PRIORITY INTEGRATED CROP PROTECTION

RESEARCH PROGRAMS

Contract AID/DSAN-G-0203

United States Agency for International Development

and

International Programs in Agriculture

PURDUE UNIVERSITY

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Abstract

Priority researchable ICP projects are identified for each of the three USAID funding modes, i.e. central bureau funded, regional bureau funded, and Mission funded.

Africa has been identified as a priority region because of the consistent food deficits; most African countries are in desperate need of assistance in achieving stabilized crop production and increased productivity of basic food crops. For this reason much of the recommended research is oriented to the problems of African agriculture.

Linkages and organizational modes are suggested for each type of research and development project. Briefly described is an approach to ICP research and development as well as training components which should be included in each of the recommended projects.

Priority Integrated Crop Protection
Research Programs
Submitted by Purdue University International
Programs in Agriculture

Background

Pre-harvest pest losses of agricultural crops are estimated to be 25-40%, a totally unacceptable level in developing countries where serious food shortages are prevalent. These losses are caused by the attack or competition of noxious vertebrate and invertebrate animals, diseases, nematodes, and weeds. Losses are often more severe in the tropics and limit the range of crop plants that can be produced.

In the developing countries approximately 65% of the population is involved with traditional agricultural practices, i.e. small, family-operated, multiple-cropped farms. These are typically labor-intensive without significant capital inputs. Small farmers rely to a great extent on traditional practices for all phases of production including crop protection. Comparatively little modern technology is used for pest control in developing countries.

If crop production is to be expanded and stabilized, pest related production constraints will have to be reduced through the use of multiple control tactics. Multiple control tactics implies the use of cultural controls, resistant cultivars, biological controls, and the judicious use of pesticides in cost effective crop protection systems - i.e. Integrated Crop Protection (ICP).

Integrated Crop Protection (ICP), used here synonymously with integrated pest management (USA) and integrated pest control (Europe), is a holistic philosophy to the solution of key pest problems. Integrated crop protection research involves not only biological studies on specific pest species, but also studies concerning the various biological interactions resulting from altering an existing ecological system by controlling one or more pest species, whether by natural, cultural, biological, or chemical means. ICP is an economically and ecologically sound pest management system.

Because integrated crop protection relies on multiple tactics the resulting strategies which are developed through ICP research will be cost effective, and environmentally sound. Control of key pre-harvest pests will result in increased crop yield and stabilization of yields of food commodities. Reduction of external inputs to the minimum will encourage adoption of the technology across regions.

Integrated crop protection research offers the development of a viable, important crop protection strategy for developing countries. It is imperative that ICP research

be conducted in developing countries and supported by USAID funding participation at levels appropriate with current budgetary levels.

During the past eighteen months Purdue University International Programs in Agriculture has developed background documentation concerning the needs and feasibility for ICP research in developing countries. An identification of the most important geographic regions, priority countries of each region, key pest related production constraints, and potential collaborating countries and institutions has been developed. This documentation includes a State of the Art paper and field team reports. An assessment of the status and feasibility of ICP research and development in developing countries was prepared with the assistance of an advisory committee composed of scientists selected for their expertise in crop protection and social disciplines.

Countries in Africa, Latin America, Southeast Asia, and the Mideast regions have been evaluated on the basis of food deficits, GNP, and other criteria utilized by FAO, World Bank, and International Agricultural Development Service to delineate the development status of individual countries. A list of potential research sites has been developed and categorized according to the basic food cropping systems of the geographic area. The selected systems include, or could include, several crops in rotation or in intercropping that are economically or nutritionally important to the small farmer.

A number of alternative funding options are available to support this important crop protection research, e.g. central bureau funded, regional bureau, or mission funded. Each of the alternative options has intrinsic advantages with regard to the development of crop protection strategies.

Centrally funded ICP research programs will provide a breadth of crop protection information dealing with problems global in nature, some of which will be based on basic research as well as applied research.

