Linking Grain Legumes Research in Asia

International Crops Research Institute for the Semi-Arid Tropics

Citation: ICRISAT (International Crops Research Institute for the Semi-Arid Tropics). 1989. Linking grain legumes research in Asia: summary proceedings of the Regional Legumes Network Coordinators' Meeting, 15-17 Dec 1988, ICRISAT Center, India. Patancheru, A. P. 502 324, India: ICRISAT.

Référence: ICRISAT (International Crops Research Institute for the Semi-Arid Tropics). 1989. Liaison des recherches sur les légumineuses à grains en Asie: comptes rendus sommaires de la Réunion des coordinateurs régionaux du réseau sur les légumineuses, 15-17 déc. 1988, Centre ICRISAT, Inde. Patancheru, A.P. 502 324, Inde: ICRISAT

The role of the Asian Grain Legumes Network (AGLN) coordinated by the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) is examined. Different kinds of agricultural research networks are discussed. The relative importance of groundnut, pigeonpea, and chickpea in the AGLN member countries is presented, together with the status of current research, future research priorities, and suggestions for strengthening collaboration. The contribution of ICRISAT is outlined. The links between AGLN and other entities involved in Asian crop research are presented. Ways of strengthening these links, and the future development of AGLN, are discussed.

Le rôle du Réseau asiatique sur les légumineuses à grains (AGLN), qui est coordonné par l'Institut international de recherche sur les cultures des zones tropicales semi-arides (ICRISAT), est examiné. Sont évalués également les différents types de réseaux de recherche agricole. L'importance relative de l'arachide, du pois d'Angole et du pois chiche chez les pays membres de l'AGLN, l'état de recherche en cours, les priorités futures en matière de recherche ainsi que les suggestions visant à renforcer la coopération sont présentés. La contribution de l'ICRISAT et les liens entre l'AGLN et d'autres organismes participant à la recherche agronomique en Asie sont brièvement décrits. Les moyens de renforcer ces liens ainsi que le développement futur de l'AGLN sont analysés.

Linking Grain Legumes Research in Asia

Summary Proceedings of the Regional Legumes Network Coordinators' Meeting

15-17 December 1988
ICRISAT Center
India

ICRISAT
International Crops Research Institute for the Semi-Arid Tropics
Patancheru, Andhra Pradesh 502 324, India

Regional Legumes Coordinators' Meeting

Objectives

The coordinators of the Asian Grain Legumes Network (AGLN) met with representatives of donor groups, regional organizations, and ICRISAT staff in order to:

- Review the progress of the AGLN since its establishment
- Re-examine country problems and research priorities for groundnut, chickpea, and pigeonpea
- Inspect the resources available to help provide solutions to priority problems
- Examine existing work plans involving the exchange of genetic materials, training, and collaborative research
- Develop future work plans in the light of the resources and priorities earlier identified
- Reconsider the objectives and scope of the AGLN in the light of new developments in the region, and make recommendations for the network's future development

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Back ground Information on the AGLN

ICRISAT established the AGLN on 1 January 1986 to meet the need of Asian legume scientists for an appropriate mechanism to disseminate germplasm, improved technology, and training in the region.

The scope of the AGLN is restricted to the three mandate legume crops of ICRISAT — groundnut, chickpea, and pigeonpea. The network currently has activities in 10 countries in the region (Bangladesh, Burma, Nepal, Sri Lanka, Pakistan, and India in South Asia; and the People's Republic of China, Indonesia, the Philippines, and Thailand in East and Southeast Asia).

The AGLN is coordinated by a two-man team and appropriate administrative support within the Legumes Program of ICRISAT. Besides ICRISAT core funding, the network has received financial support to date from several sources, including the Asian Development Bank, the Australian International Development Assistance Bureau, the Food and Agriculture Organization of the United Nations, the International Development Research Centre, and the Peanut Collaborative Research Support Program.

The overall objective of the AGLN is to facilitate the interchange of material and information among grain legume scientists at ICRISAT and in Asian countries. The ultimate aim of the network is to help the farmers of the region increase their legume production.

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OPENING SESSION

Welcome and Meeting Overview

Y. L. Nene

Deputy Director General (Acting), ICRISAT

On behalf of the Director General and the Management Committee of ICRISAT, I extend to all of you a very hearty welcome to this Regional Legumes Network Coordinators' Meeting, which is being held immediately after the Workshop on Agroclimatology of Asian Grain Legume-Growing Areas.

At ICRISAT we have a mandate to work on five crops: two cereals — sorghum and pearl millet; and three legumes — groundnut, pigeonpea, and chickpea. ICRISAT sees its three legumes as important for several reasons: they can provide important additions to diets throughout many parts of the semi-arid tropics (SAT); and they are drought tolerant, are good fixers of nitrogen, and can help diversify cropping patterns.

Exactly 5 years ago (December 1983), we organized a consultative group meeting that included legume scientists from Asia as participants. Two years later, we organized a review and planning meeting. In response to these two meetings, we established the AGLN under the leadership of Dr D. G. Faris in 1986. Last year we held a chickpea coordinators' meeting, which proved extremely useful to everyone concerned.

This meeting of the country coordinators of the AGLN, representatives of donor groups, regional organizations, and ICRISAT staff has six objectives:

- Review the progress of the AGLN since its establishment
- Re-examine country problems and research priorities for groundnut, chickpea, and pigeonpea
- Inspect the resources available to help provide solutions to priority problems
- Examine existing work plans involving the exchange of genetic materials, training, and collaborative research

- Develop future work plans in the light of the resources and priorities earlier identified
- Reconsider the objectives and scope of the AGLN in the light of new developments in the region, and make recommendations for the network's future development

This meeting provides a good opportunity to interact. Eight out of 10 AGLN country coordinators are here (Burma and Sri Lanka are absent, but we have received a paper from Sri Lanka). Two donor representatives are here, from the Australian Centre for International Agricultural Research (ACIAR) and the International Development Research Centre (IDRC) in Canada. Regional organizations and other international centers are also represented, including the Regional Co-ordination Centre for Research and Development of Coarse Grains, Pulses, Roots and Tuber Crops in the Humid Tropics of Asia and the Pacific (CGPRT), the United Nations Food and Agriculture Organization (FAO), the South Asian Association for Regional Cooperation (SAARC), and the International Rice Research Institute (IRRI). I am pleased to see Dr M.C. Saxena, the Food Legume Improvement Program Leader at the International Center for Agricultural Research in the Dry Areas (ICARDA), here. We have excellent cooperation with ICARDA on chickpea research.

As you may know, our Director General, Dr L.D. Swindale, is on sabbatical leave. Lately he has been giving considerable thought to the future strategy of ICRISAT. In a recent communication to me he stated: "All Asian countries — including India — should be encouraged to participate in the AGLN. It needs to become their network." Thus you can see that at the highest levels of our staff there is a firm belief that together we can succeed, indeed will succeed, in bringing about a revolution in legume production.

Presently the AGLN has outside financial support from the Asian Development Bank (ADB) for its operations in South Asia. The AGLN's activities associated with Southeast Asia have been supported by several groups, including ACIAR, the Australian International Development Assistance Bureau (AIDAB), IDRC, the Peanut Collaborative Research Support Program (Peanut-CRSP), and FAO. We are seeking additional funding to further strengthen cooperative activities in Southeast Asia. We are also interested in inputs from the regional groups and organizations to improve our activities on grain legumes on a regional basis.

Let me make a specific reference to groundnut. It is one of the most important income-earning crops in the SAT. Unfortunately, it is expensive to produce, with costly inputs of seed, pesticides, management, and labor. It also has special problems, including that of aflatoxin contamination. Appropriate research can reduce these problems. Only last month, ICRISAT and Indonesia organized a groundnut scientists' meeting at Malang in Indonesia, at which most countries and organizations present here participated and identified regional and national constraints to groundnut production. I hope that, at this meeting, we will be able to work out action plans taking into account the recommendations from that meeting.

