FOOD AND AGRICULTURE ORGANIZATION
OF THE UNITED NATIONS

UNITED NATIONS
ENVIRONMENT PROGRAMME

EST MANAGEMENT SYSTEMS FOR THE CONTROL OF PESTS OF COTTON

Report on an FAO/UNEP consultation
held in Karachi, Pakistan, 13-16 October 1975

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Consultation on Pest Management Systems
for the Control of Pests of Cotton

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with

the Food and Agriculture Organization of the United Nations
as a cooperating agency.

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Summary and Conclusions

The proposals adopted by the Consultation can be summarised as follows:

a) To establish at the earliest possible date three Regional Programmes on the Development and Application of Integrated Pest Control in Cotton Growing. Emphasis in these programmes should be placed on demonstration, training and research. They should be located in 1) Northeast Africa with links to other African countries, 2) the Near East with links to Middle and Far East countries, and 3) Latin America;

b) To provide in each Regional Programme a Regional Programme Coordinator, a Liaison/Training Officer and sufficient experts on specific elements of integrated pest control to form a viable cadre;

c) To establish Regional Steering Committees, comprising delegates from the participating countries who will be directly associated with the programme planning;

d) To seek the continuous guidance of the FAO Panel of Experts on Integrated Pest Control to advise on activities undertaken and to help avoid duplication of effort;

e) To request that UNEP and FAO give the broadest possible support for the implementation of the proposed Regional Programmes and that widespread publicity be given to the actions undertaken within the programmes.

1. INTRODUCTION

At its Second Session, the Governing Council of the United Nations Environment Programme recommended to the Executive Director that "Urgent steps should be taken, in cooperation with FAO, towards the development of environmentally sound pest management which would include the collection and dissemination among developing countries of existing knowledge concerning the control of pests by non-chemical methods; programmes undertaken by groups of countries to initiate pilot projects to test new methods and provide training on their application should be encouraged."

This FAO/UNEP Consultation on Pest Management Systems for the Control of Pests of Cotton (hereafter referred to as the Consultation) is the direct outcome of this request. Its objectives are as follows:

- to design a multinational programme on environmentally sound pest management systems for the control of pests of cotton, linking on-going activities of various national, international and non-governmental institutions and agencies;
- to assemble and disseminate among developing countries the existing knowledge concerning the ecologically oriented control of these pests, especially by non-pesticidal methods;
- to propose to governments and institutions a cooperative multinational programme and make specific arrangements for the coordination and implementation of this programme;
- to identify pilot projects on new pest management systems to be undertaken by a country or group of countries for coordinated research activities and to test new methods of pest control training and application.

The Consultation was opened by His Excellency Malik Khuda Baksh Bucha, Special Assistant to the Prime Minister for Agriculture, who welcomed the participants. In his opening address, His Excellency stressed the importance of cotton in the economy of Pakistan and drew attention to the severe losses caused by pests. The over-reliance on pesticides to cope with these pests has caused serious setbacks, such as the development of pesticide resistance and the resurgence of new pests. Therefore the Pakistan Government strongly favours efforts leading to the application of integrated pest control principles, and research in this area is already being pursued in a coordinated effort. His Excellency expressed his sincere appreciation to the Director-General of FAO and to the Executive Director of UNEP, who took the steps to hold this important Consultation in Pakistan, and he hoped that it would prove a turning point towards the application of pest management systems in agriculture.

Dr. A. Warren, representing Dr. Horst B.K. Geuting, Senior Agricultural Adviser and FAO Country Representative in Pakistan, welcomed the participants on behalf of the Director-General of FAO and on behalf of the Executive Director of UNEP. He stressed the various inputs needed to successfully organise such a consultation and expressed his sincere thanks to the Government of Pakistan for hosting the meeting and for providing the delegates with the necessary facilities. He especially thanked those directly involved with the details of the organization of the meeting. Dr. Warren emphasised FAO's interest in the development and application of integrated pest control, an interest which has been further stimulated by collaboration with UNEP in the development and implementation of the FAO/UNEP Cooperative Global Programme on Integrated Pest Control.

The FAO/UNEP Global Programme Coordinator on Integrated Pest Control, Dr. L. Brader, explained FAO's involvement in pest management systems by giving a brief history of the activities of the FAO Panel of Experts on Integrated Pest Control and describing the way in which the Cooperative Global Programme came into being. He proposed to the delegates a Draft Project Proposal for Regional Programmes for the Development and Application of Integrated Pest Control in Cotton Growing.

The UNEP Programme Officer, Dr. J. Hurtubia gave a statement of UNEP's involvement in the Consultation and expressed UNEP's interest. On behalf of UNEP, he thanked all those who had made it possible to organise the Consultation. He reminded the participants of an informal

meeting which was held during the second session of UNEP's Governing Council (March 1974), which considered in detail the contents of a UNEP programme for the formulation of non-chemical methods of pest control. Dr. Hurtubia recalled the environmental hazards caused by pesticides employed for the control of cotton pests and urged for action to develop non-chemical methods. As part of a short-term strategy, UNEP is cooperating in efforts to improve present methods of integrated pest control combining biological and chemical controls; but, following a long-term strategy, it is developing and stimulating the creation of a multinational programme on environmentally sound pest management systems for cotton which concentrates on non-chemical methods of control. UNEP is not a financing agency; however, it collaborates closely with the Environment Fund, which plays the same catalytic role in developing ideas and programmes with its limited resources as the UNEP Secretariat. UNEP considers it feasible that for each of these strategies a set of priorities for action can be identified. Dr. Hurtubia noted that the Consultation must formulate a framework of reference for a programme of specific activities which will lead to the attainment of the objectives. In the future, the results of both approaches will join forces to lead to the creation of better pest control methods which will not seriously affect the environment and which will ensure regular and sustained production of cotton with full economic advantage.

The programme of the Consultation provided for a series of short introductory reviews of different aspects of integrated pest control; these were completed by detailed discussions on recent developments in the participating countries. The topics discussed were the following:

- Contribution of Integrated Pest Control to Cotton Production, R.F. Smith;
- Host Plant Resistance, H.D. Thurston;
- Parasites and Predators, V. Delucchi;
- Entomopathogens, L.A. Falcon;
- Habitat Manipulation, A. Khalifa;
- Behaviour Modifying Chemicals, D.G. Campion;
- Present and Future Role of Conventional Pesticides, R. Delattre;
- Environmental Consequences of Cotton Pest Control Practices, El Sayed El Bashir;
- Training Needs for Development and Implementation of Integrated Pest Control Systems, R.F. Smith;
- Role of FAO/UNEP Cooperative Global Programme, L. Brader;
- Role of Regional Programmes, M. Way;
- Role of National Programmes, M. Vaughan;
- Information Systems for Alternative Control Methods, C.H. Huffaker.

The specialists of the various cotton producing countries had brought to the Consultation detailed country reports on the technical aspects of cotton production, particularly the currently used pest control practices. These country reports served as valuable information sources for the three Committees set up to study and prepare detailed project proposals during the Consultation. The Committees covered, respectively, the African Region, the Asian Region and the Latin American Region.

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3. SUMMARY OF INTRODUCTORY REVIEWS AND DISCUSSIONS

RAPPORTEURS: El Sayed El Bashir
H.T. Reynolds

Contribution of Integrated Pest Control to Cotton Production (R.F. Smith, USA)

This paper traced the history of pest control in cotton production over the last quarter century, noting that this short history is filled with examples of escalating pesticide use. Such escalation has often reached the point where the pest control system deteriorated completely and it was no longer profitable to grow cotton. Examples of failures in several areas of the world were given, the first occurring as early as 1950 in Peru. The reasons for such failures are complex but invariably include the development of pesticide resistance and destruction of the beneficial insect fauna.

It was noted that cotton utilises more pesticides on a global basis than all other crops combined. As a result, failures in cotton plant protection occurred more rapidly and in more areas than for other crops, and thus led cotton researchers to provide leadership world-wide in the integrated insect control concept. Integrated control has rescued cotton production from disaster in several places. Yet it is recognised that the potential for integrated control has been little realised. It is apparent that integrated insect control is relevant to cotton production, and its rapid development is imperative.

Host Plant Resistance to Cotton Insects (Paper prepared by F.G. Maxwell and P.L. Adkisson (USA), and presented by H.D. Thurston, USA)

Once developed, no other single method of pest control is more ecologically sound, so inexpensive, so easy to use and less hazardous than host plant resistance, but breeding programmes are often long and expensive and not always successful, so expectations should be realistic. Research on cotton has accelerated in recent years, but support for breeding programmes is still far from adequate. It was noted that any genetic change in a cotton plant has the potential to cause changes in pest populations of insects, plant pathogens, or even weeds. Such changes may be desirable in the control of some pests, but hinder that of others.

A wide range of resistant factors and the reactions of the more important cotton pests in the United States to these factors was described. Factors currently under investigation include frego bract, glabrous (smoothleaf), nectariless, high gossypol, glandless (low gossypol), okra and super okra leaf, red color and short season cotton. Some unidentified resistant mechanisms were also noted. Each of these has some potential against one or more pest species, and research to combine two or more resistance mechanisms is progressing. It was noted that only now is United States cotton production about to benefit from research started approximately 10 years ago. Prognosis for certain successes is now excellent, and, hopefully, resistant varieties will be a fundamental part of the integrated insect control programmes of tomorrow.

In a lengthy discussion delegates from many countries described progress and problems encountered with host plant resistance. In general, it was apparent that cotton breeding for host plant resistance has been neglected. Hirsute varieties were developed many years ago for resistance to leafhoppers, the smooth-leaf varieties being very susceptible to their attack. In the Sudan, however, these varieties were more susceptible to whitefly, and resulted in population increases of this pest. High gossypol varieties did not seem successful in reducing Spodoptera attack in Pakistan. Several delegates indicated strong interest in the potential value of short-season varieties. Nicaragua has varieties resistant to a virus disease transmitted by the whitefly. It was emphasised that cotton breeders, in developing new varieties for lint quality and quantity, should not lose existing pest resistance. Often new varieties require more insecticides than varieties traditionally grown. The development of host plant resistance is complex, as developing resistance to one pest often permits a higher degree of damage by another. The delegates agreed that host plant resistance development should be accelerated, but noted that pest problems in different regions vary sufficiently to require resistant variety development for pest problems unique to each region.

Parasites and Predators
(V. Delucchi, Switzerland)

This well-documented paper identified many species of parasites and predators important to insect pest population regulation in cotton production areas throughout the world. The following is the concluding section of this paper.

It appears from this literature survey that parasitism and predation of some pests - as for instance Anthonomus, Pectinophora, Spodoptera, Lygus - remain very inadequate. These are so-called primary or key pests which have to be maintained within tolerable limits by the use of other methods of control, including cultural practices. The natural enemy complex of secondary pests - as for instance of Heliothis - often seems to be sufficient in the absence of extreme ecological disturbances. To preserve natural enemies, the use of pesticides has to be minimised and applications timed in such a way as to cause minimum disruption of the ecosystem. An important practical goal of cotton protection programmes is therefore the preservation of existing natural enemies.