For example, the development of resistant cultivars of food crops is ideally suited for crop protection, as well as bettering nutrition, and has been employed extensively throughout world agriculture for the control of pests and diseases. Integrated crop protection systems are based on pest and disease surveillance and the prediction of damaging population levels or disease incidence. In a given cropping system ICP research will develop key pest surveillance and prediction systems, as well as principles, which will be utilized for cropping systems where applicable in other parts of the world. Crop loss assessment is another research area which has commonality of application in the cropping systems of the world. Loss assessment is an integral part of the research and development for ICP and is required in determining proper implementation of control measures. Cultural controls

(environmental manipulation) such as plant spacing, timing, rotation, sanitation, species diversity, have all been utilized globally with success to control pests.

Integrated crop protection research dealing with key pests of major cropping systems of specific agroecological zones across national boundaries, such as sorghum-millet production in the semi-arid area of Africa or rice production in southeast Asia, are examples of regionally funded programs which will develop management strategies for crops characteristic of a region. Such programs will deal with a characteristic set of key pest problems of priority commodities.

Mission funded programs will address the specific problems extant in a developing country. Thus, key pest problems of important cropping systems are researched to provide a strategy which can be implemented at the local level. Implicit in these programs is concurrent development of outreach programs and technological demonstrations.

It is apparent that programs initiated at the country-mission level can be brought together and developed into a regional approach where feasible. In addition, research conducted at the local and regional level, e.g. pest and disease surveillance, etc. will have a wider application in global programs.

Such programs should be designed to alleviate the serious shortages of trained scientists in developing countries. The assistance of a group of U. S. scientists in a research program working with their counterparts provides training desperately needed by young and/or otherwise inexperienced scientists of developing countries. The programs will provide a cadre of well trained agricultural scientists and extension personnel with crop protection capabilities.

Priority ICP research projects suitable for alternative funding modes (centrally, regionally, or mission funded) are discussed below. These projects are based on cropping systems previously identified in the highly ranked grouping of developing countries. Linkages and suggested program organization are also included.

Priority Integrated Crop Protection Projects

Centrally Funded Projects

It is suggested that a centrally funded project concerned with ICP research be initiated as a three phased program and which should be maintained on a long term forward funding mode.

We recommend that initially an ICP research project be implemented on humid highland maize, followed by a sorghum-millet project in year three, and finally, by a program dealing with upland rainfed rice in year five. Such a phased program will allow for variation in funding levels appropriate to budgetary constraints. The phasing of programs may be adjusted accordingly.

Cropping systems, key pests, linkages, and suggested program organization are discussed below.

Cropping Systems - Year 1 - Maize - humid highland agroecological zones of Africa and Latin America. Typically, multicropped and with a variety of other commodities, sometimes intercropped, such as root crops, cereal legumes, etc. Complex farming systems based on annual rainfall. The program should be initiated in Africa and followed by Latin America in year two. Previously identified potential collaborating countries are Cameroon and Tanzania in Africa and Peru in Latin America. Other identified countries of Africa and Latin America with similar agroecological zones are to be considered.

Year 3 - Sorghum and millet - semi-arid tropical regions of Africa and South Asia. Less diverse multi-crop farming systems, in some cases rotated with cotton and vegetables, but typically cropped with grain legumes or groundnuts. Initiate program in Africa (Sahel) in year three and complement with a program in South Asia in year four. Previously identified potential collaborating countries are confined to the semi-arid areas of Africa, namely Sudan and Niger. Other countries of the Sahel and South Asia offer opportunities for similar research.

Year 5 - Highland rice - rainfed regions of Southeast Asia and Africa. Rotated with vegetable crops in Southeast Asia. Rainfed rice emphasized because of importance of the cereal plus the rotational crops and because more current research emphasis on paddy rice. Initiate program in S. E. Asia in year 5 and complement with program in Africa in year 6. Potential collaborating countries of Southeast Asia are Sri Lanka and Indonesia. No collaborating countries have been identified in Africa as of this writing.

Key Pests of each of these primary cropping systems are presented in the following table. No attempt is made to present the key pests of secondary crops of the multicrop system; these key pests have been documented in other reports. In the broadest concept, ICP includes all key pests in the agroecosystem. In its most restricted concept ICP may apply to a single major pest. Key pests, those which are perennial, usually cause significant damage in the absence of control.

Key Pests - Perennial problems, major production constraints, requiring immediate attention.

