The list of persons contacted and documents and reports reviewed are included as attachments 1 and 2, respectively.

The inability to collect first hand information, the overall scope and the limited time allotted were amongst the greatest limitations to the implementation of the EA. While the entities involved with specific projects are somewhat limited in scope, the number of organizations and individuals involved in pesticide regulatory issues, imports, use, handling and IPM are considerable. The GOES presents a formidable institutional structure to be understood. Travel to project sites was constrained by both

time and security, consequently limiting the degree of firsthand data collection possible. Thus, data for environmental impacts and human health risks, specifically related to these projects, could not be collected. All conclusions are drawn from general trends based on secondary data and observations from a small sample set that is assumed to represent adequately the problems in the field.

II. DESCRIPTION OF AFFECTED AREA

A. Geographic Areas Affected

Most of the agricultural areas of El Salvador is included within one of the three ORD projects described below. Thus, environmental impacts are broad and widespread throughout different and varied physical and biological environments. It was impossible in the limited time available to fully categorize the types of habitats and soil and water conditions under which pesticides will be used. Therefore, specific environmental impacts could not be evaluated. Most of the natural vegetation of El Salvador had been removed at some point in the past, therefore, the impact on nontarget flora and fauna is probably limited to small refuge areas, coastal regions, some of the national parks and other areas that may receive the runoff of pesticide contaminated water and soil. The discussion below provides a very brief summary of the agriculture, economy, and major environmental and demographic features of El Salvador. Detailed information on the climate, physiognomy, vegetation, flora and fauna, and human population can be found in the country environmental profile for El Salvador.

1. Agriculture and Economy

El Salvador is one of the smallest countries in Latin America with a total surface area of approximately 21,000 Km2. It is bounded on the west by Guatemala, on the north and east by Honduras, on the south by the Pacific Ocean and shares the Gulf of Fonseca with Nicaragua and Honduras (Figure 2.1). El Salvador is divided into 14 Departments. However, for many national programs the country is divided into four regions (Figure 2.1 and Table 2.1).

Among the Central American nations, El Salvador is the most intensively cultivated country in the region. Currently, more than 55% of the total land area is actively cultivated (Table 2.2). Since 1970, from 55-65% of the total land area has been engaged in the production of crops or livestock. An additional 12% consistently has been classified as forest since 1970, which includes national parks. Of the remainder, which is categorized as nonagricultural lands, only 14.4% was considered unsuitable for agriculture of any sort.

The traditional export crops (coffee, sugar and cotton) and the basic grains (corn, beans, rice and sorghum) occupy more than 95% of the land under cultivation. For most of the major crops, area under cultivation rose to a peak during the years 1978-80 and then declined gradually to the current levels (Table 2.3). This period of decline coincides with the period of political and social turmoil within the country. Cotton has shown the most dramatic decline from a peak of 150,100 manzanas in 1978 to an estimated 18,000 manzanas for 1988.

Historically, agriculture has dominated El Salvador's economy. It is still the major earner of foreign exchange. For El Salvador's population of 5.1 million, agriculture provides 40 percent of employment, 23 percent of Gross Domestic Product (GDP) and 75 percent of the value of exports.

During the 1960's and 1970's El Salvador's economic growth rate was among the highest in Latin America. In spite of its high population growth rate, (2.92% per annum) real per capita income rose rapidly during the 60's and 70's. However, with the outbreak of social and political turmoil in 1979-80, which continues to this day, the economy has suffered substantial losses. Real per capita income dropped 34 percent between 1978 and 1982 (Figure 2.2). Although some progress has been made since 1982, living standards in 1988 are at essentially the same levels that existed in the 1960's with per capita income for 1987 estimated to be $678 (Table 2.4).

Prior to 1978, El Salvador had an expanding economy, a positive balance of trade, a stable currency and an extraordinarily low rate of inflation. (The rate of inflation was less than 1% per annum during the 1960's and less than 11% per annum during the 1970's). With the political turmoil, beginning in the late 70's, there has been a substantial loss of social and economic infrastructure and a consequent disruption of domestic economic activities, coupled with capital flight which has exacerbated an already serious situation. Simultaneously, since 1979, the international prices for El Salvador's major export crops (coffee, cotton and sugar) have declined substantially.

The combination of internal conflict, with its adverse economic consequences, and unfavorable prices for the country's major export crops has resulted in domestic inflation of 20 to 30 percent per year, repeated devaluations of the colon (C2.50 = US$1.00, 1979 and C5.00 = US$1.00, 1988) and an adverse balance of trade. In spite of repeated devaluations, the colon remains overvalued, which results in severe economic distortions within the country.

2. Environment

a. Climate

El Salvador is situated at latitude 13° 9'N, bordered by the Pacific Ocean on the west and landlocked by Guatemala and Honduras in the east. The climate and vegetation are strongly influenced by various features including its geographic position. The position in the tropical belt results in warm to hot temperatures and equal daylength year round. The proximity of the ocean to most of the land area of El Salvador provides a moderating influence over most weather conditions. The central mountain range and the strong north/northeasterly winds result in a dry season that is more pronounced than those regions situated along the Atlantic slopes of Central America, characterized by the long dry season and interruption of the rains during the middle of the rainy season ('la canicula').

The rains begin about May and last through September or October. This short growing season, during which water is available, has limited agricultural intensification in rainfed zones. Agricultural production is also further limited by a break in the rains which occurs during July and/or August, the height of the growing season, caused by Atlantic high pressure zones. The rainy season lasts for an average of 21 weeks with an average 4 week transition period into the dry season.

Average annual rainfall ranges from 1700mm along the coast to 2600-2800mm in the eastern mountains of the country. In most of the major agricultural regions, rainfall averages 1700-2200mm per year. Two of the three projects aim to override seasonal limitations of rainfall by expanding irrigated agriculture. Those project sites are indicated by the circled crosses in Figure 2.1. Increased and reliable access to water will permit a prolonged and continuous growing seasons, and with it may come new pest problems.

b. Tropical Forests and Vegetation

El Salvador has been characterized into six ecological life zones according to the Holdridge Life Zone System (See Figure 2.3).

Life Zone Classification	% of Surface Area
Tropical Dry Forest	0.80
Tropical Humid Forest	3.10
Subtropical Humid Forest	86.30
Subtropical Moist Forest	8.10
Low Montane Moist Forest	1.60
Montane Moist Forest	0.02

Subtropical humid forest is the predominant ecosystem in El Salvador. This life zone is drier (1400-2000mm/year) with a very marked dry season lasting six months and characterized by scrub or deciduous vegetation depending on the elevation. In reality, most (at least 80%) of the natural vegetation has been cleared for agricultural production and as shown in Table 2.2, only about 12-13% of the surface area of El Salvador remains in forest or natural vegetation. Of this approximate 260,000 ha. of forest, about 95-97% is in natural forest and 3-5% is coniferous or broadleaf forest plantations. All forests face serious threats from the collection of fuelwood and wood for construction. Mangroves are under serious pressures and mangrove organisms are exposed to runoff from coastal agricultural zones. Most protected areas are largely nonarable, steep slopes outside of cultivated areas. Natural areas and reserves, including mangroves are shown in Figure 2.4 (indicated by the dashed lines along the coast). The remaining areas have been under cultivation for decades and are currently dominated by 7 crops as shown in Table 2.2 and discussed above. Despite the intensive land use, there are a number of small woodlots and refuges interspersed in agricultural zones that may serve as refuges for wildlife, and be in sufficient proximity to suffer the impacts of pesticide use.

c. Soil Resources

While three soil types predominate in El Salvador, the distribution is quite variable on a local level. On a national level, the principle soil types include:

Red Clay Latisols	35%
Regosols (sandy or volcanic origin)	20%
Alluvial Soils	15%
Lithosols	19%

Red clay latisols and regosols are primarily volcanic in origin. Regosols found in the coastal planes are marine in origin. Red clay latisols are medium to low quality. Regosols are valued for pasture and special crop cultivation. Alluvial soils are generally highly productive, with moderate to no slopes along rivers and watercourses, e.g. coastal planes and interior valleys. These soils are however, subject to inundation and flooding. The final major soil types, lithosols, are shallow soils found largely on steep slopes and abrupt and dissected regions of the country, and are generally of poor quality.

d. Rare and Endangered Species

Extinction of the flora and fauna is a common pattern and trend in El Salvador. Many major vertebrate species are already extinct in El Salvador, including scarlet macaws, jabiru storks, crested eagles, jaguars and tapirs. Of the 700 described tree species, 77 are either unknown in the wild or restricted to refuges of national parks and reserves. Fifty-three of the 365 orchid species are listed as endangered or threatened, and 8 of the 75 described bromeliads are similarly restricted in their ranges. Of the estimated 40,000 species of animals, 75% are insects. Yet, there are no available data on the status of insect populations. Four hundred and fifty species of birds, 30 amphibians, 80 species of reptiles and 110 mammal species are described for El Salvador, and of these 78, 3, 21 and 21 respectively are listed as threatened, endangered or already extinct. These figures probably underrepresent the actual population status of many plants and animals in El Salvador. Few studies or monitoring programs are underway currently, and given the limited and restricted availability of habitat, it would be very surprising to find conditions to be better than reported here.

Three major factors account for the trends in extinction of plants and animals in El Salvador:

1) habitat destruction, isolation and reduction of habitat area;
2) overexploitation, especially for wood, collection, and hunting; and
3) loss of pollinators and dispersal agents.

Pesticide contamination of rivers and estuaries poses a serious threat to shore birds and invertebrates. Seed-eating and insectivorous birds are also threatened by pesticide contamination. Given the existing pressures in terms of loss of habitat, and the already serious population status of many plant and animal species, pesticides, particularly for aquatic and seed eating animals, pose a special threat to wildlife populations.

3. Population and Demography

El Salvador is one of the most densely populated countries in Central America. With a population of about 4.8 million, population density of 250 km2, and a population growth rate of 2.92% per annum, agricultural expansion and intensification has proceeded throughout most of the country, as discussed above. Current food production has barely kept pace with the

growing population (Table 2.5) and production goals will require increased intensification (e.g. pesticide use).

As in many developing countries, the population is largely rural and engaged in the agricultural sector. The population is predominated by younger age groups (nearly 46% of the population is less than 15 years of age - Figure 2.5). This age group is particularly susceptible to pesticide poisoning. Susceptibility to pesticide poisonings is aggravated by low literacy rates (up to 80% in some regions) and the fact that children and teenagers have little experience with the use of pesticides. Further, poisonings may be particularly grave for individuals under nutritional stress. Malnutrition rates are very high affecting more than 50% of the population, especially in the poor and marginal zones of the north and east.

B. Rural Development Projects

Each of the agriculture and rural development programs has a direct, through the use of production credit, or indirect, through technical assistance and promotion of nontraditional exports, impact on pesticide use and pest management practices in El Salvador (Table 2.6). A credit fund is administered by FUSADES in the case of the Agribusiness Development Project and the commercial banks in the case of the Agrarian Reform Financing Project. Credit funds have also been available to the Banco de Fomento under the Agrarian Reform Support Project which ended in July 1988. However, the BFA will probably be incorporated into the Agrarian Reform Financing Project in the near future. The Water Management Project comes closest to addressing some of the pest management needs of irrigated agriculture through the support being provided to the public sector under the direction of the United Schools of America.

An environmental assessment was recently completed for the Displaced Persons Project (519-0287) and is therefore, not included in this document. This project is limited in scope in terms of crops and level of support. Emphasis in the EA is placed on the use of general use chemicals.

Finally, the future directions for the mission will continue to emphasize the private sector role in the development of nontraditional crops for export. The lack of information on environmentally sound pest management further emphasizes the need for some long range planning to establish research priorities and to provide extension services and training in IPM.

1. Agribusiness Development Project (519-0327)

The Agribusiness Development Project (519-0327) is a five year (1987-1992) project with a commitment of $20 million from USAID and $6.7 million of matching contribution by private sector organizations in El Salvador. The purpose of the project is to increase the production and export of nontraditional agricultural products, thereby increasing employment and foreign exchange earnings.

The project will be managed and coordinated by FUSADES. FUSADES will procure the short-term technical services required by the client groups. It will contract directly for specific studies or will carry out studies with its own staff. FUSADES will also arrange for most, if not all, of the short-term technical training needed. In addition, FUSADES will administer the credit fund ($10 million) which will be used by the client groups participating in this project.

The target groups to receive project inputs include: (1) private companies and individuals in El Salvador and (2) private sector producer groups and agrarian reform cooperatives. Since the program is focused on nontraditional exports, the likely candidates for exploitation are melons, berries, vegetables (e.g., broccoli, cauliflower, brussel sprouts), specialty vegetables and exotic/tropical fruits and cut flowers. To date, most of the attention on production and marketing has been given to melons (cantalopes, honeydews and watermelons).

This project would offer an ideal opportunity to introduce integrated pest management (IPM) and alternative pest control strategies into El Salvador. Because the focus is on export marketing, it will be necessary to ensure that pesticide residues are within the tolerances of the importing nations (i.e., United States, Europe, Japan, etc.), and because only innovators will undertake an activity as new and uncertain as the production and marketing of nontraditional export crops, it is reasonable to presume that the producers will be receptive to new ideas, if they can be demonstrated to be profitable.

However, economic factors may also serve to encourage pesticide use. For export crops, given the importance of aesthetic quality and the high market value of those commodities, pesticide costs may represent only a small fraction of the value of the crop. External costs such as poisonings and environmental contamination do not figure into these calculations. Also if the risk of rejection is higher from pest infestation than from pesticide residues, due to differences in inspection activities, pesticide use may remain high.

2. Agrarian Reform Financing Project (519-0307)

The Agrarian Reform Financing Project (519-0307) is a five year project (1986-1991) involving planned obligations not to exceed $50 million, plus $17 million of matching GOES support. The project is intended to respond to the immediate need for agricultural credit to the reformed sector while

working to expand the role of the commercial banking system in lending to the reformed sector.

The project contains four elements: a rediscount line of credit for production and investment loans; a training program for agricultural loan officers of the Banco Central de Reserva (BCR) and Participating Financial Institutions (PFI); a series of policy studies and services; and a pilot rural savings mobilization program.

By providing incentives to commercial banks to participate more actively in agricultural credit, it is intended that agricultural credit would be placed on a firm financial standing. In other words, Phase I cooperatives and Phase III beneficiaries would, in time, emerge as credit worthy commercial borrowers and the system would become financially self-sustaining.

Because Phase I cooperatives and Phase III beneficiaries exist throughout the country, there is no geographic concentration of this program.

The primary purpose of extending agricultural production credit is to enable farmers to purchase inputs that increase productivity and profits. Among the inputs purchased are chemical pesticides. As it is currently structured, this project makes possible the purchase of pesticides, but does not focus on their use and handling. The recommendations section of this report offers mechanisms that can be implemented within the structure of the Agrarian Reform Financing Project to address this concern.

3. Water Management Project (519-0303)

The Water Management Project (519-0303) is a five year (1985-1990) project with a total commitment of $25.2 million. Of this total, AID will provide $21.3 million. Participating institutions will provide an estimated $3.9 million in local currency in the form of in-kind contributions. The goal of the project is to generate employment, income and foreign exchange. The purpose of the project is to promote diversified irrigated farming in El Salvador through institution strengthening, technology transfer, training and credit assistance. The public sector component involves support for irrigation planning, extension and training. The private sector component provides support to firms engaged in or directly connected to intensive irrigated agriculture and export marketing R & D.

In the public sector component, institutions receiving assistance include the Agricultural Technology Center (CENTA), the National School of Agriculture (ENA), The National Training Center (CENCAP), the General Directorate of Irrigation and Drainage (DGRD), the Agricultural Sector Planning Office (OSPA) and the Office of Water (OA). For the private sector component of this project, FUSADES is the overall coordinator of activities.

The focus of the project is on the production of high value, labor intensive fruits, vegetables, and flowers, which offer substantial export

possibilities. The project paper lists more than thirty crops including melons, cucumbers, berries, okra, tomatoes and sweet peas. Because these crops will be grown for export to major markets (e.g., United States, Europe, Japan) it will be essential to ensure that pesticide residues will be within acceptable levels.

4. Future Projects

Future agriculture projects will continue to promote private sector development which includes the establishment of a private sector mechanism to carry out technology development. The goal will be to carry out adaptive research, identify promising crops and technologies and provide technical assistance to help create a profitable agroindustrial sector. This activity is now being designed and will be implemented through an amendment to the Agribusiness Development Project.

At present, there is no explicit definition of the financial and human resources that will be set aside to conduct applied research in IPM (plant resistance, intercropping, rotations) for nontraditional export crops. The project amendment has not identified research priorities. It is important that research conducted under this project be designed to help meet the pest management needs being expressed in other projects.

Projects planned for the future (e.g. Commercial Farming) continue to stress high production of nontraditional crops. As the projects are being designed, pest management specialists should be included on design teams to assure that crop protection and environmentally sound, economically viable pest management are integrated into the overall project. New projects should be able to build on the progress for safe pesticide use made in current projects.

Table 2.1. Regions and Departments of El Salvador

REGION	DEPARTMENT
I	Ahuachapan Santa Ana Sonsonate
II	Chalatenango La Libertad San Salvador Cuscatlan
III	La Paz Cabañas San Vicente
IV	Usulutan San Miguel Morazan La Union

Table 2.2. Patterns of Land Use (thousands of hectares)

	1970	1977/78	1978/79	1987/88
1. CROP AGRICULTURE	631.9	656.1	668.4	592.9
Annual crops	428.7	385.9	407.5	345.6
Semi-permanent crops	38.7	52.2	42.4	44.9
Permanent crops	164.5	218.0	218.5	204.4
2. LIVESTOCK	664.9	522.4	522.4	573.8
Improved pastures	114.6	129.8	131.8	160.7
Natural pastures	550.4	393.6	390.6	413.1
3. FORESTLAND	250.3	250.0	260.9	249.1
4. NONAGRICULTURAL LANDS	552.9	666.6	652.4	688.1
5. TOTAL	2100.0	2095.1	2104.1	2103.9

Note: The nonagricultural lands include lands with agricultural potential that are abandoned or never were used, as well as lands with no agricultural potential. In 1987/88, it was estimated that only 14.4% of the nonagricultural lands had no agricultural potential.

Source: Torre and Norton, Food Exports, Agricultural Policies and Agricultural Development in El Salvador, 1960-1987.

Table 2.3. Area Planted for Some Principal Crops, 1967-1986 (thousand manzanas)

	Coffee	Cotton	Cane	Corn	Beans	Rice	Sorghum
1967	206.0	67.8	37.1	270.9	42.9	40.0	148.4
1968	206.0	75.0	37.4	285.4	45.3	39.0	162.5
1969	206.0	81.6	34.8	276.8	45.9	15.3	162.6
1970	207.0	92.8	35.0	298.2	51.2	17.0	177.4
1971	209.0	88.3	41.4	298.9	56.4	20.9	180.0
1972	212.0	111.9	47.7	298.8	56.9	15.7	186.4
1973	217.0	127.3	49.5	289.4	64.2	13.6	170.0
1974	217.0	130.7	46.6	302.9	76.0	15.9	182.0
1975	220.0	128.2	56.6	351.2	78.5	24.2	189.1
1976	224.0	115.9	50.1	334.5	75.5	19.7	178.5
1977	239.0	122.8	50.8	349.8	75.1	17.8	188.8
1978	265.8	150.1	60.4	379.9	74.8	19.9	195.4
1979	265.8	127.8	50.7	394.1	79.0	21.1	205.0
1980	265.8	112.9	45.0	417.3	73.6	24.0	170.7
1981	265.8	78.6	41.0	396.6	71.3	19.8	165.0
1982	265.8	70.7	45.3	341.0	79.4	16.0	170.0
1983	251.0	70.2	48.0	344.9	80.4	18.0	158.0
1984	246.1	55.0	58.4	347.8	82.5	21.9	166.0
1985	239.1	49.5	56.3	361.9	82.8	24.7	163.4
1986	234.2	25.6	59.1	368.0	87.0	17.2	171.5

Source: Banco Central de Reserva.

Table 2.4. Per Capita Income for El Salvador in 1987 Dollars 1960-1987

Year	Per Capita Income
1960	608
1961	578
1962	678
1963	700
1964	742
1965	727
1966	822
1967	836
1968	850
1969	837
1970	827
1971	836
1972	842
1973	878
1974	878
1975	880
1976	941
1977	1024
1978	1018
1979	913
1980	816
1981	737
1982	667
1983	663
1984	681
1985	697
1986	683
1987	678

Source: Calculations based on data from the Banco Central de Reserva.

Table 2.5. Daily Availability of Calories Per Capita, 1975-1987

Year	Calories
1975	2688
1976	2229
1977	2428
1978	2644
1979	2295
1980	2263
1981	2236
1982	2057
1983	2044
1984	2336
1985	2336
1986	2376
1987*	2416

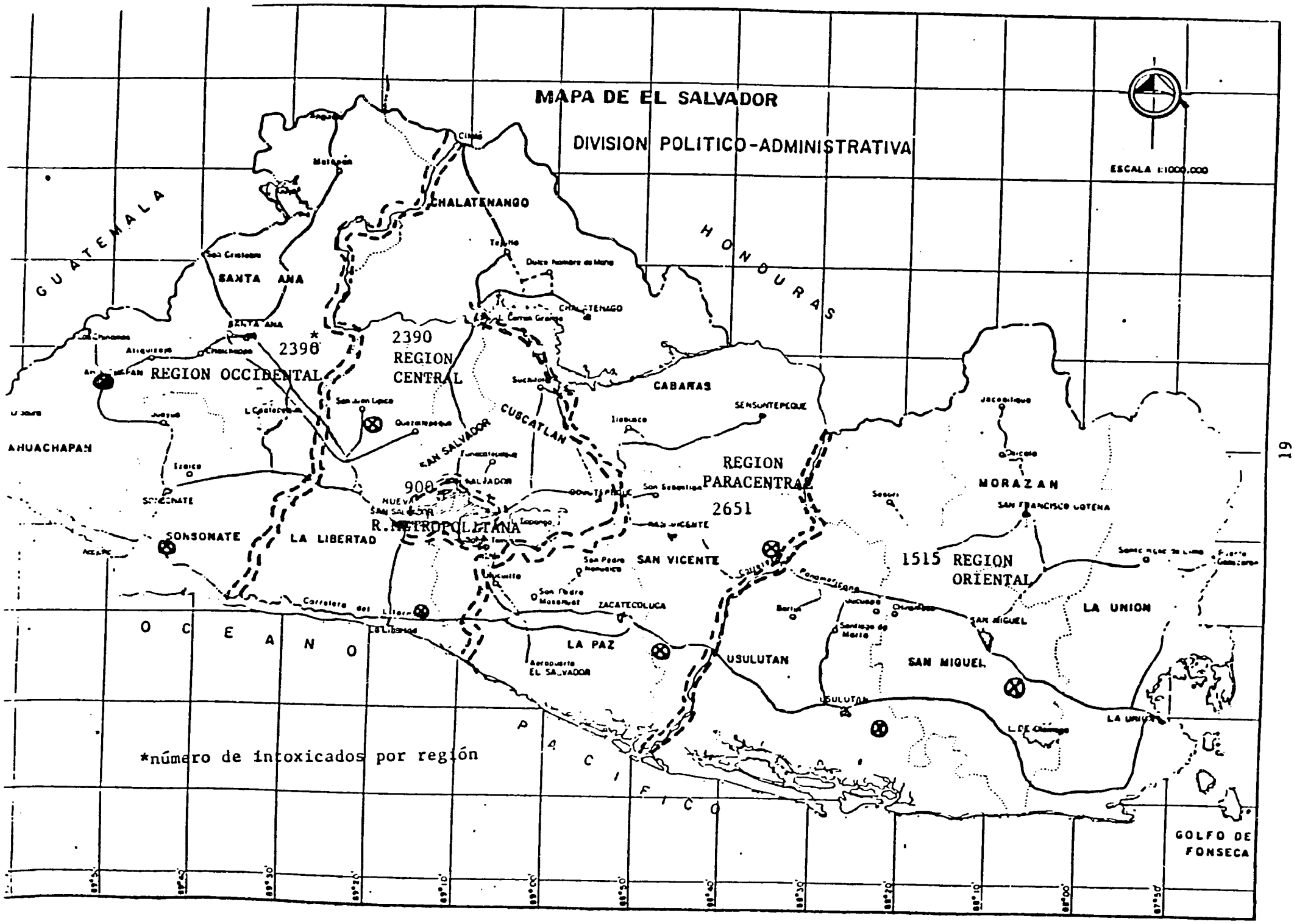
* Projected

Source: MIPLAN, Indicadores Económicos y Sociales 1983 and Economic Research Service, Statistical Bulletin No. 744 World Indices of Agricultural and Food Production, 1976-1985, USDA, Washington, D.C. 1986.

Table 2.6. ORD Projects

Project No.	Title	LOP Funding	LOP Orig.	PACD
519-0307	Agrarian Reform Financing	$50.0 mil.	5 yrs.	7-31-91
519-0327	Agribusiness Development	$20.0 mil.	5 yrs.	9-30-92
519-0303	Water Management	$18.7 mil.	5 yrs.	8-31-90
519-0265	Agrarian Reform Sector Supp.	$34.9 mil.	3 yrs.	12-31-83 ext. 7-31-88
519-0327	Amendment Agricultural Research Foundation	—	—	—
519-0351	Commercial Farming	—	—	start 1990

Figure 2.1


MAPA DE EL SALVADOR
DIVISION POLITICO-ADMINISTRATIVA
ESCALA 1:1000.000
GUATEMALA
HONDURAS
CHALATENANGO
SANTA ANA
2390
REGION OCCIDENTAL
2390
REGION CENTRAL
CABAÑAS
SENSUNTEPEQUE
CUSCATLAN
SAN SALVADOR
AHUACHAPAN
SONSONATE
LA LIBERTAD
900
R. METROPOLITANA
REGION PARACENTRAL
2651
SAN VICENTE
ZACATECOLUCA
LA PAZ
USULUTAN
MORAZAN
SAN FRANCISCO GOTERA
1515 REGION ORIENTAL
LA UNION
SAN MIGUEL
OCEANO PACIFICO
GOLFO DE FONSECA
*número de intoxicados por región

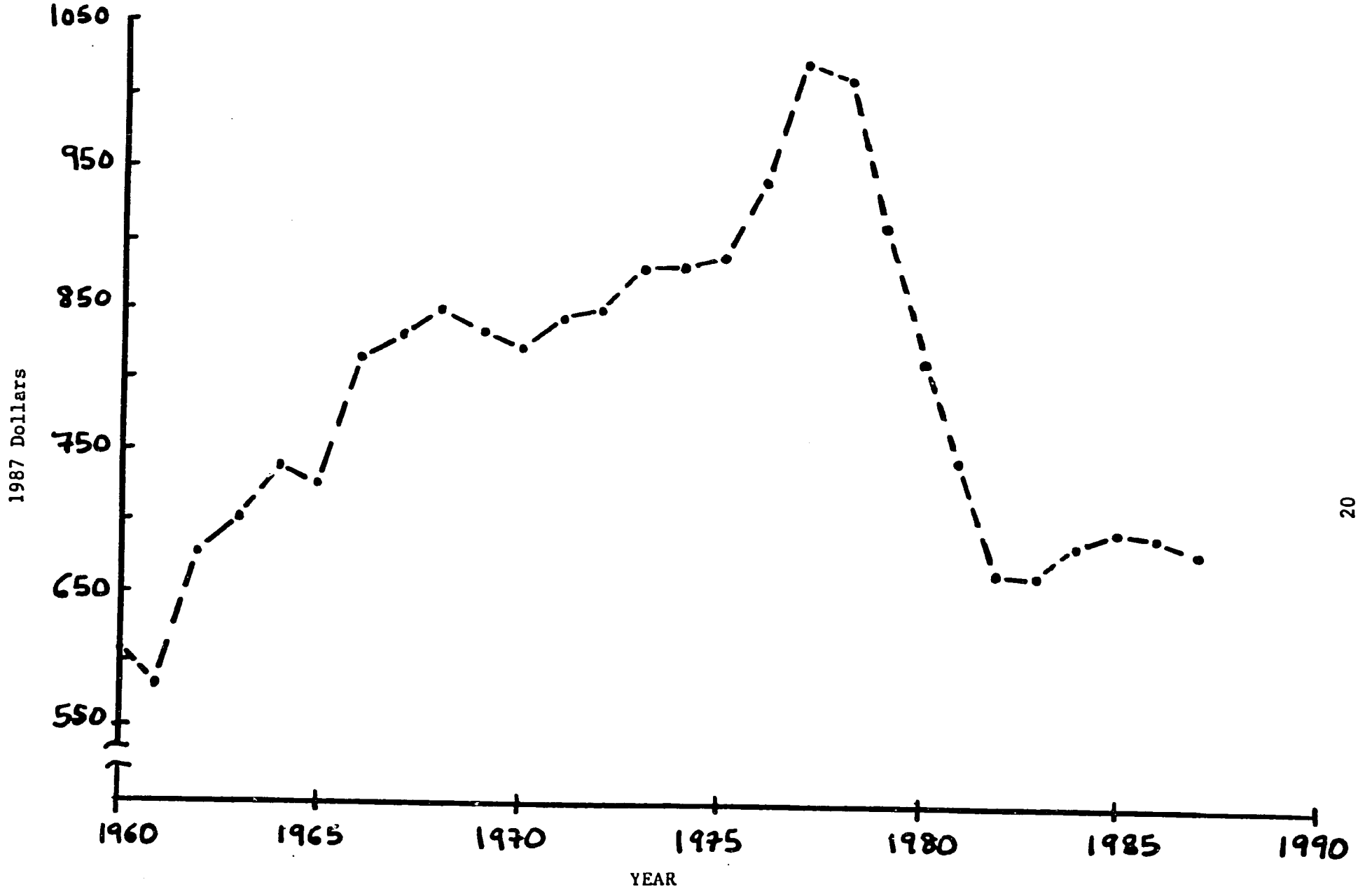


Figure 2.2. Real Per Capita Income in El Salvador in 1987 Dollars by Years 1960-1987