Key pest populations have been reduced to a tolerable level following the introduction of effective natural enemies from other regions. This has been demonstrated for the sugarcane stem borer Diatraea saccharalis F. (establishment in Central America of a parasitoid obtained from Chilo in India). Several species of parasitoids have been introduced from India into other countries, especially the U.S.A.. The list of these species includes Hymenoptera as well as Tachinidae. There are other areas which might be explored and reveal the existence of interesting species. A second practical goal of cotton protection programmes should therefore be to include the introduction of beneficial arthropods into areas where the natural enemy complex is insufficiently effective.

Sometimes it is possible to increase the impact of naturally occurring parasitoids and predators by inundative releases of laboratory-reared individuals in critical periods of the season. To do this, it is necessary to develop mass-rearing techniques which are cheap and easy to use. To date, considerable progress has been made in the mass production of Trichogramma and Chrysopa which can now be used to supplement the action of existing parasitoids and predators. Mass-culture techniques should be developed for other beneficial species. A third practical goal of cotton protection programmes should therefore be the establishment of mass production units of natural enemies.

Today there is sufficient background knowledge to achieve these goals, at least in relation to certain pest species. More research is needed to apply biological control techniques against the other pests and to understand the regulatory mechanisms between natural enemies and their hosts.

In a long discussion it was noted that repeated inundative releases may be necessary for success. But at present, the high cost of inundative releases could not compete with insecticide application costs, and thus further studies to reduce costs are necessary (e.g., on use of artificial media in rearing, on release techniques, etc.). Varied results with inundative releases were reported from Nicaragua and further studies of the ecosystem were said to be needed; for example, to determine why certain parasites and predators decline during critical periods. It was stated that the practicality of inundative releases varies widely in different countries, with successful use in the People's Republic of China and the U.S.S.R. In China, successful Trichogramma release is said to be about half as costly as pesticide use. Trichogramma was said to be a relatively inefficient egg parasite and other species may be more appropriate. Trichogramma use could be a "fad" and in many situations in cotton, predators are more efficient than parasitoids. Several delegates commented on the destruction of beneficial species by insecticides and noted the need for selectivity or selective use of insecticides. Thus in Egypt a reduction in parasitism from 75% to 2 - 5% has been noted following the use of organic insecticides.

RAPPORTEURS: M.J. Way
A.S.K. Ghouri

Status and potential of entomopathogens in pest management systems for cotton
(L.A. Falcon, USA)

The history of entomopathogens was traced back to the development of Bacillus popilliae nearly forty years ago. B. thuringiensis (BT) is a dynamic insect pathogen with new strains continuously being developed. In the USA it is now recommended for use against a wide range of lepidopterous larvae, including Trichoplusia ni on cotton. In the last ten years, research has focused on selected baculoviruses including a nuclear polyhedrosis virus (NPV) tested in detail against Heliothis zea on cotton. A commercial product containing Heliothis NPV was registered in 1975 under the name Elcar®. As for insect viruses other than baculoviruses, fungi, and protozoa, little research is being done and none are close to development as microbial insecticides.

Although applied entomopathogens have demonstrated long-term control in some situations, in practice, most hope comes from their use as microbial insecticides. Their potential value lies in their selective action against certain pest insects and harmlessness to natural enemies. However, because microbial insecticides cannot be patented like chemical insecticides, industry is not motivated to develop them. Also, because viruses in general are associated with many human diseases, the safety testing requirements for the arthropod-specific baculoviruses are complicated and expensive. It was suggested that international support and also more government funds should be provided to support studies on baculoviruses in order to permit their development. Their value in developing countries was referred to - namely freedom from patent restraints and also relative simplicity of production which, although labour intensive, is feasible for many developing countries. Application problems were also discussed - with micro-droplet ULV techniques and auto-dissemination methods showing much promise.

In the discussion, reference was made to work done on nuclear polyhedrosis viruses of Spodoptera spp. in Britain, Egypt, and East Africa. The need to survey different regions for naturally occurring insect viruses which could then be artificially or naturally produced was highlighted. However, dangers of using insect pathogens too casually were stressed. The importance of examining strains of viruses, as has been done for BT, was referred to by several speakers and possibilities for synergistic action between chemical insecticides and microbial pesticides were discussed. In the context of work on cotton pest control, UNEP's role was indicated as encouraging and supportive of research on the development and use of insect pathogens.

The role of habitat management in control of cotton pests
(A. Khalifa, Egypt)

This method of control was discussed with particular reference to Egypt. The changes created by the construction of the High Dam were described as examples of how changing the habitat can greatly increase pest problems, notably from Spodoptera and weeds. New techniques of irrigation have also made it difficult to maintain efficiency of some of the traditional control measures such as egg picking for Spodoptera control. As examples of how the habitat could be managed to minimise pest problems in cotton, the value of simultaneous sowing of the crop over large areas and of using large blocks of cotton rather than small fields was stressed. Cultivation, irrigation and plant hygiene practices were described which show that serious pest problems can be virtually eliminated by appropriate cultural practices. It was strongly emphasised that cultural controls are the core of integrated control practices and should be given far more attention in the future since they are often fundamental to the success of other methods of control such as control by natural enemies.

In the discussion it was pointed out that cultural controls are sometimes difficult to initiate and enforce. This viewpoint was, however, countered by several speakers who emphasised that, in developing country conditions, cultural controls were relatively cheap and that cotton farmers must often rely on them for success, for example against pink bollworm, which is inadequately controlled by any other means. The need to foresee changes in cultural practices which might make pest problems worse was emphasised and the basic role of habitat management as being fundamental to integrated control was strongly supported. Further examples were given of officially recommended practices, sometimes backed by legislation, which indicated, for example, how planning of crop cycles maximises parasite and predator action and how controlling irrigation practices can minimise carriers of pests from one crop to another. Dr. Khalifa, in summarising the discussion, pointed to a major difficulty in convincing farmers of the value of habitat management, namely, that it did not provide dramatic evidence of success as obtained with chemical pesticides. Thus it was usually difficult to explain or show that a method of control which prevented pests from occurring was better than one where a fire brigade action was taken against an obvious pest outbreak. The need for appropriate understanding of the agro-ecosystem, of other ecosystems where the pests occurred, and of pest ecology is probably more important for pest control by habitat management than by any other method.

The status and potential of behaviour modifying chemicals in pest management systems for Cotton (D.G. Campion, U.K.)

The speaker reviewed highlights in research on the use of pheromones throughout the world. There are at present three main uses: for studying distribution of pests, for monitoring of pests and for direct control. In distribution studies, pheromones have the advantage of high specificity and low operational costs compared with other methods such as use of light traps. Pest monitoring by pheromones is proving increasingly useful in aiding the pest management specialist or farmer to judge if and when he should apply control measures.

As a means of control, pheromones are highly specific and create no known environmental problems. Methods of control that have been studied include mass trapping of males with female sex pheromones, use of pheromone traps baited with a disease which males then transmit during copulation, and use of the confusion principle whereby the male cannot locate the female if the environment is permeated with artificial sex pheromone. In experimental work, most emphasis has been placed on the last method, producing encouraging results that need to be further tested, however, before they could be considered for use in practice. Particular reference was made to the pheromone work on boll weevil and pink bollworm control in the USA, on control of Spodoptera in Cyprus and of the red bollworm, Diparopsis castanea, in Malawi - all in relation to cotton.

In the discussion the need for more research on methods of application of pheromones was emphasised. The recent discovery of a sex pheromone in Heliothis armigera and of a mating inhibitor in Diparopsis were reported. Several delegates strongly supported the need to strengthen research on all aspects of the use of bahaviour modifying chemicals in relation to cotton pest control, such as their specificity and apparent freedom from environmental hazards.

Dr. Campion warned, however, that the use of behaviour modifying chemicals as a control measure, rather than for monitoring, was still a long way from practical application.

RAPPORTEURS: V. Delucchi
M.F. Pacheco

The development of chemical control of cotton pests in the African countries of the Francophone zone
(R. Delattre, France)

Chemical control of cotton pests in West and Central African countries is less intensive than in most other parts of the world. In the dry areas of the West African countries the response of the cotton yield to an increase of chemical applications has in general been very good, whereas in most of the humid areas, the response has been less evident (probably because of the increased incidence of bollrot, not under the control of insecticides). DDT has been used everywhere, either alone or in combination with other insecticides. The organochlorides used in Africa are endosulfan, camphechlor and endrin. The use of organophosphates, mainly methylparathion and monocrotophos, is increasing; these are generally combined with DDT. Carbamates are not used due to the fact that they are available only as wettable powders and that their cost is high, although their effectiveness has been proven against Earias and Diparopsis. It was estimated that an input of 8000 Francs.CFA per ha in the form of fertilisers and pesticides results in an increase of seed cotton production for a value of 24,000 F.CFA. It can therefore be concluded that from the economic point of view, chemical control in this type of situation is profitable. Insecticide resistance has been noted in some cases, particularly in Earias, Aphis, and Cosmophila. But this has not so far led to a crisis situation where cotton production has been permanently endangered.

The chemical control of cotton pests in West and Central Africa is in need of an efficient forecasting system. The basic scientific elements for this are mostly available, but a well-organised infrastructure and qualified manpower are needed. Currently, insecticides are applied mostly according to a pre-fixed schedule based on the growing pattern of the cotton plant and the general occurrence of the predominant pest species. Alternative control methods being studied in various countries include the release of parasites such as Trichogramma species and Tachinidae, and the use of entomopathogens, particularly insect viruses. However, these bio-control elements are not yet used on a large scale basis in practice. Recently, attention is being given to the impact on the non-target environment of chemicals used in cotton fields. This may lead to the replacement of DDT and other organochlorides by other compounds such as pyrethroids.

In the discussion, the necessity of utilising less persistent pesticides was stressed - through replacing the more dangerous organochlorides by organophosphates, and applying them in a more selective way. It was however stressed that certain organophosphates are more hazardous to the applicator due to their higher mammalian toxicity. The need for selective pesticides was considered; the high production costs compared to a relatively small market were noted as the main factor delaying their development. Support from outside industry might be needed to assist in the development of these pesticides and some delegates believed that UNEP should play a part in this.

In Central and West African cotton growing, the introduction of integrated pest control programmes should not be seen as a means of immediately reducing the current rather limited use of pesticides. But in the near future, integrated control might help in limiting to a strict minimum its further extension and in promoting the application of pesticides less detrimental to the environment. The final reduction of pesticide requirements will of course depend on the development of alternative control methods and their subsequent application at the farmer level. It was thus stated again during the discussion that the successful implementation of an integrated control programme will in the long run lend to the replacement of conventional chemical control techniques by more selective ones.

Environmental consequences of cotton pest control practices
(El Sayed El Bashir, Sudan)

The availability, simplicity of use and relative efficiency of chemical pesticides have led to their excessive application against cotton pests. Over-reliance on pesticides has induced new pests and pesticide resistance and has created pollution problems affecting water, the soil and the atmosphere.