A strong AGLN, supported by strong inputs from national programs, ICRISAT, and other regional programs, is essential. We expect national agricultural research systems (NARS) to seek more responsibility for AGLN objectives and operations. We hope the

NARS will accept this challenge. We hope also that the other regional/international agencies, such as FAO, ACIAR, IDRC, Peanut-CRSP, CGPRT, and IRRI, will join with ICRISAT to develop and implement the comprehensive research and training program needed to achieve increased grain legume productivity in AGLN countries.

Our network operations should also encourage the transfer of technology already in use by national programs. This can be done through such initiatives as ICRISAT's Legumes On-Farm Testing and Nurseries (LEGOFTEN) project, and the Asian Rice Farming Systems Network (ARFSN) of IRRI. We think such technology transfer activities should be useful to many countries. We are also looking for continuing and increasing support from donors for this kind of work.

We are often asked why ICRISAT does not assist the national programs in research on other important legumes, notably mung bean and soybean. While ICRISAT cannot work directly on these crops because of its mandate restrictions, we are exploring the opportunities for collaborative work on them with other international centers, such as the International Institute of Tropical Agriculture (IITA) and the Asian Vegetable Research and Development Center (AVRDC). We certainly recognize the importance of mung bean and soybean in the Asian region.

Let me assure you of one thing on behalf of ICRISAT — that is, our commitment to bring about a sustainable increase in legume production and productivity in Asia. We believe that, by working together with you, we can do it. Let me once again welcome you to ICRISAT and to this meeting.

Networking and the AGLN

D. G. Faris and C. L. L. Gowda

Legumes Program, ICRISAT

In recent years networking has become increasingly popular. Much of this increase in activity has been in agricultural research networks (ARNETs), of which the AGLN is one example. Today we will examine what ARNETs are, how they operate, and why they are so popular. We will also look at the structure and activities of the AGLN, so that we can explore how this network might develop in the future.

ARNETs

Definitions and Objectives

A network may be defined as "an interconnected or interrelated group or system". ARNETs have been defined as "a cluster of scientists or institutions linked together by a common interest in working dependently or interdependently on an identified shared problem or problems".

In general, ARNETs are organized to strengthen research that aims to develop the technology needed to increase world food supplies. A set of more specific objectives was spelled out at a network coordinators' meeting in Nairobi in May 1988. These were to:

- Strengthen the applied research capability of NARS to identify, address, and solve farmers* problems
- Generate appropriate technology by more effectively utilizing existing research personnel, facilities, and other resources
- Ensure stability of agricultural production through a responsive research capability
- Provide the support, both technical and financial, required to facilitate the coordination of activities on a regional basis

Structure

ARNETs vary in their structure, but most incorporate the five components outlined here.

Membership. This component makes up the nodes or body of the network. Members can be individual scientists, policy makers, and cooperators, or groups such as NARS, international agricultural research centers (IARCs), regional programs, laboratories in developed countries, and bilateral projects. The members provide the input into an ARNET and use the resulting output.

Research. This component is the main part of the network that provides answers to the problems the network was established to solve. The research component can draw on existing technology, or generate new technologies, or it can forge a new research method or approach, or it may create a new type of data base; but almost invariably it comprises some type of research specific to the network. This research may be basic, strategic, applied, or adaptive.

Coordination. This component typically consists of a unit that organizes and harmonizes the activities of the network, and a steering committee that provides guidance. The coordination unit usually consists of a network coordinator and perhaps some staff. The coordinator's role is usually to act as executive officer for the network, organizing its research, providing support, attracting funding, arranging travel and meetings, analyzing and summarizing research results, and disseminating information. The steering committee normally consists of representatives of the network membership, including research managers and scientists, as well as specialist consultants and donor representatives. It meets regularly (often annually) to review the progress of the network and develop a work plan for future activities. Also included in the coordination component are the contact persons in each participating country, known as country coordinators.

Communications. This component consists of the various links within and between the other components. These links include correspondence, publications such as newsletters and research reports, visits, workshops, monitoring tours, and training. The links furnish the means for the exchange of ideas, information, data, methods, materials, and technology, so that these can be shared by network members.

Assets. This component consists of the resources already possessed by the network, and the additional external finances required to allow it to operate effectively. External funding is required mainly for the communication and coordination components, but small amounts are frequently also used for the research component. Usually, the extra funding for research is provided through direct bilateral agreements between network members and donors. Sometimes, however, small amounts are made available through the coordination unit, in order to overcome short-term bottlenecks.

Models

ARNETs can be depicted in many ways. The one most frequently used is the wheel model, in which the coordination unit is considered the hub of the wheel, which is connected by spokes to the members or nodes, which in turn are connected to each other through a rim. A variation of this model is the component model, which depicts the four main components — membership, research, coordination, and communication. These models can be used to compare the main features of various types of ARNETs.

Information networks are the simplest form of ARNET. In this type of network the coordination unit makes information available to the members for their use, but the members have little, if any, input into the network, and are connected only through the coordination unit The Semi-Arid Tropical Crops Information Service (SATCRIS), described later in this meeting, is an example of this type of ARNET. A modification of this type of network is the newsletter network, in which members share information and ideas through a centrally produced newsletter.

Consultation networks are ones in which individual members conduct research independently on a common priority topic. Participants exchange information on the research in various ways, including the holding of regular meetings.

Collaborative research networks involve joint planning and monitoring of research among members concerning problems of mutual interest within a region. These ARNETs include elements of the first two types. They can be further subdivided on the basis of their general approach. Some ARNETs are international nursery networks, of which there are many examples at ICRISAT. Some are methodology networks; an example is the ARFSN, which will be discussed later in this meeting. Some are regional program networks, such as the ICRISAT/Southern African Development Coordination Conference (SADCC) program. And some are NARS-based networks, of which the Programa regional cooperativa de papa (PRECODEPA), which operates in Central America and the Caribbean, is a good example.

Using diagrams to depict networks can obscure the fact that networks are dynamic. To illustrate this point more fully, let us compare an ARNET to a living organism that is conceived, born, grows, develops, and goes through a learning process that includes the ability to learn by its mistakes and gain from the experiences of similar organisms. Carrying this analogy further, the network membership component can be thought of as the body of this organism, providing the bulk and muscle power to carry out activities. The research component is like the blood and cell metabolism which gives life to the body. The communication component is like the blood vessels and nerves; it "moves" the research component throughout the membership component. The coordination component can be seen as the nerve center, processing information and harmonizing the activities of the body. The assets component is like the food that provides the energy to keep the network organism alive and active.

Benefits

Having seen how ARNETs are organized, we shall now look at some of the reasons why they have become so widely used, the costs associated with them, and some of the traits considered important for success.

ARNETs are popular because they have many advantages:

- They provide links among scientists for sharing information and research results
- They are relatively inexpensive and flexible, as they use existing staff and facilities
- They prevent unnecessary duplication of efforts by providing a coordinated approach to research
- They can provide the critical mass needed to produce answers quickly and hasten scientific breakthroughs
- They allow access to sophisticated equipment and technology not normally available to individual network members
- They provide training opportunities

These benefits are not realized without costs. The major costs of ARNETs include:

- Commitment of staff and facilities by national programs
- Possible adjustment of national program priorities to accommodate network activities
- Extra funds for coordination

Nor can the benefits of ARNETs be realized unless certain ingredients crucial for success are present. These include:

- A purpose recognized by all members as both important and achievable
- A clearly focused strategy
- An existing or potential source of improved technology, and the abitity to generate technology through research
- A realistic research agenda
- Strong and effective coordination
- A steering committee that represents members' views and can commit member and national program resources
- Training to ensure that members will be able to carry out the network's research agenda
- Regular meetings, workshops, and monitoring tours to share ideas, review progress, and plan future activities
- Free exchange of results, materials, and members among network countries
- Commitment by NARS to provide the funds, resources, and staff needed to carry out network activities
- Strong self-interest of members served by the network
- Logistical support from administrators
- Adequate and flexible outside funding

The AGLN

Foundation and Objectives

The AGLN provides a good example of how a network is conceived and bom, and how it starts to grow.