Figure 2.3. Ecological Map of El Salvador

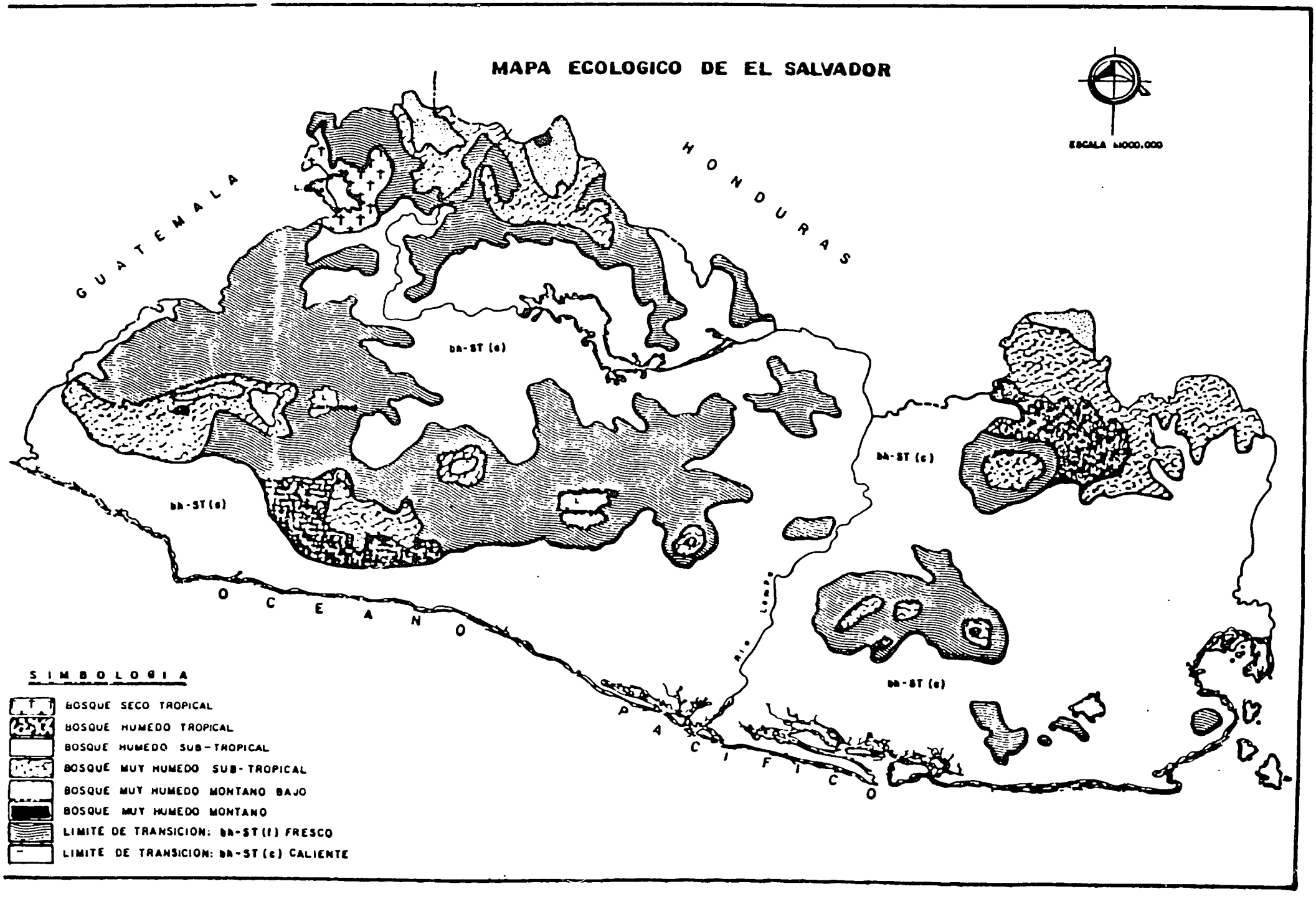


Figure 2.4. Location of Natural Areas

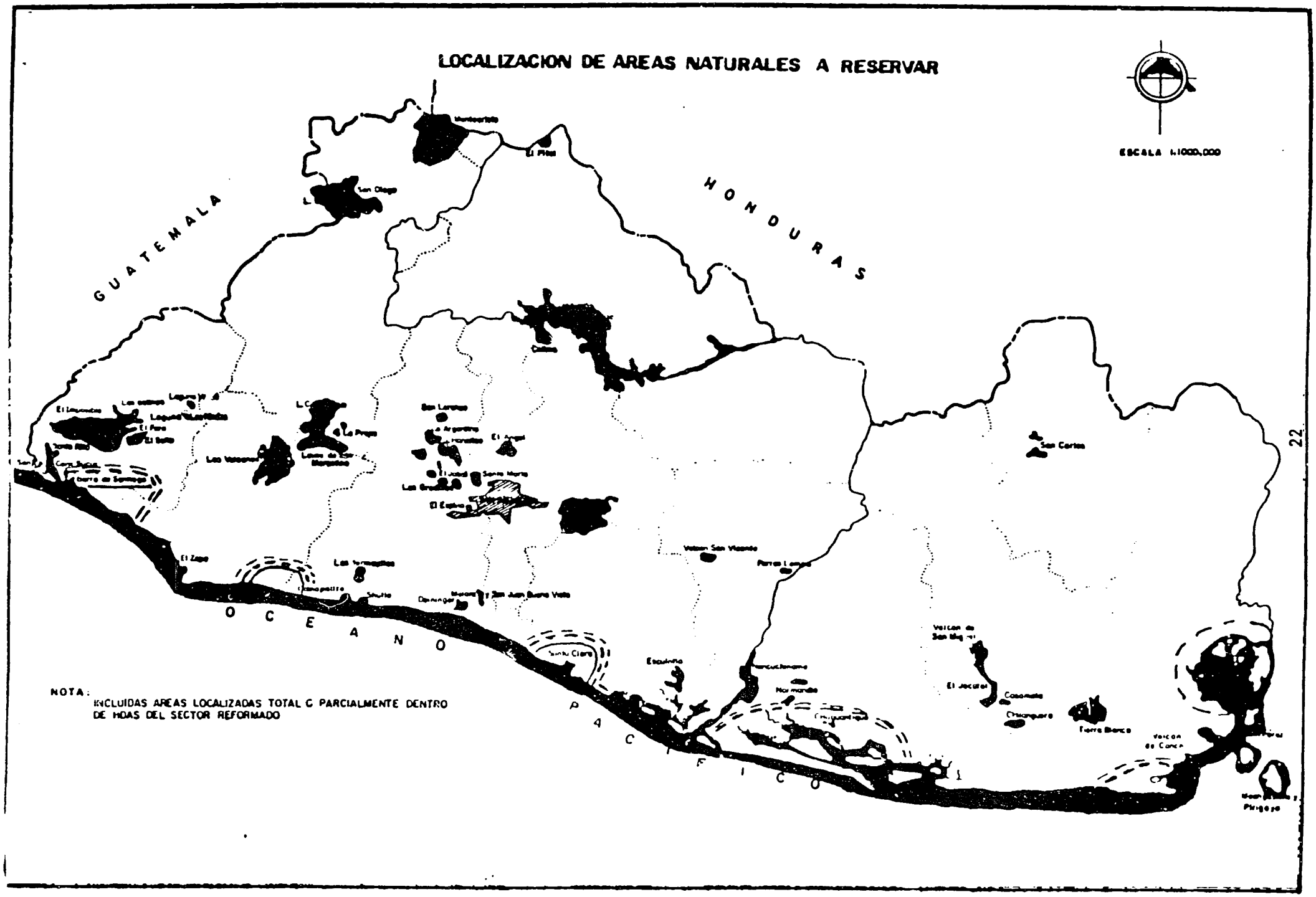
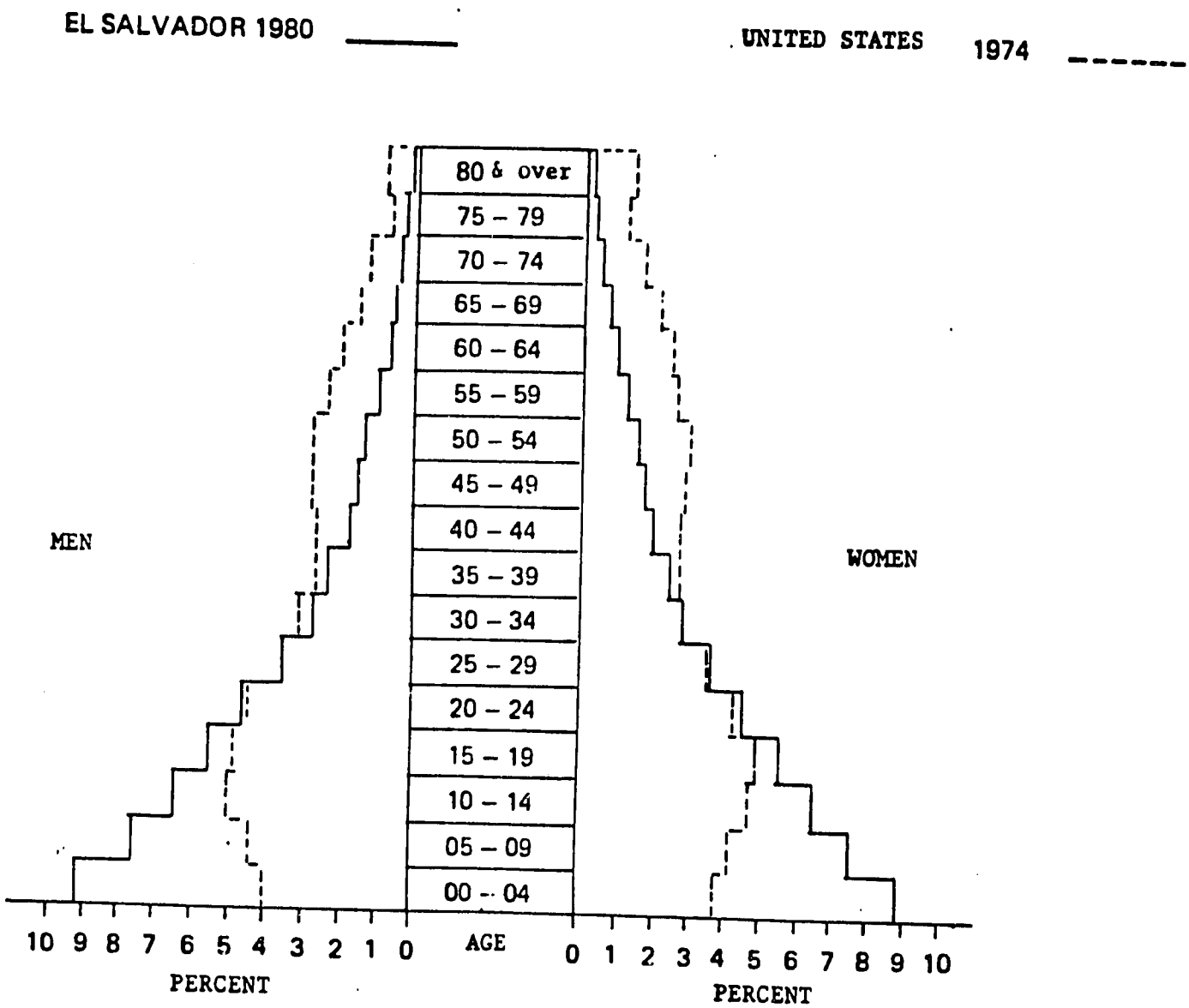


Figure 2.5

POPULATION STRUCTURE



PERCENT DISTRIBUTION BY AGE GROUPS

AGE (years)	EL SALVADOR 1980	UNITED STATES 1974
00 – 14	45.7	25.9
15 – 64	51.3	63.9
65 & over	3.0	10.2
Total	100.00	100.00

III. AN ASSESSMENT OF CURRENT POLICIES, INSTITUTIONS AND PRACTICES

A. Policies

A society has many instruments that can be used to discourage undesirable activities or to foster desirable activities. For example, the Government of El Salvador has used a variety of policies for centuries to encourage the production of coffee as an export crop. Our concerns in this report are restricted primarily to those policies which have an impact on the use and handling of pesticides.

1. Pesticide Regulations and Enforcement of Imports and Use

Currently, all pesticides are imported as finished products or as components which are formulated within the country into a finished product. In either event, only products registered for use in El Salvador with the Direccion de Defensa Agropecuaria (DDA) may be imported. Attachment 3 provides a listing of currently authorized products. In March 1988, Defensa Agropecuaria cancelled the use of the following list of chemicals based on their persistence in the environment and their toxicological hazards for humans.

Aldrin	Brushkiller
DDT	2-4-5 TP or Silvex
Dieldrin	Leptophos (Phosvel)
Endrin	Ethyl Parathion
Chlordane	Dimethoate en polvo
Heptachlor	Chlordimeform
2-4-5 T known as Tributon 600	Toxaphene
U-46 (2,4-d)	PCNB
Esterôn 245 (2.4-d)	

The authority to regulate and certify pesticides and to cancel the above pesticides is given to DDA by two major laws. These laws regulate the manufacture, import, export, distribution and use of pesticides in El Salvador.

1) Decreto 315: 25 April 1973: Ley Sobre Control de Pesticidas Fertilizantes, y Productos para Uso Agropecuario.

2) Reglamento 28: 21 May 1980: Reglamento para la Aplicacion de la Ley sobre Control de Pesticidas, Fertilizantes y Productos para Uso Agropecuario.

Regulation No. 28 guarantees the quality and composition of agricultural chemicals, outlines requirements and actions to prevent damage to human health and the environment and detailed guidelines for product registration, product formulation and manufacture, quality control, commercialization, application and use procedures, and sanctions, in cases where the pesticide law has been violated. Pesticides must be reregistered every 3 years. This process and the institutional relationship's are described further below.

There is no apparent difference in the registration requirements for the import and use of Class I (most toxic) versus Class IV (least toxic) chemicals. Import fees and taxes are all the same and there are no restrictions on distribution and use. If higher taxes could be levied on Class I chemicals or some control over their distribution could be implemented, (e.g. restricted to certified users only), then the importation and general use of Class I chemicals could be discouraged.

Other laws regarding use of pesticides and control of pests include:

a. Decreto No. 89 Prescripciones para el uso de insecticidas mediante.

b. Decreto No. 31 and 2690. Mosca del Mediterraneo. Establishes an agricultural inspection service to control movement of produce infested with the Mediterranean Fruitfly.

c. Decreto No. 229. Ley de Sanidad Agropecuaria.

d. Decreto No. 145 that regulates the importation of animals, vegetables and their products and subproducts.

In general, the existing laws are relatively complete and if the resources and institutional structure were available to assure implementation of the laws and enforcement, many problems could be reduced.

Decree No. 8 of January 29, 1987 established El Centro de Tramites de Exportacion e Importacion (CENTREX) in order to provide a central office to expedite the handling of authorizations for imports and exports. All pesticides have import duties varying from 5 to 30 percent. However, the Banco de Fomento Agropecuario (BFA) is authorized to import pesticides and fertilizers without payment of a duty. BFA also sells those pesticides at a favorable price relative to the market price. Since BFA handles approximately 20 percent of all pesticides imported and sold in the country, this represents a modest form of encouraging pesticide use.

In summary, officially stated policies are designed to protect human health and the environment. The registration process enables the government to prohibit pesticides which are deemed to be excessively dangerous. The three year life of a registration keeps the list of approved pesticides current. The import duties levied on pesticides are in the same range as the duties levied on other imported agricultural inputs, thereby neither tipping the scale in favor of nor against pesticides for pesticides imported by private firms. However, all pesticides imported appear to have the same duties levied regardless of toxicity category. A sliding scale on import taxes according to toxicity rating could represent a valuable disincentive to the import of the more toxic substances short of banning their use. Further, import fees on pesticides could be directly channeled into support of a variety of potential programs: a) residue monitoring; b) IPM research and extension; and c) pesticide safety training.

2. Rates of Exchange and Import/Export Policy

There are also policies and circumstances that are not primarily concerned with pesticide use but which have a major impact on the actual use of pesticides in El Salvador and their consequent impacts on human health, environmental integrity and farm income.

The most important macroeconomic policy which has an impact on the quantity of pesticides used in El Salvador is the rate of exchange between the colon and the U.S. dollar. In their study Food Imports, Agricultural Policies and Agricultural Development in El Salvador, 1980-1987, Torre and Norton attempted to analyze the policies and factors which affect the importation of food into El Salvador. The main conclusions of their analysis were:

> "In the aggregate, agricultural imports have responded to the expected kinds of economic influences: domestic purchasing power, domestic agricultural production, and the exchange rate. Food import policy has not brought in agricultural commodities in excess of the amounts indicated by the economic circumstances of the country. However, exchange rate policy is the major determinant of those imports. In particular, the overvaluation of the exchange rate in recent years has encouraged more reliance on imported agricultural goods.
>
> The overvalued exchange rate also has been the major cause of the decline in real farmgate prices, although international price movements and declining domestic demand also have had an affect in this regard. In effect, the exchange rate has emerged in recent years as the main instrument of agricultural pricing policy in El Salvador. Another implication is that it is not the amount of agricultural imports in recent years that is depressing domestic farm production, but rather their prices, and the exchange rate has been the principal factor making those prices low relative to domestic farm prices. Even though the latter have declined considerably in real terms, food import prices in colones have declined even more, because of exchange rate policy."

In other words, imports are not depressing domestic production, but rather both of them are jointly determined by a "third force," and that third force is exchange rate policy. It is strong enough to swamp the effect of other domestic policies oriented at influencing agricultural prices.

Thus the appropriate level of food imports is not independent of the macroeconomic policy framework adopted by the Government, in particular policies affecting the growth of aggregate demand and the exchange rate. In recent years, the Salvadorean Government has pursued macroeconomic policies that are not particularly favorable to expansion of agricultural output and are conducive to relying more on food imports. At the level of sector aggregates, a change in macro policies would be the key to a program designed to i) increase agricultural production and incomes, ii) increase

agricultural exports and net foreign exchange earnings, iii) decrease the need for agricultural imports."

In their study, Torre and Norton report a steady deterioration in the parity exchange rate 1/ since 1974 when the parity exchange rate was equal to the official rate of C2.50 = US$1.00. They estimate that for 1977 the parity exchange rate is C8.33 = US$1.00 in contrast to the official rate of C5.00 = US$1.00. Such an overvalued currency results in purchased imports costing less than they should. For example, a pesticide costing US$100.00 is imported at the official rate of exchange and therefore is seen within the country as costing C500.00 If the rate of exchange equaled the parity rate (C8.33 = US$1.00), the cost of this pesticide would be seen as C833.00.

As can be seen from this simple example, the current exchange rate policy results in a discount for pesticides (and other purchased imports) of approximately 40%. If exchange rates were permitted to move freely, pesticide prices within the country would increase substantially. As a result, the current exchange rate policy of El Salvador constitutes a major subsidy for imported pesticides. As El Salvador's currency becomes increasingly overvalued, this form of subsidy for pesticides (and other purchased imports) will become still greater.

3. Agricultural Credit Policy

A second policy, which again is not developed for pesticides but has a major impact on pesticide use, is El Salvador's policy regarding agricultural credit. The study by Ladman, Torrico and Bunce, Rural Savings Mobilization/Agricultural Credit Project, provides a comprehensive review of current agricultural credit policies, institutions and practices.

The GOES has for many years attempted to foster an environment that would increase credit opportunities for farmers. The Administraciôn de Bienestar Campesino (ABC) was established in 1962 as a branch of the Ministry of Agriculture to provide supervised credit and technical assistance to small and medium sized farmers. In 1973, the Banco de Fomento Agropecuario (BFA) was established as an autonomous public sector institution which superceded the ABC. The BFA provides financial and related services to promote development of the agricultural sector. Although the BFA serves the credit needs of farmers regardless of size, it still has a priority of providing credit to small and medium sized farmers.

The BFA is the single largest provider of formal agricultural production credit in El Salvador with approximately 20 percent of the value of all agricultural loans. The BFA has 26 offices throughout the country with approximately 350 agents to work directly with farmers to monitor loans. In addition to its credit department, the BFA has a commercial department which sells agricultural inputs including pesticides and fertilizers. It is the policy of BFA to extend credit in kind as a means of

1/ The parity exchange rate is the rate that would have been consistent with the difference between the Salvadorean inflation rate and the weighted average inflation rate of its trading partners.

ensuring that agricultural loans are used according to the plans developed during the initial loan request. Consequently, the farmers loan plan, extension of credit in kind and subsequent monitoring of the farmer's activity by the BFA agent all combine to encourage a predetermined level of pesticides regardless of levels of pest infestation. In addition, because profits from the commercial component of BFA offset the losses incurred in the credit component, the bank has an incentive to encourage the rate and use of pesticides, which they are able to import without payment of duty.

The BFA has several lines of credit with varying terms and interest rates. The current interest rate on production credit is 16% per annum. Although the loan interest rate has been raised several times, it continues to remain well below the opportunity cost of capital within El Salvador. Ladman, Torrico and Bunce report that in several years since 1979, the real rate of interest on credit from the BFA was actually negative. Such low rates of interest clearly encourage the use of purchased inputs including pesticides.

In summary, the agricultural credit policy of El Salvador has several facets, each of which encourage increased use of pesticides:

1) Low interest rates encourage the use of all purchased inputs-including pesticides.

2) Because the BFA has both a commercial component (which is profitable) and a credit component (which is not), there is an incentive to the bank to encourage the purchase of the agricultural inputs which it sells.

3) Because the interest rates are very low, credit is extended in kind in order to ensure that the loan will be used for the purposes authorized. By extending credit in kind, the BFA encourages the use of the pesticides issued regardless of the level of pest infestation.

4) The 350 agents, whose primary purpose is to monitor the loan activity, are primarily concerned with ensuring that the inputs obtained are in fact being used.

In summary, the current laws and policies of El Salvador, which are targeted at safe pesticide use and handling, are designed to protect human health and the environment. Unfortunately, there is a large disparity between policy and practice. In addition, there are policies which are targeted at other concerns (e.g., the foreign exchange rate, agricultural credit) but are fostering increased use of pesticides without ensuring that these pesticides are used safely and effectively.

B. Institutions

1. Regulatory Control

Direccion de Defensa Agropecuaria: The primary responsibility for the implementation of the laws regulating the importation, exportation, registration, use, handling, storage and disposal of pesticides lies with the Direccion de Defensa Agropecuaria (DDA). Defensa Agropecuaria sets policy regarding the types of chemicals that can be imported into El Salvador, the registration status of those chemicals, quality standards based on the Norms of Santa Tecla, use standards, environmental protection and human health and safety. There are four major departments responsible for implementation, Departamento Juridico, Registro y Certificaciones, Sanidad Animal, and Sanidad Vegetal with a total of about 10 technical staff members.

Defensa is a regulatory agency and as such depends on CENTA to conduct the necessary analyses and monitoring of agricultural chemicals which include pesticides and fertilizers. With regard to the use of pesticides, there are basically two operative processes: the registration of pesticides and quality control of agricultural chemicals. Both of these processes are illustrated in the flow diagrams in figures 3.1 and 3.2. Residue analyses on foodstuffs have mostly been done on an ad hoc basis. The responsibility for inspection of residues on exports or imports is not clear. IPOA (Instituto de Productos Origen Animales) along with Sanidad Animal monitor animal products, and may play a role in the export of vegetables in the future. The organization of the inspection service is yet to be worked out.

New agricultural chemicals must be registered for use in El Salvador with DDA. This is done when the product first comes in and must be renewed every three years (Figure 3.1). The formulator and/or importer solicits DDA to permit the registration of a new compound in El Salvador. The private firm must submit an analytical standard, samples of product, analytical techniques, efficacy data and technical literature to DDA. The sample goes to CENTA for analysis. A protocol for investigation is developed and submitted if the product is new. The importer must certify that the compound is registered for the same or similar use in the originating country (e.g. according to the guidelines of the U.S. Environmental Protection Agency for U.S. products), and is sold freely for the stated use. The company pays for the analyses conducted by CENTA. Finally, as outlined in Article 43 the company must develop an approved label for the product that appears to follow basically the protocol used by EPA and FAO. The label must be complete, be color labeled (i.e. red, yellow, blue and green in order of decreasing toxicity), and include the following information: category of toxicity, conditions of use (when, dosage, interval before entering the field, interval before harvest), tolerances, for use on which crops and against which pests, specific environmental hazards, specific safety measures and hazards, the commercial and common name, and the percent active ingredient. There are currently at least 90 to 95 pesticides listed for use in El Salvador, which are included in attachment 3. The list of authorized chemicals is kept up-to-date by requiring registration every three years.

DDA's second major responsibility is in the monitoring and control of the quality of agricultural chemicals. DDA administers a national program to monitor the quality of agricultural chemicals. Samples are collected from the factory or warehouses and sent to CENTA for analysis. These are blind samples, the results for which are sent back to DDA. In 1987, about 800 samples were sent to CENTA for analysis of which 76.7% were considered good and 23.3% bad quality in terms of the formulations and percent active ingredient. This means that a substantial portion of products being used by farmers are likely to be ineffective. If quality is below standards set by the Norms of Santa Tecla, then the Departamento Juridico initiates legal action against the importer and/or formulator. A fine of 100-1000 colones ($50-200 at the current exchange rate) must be paid for each infraction of the pesticide law. After three violations for the same infraction, the Depto. Juridico can cancel inscription of the product. It can also take action against products found to be falsified. The fine structure was established in Decreto No. 315 in May 1973, and is therefore somewhat low in 1988 terms and may not serve to deter effectively violations of the pesticide laws.

DDA works with the Gerencias Regionales through the Seccion Servicio y Control Legal (SSCL) of the regions. The regions send samples for analysis to the DDA and CENTA, and training has been provided on sampling methodology. In practice, there is little contact between the two due to lack of resources. Since the regional office does not have any direct line of responsibility to DDA, DDA can only solicit the collaboration of the regions, encourage regular communication and reports to DDA and attempt to visit the regions. If the region has noted an infraction of the law, such as the sale of illegal pesticides, DDA can take action following notification of the incident.

CENTA Residue and Quality Control Laboratories: The analytical laboratories at CENTA have five professional staff members (although all positions are not currently filled), and is divided into two sections: pesticide analysis for registration and quality control and pesticide residue analysis. Each section has an extraction laboratory about 30'X 60' with sufficient bench space, glassware and equipment for extraction of samples. Each section has a smaller instrument room (about 10'X20') equipped with two Perkin-Elmer Gas Chromatographs (GC). One GC has two electron capture detectors and one has a flame ionization detector and a flame photometric detector. They also have a high performance liquid chromatograph (HPLC) with an Ultra-Violet absorbance detector. Some maintenance is required on their hydrogen generator to make the flame photometric detector operative. There is a spectrophotometric room with an Infra-red and UV-VIS spectrophotometer.

The labs are seriously constrained by an inadequate operating budget and insufficient staff. To operate effectively, at least 5 professionals and two auxiliary staff are needed. Fiscal constraints have made it difficult to keep staff. The labs should have at least 35 reagents on hand but are usually operating at less than a third of that level. The library resources are scarce. The last journals on analytical chemistry, pesticide

chemistry and environmental chemistry date back to 1980. The lab did not even have recent copies of the Farm Chemicals Handbook nor do they regularly receive updates of analytical methods for pesticides.

Despite the limitations of staffing and supplies, the labs have continued to produce, largely under the direction and from the initiative of the lab chief. During the past year, the labs have analyzed approximately 250 samples for registration, 800 for quality control, 500 samples for pesticide residues and 300 for acetylcholinesterase (AcCH) activity. The only regular monitoring that takes place is for pesticide quality control as is mandated by law. Residue analyses of pesticides in the environment and on food commodities has been limited to specific research projects or activities. This is the only government laboratory in the country with the mandate to monitor residues in foods, water, humans and the environment. While the lab can theoretically supplement its budget or at least meet the costs of its services by analyzing samples on a fee-for-service basis, these funds are not directly channeled back to the lab. Fees received by CENTA return to a revolving fund for the whole center, and the labs generally do not benefit directly from these fees. CENTA labs are further hindered by the government procurement process. They must go through the same bureaucratic purchasing channels to acquire imported goods, which slows getting the necessary reagents and replaceable items.

An additional problem arises from the regionalization of the Ministry of Agriculture and Ganaderia (MAG) that applies to the processes described above and to the development of new technologies and extension of those technologies described below. The regions are generally disarticulated from the central activities of CENTA and DDA, and without a direct line of responsibility, reporting and monitoring may be neglected. While it is important to work within regional priorities, the current lack of coordination inhibits effective environmental protection, public health and safety and proper use of agricultural chemicals.

Centro de Tramites de Exportacion e Importacion (CENTREX): CENTREX was created in 1987 by Decree No. 8 to streamline the import and in particular, export permitting and licensing process in the Ministry of Comercio Exterior. CENTREX's major objectives are to centralize the export/import functions of different government institutions and to facilitate importers and exporters to offer effective support to commercial activities in the country. In order to meet the regulatory requirements and meet the goals of CENTREX, thus reducing costs for importers and exporters, CENTREX incorporates the delegates of the Defensa Agropecuaria, Economia Agropuaria (DGEA) and Centro de Desarrollo Pesquero (CENDEPESCA). CENTREX plays a key role in authorizing pesticide imports as determined by DDA and DGEA, and monitoring phytosanitary requirements (pests and pesticide residues) for both imported foods and exports. Current requirements are limited to assurance and certification to the importing country that the Salvadoran products being imported are free of bacteria, diseases and pests. Residues are not yet included in this requirement. Thus each shipment would require a "Solicitudes de Certificado Fitosanitario" with the impress of Defensa Agropecuaria. It is unclear from documents and discussions how effective this process is, nor whether CENTREX can assist with the certification

process. CENTREX appears to be mostly a clearinghouse seeing that the necessary regulatory requirements have been met. The phytosanitatary certification would have to remain with CENTA and Sanidad Vegetal of Defensa Agropecuaria with regards to pest and pesticide residues.

CONCLUSIONS: As with many other areas, both DDA, the regions and CENTA suffer from the lack of resources to effectively enforce the law. It is difficult to control the quality of the samples sent in from the regions since they have little equipment to take samples. There needs to be more consistent contact between DDA and the Regions, but the lack of vehicles and petrol and the shortage of staff make visits difficult. At least 95% of DDA's budget goes into salaries. This definitely constrains enforcement of the law. Finally, DDA has experienced difficulty in receiving information on registration status of different chemicals from EPA. It might be desirable for ROCAP to analyze the flow of information from U.S. EPA and USDA to the appropriate agencies, either directly or via the American Embassies, in each of the Central American countries.