The pollution of water is a serious problem in many cotton growing areas. To decrease the level of water pollution in the Sudan, direct application of insecticides over major irrigation canals as well as direct pumping of canal water into the spray mixing tanks have been prohibited, and this has led to substantial improvement. However, it must be realised that little can be done to prevent the continuous flow of insecticides into the rivers which constitute natural drains for most cotton fields.

Soil is probably the most highly polluted part of the cotton environment. It has been calculated that only about 5% of the dose of chemical applied against cotton pests actually reaches the plant; a great deal of the remainder goes into the soil, disrupts soil fauna and contaminates food crops following cotton in the rotation. Due consideration should therefore be given to this problem.

In several cotton producing countries aerial spraying of insecticides is the main technique of control. Spray drift is unavoidable. Chemical pesticides are often transported over long distances. Excessive drift should be prevented and application of pesticides reduced to the minimum.

There is no disagreement about the need to improve cotton production in order to prevent damage to the environment from misuse and misapplication of pesticides, but the use of toxic chemicals for pest control will unfortunately continue until a substitute is found for them; in the meantime, major modification of our present-day concepts will have to be seriously considered. Sufficient thought must be given to the improvement of the existing methods of pesticide application as well as to the development of better and "safer" chemicals. The fact that more than 90% of the dose applied in the field actually misses its target and goes where it is not needed can hardly be tolerated in a world of limited resources in which pollution problems are rapidly mounting. In planning future pest control strategies, a careful evaluation of means which allow the establishment of a balanced ecological system must be immediately implemented. Such a search should be pursued in all countries with the necessary support and confidence in its ultimate results. It should be augmented by the use of cotton varieties resistant to pest injury and all possible means that help decrease over-reliance on pesticides.

Training needs for development and implementation of integrated pest control systems
(R.F. Smith, USA)

The FAO/UNEP Cooperative Global Programme for the Development and Application of Integrated Pest Control in Agriculture as developed just a year ago in Rome incorporated training for all levels of personnel participating in the programme. As envisioned at that time, the Global Programme was designed around a number of regional projects, emphasising cooperation by a group of countries with similar pest problems.

Whatever the precise and detailed final form of the Regional Projects, they should include a significant training component. This will be necessary in order to familiarise all involved with the programmes, i.e., the researchers, technicians, extension workers, administrators, etc., with the overall development and functioning of an integrated pest control programme and to develop genuine understanding and ability to transfer their experience and knowledge to the farmer. The precise form of a training component in each Regional Programme will o course have to be modified to fit the particular needs of that Region and its Programme.

The Global Programme document suggests a variety of potential training activities, as for instance:

1) In-service training in the field: this form of training is the only way to obtain a real feeling for the integrated pest control approach. The duration of "in-service training" should be at least two years for research workers and may be somewhat less for extension workers.

2) Short courses: these would be designed for research scientists, extension advisers, and technicians and would provide background on special techniques such as sampling procedures, host plant resistance, use of natural enemies, design of cultural control, pesticide application, system analysis and modeling, etc. These would be intensive courses of perhaps one to six weeks with a large element of practical work and would be given by relevant experts in an appropriate centre in the region.

3) Short courses for extension workers: these short courses would be essentially practical courses, dealing with sampling procedures, scouting tactics, diagnosis, decision-making in the fields, etc. They could be given in a centre of the Region, but it may be more desirable to give them independently in the individual countries in relation to local problems and practices.

4) Workshops and seminars: these would provide an updating on new concepts and techniques for participants in the Regional Programme, but they would also play a coordinating role for the workers in the different countries. These might last from one to three weeks and probably would be needed each year. The site should be rotated among the several countries of the region.

There may be other training needs not listed by the outline presented above. One of the great gaps in the development of almost all training activities is the lack of a clear understanding of the true need or demand for the intended training. There is no point in training students for whom there is no place in the system.

In the discussion, several delegates expressed the need for training in integrated pest control, particularly in order to create a better liaison between researchers and extension workers. It was emphasised that appropriate education on integrated pest control should also be given to administrative "decision-makers" responsible for overall integrated control work.

RAPPORTEURS: P.T. Haskell
O.S. Bindra

Implementation of Multinational and National Programmes

The FAO/UNEP Global Programme Coordinator (L. Brader) outlined the background of the multinational programme approach, emphasising that it was basically designed to strengthen or initiate national programmes of integrated pest control. He pointed out that the regional programme concept was designed to assist national efforts by joint attack on common problems and exchange of information, thus making best use of scarce manpower. The need for the Consultation to produce definite proposals for the Regional Programmes was emphasised, since without them no approach to funding agencies could be made.

In his paper on the Role of the Regional Programmes, M.J. Way outlined basic requirements and discussed some constraints, such as shortage of expert manpower, lack of institutional facilities and scarcity of funds, which hinder the implementation of such programmes in developing countries. This situation could be improved by cooperation and coordination of country efforts in a Regional Programme comprising research, development and training components. After giving details of the proposed regional programme structure, he suggested that the Consultation consider the desirability, siting, design, staffing and priorities of such programmes.

In his paper on the Role of National Programmes, M. Vaughan described the approach in Nicaragua, where a deteriorating situation in cotton pest control had been ameliorated by adoption of an integrated control approach suggested by the FAO Panel of Experts.

In the ensuing discussion, the successful implementation of the integrated control approach in several Latin American countries was described and it was suggested that, with some modifications to suit local conditions, it could be applied anywhere in the world where cotton was grown.

It was emphasised that UNEP expected the Consultation to develop definite proposals for Regional Programmes. Asked about possible sources of support funds, Dr. Hurtubia replied that the role of the Environment Fund of UNEP is to act as a catalyst in this field and that it could not alone support Regional Programmes, its primary interest being to support critical components of environmental interest.

In discussions on the applicability of the approach, it was pointed out that in Africa less pesticides were used than in Latin America and that many developing countries would be unable to use pesticides on cotton to such an extent.

Pakistan's plans and constraints to the development of integrated control were outlined, with emphasis on the need for outside support. The example of Colombia, where, backed by legislation but without outside help there had been promising results, was also cited.

Information systems for alternative methods of pest control
(C.B. Huffaker, USA)

This paper summarised a report on information systems for integrated pest control work. Consultation delegates agreed that it was an important topic and that present services were inadequate. As the development of a global information system is a UNEP interest, the Consultation was asked to consider how it might be brought about. Various delegates spoke in support of the general proposal and made it clear that lack of information exchange was hindering the development of national programmes.

4. REGIONAL PROGRAMMES FOR THE DEVELOPMENT AND APPLICATION OF INTEGRATED PEST CONTROL IN COTTON GROWING

Background Document: FAO/UNEP Report on an *ad hoc* session of the FAO Panel of Experts on Integrated Pest Control, held in Rome, 15-25 October, 1974. "Formulation of a Cooperative Global Programme on the Development and Application of Integrated Pest Control in Agriculture".

Technical Information: "Guidelines for Integrated Control of Cotton Pests", FAO, Rome 1973, 92 pp.

4.1 Background

These proposed Regional Programmes are designed as a follow-up to the FAO/UNEP Project FP/0108-74-04 (780) entitled: "Initiation and Coordination of a UNEP/FAO Cooperative Global Programme for the development and application of integrated pest control in agriculture", of which the objectives are:

a) to start the UNEP/FAO Cooperative Global Programme for the development and application of integrated pest control in agriculture, by preparing programme proposals and negotiating with interested countries and potential donors;

b) to enlist governments and institutions of developing countries to participate in and derive benefits from regional research and training programmes on the protection of economically important crops such as cotton, rice, maize, sorghum, millet;

c) to coordinate proposed programmes with other on-going and future field projects in integrated plant pest control supported by multilateral and bilateral agencies;

d) to manage and coordinate the Cooperative Global Programme.

The above-mentioned project has provided funds for an initial two-year appointment of the Global Programme Coordinator and for the necessary secretarial, administrative and travelling expenses.

The information given in the background document clearly stressed the need for development and application of integrated pest control in cotton growing. Cotton, which is grown on more than 32 million hectares throughout the world, is the predominant world textile and it is likely to become increasingly important as a result of increasing costs in the production of synthetic fibres, which are heavily fossil fuel dependent. Cotton seed is also a valuable foodstuff, annually providing over 16 million and 5 million metric tons respectively of calories and protein foodstuffs. As a cash crop cotton is fundamentally important to the economy of many countries and to a very large number of small farmers in developing countries, as well as larger farm enterprises in both developing and developed countries.

Cotton is severely damaged by many pests - often the most important factor limiting yield. The control of cotton pests in many parts of the world is almost totally dependent upon chemical pesticides. The amounts of pesticides used on cotton in the United States of America is almost as great as the total used on all other crops combined, cotton being the outstanding pesticide consumer in many developing countries as well. There is extensive evidence that this unbalanced approach has created serious environmental contamination which is being exacerbated by spiralling problems induced by pesticides, such as the development of resistant pests and the elimination of natural enemies. In some areas, the number of insecticide applications has increased from a few to forty in a crop season. The inevitably greater cost has created economic crises and sometimes put cotton out of production, especially where the efficiency of pest control has declined, decreasing yields despite increased pesticide usage.

There is now strong evidence from several areas of the world that integrated pest control technology can be developed in ways which make cotton production economically sound and simultaneously ensure environmental quality. For example, adoption of it in Nicaragua has decreased the amount of pesticide applied by about 35 percent in four years. Sufficient basic knowledge is currently available to enable the successful application of integrated pest control in cotton growing in the major cotton producing countries.

4.2 Objectives

The project aims to promote the development and application of safer, more effective and more permanent pest control procedures and techniques in the major cotton growing areas through the combined use of all compatible methods based on ecological considerations and crop economics, in order to avoid environmental pollution while at the same time ensuring continuing profits to the farmer. In this way, it will warrant the development of an effective and well-balanced crop protection system that enables the grower to safeguard and to draw full profit from all the other crop production inputs.

These objectives will be fulfilled through the development of sufficient expertise in the application of the integrated pest control concept by providing guidance and training in research and application. Direct assistance will be given to national research and advisory bodies through the development of regional programmes.

Success in establishing integrated control practices is most likely to be assured through the concentration of a wide range of appropriate expertise on demonstration/training/research projects. These would help to enable the necessary breakthrough which proves the practical value of this new approach, in turn creating confidence, particularly among extension service officers and farmers. The integrated control approach will operate by an open-ended strategy, i.e., new techniques will be tested and introduced and less effective ones withdrawn. Research on new techniques and methods of control is therefore envisaged as a continuing process occurring concurrently with extension and demonstration activities.

It is felt that the objectives can be best realised by the establishment of Regional Programmes, which will ensure the following benefits:

- With a relatively limited amount of manpower, the development work, research and training activities of many countries can benefit from available expertise and information.
- The location of bases in various countries in the region will distribute research needs and activities according to the available expertise and so allow the whole region to benefit more from various local inputs.
- The essential long-term continuity of activities will be best ensured by the regional character of the programmes.