In 1983 a consultative group meeting at ICRISAT, attended by legume scientists from several Asian countries and by representatives from regional donor agencies, identified the major constraints to the production of groundnut, chickpea, and pigeonpea in Asia, and the priority research needed to overcome those constraints. With these needs in mind the group endorsed ICRISAT's concept of an Asian Regional Legume Research Program, and recommended that ICRISAT appoint a coordinator for the program. At the follow-up review and planning meeting held at ICRISAT in 1985, ICRISAT's Director General announced that the Institute had identified a coordinator for what since late 1986 has been called the Asian Grain Legumes Network (AGLN). This meeting also recommended a general plan of action and a list of specific activities to be undertaken by the coordinator. The coordinator took up his duties on 1 January 1986. Since then the AGLN has been structured and has developed activities based on the recommendations of the two earlier meetings.

The general objective of the AGLN is to facilitate the interchange of material and information between grain legume scientists at ICRISAT and in Asian countries. The ultimate aim of the network is to help the farmers of the region increase their legume production.

The specific objectives of the AGLN are to:

- Produce a directory of AGLN cooperators
- Operate an information bank for the cooperators
- Identify adapted grain legume lines and the appropriate agronomy for their cultivation in each AGLN country
- Promote training of legume scientists from AGLN countries
- Foster special research support projects

Clear objectives are essential to guide the activities of any organization. For this reason the AGLN's objectives will be reconsidered in the light of the recommendations of this meeting.

Structure and Operations

The structure and operations of the AGLN are founded on strong links between ICRISAT and national program scientists based on a formal memorandum of understanding with each country. By the end of 1988 there will be a signed memorandum of understanding with 10 major AGLN countries. These are: Bangladesh, Burma, India, Nepal, Pakistan, and Sri Lanka in South Asia; and the People's Republic of China, Indonesia, the Philippines, and Thailand in East and Southeast Asia. The AGLN also works with other countries of Asia when its assistance is requested.

Work plans for each country have been developed as part of each memorandum of understanding. Wherever possible these have been developed at a review and planning meeting in the country concerned. They set out the specific commitments of ICRISAT and the country.

Another feature of the AGLN's structure is the country-AGLN coordinators whom we have with us here today. They are the administrative contact persons with ICRISAT in each member country. By decentralizing the responsibility for network operations they increase the effectiveness of the AGLN's Coordination Unit.

Also here today are several donor and international institute representatives. They too are an integral part of the AGLN's structure. The continued interaction of the AGLN with this group was a major recommendation of the 1985 meeting. The Coordination Unit has found contacts and joint activities with this group to be very fruitful. We will describe some of these later.

The Coordination Unit consists of a network coordinator, a breeder, and a secretary.

The unit receives guidance from an Advisory Committee at ICRISAT, from meetings with national program scientists, country coordinators, and administrators in each country, from meetings such as this one and the chickpea coordinators' meeting held in 1987, and from other sources.

The main mode of action of the Coordination Unit is to facilitate contacts between legume scientists in AGLN countries and those at ICRISAT Center. The scientifically productive contact is directly between scientists, and after the initial contact the involvement of the Coordination Unit becomes secondary. In fact, the less the unit needs to be involved in each contact, the more the network is probably accomplishing. New initiatives are relatively easy to launch because the contacts and agreements with each country have already been made.

The Coordination Unit is supported by ICRISAT, which has also provided funds for its scientists to visit AGLN countries, and for the training of scientists from AGLN countries. The value of outside funding is demonstrated by the large number of activities and additional research that have been made possible in the South Asian countries by a grant from the ADB. This grant was for the strengthening of legume research programs in Bangladesh, Burma, Nepal, and Sri Lanka. Similarly, money made available by AIDAB has resulted in several important research activities in Indonesia on peanut stripe virus (PStV), and in Thailand on pigeonpea.

Progress

The AGLN's objectives are an excellent basis on which to evaluate the network's progress. The degree to which the recommendations of the 1983 and 1985 meetings have been met also forms a good measure of progress.

AGLN directory. Almost 500 scientists have responded to the invitation to become a cooperator in the AGLN. Their names have been entered in a data base, and the first edition of the directory, giving names and addresses, should be available soon. Later editions will list the crop(s) and discipline(s) of each cooperator.

Information bank. Information from ICRISAT is available to network cooperators through the Center's Information Services, its Legumes Program and its library, which operates SATCRIS.

Pamphlets, books, reports, and maps from each country have been collected and are being cataloged. In addition, unpublished information about each country is collected by the Coordination Unit staff when traveling. A management information system called AGLNIS is currently being developed by ICRISAT's Computer Services to allow easy access to this information. Apart from handling information from trip reports, AGLNIS will help in correspondence, as it is linked with the AGLN directory, and in the production of progress reports.

ICRISAT material. Trials containing advanced generation material have been made available to network cooperators directly through scientists in ICRISAT's Legumes Program, who are also AGLN cooperators. Special experiments have been designed cooperatively by country and ICRISAT scientists, using seeds supplied by ICRISAT. An example is a series of pigeonpea trials in Sri Lanka, using extra-short-duration lines designed to overcome the *Helicoverpa* pod borer problem. These experiments are usually decided on at the work planning meetings and included in each country's work plan. Attempts are made to visit all trials, and to review all results at annual planning meetings. The results are published in the various reports distributed by ICRISAT.

Training. The Coordination Unit has facilitated several special training courses and has supported several trainees in regular ICRISAT courses.

Special research projects. Most of the AGLN's special projects arise from specific recommendations of the 1985 meeting. As an example, we will discuss our work on PStV, since this shows how inputs from many groups can be used to tackle a common problem.

The virus was recognized as a unique disease about 4 years ago. It was first realized that it occurred extensively in the People's Republic of China, and later recognized as being widespread in Indonesia, the Philippines, and Thailand. Its appearance in the USA through seed imported from the People's Republic of China indicated the ease with which it could spread. In an effort to bring together all the information available on this disease, to develop a crash plan to learn more about it, and to mobilize resources to meet its threat, a PStV researchers' workshop was organized by the AGLN in Malang, Indonesia, with support from the Indonesian Government, the ACIAR, the FAO, the Peanut-CRSP of the USA, the IDRC, the Dutch Government's Agriculture Technical Assistance project in Indonesia, and ICRISAT. As a result of this meeting:

- The nomenclature of the disease was agreed upon and published
- A training course in methods for identifying this and other groundnut virus diseases was given in Indonesia by ICRISAT staff, assisted by specialists from the USA and Australia (a second course is planned for July 1989 at ICRISAT Center)
- Over 8500 accessions, mainly from ICRISAT's groundnut germplasm collection, were screened for resistance to PStV in Indonesia in 1987 and 1988
- A Thai national scientist is taking a collection of different isolates of PStV to Montpellier, France, to compare the symptoms they cause under uniform conditions and to develop antisera for their identification
- National programs have been made aware of the threat posed by this disease and of the need to provide PStV-free seed

Other activities. Other activities that illustrate the AGLN's collaboration with other organizations include:

- The agroclimatology workshop held over the past 10 days, with inputs from all AGLN countries, FAO, the International Benchmark Sites Network for Agrotechnology

Transfer (IBSNAT), IRRI, the Resource Management Program (RMP) at ICRISAT, the AGLN itself, and local geography and cartography consultants

- The analysis of pigeonpea production data and the development of a pigeonpea growth model by ACIAR staff working partly at ICRISAT
- Collaboration with the ACIAR pigeonpea project in Thailand and Indonesia, and with the groundnut project in Indonesia
- In-country training courses on chickpea, pigeonpea, and lentil given by national, ICRISAT, and ICARDA staff and financed by the ADB through the AGLN
- In-country courses on integrated pest management, given in Thailand and Indonesia by local, ACIAR, and ICRISAT staff
- A groundnut scientists' meeting held in Indonesia and a chickpea scientists' meeting held in Pakistan
- Plans for a Nepal/IRRI/AGLN workshop on the improvement of chickpea, pigeonpea, and other pulses, to be held in 1989

Conclusion

These are only a few of the initiatives that the AGLN has facilitated. We have plans for more in the future and will be glad to cooperate in initiatives started by others.