CENTA lab capabilities appear to be the most significant bottleneck to effective monitoring and enforcement. While the labs are reasonably well-equipped, they are very short on staff and operating funds to resupply necessary reagents and disposable lab equipment. CENTA could reorient its efforts more towards residues by decreasing the number of quality control samples and focusing on the most commonly used pesticides, and sampling a statistically suitable number of products. A larger operating budget and increased staff is needed both to run the analyses and either collect and/or administer the collection of quality control samples and residue samples. While a redistribution of efforts and reordering of priorities could help CENTA's lab analytical capabilities, the current staff and operating budget will continue to be a definite constraint to expanding the needed health and environmental monitoring and quality control for export crops for pesticide residues.

2. Research

Most IPM related research is conducted at CENTA. While some research is done at Salvadoran universities, they are constrained by lack of resources and facilities. Some IPM and environmental chemistry investigations are undertaken by university students done largely in collaboration with researchers at CENTA. Given the scarcity of research funds, what does get done is done on a shoestring budget. In other words, research funds in El Salvador are scarce.

Outside of the Israeli supported project in the late 60's and early 70's, the first substantial efforts to expand IPM in El Salvador began with the Integrated Pest Control (CIP) project funded through a project amendment to the AID/GOES Agrarian Reform Credit Project (519-0263). This project was financed by USAID/San Salvador with PL480 funds. Its initial main objective was to validate and implement IPM on cotton grown on a 4,200 ha pilot zone of coastland located in the provinces of La Paz and La Libertad. During its third year, the project began to work on maize and beans grown in this pilot zone, and during its final two years it added cantaloupes and watermelons,

also grown in this area. At its peak it was staffed by some 34 technicians, several of which were ingenieros agronomos who specialized in various crop protection disciplines. Among its achievements, this project demonstrated that under IPM the number of pesticide applications on cotton could be reduced from 23 to 17 applications/season. Although the project as such ended in 1987, some of the cotton IPM work is being continued by the CENTA research division and will soon receive support from GTZ.

In 1985, the CATIE/ROCAP Regional IPM project began to function in El Salvador through a Ph.D. level technical coordinator and assistant. With local currency funds supplied by USAID/San Salvador, specifically for support of IPM, in 1986, CENTA hired a team of 20 young technicians as a counterpart technical unit for the ROCAP regional IPM project. There are currently 17 technicians at CENTA working with the project. The team received training and guidance from CATIE IPM Project staff during their first two years. In 1987, CENTA formally included the IPM unit in its organizational structure. During 1987-88, the group has been working on various pest management problems on maize, beans, chile, cabbage, potatoes and tomatoes, in four priority regions of the country (Guaymango, Atiquizaya, Zapotitan, Las Pilas). Each of these project sites is staffed by three 'agronomo' level technicians at the who are charged with conducting and administering the research, visiting farmers, and extending information. Most of the research is conducted on farm, but farmers are neither directly nor consistently involved with the design or implementation of the research. Initial farm trials are smaller in scale but are generally followed by full scale trials to examine potential constraints to adoption of new technologies.

Research activities primarily have stressed loss determinations, population dynamics, management (3 of which were management with pesticides), and socioeconomic analyses of pest management practices. There were no apparent studies underway that were aimed at developing sampling regimes and strategies for farmer use. Nor were there any recent reports on biological control research underway at CENTA or in the field. A summary of research conducted up until 1987 under CATIE/MIP is included in Table 3.1. The emphasis on corn and Phyllophaga is reflected by the relatively greater number of research papers.

In the CATIE/MIP, on farm research and farmer participants are limited to small to medium size parcels, where most of the labor needs are provided by the family. The project has additional contact with farmers through field days where information on diagnostics and management are provided to farmers. There have been three field days during the past year, and the response from farmers was very positive. More than 60 farmers near Guaymango attended the last field day.

The CATIE/MIP project has had limited contact with extension agents, except through efforts and interests of individual extension agents. The lack of coordination with the Gerentes Regionales probably limits the overall impact and adoption of IPM technologies. It is strongly recommended that the CATIE/MIP project strengthen these contacts particularly now as information has been generated and is ready, in some cases, for transfer to

the field. The new GTZ supported project may further be able to extend some of the CATIE/MIP information given the extension emphasis of that project (see Section B.6. below).

This project will likely be extended for an additional 3 years until March 1992 and may provide a vehicle to support and build IPM research in horticultural crops in the public sector. A redirection of research priorities and work on new crops will require a period of familiarization and transition. It is important, however, to support these efforts, to assure continued public sector involvement in IPM research. The private sector does not have its own infrastructure for research and would therefore be dependent on the use of public sector facilities. Also, the private sector is oriented more towards larger, more sophisticated operations that may be able to afford their own technical assistance and be able to support their own research program. Small farmers have very little access to information and only the public sector research is emphasizing small farmers. Small farmers are more likely to get involved with import substitution crops, given the quality requirements and level of sophistication required for nontraditional exports (e.g. precision irrigation).

The private sector has been involved to some degree in research activities. Fundacion Chile was supported by FUSADES to examine and identify horticultural crop varieties suitable for promotion. Most of the research activities have emphasized production methodology, and within the Fundacion Chile program, pest management has continued to rely largely on pesticides. More recently FUSADES has contracted with a U.S. specialist to look at the virus and vector problems plaguing melon production. These are particularly difficult management problems which will require investigation. It was not clear however, what the priorities for research will be in attempting to manage the virus/vector problems. While it is commendable that the necessary T.A. has been contracted, it is strongly recommended that some longer term planning be done to begin to put in place a research agenda to anticipate future needs.

Conclusions:

Research in IPM is limited in El Salvador. Nevertheless, there is still a variety of applied work being done that can contribute to improved pest management and decreased pesticide use. Several institutional problems are apparent. First, as already mentioned, facilities are run down and resources are scarce. For example, CENTA has a relatively good reference collection of pests and natural enemies to assist them with diagnostics. This, however, is not being maintained. If funds could be made available to support a university student, and students could be identified, this could be an economical source of labor and an educational experience for the student.

Second, better integration among the CENTA units is needed. There appeared to be very little coordination between the MIP project and the socioeconomic section of CENTA. Further, there is very little coordination between ENA and CENTA. If ENA students could get involved in CENTA research

projects, it may serve as a valuable experience and increase their level of understanding of research and experimental methodology. Integration is probably more critical now than ever, given the GTZ supported project, CATIE/MIP and the Water Management Project. GTZ will focus on basic grains and cotton which may free up the CATIE project to consider horticultural crops. This may be influenced by CATIE's priorities.

Third, the CATIE/MIP project should increase its linkages in the future with the Regional Chiefs, particularly if the project moves into horticultural crops and crops under irrigation. MIP could work with the Water Management Project to strengthen regional ties. This project is establishing strong links with the regions in the form of staff and resources and has a very capable long-term advisor with experience in pest management.

Fourth, private sector research efforts to date have been largely ad hoc, limited to varietal testing and lacked long term planning. FUSADES should consider bringing on a full-time IPM specialist to help identify research needs and priorities. Given the current set of problems with viruses in melons and cucurbits in general, several key areas emerge: 1) plant resistance for diseases; 2) vector ecology and disease transmission; 3) sampling methodology to limit pesticide use to times when needed; 4) intercropping and other cultural control methods to reduce pest infestations; and 5) diagnostics of pests and natural enemies in non-traditional export crops (in collaboration with the CENTA diagnostics lab). Many of these suggested research problems could be undertaken on demonstration plots and used as a way to extend technologies to farmers.

Fifth, research on pesticide residues and environmental contamination has been limited to specific topical problems when resources are made available or when university students undertake a thesis problem in conjunction with CENTA staff. Resources should be provided to enable CENTA to implement an environmental monitoring and residue monitoring program. This will require increased staff at CENTA, upgrading equipment and providing resources for reagents and other disposable supplies. Population studies of indicator species should accompany the residue monitoring in order to effectively track impact on nontarget organisms.

Finally, the plan to establish a private sector mechanism to carry out technology development has clear merits and potential dangers. Given the scarcity of research funds, a foundation could handle a competitive grants program that would be open to public and private sector research. A funding source could serve as an incentive for the development of innovative solutions. Priority research modules should be defined at the outset and it is strongly recommended that IPM be part of that focus. On the other hand, depending on the flow of resources and access, a private foundation could further cripple public sector research. Use of resources should be to stimulate research. A grants program could even be opened to university staff and students. While a detailed review was not possible, capable biologists are still to be found within the universities. They are still training the agronomists, biologists and chemists. The students need practical research experience but funds are limited. Students and faculty

alike are also an untapped resource, who with modest support, could be generating needed information.

Table 3.1. Summary of Research Conducted Under CATIE/MIP Project in El Salvador

	Beans	Corn	Cabbage	Potatoes	Weeds	Post Harvest
Population Fluctuations of Pests	1	8	1	1	-	-
Loss Estimates	-	-	-	2	1	1
Management	1	2	-	1	2	-
Cultivar Resistance	-	1	-	2	-	-

3. Extension Services

a. Public

Ministerio de Agricultura y Ganaderia (MAG) (See Organogram, Figure 3.3)

Prior to the current political crisis, El Salvador had one of the more advanced government programs of agricultural research and technology transfer in Central America. The government's agricultural extension system was built around the five outreach programs of the Ministerio de Agricultura y Ganaderia (MAG). These included: CENTA, CENREN, CDG, CDP, and ISIC. Each of these institutions formerly administered substantial extension operations. In addition to these outreach divisions, support for short-term agricultural training was provided by CENCAP, while long-term training for agricultural technicians was provided primarily by ENA.

Over the past decade, political conflicts and budgetary constraints have unfortunately contributed to the marked deterioration of MAG's extension system. In addition, two broad policy changes have complicated the task of delivering technical assistance to farmers. The first of these was the implementation of the agrarian reform program in the midst of an intractable government fiscal crisis. Prior to the agrarian reform, large producers of cotton, coffee, and sugar did not generally rely on technical assistance from MAG. For the most part, they had their own competent technical staff and also received marketing services and technical information from banks, input suppliers, and exporters. As a result, during the pre-reform period, MAG was able to concentrate on providing assistance to small and medium sized farms in the traditional sector. With the introduction of the agrarian reform, MAG was obligated to provide technical

assistance to newly formed cooperatives on estates that it previously had not serviced. Lacking the resources to do this and meet its former obligations, MAG was forced to sharply curtail assistance to its clientele in the traditional or nonreformed agricultural sector. All sources report that eight years after the institution of the agrarian reform program, MAG continues to be greatly overextended. Its regional offices lack sufficient staff, and a shortage of vehicles and gasoline prevents its extensionists from making an adequate number of site visits.

The second policy change that has had significant repercussions for government extension services was the regionalization of the ministry in 1986. In that year, the four regional divisions of the ministry took over the majority of extension resources and responsibilities from MAG's five outreach institutions. The research and training units of MAG still provide some technical assistance to agrarian reform beneficiaries, but for the most part they must rely upon the regional offices to deliver those services to farmers. In practice, there appear to be serious problems of coordination between these regional offices and the institutions charged with developing new technologies. Each Gerente Regional (GR) apparently has considerable personal autonomy within his region. In order to promote technology transfer in any area, it is necessary to convince the GR of the program's utility. Extension priorities vary across regions in accordance with the concerns of the GRs, but in no case does either training in safe pesticide use or IPM appear to be a high priority.

Although their training in ENA is broad and interdisciplinary, within MAG, extensionists are usually given crop specific assignments. Extensionists tend to become specialists in one or two farm commodities. This administrative arrangement is an impediment to the establishment of IPM and farming systems projects which are inherently interdisciplinary.

Banco de Fomento Agropecuario

Loan officers of the BFA, a government agricultural development bank, also provide limited technical assistance to farmers. For the most part this assistance consists of the development of farm plans. BFA farm plans include programs for agrochemical application which specify the type of pesticides, dosage and application schedule that the farmer should use. The policies of the BFA will be discussed in greater detail below, in the section on agricultural credit.

b. Private

An array of private firms provide technical, marketing, and training services to the agricultural sector, including advice about pesticide use. The most active of these is the Fundacion Salvadorena para el Desarrollo Economico y Social (FUSADES). FUSADES is a nonprofit research and consulting firm that is dedicated to the promotion of private sector development which was established in 1983 by its private sector members. FUSADES provides technical, marketing, and training assistance to producers, processors, and exporters of nontraditional agricultural commodities. To date, the most important of these new products are okra, honeydew,

cantaloupe, and cashews. Production of blackeye peas, baby corn, jalapeno peppers and seedless watermelon has also begun on a smaller scale. A large number of other experimental crops are projected for the near future. Given the state of IPM research, production of most of these crops in the tropics currently depends largely on pesticides for pest control.

In some instances FUSADES has worked directly with farmers, but for the most part their assistance program is directed towards packing plants, exporters, and other intermediaries. It is hoped that these processors/exporters will provide technical assistance directly to those farmers who supply their produce. Thus, by working through exporters of nontraditional products, FUSADES is in a good position to introduce new technologies to the entire nontraditional export sector.

FUSADES' highly qualified technical staff includes agronomists who are well versed in pesticide use and aspects of pest management. To date, DIVAGRO, the division of FUSADES charged with the promotion of nontraditional agriculture, has prepared literature on pest management for a variety of nontraditional export commodities including: cucumber, cabbage, sweet chile and green beans. These materials advise producers on pest control relying almost completely on the application of pesticides, specifying the type, dosage and application schedule that should be followed. They are however, at least in the guidelines, recommending use according to the presence of the pest and are trying to recommend those pesticides that are registered for use on the crops in question. These guidelines illustrate the serious need to develop economic thresholds. The guides are discussed further in Section III. C.4.

DIVAGRO's primary orientation is towards the marketing of nontraditional exports overseas. The concerns of DIVAGRO's technical staff with regards to pesticide use reflect the contradictory requisites for penetrating the U.S. marketplace. On the one hand, DIVAGRO technicians are concerned that Salvadoran exports may be rejected in the U.S. because of high pesticide residues. Consequently, they have shown an interest in finding techniques to reduce pesticide application, although they appear to have done little research or extension to identify alternatives or substitutes for pesticides use. On the other hand, they are also concerned about technical problems of producing crops that will meet the high quality specifications demanded by U.S. consumers. This has led them to recommend significant applications of EPA restricted use pesticides to produce blemish free, aesthetically acceptable commodities. At present, DIVAGRO extensionists appear to be more concerned about product appearance than about the issue of pesticide residues. DIVAGRO extensionists complained to team members that a draft version of a list of general use pesticides prepared by Dr. Angel Chiri, USAID/ROCAP (which is similar to a list currently being prepared by this team) was too restrictive to meet the needs of growers, and the demands and constraints of entering the export market to produce blemish free commodities.

The DIVAGRO extensionists clearly understand that in the U.S. the application of EPA restricted use pesticides is limited to applicators who have passed a certified safety course. They also understand that A.I.D.

could demand similar restrictions on A.I.D. funded FUSADES projects. By working through intermediate commercial institutions, DIVAGRO is well situated to introduce safety information throughout the nontraditional sector. Moreover, DIVAGRO technicians are currently interested in providing safety training for pesticide applicators and have prepared a basic safety manual for operators. This is commendable. They are also organizing training workshops for producers on U.S. regulations. However, current efforts in safety training fall far short of what should be required in order to certify applicators of restricted use pesticides. Standards for certification need to be developed and implementation would require capable training and subsequent monitoring and evaluation of a certification process.

A final note, although the team did not have time to contact this individual. FUSADES has contracted a specialist to look at viral transmission in cucurbits. This is a problem that has arisen in melons, particularly during the dry season, and is beginning to limit production. It is commendable that they have responded but they should take a more detailed, long-term look at pest management needs and bring on a long-term advisor to develop some of the needed technology and conduct the necessary research. This was discussed in Section III.B.2.

Agro-Exporters

Naturally, the concerns of DIVAGRO's technical staff with regards to penetrating the U.S. marketplace are shared by the processors/exporters of nontraditional commodities. These concerns are oftentimes reflected in the contracts between merchants and farmers, which frequently include fairly stringent quality control clauses both with regards to the condition of the product and, in some cases, on production techniques that are to be employed. The latter sometimes specify the type, dosage and application schedule of pesticides that are to be utilized. Contractors employ agronomists to provide technical assistance to producers and to monitor compliance with these provisions. Of critical importance here are the priorities of the contractor, who may be weighing product appearance against the threat of product rejection due to pesticide residues. Given that processor/exporters are sensitive to the latter possibility, an effective way of reducing pesticide applications in the nontraditional sector may be to work through FUSADES to increase awareness of USDA monitoring capabilities and to recommend an appropriate pesticide application regimen, while at the same time supporting the development of pest management techniques.

Input Suppliers

Asociacion de Proveedores Agricolas (APA): APA is a trade organization of manufacturers and importers of agricultural chemicals (fertilizers and pesticides). It has a membership of 13 national and 2 transnatical companies that are amongst the major importers and formulators of agricultural chemicals in El Salvador (Agroconsa, Agroquimicos Jell, S.A., Agropoesa, Avelar Hnos, S.A., Bayer, Commercial Agropecuaria, Duque y Cia., Expro,S.A., de C.V.; Moore Commercial, S.A., Quimagro, S.A. Quimica Hoechst,

Quimica Integrada, S.A., Sagrisa, Ciba-Geigy, ICI.) APA members are responsible for about 70-75% of the pesticide imports entering El Salvador. There are currently six other firms also involved in agricultural chemical imports that are not members of APA. APA is not a member of the International Group of National Associations of Manufacturers of Agrochemical Products (GIFAP), but they are in contact with one another, and GIFAP has made its publications on pesticide safety and management available to APA.

APA is involved in a variety of activities which includes the promotion of safe pesticide use. As a result of a 1986 meeting of chemical manufacturers, APA has been focusing its efforts and is trying to identify key points or areas of emphasis to promote safer use of agricultural chemicals. These include some of the following: applicator education, public service messages on the radio, publication and dissemination of safety documents, public awareness, training courses for managers and workers of distributorships through short courses. APA is investing $50,000/year into their safety programs. This comes directly from membership fees (annual quota paid per year depends on the size of the company) without any support from transnationals to implement their program.

APA members expressed concern for a number of problems areas. First is the need for better packaging to avoid or minimize repackaging. Second is the need for better information and labeling to distinguish toxicity, especially for illiterate farmers. And third is the need to work with small farmers and government institutions and credit agencies, which are involved in pesticide procurement.

They are very well-informed and relatively progressive in their approach. APA may represent a useful means of implementing training activities for certain institutions, such as banks, credit agents and vendors. They already provide training for distributors of their products, and are developing training materials. They do not have a corresponding monitoring program however. While it might be worth supporting their programs to some degree, any support should be conditioned on the inclusion of additional information on IPM in the training courses. While safety is critical, it must be accompanied by information on effective pest management if pesticides are to be used prudently. Training materials should be developed with the assistance and input of a pest management specialist to broaden the focus beyond pesticides. Further, APA should be encouraged to communicate the hazards of restricted use chemicals and to promote general use chemicals, particularly by small farmers. While the team did not have an opportunity to visit a large sample of vendors of agricultural supplies, APA should require that adequate stocks of safety and protective gear be maintained at its distributorships. Distributors do not see the demand and therefore do not carry safety equipment. They could in part encourage or create that demand.

Private Contractors

Private sector technical assistance is provided primarily to large and/or irrigated farms. Small traditional farms or Phase III farms receive little assistance from the private sector unless firms are specifically contracted to provide such services by GOES or international agencies. Small farmers tend to be numerous and scattered. The costs of reaching them are high whereas their purchasing power tends to be low. Consequently, they are not a particularly attractive market for input salesmen, commercial banks or other private sector intermediaries. Therefore, these small farmers are comparatively dependent upon public sector institutions for technical assistance. Until the public sector extension program is expanded and revitalized, the lack of an adequate government extension service will inhibit the transfer of information on safe pesticide handling and integrated pest management to small farmers. Private sector extension may be critical. Its efficacy to date in working with the Agrarian reform is mixed. Training of private sector extension agents would strengthen their knowledge base and ability to transfer information on pest and pesticide management. Technoserve Inc. has recently brought on a long-term advisor in a grant to CLUSA to facilitate and improve production and marketing of nontraditional exports, with cooperatives financed under the Agrarian Reform Financing Project. This individual will also provide training in applicator safety practices. Though he is a certified pesticide applicator, he lacks the detailed understanding of pest management. The mission should consider providing additional assistance on pest management training for Technoserve extensionists, particularly as Technoserve moves more into horticultural crop production.

4. Agricultural Credit

Formal institutions that extend credit to agriculture may be divided into six broad categories:

a. Banco Hipotecario -- a private commercial bank that is able to raise capital by granting long term mortgages;

b. the nine "mixed" banks -- government controlled commercial banks;

c. Banco de Fomento Agrapecuario (BFA) -- the government agricultural development bank;

d. INCAFE -- the national coffee institute that offers credit to coffee producers, but which has reduced its line of production credit in recent years;

e. FEDECACES -- a federation of credit unions, a portion of which are located in rural areas;

f. FEDECCREDITO -- a federation of loan associations that channel funds from the Banco Central and international organizations to the poor.

In addition, small amounts of agricultural credit are available through private associations and an active informal credit market.

The most common type of agricultural credit consists of short-term production loans to finance labor costs and the purchase of agricultural inputs, including pesticides. All Salvadoran banks offer production loans for agriculture through a system of programmed lending under which loan officers and borrowers draw up a farm plan which schedules production expenditures for the coming year. These plans typically include a program of pesticide application. Thereafter, credit is disbursed in periodic installments in accordance with the plan. After each disbursement the farmer is required to present receipts to document that his expenditures were in accordance with the plan. This documentation is a condition of further disbursement of funds. Loan officers, who are usually trained agronomists, also make periodic site visits to ensure that the farmer is complying with the plan. Loan officers often also provide advice to the grower on the type, dosage and method of applying chemical inputs. This advice frequently includes recommendation of EPA restricted use pesticides.

The programmed use of pesticides in accordance with farm plans hampers efforts to minimize pesticide use in two ways.

(1) Farmers receive credit for chemical inputs at low, and at times negative, real rates of interest. However, Salvadoran banks do not presently extend significant amounts of credit for alternatives to pesticide application such as biological or mechanical pest control measures. Because of these lending priorities, farmers find themselves locked into the use of chemical control measures. Further, there are no provisions within the farm plan budget for the necessary protective equipment that should accompany the purchase and use of pesticides. Loan agents could include health and safety as a component of the risk analysis for the loan. With training, those same loan agents could follow compliance with safety recommendations during farm visits. Incorporation of safety practices could become an additional condition of continued disbursements.

(2) Under the current system, farm plans are based on the farm budget for the previous year; last year's expenditures become the basis for estimating production costs for the coming year. This system makes it difficult for the farmer to acquire credit for new crops or technologies. Specifically, the system of programmed credit disbursement hinders attempts to reduce pest resistance to chemical control measures through the introduction of flexible strategies of pest control such as crop and pesticide rotation.

Banco de Fomento Agropecuario (BFA)

The BFA warrants special concern because: (1) in addition to its lending activities, the BFA also functions as a distributor of agrochemical inputs through its Commercial Division; (2) its clients receive preferential prices for those inputs; and (3) it is frequently the only formal source of credit available to poorer farmers both from the traditional and the agrarian reform sectors.

The BFA receives dollars at a favorable exchange rate from the BCR and additional foreign currency from international institutions, particularly the IDB. In this fashion, the BFA is able to finance its agrochemical imports, which account for a substantial portion of those of the nation as a whole. The BFA currently imports an estimated 45% of the nation's fertilizers, roughly one third of all herbicides consumed, as well as smaller quantities of insecticides and fungicides. The BFA pays no customs duties on these imports. The BFA then offers these inputs to clients at favorable prices as part of the production loan package. These loans in kind are not optional. That is, if the farmer wants a BFA production loan, he must accept the entire loan package, including inputs. To the extent that BFA's customers do not have recourse to other sources of credit, which is commonly the case for poorer farmers and agrarian reform cooperatives that have a low credit rating, the BFA has a captive market for agricultural inputs. Nor is the farmer entirely free to select the inputs that he prefers. Loan officers develop a farm plan that specifies the type of chemical inputs that will be disbursed. Farmers certainly have a say in the development of their farm plan, but it is not unusual for loan officers to override the preference of the farmer, either because they disagree for technical reasons or because the BFA does not have the requested chemical in stock. The BFA loan officer also would not consider a loan request and farm plan which excludes use of chemicals by substituting a suite of cultural and mechanical controls to be a good risk. Such a request is likely to be declined further tying a farmer to the use of pesticides.

Although the BFA disburses pesticides and application equipment, it does not disburse safety equipment or information about the safe handling of pesticides to its clients. The BFA will disburse credit for the purchase of safety equipment, but unlike the acquisition of chemical inputs, the purchase of safety equipment is entirely at the discretion of the farmers.

All accounts indicate that the distribution of agricultural inputs has been a consistently profitable sideline for the BFA. The Commercial Division has in fact subsidized the bank's Credit Division, which has just as consistently absorbed substantial losses.

5. Education and Training

Three major types of institutions provide training in agricultural sciences: 1) technical programs administrated by the Ministry of Education; 2) the National Agricultural School (ENA); and 3) universities.

1) The team did not have an opportunity to visit the Ministry of Education programs. These programs produce 'tecnicos agricolas' with specialization more in production and processing. Given the tight job market, however, these students compete with the ENA graduates.

2) ENA is a semi-autonous unit of the Ministry of Agriculture (See Figure 3.8). It provides three year training for students in agronomy and is considered to be a higher level of training than those

graduating from the Ministry of Education programs. It is broad and general training in agronomy and many of the graduates are prepared to move into extension positions or to work as agronomists with Phase I cooperatives. There are about 100-120 new students each year and a total of about 300 are currently enrolled. There is a staff of 49 professors, many of which are only at the agronomo level. A new program specialization in irrigation is being developed under the Water Management Program that is greatly strengthening the training received in IPM in irrigated agriculture. This is discussed in greater detail under number (4) below. There are several general problems with the ENA program and curriculum.

a. First, the lab facilities at ENA are in very poor condition. There is very little equipment (e.g. microscopes). The insect teaching collection is in very poor condition. The library lacks many key resources.

b. Second, while ENA's facilities are in poor condition, and could be complemented by those at CENTA, there is little coordination between ENA and CENTA, except on an individual level. In addition, ENA students could gain research experience by working in the labs and with CENTA researchers. This is a policy issue that would require the attention of the administration of ENA and CENTA to resolve. Coordination would enable more efficient use of scarce resources.

c. Third, the ENA curriculum takes a very traditional approach, focusing largely on production and on single crops, and less on agricultural systems as a whole. Many extensionists must deal with mixed cropping systems yet they receive little training in agricultural ecology, farming systems methodology, IPM, and biological control.

   A general ecology course is offered but appears to approach ecology from a broad level. Although this is valuable, it might be far more constructive to introduce ecology in the context of an agricultural system. Such a course could introduce management practices based on ecological principles (e.g. polyculture and intercropping, biological control, and evolution of resistance to pesticides). This would reinforce the ecological principles, present meaningful management information and put the ecological principles into the context of agriculture and agronomy. A sample curriculum is prepared as Attachment 5.

   ENA offers phytopathology, nematology and entomology courses. The emphasis is on identification and classification which are both critical for effective management. These courses include management within the context of the entomology course but do not offer separate courses in pest management and/or IPM. ENA needs to train its students on alternatives to control with pesticides, encourage field experiments, assessment of economic damage and design of sampling techniques. Given the problems with both pest

and pesticide management in El Salvador, a single course in IPM is needed rather than as a component of other courses.

d. The government staffing policy, while a general problem for government institutions in El Salvador, creates a very serious constraint to maintaining quality teaching and instruction at ENA. Faculty slots are designated at a certain level, and there appears to be little room for change and movement in terms of salary and status within such a position. Therefore, in order to advance in position and in income, a young ingeniero would need to seek a new position, leaving little incentive for improvement within his or her current position at ENA. Short of tackling government policy, some outside system of incentives is needed to encourage improved and innovative approaches to instruction at ENA.

3) While the team did not have an opportunity to review the 'ingeniero agronomo' curriculum at the universities, it appears, from discussions with university faculty at the national university, that there is a greater degree of emphasis being placed on agricultural ecology and IPM than at the agronomo level. Courses in IPM are offered and some students do their theses on IPM projects, in most cases in consultation with CENTA CIP and MIP staff.

The universities are also training students in food chemistry and environmental chemistry. A number of these students undertake research projects in collaboration with the residue labs at CENTA.

These theses projects are a valuable experience for students. They also provide an important service to the labs in terms of data collection and lab assistance. However, funding is a major constraint to project implementation. Students must acquire their own support for lab supplies and transportation. Use of local currency for 'becas' for university students could improve the scientific quality of the work by allowing students to increase sample sizes, etc. and by enabling more students to gain practical research experience, thus building in country capabilities. If funds were assured, CENTA could plan certain research activities into their annual work plans that could be carried out by students. In the past 1-2 years, there have been about 10 students from chemistry and about 25 in plant protection who have worked with CENTA.

4) As part of the training and institution building activities at CENTA, the Water Management Project is developing training modules, courses and workshops in water management. These workshops are designed for researchers on the one hand, and extensionists on the other. The technical assistance being provided through the United Schools of America is very capable. Considerable emphasis is being placed on building IPM capabilities both during workshops and in the research activities that will be conducted on the project demonstration research plots. The goal is to improve the pest management in irrigated agriculture. The type of training and the evaluation methodology is well-designed. More importantly, the project is trying

to target the same students (i.e. extensionists) in different workshops, thereby encouraging followup, providing continuity and reinforcing information.

6. Other Donors

GTZ

GTZ is the only other donor that is currently providing support to develop integrated pest management technologies in El Salvador. This is a new project which only just started in September 1988. The first phase of this 8 year project is planned for 3 years. A total of three German advisors will reside in country, working as counterparts to the staff at CENTA's Plant Protection Unit. To begin, the project will work in three departments, La Libertad, La Paz and Santa Ana.