4.3 Organization

4.3.1. General outline

To fulfill the aims of the Cooperative Global Programme for the Development and Application of Integrated Pest Control in Cotton Growing, the setting up of three Regional Programmes is proposed. Choice of countries to be included is based insofar as possible on the following criteria:

- major problems common to the countries in the regions proposed;
- the relative economic importance of cotton in these regions and the countries concerned;
- the availability of local counterpart expertise;
- the presence of suitable research/demonstration areas and adequate laboratory and office space and facilities for training, including accomodations for students;
- the proximity of institutions and universities where information on biological sciences and agriculture is available and liaison with research and teaching activities is possible;
- the existence of extension services.

Each Regional Programme will consist of a group of national projects. A Regional Programme Leader will be responsible for the implementation of a Regional Programme. The programme will be implemented in appropriate locations or bases in the participating countries. A single Programme Activity Base will serve as headquarters for Regional Programme activities. Each programme will have three components: 1) demonstration, 2) training, and 3) research.

A Regional Steering Committee of one delegate from each participating country, plus programme experts will oversee regional activities. The Regional Programme Leader will be the Technical Secretary to this Committee. Its chairmanship will rotate at three-year intervals. Regional meetings will be held annually; sub-regional meetings will be held as needed.

Communication is to be supported through a quarterly newsletter. It is suggested that the newsletter be a simple, mimeographed, free publication available to all in the region interested in integrated control of cotton pests.

In summary, the Programmes aim to provide an efficient, effective and workable approach to the development and implementation of integrated pest control in agriculture. For this, the following plan of work will be carried out:

a) Identify the real pest control and crop management problems;

b) Demonstrate the integrated control approach;

c) Establish research programmes to:

   1) investigate identified problems;
   2) refine integrated control programmes;
   3) develop alternative methods of pest control and crop management;

d) Establish and maintain active extension programmes;

e) Implement progressively efficient, practical and effective integrated pest control and crop management at the grower level;

f) Execute training programmes on the integrated control approach to educate all people involved in crop protection and production, (i.e., field workers, growers, advisors, administrators, decision-makers, bankers, chemical sales people).

g) Keep all participants fully informed of research results, programme changes, recommendations, economics, etc.

(It should be noted that the above is not necessarily a chronological sequence. Items "f" and "g", for example, may be among the first to be implemented.)

Coordination on a global scale will be carried out through the Global Programme Coordinator. This will comprise:

- contacting the countries concerned to solicit their cooperation in preparing detailed proposals for the establishment of Programme Activity Bases;
- establishing contacts with national and international research institutes to foster scientific backstopping and avoid duplication of research activities;
- coordinating the programme activities with on-going field projects in integrated pest control;
- ensuring a regular exchange of information on the latest developments of integrated pest control techniques and results achieved within the Regional Programmes;
- continuously evaluating the progress made within the Regional Programmes and preparing proposals for change where needed;
- informing the FAO Panel of Experts on Integrated Pest Control of all relevant matters concerning the programme and seeking their advice for further developments. The FAO Panel will function as the main channel for planning, coordination, periodic review and evaluation of the programme. This function will be carried out through annual sessions and ad hoc meetings of the Panel and consultantships.

4.3.2. Detailed Work Plan

Regional Programmes are planned for:

a) the Near East Region, comprising:

- Afghanistan, Greece, Iran, Pakistan, Syria and Trukey, with links to India and other cotton producing countries in Asia;

b) the African Region, comprising:

- Egypt and Sudan, with links to other relevant cotton producing countries in Africa;

c) the Latin American Region, comprising:

- Argentina, Bolivia, Brazil, Colombia, Costa Rica, Cuba, Ecuador, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Paraguay, Peru and Venezuela;

(Countries are named on a tenative basis; participation in the Regional Programmes should be discussed with each of them during the preparation of project proposals.)

It is felt that to be successful, these integrated control programmes must evolve over many years. However, for operational, administrative and planning purposes, each Regional Programme may be divided into three phases. A possible example of such a breakdown follows:

First phase - three years: (See Appendix I)

- development of systems of integrated cotton pest control at various bases;
- training of all people involved in the countries concerned;
- planning and initiation of a comprehensive regional programme.

Second phase - three years:

- continuation of research and training activities;
- specific support for participating countries to put integrated control programmes into practice at the farmer level.

Thrid or final phase:

- more widespread practical application of the programme;
- transfer of complete responsibility for integrated control activities to national staff.

During the first phase the following methodology will be used:

a. Establish Demonstration-Study Areas as described in Appendix II.

The Demonstration-Study Area serves as the foundation for the development and implementation of the integrated control programmes. Properly executed, the DSA will serve:

1) to identify problems;

2) to demonstrate the integrated control approach;

3) to encourage utilisation and implementation of integrated control;

4) as a testing ground for new findings and ideas developed by the research programmes;

5) as a field laboratory for the training programmes.

b. Progressively implement integrated control programmes, which can be and has been accomplished in various ways, including:

1) utilisation of existing extension services;

2) government subsidies to growers;

3) private consulting firms;

4) grower-financing agencies;

5) legislation.

c. Develop in-country research activities and facilities to maintain an active investigation programme. This should serve to continually refine, update, and if necessary drastically change integrated control programmes and approach.

d. Achieve effective extension through frequent contact with growers, pest control specialists, administrators, decision-makers, bankers, chemical salesmen, by means of meetings, radio, television, newspapers, newsletters and publications.

4.4 Training

Transfer of knowledge on integrated pest control is an important element of every Regional Programme. Since this will concern all levels of the agricultural community, the following kinds of courses should be considered:

4.4.1. Short courses:

Training of "Scouts"

This will be practical training in the field covering recognition and sampling of pests and their natural enemies, measurements of plant growth as required, and damage assessment. These courses should be offered in the locality where the Scouts work and in direct relation to a particular cropping system for which practicable pest control measures have been elaborated. These courses, which will be repeated at least annually, should be of one to two weeks' duration and can be given by a technical officer assisted by previously trained Scouts.

Training of supervised pest control specialists, extension officers and research workers

It is difficult to sub-divide training required for these specialists. All trainees should have adequate basic training in agricultural biology or biological subjects, (e.g., B.Sc, M.Sc or perhaps Ph.D). They should possess two or more years of field experience in pest control as a pre-requisite to to the courses indicated below:

a) Practical courses lasting 2 to 5 weeks, primarily for supervised control specialists: these should cover advice to farmers on pest control measures, such as methods of control, pesticides and their application, and the need for control indicated by information from the Scouts. The courses must concentrate on field practicalities, covering the relevant crops and pest problems with particular regard to the specific decision-making processes required for control of individual pests and pest complexes on each crop. Such courses will usually be national rather than regional in scope, in view of local variations in crop and pest conditions.

b) Intensive courses on specialised topics: these should last two to four weeks, as and when required, covering the specialised technology of such topics as pesticide application, use of pheromones, use of pathogens, systems analysis, etc. They will be intended primarily for research and extension workers and should be regional in scope.

c) General courses on principles and practice of integrated pest control: their objective is to introduce integrated pest control theory and technology to technical plant protection officers (consultants, extension workers, research workers) who have not had adequate previous experience and training in the integrated pest control approach. Such courses should be organised on a regional basis. The FAO/UNDP course on Crop Pest Control, especially locusts, is a development towards this objective. The proposed courses in integrated pest control in South America (Reg.AGP/IPC/75/2A) should fulfill this objective as regional projects. The training programme in integrated pest control operational at the Universidad Nacional Autonoma de Nicaragua (UNAN) since 1970 with the assistance of FAO is an example of utilisation of national universities for training purposes.

Background information courses for Government administrators responsible for integrated pest control activities and relevant staff of organizations providing funds for integrated pest control projects

Courses should be of four to five days' duration and include lectures, discussions and field visits outlining and demonstrating the essential need for integrated pest control and the principles, practice and sequence of events required to develop an integrated pest control programme. The courses should be given on a regional basis.

Training of Farmers and Farm Managers

Probably locally organized, these should be four to five day courses or evening sessions with field visits to demonstration plots and farmers' fields. They should be strictly limited to the relevant crops and should refer to simple principles of integrated pest control, but should particularly emphasise the precise requirements and economics of supervised control in relation to the farmers' particular problems.

4.4.2. Long-term courses

Technical college or university training in agriculture, agricultural biology or biological sciences is a basic need for all integrated pest control specialists. This could be given as a vocational course in a technical college or as a university course leading to a B.Sc degree, where more fundamental aspects would be covered in greater depth. Ph.D training on specific aspects of integrated pest control may be needed in a few cases. This should be undertaken after the graduate has received adequate practical experience of field problems in integrated control, i.e., one or two years working on an integrated pest control programme.

4.4.3. Implementation of training

Recommendations for training must be flexible to match the difference in degree structures in different countries. Furthermore, the nature of training will vary according to the individual student as well as in relation to the integrated pest control research and development work that is needed for a particular programme.

The sequence of activities for organizing and implementing training within the Cooperative Global Programme is outlined below:

a) Establish training/information officers in:

1) Asia,
2) Africa, and
3) Latin America;

b) Publish training and education guidelines;

c) Identify training and education needs;

1) in relation to geographical level (global, regional, sub-regional, local);
2) in relation to agricultural conditions and problem crop(s); and
3) in terms of types of training (short courses, long-term courses);

d) Promote and develop specific training activities.

5. IMPLEMENTATION OF THE THREE REGIONAL PROGRAMMES

Details of these Regional Programmes were worked out by Committees set up during the FAO/UNEP Consultation on Pest Management Systems for the Control of Cotton Pests held in Karachi, 13 - 16 October 1975, and partly redrafted during the Sixth Session of the FAO Panel of Experts on Integrated Pest Control, also held in Karachi, 20 - 23 October 1975. The Committees were made up of delegates from the respective regions who were joined by other participants at the Consultation.

5.1. Latin American Regional Programme

5.1.1. Introduction

The Latin America Region was represented by delegates from six countries (Bolivia, Colombia, El Salvador, Mexico, Nicaragua, Peru). For each country, a working paper was presented which discussed the current cotton pest control situation, problems and requirements. Research activities and needs were identified, a plan of work was developed, and staffing requirements determined. The Committee discussed other cotton growing countries in Latin America: Brazil, Paraguay, Argentina, Venezuela, Ecuador, Cuba. It was agreed that these countries should also be included in this activity.

5.1.2. Major Research Activities

The major on-going research activities on cotton pest control in the participating countries were identified:

a) Mexico: field testing of new cotton varieties developed in the USA, study of crop losses by simulation of damage.

b) El Salvador: pesticide quality control, pheromones, Bacillus thuringiensis field studies.

c) Nicaragua: cotton plant and insect dynamics, systems analysis, economic injury levels, development of pest tolerant/resistant cotton varieties.

d) Central America: ICAITI (Guatemala) pesticide residue analysis, impact monitoring of pesticide residues, agricultural economics analysis.

e) Colombia: pesticide application methods, pesticide efficacy, pesticide quality control, insect population dynamics, breeding for pest resistance.

f) Peru: assessment of biological control, manipulation of parasites and predators.

g) Bolivia: assessment of biological control, manipulation of parasites and predators.