CROP	KEY PESTS		
	Insects	Diseases	Weeds
Maize	stalk borers, Busseola, Chilo sp., and Sesamia sp.; earworms, Heliothis sp.; armyworms, Spodoptera sp.; maize leafhopper, Cicadulina sp.	leaf diseases; Helminthosporium sp.; smuts and rusts; Meloidogyne sp., root knot nematodes, and Pratylenchus sp.; streak	Striga sp.; Echinochloa sp.; Cyperus sp.
Sorghum-millet	stemborers, Busseola and Sesamia; sorghum midge, Contarinia sorghicola; shootfly, Antherigona soccata	downy mildews, Sclerospora sp.; smuts, Sphacelotheca sp.; Meloidogyne sp., root knot nematodes	Striga sp.; Echinochloa sp.; Cyperus sp.
Rice (upland)	stemborers, Chilo sp., Sesamia sp.; leafhoppers, Nephotettix sp. as vectors brown planthopper, Nilaparvata lugens; rice bugs, Leptocorisa sp.; armyworms	Blast, Pyricularia oryzae; stem rot, Helminthosporium sp.; bacterial leaf blight, Xanthomonas oryzae; tungro, grassy stunt, and numerous other virus diseases; nematodes, Meloidogyne sp., and others	Striga sp.; Cyperus sp.; Echinochloa sp.; Eleusine sp.

Linkages - Ongoing USAID projects as well as those supported by other donors have been identified and which provide a logical linkage to the centrally funded program suggested here.

Firstly, the maize based cropping system ICP project may link with the following programs.

The National Cereals Research and Extension (NCRE) Program, USAID Cameroon; the Resources for Village Production and Income, USAID, Tanzania; and the Agricultural Research, Extension and Education Project, USAID, Peru.

Secondly, the sorghum-millet CRSP (Collaborative Research Support Program), INTSORMIL, the Niamey Department Development, Phase II project USAID, Niger and the Nigerien Agricultural Development Project provide linkages with research and development on the sorghum-millet based cropping systems.

Thirdly, the Regional Program on the Integrated Management of Insect Pests and Diseases of Rice in West Africa, WARDA, USAID and member countries is proposed and will offer a potential linkage on rice based cropping systems of Africa. In Southeast Asia the USAID, Indonesia Comprehensive Pest Management Project (proposed) presents a linkage with rice based systems in Asia.