The overall goals of the project will be to improve integrated pest management in cotton, corn and beans, by first identifying existing technologies, then extending that technology, and where necessary, conducting research. The distribution of resources is split 30% on research and 70% on extension. The encouraging part of the GTZ project is the emphasis being given to extension and on-farm research to develop technologies that can be applied by farmers themselves, e.g. effective and simplified sampling methodologies. The intent is to incorporate the extensionist and the farmer into the research activities, so that they are involved in the development as well as the receipt of the new technology. Working directly with extensionists may overcome any resistance on the part of the Gerente Regional since the project will also be supplementing resources, such as vehicles and motorcycles. Lead farmers, identified as leaders by the community, will further help to extend information generated by the project.

The details of the project have not yet been worked out, e.g. number of farmers involved, sites for on-farm research, etc. The CATIE/MIP project has generated a considerable amount of information that will have application in the GTZ project. Coordination will be critical among this activity, the A.I.D. supported Water Management Project, and CATIE/MIP. These projects could collaborate at several levels:

1) to establish research priorities for small farmers involved in basic grain cultivation which is mixed with vegetable and/or nontraditional crop production, such as the temporal and spatial relationships of pests and natural enemies among these different crops;

2) as a means of extending information, where available, to small farmers on crop protection for horticultural crops; and

3) to develop training methods and evaluation and monitoring of training for extensionists and small farmers in IPM for mixed cropping systems which are based on basic grains.

Interamerican Development Bank: While GTZ is the only other donor involved in a substantive way in developing integrated pest management systems, other donors provide assistance for the procurement of pesticides. IDB is supporting a variety of programs including the construction of an animal products lab at the Centro de Desarrollo Ganadero and the procurement of fertilizers and pesticides through the Departamento de Comercio and distributed through the Banco de Fomento Agropecuario. The team unfortunately did not have the time to meet with IDB staff to discuss their policy on pesticide imports. Their funds do appear to be used to procure restricted use chemicals, e.g. paraquat and ethyl parathion. It would be valuable for the Mission to discuss this policy with IDB, particularly if there is interest in negotiating changes in BFA policy related to the provision of agricultural inputs.

7. Regional Institutions

Central American Bank for Economic Integration (CABEI). With the assistance of ROCAP and a ROCAP supported environmental advisor within the bank, CABEI has developed a database on pesticides by crop and by pesticide. Most of the information on the database is extracted from information included on pesticide labels. It also includes the type of pests and registration status in the different Central America countries. Accompanying the database will be a set of technical guidelines for crop practices including pest management.

The database is on Lotus and as such is a little difficult to view single entries, although it may be too large for DBASE III. A copy of the diskette was obtained for CABEI and left at the mission and at FUSADES. CABEI is very interested in coordinating with others interested in using this information to assure its usefulness and the advisor in Honduras may be available for consultation. This could be an important role for CABEI and CATIE (discussed below) to serve as a clearinghouse and coordinator to assure continuity and compatibility of information and updates and among systems.

Tropical Agricultural Research and Training Center (CATIE): The research being conducted under the CATIE/MIP project was described above in B.2. CATIE should continue to play an important role in the region in developing agricultural technologies. It may be appropriate for CATIE to coordinate increased communication with FAO/WHO and U.S. EPA on the registration status of pesticides.

Figure 3.1. Pesticide Registration Process Based on Decree No. 315

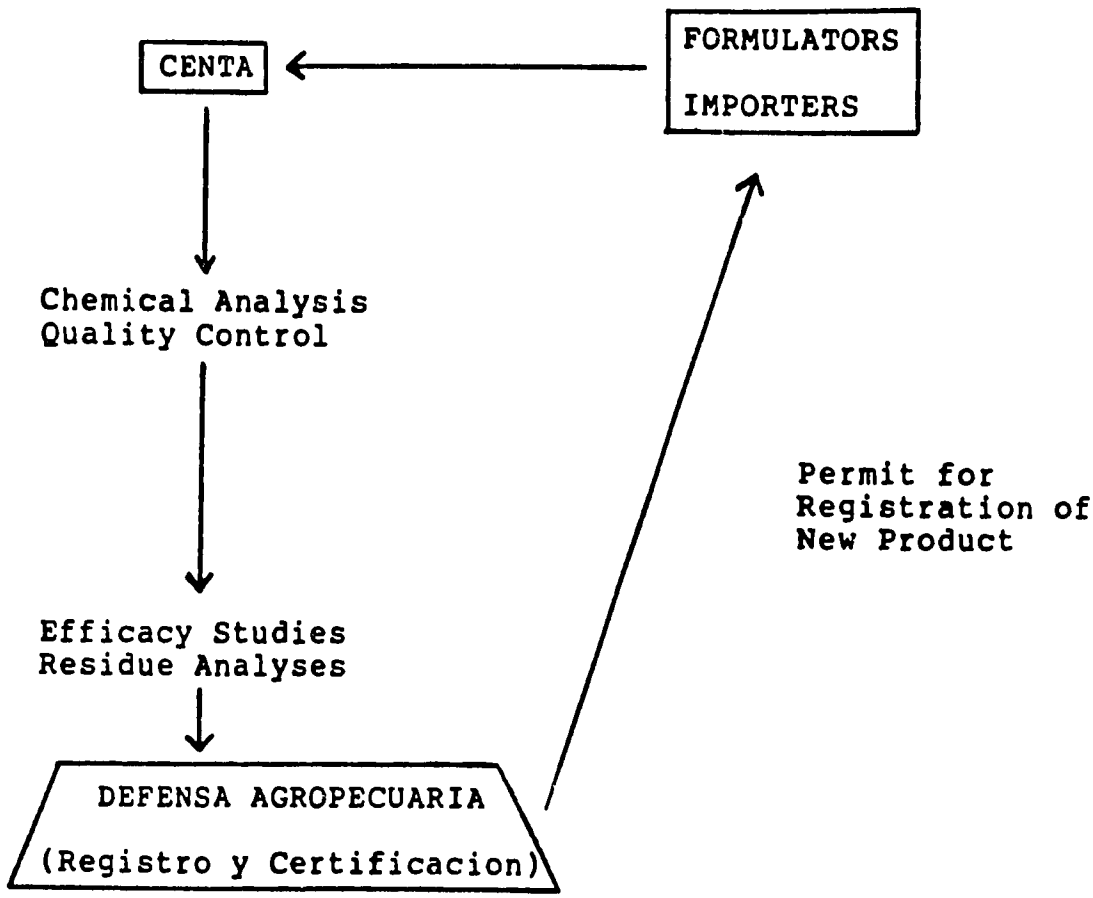


Figure 3.2. Pesticide Quality Control Process Based on Decree No. 315

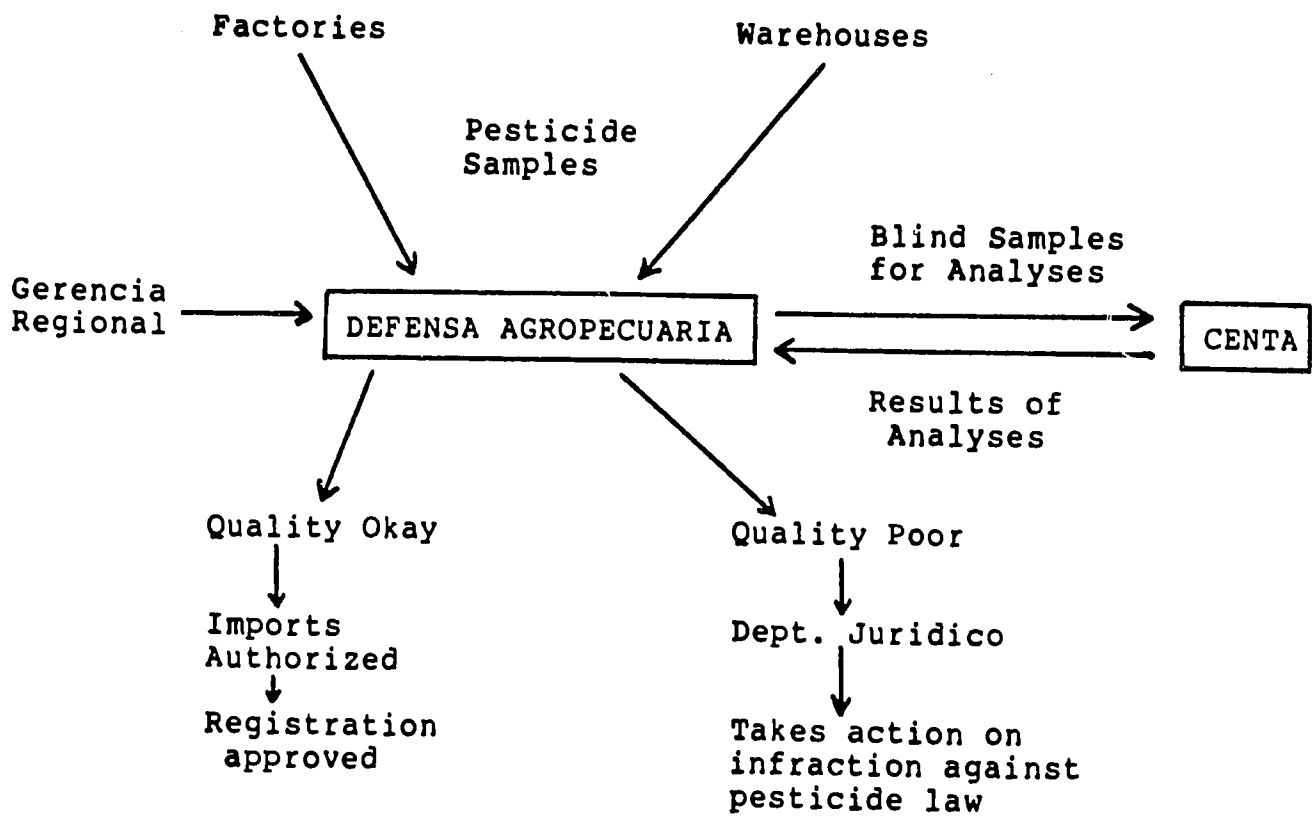
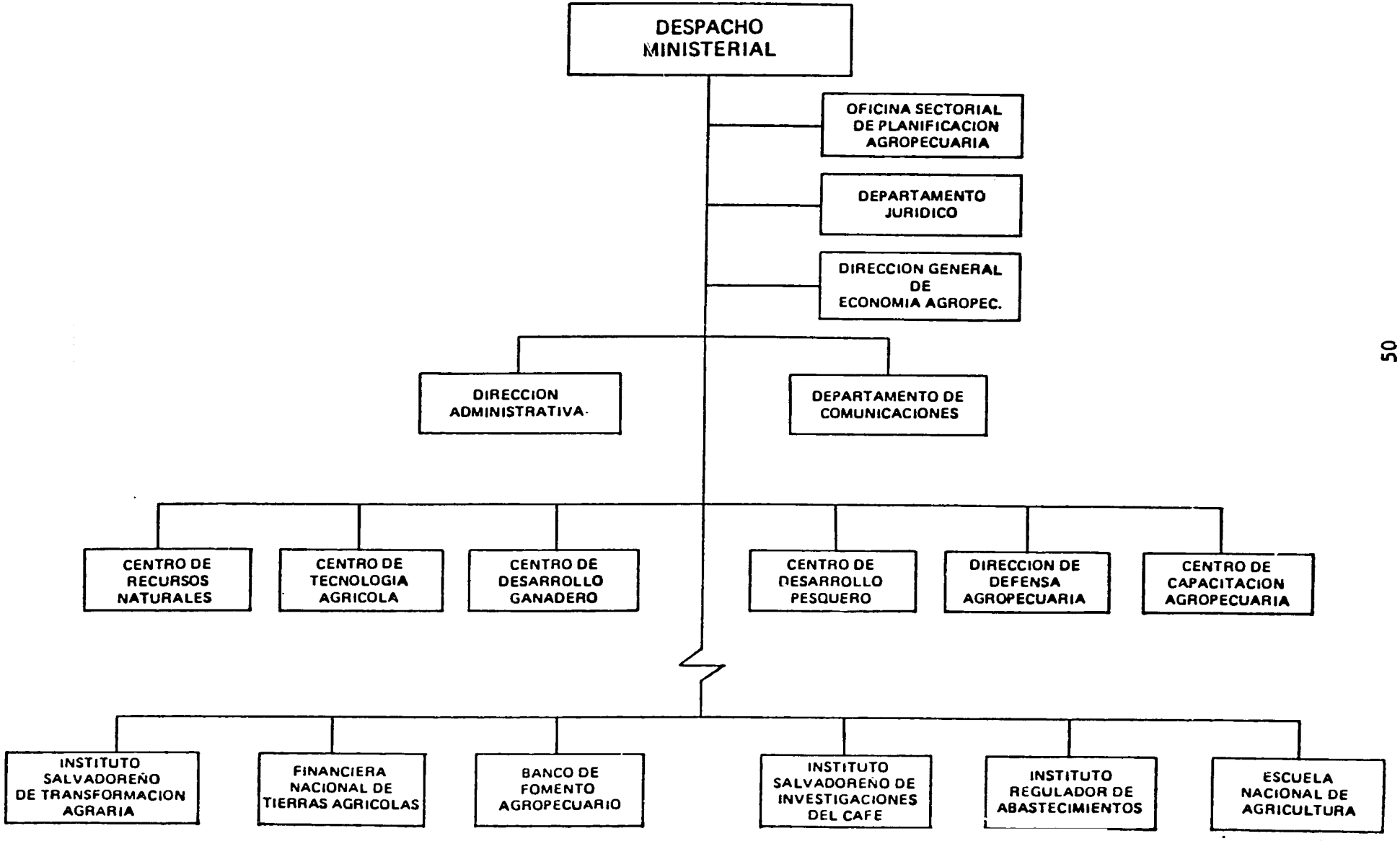


Figure 3.3

EL SALVADOR

ORGANIGRAMA ESTRUCTURAL DEL SECTOR PUBLICO AGROPECUARIO



C. Impact of Current Practices

1. General Discussion

a. Pesticide Impacts and Safety

All pesticides are potentially hazardous to humans and the environment and should be treated with caution regardless of their relative toxicity. The potential health hazard depends on the toxicity of the chemical, the selectivity of action, the formulation, the method of exposure (i.e. inhalation, dermal contamination, ingestion) and the frequency of exposure. Acute toxicity is expressed by the LD50 value which is the amount of the chemical necessary to kill 50% of the experimental animal population (e.g. lab rats or house flies). This value is expressed in the weight of pesticide per unit weight of body (mg/kg) when swallowed (oral toxicity), absorbed through the skin (dermal toxicity) or inhaled. The latter value, inhalation toxicity, is usually expressed in parts per million (ppm) per unit volume of air.

Pesticides with the lowest LD50 value are potentially the most toxic to humans. Ingestion of just a few drops to a teaspoon of a pesticide with an oral LD50 value of less than 50 might be sufficient to kill an adult person. An adult would probably have to consume 16 tablespoons to 1/2 kilogram or more of a pesticide with an oral LD50 of 5,000 before dying. However, formulation (percent active ingredient) is also critical to the evaluation of toxicity. Rodenticides (rat poisons), for example have low oral toxicity values but would be considered only moderately hazardous to humans because their pellet formulations contain only about 2% active ingredient. In addition, selectivity of the toxic effects of the chemical to specific physiological processes in pests (e.g. molting hormone analogues) can further limit the mammalian toxicity.

The Environmental Protection Agency (EPA) classifies pesticides according to their level of toxicity. These "signal words" appear on the labels of EPA registered pesticides. The criteria for signal word designations are outlined in Table 3.2. Pesticides assigned the signal word "DANGER" are highly toxic compounds and are not recommended by EPA for general use. Materials showing the words 'WARNING' or "POISON" also present high potential hazard to the user. EPA classifies the registration status of a chemical based on the relative human health hazards and environmental risks. Although restricted use chemicals can be funded with A.I.D. funds, they require careful training and certification of applicators and users, a level which is generally difficult to attain with small farmers. Further, the unavailability of protective equipment and the unwillingness to use equipment, if available, emphasizes the need to limit pesticide use and procurement to those chemicals that are registered for general use. Therefore, if adequate training cannot be assured, restricted use pesticides should not be used.

Pesticides used should be registered for the same or similar use by EPA with established residue tolerances. If tolerances are not available, provisions should be made to develop tolerances or those pesticides will not

be authorized. Residue tolerance is the amount (in ppm) of pesticide that may legally and safely remain in or on any raw farm products at the time that these products are sold for consumption by humans or livestock. However, in those cases where crops do not grow in the U.S., and the EPA has not registered the chemical for the same or similar use, the chemicals in question may have WHO/FAO residue tolerances, thus allowing its use with A.I.D. funds.

b. Potential Human Health Impacts of Pesticides

Past experience with the use of organochorines is characterized by, high levels of residues in human tissue and nontarget organisms, and the environment, but without associated risks of acute poisoning as is the case for organophosphate (OP) and carbamate pesticides. Nevertheless, organochlorinated pesticides are lipophilic, are stored in body fat, and some are carcinogenic; therefore, their use should be minimized. Shift to the use of OPs, while generally thought to be more environmentally benign due to their short half life in the environment, poses serious acute and chronic risks to human health and safety.

While the short-term risks from poisoning may be high no long-term effects are known for organophosphate chemicals with the exception of Chlorpyrifos, and DDVP which are lipophilic and can be stored in body fat, and mephosfolan which has been shown to cause demyelinization (removal of the mylial nerve sheath), and permanent paralysis in chicken.

Esters of cholorophenoxy acids instead of the salts are more dangerous because of respiratory exposure even though the oral LD50 of both are approximately the same. The salts are systemic in plants, and therefore residues may accumulate within the food crop. Chlorophenoxy acids, and organocholorines are central nervous system stimulators and can also cause chloracne.

Pyrethroids have low mammalian toxicity and do not pose an acute poisoning threat to applicators. Residues may build up in human tissue, but little is known of long term effects. Pyrethroids are primary irritants and can cause dermal problems for applicators.

c. Proper Handling and Disposal

If the labeling instructions are followed for the use of general use pesticides, most long-term effects and incidence of residues on foods can be minimized and/or avoided. Pesticides should always be stored in their original containers in a facility specifically designated for that purpose. The facility should be locked with keys assigned only to authorized personnel. A sign reading "DANGER: PESTICIDE STORAGE AREA" should be posted. Pesticides should not be stored near food, water, animal feed, animals nor humans. The storage place should be in an area protected from tropical storms and fire hazards.

Empty containers should never be reused since there is no practical method of removing all the toxic residues. Liquid containers should be

treated as follows: empty the container's content into the spray tank, drain in a vertical position for 30 seconds. Refill the container 1/4 full, rinse and pour into the tank, and drain. Repeat rinsing and draining three times. Use the rinse water in the sprayer. Punch several large holes in the container and dispose in a designated land disposal site on high ground away from water to minimize contamination and impact on aquatic organisms.

Containers and small quantities of leftover pesticides should be buried in pits in the soil about 1/2 meter deep. Bottoms and sides of the pits should be lined with lime, carbon, charcoal, or organic matter such as leaves, straw or other plant debris. Any of these materials is a good absorbent and facilitates breakdown of the chemical. The pits should be refilled and mounded above ground level with the soil. Empty paper containers and bags also should be buried in similar burial pits. Small amounts of paper containers can be burned away from residences as long as the pesticides do not contain heavy metals.

d. Environmental Hazards

The environmental fate (e.g. persistence) of pesticides and thus, the hazards posed by their use is a function of a large number of variables. Direct impact on nontarget organisms will depend on the safety precautions taken during use: minimizing drift and run-off, proximity of water sources and nontarget habitats, safety precautions taken during disposal and cleaning of application equipment, and timing applications to reduce impact on natural enemies. Environmental fate of and contamination by pesticides, and subsequent impact on nontarget ecosystems is largely a function of the physical, chemical and biological interactions of the pesticides in the environment, including the solubility of the chemical, its sorption coefficient, its chemical composition (e.g. presence of heavy metals), humidity, temperature, soil type, pH, rainfall, and soil microfauna. For example, the persistence of specific chemicals can be determined by the water solubility and sorption coefficients shown in Table 3.3. The most persistent compounds, organochlorines such as DDT and Lindane are not very soluble in water, and thus do not pose a particularly serious threat to water systems. However, they are also characterized by high sorption coefficients and are strongly held by soil particles and soil organic matter, maintaining their presence in the environment. In contrast to organochlorines, organophosphates and carbamates are generally less persistent in the environment, and are characterized by high water solubility and low absorption to soil particles. The list below presents a representative sample of chemicals classified in terms of mobility:

Very Mobile	Dalapon, Dicamba
Moderately Mobile	Picloram Amitrole, 2,4 D
Intermediate	Fenuron, 2,4,5 T, Atrazine
Partially Mobile	Terbutryn, Propanil, Azinphosmethyl Diazon
Immobile	Phorate, Parathion, Disulfoton, Zineb, Morestan, Benomyl, Dieldrin, Paraquat, Endrin, Toxafeno, DDT

Absorption can also be influenced by pH. Under acid conditions, a condition prevailing in many areas of El Salvador a higher concentration of hydrogen ions is available to bond with pesticides, giving them a positive charge. This increases their affinity to attach to negatively charged soil particles. In other cases, such as with 2,4 D, pH can cause the molecule to dissociate to a form with a negative charge, thus decreasing absorption to negatively charged soil particles, and potentially increasing its mobility.

The use of organophosphates, carbamates and pyrethroids is generally favored over the use of organochlorines. These compounds tend to degrade rapidly in the soil, particularly under warm and humid tropical conditions. For example, Malathion has a half-life of about 7 days in soil at a pH of 6 (See Table 3.4). Under acid conditions, hydrolysis in water however is much slower. While OPs and carbamates tend to degrade rapidly, there is evidence that these chemicals do move into water sources and are absorbed by nontarget organisms, therefore potentially causing mortality in nontarget organisms. The impact of pesticide use on populations of wildlife in tropical regions has not been well-studied. Acute poisonings have been documented in Costa Rica and El Salvador, while chronic impacts on wildlife are poorly understood (See Section 3 below). Extreme care should be taken with the use of pyrethroids in coastal regions due to high toxicity in fish and other aquatic life. In addition, triazine (e.g. atrazine, a commonly used herbicide) use near water supplies and coastal areas can lead to contamination due to its relatively high water solubility.

Accumulation and persistence is not limited to organochlorines. The heavy and consistent use of a number of fungicides and bisdithiocarbamates can perhaps lead to contamination with inorganic compounds (e.g. arsenic, mercury, lead and copper) in soil and water. Copper contamination has been associated with damage to soils and to crops in Costa Rica (Cordero and Ramirez, 1989). Fassbender (in Mora et al 1984) also reported high levels of arsenic (10.6 to 49 ppm) in soil as a result of its use in coffee in Costa Rica. Build-up of paraquat has been noted in Costa Rica (Rojas 1984), which could lead to phytotoxicity of subsequent crops.

Table 3.2
Toxicity Categories of Proposed Pesticides by Hazard Indicator

Hazard Indicators	I[1]	II	III	IV
Oral LD_{50}	50 mg/kg or less	50-500 mg/kg	500-5,000 mg/kg	5,00 mg/kg
Inhalation LD_{50}	.2 mg/liter or less	.2-2 mg/liter	2.0-2- mg/liter	20 mg/liter
Dermal LD_{50}	200 mg/kg or less	200-2,000 mg/kg	2,000-20,000 mg/kg	20,000 mg/kg
Eye Effects	Corrosive; corneal opacity not reversible within 7 days	Corneal opacity reversible within 7 days irritation persisting for 7 days	No corneal opacity; irritation reversible within 7 days	No irritation
Skin Effects	Corrosive	Severe irritation at 72 hours	Moderate irritation at 72 hours	Mild or slight irritation at 72 hours
EPA Signal Word	"DANGER"	"WARNING"	"CAUTION"	"CAUTION"

[1] The word "POISON" and also a picture of skull and crossbones appear on the labels of EPA registered pesticides in Category I.

Table 3.3
Water Solubility and Sorption Coefficient of Pesticides (References 1 and 3)

Pesticide Common Name	Trade Name(s)*	Water Solubility ppm	C	Sorption Coefficient K ** oc
Oxamyl	Vydate, Vydate L, HA-2214	280,000	025	6
Aldicarb	Temik, Temik 15G, OMS771	9,000	030	10
Dicamba	Banvel D. Banex, Dianat, Weedmaster	4,500	025	11
Picloram	Tordon, Amdon, Grazon	420	025	26
Carbofuran	Furadan, Yaltox, Curaterr	700	025	29
2,4,D	Agrotect, Amidox, Weed-B-Gone, Weddtrol	900	025	32
Terbacil	Sinbar	710	025	46
Fonofos	Dyfonate, N-2790	13	021	68
Bromocil	Hyvar XL, Borocil, Ureabor	815	025	72
Simazine	Aquazine, Princep, Simadex Sim-trol	3.5	020	158
Atrazine	AAtrex, Griffex, Atranex Vectal SC	33	025	163
Carbaryl	Sevin, Denapon, Tercyl, Septene	40	025	229
Diuron	Karmex, Urox D, Direx 4L Diurol	42	025	389
Lindane	Gamma BHC, Isotox, Lintox Silvanol	7.3	025	1,081
Malathion	Mercaptothion, Calmathion, Carbofos, Cythion	145	025	1,778
Glyphosate***	Roundup	12,000	026	2,640
Methyl Parathion	Metafos, Parathion-Methyl, Devithion, Nitrox 80	55-60	025	7,079
Parathion	Thiophos, Bladan, Orthophos Panthion	24	025	7,079
Paraquat***	Ortho paraquat CL, Dexuron	1,000,000	025	15,423
DDT	Tech DDT, Zerdane, Anofex Gentox	<0.01	025	243,000

* Trade names given for convenience and does not represent endorsement by team.

** The larger the Koc, the more strongly the pesticide is held in the soil organic matter and the less likely it will leach through soil.

*** Note: These pesticides are ionic and are exception to the inverse solubility t Koc relationship.

Table 3.4

Environmental Fate of Malathion

Air	Photolysis rates too slow to be of significance in environmental degradation (Wolfe et.at., 1977)
Soil	Rapid chemical and microbial degradation (Gibson and burns, 1977) (Jenkins et.al., 1978) Linsley (1979) found the half-life of malathion in soil is 0.5 day. No accumulation of parent compound and most degradation products (Paschal and Neville, 1976) minimal transport through soil colum washoff and overland transport to local waterways are possible.

PH	Pesticide	Condition	Half-life (days)
6.2	Maloxon	Sterile	7.5
		Non-Sterile	6.5
7.2	Maloxon	Sterile	5.1
		Non-Sterile	4.6
8.2	Maloxon	Sterile	3.9
		Non-Sterile	3.5

Paschal and Neville, 1976

WATER

Spiller 1961 — Malathion

pH 12 Complete hydrolysis almost immediately
pH 9 50% hydrolyzed in 12 hours
pH 5-7 No hydrolysis after 12 days

Kenrad et.at. 1969

pH 11 100% hydrolyzed after 7 days
pH 9 25% hydrolyzed after 7 days
pH 2,4,6 No degradation after 7 days

2. Current Pesticide Use and Practices

a. Pesticide Imports

The importation and use of pesticides in El Salvador has been and continues to be on a par with or higher than that seen in other Central American countries (Table 3.5).

For a country with a surface area of only 21,000 Km^2, of which only 12,000 Km^2. (Table 1.2) is actively engaged in agriculture, the past levels of pesticide imports translate into very heavy pesticide loads on a square kilometer basis. Imports and exports of pesticides by pesticide category, amounts and value from 1982-1988 are shown in Tables 3.6 and 3.7. As a point of comparison with Guatemala, in 1984, Guatemala applied 2.245 mil. kg. (difference between imports and exports) while the demand for pesticides in El Salvador in El Salvador was 5.0 mil Kg and 6.14 mil liters (Seminario Sobre Problemas Asociados Con El Uso de Plaguicidas en Centroamerica y Panama).

Table 3.5. Pesticide Load Per Total Surface Area of Country for Organochlorines and Parathion. (Kg/Km^2)

Country	1972	1973	1974	1975
El Salvador	427.0	593.5	424.2	345.2
Guatemala	48.6	94.4	102.9	123.7
Honduras	-	2.02	1.42	
Nicaragua	60.2	66.0	41.0	
Central America	-	85.5	75.7	

Source: ICAITI

Although cotton hectarage, which has accounted for 60-80% of the pesticide use in El Salvador, has declined by about 88% in the past 10 years, to about 18,000 mz. planted in 1988 from the high of 150,100 mz. in 1978 (Table 1.3), there has not been a comparable decline in pesticide imports, except for very recently (1986/88). The most dramatic decline in imports was in 1987/88. The dollar figure for pesticide imports was almost cut in half in 1987/88 based on policy that existing, in-country stocks would be sufficient to meet current needs (Table 3.7) The chemical manufacturers have however, come back with a request to allow at least $34 million worth of pesticide imports in 1988/89.

Twenty-one commercial firms and formulators (including national and foreign businesses), OIRSA and the Banco de Fomento Agropecuario (BFA) were responsible for all of the imports in 1987, the final year for which data are available. In 1987 and 1988, 87 and at least 100 different chemicals, respectively, were available in El Salvador. This included everything from insecticides to growth regulators. The greatest percent of imports both in terms of cost and amount continues to be insecticides followed by herbicides

(Table 3.6 and 3.7). However, the volume (liters) of herbicides has been gradually increasing since 1982 (Table 3.6). During the past 7 years, 12.7% of the registered products were formulated or imported by Central American companies; 33.1% were U.S. owned or affiliated. Overall, from 1976-87, a total of 436 formulations, from a total of 19 companies were registered for use in El Salvador (Lopez Zepeda et al. 1988). Most liquid insecticides (90%), wettable powder insecticides (60-70% and herbicides (90%) are formulated in country (APA, personal communication).

b. Pesticide Use: Safety Practices and Patterns of Use

Among the large number of options of pesticides available for farmers, several compounds predominate. In general, from interviews and by reviewing other reports, lannate, tamaron, volaton, and methyl parathion are among the most commonly mentioned insecticides. Benlate and mancozeb were the most frequently noted fungicides, while gramoxone, atrazine and 2,4 D are the most frequently used herbicides. In terms of the number of applications and number of different chemicals being used, melons and green peppers rank highest along with cotton. Fewer chemicals are used and are used less frequently on other crops. Visits to three cooperatives revealed use of most of these same chemicals.