The basic aim of the AGLN is to support and strengthen groundnut, chickpea, and pigeonpea research programs in Asian countries. The most important objective of this meeting is to get recommendations from this group to guide our future activities. We look forward to your input throughout this meeting, but particularly in the discussion groups and in the development of the recommendations.

NATIONAL REPORTS

Bangladesh

M. A. Khaleque and M. M. Rahman

Bangladesh Agricultural Research Institute, Joydebpur and Ishurdi

Introduction

Chickpea, the third most important pulse crop in Bangladesh, is grown on about 50 000 ha (19.5% of the total area cultivated to pulses). Pigeonpea is a minor pulse crop, grown on about 3000 ha (less than 1 % of the total pulse area). Groundnut, the country's third most important oilseed crop, is grown on 17 512 ha.

It was primarily for the improvement of chickpea that links between the Bangladesh Agricultural Research Institute (BARI) and ICRISAT were established in 1980; these links were strengthened by the subsquent formation of the AGLN. Large quantities of germplasm, including advanced lines and some international nurseries and trials, have been tested. BARI now gets only trials, nurseries (such as the *Helicoverpa* resistance nursery), and segregating materials relevant to the country's specific problems. ICRISAT has been requested to develop botrytis gray mold and collar rot *(Sclerotium rolfsii)* resistance nurseries for Bangladesh.

Short- and medium-duration pigeonpea lines from ICRISAT and the United States Department of Agriculture (USDA) are being introduced. One of the short-duration lines, 76012, has a high yield potential of 2.0-2.5 t ha^{-1}, but is difficult to fit into existing cropping patterns and is extremely susceptible to *Helicoverpa* pod borer. Despite these problems, this research is continuing, for the time being, in the hope that worthwhile results will eventually emerge.

Groundnut germplasm and advanced lines from ICRISAT are also being introduced and tested. International trials have been conducted since 1982. The SAARC trials on groundnut have been conducted in Bangladesh since 1987. Four varieties from Bangladesh have been included in the trials.

Scientists from ICRISAT visit national experiments, study field problems and participate in BARI's annual research review and planning meetings. Until recently, however, the lack of a memorandum of understanding between ICRISAT and the Government of Bangladesh imposed a major constraint on collaborative research in that scientists from Bangladesh were unable to go to ICRISAT Center for training. This situation should now improve following the signing of a memorandum in November 1988.

Achievements in Collaborative Research

Ajoint BARI/ICRISAT mission collected 134 lines of chickpea in 1985; there are now 167 Bangladesh lines being maintained at ICRISAT's gene bank. One ICRISAT chickpea line, ICCL 81248, was released in Bangladesh in 1987 under the name of Nabin and is now being extended to farmers. Eight chickpea lines (ICCL 83103, 83105, 83003, 83007, 83008, 83228, 83127, and ICC 11320) have been identified as wilt resistant and are likely to be released soon; their yield potential is being tested at various locations.

Ninety groundnut lines from ICRISAT have been introduced and tested under Bangladeshi conditions. Some of these lines responded well, and will doubtless be selected as prospective candidates for release in the near future.

Priorities for Collaborative Research

Chickpea. In addition to resistance to wilt and root rot, priority should be given to developing botrytis gray mold resistance. Standard field screening techniques for botrytis should be developed. Efforts should also be made to explore the possibilities of developing varieties resistant to collar rot.

Drought is one of the causes of poor germination, and there are variations in germinability both between and within cultivars. Efforts should be directed towards developing varieties which have a fast germinating capacity under a minimum soil moisture regime.

To halt the decline in the area cultivated to chickpea, varieties responsive to inputs need to be developed.

Pigeonpea. The introduction of short-duration varieties which are resistant to wilt, sterility mosaic disease, and *Helicoverpa* pod borer should continue, with selection of high-yielding varieties.

Groundnut Germplasm should be collected both in Bangladesh and abroad. High-yielding varieties with short duration and resistance to rust should be developed. Attempts should also be made to develop varieties with a seed dormancy of 20 to 30 days and with long viability (over 4 months under ordinary storage conditions during the summer season).

Suggestions for Improving Collaborative Research Links

Several suggestions for improving collaboration can be made. The memorandum of understanding between ICRISAT and the Government of Bangladesh needs to be implemented so as to allow Bangladeshi scientists to participate more fully in AGLN activities. Lists of the available nurseries and F_2 materials (identifying the crosses against specific diseases) should be sent together, and all requested seed materials should be sent at the same time in one container, to facilitate release. Seed materials of AGLN crops should not be sent to any Bangladeshi institutes other than BARI unless the request is forwarded by the country-AGLN coordinator. Provision should be made for a tour by country-AGLN coordinators to AGLN countries in the cropping season, to exchange views on national programs. Visits by ICRISAT scientists to AGLN countries should be continued, and ICRISAT scientists should be sent to AGLN countries for short periods to train national scientists on specific technologies, if requested. ICRISAT should consider providing AGLN national scientists with opportunities to work at ICRISAT Center on sabbatical leave or as postdoctoral fellows, with honoraria or salaries similar to those paid at other international institutes.

People's Republic of China

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Introduction

Groundnut is the only AGLN crop of importance in the People's Republic of China; the area under pigeonpea and chickpea, the other AGLN crops, is minimal. Grown as both an oilseed crop and a food crop, groundnut has increased significantly in economic importance over the past decade. Production and cultivated area rose from 1.96 million t of dried pods grown on 1.7 million ha in 1976to5.99millionton3.50 million ha in 1986, representing an average annual production growth rate of 12.7%.

Although groundnut can be grown in many parts of the country, it is concentrated in a few areas, notably Shandong, Henan, and Guandong Provinces. Regional differences in agroclimatic conditions and temperature and rainfall changes from south to north influence the cropping systems and varieties required, and impose varying constraints on farmers.

Production Constraints

Diseases. Both early and late leaf spots occur sporadically throughout the country. Leaf spots are most important in the north, while groundnut rust and bacterial wilt cause more yield loss in the center and south. In addition, several virus diseases have recently become important in the People's Republic of China.

Pests. Aphids and cutworms are widely distributed. Thrips are most important in the north. However, limited work has been done on these and other groundnut pests.

Drought. This is a serious problem in the north and in the Yellow Soil Highland Zone. Drought in the spring can result in poor seed emergence. Yield losses resulting from drought and high temperatures are often experienced in the central growing areas. Waterlogging can be a problem sometimes, especially in the south.

Soil **and nutritional** problems. The soils in groundnut-producing areas are mostly alluvial sandy soils in the north, and red and yellow sandy loam soils (pH less than 7) in the south. In the central areas, mixtures of these soil types occur. Poor soil fertility, particularly in the south, often results in low yields. Boron (B) deficiency is believed to be a problem in the south.

Shortage of suitable cultivars. Locally adapted groundnut cultivars capable of withstanding the various agroclimatic stresses and of fitting into the different regional cropping systems are needed urgently. At present there arc few good varieties with special characteristics such as early maturity and resistance/ tolerance to drought, diseases, shade, acid soils, and extreme heat or cold.