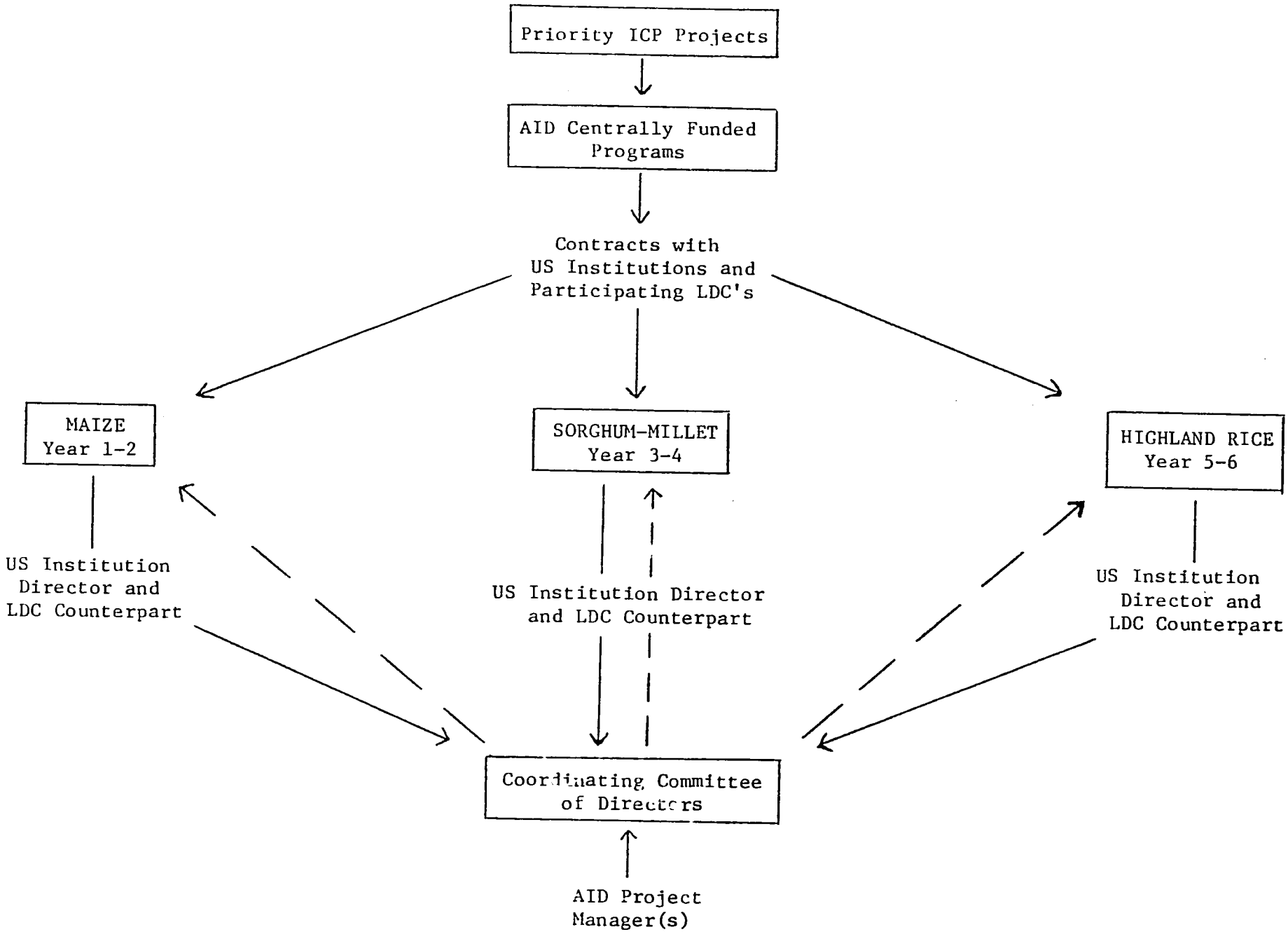
Lastly, the International Agricultural Research Centers (IARC's) were contacted by study teams and a number (IITA, ICRISAT, IRRI, CIAT and CIP) have indicated a willingness to collaborate in the event ICP research is funded in ecological areas encompassed by specific IARC research, development and education.

A more broad linkage between an ICP and other USAID sponsored projects will be beneficial, particularly with the Oregon State Weeds Control Systems Project, the North Carolina International Meloidogyne Project, and U. California Pest Management and Related Environmental Protection Project. The latter project will be a particularly beneficial linkage in the development of training and demonstration programs.

Program Organization - A suggested organizational plan is presented on the following page. It is suggested that the program be phased into activity, thus the high priority program in Africa will be commenced first, followed by the addition of the others at a later date, depending on available funds and the indicated success of the initial programs as judged by USAID. The intent in the design is to maintain a minimum of management personnel.

It is anticipated that the lead contract institutions will, in some cases, solicit subcontractors to fulfill the terms of the contracted research and development. It is recommended that subcontracting institutions do not have membership on the coordinating committee.

Design and implementation will be undertaken by the scientists of the lead U. S. institutions and their counterparts in the developing countries.


Priority ICP Projects
AID Centrally Funded Programs
Contracts with US Institutions and Participating LDC's
MAIZE Year 1-2
SORGHUM-MILLET Year 3-4
HIGHLAND RICE Year 5-6
US Institution Director and LDC Counterpart
US Institution Director and LDC Counterpart
US Institution Director and LDC Counterpart
Coordinating Committee of Directors
AID Project Manager(s)

Regionally Funded Project

Africa has been identified as a geographic region in desperate need of assistance in achieving stabilized crop production and increased yields of basic food crops. The maize-root crop system provides much of the basic food needs of many African countries. For these reasons we recommend a Regionally Funded research and development ICP project based on this cropping system.