5.1.3. Work Plan

5.1.3.1. Organization

It was decided that Latin America should be treated as one region with three sub-regions:

1) Mexico north of Mexico City, 2) Middle America, comprising Mexico south of Mexico City, Guatemala, El Salvador, Honduras, Nicaragua and Costa Rica, and 3) South America. Centres and sub-centres are not proposed, rather experts are distributed by country with Managua, Nicaragua functioning as the project coordination centre.

5.1.3.2. Demonstration study areas

Demonstration Study Areas will be established and maintained in each participating country for at least three years. Each Demonstration Study Area will be comprised of at least three plots: 1) untreated, 2) current local programme, and 3) integrated control as adopted by the Regional Programme. Three such Demonstration Study Areas will comprise one unit providing a paired-comparisons experimental design.

The in-country staff will set up and maintain the Demonstration Study Areas with the advice, supervision and assistance of programme experts and consultants.

5.1.3.3. Research acitivities

Short and long-term research activities will be conducted as needed. For short-term programmes, emphasis will be on:

1) Studies on relevant aspects of the growth and development of the cotton plant, 2) pest population dynamics, 3) determination of economic injury levels, 4) assessment of natural enemies, 5) utilisation of habitat management, 6) selection and testing of pest tolerant/resistant cotton varieties, 7) improved efficiency through better application techniques.

Long-term projects include:

1) Development and registration of entomopathogens, 2) manipulation of parasites and predators, 3) studies on migration potential of noctuid moth populations, 4) systems analysis and development of crop and pest monitoring/forecasting systems, 5) mass culture, release and protection of parasites and predators, 6) development of pest tolerant/resistant commercial cotton varieties, 7) development of the use of pheromones for population monitoring and pest control.

5.1.4. Staffing requirements

A total of ten experts is requested for Phase 1. In addition, a support staff of one associate expert and two U.N. volunteers is requested for each expert (Appendix III).

5.1.4.1. Short-term research

The suggested distribution of experts is as follows:

1) One integrated control expert (specialist in experimentation on integrated pest control techniques) in the northern Mexico sub-region, located at Torreon;

2) One integrated control expert (specialist in experimentation on integrated pest control techniques) based in San Salvador, El Salvador, to work in the middle America area north of Nicaragua;

3) One entomologist/ecologist (biological control specialist, evaluation of natural enemies) based in Cali, Colombia;

4) One agronomist/entomologist (liaison officer, relations with other experts, plant physiology specialist) based in Cali, Colombia;

5) One cotton agronomist (breeder/entomologist to test host plant tolerance/resistance) stationed in Bogotà, Colombia (field work in Espinal);

6) One integrated control expert (specialist in experimentation on integrated pest control techniques) based in Lima, Peru;

7) One integrated control expert (specialist in experimentation in integrated pest control techniques), based in Santa Cruz, Bolivia.

5.1.4.2. Long-term training

One programme training officer based in Managua, Nicaragua and associated with UNAN (National Univeristy).

5.1.4.3. Long-term research

1) One entomologist/ecologist (microbiological control specialist, development of entomopathogens, liaison officer for relations with other experts) based in Guatemala City and associated with ICAITI;

2) One integrated control expert (regional programme leader, entomologist/specialist in systems analysis) based in Managua, Nicaragua to work in Nicaragua and Costa Rica.

5.1.4.4. Experts

The experts will establish operations in a base country. Each one, however, will be available to visit other areas in the region for advisory purposes.

5.1.4.5. Consultants

Consultantships for each area during Phase 1 are distributed as follows:

a) Northern Mexico: 3 man/months (biological control, plant physiology, systems analysis, microbiological control);

b) Middle America: 12 man/months (pesticide application, biological control, plant physiology, pheromones, systems analysis, plant breeding);

c) South America: 15 man/months (pesticides application, biological control, microbiological control, systems analysis).

5.2. African Regional Programme

5.2.1. Introduction

The African Region was represented by delegates from Egypt, Niger and Sudan. The Committee discussed the great ecological and technical differences that exist between Northeast and Central/West Africa and reviewed the draft project proposal submitted to the Consultation.

5.2.2. Major research activities

The Committee did not review in detail the major research activities. In Egypt almost all elements of integrated pest control are studied, but certain areas such as insect pathology, host plant resistance and research on economic injury levels could be stressed further. In the Sudan, an operational scheme of field checking exists, but more research is needed on subjects like crop loss assessment, natural enemies and host plant resistance. In other

cotton growing countries of Africa, elements such as microbial control, parasites and predators and host plant resistance to be used in integrated pest control have been studied individually, but so far a comprehensive integrated pest control scheme has not been developed.

5.2.3. Work Plan

5.2.3.1. Organization

It was accepted by the Committee that Northeast Africa was a logical choice for a regional set-up of programme activities. Both Sudan and Egypt have large areas of irrigated cotton in a relatively homogenous ecological zone with several problems in common - good control of many inputs and increasing pesticide use. The rainfed cotton belt in Central and South Sudan provides conditions comparable to those of other East African cotton producing countries.

The Committee agreed that Egypt and Sudan are both suitable locations for activity bases. Both have available records of cotton pest research and are currently served by admirable cotton research institutions and individuals. The available expertise and records should form a firm basis from which effective integrated control programmes can be developed. The final choice of the Programme Activity Base should be decided upon further consultation with the authorities in these two countries.

However, the Committee wishes to strongly emphasise that the development of successful integrated control programmes within Northeast Africa will have relatively little relevance to cotton growing countries in Africa south of the Sahara. Although the training facilities developed at such a base may be of use in training workers from other African countries, great care must be taken to ensure that there is no attempt to simply transfer the overall developed integrated control programmes into the other countries where the cotton is grown in very different social and ecological conditions. Similar attempts to transfer developed technology into some of these countries have in the past led to local catastrophes, which must never again be suffered, particularly since up to 70 percent of cash income may be derived from cotton. It might therefore be necessary to locate a coordination centre at a suitable site in Central or West Africa. The large ongoing and prospective research activities in Egypt and Sudan could provide very valuable inputs for these countries.

5.2.3.2. Research activities

A few of the main points to be considered in planning the research work for the project, much of it long-term, are:

a) Basic ecosystem studies, including phenology, behaviour, growth and development of the concerned organisms: these studies should cover cotton and other host crops in the area, as well as pests and their natural enemies. Studies of the abiotic factors affecting the abundance and distribution of pests and natural enemies are also essential.

b) Studies on the migration potential of the species concerned;

c) Establishing economic injury levels for the pests in different environments and crop conditions;

d) Monitoring pest populations and forecasting infestations;

e) Studies on the biological control of cotton pests, including studies on the indigenous parasites, predators and pathogens, assessment of their roles in the regulation of the pest populations, introduction and releasing of adequately promising exotic natural enemies, and protection, manipulation and augmentation of natural enemies;

f) manipulation of all cultural habitat management practices proven useful to keep injurious insect populations at a minimum, and studies to establish the usefulness of others;

g) Studies on efficiency, selectivity and minimum adverse side effects in pesticide use;

h) Breeding varieties of cotton resistant to major pests;

5.2.4. Staffing requirements

For the Egypt and Sudan bases, the staffing requirements should be discussed further with the local authorities, but it is likely that at least the following experts will be needed:

- Egypt: one insect pathologist, one host plant resistance speicalist, and one integrated control specialist concentrating on research on economic injury levels.
- Sudan: one host plant resistance specialist, one biological control specialist (evaluation of natural enemies), one entomologist/agronomist, one cotton plant physiologist and one coordinator/integrated control specialist.
- One training officer between the two countries.

At the activity centre in Central or West Africa, the following experts may be considered: one coordinator/integrated control specialist, one host plant resistance specialist, one biological control specialist and one training officer.

Consultantships for the first phase of three years of project implementation should be provided in the various disciplines mentioned above, for an approximate duration of 30 man/months.

5.2.5. Funding

Adequate funding is required to assure necessary facilities, equipment and transportation for all experts involved in the programme.

5.3 Near East/Asia Regional Programme

5.3.1. Introduction

The Near East/Asia region was represented by delegates from five countries (Greece, India, Pakistan, Thailand and Turkey). The Committee discussed various aspects of the proposed Regional Programme and there was unanimous agreement that a collaborative programme between countries with common problems is required for the development of integrated pest control in cotton.

5.3.2. Major research activities

Currently the countries represented rely almost exclusively on pesticides for the control of cotton pests. Testing of pesticides is thus a common feature in all countries concerned. Pakistan has a well-structured programme on integrated pest control in four different crops, including cotton. This programme covers a wide range of relevant research elements. In India, a wide range of expertise on various techniques of significance for the development of integrated pest control in cotton is concentrated in the All-Indian Coordinated Cotton Improvement Project and the Operational Research Project on Integrated Pest Control. There is less research activity in other countries.

5.3.3. Work Plan

5.3.3.1. Organization

It was agreed that a single Regional Programme comprising all countries in this region would be unworkable, not only because the cotton growing conditions differ widely but also because it would be too cumbersome. It was accepted, however, that there are common pest problems and approaches to control which merit certain links between all the countries.

It was suggested that the Regional Programme initially concentrate on the Near and Middle East cotton producing countries, probably including Afghanistan, Greece, Iran, Pakistan, Syria, Turkey and perhaps other countries. However, links should be established with India

and possibly with Egypt because of common problems. Distinct differences between and within countries are emphasised, e.g., in Turkey between the "Mediterranean" and "Agean" areas. However, throughout almost all of the proposed region, at least one, and sometimes all, of the three bollworm species (Heliothis, Earias, Pectinophora) are key pests. Other key pests such as Spodoptera are common to several of the countries. There are therefore some common major pests and research needs, providing opportunities for collaboration or subdivision of the necessary research and development work.

In India, cotton is grown in four distinct conditions, and more land is devoted to the crop than in all the other countries of the Near East/Asian group combined. It was indicated that India represents a regional situation in itself. However, some Indian cotton areas have problems and conditions similar to countries to the west and others to Thailand. Hence, there is justification for links between all countries represented on the Committee. In general, the organization of a Regional Programme as indicated in the Draft Proposal was considered acceptable subject to two main qualifications:

a) Possible new inputs to a programme base, for example, must not be made at the expense of support that might otherwise be given to particular national programmes. From its inception, the programme should serve to strengthen individual national activities as well as to benefit the region as a whole.

b) Immediate choice and function of a Regional Programme Activity Base is considered premature, but the development of a Regional Programme nevertheless demands the appointment of a Regional Programme Leader.

The Committee agreed that elaboration of detailed specific proposals for a Regional Programme should be the first task of the Programme Leader and that to assist him a Regional Scientific Liaison Committee should be appointed.

Institutes in various countries where there are ongoing or projected programmes of integrated pest control of cotton pests will form bases.

The Committee welcomed the offer of the Pakistan Delegation to provide headquarters for the Regional Programme Leader and the Training/Information Officer, together with their auxiliary staff.