Research Priorities

Germ plasm resource. Over 5000 groundnut germplasm accessions have been collected from different regions of the Peoples' Republic of China, and from abroad. They are preserved in the gene banks at the Chinese Academy of Agricultural Sciences' (CAAS) Oil Crops Research Institute in Wuhan, at the Shandong Peanut Research Institute, and at the Guandong Agricultural Academy. Recently, more intensive work has been done to register, document, and preserve these accessions at the national gene bank in Beijing.

Studies on the material to identify botanic and agronomic traits and reactions to various biotic and abiotic stresses are being conducted in different research units. Evaluation for possible inclusion in breeding programs is also being carried out

Some research efforts have been devoted to the wild *Arachis* species found in the People's Republic of China. The use of wild species in the development of groundnut varieties, especially for disease resistance, appears promising.

Variety improvement Groundnut breeding has been an important research priority in recent decades. New varieties have been released in Shandong, Guandong, Hubei, Jiangsu, Sichuan, and Henan Provinces and have played an important role in increasing groundnut production.

Research efforts have stressed high yield, early maturity, resistance to disease, and good quality. The need for adaptability to different cropping systems and for special traits for specific environments are also important. For example, tolerance to drought is needed in dry, sloping, poorly irrigated areas/fields, while tolerance to shade is needed for intercropping groundnut with tall crops.

Breeding for disease resistance has been a major effort. In north China, developing resistance to groundnut leaf spot is an important research objective, while resistance to bacterial wilt and rust is a major objective in the south. Resistance to virus diseases and to *Aspergillus flavus* is now attracting more attention.

Biotic and abiotic stresses. Studies on the epidemiology, ecology, and management of diseases are important. Groundnut rust and bacterial wilt have both been studied extensively and some research on leaf spot has been carried out in the north. Continued efforts are needed to further the understanding of disease and pest resistance, and to introduce effective management practices to control diseases. More work needs to be carried out on abiotic stresses.

Fertilizer use and soil improvement. Research is being carried out on the effects of nitrogen (N), phosphorus (P), and potassium (K) on groundnut in different soils, and the effect of B in many places in the south. Nitrogen fixation by rhizobia is also being studied.

Groundnut processing. Research has been initiated on the processing of groundnut.

Research Constraints

The People's Republic of China does not have enough groundnut germplasm possessing specific traits. For example, very few germplasm lines with high leaf spot resistance have been found, and no effective resistance to virus diseases has yet been identified. Additional research constraints are poor technology exchange with other countries and the shortage of funds and information.

Suggestions for Improving Collaborative Research Links

More groundnut germplasm accessions, including genes transferred from wild *Arachis* species, and interspecific hybrid derivatives could be provided by ICRISAT. The Center could carry out experiments to test cultivars for their adaptation to conditions in the Peoples' Republic of China. Assistance from ICRISAT is needed to train scientists in specialized fields. ICRISAT's information services could be useful. More cooperation between Chinese and ICRISAT scientists on groundnut experiments would be welcomed.

India

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Introduction

India is Asia's foremost grain legume producer. Owing to the great variability of its agro-climatic conditions, the country is able to grow many grain legumes: chickpea, pigeonpea, groundnut, soybean, mung bean, urd bean, lentil, pea, cowpea, lathyrus, horse gram, moth bean, rice bean, faba bean, and lablab bean. Among the pulses, chickpea and pigeonpea are the most important. Groundnut and soybean are the most important oilseeds.

Achievements in Collaborative Research

Important collaborative research achievements include germplasm exchange, the development of disease and pest screening nurseries, the establishment of yield nurseries, and the availability of nucleus and breeder seed of released or promising varieties.

National program staff have been trained in specific areas, such as disease diagnosis and screening, integrated pest management, and the use of a farming systems approach.

Through collaboration, two chickpea varieties, ICCC 4 and ICCC 32, two pigeonpea varieties, ICPL 87 (Pragati) and ICPL 151 (Jagriti), and one groundnut variety, ICGS 11, have been released.

Priorities for Collaborative Research

The following areas of collaborative research should have priority: resistance to *Helicoverpa* pod borer in chickpea and pigeonpea, and the control of podfly in pigeonpea; resistance to ascochyta blight and wilt in chickpea; resistance to wilt and sterility mosaic disease in pigeonpea; development of early-maturing varieties of chickpea to be grown in rice fallows; development of early-maturing varieties of groundnut suitable for both rainy and postrainy seasons; development of technology for growing grain legumes in rice fallows; breeding grain legume varieties for drought resistance; and studies on demand for, and use of, pulses.

Suggestions for Improving Collaborative Research Links

The links between India and the AGLN would be strengthened if ICRISAT and national program staff made regular visits to field trials within the network. A forum should be created for the in-depth discussion of trial results, and ICRISAT should sponsor national scientists to attend meetings on grain legumes. Increased participation of the Nitrogen Fixation by Tropical Agricultural Legumes (NifTAL) program in the network would promote the use of rhizobia and mycorrhizae. International organizations such as the AVRDC and the IDRC should increase their involvement in manpower development and the strengthening of national laboratories. There should be more short- and long-term training for national scientists at ICRISAT and other international centers.

Indonesia

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Introduction

Grain legumes form a significant pan of the diet of the majority of Indonesians and are an important factor in the food diversification program launched by the government to achieve food self-sufficiency. In 1987 a total of 1.4 million t of soybean, 0.8 million t of groundnut, 0.3 million t of mungbean, and about 0.2 million t of other grain legumes (cowpea, rice bean, pigeonpea, dolichos, and mucuna) were consumed as human food and animal feed, and as raw materials for local industry.

Groundnut is sown in less diverse soils than those under soybean. About 66% of the groundnut crop is harvested from drylands; the rest comes from wetlands. The crop area is forecast to increase by 1.7% and the average yield by 1.9% per annum until the year 2000.

Pigeonpea is a minor legume crop, used mainly as human food. Total annual production is estimated at about 50 t of dry seeds. There are several areas in Indonesia with a potential for growing more pigeonpea, especially in the drier eastern islands.

Production Constraints

Groundnut is grown as a component of cropping systems, mainly as a complementary crop. About 50% of the harvested area is still sown to local low-yielding and small-seeded varieties. Most farmers cannot afford to purchase improved varieties. Generally, they sow seeds from their own field or purchase seeds of questionable quality from the market.

Disease is a serious production constraint, and has led to estimated losses of 25 to 50%; in some places this has led farmers to change to other crops, such as mung bean or cowpea. The most common groundnut diseases are PStV, leaf spot, and rust, against which farmers rarely take control measures. Bacterial wilt is a serious problem in germplasm introduced to the country, but all 10 recommended varieties are resistant to bacterial wilt.

Because it is sown in the dry season, groundnut is frequently subject to unreliable rainfall. Yields are much lower in areas where the soils suffer from potassium (K) deficiency, such as in East Java.

In the drylands (outside Java island) the major soil for growing grain legumes is the red/yellow Podzol, an acidic soil which is low in phosphorus (P) and calcium (Ca). Despite the positive response of groundnut to P and Ca application shown in experiments, only a few farmers apply fertilizer.

National Research Priorities

Among the legume crops, soybean still receives most attention. An attempt to define the importance of the constraints to groundnut production in different agroecological regions was made by the National Coordinated Research Program during a workshop organized by the Central Research Institute for Food Crops (CRIFC) at Bogor in June 1988. The legumes program will be reviewed in detail at our annual planning workshop and updated according to new research results, feedback from on-farm research, changes in government policies, and improvements in research facilities and skills.

Based on the constraints identified, the main groundnut research issues, in order of priority, are: crop establishment improvement; adaptation to different farming systems and agroecological conditions; crop management improvement; improvement of seed availability and quality; increased yield potential; improvement of grain quality and reduction of postharvest losses; groundnut production economics; and groundnut utilization.

During the CRIFC workshop it was decided that the National Coordinated Grain Legumes Program would be responsible for coordinating all grain legumes research activities in Indonesia.