This recommendation is not to be construed as overlooking the needs of the Sahelian countries and the pest and disease problems of the sorghum-millet groundnut cropping system. However, the research activities resulting from the CILLS-USAID Integrated Pest Management Program suggest that an ICP research and development project on the maize-root crop system is currently of higher priority than the initiation of a complementary ICP project in the Sahel.

The key pests and diseases of maize are indicated in the foregoing table and we consider the management of these major pests, through the development of programs which can be farmer implemented, as critical to the stabilization of basic food production. Such a research and development program should include regional workshops through which local agricultural technical personnel can be trained, and later present in outreach programs, the methods of ICP, e.g. pest and disease identification and surveillance, economic (damaging) pest densities or disease incidence, etc.

Because maize is grown extensively in Africa, an ICP research and development program can be initiated in a number of countries located within defined agroecological zones and we recommend that ICP programs be initiated in the upland-humid areas of West Africa.

In the earlier planning process we initiated dialogue with the scientists and the Ministry of Agriculture personnel in the Republic of Cameroon. Interest in assistance with ICP research and development was indicated during the May, 1980 study team visit. Guinea, Ivory Coast and Ghana are other West African countries considered for inclusion in a West African region project on maize based cropping systems. A similar ICP project of high priority can be designed for East Africa and warrants consideration. Tanzania is to be recommended for inclusion in such a program and other countries such as Kenya, Zaire and Zambia should be considered. English speaking East African countries obviously offer an advantage over francophile West African countries when considering the ease of communicating and implementing research and development projects.

Linkages - The NCRE USAID, Cameroon Project and the USAID Regional Food Crop Protection program are logical programs with which to link an ICP regional program. Other linkages, as indicated under centrally funded programs, should be made where applicable. The International Institute of Tropical Agriculture can be particularly helpful to the proposed project as a direct result of their ongoing programs concerned with maize and pests of that commodity.

Program Organization - A single U. S. lead institution should form the design and management entity for such a regional program. Subcontracts may be let to accomplish the proposed research and development.

Design and management should be undertaken jointly with the USAID, the lead institution and the counterparts in the developing countries.

Mission Funded Programs

A number of African countries offer potential for an ICP research and development effort and support of such should be considered by the Missions. Concentrating research efforts on basic food crops in the multicrop farm system coupled with the development of a cadre of technical and scientific personnel through training programs and on-the-job training with U. S. counterparts will assist host governments in overcoming food deficits and the development of stable production systems.

As in the case of the recommended regional project, maize is considered a priority basic food crop. However, in dealing with Mission funded programs other basic food crops of Africa should be considered, i.e. sorghum, millet, rice, and grain legumes. The intercropped food crops will be considered as an inherent part of the farming system.

Visits by study teams during 1980 indicated a number of potential collaborating host governments. Cameroon has also been mentioned above in considering a regional maize based program, Tanzania offers a similar opportunity in considering maize, Sudan presents the possibility to develop ICP technology in a sorghum-millet - cotton or groundnut system, and because of ongoing USAID programs in Niger, it is suggested that serious consideration be given to support of an ICP program in that country. Research on the upland rainfed rice rotation system in Liberia and other African countries is worthy of support since most research and development efforts on rice are directed toward the paddy rice production systems.

In other geographic regions the rainfed maize based multicropping systems of upland Peru is recommended for the development of ICP technologies on basic food crops of Latin America. The rainfed upland rice rotation system presents the opportunity to conduct ICP research on this system in Africa. Results of such a program in Africa can be used to advantage in devising management systems in South-east Asia.

Linkages - The projects which were addressed above as potential linkages with the centrally funded ICP programs may serve in the same capacity, where applicable, in Mission funded programs, e.g. if sorghum-millet program is funded, link with CILLS - USAID Pest Management project on pest constraints associated with sorghum-millet production.

Program Organization - Single U. S. lead institution collaborating with counter-parts in developing countries, and USAID, in the research design and implementation, as well as outreach programs, for the designated cropping system(s).

Training and Development of Technical Personnel

Only a small part of the global research and development budget is shared by developing countries, and only a few of the world's agricultural scientists reside in developing countries. These countries have been overly dependent upon imported, and often inappropriate technology. Only through the development of educational programs to provide trained research personnel will the numbers of crop protection specialists be significantly increased in developing countries. As a result of graduate training (MS and Ph.D. programs) the developing countries will increase their crop protection response capabilities.