Many chemicals commonly used are restricted use chemicals and considered highly hazardous for the user and/or the environment (Table 3.9). Of the more than 90 chemicals available in El Salvador (Attachment 3 and Table 3.9), nearly 30% of these are restricted use chemicals, and consequently pose a very serious health and environmental risk. The toxicity ratings for some of these chemicals are provided in Table 3.10. Pesticides recommended for use by CENTA and FUSADES are shown in Tables 3.21 and 3.22. A number of these chemicals are highly toxic. Given the patterns of use observed in the field, and described below, reports from farmers on poisonings, and experiences of technical personnel in El Salvador, regarding the lack of use of protective gear, it is strongly recommended that the first step be to limit pesticide procurement to general use compounds only.

Santa Clara (1) (Phase I - cotton & mixed crops)	Santa Emilia (2) (Phase 3 -	San Raymundo (3) (Phase 1 - diversifying)	Canada (4) (Phase I - (cane & cattle)
metamidofos	tamaron	lannate liquid	daconil
methyl parathion	volaton	gramoxone	benlate
fenvalerate	gramoxone	propanil	furadan
volaton 800 ULV	lannate	LV-10STAM	lannate
dipteryx	(metomyl)	2,4D	lorsban
Jupiter		benlate	phosxene
cipermetrina		dithane M45	paraquat
(dominex)		Sencor 70%	tamaron
lorsban 2.5%		agromycin 500	volaton
		gesaprin 800	vydate
		karmex	dipel
		caracolicida	
		tordon 101	
		decis	
		roundup	
		nudrin 90	
		nuvacon 60SCW	
		(monocrotophos)	
		metaldehyde	
		fusil	

(1), (3) and (4) List includes packages found in the storage areas and as result of interviews.
(2) List result of interviews only.

The team visited four cooperatives (three Phase I and one Phase III) as noted above in an effort to get an impression of pesticide use problems in rural communities. The San Raymundo, Ahuachapan cooperative (Phase I) was more similar to the Phase II cooperative with regards to cropping patterns and the diverse array of crops and pest problems than it was to the other two Phase I cooperatives. Ahuachapan had about 100-130 families in the cooperative. The area had largely been in sugarcane and coffee but the cooperative was diversifying and moving into new crops. Cane areas were being converted to beans and tomatoes, with ultimate plans for citrus. The tomato field we visited was interplanted with first year citrus saplings. At the Phase III cooperative in Cuyultitan, farmers owned their own small parcels with a variety of both perennial and annual crops, including plantanos, cana de papa, coconut, sesame, and oranges. There were approximately 45 families in the coop. In both cases, the coops were receiving credit from the BFA.

At all three Phase I coops, pesticides were stored in a bodega under lock and key. The organization and management of the bodegas varied a great deal. At the San Raymundo coop. At least 19 chemicals were being stored

(see list above), a number of which were no longer being used. The coop receives pesticides from the BFA which are used, but if they do not work, they go out to local distributors to buy others. Pesticides found to be ineffective or not what was needed, were just piled up in a corner of the bodega. The individual in charge of the bodega did not keep records of use, and there did not appear to be a great deal of planning involved in pesticide procurement. Safety equipment was not available for the applicators. If equipment had been available, there was some doubt that it would be used. Pesticide application is being done largely by the female coop members since women can be paid (albeit illegally) less than the men. On our way out to the field, we ran into a group of about 10-12 women returning from fumigating the tomato fields with Benlate. The plants were showing a number of symptoms of fungus infection which in part is aggravated by poor cultural practices (irrigation methods and no staking to keep the fruits out of contact with the soil). The women all reported experience in the past with pesticide poisoning, responding quite cavalierly as if it were just part of the life. It is no problem they said, they go to the hospital in Ahuachapan when they feel as though they may have been poisoned, receive a shot and come back home. No one was wearing any type of protective gear.

Cuyultitan, La Paz

At Cuyultitan, we met with about 40 of the coop members (men and women were about equally represented). Everyone noted some experience with pesticide poisoning (e.g. headache, nausea, dizziness) after fumigating. They also did not use protective gear. The men were largely doing the fumigating and all women said they did not use pesticides when they were pregnant. Pesticides were largely kept in the house, and then the group jokingly added, under the bed of course, to keep the fleas off. This coop was further limited by the lack of water to enable them to bathe after spraying and wash clothing that is used for fumigating. They were impressively well-informed, understood the problems and recognized that they in fact had a problem. They asked questions regarding residues and the appropriateness of mixing pesticides. While these farmers were relatively aware of the dangers of pesticides, improving use and handling in the coop would depend on several factors: appropriate equipment, advice on safer alternatives and proper handling, pest management information, and ways to identify pest problems and effective sampling regimes.

Santa Clara, La Paz

At the Santa Clara coop, pesticides were being used only on cotton. The coop had a trained agronomist working full time who was quite knowledgeable on pest management, sampling practices, etc. There were no reported poisonings at the clinic that we visited that is part of the coop. The clinic had a full-time nurse and half-time doctor. The storage site for pesticides was dry, neat and under lock and key. Someone was in charge of the pesticide use and kept very careful records. Empty pesticide drums (50 gal) were burned inside with gasoline after use and then sold. In some cases, the barrels were welded together and then used for sanitary receptacles. Application was being done by airplane and they reported that

protective gear was available and worn. Although we did not get a chance to see the loading process, it appears that they have a very open system for loading the planes offering a number of opportunities for spills and contamination. The Ministry of labor is responsible for worker safety at cotton coops and in theory conducts periodic inspections. These apparently are not very effective and are resisted by the cotton growers. However, we did not have an opportunity to speak with Ministry personnel.

La Canada, Sonsonate

The final cooperative visited was in Sonsonate, La Canadá. The coop was about 430 mz with about 70 families. The cooperative was growing sorghum for cattle, raising cattle and sugar cane. They had attempted some diversification into melons. This however had failed. The vice president described soil problems, marketing and very serious virus infection in the second melon crop as the major obstacles. They had on-hand quite a few pesticides, (see above) in a locked bodega, some of which were not being used, such as Dipel (Bacillus thuringiensis). The vice president was uncertain how Dipel should be used. Pesticides were pretty much thrown into the bodega with very little organization. Again no protective gear was available.

Patterns of Use

Where pesticides are being used in El Salvador, it is largely done on a calendar basis, without regard to pest incidence or damage. If pests or pathogens are then noted, the spray regime is stepped up. At Cuyultitan, soils are treated with volaton before planting. They then spray about once per week unless pests are found, then it is about two times per week. They felt that if they did not spray regularly and waited to be able to see the pests, that by the time pests were visibly evident, it would be too late. To protect corn plants from the 'cogollero' (Spodoptera frugiperda), volaton granules were applied with their bare hands to the whorl of the corn plant. They described other disease and/or pest problems but had not received much assistance from extensionists to enable identification and thus proper management.

At Santa Clara, the agronomist visited the field every day to sample densities of the cotton boll weevil, bollworm, whitefly and Alabama sp. Stubble was being destroyed, trap crops and pheromone traps were being used. Nevertheless, the fields were being treated every frequently with methyl parathion, dominex (a synthetic pyrethroid) or dipteryx. Workers are then not allowed in the field for 48 hours after spraying in the case of methyl parathion and 24 hours after the use of dominex. The first application of dipterex was made only 23 days after planting suggesting that the off season practices are not being fully implemented in the area so that pest populations are high at the beginning of the season, or the sampling regime is not adequate and fields are being fumigated before it is absolutely necessary.

The president of the San Raymundo coop said he would spray when symptoms were noted and then the use was on a more or less regular basis.

Farmers very frequently mix pesticides in the same spray container; kill two bugs with one squirt, and minimize labor costs. Depending on the chemicals, this can pose certain problems. The presence of one chemical can inactivate that of another. This type of management information is not available for farmers. Also, some chemicals can be phytotoxic when used in the presence of another. For example, propanil (an herbicide) is toxic if applied 15 days before or after the use of an organophosphate or carbamate. Without specific information on the compatibility of different chemicals, it is best to recommend against mixing. It not only may render certain chemicals ineffective or phytotoxic but probably contributes to overuse.

c. Efficacy of Pesticides

There is every indication that pesticide resistance is widespread in El Salvador, although there are no concrete data, to quantify this except for the limited information regarding development of resistance for malaria vectors. The agronomist at Santa Clara noted problems with different pesticides which could have been due to the quality of the formulation as well as the presence of resistant pests. The Asociacion de Proveedores Agricolas (APA) has noted many changes in chemical use in response to changes in efficacy, suggestive of resistance. APA reported that samples of Heliothis and Spodoptera have been sent to the U.S. for analysis by private firms.

There is a critical need to examine resistance to pesticides in El Salvador. Pesticides need to be managed more effectively to minimize or at least to slow the development of resistance. Given the high levels of pesticides that have historically been used, resistance, particularly in cotton, is likely to complicate the task of pest management and the appropriate use of pesticides. High levels of use in vegetable crops is very likely to lead rapidly to pesticide resistance. The malaria advisor to the Ministry of Health said that there is some degree of resistance in Anopheles albimanus to nearly every pesticide which is largely attributable to excessive use in agriculture. The CATIE/MIP project should coordinate with the GTZ project to begin to monitor pesticide resistance. GTZ will be focusing its efforts on pests of cotton, corn and beans. There are some simple field techniques to monitor resistance being developed for vectors by the Centers for Disease Control that may have application with herbivorous insects. CATIE/MIP should contact the S&T/Health Vector Biology and Control project to get information on these techniques and their applicability to agricultural pests.

A similar problem was encountered when trying to gather information on secondary pest outbreaks related to pesticide use and the destruction of natural enemies. Since there is little consistent population monitoring of pest populations being done, reports on secondary pests tend to be largely anecdotal. Whitefly was reported to be a serious problem in the Santa Clara coop. Presence of whitefly is often associated with high pesticide use. Mites have also been reported as a problem in cotton, related to spraying regimes. Calendar spraying will contribute to added pest problems. Not only does it fail to take into account the presence of the pest, but fails to take measures to minimize adverse impacts on natural enemies.

Contraband pesticides may be below quality standards and contribute to decreased pesticide efficacy. This is evidenced by the quality control results from the CENTA labs.

3. Environmental Impacts of Pesticide Use

The environmental impact of pesticide use in the Central American region, including El Salvador is poorly understood. In most cases the data are patchy, collected as part of a specific project or projects, or completely lacking. There have been almost no systematic studies or monitoring programs of animal and plant populations with respect to pesticide use in El Salvador. Nevertheless, there are past experiences and current trends that highlight problem areas of the past and for the future.

Pesticide use was greatest on cotton, primarily organochlorine compounds such as DDT, dieldrin, endrin, BHC etc. All of these chemicals are persistent to some extent in the environment and characteristically bioaccumulate in the food chain. In 1977, ICAITI conducted a study of the environment, health and economic risks and costs of pesticides use in cotton. The high levels of organochlorines was evidenced by the high residue levels of contaminants in plants and animals. From the extensive surveys conducted in the ICAITI study, contamination was lowest in water and soil and highest in the higher trophic levels (fish and cows). Residues of methyl parathion were evident in fish in the range of 0.009-1.26 ppm. High levels of DDT and DDT metabolites have been found in cows milk, beef, cheese, mothers' milk, ground water, soil, and fodder. Tables 3.11, 3.12 and 3.13, provide some of the patterns of residues found in beef from three different studies in 1972-74, 1980 and 1988. It was not possible to compare methodology and therefore compare results, but it is encouraging to note that organochlorine residue levels are declining.

Lopez Zepeda (1977) showed similar trends in his studies in the Jiquilisco Lagoon. During the months of August through November, corresponding to periods of pesticide use, he sampled water and estuary invertebrates and fish for DDT, endrin, dieldrin and ethyl parathion. He found residues of organochlorines in nearly all samples of water, fish, shrimp, clams and starfish (Table 3.14). One species, Anadara sp., also showed levels of ethyl parathion residues in the tissue. From the patterns of contamination, Lopez Zepeda (1977) concluded that pelagic fish receive the highest temporal concentrations of pesticides from September-December, filter feeders receive a lower but more stable level throughout the same period since ethyl parathion is probably more stable in sediment than in water, and predator starfish showed high and stable concentrations of DDT and high temporal concentrations of endrin and dieldrin. Though the sample sizes for soil analyses are small it is interesting to note that higher residues were found in soil from farms that had been under cotton cultivation for the longest periods indicating a cumulative effect (Table 3.15).

Another study by Calderon conducted in 1977-78 also demonstrated organochlorine contamination of subsurface soils. The highest levels of residues were found for aldrin and dieldrin in corn, cotton and pasture

lands within the cotton growing regions. Persistence varied with soil type and the highest amounts were found in red clay latisol soils (Latosol Arcillo Rojizo). Calderon also noted organochlorine residues in river and wells in cotton growing regions in the late 1970's.

There are few data on residues of organophosphates in water, soil and nontargets and on the behavior of OPs under conditions in El Salvador. As noted above, methyl parathion residues were detected in fish in the ICAITI study and in Lopez Zepeda (1977). More recently, two students at the Universidad de El Salvador examined bioaccumulation of methyl and ethyl parathion in estuaries in the cotton growing regions of the Estero de Jaltepeque. Dominguez Pantoja and Paz Quevedo (1988) examined residues of methyl (EtPt) and ethyl parathion (EtPt) and ortho-paraoxon (metabolite) in water, sediment and different estuary organisms as a function of feeding behavior and habitat:

Shrimp (Penaeus)	Herbivore/Detritivore	Benthic
Jaiba (Callinectes)	Detritivore	Benthic
Curil (Anadara (clam))	Filter-feeder	Benthic
Ruco (Pomodasys)	Detritivore/Carnivore	Benthic
Jurel (Caranx)	Predator	Pelagic
Bagre (Arius)	Omnivore	Benthic

Sampling was done during three parts of the cotton growing season (June, early November, late November) corresponding to planting, maturing fruits and harvesting.

None of the first samples (June) showed evidence of residues of MtPt nor EtPt, while paraoxon was present in tissue of most of the organisms sampled. Following the application of pesticides, tissue levels of MtPt and EtPt were detected in all organisms sampled, with the greatest accumulation in Andara, the filter-feeder, and Pomadasys, a detritivore/carnivore. While the sample sizes are small and thus do not indicate the degree of the variability in chemical contamination, several important factors are illustrated by this study.

1) This study agrees with others that MtPt and EtPt degrade rapidly and do not accumulate in the environment (i.e. absent in water and sediment samples).

2) There was accumulation of the metabolite, ortho-paraoxon in animal tissue. The early season levels may, however, have been related to pesticide use on crops other than cotton and may not represent accumulation of residues.

3) Methyl and ethyl parathion do show high levels of bioaccumulation in fat tissue of aquatic organisms.

4) Movement and behavior of estuary inhabitants, and physiological factors all may contribute to the likelihood of bioaccumulation but elucidation would require further studies.

5) Alkaline conditions in the estuary favor bioaccumulation of ethyl parathion but accelerate degradation of methyl parathion.

It is impossible to state definitively the impact of pesticides on nontarget organisms in El Salvador from the data available. In comparison to trends in the U.S., it is very likely that the use of organochlorines has had a similar if not more pronounced impact on the avifauna particular predatory birds, of El Salvador, considering the levels of use. No population studies were available, however. The presence of residues in tissues of estuary inhabitants suggests a potentially negative impact on estuary ecosystems but corresponding population data for El Salvador is not available. There have been reported declines in fish and clam harvest in the Jiquilisco lagoon that are felt to be largely due to mangrove habitat destruction and pesticides (Lopez Zepeda 1977), and fishermen have noted declines in fish takes during the cotton season. From 60's to 70's, shrimp catch has been declining and started to increase from mid-70's but increases have been accompanied by more intensive fishing, and may not therefore represent an increase in shrimp populations (Lopez Zepeda 1977). The early part of the life cycle of shrimp is spent in the lagoons and acute toxicity of larvae from run-off may be more important than the absence of residues and accumulation in shrimp tissue. Without monitoring programs, it is difficult, however, to effectively target management efforts and implement mitigations.

A number of reports of poisonings of both domestic and wild animals have been recorded by the Centro de Desarrollo Ganadero and Vida Silvestre. Specific reports of impact of pesticides on domestic animals are listed in Table 3.16. These data were compiled by Lopez Zepeda et al. (1988) for a study supported by CSUCA and the Norwegian government. Residues have also been found in eggs in the cotton growing region (Table 3.17). While, there are few natural areas within cultivated zones in El Salvador, poisonings of wildlife are still a problem. Recent reports include the death of large numbers of doves related to the use of fungicides and insecticides in melons, rice and corn, respectively. It is likely, however, that habitat disturbance and destruction have been and still are a more important factor threatening species. Coastal regions as discussed above and aquatic habitats (rivers) are likely to be more sensitive to pesticide contamination in terms of the role they play as breeding grounds for a number of commercial and noncommercial species. USAID/EL Salvador may wish to place particular emphasis on improved management of coastal resources in natural resource management and conservation of biological diversity activities planned for the future. Training for biologists (short and long-term) and a review of policy factors affecting coastal resource management should be considered, particularly related to the environmental contamination problems and agrochemical use.

The use of most organochlorine compounds has been banned since March 1988 in El Salvador, although existing stocks may yet be used. This cancellation will reduce the negative impact of some of the more dangerous and heavily used pesticides, such as ethyl parathion. From 1979-83, methyl parathion and ethyl parathion accounted for up to 50% of insecticide imports

and in 1987, 589,000 kg of EtPt (about 45% of insecticide imports) were imported. It is yet one of the most commonly used pesticides in cotton.

The environmental impact of a number of chemicals is still poorly understood. Heavy use of paraquat and atrazine and metal based fungicides may have important implications and impacts on soil microfauna affecting soil fertility. Some focused studies of these impacts should be undertaken. More importantly, alternative control practices need to be developed and implemented to reduce the reliance on fungicides. Crop rotations, cover crops and intercropping require investigation and application at the farm level.

A variety of chemicals being used may have significant impacts on aquatic organisms and avifauna (see Table 3.9). Even some of the safer pesticide substitutes suggested in Table 3.18 pose some risk. Therefore, their use should be carefully monitored and controlled, particularly in coastal regions and in proximity to shrimp pond and other aquaculture enterprises, where aquatic life is in danger. The interest and plans to expand shrimp production from the current 200 ha. to 8000 ha. could be seriously constrained by the level of pesticide use (Action Plan for Shrimp Mariculture Development in El Salvador, October 1988). Soil samples for pesticides residues will need to be done (some are underway) before site selection. Water quality of water being pumped into ponds will require testing and monitoring and finally, run-off from local pesticide use will need to be monitored and controlled. Agricultural areas in proximity to shrimp pond sites should be high priority areas for the implementation of IPM programs.

There have been no reported problems of impact on bees and honey production. Most beekeepers are reported to move their hives to follow the flowering phenology of crops and move out of areas being sprayed. The team however, did not have an opportunity to speak directly with apiculturists. Ecologists at the National University plan to initiate some studies in the coming year.

Natural enemies are clearly affected by pesticides, as suggested by secondary pest outbreaks, but no population monitoring has been done. Sampling programs primarily focus on pest incidence. There is an important need to develop sampling regimes which also examine natural enemy incidence in addition to pest incidence so that pesticide application can be planned to minimize impact and take advantage of natural biological control mechanisms. Sampling and population monitoring should be examined carefully in determining research priorities for IPM activities.

In general, definitive information on the impact of insecticides, herbicides and even less for fungicides is lacking under tropical conditions. To a certain extent, information can be extrapolated from temperate regions, particularly climatically similar areas (e.g. Florida, California and Texas). Increasing pesticide use, changing patterns of use and patterns of land use complicate the picture in El Salvador. Cultivation on steep slopes with associated levels of run-off and erosion may move chemicals offsite more rapidly with unknown impacts (e.g. paraquat). There

is a definite and clear need for monitoring and studies of pesticide behavior and their impact on nontarget ecosystems under tropical conditions. In addition, ongoing monitoring programs of pesticide residues and metabolites in the environment are needed.

4. Pest Management Practices

a. Current Pest Problems

As already discussed, there is very little implementation of pest management technologies in El Salvador. Farmers rely primarily on pesticides for pest control with an application schedule that bears more resemblance to the days of the week than to the fluctuating levels of pest populations. Sampling regimes are almost nonexistent and economic thresholds have been established for very few crops and very few pests.

While pest diagnostics have been completed for basic grains, some vegetables and traditional export crops (e.g. cotton), little of this information gets out to farmers. Farmers interviewed were familiar with some of the more common pest problems but all described unknown pest problems of one sort or another. Extension agent visits were generally rare, making it difficult to identify the problems and thus manage them effectively. In addition, there was in general a very little understanding of natural enemies. Again while preliminary pest and disease diagnostics are available for some horticultural crops, there is very little accompanying information on biological control agents.

Changing Pest Problems: Changing trends in agricultural practices and land use patterns is leading to a new suite of pest management concerns, i.e. cultivation of nontraditional crops and increased area under irrigation. Nontraditional exports may represent an important source of export earnings but will come at a considerable cost given the stringent phytosanitary standards that are required. Irrigation holds particular promise to intensify cultivation and increase production, but will be accompanied by new pest problems given the continuous cultivation, heavy use of pesticides knocking out natural enemy populations, changing pest community composition on crops grown under irrigation, and increasing use of fertilizer, further encouraging population growth of pests.

Cucurbitaceae: The key pests in cucurbits (melons, cucumbers), aphid vectored viruses, present a particular problem in the second melon crop, so much so that the whole crop may fail. Vector populations are related to water management practices. Viruses are difficult to manage since transmission may be widespread long before the symptoms are obvious. An IPM program in this case should include some of the following:

1) greater understanding of virus transmission, including the role of wild reservoir hosts in the vicinity of the crop;
2) economically threatening aphid populations for disease transmission;
3) use of resistant crop varieties;
4) rotations; and

5) intercropping with a nonhost species.

Weed Management: The use of herbicides has steadily increased in volume since 1982 (Table 3.6). Paraquat is both cheap and effective and favored by farmers, making it difficult to compete with most alternatives. Several aspects of weed control should be considered:

1) use of cover crops and rotations to reduce weed populations;
2) experimentation with alternative, safer herbicides, e.g. roundup (glysophate). Efficacy trials may be needed to examine relative efficacy, application rates and cost. For example, although glysophate is more expensive on a per unit basis, cost/hectare could be reduced if used with urea; and
3) intercropping to reduce weed growth.

Water Management and Disease Control: A third key pest management problem is related to improved water management to reduce disease transmission and also certain weed problems. Special attention should be paid to the types of irrigation systems that will not promote transmission, as well as the necessary cultural practices to incorporate into the irrigated cropping system to reduce transmission of diseases.

Biological Control: Both classical and less traditional biological control opportunities may be possible. For example, *Plutella maculapennis* may be a possible candidate for classical biological control. Cabbage demands considerable pesticide use to control the diamond back moth (Table 3.28). Good control has been possible by introducing a parasitoid, *Apanteles plutella*. The Commonwealth Institute of Biological Control has recently introduced this species to Honduras. CENTA/MIP could contact Zamorano to find out the status of this effort.

A little examined area of BC in Central America is the possible use of insect pathogens. They can be produced locally and are likely to be readily accepted by farmers since application of viruses can be done much like using a pesticide. The key to success with the use of viruses or bacteria is the proper timing of applications to target the most susceptible stage. This demands that effective sampling and monitoring methodologies be developed to accompany the use of pathogens.

Viruses and other more selective pesticides would also be far more compatible with other control interventions, particularly maintenance of natural enemy populations and biological control organisms.

b. IPM Research and Extension

Most of the above areas will require some research, some of which will be primarily adaptive in nature. Research programs should be designed with plant protection needs in mind. Also greater links between research and extension should be promoted. Most of these issues have already been covered in Sections IIIB.2 and IIIB.3.

c. General Use Chemicals Recommended

In the short-term, general use pesticide substitutes should be promoted in lieu of some of the more toxic restricted use chemicals. Some suggested alternatives with EPA tolerances have been identified and are listed with the use, the crops for which they are registered and their tolerances in Tables 3.18 and 3.19. These chemicals are mostly Class III chemicals, with some Class II and IV. It is impossible to determine their relative efficacy without testing. These are all chemicals that are available and registered for use in El Salvador. The unit prices may not all be comparable but in some cases, the more expensive chemicals may average out to be equal or greater if less is needed to do the same job of some of the restricted use chemicals. These chemicals are listed in Table 3.18 and the prices are given in Table 3.20. These products should be recommended as substitutes for highly toxic alternatives through ICIs and in reviewing loan requests.

Table 3.6. Pesticide Imports and Demand During 1982-1988

	1982							
	IMPORTS				DEMAND			
	LITERS	%	KILOGRAMS	%	LITERS	%	KILOGRAMS	%
Insecticide	1,181,222	59	810,053	85	3,082,448	66	3,383,606	95
Herbicides	826,505	41	49,725	5	1,565,141	34	85,058	2
Fungicides	9,270	-	97,178	10	14,274	-	109,116	3
Total	12,016,997		956,956		4,661,863		3,577,780	

	1983							
	IMPORTS				DEMAND			
	LITERS	%	KILOGRAMS	%	LITERS	%	KILOGRAMS	%
Insecticides	667,111	45	806,087	81	2,873,560	61	3,575,178	85
Herbicides	720,393	51	65,060	7	1,849,453	39	110,710	8
Fungicides	14,281	4	117,509	12	25,417	-	303,422	12
Total	1,401,785		988,656		4,748,430		3,989,310	

	1984							
	IMPORTS				DEMAND			
	LITERS	%	KILOGRAMS	%	LITERS	%	KILOGRAMS	%
Insecticides	577,650	42	639,904	32	3,368,284	55	4,580,682	91
Herbicides	10,775	1	136,474	7	2,736,278	45	165,709	4
Fungicides	772,977	57	100,793	4	35,429	-	268,440	5
Tech. Mat.	-	-	1,152,033	57	-	-	-	-
Total	1,361,402		2,029,204		6,139,991		5,014,831	

	1985							
	IMPORTS				DEMAND			
	LITERS	%	KILOGRAMS	%	LITERS	%	KILOGRAMS	%
Insecticides	406,263	27	1,741,671	41	2,319,084	44	4,734,619	91
Herbicides	1,073,450	71	343,698	8	2,889,520	55	277,765	5
Fungicides	38,498	3	173,010	4	69,704	1	186,689	4
Tech Mat.								
Insecticides	-	-	1,603,300	38	-	-	-	-
Herbicides	-	-	338,086	8	-	-	-	-
Fungicides	-	-	34,938	1	-	-	-	-
Total	1,518,211		4,234,703		5,279,108		5,199,073	

	1 9 8 6							
	IMPORTS				DEMAND			
	LITERS	%	KILOGRAMS	%	LITERS	%	KILOGRAMS	%
Insecticides	227,531	13	1,215,758	40	1,224,321	34	3,922,998	87
Herbicides	1,486,822	86	268,504	9	2,299,037	64	339,662	8
Fungicides	20,328	1	220,040	7	43,038	2	231,784	5
Tech. Mat.	-	-	-		-	-	-	-
Insecticides	-	-	806,316	26	-	-	-	-
Herbicides	-	-	551,632	18	-	-	-	-
Fungicides	-	-	16,454	1	-	-	-	-
Total	1,734,681		3,077,704		3,566,396		4,494,444	

	1 9 8 7							
	IMPORTS				DEMAND			
	LITERS	%	KILOGRAMS	%	LITERS	%	KILOGRAMS	%
Insecticides	9,229	5	478,087	37	140,465	29	3,507,428	91
Herbicides	183,737	92	126,151	10	1,763,009	70	239,424	6
Fungicides	6,244	3	13,683	1	32,633		116,434	3
Tech Mat.								
Insecticides	-	-	438,482	34	-	-	-	-
Herbicides	-	-	221,392	16	-	-	-	-
Fungicides	-	-	21,816	2	-	-	-	-
Total	199,210		1,289,611		2,536,107		3,863,286	

Table 3.7. Importation of Pesticides Authorized by Banco Central de Reserva During 1983-87 (in thousands of dollars)

	1983/84	1984/85	1985/86	1986/87*	1987/88*
Number of Importers**	20	23	25	22	21
Total Value	26,209	25,396	25,654	22,739	12,842.6

* Includes foliar

** Includes BFA which accounted for 1%, 6%, 5% and 4% during 84/85, 85/86, 86/87, 87/88 respectively. Also includes OIRSA

Source: Direccion General de Economia Agropecuaria

Table 3.8. Imports of Pesticides in 1987/88

	Volume Liters	Volume Kilograms	Total Value (U.S.Dollars)
Insecticides	9,229	916,569	7,033,593.00
Herbicides	183,737	337,543	4,558,668.00
Fungicides	6,244	35,499	543,503.00
Total	199,210	1,289,611	12,135,764.00

Source: Direccion General de Economia Agropecuaria

Table 3.9. Restricted and/or U.S. Prohibited Pesticides Currently Used in El Salvador and Reason for Restriction

Pesticide (Commercial Name)	Action*	Restricted Formulation	Reason for Restriction
Aldicarb (Temik)	I/N	Granular	Avian toxicity Dermal toxicity
Aluminum Phosphide (Phostoxin)	I	Sole active ingredient	Toxic inhalation hazard to humans
Carbofuran (Furadan)	I	All granular, all concentrate suspensions wettable powders 40% or greater	Acute inhalation
Brodifacoum (Klerat)	R		
Captafol (Difolatan)	F		Extremely toxic to fish and aquatic life
Chlorpyrifos (Lorsban)	I		
Cypermethnn (Ripcord Arrivo)	I		
Dibromochloropropane (DBCP)	SF	All use prohibited in U.S.	Male sterility
Dicrotophos (Bidrin, Carbicron)	I	All liquids 8% or greater	Acute dermal Avian toxicity
Dinocab (Karathane)	F/A	All use prohibited in U.S.	
Disulfoton (Dysyston)	I/A	Emulsifiable powder	Dermal toxicity
Ethoprop (Mocap)	N	All granular emulsifiable concentrate 40% or greater	Acute dermal
Fenamiphos (Nemacur)	N	15% granular, emulsifiable concentrate 35% or greater	Avian toxicity; Inhalation and dermal toxicity

Table 3.9. Restricted and/or U.S. Prohibited Pesticides Currently Used in El Salvador and Reason for Restriction (Cont'd).