Suggestions for Improving Collaborative Research Links

Significant progress has been made through collaboration with ICRISAT and ACIAR on screening groundnut germplasm for PStV resistance and on improving cultural management practices for pigeonpea. Suggested priorities for future collaboration are: breeding groundnut varieties for disease resistance; developing early-maturing pigeonpea with resistance to *Helicoverpa* and *Maruca* species; studying the effect of drought on groundnut; studying alternative uses of pigeonpea; and studying groundnut yield losses from disease. Training is needed in pigeonpea pest management, cultural management practices for pigeonpea, and control of groundnut diseases.

Nepal

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Introduction

Informal links between Nepal and ICRISAT date back more than a decade. The improvement of pigeonpea and chickpea, which are mandate crops of Nepal's National Grain Legumes Improvement Program (NGLIP), has featured strongly from the start More recently, informal links were formed between ICRISAT and the National Oilseeds Development Program (NODP). These links were formalized by the signing of a memorandum of understanding between Nepal and ICRISAT in December 1987.

Achievements in Collaborative Research

Materials. Twelve trials of chickpea, eight of pigeonpea, and six of groundnut were conducted in 1987/88, using materials sent by ICRISAT. Good links have also been established between NGLIP and IRRI, and NGLIP regularly receives materials for testing from IRRI's cropping systems program. NGLIP also has links with several other international centers, including IITA and ICARDA. Both NGLIP and NODP receive donor agency support from IDRC; NODP also receives support from the World Bank.

Grain legume production in Nepal has already begun to benefit significantly from the materials developed at ICRISAT. For example, out of four chickpea cultivars released so far in Nepal, one was from ICRISAT (ICCC 4), two were local selections and one was from India (JG 74). Many more materials are in the pipeline for release in the near future.

Training and monitoring. An in-service training course on chickpea, pigeonpea, and lentil was held at Parwanipur in March 1988. The course was sponsored by ICRISAT and organized by NGLIP, and among the instructors were scientists from ICRISAT, ICARDA, and the National Agricultural Research Services Center (NARSC). Later that month a joint monitoring tour of chickpea and pigeonpea trials, both on station and in farmers' fields, was conducted by ICRISAT and NGLIP scientists. A similar tour of groundnut trials was conducted in September 1988.

Exchange of scientists. NGLIP has benefited greatly from the outposting of an ICRISAT chickpea breeder for a year, and periodic visits by other ICRISAT scientists have contributed to chickpea, pigeonpea, and groundnut improvement in many ways. Unfortunately, Nepalese scientists have not been able to take full advantage of scientist-exchange and training opportunities at ICRISAT, primarily because of the lengthy bureaucratic procedure for officially nominating participants from Nepal.

Crop improvement Varietal improvement in chickpea was the major research activity during 1987/88. Chickpea lines ICCL 82108, 85403, and 85225 performed well in multilocational advanced yield trials carried out in the Tarai region, indicating relatively wide adaptation and high yield potential. The varieties ICCC 4 and JG 74 have been renamed Sita and Radha and released for the dry Tarai environment. The line ICCL 82108 performed well in coordinated varietal trials and farmer field trials in both the humid and dry areas of the Tarai, and this line is now being considered for release. The major biotic constraints to chickpea production in Nepal have been identified as botrytis gray mold, *Helicoverpa* pod borer, nematodes, and fusarium wilt; no resistant lines were identified in screening nurseries for the first three of these, but some lines resistant to fusarium wilt were identified. Agronomic experiments carried out on intercropping chickpea with linseed and wheat gave high returns.

Pigeonpea crops in Nepal are severely affected by sterility mosaic disease and insects, particularly podfly and *Helicoverpa* pod borer. The ICRISAT line ICPL 366, which was found to be both high yielding and resistant to sterility mosaic disease, is one of the long-duration varieties which is a likely candidate for release. The sterility mosaic disease screening nursery at Rampur has enabled some resistant lines to be identified. Short- and medium-duration varieties of pigeonpea showed good adaptability when grown during the postrainy season.

The groundnut lines ICGS 36, ICGS(E) 52, and ICGS(E) 56 were found to be both early maturing and high yielding. The line ICGS 36 has emerged as a likely candidate for release. Lines ICGV 86564, ICG 156 (M 13), ICGV 86550, and ICGV 86027 showed promise as confectionery types. At Nawalpur, early leaf spot was found to be the major disease attacking groundnut; all the ICRISAT lines tested were found to be susceptible to early leaf spot, and the lines ICGV 87163, ICGV 87184, and ICG 7827 were also susceptible to late leaf spot.

National Research Priorities

The major research thrusts for grain legume production in Nepal will be:

- Development and promotion of high-yielding cultivars of chickpea which have stable resistance to botrytis gray mold, fusarium wilt,and *Helicoverpa* pod borer
- Identification of all types of pigeonpea (short-, medium-, and long-duration) for rainy- and postrainy-season cropping, with resistance to sterility mosaic disease, *Helicoverpa* pod borer, and podfly
- Development and promotion of oil type groundnut cultivars with high and stable yields, early maturity, and resistance to early and late leaf spot diseases
- Identification of high-yielding, stable confectionery types of groundnut cultivars
- Identification of other biotic and abiotic constraints, and generation of suitable technologies to overcome them
- Screening of chickpea genotypes for tolerance to acidic soil conditions and resistance to nematodes and botrytis gray mold

Suggestions for Improving Collaborative Research Links

ICRISAT should seriously consider using Nepal, with its wide range of environments, as a test-bed for other areas of Asia and the world. The posting of an ICRISAT scientist to Nepal to assist in the activities of NGLIP in 1987/88 proved to be extremely useful, and in view of the shortage of manpower within both NGLIP and NODP, we would like this arrangement to continue. Seed materials sent from ICRISAT are often received late; ICRISAT should ensure the timely despatch of seed. A specific number of training slots at ICRISAT Center should be made available for scientists from Nepal, and these should feature in the annual work plan. The annual work plan should also specify exchange visits, and these should be automatically implemented. The exchange of policymakers\should be encouraged, so as to ensure greater national commitment to the AGLN and to strengthen existing links. Regional monitoring tours and workshops should become permanent components of AGLN activities, and the use of country-AGLN coordinators for regional consultancies should be encouraged.

Pakistan

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Introduction

In Pakistan, grain legumes are cultivated almost entirely on rainfed lands and occupy 8% (1.5 million ha) of the country's total cropped area (19.32 million ha). They play a vital role in the diet of the rural poor, especially in rainfed areas, because of their high protein content and relatively low price. They are consumed in a variety of forms, including *dhal,* whole grain, green pods as vegetables, roasted grains, and confectionery products. Unfortunately, production is not keeping pace with the population growth rate of 3 % a year. The husks and broken grain of legumes are also used as animal feed.

In terms of area and production, chickpea is the principal grain legume. Out of about 1 million ha grown, 70-75% of the crop is produced in rainfed areas, where it is a major source of income for producers. Pigeonpea is currently grown chiefly as a border crop around sugarcane and cotton in the districts of Sialkot (Punjab) and Nawabshah (Sind). Groundnut, grown only in dryland areas, occupies about 63 000 ha, from which 75 000 t are produced annually. About 84% of the groundnut area is in Punjab, 11 % in the North West Frontier Province, and 5% in Sind.

Production Constraints

Grain legume production in Pakistan suffers from a number of constraints. In the case of chickpea and groundnut these constraints have resulted in production remaining static during the past 10 years.

Chickpea. The production constraints affecting chickpea are the lack of: reliable rainfall; productive land; improved cultivation practices; suitable cultivars; effective pest management; input supplies; technology transfer; trained scientific manpower; adequate resource allocations; labor availability; adequate credit facilities; and transport and marketing facilities.