It is recommended that ICP research and development assistance projects, irrespective of funding mode, incorporate a strong academic training component. It is stressed that graduate research should be undertaken in the agroecological zone in which the potential scientist will be working. Academic training can be obtained in U. S. institutions and the degree candidate can return to his native country to conduct research studies under the direction of a major professor in country or in the collaborating U. S. institution. In the latter case the professor would be required to make periodic visits to the research site to discuss design and implementation of the research.

The IARC's have indicated a willingness to be involved with ICP graduate training programs and such linkage should be explored.

In addition, the assistance of a group of U. S. scientists in ICP research programs will provide practical experience for young and/or otherwise inexperienced scientists in developing countries.

The ultimate goal of such educational programs is to elevate the capabilities of the developing countries to provide their own training on a self-perpetuating basis.

Outreach Capabilities - Most of the countries visited by the study teams needed additional trained technical personnel (BS or near equivalent). The recommended ICP projects should include a provision for training additional personnel to visit with the various programs involved in crop protection, including extension. This is particularly important in developing adequate pest/disease surveillance and prediction networks, and loss assessment programs. Workshops, short courses, and seminars should be taught, insofar as possible, by local scientists from appropriate universities, institutes and ministries, augmented when necessary by short term U. S. consultants.

USAID training programs such as the Regional Food Crop Protection Program in West Africa or the UC/AID Pest Management and Related Environmental Protection project can be linked to the ICP programs to provide assistance in training.

Approach to Implementation of Integrated Crop Protection Research and Development

As defined, integrated crop protection research is approached much in the same manner as farming systems research - the approach is "holistic" - therefore an all inclusive analysis of the system. ICP research and development programs emphasize the technical elements of the farming system. At the same time a serious consideration is given to the influences, as well as the reciprocal effects, of the technical research on the human element.

A means by which the individual problems, both technical and human, of the complex multicrop farming system may be best addressed is required to provide a working framework for ICP research and development. The scheme employed in FSR and which is similar to that suggested by some crop protection specialists for integrated crop protection research, involves a framework of four stages which delineate the research. They are as follows:

(1) The descriptive or diagnostic stage. In this initial stage the actual farming system is examined in the context of "total" environment as a means of identifying constraints faced by the farmer. Also considered is the flexibility of the system with regard to timing of planting, available resources, etc. An effort is made to understand the goals and motivations of farmers insofar as they may influence their efforts to improve the farming system.

(2) The design stage in which a range of tactics (cultural and biological controls, resistant cultivars, pesticides) are identified as relevant to deal with the constraints delineated in the descriptive stage.

(3) The testing stage in which a small number of promising tactics identified in the design stage are evaluated under farm conditions to determine their feasibility for inclusion in the development of an effective strategy which is suitable in the existing farm system. This stage should be a two stage process: initial trials with joint participation of the farm and researchers and secondly, the farmer's testing totally under his control.

(4) The extension stage in which the strategies which have been identified through the design and testing stages are implemented.

It is recommended that this scheme be utilized in the design of research and development projects dealing with integrated crop protection.

In practice it is expected that overlap between stages will exist and that no clear boundaries exist between stages. Design studies for example may overlap with descriptive stages and they may also extend into the testing stages.

The described approach incorporates the farming family directly into the design and testing process and views the farmers as individuals as well as members of the community and society. It also recognizes the farmer as an integral part of the research and it provides a means by which multidisciplinary research teams can examine problems of the small farming system including the interrelationships between resources and enterprises.

Integrated crop protection research and development programs fill a niche not currently occupied by ongoing development projects, many of which deal only with reductionist approaches. ICP therefore offers an unique opportunity to research a severe agricultural problem through a farming systems approach and which will result in the development of technologies useful to the small farmers of developing countries. ICP research and development necessitates the collaborative and interdisciplinary efforts to satisfactorily study the multiple technical and human factors involved in the management of pest problems extant in the developing countries or other agroecosystems.

Integrated crop protection research and development programs such as those recommended here are not being conducted effectively in ongoing programs.