Pesticide (Commercial Name)	Action*	Restricted Formulation	Reason for Restriction
Nancozeb (Dithane M-45)	F	Zineb suspended in U.S.	
Metaldehyde (Metaldehyde)	M		
Methamidophos (Tamaron)	I/A	Liquid 40% or greater Dust 2.5% or greater	Acute dermal Avian toxicity
Methidathion (Supracide)	I	Emulsifiable concentrate	Inhalation; Wildlife toxicity
Methyl Bromide			
Methomyl (Lannate)	I	All concentrate 90% wettables	Other hazards; Accidents
Methyl Parathion (Folidol)	I	All dust, granular, liquids, wettable	Residue effects on mammals and birds; Acute dermal
Mevinphos (Phosdrin)	I	Emulsifiable Concentrate, water soluble	Avian toxicity
Monocrotophos (Azodrin)	I	Walter miscible	Avian toxicity
Oxamyl (Vydate)	I/N	Water soluble liquid	Dermal toxicity
Paraquat (Gramazone)	H	All formulations	Human toxicity data; Other hazards, accidents
Parathion	I		
Permethrin (Ambush)	I	Wettable powder	Fish toxicity
Phoxim (Volaton)	I	All use prohibited in U.S.	

Table 3.9. Restricted and/or U.S. Prohibited Pesticides Currently Used in El Salvador and Reason for Restriction (Cont'd).

Pesticide (Commercial Name)	Action*	Restricted Formulation	Reason for Restriction
Prophenofos (Tambo, Selecron) Curacron	I/A		Acute dermal; Toxicity to fish, wildlife, bees
Terbufos (Counter 2.5%G)	I/A	Granular 15% or greater (Counter 2.5% G not restricted	Acute oral and dermal toxicity
Toxaphene (Strobane Phenatox)	I	All use suspended in U.S.	

* I = Insecticide, A = Acaricide, N = Nematocide, H = Herbicide, M = Molluscicide, SF = Soil Fumigant, R = Rodenticide

Table 3.10. Toxicity of Pesticides Available in El Salvador

Common Name and (Brand Name)	Acute LD_50 Oral	Acute LD_50 Dermal	EPA Signal Word1/
Baythion (VOLATON, PHOXIM)	1,845	1,000	
Benomyl (BENLATE)	10,000	10,000	CAUTION
Bti (DIPEL)	-	-	CAUTION
Captan (CAPTAN)	9,000	-	CAUTION
Carbaryl (SEVIN)	850	-	CAUTION
Captafol (DIFOLATAN)	5,000-6,200	-	WARNING
Carbofuran (FURADAN)	11	10,200	WARNING/DANGER2/
Copper hydroxide (KOCIDE)	1,000	-	CAUTION
Copper oxychloride (CUPRAVIT)	1,000	-	-
Chloroppyrifos (LORSBAN)	96-270	500-2000	WARNING
Daconate (DCPA)	10,000	10,000	CAUTION
Deltamethrin (DECIS)	128-5,000	2,000	-
Demeton Methyl (METASYSTOX)	170-300	260-410	WARNING
Diazinon (BASUDIN)	300-400	3,600	CAUTION
Disulfoton (DISYSTOX)	2-12	6-25	DANGER
2,4-D (HENODAL)	375-805	-	WARNING
ddvp (vapona)	56-80	75-107	DANGER
Ethoprop (MOCAP)	61.5	2.4	WARNING/DANGER3/
Fenthion (LEBAYCID)	255-298	1,680-2,830	WARNING
Glyphosate (ROUNDUP)	4,300-4,900	-	CAUTION
Malathion (MALATHION)	1,000-1,375	4,100	CAUTION
Maneb (MANZATE)	7,990	-	CAUTION
Metalaxyl (RIDOMIL)	669	3,100	WARNING
Metaldehyde (METALDEHYDE)	250-1,000	630	CAUTION/WARNING
Methomyl (LANNATE)	17-24	5,880	DANGER
Methamidophos (TAMARON)	18-21	118	DANGER
Monocrotophos (AZODRIN)	8-23	354	DANGER
Oxamyl (VIDATE)	37	2,960	DANGER
Paraquat (GRAMAXONE)	150	-	DANGER
Propineb (ANTRACOL)	5,000	5,000	-
Thiram (THIRAM)	780	-	CAUTION
Triadimefon (BAYLETON)	1,020-1,855	5,000	-
Trichlorfon (DIPTEREX)	150-400	500	WARNING
Warfarin (WARFARIN)	3	-	WARNING/CAUTION
Zineb (ZINEB)	5,200	2,500	-

1/ See Table 3.1 for explanation. More than one signal word indicates a difference in formulation (dry vs. liquid) or percentage active ingredient.
2/ WARNING = granules
DANGER = liquid
3/ WARNING = 10% granules
DANGER = 15% granules and 6% E.C.

Table 3.11. Pesticide Residues in Beef 1972-74

	1972		1973		1974	
	% Cont.	% Exceed Tolerance	% Cont.	% Exceed Tolerance	% Cont.	% Exceed Tolerance
Lindane (2 ppm)	35	0	80	0	68.5	0
Heptachlor (0.2 ppm)	0	0	10.5	4.3	86	16.7
Dieldrin (0.2 ppm)	49	14.3	8	38.2	100	76.8
DDT (5 ppm)	100	31.2	100	3.41	100	29.2

Source: Calderon 1981. Residues of DDT, Dieldrin, Heptachlor Epoxide and Lindane in Beef 1972-74. Boletin Tecnica 10-81.

Table 3.12. Average Pesticide Residues in Fat, Tissue and Blood of Cattle From the Eastern (Zone 1), Central (Zone 2) and Western (Zone 3) Zones of El Salvador (in ppb)

	OC-BHC + r-BHC	Heptachlor + Epoxy Heptachlor	Aldrin & Dieldrin	DDT & Metabolites	Chloradane
Fat					
Z1	68.25	21.87	25.62	85.50	30.25
Z2	85.30	12.30	66.50	57.00	6.10
Z3	38.00	14.00	11.25	80.75	0
Tissue					
Z1	239.62	98.50	97.62	291.37	107.87
Z2	402.90	73.20	368.40	179.50	23.50
Z3	92.50	45.50	70.50	51.50	23.50
Blood					
Z1	10.25	0.12	5.87	22.00	5.00
Z2	13.00	6.80	4.30	13.50	30.60
Z3	6.25	0.25	2.25	80.75	3.00

Source: Zelya + Laxo (198C)

Table 3.13. Average Pesticide Residues in Fat, Liver and Blood in Beef in Eastern (Zone 1), Central (Zone 2), Western (Zone 3) Zones of El Salvador (in ppb)

	BHC	BHC	Heptachlor + Epoxy Heptachlor	Aldrin & Dieldrin	DDT & Metabolites	Methyl Parathion
Fat						
Z1	0.34	0.23	-	-	0.36	-
Z2	0.29	0.56	-	-	3.024	0.15
Z3	-	1.17	-	-	3.42	0.57
Liver						
Z1	0.19	0.09	-	-	0.03	-
Z2	0.21	0.30	-	0.002	0.33	0.31
Z3	0.06	0.05	-	-	-	-
Blood						
Z1	-	-	0.0046 + 0.001	0.00003	0.142	0.012
Z2	0.011	0.026	0.007	0.997	0.997	0.14
Z3	-	0.13	-	0.0008	0.389	0.0015

Source: Meléndez and Bonilla (1988)

Table 3.14. Average Level of Pesticide Residues in Some Fish, Molluscs and Echinodems in the Jiquilisco Bay (in ppm)

Scientific & Common Name	DDT	Endrin	Dieldrin	Ethyl Parathion
Cynoscion spp. (Curvina)	2.33	0.16	0.04	-
Mugil spp. (lisa)	1.86	0.27	0.05	-
PomadaSys spp. (Ruco)	1.79	0.07	0.52	-
Peneaus spp. (Camaron)	0.56	-	-	-
Anadara spp. (Curil)	0.75	0.05	0.03	-
Mytella spp. (Churria)	0.62	0.03	0.02	0.01
Oneaster spp. (Starfish)	0.35	0.06	0.02	-

Source: Lopez Zepeda (1977)

Table 3.15. Pesticide Residues in Soil Samples Collected from Cotton Fields (in ppm)

Sample	DDT	Toxaphene	Organo Phosphate	pH	Approximate Years Under Cultivation
1	0.80	1.43	0	5.6	5
2	0.39	2.50	0	5.4	17
3	1.08	4.17	0	5.7	25
4	0.50	1.83	0	5.8	5
5	0.61	1.00	0	5.8	3
6	0.58	1.66	0	6.5	8
7	0.94	5.03	0	6.0	20
8	0.16	0.69	0	5.2	6
9	0.29	1.10	0	6.2	12
10	1.61	7.86	0	6.2	34

Source: Lopez Zepeda (1977)

Table 3.16. Pesticide Mortality in Domestic Fauna

Year	Species	Number	Pesticide Detected
1981	Cow	2	Organochlorines + Organophosphates
1982	Cow	3	Organophosphate
	Cow	2	Organochlorine
	Dog	2	Organophosphate
	Cat	2	Organochlorine
1983	Cow	1	Organochlorine
1984	None	-	-
1985	Horse	2	Organophosphate
1986	Cow	2	Organophosphate
	Cow	10	Organochlorine + Organophosphate
	Cow	4	Organochlorine
1987	Cow	3	Organophosphate
	Cow	6	Organochlorine
1988	Cow	3	Organophosphates + Organochlorines
	Cow	14	Organochlorines

Source: Toxicology Laboratory
Center for Development of Cattle
Ministry of Agriculture

Table 3.17. Residues of Organochlorine Pesticides in the Coastal Zones of El Salvador (in ppm)

Residuos de pesticidas organoclorados expresados en partes por millón (PPM) para granjas avícolas y caseríos de las Zonas Costeras de El -- Salvador (Frances, 1980).

Pesticide / Origin	α BHC	γ BHC	Hepta-cloro	Aldrin	Hepta-cloro epoxido	PPDDE	Diel-drín	OPDDT	PPDDD	PPDDT	Endrin	Total DDT
Ahuachapan	0.01	0.07	—	0.02	—	0.06	—	—	—	—	—	0.06
La Libertad	0.02	0.34*	—	0.05	—	0.33	0.50	—	—	—	0.04	0.33
San Salvador	0.03	0.23	0.40	0.02	—	0.[illegible]5	0.03	0.03	—	0.06	—	0.23
Usulután	0.02	0.17	0.35*	0.04	0.02	0.36	0.69*	—	—	0.42	0.02	0.78*
San Miguel	0.03	0.18	0.12	—	—	0.59*	0.02	0.03	—	0.06	—	0.67*
La Unión	0.01	0.15	0.07	0.03	—	0.35	0.05	0.03	—	0.06	—	0.44
Cas. Metalío	0.08	0.03	0.4	0.04	—	0.78*	0.02	0.07	—	0.38	—	1.22*
Cas. El Presidio	0.15	0.40*	—	0.14*	—	0.96*	0.08	—	—	0.56*	—	1.23*
Cas. Entre Ríos	0.02	0.24*	0.04	—	—	1.49*	—	—	—	1.03*	—	2.53*

* Sobre los límites máximos permisibles.

Source: Frances (1980) from Lopez Zepeda et al. 1988.

Table 3.18. Suggested Pesticide Substitutions

INSECTICIDE SUBSTITUTIONS

Restricted Insecticides[1]	Crops[2]	Use
Methamidophos (Tamaron)	2	Aphids, Mites, Lepidopters
Profenofos (Tambo, Selecron)	2	Cotton Pests
Dicrotophos (Carbicron)	2	Cotton Pests, Coffee Borer
Methyl Parathion (Folidol)	2	Lepidoptera
Chlorpyrifos (Lorsban)	2	Aphids, Lepidoptera
Disulfoton (Dysyston)	2	Broad Spectrum
Methidathion (Supracide)	2	Mites, Lepidoptera
Methomyl (Lannate)	2	Broad Spectrum
Mevinphos (Phosdrin)	2	Aphids, Mites, Lepidoptera
Monocrotophos (Azodrin)	2	Aphids, Mites, Lepidoptera

Nonrestricted Substitutes for Restricted Insecticides Above

Substitutions[3]	Use	Crops	Tolerance[4] (ppm)	Environmental Concerns
Acephate (Orthene)	Aphids, Mites Lepidoptera	Beans	3.0	Avian and bee toxicity.
		Cotton seed	2.0	
Allethrin (Fynamin I Forte)	Broad Spectrum	Beans	Exempt	Insoluble in water. Possible aquatic toxicity.
		Beets	Exempt	
		Broccoli	Exempt	
		Cabbage	Exempt	
		Carrots	Exempt	
		Corn	Exempt	
		Garlic	Exempt	
		Musk Melon	4.0	
		Onions	Exempt	
		Peppers	Exempt	
		Potatoes	Exempt	
		Radishes	Exempt	
		Sorghum	Exempt	
		Tomato	Exempt	
Bacillus Thuringiensis (Dipel)	Lepidopters	2	N/A	Completely safe.

Table 3.18. Suggested Pesticide Substitutions (Cont'd)

Nonrestricted Substitutes for Restricted Insecticides Above (Cont'd)

Substitutions[3]	Use	Crops	Tolerance[4] (ppm)	Environmental Concerns
Carbaryl (Sevin)	Broad Spectrum	Tomato	10.0	Extremely toxic to aquatic life.
		Rice	5.0	
		Potato	0.2	
		Cabbage	10.0	
		Cucumber	10.0	
		Radish	5.0	
		Corn	5.0	
		Sorghum	10.0	
		Carrots	10.0	
		Beans	10.0	
		Beets (Roots)	5.0	
		Melons	10.0	
		Cotton Seed	5.0	
		Broccoli	12.0	
		Eggplant	10.0	
Diazinon (Basudin)		Beans	0.75	Toxic to bees, wildlife and fish.
		Beets	0.75	
		Broccoli	0.75	
		Cabbage	0.75	
		Carrots	0.75	
		Coffee Bean	0.2	
		Corn	0.75	
		Cotton Seed	0.2	
		Cucumbers	0.75	
		Melons	0.75	
		Onions	0.75	
		Peppers	0.75	
		Potato	0.1	
		Radish	0.75	
		Sorghum	0.75	
		Sugarcane	0.75	
		Tomato	0.75	

Table 3.18. Suggested Pesticide Substitutions (Cont'd)

Nonrestricted Substitutes for Restricted Insecticides Above (Cont'd)

Substitutions[3]	Use	Crops	Tolerance[4] (ppm)	Environmental Concerns
Malathion (Lucathion)	Broad Spectrum	Tomato	8.0	Toxic to fish. Formulations should be analyzed for Isomalathion, a very toxic contamination.
		Rice	8.0	
		Potato	8.0	
		Cabbage	8.0	
		Broccoli	5.0	
		Eggplant	8.0	
		Cucumbers	8.0	
		Radish	8.0	
		Corn	2.0	
		Sorghum	8.0	
		Onions	8.0	
		Carrots	8.0	
		Garlic	8.0	
		Beans	8.0	
		Beets (Roots)	1.0	
		Melons	8.0	
		Cotton Seed	2.0	
Endosulfan (Thiodan)	Lepidoptera, Aphids, Coleoptera	Tomato	2.0	Toxic to wildlife and aquatic life
		Broccoli	2.0	
		Potato	0.2	
		Corn	0.2	
		Cabbage	2.0	
		Eggplant	2.0	
		Cucumbers	2.0	
		Sugarcane	0.5	
		Carrots	0.2	
		Beans	2.0	
		Melons	2.0	
		Cotton Seed	1.0	
		Beets	0.1	

Table 3.18. Suggested Pesticide Substitutions (Cont'd)

HERBICIDE SUBSTITUTIONS

Restricted Herbicides[1]	Use	Crops	Tolerance[4] (ppm)	Environmental Concerns
Paraquat (Gramoxone)	Broad Spectrum weed & grass	Potato	0.5	Very water soluble, but is held tightly in soil. Water source contamination possible due to soil erosion. Toxic to wildlife.
		Cabbage	0.05	
		Cotton Seed	0.05	
		Cucumbers	0.05	
		corn	0.05	
		Sorghum	0.05	
		Onion	0.05	
		Broccoli	0.05	
		Carrots	0.05	
		Beans	0.05	
		Sugarcane	0.05	
Nonrestricted Substitutes for Gramoxone				
Ametryn (Gesapax)		Cassava	0.1	Somewhat water soluble, but not very toxic.
		Corn	0.25	
		Potato	0.25	
		Sugarcane	0.25	
Atrazine	Annual broadleaf & grass weeds	Corn	0.25	Has been found in water sources in U.S. Toxic to aquatic life.
		Sorghum	0.25	
		Sugarcane	0.25	
Metolachlor (Dual)	Annual grasses & certain broadleaf weeds	Corn	0.1	Water solubility is threat to water supply contamination. Low toxicity.
		Cotton Seed	0.1	
		Chili Pepper	0.5	
		Potato	0.1	
		Rice	0.1	
		Sorghum	0.3	
EPTC (Erradicane)	Annual broadleaf & grass weeds	Cotton Seed	0.1	Not very water soluble nor very toxic.
		Cabbage	0.1	
		Potato	0.1	
Metribuzin (Sencor)	Broadleaf weeds & certain grasses	Carrots	0.3	Water soluble. Threat to water supply, but not very toxic.
		Corn	0.05	
		Potato	0.6	
		Sugarcane	0.1	
		Tomato	0.1	

Table 3.18. Suggested Pesticide Substitutions (Cont'd)

Nonrestricted Substitutes for Gramoxone (Cont'd)

Herbicides	Use	Crops	Tolerance[4] (ppm)	Environmental Concerns
Oxyfluorfen (Goal)	Broadleaf & annual grass control	Broccoli	0.05	Not very water soluble. Very toxic to aquatic
		Cabbage	0.05	
		Coffee	0.05	
		Corn	0.05	
		Cotton Seed	0.05	
		Onions	0.05	
		Tomato	0.05	
Pendimethalin (Dragon, Prowl)	Annual grasses & certain broadleaf weeds	Beans	0.1	Not very soluble in water. Toxic to fish.
		Corn	0.1	
		Cotton Seed	0.1	
		Potato	0.1	
		Rice	0.05	
		Sorghum	0.1	
Glyphosate[5] (Round-Up)	Foliar spray for most weeds	Coffee Beans	1.0	Has been used on aquatic weeds with no residues found in water. Very low levels needed for action on weeds. No danger to aquatic life.
		Cotton Seed	15.0	
		Corn	0.1	
		Sorghum	0.1	
		Cabbage	0.2	
		Potato	0.2	
		Cucumber	0.5	
		Carrots	0.2	
		Sugarcane	2.0	

Table 3.18. Suggested Pesticide Substitutions (Cont'd)

FUNGICIDE SUBSTITUTIONS

Restricted Fungicides[1]	Crops	Tolerance[4] (ppm)	Environmental Concerns
Captafol (Difolatan)	Corn	0.1	Hazard to aquatic life.
	Cucumbers	2.0	
	Melons	5.0	
	Onions	0.1	
	Potato	0.5	
	Tomato	15.0	
Mancozeb[6]	Beans	0.5**	Rapidly degrades in water. Copper is threat to aquatic life.
	Carrots	0.5**	
	Cucumbers	0.5**	
	Melons	1.0**	
	Potato	0.1**	
	Tomato	3.0**	
Nonrestricted Fungicide Alternatives for Captafol and Mancozeb			
Fungicides			
Benomyl (Benlate)	Beans	2.0	Practically insoluble in water. Toxic to fish.
	Broccoli	0.2	
	Cabbage	0.2	
	Carrots	0.2	
	Cucumbers	1.0	
	Eggplant	0.2	
	Garlic	0.2	
	Melons	1.0	
	Pepper	0.2	
	Rice	5.0	
	Tomato	0.2	
Carbendazim (Bauistin)	Beans	2.0*	Toxic to fish.
	Coffee Bean	0.1*	
	Cucumber	0.5*	
	Melons	0.5*	
	Tomato	5.0*	
Chlorothalonil (Daconil)	Beans	5.0	Insoluble in water. Toxic to fish.
	Broccoli	5.0	
	Cabbage	5.0	
	Carrots	1.0	
	Coffee Bean	0.2	
	Corn	1.0	
	Cucumbers	5.0	
	Melons	5.0	
	Onions (Dry Bulb)	0.5	
	Onions (Green)	5.0	
	Potato	0.1	
	Tomato	5.0	

Table 3.18. Suggested Pesticide Substitutions (Cont'd)

Nonrestricted Fungicide Alternatives for Captafol and Mancozeb (Cont'd)

Fungicides	Crops	Tolerance[4] (ppm)	Environmental Concerns
Copper Hydroxide (Kocide)	All	Exempt	Water soluble. Toxic to fish.
Copper Oxychloride (Cupravit)	All	Exempt	Water soluble. Toxic to fish.
Edifenphos (Hinosan)	Rice (hulled) Rice (in husk) Rice (polished)	0.05* 0.2* 0.01*	Insoluble in water. Fairly toxic.
Maneb (Manzate)	Beans Carrots Cucumbers Melons Tomato	0.5** 0.5** 0.5** 1.0** 3.0**	Moderately soluble in water, but degrades rapidly. EDTU metabolite is carcinogenic. Toxic to fish.
Thiram	Same as Maneb		

Table 3.18. Suggested Pesticide Substitutions (Cont'd)

NEMATOCIDE SUBSTITUTIONS

Restricted Nematocides[1]	Crops	Tolerance[4] (ppm)	Environmental Concerns
Ethoprop (Mocap)[7]	Beans	0.02	Slightly water soluble and very toxic.
	Broccoli	0.02	
	Cabbage	0.02	
	Corn	0.02	
	Cucumbers	0.02	
	Potato	0.02	
	Sugarcane	0.02	
Fenamiphos (Nemacur)[8]	Cabbage	0.1	Soluble enough in water to be a threat to aquatic life. Toxic to fish and wildlife.
	Cotton Seed	0.05	
	Garlic	0.5	

Nonrestricted Nematocide Alternatives

Nematocides	Crops	Tolerance[4] (ppm)	Environmental Concerns
Carbofuran (Furadan, Curater)[9]	Coffee Bean	0.05	Soluble in water. Could be a threat to aquatic life. Toxic to fish, birds and wildlife.
	Corn	1.0	
	Cotton Seed	1.0	
	Cucumbers	0.4	
	Melons	0.4	
	Potato	2.0	
	Rice	0.2	
	Sorghum	0.1	
	Sugarcane	0.1	
Counter 2.5% (Terbufos)[10]	Corn	0.05	Only slightly water soluble.
	Sorghum	0.05	

Table 3.18. Suggested Pesticide Substitutions (Cont'd)

References

1. See Table 3.19.
2. See Attachment 3 for crops for which these insecticides are currently being used.
3. No efficacy data for El Salvador.
4. EPA Tolerances.
5. Safest, but most costly.
6. Although Mancozeb is not restricted, it contains Zineb whose use has been suspended in the U.S. It is best not to make long range plans including Mancozeb use.
7. Emulsifiable concentrates 40% or greater are restricted.
8. Emulsifiable concentrates 35% or greater are restricted.
9. Concentrate suspensions and wettable powders 40% or greater are restricted.
10. Granular formulations 15% or greater are restricted.

Table 3.19. Nonrestricted Pesticides for Use in A.I.D. Funded Projects Which are Available in El Salvador

Common Name and (Brand Name)	Action	Toxicity Category	TOMATO 1	RICE 2	POTATO 3	SUGAR CANE 4	CHILE 5	CABBAGE 6	CASSAVA 7	BROCCOLI 8	EGGPLANT 9	CUCUMBERS 10	RADISH 11	CORN 12	SORGHUM 13	ONIONS 14	CARROTS 15	GARLIC 16	BEANS 17	BEETS 18	MELONS 19	COFFEE 20	COTTON 21
Acephate (Orthene)	Insecticide	III																	X				X
Allethrin (Fynamin I Forte)	Fungicide	III	X											X	X						X		
Ametryn (Gesapax)	Herbicide	III			X	X			X					X					X				X
Atrazine	Herbicide	III												X	X								
Bacillus Thuringiensis (Dipel)	Insecticide	III	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Carbaryl (Sevin)	Insecticide	III	X	X	X			X				X	X	X	X		X		X	X	X		X
Chlorothalonil (Daconil)	Fungicide	II	X		X			X		X		X		X		X	X		X		X	X	
Copper Hydroxide (Kocide)	Fungicide	III;I	X		X		X	X		X		X				X			X		X		
Copper Oxychloride (Cupravit)	Fungicide	III	X		X		X			X									X				
Diazinon (Basudin)	Insecticide	III;I	X		X			X	X			X		X	X	X	X		X	X	X		X
Dicamba	Herbicide	II				X								X	X								
Diuron (Karmex)	Herbicide	II			X									X	X								X
Endosulfan (Thiodan)	Insecticide	I	X		X			X				X					X		X		X		X
EPTC (Erradicane)	Herbicide	III			X									X					X				
Fluzifop-Butyl (Fusilade)	Herbicide	III																					X
Glyphosate (Roundup)	Herbicide	II		X	X			X			X			X	X	X	X		X	X		X	X
Kasugamycin (Kasumin)	Fungicide	IV	X	X																			
Malathion (Lucathion)	Insecticide	III	X	X	X			X		X	X	X	X	X	X	X	X	X	X	X	X		X
Maneb (Manzate)	Fungicide	III	X		X							X		X		X	X				X		X
Metaldehyde	Molluscicide	III																	X				
Metalaxyl (Ridomil)	Fungicide	II	X		X			X		X	X	X				X					X		X
Methyl Pirimphos (Actellic)	Insecticide	III												X	X								
Metolachlor (Dual)	Herbicide	II		X										X	X				X				X
Metribuzin (Sencor)	Herbicide	III	X		X									X					X				
Oxadiazon (Ronstar)	Herbicide	II		X																			
Oxifluorfen (Goal)	Herbicide	II												X		X							X
Pendimethalin (Dragon; Prowl)	Herbicide	II		X	X									X	X				X				X
Phosalone (Zolane)	Acaricide Insecticide	II			X																		
Propanil (Herbax; Stam)	Herbicide	II		X																			
Phoxim (Volaton; Baythion)	Insecticide	II		X	X							X		X	X				X				

Table 3.19. Nonrestricted Pesticides for Use in A.I.D. Funded Projects Which are Available in El Salvador (Cont'd)

Common Name and (Brand Name)	Action	Toxicity Category	TOMATO 1	RICE 2	POTATO 3	SUGAR CANE 4	CHILE 5	CABBAGE 6	CASSAVA 7	BROCCOLI 8	EGGPLANT 9	CUCUMBERS 10	RADISH 11	CORN 12	SORGHUM 13	ONIONS 14	CARROTS 15	GARLIC 16	BEANS 17	BEETS 18	MELONS 19	COFFEE 20	COTTON 21
Terbufos (Counter 2.5%G)[1]	Insecticide Hematocide	I												X	X								
Triadimefon (Bayleton)	Fungicide	II										X									X		
Trichlorfon (Dipterex)	Insecticide	II	X											X					X				X

[1]Granular Formulations 15% or Greater are Restricted

Table 3.20. Cost Implications of Pesticide Substitutes (1)

RESTRICTED INSECTICIDE	APPLICATION RATE/ACRE(2)	AI(3) (%)	COST/ UNIT	HIGH COST/ ACRE	COST AI/ ACRE (4)
Methomyl (Lannate)	0.5-1.0 lb.	90	C108/lb	C54-108	C48.6-97.2
Methamidophos (Tamaron)	0.5-1.0 gal.	-	C212/gal	C106-212	-
Chlorpyriphos (Lorsban 4E)	0.38-0.95 l.	40.7	C57/l	C21.6-54	C8.79-22.0
Ethyl Parathion	0.12-0.47 l.	81	C27.5/l	C3.3-12.9	C2.67-10.45
Disulfoton (Di-syston 10)	4-20 lb.	15	C4.4/lb.	C17.6-88	C2.64-13.2
Dicrotophos (Bidrin)	0.12-0.47 l.	82	C48/l	C6.27-22.6	C5.14-18.5
NONRESTRICTED INSECTICIDE					
Acephate (Orthene)	0.15-0.6 kg.	75	C175/kg	C26.3-105	C19.7-78
Dipel 2X	0.11-0.45 kg.	6.4	C58.9/kg	C6.5-26.7	C.41-1.7
Malathion	0.24-0.47 l.	91	C23.8/l	C5.7-11.2	C5.2-10.2
Diazinon 4E	0.13-0.94 l.	48	C87/l	C11.3-81.8	C5.4-38.8
Endosulfan	0.63-1.26 l.	35	C167/gal	C105-210.4	C36.8-73.6
RESTRICTED HERBICIDES					
Paraquat (Gramoxone)	0.95-2.89 l.	29	C27.5/l.	C26.1-52	C7.6-15.1
NONRESTRICTED HERBICIDES					
Atrazine 80 WP	0.57-1.36 kg.	78	C46.5/kg.	C26.5-63.3	C20.8-49.7
Dicamba (Banvel D)	0.13 gal.	48	C210/gal	C26.25	C12.65
Metribuzin (Sencor 70WP)	0.23-0.6 kg.	50	C175/kg.	C40.25-105	C20.1-52.5
Perdimethalin					
(Prowl 500)	0.13-0.5 gal.	42	C284/gal	C37-142	C15.6-60
(Prowl 500EC)	0.47-1.89 l.	42	C85.1/l.	C40-161	C17-68
Glyphosate (Roundup)	0.95-1.89 l.	41	C149/l.	C142-282	C58-115.6
Alachlor (Lasso)	1.89-2.84 l.	45	C36/l.	C68.5-103	C31-46.4

(1) Cost comparison calculations made for a single application are based on application rates recommended on labels and the cost figures on a unit price basis provided by the Seccion de Socioeconomia de la Unidad de Validacion y Transferencia de Tecnologia of CENTA. These are approximate, general figures. Actual application rates and cost figures will vary with the crop, the duration of the infestation, the length of the season, and the number of applications per season.