Pigeonpea. The problems affecting pigeonpea are the shortage of: short-duration varieties; production technology; adequate resource allocations; trained manpower, and price support

Groundnut. Groundnut production suffers from a lack of: reliable rainfall; short-duration varieties; certified seed; sufficient inputs; and appropriate cultural practices.

Collaborative Research

Pakistan's federal and provincial institutions are actively involved in chickpea and groundnut research through a cooperative program headed by national coordinators. Scientists from the federal and provincial research institutes/stations meet annually before the growing season to formulate chickpea and groundnut cultivation recommendations and discuss future research plans. The Pulses Programme at the National Agricultural Research Centre (NARC) in Islamabad is screening short-duration pigeonpea genotypes for their yield potential, with special emphasis on yield stability.

Regional and international links are also provided through the national coordinators. These links are:

- Cooperation with ICRISAT in terms of research materials, literature, and training with regard to desi chickpea, pigeonpea, and groundnut
- Provision by ICARDA of kabuli chickpea material and training
- Provision by ACIAR of early-maturing pigeonpea material

The IDRC, ADB and the Canadian International Development Agency (CIDA) have provided the funds to conduct grain legume research. Funds are also provided under the FAQ's RAS/82/002 project and the United Nations Development Programme (UNDP).

Research Achievements in 1987/88

Chickpea. Over 15 000 crosses were made to create genetic diversity and 275 hybrid seeds were obtained. The F_1, F_2, and F_3 generations were harvested on a single plant basis; F_4 was bulk harvested. Promising material selected from these hybrid lines was used in preliminary yield trials. Out of 44 lines, two genotypes (ICCL 82317 and PK 51832 x CM 72) gave higher yields than the control variety. National trials were conducted and KC 1285, DC4, and CM1 were selected as candidate varieties for release.

A total of 534 entries of local chickpea germplasm, 57 crosses (F_3, F_4, F_5, F_6, and F_7), and chickpea screening nurseries containing national and international material were evaluated for resistance to ascochyta blight *(Ascochyta rabiei).* Rip 82-291C, Flip 82-144C, Flip 82-140C,NEC 138-2 (Karak),ICCL 83156, CM 107-2/80, CM 342/80, CM 707/82, CM 973/82, CM 976/82, 87037,87071,87111, 87136, 87145,87147,87157,87158, 87164, Rip 84-796, ICC 4181, and ICC 4475 showed resistance to ascochyta blight. The cross PK 51863 x NEC 138-2 showed resistance and was free from pod infection. In view of the existence of different biotypes of ascochyta blight, blighted debris from five locations was collected and tested. It was concluded that a biotype collected from Attock was themost aggressive.

Unlike chemical pesticides, biological or bacterial insecticides cause no pollution hazards and no danger to beneficial insects. In one experiment results Showed that the application *of Bacillus thuringiensis* on small larvae of the chickpea pod borer *(Helicoverpa armigera)* could be useful, and further studies will be carried out. The population dynamics of this pest are being studied. Preliminary trap experiments using pheromone indicated that *H. armigera* adults started to emerge from the second week of February, reaching peak levels on 17 March 1988. In a trial to test sowing dates and genotypes, PK 51832 x CM 72 sown on 10 November gave the highest yield.

Pigeonpea. Little interest is shown by farmers in growing pigeonpea as a sole crop. The local cultivars do not fit into existing farming systems. There is a need to replace the late-maturing landraces with early-maturing, high-yielding, and better-adapted genotypes. The Pulses Programme at NARC is actively involved in screening short-duration pigeonpea genotypes supplied by ICRISAT. Prospects for expanding pigeonpea cultivation exist because it is well adapted to rainfed agriculture, and could fit well into several crop combinations.

Groundnut. The Barani Agricultural Research and Development (BARD) project at NARC evaluated 700 germplasm lines from ICRISAT for yield and adaptation to conditions in Pakistan. Of these, 50 were selected and evaluated in yield trials at different locations; varieties BG 1, BG 2, and BG 3 are now being registered with the National Seed Registration Department. BARD has also developed improved groundnut cultivation practices and has placed major emphasis on developing machinery, including a multi-seed planter, a hand-sheller (based on an Indian model), a power thresher, and diggers.

Under the BARD project, one scientist is engaged in graduate training, and another received 6 weeks training in agronomy and farming systems research (FSR) at ICARDA. The first national groundnut workshop, traveling seminar, planning and strategy meeting, and field days were conducted under this project in 1986.

Research Priorities

The research priorities for AGLN crops in Pakistan are:

- Evaluation of germplasm for drought tolerance, iron deficiency tolerance, high yield potential, and resistance to diseases and insects
- Development of varieties responsive to high input levels, such as irrigation, high plant density, and fertilizer
- Selection of suitable genotypes for intercropping and monocropping
- Selection of cold-tolerant varieties, especially in late-maturing pigeonpea and in chickpea
- Nitrogen fixation, specificity, and efficiency in different environments
- Development of improved packages of technology to raise the production of AGLN crops at farm level
- Introduction of an improved package of technology to farmers through demonstration trials at their farms, and links with FSR programs
- Identification of different biotypes of ascochyta blight in chickpea
- Biological control of *Helicoverpa armigera* using *Bacillus thuringiensis* as an insecticide

The Philippines

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Introduction

The major legumes in the Philippines are soybean, mung bean, and groundnut Because of their high protein content, they remain important sources of cheap, nutritious food for people, and of raw feed ingredients for poultry and swine.

Groundnut, known locally as *mani,* is one of the most widely grown grain legume crops in the Philippines. The crop area in 198S was estimated at 50 210 ha, with an average yield of 0.90 t ha^{-1}. This comparatively low yield is attributed to the use of low-input technology by local groundnut farmers and to intercropping with other upland crops such as maize and cassava, rather than cultivation as a primary crop. About 66% of the groundnut production is consumed as food, 26% is used for animal feed, and 8% is used as seed.

Pigeonpea is still a minor crop, grown mostly in the hills of northern Luzon, Panay, the Negros Islands, and southern Mindanao. Chickpea has performed well in trials but is yet to be introduced in some suitable areas of the country.

Achievements in Collaborative Research

There are 12 international research agencies and programs collaborating with the National Research and Development System (NRDS) through the Philippine Council for Agriculture, Forestry, and Natural Resources Research and Development (PCARRD) in grain legumes research and development. Those with an interest in groundnut are: ICRISAT, IDRC, UNDP/FAO's RAS/82/002 project, the Agricultural Support Services Project (ASSP) of the World Bank, and some projects supported by the United States Agency for International Development (USAID), namely the Peanut-CRSP, the NifTAL program, and the Rainfed Resources Development Project

Collaborative efforts take the form of germplasm exchange, provision of funds for research projects, manpower development and training, equipment support, and exchange of scientists, new technologies, research findings, and methods.

PCARRD has collaborated with ICRISAT since the signing of a memorandum of understanding in 1975. Collaboration covers germplasm exchange, adaptive trials, and non-degree training. Between 1985 and 1987, researchers and AGLN collaborators in the Philippines received 26 lines and accessions of groundnut, 285 of pigeonpea, and 45 of chickpea. These materials were included in the various trials of agencies such as the Department of Agriculture, Mariano Marcos State University, and the University of Southern Mindanao. Training opportunities offered by ICRISAT have allowed Filipino researchers to participate in courses at ICRISAT Center; in the past decade 24 researchers have benefited from ICRISAT's training program, notably from in-service fellowships in different disciplines.

The National Cooperative Testing (NCT) project which is funded by ASSP serves as a testing ground for germplasm acquisitions. Through the NCT project, the best entries in terms of yield and other agronomic characters are approved and released by the Philippine Seed Board as varieties recommended for commercial use. The latest variety of groundnut (UPL-Pn6) to have undergone testing in several locations is now being promoted through the Peanut Development Action Project (PDAP), which is funded and coordinated by PCARRD.