The Committee recommends that advantage be taken of the opportunities that exist for early inputs into practical programmes in Pakistan and Turkey. In Pakistan, this should complete the activities undertaken within the framework of the PL 480-funded integrated pest control programme. In certain parts of Turkey, the cotton situation seems to have reached a crisis point. There is active interest on the part of scientists in the development of integrated pest control, and there are outstanding opportunities for applying current knowledge to make an early improvement, thereby avoiding potential disasters in pest control and environmental contamination.

5.3.3.2. Research activities

Short term:

It was agreed that identification of the gaps in knowledge and the needs in the countries concerned is a pre-requisite to considering the structure and activities of a possible Regional Programme. A first attempt to identify some of them is given below, but it is emphasised that more time is needed to adequately define them.

In any integrated pest control programme in this region, special consideration must always be given to the following general approaches:

a) basic ecological work on the whole complex of host plants/pests/natural enemies and abiotic mortalities;

b) definition of economic injury levels: this vital need has been grossly neglected even in places where much work has been done on integrated pest control. Use of economic injury criteria is crucial to the rational use of chemicals as well as to the choice of other control methods to be implemented;

c) development of improved early warning and monitoring systems;

d) examination of specificity of insecticides, including specificity obtained through formulation and method or timing of application;

e) improvements in pesticide application to minimise wastes which also create an unnecessary environmental hazard;

f) studies aimed at preserving and enhancing the role of indigenous natural enemies;

g) studies on habitat management practices aimed at 1) dislocating the pest's life cycle, 2) encouraging natural enemies, and 3) avoiding changes in cultural practice which are beneficial to pests;

h) development of varieties resistant to key pests.

It should be noted that six of the eight requirements listed are non-chemical methods with minimal environmental hazard.

Long term:

It is anticipated that the goal of non-chemical control of cotton pests can best be attained through the gradual phasing out of the chemical control component of a particular integrated pest control programme as other techniques increasingly replace it in the control of various pest species, although the time scale of this process cannot be predicted. This approach is recommended because the successful incorporation of non-chemical controls will increasingly depend on detailed knowledge of crop/pest interaction and pest behaviour which will of necessity be accumulated in an evolving integrated pest control programme.

5.3.4. Staffing requirements

It was agreed that it was premature to decide in detail the nature of the specialist expertise needed in the region. This should be the task of the Global Programme Coordinator in consultation with member countries seeking such assistance within the Regional Programme network. It is stressed that at least as much consultant time as indicated in the Draft Proposal (30 man/months during the first three-year phase) will be needed, such is the potential size of the programme and the complexity of the problem.

For the immediate future it will be essential to establish the core staffing of the Regional Programme by the appointment of a regional programme coordinator and a training/liaison officer. The team should then be completed as soon as needs have been identified. At least six experts in various fields of integrated pest control will however be needed. These will undoubtedly include one or two integrated control specialists, a biological control specialist in each participating country, a specialist for resistance breeding at the Programme Activity Base, and experts in pesticide application and pest monitoring for the region as a whole.

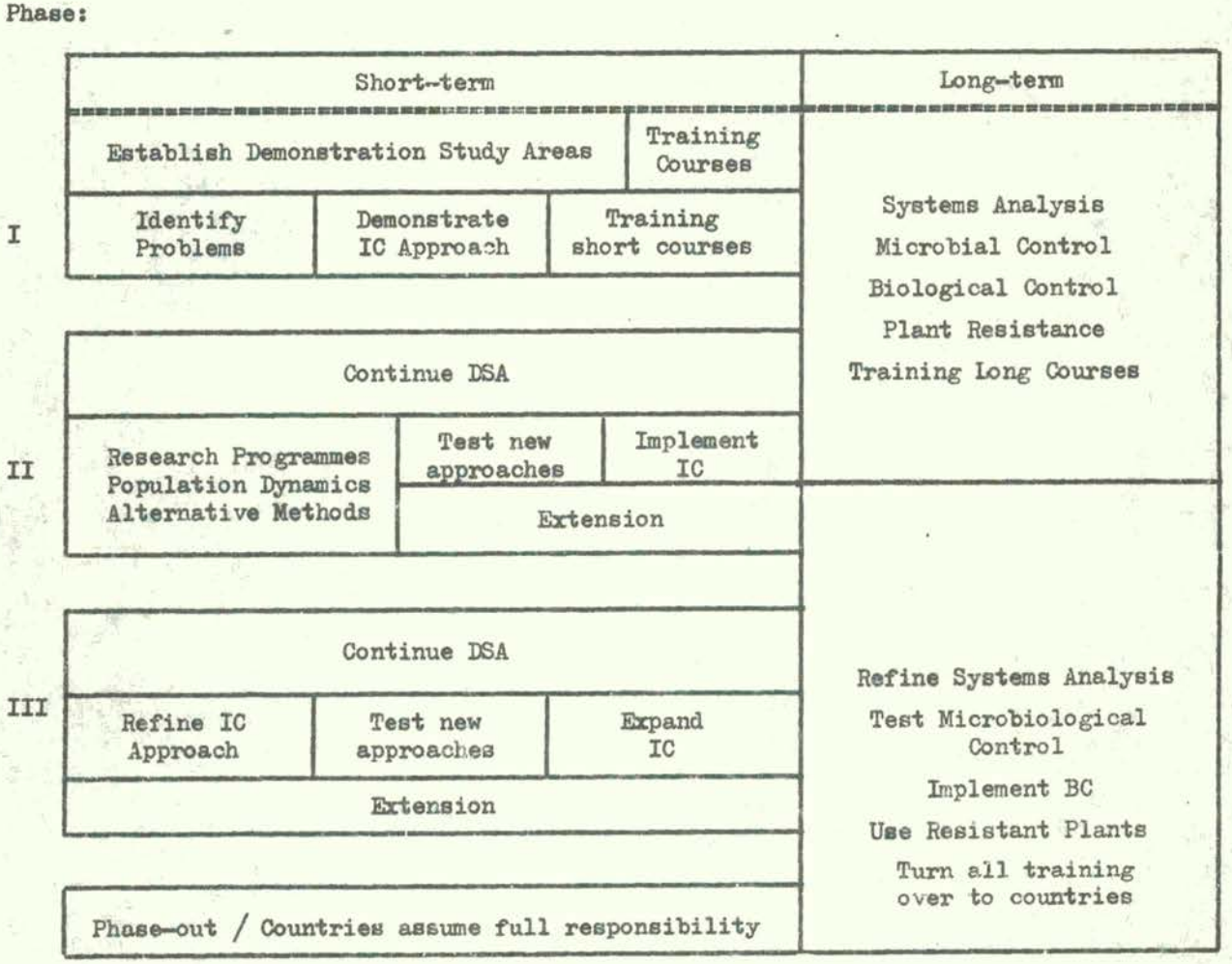
5.3.5. Funding

It was agreed by the Committee that the budget could in general be represented by the requirements listed in the Draft Proposal. This would be subject to a further analysis of special needs, allowing for the possibility of a greater allocation of funds for consultants and possible modifications of the biological control component following further consultation with the countries concerned.