(2) Application rate based on label recommendations

(3) A.I. = Active Ingredient

(4) Cost A.I./acre = (Application Rate) X (% A.I.) X (Cost/Unit)

Table 3.21. List of Pesticides Recommended by CENTA for Use on the Crops Indicated

RICE
Furadan 5% G; Lannate 90%; Tamaron 600; Benlate; Manzate 200; Hinozan 500 EC; Disapen; Propanil; Prowl. Surcopur 360 EC; Hedonal M600 SL

BEANS
Furadan 5% G; Caracolicida; Tamaron 600; Dithane-45; Benlate; Disapen; Folidol M-48 EC; Paraquat

GANDUL
Volaton; Lannate 90%; Tamaron 600; Gramaxone

CORN
Furadan 5% G; Lannate 90%; Atrazine; Lasso; Paraquat; Tamaron 600; Volaton 2.5% G

SORGHUM
Furadan 5% G; Folidol M-48; Tamaron 600 S.L.; Lannate 90; Volaton 2.5% G

GARLIC
Furadan 5% G; Lannate; Difolatan, Dithane M-45; Tamaron 600

EGGPLANT
Furadan 5% G; Tamaron 600; Dithane M-45; Benlate, Disapen

BROCCOLI
Bayfolan; Furadan 5% G; Lannate 90%; Tamaron 600; Dithane M-45; Benlate

ONION
Furadan 5% G; Malathion 5%; Tamaron 600; Dithane M-45; Gramoxone

SWEET CHILE
Furadan 5-6% G; Benlate; Folidol M-2, Lebaycid 500 EC; Malathion 57%; Disapen

HOT CHILE
Lorsban 2.5%; Lannate 90%; Baythroid 0.25; tri-PCNB; Dithane M-45

CAULIFLOWER
Furadan 5% G; Lannate 90%; Dithane M-45; Benlate;

ELOTE
Tamaron 600, Lannate 90%, Dithane M-45

LETTUCE
Furadan 5% G; Lannate 90%; Dithane M-45; Tamaron 600

MELON
Furadan 5% G; Nuvacron; Decis; Lannate 90%; Difolatan, Dithane M-45, Ridomil M2-45

Table 3.21. List of Pesticides Recommended by CENTA for Use on the Crops Indicated (Cont'd)

OKRA
Furadan 5% G; Lannate 90%; Dithane M-45; Mirex; Dipel; Sencor

CUCUMBER
Furadan 5% G; Vydate; Lannate 90%; Difolatan 80; Dithane M-45; Disapen; Daconil; Azodrin; Decis; Disapen

RADISH
Malathion; Furadan 5% G

BEETS
Furadan 5% G; Dithane M-45; Lannate 90%

CABBAGE
Furadan 5% G; Lannate 90%; Tamaran 600; Malathion 57% EC; Dithane M-45

WATERMELON
Volaton 25G; Dipterex 95%; Melaza; Dithane M-45; Malathion 7%; Folidol M-2

TOMATO
Furadan 5% G; Dithane M-45; Ridomil M2-58; Dipterex 95; Lannate 90%; Tamaron 600; Malathion 57%; Sencor; Disapen

CARROTS
Sencor; Lannate L; Tamaron 600; Dithane M-45; Mocap 10 G

SUGAR CANE
Counter 2.5 G; Tamaron 600

CARDAMON
Volaton; Carbofuran, Furadan; Folidol M-45

Table 3.22. Pesticides Recommended for Use by Fundacion Chile and FUSADES

Cucumber and Baby Cucumber

Insecticides	Toxicity Category
Marlate 50 WP (Methoxychlor)	
Thiodan 2E (Endosulfan)	I
Diazinon 60 CE	III:I
Lannate 90 WP (Restricted	I
Fungicides	
Daconil (Chlorothalonil)	II
Kocide 101 (copper)	
Dithane M-45 (mancozeb) (suspended in US)	
Benlate 50 WP (Benomyl)	III
Ridomil MZ58 (Metalaxyl)	

Melons and Watermelons

Insecticides	Toxicity Category
Ambush 10CE (Permatrina)	III
Dipel	III
Gusathion 25% (Azinfos metil) (Restricted)	I
Lannate 90WP (Metomyl) (Restricted)	I
Lorsban 2.5G (Chloropyriphos) (Restricted)	II
Furadan 10G (Restricted)	I:II
Tamaron 600 (Restricted)	I
Metasistox 25CE (Oxidimeton metil)	
Pirimor (Pirimicarb)	
Thiodan 35CE (Endosulfan)	I
Basudin 60CE (Diazinon)	III:I
Fungicides	
Manzate 300, Dithane M45 (Suspended in US)	
Benalte (Benomyl)	
Cupravit	III
Daconil	II
Ridomil MZ58 (Metalaxyl)	II

5. Health Impacts

a. Pesticide Intoxication in El Salvador

The number of pesticide poisonings in El Salvador has been historically high in El Salvador, and the past 8 years have been no exception. In a study of the epidemiological reports for 1980 through 1987 from the Ministry of Public Health and Social Assistance (MSPAS), an average of 1176 ± 360 cases of pesticide poisonings per year were reported (Table 3.23). These were acute poisonings where hospital visitation was required, and gives no indication of the actual level of pesticide poisonings.

The trends in pesticide poisonings correspond in part to patterns of crop production. For example, the western region of the country has shown a steady increase in pesticide poisonings since 1980. In this region, irrigated agriculture and the development of nontraditional exports have also grown in terms of the area under cultivation. The other notable trend is the decrease in pesticide poisonings in the Oriente which in part may be attributable to changes in land use and a decrease in land under cultivation in these conflictive zones.

The Ministry of Public Health while collecting statistics on pesticide poisonings from clinics and hospitals, does not keep detailed data on the types of intoxications, the degree, the occupation of the patient, and the responsible pesticide. Guadalupe Barrera and Ponce Vega (1988) investigated some of these epidemiological patterns by reviewing pesticide intoxications at 10 hospitals during 1982-87. Of the total 2386 clinical charts studied, 1565 (65.6%) poisonings resulted from accidents, while 821 (34.4% were believed to be attempted suicides. The severity of cases varied from 48.4% (988) slight, 10.31% (246) serious and 11.44% (273) fatal. In fact, according to MSPAS data, pesticide poisonings are among the top ten causes of mortality of those individuals that seek hospital treatment (Figure 3.4). From all of the available data, poisonings are greater for men than for women. Guadalupe Barrera and Ponce Vega reported 1718 poisoning cases (72%) for the male population and 668 (28%) for women from 1982-87. It is interesting to note however, that a greater number of deaths occurred in women than in men (Figure 3.4). The age distribution for poisonings was similar between men and women (Figure 3.5).

By occupation, 1409 cases (60%) were agricultural workers and 487 (40%) were domestic service workers. Of the female domestic service workers experiencing poisonings, many may have been visiting the field after spraying to carry food to the male laborers. As expected, the proportion of cases were lowest in the youngest and oldest members of the population and evenly distributed among the age groups 11-20 and 21-30 (Figure 3.5). The decline in intoxications in individuals 31-40 years of age may be attributed to several factors. They often either move out of agriculture, become less likely to experience poisoning as they learn how to handle the pesticides and thus avoid intoxication, or leave the responsibility for fumigation with the younger workers and/or the women. The majority of cases cited in this study occurred during the months of July through December, and the greatest number of cases were treated in Santa Ana, San Miguel and Usulutan where

better medical services are found. San Miguel and Usulutan are within the major cotton growing regions of the country. This is the same pattern noted by Lopez et al. (1988) in a similar survey conducted during 1986-87.

The greatest number of poisonings reported in Lopez et al. (1988) result from oral exposure (58%) followed by inhalation and dermal contamination. Some proportion of those ingesting pesticides would be deliberate as a result of attempted suicides (Table 3.23). According to the individuals bringing the patient to hospital, the most frequently reported cause of pesticide poisonings were from the use of the following pesticides (in descending order of importance): tamaron, organophosphorus, carbamates (lannate and furadan) and phostoxim (especially when the intoxications were due to suicide attempts) and paraquat.

b. Hospital Treatment

Interviews with medical professionals and the review of the high mortality of patients visiting hospitals (Figure 3.4) indicate that pesticide intoxications in El Salvador are oftentimes improperly treated. First of all, there is a tendency to treat all patients in the same manner, regardless of the intoxicant. The data confirmed that organophosphates and carbamates were responsible for the highest number of pesticide poisonings. These symptoms are easily recognized and include accumulation of fluid in the respiratory system, vomiting, stomach pain, etc. On the other hand, when the intoxication is caused by organochlorines, it is harder to diagnose since the main symptoms are headache, disorientation, dizziness and excitation. Pesticides may induce a variety of symptoms that are not associated with pesticides (e.g. cardiac failure, lung disorders). Lung lesions are generally not diagnosed as being associated with paraquat use while paraquat may in fact be the causal agent of respirator disorders.

In addition, there is little to no information on the chronic and long term impact of pesticides on human health. Many reproductive disorders (e.g. impotence, abortion, still births, congenital malformations) may be related to pesticide exposure.

Oftentimes when patients arrive at the hospital, they are not stripped and bathed. Consequently, if pesticide remains on the skin or clothing, intoxication may continue even while the patient is under medical care. Adding to the wrong diagnosis of the poisoning and the improper care and handling of the patient is the lack of local labs that can analyze and thus confirm the causal substance to enable better treatment of the intoxicated patients. Local labs could also monitor acetylcholinesterase activity to follow recovery. These capabilities also do not exist.

In terms of preventive medicine, it is imperative to identify those circumstances and social groups that are most associated with pesticide intoxications. Although there are some data on the distribution of intoxications by region, age, and occupational group, that information is inadequate if health planners are to monitor closely the problem and to fine tune the delivery of safety training. The Ministry of Health does not attempt to gather data in any consistent or systematic way on the

circumstances of intoxications or on the socioeconomic characteristics of the victims. It does not maintain a registry of pesticide intoxications. Nor has any consistent effort been made to survey the rural population with regards to pesticide use and intoxications. The information that does exist is not always easily accessible and is not routinely shared amongst the various public and private institutions that have expertise and responsibilities in this area. This data gap hinders attempts to utilize training resources effectively.

Hospitals and clinics rarely have available to them current information on the types of treatment that are appropriate for different types of poisonings. This thus constrains their ability to treat the patients correctly even if the causal substance could be identified. Finally, it is important that hospitals take advantage of this contact with the patient to reinforce pesticide safety measures, particularly when the memory of pesticide poisoning is very fresh in a patient's mind.

c. Pesticide Residues

There are currently no systematic monitoring programs for pesticide residues on foodstuffs destined either for the export or domestic market. CENTA has periodically conducted studies of pesticide residues, largely under the direction of Dr. Gloria Ruth Calderon. CENTA, in collaboration with Defensa Agropecuaria, is looking for support to implement a monitoring program for vegetables in the domestic market. This proposal is included as Attachment 7.

In those studies that have been conducted, pesticide residues have been clearly evident on many vegetables that in some cases exceed allowable tolerances. Residues of organochlorines (Lindane, DDT, Dieldrin, and Epoxy Heptachlor) were observed in vegetable oils and fats for samples taken in 1978 and 1979. DDT levels were highest, followed by dieldrin and lindane (Calderon 1982).

More recently, Calderon (1985) examined residues on cabbage, tomato, cucumber, and sweet peppers for samples taken from four zones of the agricultural market of Zapotitan, collected during three months. Milk products were also sampled. In this case, both organochlorines (lindane, aldrin, dieldrin, heptachlor and epoxy heptachlor, DDT) and organophosphates and carbamates (methyl and ethyl parathion, dipteryx, volaton, tamaron, diazinon and disyston) were monitored. The largest residue levels were found in milk products such as milk, cream and cheese. Those found were organochlorines. Some of these exceeded allowable tolerances. Vegetables also showed levels of OPs and carbamates, and in the case of tomatoes and cabbage, FAO tolerances were exceeded for some samples contaminated with dipteryx, diazinon and tamaron.

d. Human Contamination

With the recent cancellation of most organochlorine pesticides, chronic exposure and bioaccumulation will slowly decrease, while some of the long term impacts of the past exposure (e.g. central nervous system problems,

potential mutagenic effects) may yet be felt. The trend towards the use of more OPs and carbamates is likely to have a far greater impact on acute poisonings than on chronic poisonings, as has already been described above in Section a.

e. Malaria and Pesticide Resistance

The number of malaria cases has decreased considerably during the past 2 years as shown in Table 3.24. This decline in incidence is attributed to intensive control efforts which have included residual house sprays, breeding source control and drug chemotherapy. This has been a highly effective approach in the short term, but is threatened by the development of resistance to pesticides in the vector population that are exposed to pesticides in agricultural runoff. Some resistance has been noted for most zones in El Salvador to nearly every available pesticide (Sauerbrey, personnel communication). Malaria outbreaks in the past (1970's) have been clearly associated with the development of resistance in vector populations to pesticides used in agriculture long before they became common in public health. Certain pesticides should be restricted to use in public health and precautions should be taken to minimize agricultural use of chemicals that may have cross resistance with important public health chemicals. Agricultural use should be done in a way to limit drift and runoff and therefore indirect exposure of vector populations. There is no apparent attempt to coordinate pesticide use between agriculture and public health. For example, although propoxur (5% A.I.) use does not appear to be common in agriculture, there may be cross resistance with other commonly used agricultural pesticides. Malaria endemicity is high in important agricultural zones (Figure 3.6). Therefore, lack of control methods is a serious threat to human health and thus agricultural productivity.

Table 3.23. Pesticide Poisonings Requiring Hospitalization By Region 1980-1988*

REGION	1980	1981	1982	1983	1984	1985	1986	1987	1988**	Total
Western	132	102	168	289	300	360	390	405	244	2390
Central	213	270	372	263	250	266	281	271	204	2390
Metropolitan	7	54	162	139	117	141	95	138	47	900
	167	143	155	351	220	207	1090	196	122	2651
Eastern	241	238	236	141	115	144	44	211	145	1515
Health Center	40	54	29	27	23	42	76	31	23	345
Total	800	861	1122	1210	1025	1160	1976	1252	785	10191

*Source: Reporte Epidemiológico Semanal. Division de Epidemiologia. Ministerio de Salud Pública y Asistencia Social.

**1988. Includes only 30 weeks.

Table 3.24
Number of Malaria Cases From 1980-1987

Year	Number of Cases
1980	95,835
1981	93,187
1982	86,202
1983	65,377
1984	66,874
1985	44,473
1986	23,953
1987	12,834

Figure 3.4. The Ten Primary Causes of Death, Ages 15-44, 1987, of Hospital Visits

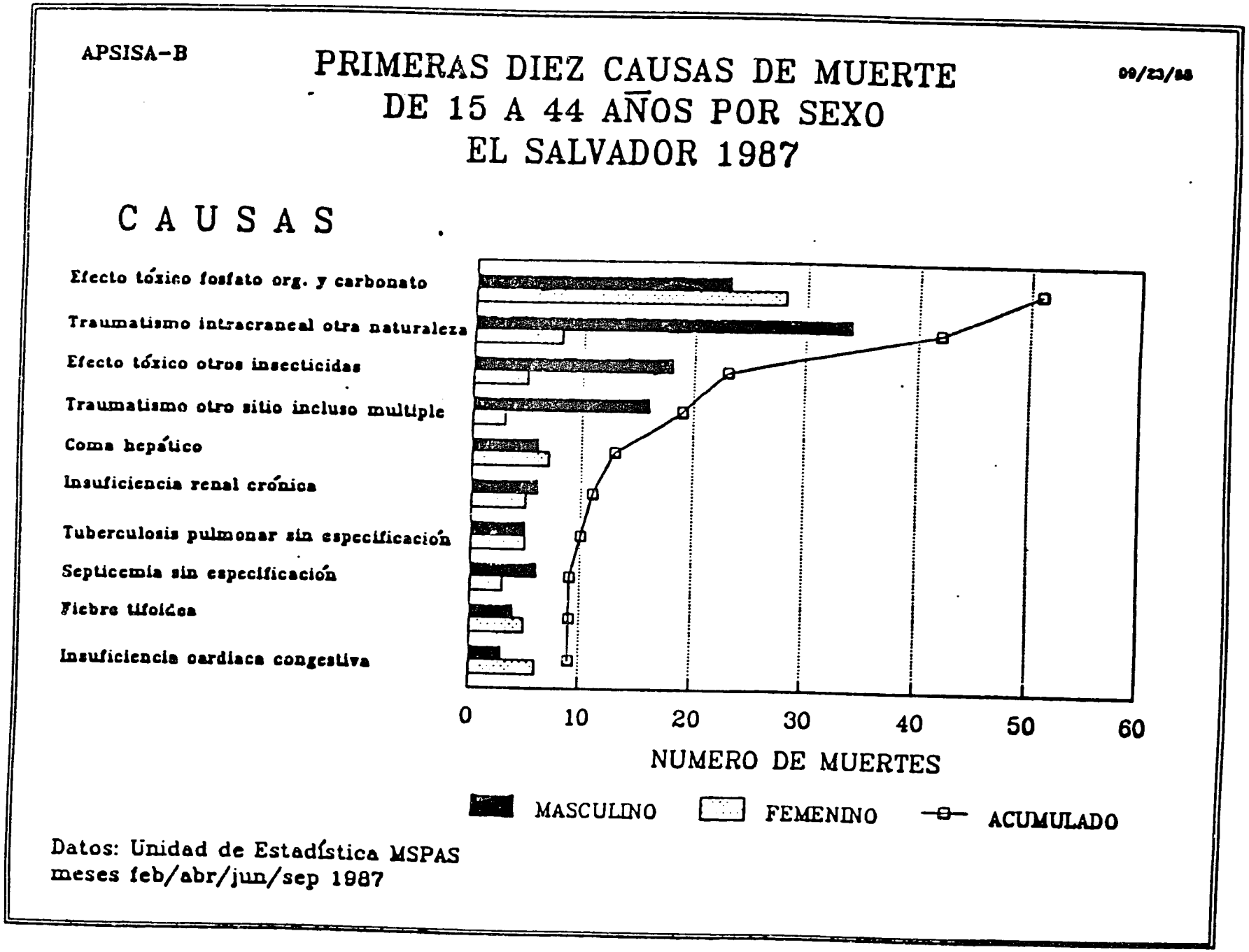
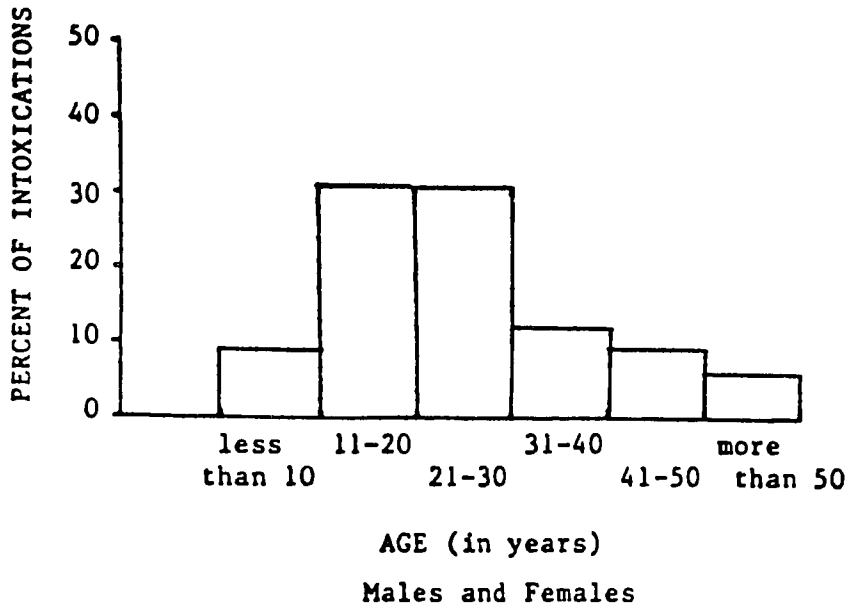
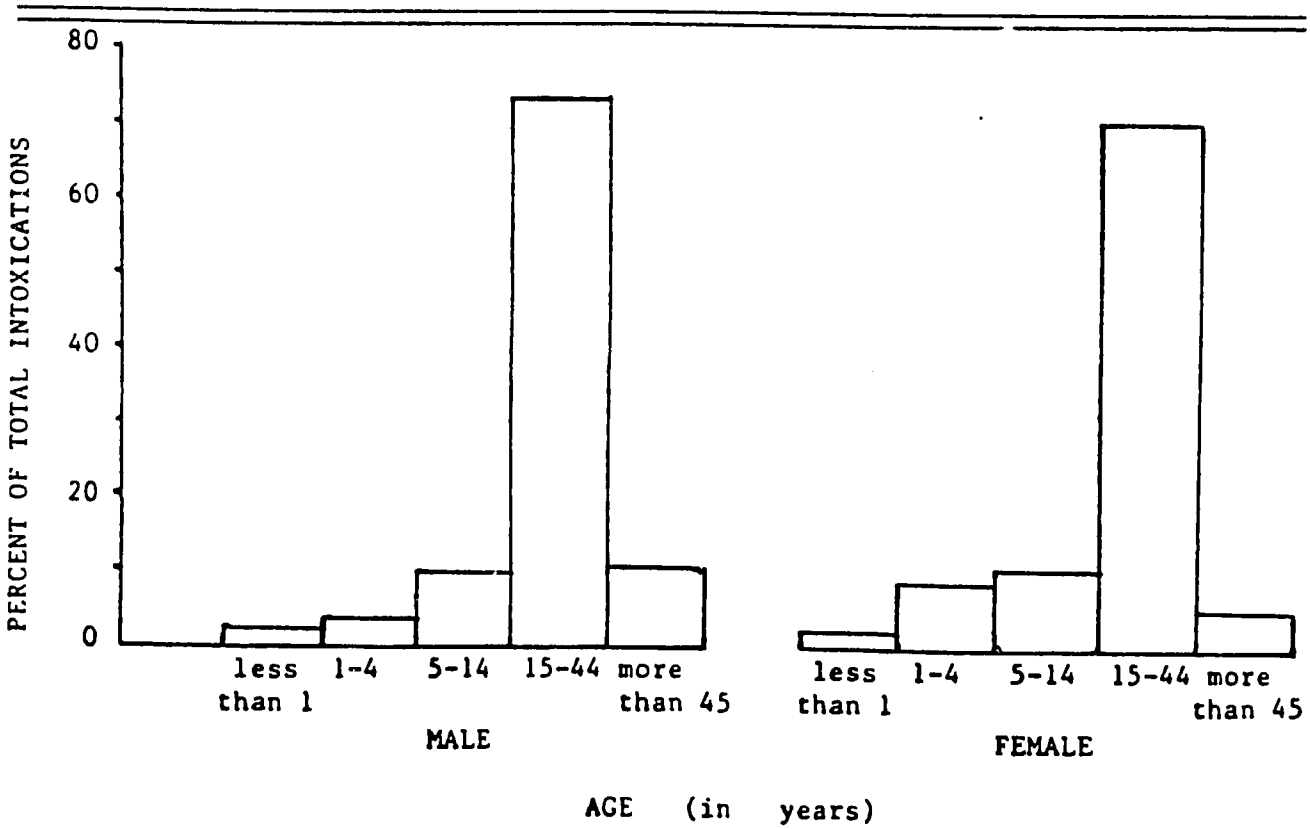


Figure 3.5. Pesticide Poisonings as a Function of Age and Sex



Source: Guadalupe Barrera and Ponce Vega (Data from 1982-86)

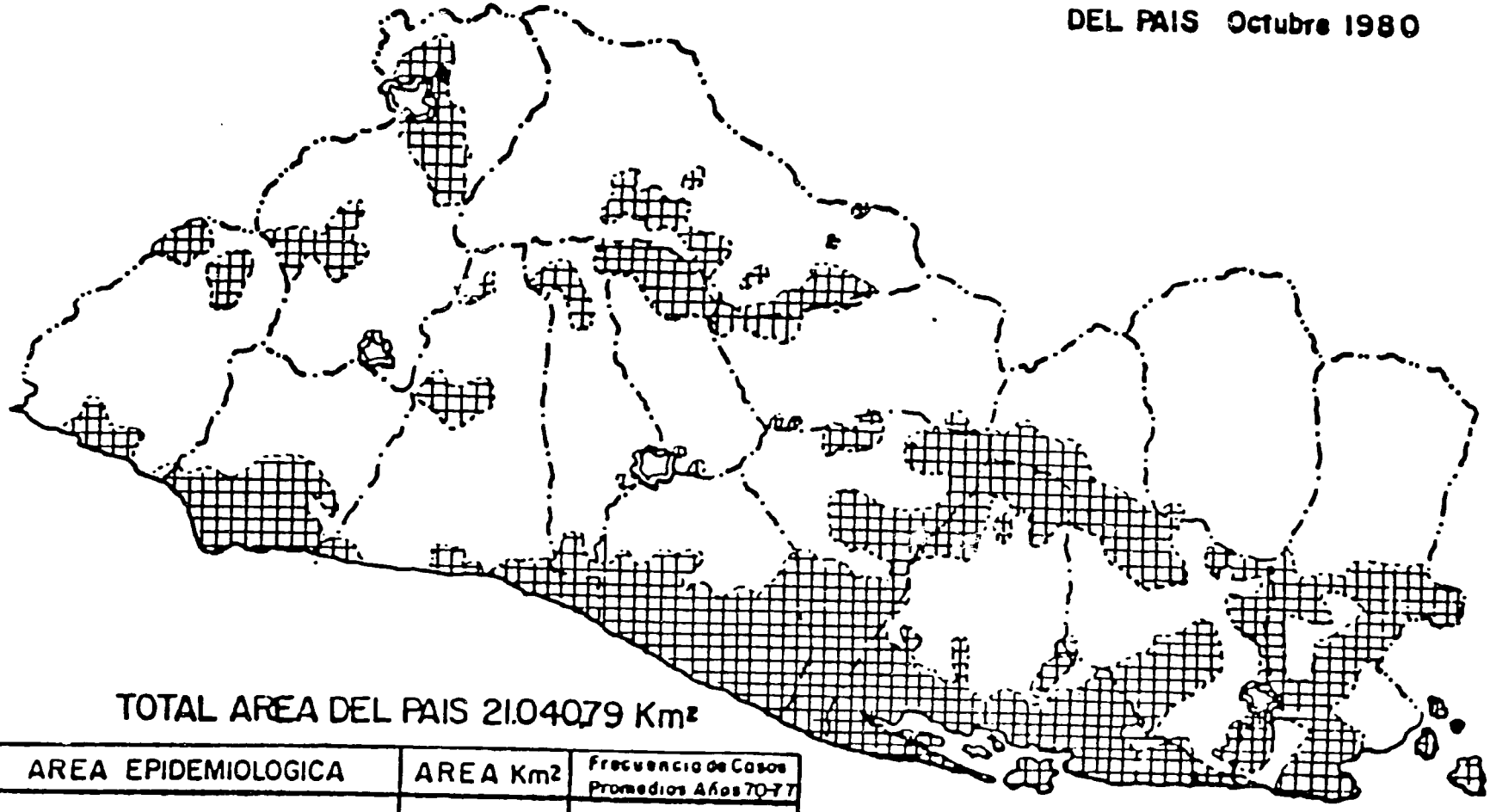


Source: Ministry of Public Health and Social Assistance (1987)

Figure 3.6

MAPA DE EL SALVADOR

DELIMITACION GEOGRAFICA EPIDEMIOLOGICA DEL PAIS Octubre 1980



TOTAL AREA DEL PAIS 21.040,79 Km²

AREA EPIDEMIOLOGICA	AREA Km²	Frecuencia de Casos Promedios Años 70-77
Hiperendémica de 1a y 2a Prioridad de 0 a 300 mts. de altura	4.819.30	Mas de 60 casos

DIVISION DE MALARIOLOGIA

6. Socioeconomic Effects

a. Rural Conditions

The EA team visited two Phase I cooperatives and one Phase III cooperative in an effort to get an impression of pesticide use problems in rural communities. These are discussed in detail above in Section III.C.2. A systematic assessment clearly cannot be produced during such a cursory field survey, and the team makes no claims as to the empirical validity of its observations. Nonetheless, the team feels that certain issues that became apparent during field visits merit more systematic investigation in the future.

Upon interviewing peasants, it quickly becomes apparent that very serious pesticide handling problems are ubiquitous features of Salvadoran rural communities. In Cuyultitan, La Paz virtually every member of the community convincingly expressed familiarity with symptoms of intoxication, and several individuals gave detailed descriptions of acute intoxications. In San Raymundo, Ahuachapan residents also reported cases of intoxication. Amongst the communities that we visited, these problems seemed to be least serious in the Phase I cotton cooperative at Santa Clara, La Paz. On that farm there had been no reported pesticide intoxications during the previous year. Several factors may have contributed to the fact that intoxication problems were not as acute in Santa Clara as elsewhere. Santa Clara has trained farm managers who are familiar with pesticide handling techniques. Fumigation of cotton is done aerially, rather than by hand. The fact that few workers are actually handling toxic substances may more than compensate for the risk of pesticide drift during aerial application. Finally, pesticide storage was relatively well administered.

Integrated pest management including the use of chemicals is a complex technology that is difficult to manage under the best of circumstances. El Salvador's small farmers appear to be especially handicapped when it comes to coping with the risks of pesticide management. Small farmers are not well situated to acquire technical information, including information about safe pesticide handling. This is in part due to the generally low levels of education amongst the Salvadoran peasantry, and also due to the fact that the technology transfer infrastructure is clearly insufficient to meet rural demand for technical assistance. These factors include:

1) Lack of critical resources;
2) Lack of safety equipment and resources to purchase equipment;
3) Malnutrition and other endemic conditions (e.g. illiteracy) that contribute to high morbidity among the rural poor; and
4) Local problems such as the lack water to bathe after spraying.

Literacy, water and poverty are particularly critical issues. The potential implications of these factors is illustrated in the report by Gore, Reynolds and Johnston, The 1988 El Salvador Agricultural Land Ownership and Land Use Survey, that provides baseline information regarding the status of rural families. The families interviewed were divided into three categories based on size of farm. Stratum I includes farms from 1 to

24.99 hectares in size. This represents 95.5% of all agricultural property in El Salvador and 32.4% of all agricultural land. Stratum II includes farms which range in size from 25 to 100 hectares. This category represents 3.7% of all agricultural properties and 25.8% of the agricultural land area. Stratum three includes land holdings of more than 100 ha. This represents 0.8% of all properties and 41.8% of the agricultural land.

For the three strata: I, II and III, the rates of illiteracy were 80.4%, 62.1% and 53.4% respectively. Consequently, written instructions for the handling and use of pesticides are virtually meaningless for a substantial proportion of the population. Unfortunately farmers cannot rely upon existing technical services to bridge this gap since Gore, Reynolds and Johnston report that for the three strata: I, II and III, only 3.8%, 11.9% and 19.5%, respectively received technical assistance. For the purposes of their study, all forms (Ministry of Agriculture, public sector institutions, private commercial firms, private consultants, etc.) of technical assistance were included. Clearly the farmers with the highest literacy rate were receiving the most technical assistance.

Water is essential to the proper use of pesticides for mixing, application and clean up afterward. Individuals who handle pesticides must wash thoroughly after exposure to pesticide to avoid intoxication. In the rural areas of El Salvador, there is a severe lack of running water and bathing facilities making the safe use and handling of pesticides an extraordinarily difficult task. Gore, Reynolds and Johnston in their study The 1987 Resurvey of the 1978 El Salvador Nonmetropolitan Household Study report the number of households with these services. Of the households interviewed in 1987, the following results regarding bathing facilities were obtained:

Private Shower or Tub	23.7%
Shared Shower of Tub	3.0%
No Bathing Facilities	73.3%

The following results regarding water source were obtained:

Private Indoors Pipe	27.6%
Communal Indoors Pipe	3.0%
Private Well	10.9%
Private Cistern	0.3%
Public Spigot	17.5%
Common Well	9.0%
Other (Rivers, Rain)	31.7%

As Gore, Reynolds and Johnston point out, this study was not intended to portray national rural conditions but rather was a resurvey of families interviewed in 1978. Furthermore, the original cluster sample procedure resulted in the inclusion of metropolitan households and had a disproportionate share of rural households that were near main or secondary roads. Therefore, it is unlikely that rural households are as well off as these results imply.

In summary, the poorest, most illiterate farmers have the least access to resources and technical assistance to compensate for that poverty, and mitigate against the negative impacts of pesticide misuse.

b. Economic Costs

Pesticides can have beneficial or detrimental effects depending upon their use. Used wisely and effectively, pesticides can reduce crop losses without significantly affecting human health and the environment. Unfortunately, the use of pesticides in many countries has been detrimental to human health, the environment and the economic well-being of pesticide users. El Salvador is no exception in this regard.

Currently, El Salvador exports commodities valued at $340 million each year. For the last ten years, agricultural products represented approximately 75% of total commodity exports. Projections of production of nontraditional crops is rather ambitious and indicates the importance being placed on nontraditional crops ($10.4 million to $84.6 million from 1988-92). Since El Salvador is running a trade deficit, any action which reduces exports exacerbates an already serious problem. The major importing nations (e.g., United States, Europe and Japan) are increasing their scrutiny of food imports for pesticide residues. Consequently, all of El Salvador's exports of food products are potentially vulnerable to the threat of being rejected for residues in excess of established tolerances. At this time, there is no systematic monitoring of pesticide residues on foodstuffs in El Salvador. As a result, it was not possible for the study team to provide a definitive answer regarding the seriousness of this problem. However, where sampling has been conducted, residues are evident (see Section C.5).

In her study, the Cotton Integrated Pest Management Program in El Salvador: Preliminary Study of Technology Transfer and Socio-Economic Impacts, L. Ann Thrupp provides a case study of the use of pesticides in cotton. Historically, cotton accounts for 80-85% of the use of insecticides in Central America. Furthermore, growers found that they were using ever larger quantities of insecticides in cotton where applications per seasons have increased from an average of 15 per season in the 1950's to 35 per season in the 1970's. In the 1980's, pesticides accounted for more than 40% of the cost of producing cotton in El Salvador.

The heavy and indiscriminate use of pesticides causes the destruction of natural enemies and consequently results in outbreaks of secondary pests. In addition, indiscriminate use of pesticides accelerates the development of resistance requiring ever increasing applications of pesticides. It is impossible to quantify these losses.

As noted for cotton, production costs associated with the use of pesticides can be very high. Fundacion Chile reported costs ranging from 14-28% of the total production costs (including labor) for tomatoes, carrots, peppers and potatoes. BFA production budgets include levels as high as 35-39% for vegetables and cotton. These values do not include the costs of transportation which generally far exceed the costs of inputs. The CATIE/MIP project in Guatemala attributes up to 45-50% of production costs

to the use of pesticides in sweet chiles. This is a considerable cost to small farmers, much of which is probably unnecessary use, given the calendar application schedule of pesticides.

In addition to the direct economic costs of pesticide use in cotton, there are other measurable economic costs. Thrupp estimated that the beef industry of El Salvador lost $23 million between 1980 and 1984 because of the rejection by the United States of meat which had been contaminated by insecticides used in cotton. In addition, one of El Salvador's two major exporters of beef was forced into bankruptcy due largely to this problem. The loss of exports in beef because of the use of pesticides in cotton is one type of economic cost that indiscriminate use of pesticides can cause.

The beef industry of El Salvador currently attempts to deal with this problem of contamination by feeding uncontaminated feed to animals for 90-150 day period prior to slaughter. Obviously, such a practice increases the cost of production for export beef and leaves El Salvador at a competitive disadvantage in the world market. More importantly, such a "detoxification" practice would not be possible with shrimp, if rivers and coastal waters become contaminated with pesticides.

Far more difficult to quantify in economic terms are the costs associated with deteriorating human health as a result of heavy use of pesticides. Farmers and handlers of pesticides are exposed directly to pesticides during transportation and use. Aerial applications of pesticides often contaminate individuals that live adjacent to the fields that are sprayed. Furthermore, low income farmers often store pesticides in their homes, in order to provide security for a high cost input. In so doing, they expose themselves and their families to the toxic fumes. Finally, the entire population is ingesting pesticides as residues on domestically produced foodstuffs (see Section III.C.5).

It is not possible to put a dollar figure on losses to the Salvadoran economy from deaths, miscarriages, days of work or schooling lost due to illness, central nervous system disorders and shortened lifespans that result from current pesticide use and handling practices. The number of pesticide poisonings reported in the country indicate that the problem in severe. To quantify the cost to human health in dollar terms would require a special study.

Since nearly 95% of El Salvador's agricultural exports are foodstuffs and potentially vulnerable to rejection, excessive pesticide residues could result in the complete collapse of El Salvador's export market and the near devastation of the country's economy. The potential for the loss of markets due to pesticide residue problems exists. It is in the economic self interest of the country to take action to ensure that pesticide residues on export crops are well within the tolerances set by the major markets to which El Salvador ships its products.

c. Economic Risk

There is a question of whether the shift to production of nontraditional exports which require substantial pesticide inputs carries with it an associated economic risk for Central American farmers.

The risks that are specifically related to pesticide inputs include the following:

1. Congress is currently considering a bill that would significantly strengthen the FDA's ability to monitor agricultural imports for pesticide residues.

   Should this bill pass, as seems likely, the risk that Salvadoran exports will be rejected from the U.S. market because of high pesticide residues will be substantially increased. Loss of export markets carries an associated economic risk. There further may be a potential conflict in policies. It may be impossible to remain within the allowable residue tolerance levels while at the same time producing commodities that are pest-free.

2. Secondly, there is the risk that pests will become resistent to current chemical controls, and that production costs will consequently increase unless other control measures can be developed.

   This has happened with cotton. It could very well happen for tomatoes, okra or any of a number of nontraditional crops that already require a great deal of pesticide application.

3. FUSADES, which is certainly capable of attempting an economic assessment of these risks, has taken no steps to do so. It is recommended that FUSADES add this issue to their research priorities. They have at their disposal production projections, costs of production and marketing data which should enable an assessment of this type.

IV. CONSEQUENCES OF ALTERNATIVE ACTIONS

There are several alternative actions available regarding the use of pesticides. A NO ACTION alternative would restrict funding of all pesticides. Other alternatives are represented by the variety of recommendations included in this assessment, but are presented as a single option. It is recommended that in order to be effective, action must be taken on several levels and in different sectors (agriculture and health).

A. NO ACTION

Pesticides could be excluded from all production credit packages. Although this alternative may restrict pesticide use, it is very unlikely to eliminate the use and reliance on pesticides as the sole means of pest control nor the widespread use of highly toxic chemicals. As noted above, pesticide use is widespread and pesticides are widely available. By taking no action, the existing patterns of use will continue, accompanied by the human health and environmental impacts already discussed. This includes: a) use of highly toxic, Class I pesticides; b) in many cases, inappropriate and excessive use of these chemicals; c) high level of acute intoxification as OPs and carbamates are used in favor of more environmentally dangerous organochlorines; and d) poisonings of non-target organisms, both wild and domestic.

The direct, short-term program costs will be minimal. However the long-term costs are likely to be considerable. These are expressed in terms of hospital and health care for intoxication cases, loss of flora and fauna, pesticide residues on export commodities and potential loss of export markets, and loss of agricultural productivity due to soil and water contamination, insecticide resistance and secondary pest outbreaks. Pesticides can comprise anywhere from 4-39% of the input production costs (including labor) depending on the crop. These values could rise if higher application rates are necessary and if more expensive pesticides are required as resistance develops. While a short term production focus may appear the most economical, there is every indication from the data in El Salvador and other countries, that the long term costs can be significant.

B. ACTION ALTERNATIVE

A variety of recommendations are outlined in the Summary and Recommendations section. This includes supervised distribution of general use pesticides only, the provision of technical assistance for training in the proper use and handling of pesticides, initiation of research in IPM for nontraditional export crops, policy reform to remove incentives (e.g. cost of pesticides and credit) to the use of pesticides, and training and extension on alternative pest management strategies.

Training on safe pesticide use can be incorporated into all agriculture projects at a minimal cost, and in many cases could be supported with local currency. To be effective these courses will require follow up and monitoring and evaluation. Similarly, loan officers from the commercial

banks can receive training in pesticide management to be included as a component of their loan request assessments. An illustrative budget for these types of training is included as Attachment 4.

The development of IPM technologies requires a longer-term investment of both time and resources. Where technologies are available, the emphasis should be on extension, implementation, and farmer training. This is the case for basic grains, cotton and some vegetables (tomatoes and sweet peppers). In the case of nontraditional exports, a long term advisor is needed with a specialization in IPM in vegetable and horticultural crops to identify research priorities and to assist in the design of applied research programs and to guide the implementation. Local currency can support local research costs. Considerable information may be available on pest management in horticultural crops, particularly basic biology of pest organisms, from other countries (e.g. Mexico and Chile). This information may be adapted to El Salvador conditions. Without taking a longer term approach, the nontraditional export crop promotion programs will need to continually play catch up with pest problems as they arise.

ATTACHMENT 1

USAID/El Salvador

Kenneth C. Ellis, RDO
Clemence J. Weber, ADO
Rodolfo Cristales
Isaac Torrico
Eduardo Hipsely
Enrique Barrau
Michael Wise

US Embassy

Paul Trevell - Second Secretary, Economics Section
Francisco Molina - Commercial Economics

Asociacion de Proveedores Agricolas

Raul Eduardo Gochez
Roberto Callejas - Agroproesa
Marcelo Brito L. - Agroquimicos
Federico Bolanos - Moore Comercial
Francisco Arturo Fischnaler - Quimica Integrada

Banco de Fomento Agropecuario

Mario Roberto Martinez - Gerente Division Comercial
Jorge Alberto Arguello - Subgerente del Depto. de Creditos
Ricardo Romero Gaitan,- Asesor de Cooperativas
La Libertad Branch Office

CABEI - HONDURAS

Mauricio Athie

CABEI - EL SALVADOR

Francisco Ramirez Cuadra

CATIE/MIP

Joaquin Larios - Central Office, San Salvador
Oficina de Guaymango

CENTA

Enrique Mancia - Director de Investigaciones
Gloria Ruth Calderon - Jefe de los Laboratorios de Residuos
Ing. Betancourt - MIP
Ing. Bonilla - MIP
Ing. Luis Alfonso Alvarez Nieto - Depto. de Planificacion

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Rogelio Posada B. - Departamento de Planificacion
Edgar Noel Ascencio Campos - Jefe Unidad de Investigacion y Validacion Regional.
Ing. Carlos Arturo Tobar Palomo
Ricardo Duran

GERENTE REGIONAL OCCIDENTAL

Victor Torres

CENTREX

Jorge Alberto Morales S. - Director

COOPERATIVES

Santa Clara
Santa Emilia, Cuyultitan
Canada, Sonsonate
San Raymundo, Ahuachapan

Direccion de Defensa Agropecuaria

Balmore Ochoa
Ana Cecilia Vasquez
Lic. Miranda
Transito Abrego

Direccion General de Economia Agropecuaria

Ing. Jose Roberto Revelo

FINATA

Ing. Lucio Villalta

FUSADES

DIVAGRO
Filadelfo Baires
Guillermo Gower
Cesar Hanania
Roberto Arbizu
Manuel Rodriguez Cedillos
Emilio Suadi
Ricardo Suarez
Susanna Weber

FUNDACION CHILE

Pablo Rio Seco

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DEPARTAMENTO DE ESTUDIOS ECONOMICOS Y SOCIALES

Mercedes Llort
Roger Norton

GTZ

Rainer Daxl

Ministry of Health

Mauricio Sauerbrey - Malaria Advisor

Ministry of Social Security

Office of Health USAID

Sandy del Prado
Kevin Armstrong

TECHNOSERVE

Jeffrey Nash
Stanley Kuehn

Universidad de El Salvador

Facultad de Biologia
Ernesto Lopez Zepeda
Jorge Alcides Santamaria

Facultad de Agronomia
Victor Rosales

Facultad de Medicina

United Schools of America - Water Management Project

Hugo Sosa
Eduardo Huidobro

Agricultural Supply Store

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ATTACHMENT 2

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Attachment 3

Pesticides Available and Registered for Use in El Salvador
Also Shown are Toxicity Categories of Listed
Pesticides (1,2,3,4,5,6,7)

Common Name and (Brand Name)	Action	Toxicity Category	TOMATOE 1	RICE 2	POTATO 3	SUGAR CANE 4	CHILI 5	CABBAGE 6	CASSAVA 7	BROCOLI 8	EGGPLANT 9	CUCUMBERS 10	RADISH 11	CORN 12	SORGHUM 13	ONIONS 14	CARROTS 15	GARLIC 16	BEANS 17	BEETS 18	MELONS 19	COFFEE 20	COTTON 21
Acephate (ORTHENE)	Insecticide	III																					
Alachor (LASSO)	Herbicide	I			X									X	X				X				X
Aluminum Phosphide (PHOSTOXIN)*	Insecticide	I																	X				
Allethrin (Fynamin I Forte)	Fungicide	III	X																				
Ametryn (GESAPAX)	Herbicide	III			X	X			X					X	X						X		
Atrazine (AATREX)	Herbicide	III				X								X									
Arsenal	Herbicide	III												X	X				X				X
Asulam (ASULOX)	Herbicide	III				X																	
Bacilus thuringiensis (DIPEL)	Insecticide	III	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Bayten (BAYFIDAN)	Fungicide	III																					
Baythion (VOLATON)	Insecticide	II																					
Benomyl (BENLATE)	Fungicide	III	X	X				X		X	X	X					X	X	X				
Bentazon (BASAGRAN)	Herbicide	II		X															X				
Brodifacoum (KLERAT)* 6	Rodenticide	III												X	X				X				
Captafol (DIFOLATAN) 8	Fungicide	II	X	X																			
Carbaryl (SEVIN)	Insecticide	III	X	X	X			X				X		X		X					X		
Carbendazin (BAVISTIN) 2	Fungicide	III										X	X	X	X		X		X	X	X		X
Carbofuran (FURADAN)(CURATER)	Insecticide	II;I		X	X																		
	Acaricide											X		X	X						X		X
	Nematocide																						
Chlorothalonil (DACONIL)	Fungicide	II	X		X			X		X		X		X		X	X		X		X	X	
Chlorpyrifos (LORSBAN)*	Insecticide	II			X			X						X	X	X							X
CopperHydroxide (KOCIDE)	Fungicide	III;I	X		X		X	X		X		X				X			X		X		
Copper oxychloride (CUPRAVIT)	Fungicide	III	X		X		X			X						X			X		X		
Cyfluthrin (BAYTHROID)*	Insecticide	I	X	X	X		X	X	X	X	X	X	X	X	X	X	X		X	X	X		X
Cypermethrin (SHARPA, AMMO, CYMBUSH, RIPCORD)*	Insecticide	III																					X
2,	Herbicide	I;III		X																			
Daconate (MSMA)	Herbicide	III												X	X								
DDVP)VAPONA)	Insecticide	I	X									X	X										X

Common Name and (Brand Name)	Action	Toxicity Category	TOMATOE 1	RICE 2	POTATO 3	SUGAR CANE 4	CHILI 5	CABBAGE 6	CASSAVA 7	BROCOLI 8	EGGPLANT 9	CUCUMBERS 10	RADISH 11	CORN 12	SORGHUM 13	ONIONS 14	CARROTS 15	GARLIC 16	BEANS 17	BEETS 18	MELONS 19	COFFEE 20	COTTON 21
Deltamethrin (DECIS)[2]	Insecticide	I	?																				
Diazinon (BASUDIN)	Insecticide	III;I	X		X			X	X			X		X	X	X	X		X	X	X		X
Dicamba	Herbicide	II				X								X	X								X
Dichlorvos (VAPONA; DDVP)[4]	Insecticide	I	X																				
Dicrotophos (BIDRIN;CARBICRON)*	Insecticide	I																					
Dimethametryn (AVIROSAN)	Herbicide	III																					X
Disulfoton (SOLVIREX:DISYSTON)*	Insecticide	I	X		X			X						X	X				X				X
Diuron (KARMEX)	Herbicide	III			X									X	X								X
Edifenphos (HINOSAN)[2]	Fungicide	II																					X
Endosulfan (THIODAN)	Insecticide	I	X		X			X				X					X		X		X		X
EPTC (ERRADICANE)	Herbicide	III			X									X					X				
Ethoprop (MOCAP)*	Nematocide	II			X			X				X		X									
Fenamiphos (NEMACUR)*	Nematocide	I						X															
Fenitrothion (FOLITHION)	Insecticide	II																					X
Fenthion Lebaycid (BAYTEX)	Insecticide	II																					
Fluzifop-Butyl (FUSILADE)	Herbicide	III																					
Glyphosate (ROUNDUP)	Herbicide	II		X	X			X			X			X	X	X	X		X	X		X	X
Heptachlor[9]	Insecticide	II																					
Hexazinone (VELPAR)	Herbicide	II				X																	
Isofenphos (OFTANOL)	Insecticide	I																					
Karate	Insecticide	?																					
Kasuganycin (KASUMIN)	Fungicide	IV	X	X																			
Malathion (LUCATION)	Insecticide	III	X	X	X			X		X	X	X	X	X	X	X	X	X	X	X	X		X
Maneb (MANZATE)	Fungicide	III	X		X							X		X		X	X		X		X		X
Metaldehyde	Molluscicide	III																					
Mephosfolan (CYTROLANE)[2]	Insecticide	I		X										X									
Metalaxyl (RODOMIL)	Fungicide	II	X		X			X		X	X	X				X					X		X
Methamidophos (TAMARON;MONITOR)*	Insecticide	I	X		X			X				X								X	X		X
	Acaricide																						
Methiodathion (SUPRACIDE)*	Insecticide	I													X								
Methomyl (LANNATE)*	Insecticide	I	X		X			X				X		X	X	X	X		X	X	X		X
Methy Bromide *	Fumigant	I	X	X	X			X			X	X	X	X	X	X	X	X	X	X	X	X	X
Methyl Parathion (FOLIDOL;MITIDOX)*	Insecticide	I	X	X	X			X				X		X		X	X		X	X			X
Methyl Pirimiphos (ACTELLIC)	Insecticide	III																					
Metolachor (DUAL)	Herbicide	II		X																			

Common Name and (Brand Name)	Action	Toxicity Category	TOMATOE 1	RICE 2	POTATO 3	SUGAR CANE 4	CHILI 5	CABBAGE 6	CASSAVA 7	BROCOLI 8	EGGPLANT 9	CUCUMBERS 10	RADISH 11	CORN 12	SORGHUM 13	ONIONS 14	CARROTS 15	GARLIC 16	BEANS 17	BEETS 18	MELONS 19	COFFEE 20	COTTON 21
Metribuzin (SENCOR)	Herbicide	III	X		X																		
Mirex	Insecticide	II												X									
Monocrotophos (NUVACRON);GUSATHON AZODRIN)*	Insecticide	I																					X
Omethoate (FOLIMAT)	Insecticide	II																					
	Acaricide	II																					
Oxadiazon (RONSTAR)	Herbicide	II		X																			
Oxamyl (VYDATE)*	Insecticide	I	X		X							X				X					X		X
	Nematocide																						
Oxifluorfen (GOAL)	Herbicide	II																					
Oxythioquinox (MORESTAN)	Insecticide	III												X		X							X
	Acaricide																						
	Fungicide																						
Paraquat (GRAMESEN;GRAMAXONE; KENOQUAT; PARADOX;GRAMAFIX)*	Herbicide	I	X		X			X	X			X		X	X	X	X		X		X		X
Parathion*	Insecticide	I	X	X	X	X		X			X	X	X	X	X	X	X	X	X	X	X	X	X
Pendimethalin (DRAGON;PROWL)	Herbicide	II		X	X									X	X				X				X
Permethrin (AMBUSH;LORNADA)*	Insecticide	III			X			X						X									X
Phorate (Thimet)*	Insecticide	I	X	X	X	X								X									X
Phosalone (ZOLANE)	Acaricide	II			X									X	X				X				X
	Insecticide																						
Phoxim (VOLATON;BAYTHION)2	Insecticide																						
Pichloram (TORDON)	Herbicide	II																					
Profenofos (TAMBO;SELECRON); CURACRON)*	Insecticide	II																					
	Acaricide																						X
Piperophos (AVIRASAN) 2	Herbicide	?																					
Propanil (HERBAX; STAM)	Herbicide	II		X																			
Propineb (ANTRACOL)	Fungicide	II																					
Propoxur (BAYGON)	Insecticide	II																					
Prothiophos (TOKYTHION) 2	Insecticide	?																					
Temephos (ABATE)	Insecticide	III																					
Thiram (THIRAM) 2	Fungicide	III																					
	Animal Repellant																						

Common Name and (Brand Name)	Action	Toxicity Category	TOMATOE 1	RICE 2	POTATO 3	SUGAR CANE 4	CHILI 5	CABBAGE 6	CASSAVA 7	BROCOLI 8	EGGPLANT 9	CUCUMBERS 10	RADISH 11	CORN 12	SORGHUM 13	ONIONS 14	CARROTS 15	GARLIC 16	BEANS 17	BEETS 18	MELONS 19	COFFEE 20	COTTON 21
Terbufos (Counter)	Insecticide Nematocide	II												X	X								
Terbutryn (IGRAN)	Herbicide	II													X								
Toxaphene (STROBANE, PHENATOX)9	Insecticide	II													X								
Triadimefon (BAYLETON)	Fungicide	II																					
Trichlorfon (DIPTEREX; DANEX; DYLOX)	Insecticide	II	X									X									X		
Tridemorph (CALAXIN)	Fungicide	II												X						X			X
Zineb (ZINEB; MANCOZEB)9	Fungicide	III																					

1. Aerial Application Prohibited
2. Not Registered by EPA
* Restricted Use in some if not all formulations
3. Residue tolerance have not been established by EPA or recommended by FAO/WHO
4. Currently under review by EPA
5. Granular formulations of Carbofuran are not restricted, but all concentrate suspensions and wettable powers 40% and greater are. FURADAN 5% granules are proposed here.
6. Restriction can be lifted if labeling modified
7. Use approved subject to adherance to U.S. labelling provisions
8. Voluntary cancellation of all products in U.S.
9. Use suspended in the U.S.

Attachment 4

Illustrative budget and course outline for pesticide safety training for loan officers.

	U.S. Dollars	Local Currency
U.S. Trainer		
4 wks. @ 250/d	6,000	
40% post differential	2,400	
Perdiem		
28 days @ $77/d		2,156
Airfare		
RT U.S.-San Salvador	800	
Materials Preparation and Transportation	3,800	
Subtotal	13,000	
Overhead (50%)	6,500	
Local trainers		
15 persons X 7 @ $200/d		21,000
Perdiem and local transportation		5,000
Trainees (300 loans officers)		
Perdiem and local transport		10,000
Equipment and supplies		1,500
Facilities		3,000
Total	19,500	42,656

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A one week training course could be offered to loan officers of the BFA and the commercial banks. A short-term consultancy from a U.S. trainer is recommended to help design the course and train Salvadorean trainers. These trainers would then be expected to carry out the training. Evaluation criteria will be designed into the course. While a principal Salvadorean trainer will conduct most of the training, assistance or guest presentations can be provided from Salvadorean ministry staff.

The emphasis in the course will be on several key issues.

1. Safe and effective general use chemicals. What they are, how they should be handled, applied and managed.

2. Pesticide costs and analysis of costs in designing production budgets.

3. Health and environmental risks of pesticides.

4. Management problems created by pesticide misuse.

5. Worker safety, safety equipment and pesticide labeling and safe handling.

6. Alternative pest control and types of pesticides and cost benefit analysis of alternatives (e.g. costs of monitoring programs).

Attachment 5.

Agricultural Ecology. A course for agronomy students.

Course Description: This course will cover basic principles of ecology as they apply to agricultural ecosystems. Ecosystem concepts will be developed. The biotic and physical components of agricultural ecosystems will be explored.

Objectives of the Course: Upon completion of this course, the student should understand the following issues and concepts:

1. basic principles of the science of ecology;
2. the concept of agroecosystems;
3. major agricultural ecosystems of the world;
4. crop production as a means of capturing solar energy;
5. inputs (fertilizers) and outputs (harvesting) and management of internal resources of agroecosystems;
6. population ecology of crops, pests, natural enemies and weeds;
7. community ecology of agricultural ecosystems;
8. evolutionary ecology of agricultural ecosystems;
9. physiological ecology of crops and weeds; and
10. the biophysical relationships between crops, soil, water, weeds, pest and natural enemies.

Classroom hours per week:	3
Laboratory and field hours per week:	3

Evaluation:	Mid-term examination	25
	Final examination	25
	Field notes	25
	Laboratory write-ups	25

I. What is the science of ecology?
II. What is an ecosystem?
III. What are of major ecosystems of the world?
IV. What is an agricultural ecosystem?
V. What are the major agricultural ecosystems of the world?
VI. What are the boundaries of the agricultural ecosystem?
VII. How is it different from natural ecosystems?
VIII. Biotic versus abiotic components of agricultural ecosystems.

Biotic Interactions

Producers	Consumers	Decomposers
Crops	Humans	
Crops/Weeds		
Crops	Insect Pests	
Crops	Pathogens	
	Insect Pests/Natural Enemies	
Crops/Weeds	Insects	Soil biota

Abiotic Interactions

Temperature
Solar radiation-harvesting the suns energy
Precipitation
Photoperiod
Soil - structure
organic content
stability
moisture content
nutrient content

IX. Population Ecology

Birth rate
Death rate
Population growth rates
Life Table analysis
Economic Thresholds

X. Community Ecology

Crop - Weed Interations	Competitive interations for: light, water, nutrients. Effect of inputs on competitive interactions.
Crop - Insect Interactions	Predation of insects on seeds. Parasitism or Herbivory Impact on plant productivity

Insect Pest - Natural Enemy Interactions - Biological Control

Crops - Pathogens - Insect Vectors

XI. Physiological Ecology

Crop - Light
Crop - Water
Crop - Nutrients

XII. Evolutionary Ecology

Plant Breeding
Genetic Diversity
Genetic vulnerability and stability of crop cultivars
Biotype development in pest and pathogens
Insecticide resistance

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XIII. Interventions and impact of the ecology of agricultural systems.

Irrigation
Runoff
Fertilizers
Pesticides
Harvests
Rotations
Intercropping/Polycultures

XIV. Field Techniques

Sampling methodology
Population monitoring
Trapping methods
Field identification

XV. Environmental Consequences of Agriculture

Soil erosion
Environmental contamination
Deforestation

XVI. Agricultural Systems and the World Food Balance

Attachment 6

Questionnaire for Health Clinics to Be Administered to Patients Poisoned by Pesticides

1. Date
2. Name of patient
3. Address

4. Age 5. Sex
6. Years of schooling
7. Occupation
8. Duration of exposure to pesticides

   a. Hours Daily
      less than 2
      less than 4
      less than 6
      more than 6

   b. Months per year
      less than 2
      less than 4
      less than 6
      more than 6

   c. Years Exposed
      less than 2
      less than 5
      less than 10
      more than 10

9. Type of pesticide used immediately prior to entry in hospital.
10. Method of exposure and duration of exposure.
11. Most recent use prior to poisoning incident.
12. Protective clothing use.
    Mask
    Gloves
    Boots
    Overalls

13. Action taken prior to coming to hospital

14. Symptoms
15. Previous experience with pesticide poisonings.
16. Type of crops being fumigated.
17. Size and type of landholding (Phase I or III cooperative).
18. Income level
19. Life style
    Smoking
    Amount and frequency
    Drinking

Attachment 8.

Pest and Pesticide Database

A pest and pesticide database should be developed. It can be housed at CENTA, FUSADES and Defensa Agropecuaria and serve several functions. It would provide up-to-date information on the registration status of pesticides. It will provide ready access to information on appropriate handling, specific environmental and human health concerns, toxicity data and application methods. For the crops and pests included in the database, it will provide information on specific pest problems, safer pesticides that may be used, alternative control practices and pest biology. The following information should be included in the database.

Crop scientific name — Crop common name
Growing season — Management practices
Pest species (Insect, pathogens, nematodes, mites and weeds)
- Scientific name — Common name
- Symptoms
- Damage
- Natural history
- Natural enemies and effective biological control
- Cultural controls
- Resistant varieties
- Economic threshold data

Pathogen
- Alternative hosts
- Insect vector
- As above for pests

Pesticides
- Common Name — Commercial Name
- Color labeling
- Action (insecticide, fungicide etc.)
- EPA registration status
- EPA tolerance data
- WHO/FAO Tolerance
- EPA registration category
- EPA warning words
- Toxicity data - oral, dermal, inhalation, and eye effects
- Health effects - chronic and acute
- Specific environmental hazards
- Environmental mitigations
- Appropriate disposal
- Emergency treatment measures
- Recommended dose - by crop
- Recommended frequency, timing, appropriate weather conditions, interval between last application and harvest
- Alternative general use chemicals