APPENDICES

APPENDIX I

PROGRAMME OF ACTIVITIES BY YEARS



IC = Integrated Control

BC = Biological Control

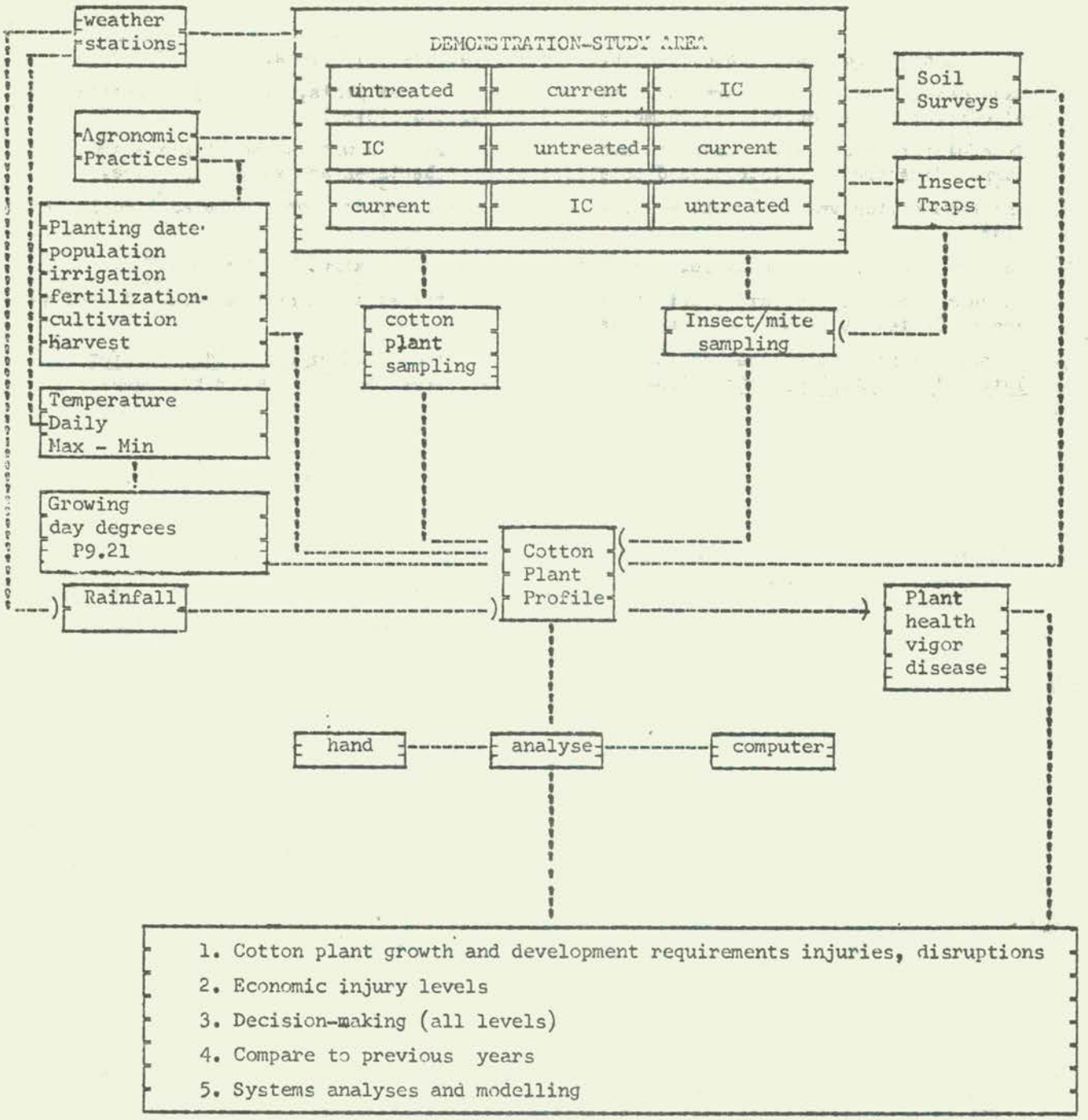
DSA = Demonstration Study Area

APPENDIX II

IMPLEMENTATION OF DEMONSTRATION-STUDY AREAS

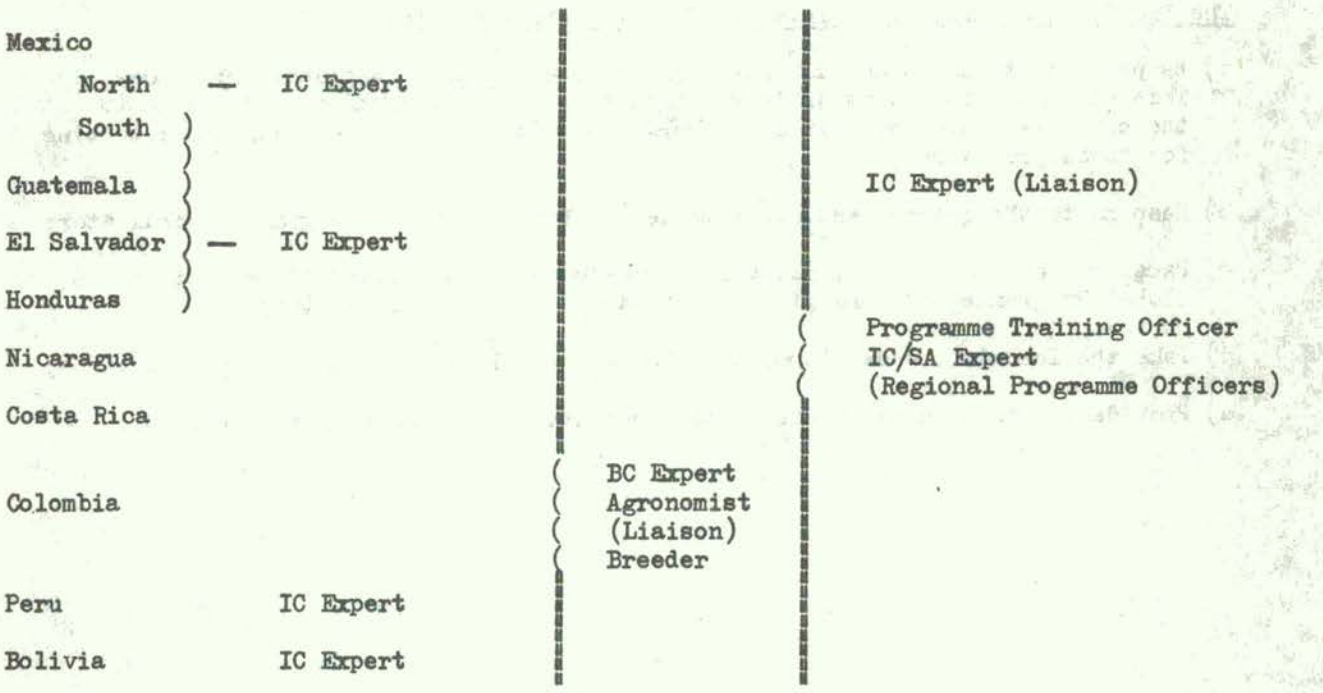
1. In each homologous zone establish three demonstration-study areas.
2. Each demonstration-study area consists of at least three plots, i.e., a) untreated, b) current local control programme, and c) integrated control approach.
3. Each plot must be large enough to avoid major interaction with adjacent plots and surrounding areas. Plots should be a minimum of 5 hectares and square in shape.
4. The same cotton variety, soil type, cropping conditions, etc. should be adopted for each plot.
5. For purposes of data analysis, the plots are treated as paired comparisons.
6. In each plot, appropriate plant growth data are gathered about once a week. Insect data are collected at about 3 - 4 day intervals.
7. Sampling instructions are provided on pages 67-69 and 71-75 of FAO Guidelines for Integrated Control of Cotton Insect Pests. Pages 12-25 should also be reviewed.

FLOW-CHART - DEMONSTRATION STUDY AREAS



APPENDIX III

STAFFING REQUIREMENTS: LATIN AMERICAN REGIONAL PROGRAMME



1 Associate Expert

2 UN Volunteers assigned to each expert

APPENDIX IV

EXTRACT FROM THE REPORT OF THE SIXTH SESSION
OF THE FAO PANEL OF EXPERTS ON INTEGRATED
PEST CONTROL, KARACHI, 20 - 23 OCTOBER 1975

6.0 Coordination between global programmes and the panel of experts on integrated pest control

The FAO Panel of Experts on Integrated Pest Control should:

a) Be prepared to serve as "advisors" on selected specific regional programmes. This will require attention to the details of these programmes and visits to the countries involved. In other words, provide technical advisory backstopping for these programmes;

b) Respond to the queries and other matters submitted by the Programme Coordinator;

c) Panel Members should copy relevant correspondence concerning any aspect of the Global Programme and send it to the Chairman and the Coordinator;

d) Take the lead in the development of long-range planning of the Global Programme;

e) Provide inputs as appropriate to the Coordinator for his Quarterly Reports.

APPENDIX V

SUMMARY OF COUNTRY REPORTS TO THE CONSULTATION

1.	NUMBER OF HA. UNDER COTTON	NUMBER OF HA. IRRIGATED	FERTILIZER/HA.
BOLIVIA	58,000	0	small amounts on a limited scale
COLOMBIA	290,000	15% Atlantic Coast 45% interior 80% Cauca Valley	N, K, P } 100–400 Kg/ha + urea 100–200 Kg/ha
EGYPT	612,600	612,600	N (15.5%) 200–400 Kg/feddan P (15% P_2O_5) 100–200 Kg/feddan
EL SALVADOR	73,500	-	N 200–225 units/ha P 85–115 units/ha
GREECE	154,044	144,539	N 90 Kg/ha P 64 Kg/ha
INDIA	7,689,000	1,884,000 (24.5% of total)	not reported
NICARAGUA	178,000	1,865	N 85 lb/acre P_2O_5 42 lb/acre K_2O 13 lb/acre
PAKISTAN	2,032,000	irrigation practised, hectares not reported	N 40 lb/acre P_2O_5 10 lb/acre
SUDAN	505,000	about 420,000	N 40 Kg/acre
THAILAND	53,100	-	N 75 Kg/ha K 37.5–75 Kg/ha P 75 Kg/ha (where needed)
TURKEY	750,000	most of total 750,000	N 100–150 Kg/ha P 40 – 50 Kg/ha

1 feddan = 1.04 acre = 0.421 ha.
1 acre = 0.405 ha.

2. COTTON VARIETIES GROWN

BOLIVIA

Stoneville 7A
Stoneville 213

COLOMBIA

Delta Pine 16 (84%)
Acala 1517 BR2 (2%)
Delta Pine Smooth Leaf (6%)
Acala 1517-70 (4%)
Stoneville 213 (0.2%)
Delta Pine 45-A (3%)
Coker 201 (0.6%)
Delta Pine 25 (0.2%)

EGYPT

G. Barbadense varieties:

Menoufi
Giza 66
Giza 67
Giza 70
Giza 69
Giza 68
Dandara
Giza 72
Ashmouni
Giza 45

EL SALVADOR

Stoneville 213
Copal 68

GREECE

4S (93%)
Coker 100 Wilt (6%)
Acala 4-42 (0.5%)

INDIA

G. hirsutum varieties (50%)
G. arboreum varieties (29%)
G. herbaceum varieties (21%)
G. barbadense varieties (0.01%)

NICARAGUA

Conal S. (61%)
Nicaragua HL (21%)
Stoneville 213 (12%)
Others (6%)

PAKISTAN (Sind Province)

Desi varieties:	T.D-1
	S.K.D-10/19
Upland varieties:	M-100
	Qalandri (H.59.1)
	Sarmast (S.59.1)

SUDAN

Long staple:	Bar XLI
	Barakat
	Bar 14/25
	V.S.
	V.S. (A)
Medium & short staple	Acala 4.42
	Barac
	Bar 11/7
	Albar

THAILAND

Reba BTK12
Delta Pine Smooth Leaf

TURKEY

Coker 100 A/2 (66-100)
Carolina Queen
Delta Pine 15/21
Acala

3. MAJOR PESTS
(those marked with an asterisk are in decreasing order of importance)

BOLIVIA

Heliothis virescens
Heliothis zea
Pectinophora gossypiella
Dysdercus palidus
Conatrochelus denieri
Alabama argillacea
Spodoptera frugiperda
Prodenia ornitogally
Aphis gossypii
Thrips tabaci

COLOMBIA

Agrotis ypsilon
Aphis gossypii
Alabama argillacea
Trichoplusia ni
Pseudoplusia includens
Spodoptera frugiperda/spp.
Heliothis virescens
Anthonomus grandis
Sacododes pyralis
Pectinophora gossypiella
Tetranychus sp.
Mononychus planki
Bemisia tabaci
Heliothis zea

EGYPT*

Pectinophora gossypiella
Spodoptera littoralis
Thrips tabaci
Tetranychus spp.
Heliothis armigera
Aphis gossypii
Bemisia tabaci
Empoasca spp.
Spodoptera exigua

EL SALVADOR

Alabama argillacea
Aphis gossypii
Anthonomus grandis
Heliothis zea
Prodenia spp.
Bemisia tabaci
Trichoplusia ni
Spodoptera exigua
Verticillium alboatrium

EL SALVADOR (cont'd)

Thielaviopses basicola
Rhizoctonia solani
Fusarium oxysporum
Phytium spp.

GREECE*

Pectinophora gossypiella
Heliothis armigera
Thrips tabaci
Tetranychus sp.
Bemisia tabaci
Aphis gossypii

INDIA

Pectinophora gossypiella
Earias spp.
Heliothis armigera
Empoasca devastans
Aphis gossypii
Pempheres affinis
Bemisia tabaci
Mylocerus maculosus

NICARAGUA

Anthonomus grandis
Heliothis zea
Bemisia tabaci
Creontiades spp.
Alabama argillacea
Trichoplusia ni
Aeolus sp. / Epitragus spp.
Spodoptera sunia
Spodoptera exigua
Spodoptera latisfacia

PAKISTAN

Earis insulana
E. fabia
Platyedra gossypiella
Empoasca devastans
Thrips tabaci
Scirtothrips dorsalis
Bemisia tabaci
Tetranychus urticae
Microtermes obesi
Heliothis sp.

SUDAN*

Heliothis armigera
Bemisia tabaci
Empoasca lybica
Esrias insulana
Diparopsis watersi
Aphis gossypii
Pectinophora gossypiella
Caliothrips sudanensis
Podagrica puncticollis
Caliothrips fumipennis

THAILAND

40 species of insects, most important of which are: Bollworm
Spiny bollworm
Leafhoppers

most important disease:
Leafroll

TURKEY*

in the Mediterranean:

Bemisia tabaci
Tetranychus spp.
Spodoptera littoralis
Heliothis armigera
Pectinophora gossypiella
Agrotis ypsilon
Laphygma exigua
Earias insulana
Aphis gossypii
Empoasca spp.
Thrips tabaci

in the Aegean:

Aphis gossypii
Agrotis ypsilon
Tetranychus spp.
Pectinophora gossypiella
Empoasca spp.
Bemisia tabaci

4. CONTROL MEASURES

		Other control measures
BOLIVIA	Biological control + Chemical control +++	
COLOMBIA	Biological control ++ Chemical control +++	mechanical cultural
EGYPT	Biological control + Chemical control ++	mechanical cultural
EL SALVADOR	Biological control ++ Chemical control +++	mechanical cultural
GREECE	Biological control + Chemical control ++	P. gossypiella seed treatment stalk destruction early sowing
INDIA	Biological control + Chemical control +	short duration varieties resistant varieties
NICARAGUA	Biological control ++ Chemical control +++	attractants: early season releases of Trichogramma on about 20% of the area seed treatment
PAKISTAN	Biological control 0 Chemical control +	agronomic practices resistant varieties
SUDAN	Biological control 0 Chemical control ++	cultural legislative physical
THAILAND	Biological control 0 Chemical control +++	resistant varieties
TURKEY	Biological control 0 Chemical control + (Aegean) +++ (Mediterranean)	cultural seed treatment stalk destruction

Biological control
- 0 not used
- + slight use
- ++ moderate use
- +++ intensive use

Chemical control
- +++ intensive use
- ++ moderate use
- + slight use
- 0 not used

5.	NUMBER OF PESTICIDES	NUMBER OF APPLICATIONS/SEASON	RECENT CHANGES
BOLIVIA	13	10–14	++ organophosphates
COLOMBIA	11	1–12	- number of applications - amount per hectare
EGYPT	35	4.4/feddan	0
EL SALVADOR	39	18.22/ha	-- number of applications/year -- organochlorides ++ organophosphates
GREECE	31	1–5	0
INDIA	not reported	on 13% of total cotton area, 200 g/ha (2–4 treatments)	0
NICARAGUA	13	19	0
PAKISTAN	not reported	0–1 average for country (5–7 recommended)	0
SUDAN	18	6	0
THAILAND	2	14–16	0
TURKEY	38	1–3 Aegean region 8–12 Mediterranean region	++ number of applications per season in the Mediterranean region 0 in the Aegean

0 none
++ significant increase
- slight decrease
-- significant decrease

6. RECENT CHANGES IN PESTICIDE USAGE

BOLIVIA	none reported
COLOMBIA	± organochlorides (less than 20% of total usage) + organophosphates
EGYPT	none reported
EL SALVADOR	switch from broad spectrum to selective
GREECE	- organochlorides (since 1972)
INDIA	none reported
NICARAGUA	- BHC and Endrin + ovicide formetanate
PAKISTAN	none reported
SUDAN	- Endrin (1965) + Endosulfan 35 E.C., Carbaryl 85 + Formothion 25% (1966/67) + Camphechlor/Methyl parathion 10, Malathion 57% E.C., Malathion 96% ULV, Endosulfan + Dimethoate } 1969/70 + Several ULV formulations (1972) + Aldicarb, DDT/Monocrotophos E.C., Monocrotophos 55.2 E.C. (1973)
THAILAND	- Endrin/DDT, Carbaryl/DDT, Azinphosmethyl/DDT, Endosulfan/DDT, Toxaphene/DDT } 1965
TURKEY	± chlorinated hydrocarbons + monocrotophos + Aldicarb + Phorate + Pirimiphos-methyl

- no longer used
± strongly reduced usage
+ recently introduced

7. PESTICIDE RESISTANCE

BOLIVIA	none reported	
COLOMBIA	H. virescens	+ Endrin + Methyl parathion ++ DDT
	Heliothis spp.	++ DDT + Methyl parathion
EGYPT	Cotton leafworm	+ Leptophos ++ Endrin ++ Toxaphene ++ Monocroptophos ++ Carbaryl ++ Dipterex
EL SALVADOR	not studied	
GREECE	Mites	+ Demetonmethyl + Carbophenothion
INDIA	none reported	
NICARAGUA	Heliothis zea	++ Methyl parathion ++ Endrin
PAKISTAN	none reported	
SUDAN	none reported	
THAILAND	H. armigera	+ Toxaphene/DDT ++ Endrin/DDT ++ Carbaryl/DDT ++ Azinphosmethyl/DDT ++ Endosulfan/DDT
TURKEY	S. littoralis and Tetranychus spp.	+ Toxaphene DDT + Methyl Parathion + Monocrotophos and Dimethoate + Demeton + Thiodemeton + Dicrotophos + Monocrotophos

+ moderately resistant
++ heavily resistant

8. RECENT CHANGES IN PEST SITUATION

BOLIVIA	formerly unimportant pests becoming dangerous to cotton production	
COLOMBIA	++ Trichoplusia ni	
	++ Pseudoplusia	
	++ Tetranychidae sp.	
	++ Anthonomus grandis	
	++ Pectinophora gossypiella	
	++ Sacododas pyralis	(increased particularly in the last 2 seasons)
	+ Heliothis sp.	(increased particularly in the last 2 seasons)
EGYPT	+ Bemisia tabaci	
	+ Empoasca lybica	
	+ Nezara viridula	
	++ Heliothis armigera	
EL SALVADOR	-- Anthonomus grandis	
	+ Heliothis zea	
	++ Spodoptera exigua	
GREECE	++ P. gossypiella	
	-- H. armigera	
INDIA	++ spider mites	
NICARAGUA	- Anthonomus	
	- Heliothis	
	- Bemisia	
	++ Creontiades	
	-- Prodenia latisfacia	
	- Spodoptera exigua	
PAKISTAN (Sind Province)	++ spider mites	
SUDAN	+ Podagrica puncticollis	
	+ P. pallida	
	+ Calothrips fumipennis	
	+ C. sudanensis	
	-- Empoasca lybica	
	++ Bemisia tabaci	
	++ Aphis gossypii	
	++ Heliothis armigera	
	++ Diparopsis watersi	
	++ rats	
THAILAND	none reported	
TURKEY	Mediterranean:	Aegean:
	++ Bemisia tabaci (since 1974)	+ Bemisia tabaci
	- Tetranychus spp.	-- Tetranychus spp.
	- Heliothis armigera	+ Empoasca spp.
	- Spodoptera littoralis	- Aphis gossypii
	+ Pectinophora gossypiella	+ Pectinophora gossypiella

\+ slight increase - slight decrease
++ important increase -- important decrease

9. COMPULSORY CONTROL MEANS

BOLIVIA	none reported
COLOMBIA	sanitary inspections control of date of sowing destruction of stalks registration of pesticides seed quality control recourse to quarantine control of aerial spraying of pesticides
EGYPT	destruction of hibernating pink bollworms in ginned cotton withholding irrigation of clover (berseem) fields after May 10 organized handpicking of egg masses of Spodoptera spp. in cotton fields throughout the country annual recommendations published by the Ministry of Agriculture and implemented under its close supervision laws on importing, specifications, storage, marketing, handling, and application of pesticides plant quarantine laws and regulations against cotton and seed imports
EL SALVADOR	laws on use, quality, method of application of pesticides date of sowing regulations destruction of stalks areas free from cotton seed import laws
GREECE	destruction of stalks in some districts
INDIA	laws for: seed fumigation limiting number of varieties in an area destruction of stalks withholding irrigation prevention of ratooning
NICARAGUA	date of sowing destruction of cotton stalks registration of pesticides
PAKISTAN	none reported
SUDAN	control of varieties grown control of variety by area date of sowing regulations pesticide use regulations crop-free period regulations
THAILAND	none reported
TURKEY	recommendations for: end of season plant removal time of sowing and irrigation rotations eradication of weeds near fields seed treatment

10. INFORMATION ON NATURAL CONTROL ELEMENTS

BOLOVIA

Allograpta exotica
Allograpta oblicua
Chrysopa sp.
Hippodamia convergens
Geocoris sp.
Cicloneda sanguinea
Calosoma sp.
Orius insidiosus
Notoxus monodon
Zelus renordi
Nabis ferrus
Trichogramma minutum
Atta sp.

COLOMBIA

113 different species, of major importance are:

Polistes sp.
Azya sp.
Zelus sp.
Archytas sp.
Rogas sp.
Spilochalcis femorata
Orius insidiosus
Coleomegilla maculata
Cycloneda sanguinea
Hippodamia convergens
Cardiochiles migriceps
Euplectrus plathypenae
Spicaria rileyi
Copidosoma truncatellum
Lysiphlebus sp.

EGYPT

Coccinella undecimpunctata
Scymnus interruptus
Scymnus syriacus
Paederus alfierii
Chrysopa carnea
Orius albidipennis
Orius laevigatus
Strobliomyia aegyptia
Zele chlorophthlama
Microplitis rufiventris
Chelonus inanitus
Exeristis roborator

EL SALVADOR

Aphis gossypii (5)[1/]
Alabama argillacea (7)
Prodenia sunia (3)
Heliothis zea (7)
Trichoplusia ni (3)
Estigmene acrea (1)

GREECE

Pectinophora gossypiella (2)
Heliothis armigera (2)
Aphis gossypii (7)
Tetranychus sp. (5)

INDIA

Earias (26)
Pectinophora gossypiella (12)
Empoasca devastans (10)
Bemisia tabaci (2)
Thrips tabaci (2)
Aphis gossypii (18)
Sylepta derogata (19)
Pempheres affinis (8)

NICARAGUA

105 different species found on all major pests. Full details are published in "Guia de control integrado de plagas del algodonera para 1975-1976". Managua, Nicaragua

PAKISTAN (Sind Province)

13, effective against spotted bollworm

THAILAND

23 species

TURKEY

Aphis gossypii (2)
Aphid sp. (2)
Nezara viridula L. (1)
Empoasca sp. (1)
Pectinophora gossypiella (3)
Autographa (Plusia) gamma L. (4)
Agrotis ypsilon (7)
Agrotis segetum (2)
Aphis gossypii (4)
Thrips, spider mites (1)

1/ Number in parentheses indicates number of parasites and predators effective against that pest.

11. BREEDING RESISTANT VARIETIES

BOLIVIA	none reported
COLOMBIA	none reported
EGYPT	resistance to fusarium wilt
EL SALVADOR	none reported
GREECE	none reported
INDIA	resistance to jassid, pink bollworm and blackarm
NICARAGUA	resistance to virus carried by the whitefly
PAKISTAN	jassid resistance
SUDAN	jassid resistance
THAILAND	resistance to leaf roll disease
TURKEY	resistance to *Verticillium* wilt

12. EFFECTS OF INSECTICIDES ON THE ENVIRONMENT

BOLIVIA	increase of previously unimportant pests
COLOMBIA	not systematically studied
EGYPT	decrease in parasites and predators
EL SALVADOR	not systematically studied
GREECE	not systematically studied
INDIA	Endosulfan residues in cotton seed; changes in pest situation
NICARAGUA	secondary pests; human intoxications; contamination of human milk; residues in marine life; new pest problems; aggravation of problems in surrounding crops; resistance in Heliothis zea; malaria resurgence
PAKISTAN	none reported
SUDAN	none reported
THAILAND	none reported
TURKEY	increase of previously unimportant pests

MR/H7724/E/3.76/1/400