Some groundnut lines from ICRISAT are among those found promising in the screening trials for shade tolerance in rainfed areas. This project is being funded by the Rainfed Resources Development Project of USAID. Some pigeonpea lines from ICRISAT were identified as high yielding, drought resistant, and adaptable under the dry conditions at Ilocos(ICPL 85016, ICPL 151, ICPL 83024, etc). This was the result of several seasons' trials conducted by state colleges, universities, and experiment stations.

Priorities for Collaborative Research

Collaborative research efforts on groundnut will continue. Varietal improvement and development, mainly through NCTs, will be pursued vigorously, as will cultural management and crop protection studies. Support will also be given to studies on postharvest handling, processing, and utilization. Technology transfer, carried out through PDAP, will demonstrate improved production and postharvest technologies at village level.

For pigeonpea and chickpea, NRDS intends to continue giving the same level of support as in previous years. The emphasis in research will be on adaptive trials in selected locations as well as on assessment of market potential and on acceptability as human food and for other uses.

Suggestions for Improving Collaborative Research Links

ICRISAT should continue to provide promising germplasm materials and other appropriate technologies, as well as training designed to refresh and upgrade research capabilities in AGLN countries. The exchange of information could be facilitated through a common publication, such as a newsletter, which would highlight results from collaborative research. Some cost-sharing would be a useful incentive to organizing collaborative trials, and some support is needed to meet the costs of holding annual review and evaluation meetings.

Sri Lanka

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Introduction

Grain legumes grown in Sri Lanka include mung bean, cowpea, black gram, soybean, groundnut, and pigeonpea. These legumes are grown under both rainfed and irrigated conditions in a variety of farming systems and environments. In comparison to cereals, however, yields are low, ranging from 0.3 to 0.91 ha^{-1} This is primarily because the varieties grown at present are not adapted to the environments; the crops are susceptible to various pests and diseases, have long maturity periods, show poor seedling vigor, and are susceptible to drought and waterlogging.

Despite these constraints, the important role of grain legumes in Sri Lanka is well recognized by the Department of Agriculture (DOA). Having achieved considerable success in rice production, the DOA is increasing its effort to improve the production of other crops, including grain legumes, and is giving priority to collaborative research with other institutions.

Achievements in Collaborative Research

Among the regional and international institutions and agencies with whom the DOA has established collaborative research links are ICRISAT, IRRI, AVRDC, IITA, the Centro Internacional de Mejoramiento de Maiz yTrigo (CIMMYT), IDRC, USAID, and FAO.

Sri Lanka has benefited from these links in the following ways:

- Improved varieties and new technology and equipment have been made available
- The procedures for the exchange of germplasm and the preservation, breeding, and testing of varieties have been strengthened
- Country-level studies on crop production have been organized
- Participation in short-term, long-term, and postgraduate courses has increased the country's trained manpower
- The exchange of information through technical reports, newsletters, meetings, workshops, monitoring tours, study tours, and scientific visits and consultancies has been developed

The training opportunities offered by ICRISAT have been particularly beneficial to the DOA. Researchers have visited ICRISAT as research fellows, in-service fellows, and in-service trainees. Many researchers have visited ICRISAT to participate in special study tours.

Links between the DOA and the AGLN were established after the signing of a memorandum of understanding in April 1987. Pigeonpea and groundnut were identified as being equally important AGLN crops in Sri Lanka, while chickpea was given lower priority. It is likely that government policies will be implemented to encourage pigeonpea production, and thus in the future this crop may be given higher priority than groundnut.

During the two cropping seasons in 1987, 28 trials of AGLN crops were conducted at 10 locations. A large number of varieties, representing a wide range of genotypic and phenotypic characteristics as well as resistance/tolerance to pests and diseases, were tested for their high-yielding ability and their environmental adaptation. Some improved varieties of pigeonpea and groundnut showed tremendous potential in terms of high yield and adaptability to Sri Lankan farming systems, but more research needs to be carried out on |chickpea.

Priorities for Collaborative Research

Pod borers *(Helicoverpa armigera)* are a serious pest of pigeonpea in Sri Lanka, and it will be difficult to introduce promising pigeonpea varieties into farming systems until an effective and economical method of controlling these pests is found.

Further testing and screening of chickpea varieties for local adaptability, high yield, and heat tolerance are necessary. Studies on sowing date, disease and pest control, and other cultural practices should be carried out The screening of segregating material (F_2) of AGLN crops should be strengthened. There should be increased access to germplasm.

Trained manpower should be increased through arranging short-term courses on specific problems identified by the country, increasing in-service training, arranging more workshops and study tours, providing support for thesis research work by postgraduate students, and providing more training on the transfer of technology. More work needs to be done, and information provided, on new forms of food and feed, and on improving agricultural implements.

Thailand

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Introduction

Only a few species of grain legumes are cultivated extensively in Thailand. They fall into two major groups: those that are produced only for domestic consumption (soybean, cowpea, and pigeonpea); and those that are produced partly for domestic consumption and partly for export (mung bean, groundnut, and rice bean).

The production of soybean in 1987/88 totalled about 300 000 t, which represents only half the country's annual requirement. Soybean is often imported in the form of bean cake. Cowpea production records have not been kept, but it is estimated that 1000 to 1200 t are produced annually, mainly for domestic consumption in the form of dry grain. Pigeonpea is grown on a small scale in certain areas. The fresh pods are used for human consumption, the dry grain for poultry feed. Some areas, especially in the north, were recently sown to pigeonpea for lac culture, which resulted in more income than production for grain.

About 300 000 t of mung bean are produced annually. About half of this (mostly green gram) is consumed locally; the rest (as well as black gram) is exported. Of the 170 000 t of groundnut produced annually, 15 000 to 20 000 t are exported. The annual rice bean production amounts to only about 30 000 t, most of which is exported.

Groundnut is the most important AGLN crop in Thailand, and has high priority. Pigeonpea has second priority, and has shown good potential in many areas, but faces the problem of marketing. Chickpea is a new crop.

Achievements in Collaborative Research

Support for collaborative research on grain legumes in Thailand comes from many sources, including ACIAR, Peanut-CRSP, ICRISAT, IRRI, AVRDC, and ITTA.

ACIAR supports soybean, mung bean, and pigeonpea research. The emphasis is on climatic adaptation and germplasm exchange in soybean and mung bean, on saturated soil culture and bacterial pustule resistance in soybean, and on varietal selection and the identification of sowing dates suitable for Thai conditions in pigeonpea. Production costs and socio-economic impact are taken into consideration. Study tours and training courses have been organized for Thai researchers, to acquaint them with research in Australia.

Peanut-CRSP supports studies on the varietal improvement of groundnut for high yields, short duration, drought tolerance, and resistance to *Aspergillus flavus,* rust, and leaf spot diseases. Pest management is also studied. Thai researchers occasionally participate in the annual Peanut-CRSP meetings held in the USA.

ICRISAT support concentrates mostly on varietal adaptation trials for groundnut and pigeonpea. The most promising cultivars are tested in Thai environments every year. Funds for annual meetings and training are also made available.

IRRI focuses mainly on research on varietal yields in rice-based cropping systems, where the grain legume is cropped both before and after rice. Groundnut, soybean, mung bean, cowpea, and pigeonpea are used in these studies. Training scholarships are awarded, and meetings and workshops are organized.

AVRDC is concerned with germplasm collection and improvement of mung bean,and soybean. Hybrid selections of both early and late generations of these crops have been tested under Thai conditions. Training courses are provided, and these have sometimes been held in Thailand in cooperation with Kasetsart University.

IITA supports varietal yield trials and germplasm collections of cowpea. Training scholarships and invitations to meetings are sometimes provided.

The support given by international and regional organizations has greatly assisted Thailand in identifying promising varieties. Three varieties of mung bean from AVRDC (VC 1973 A, VC 2778 A, and VC 1178) were released as Kampaengsan 1, Kampaengsan 2, and Chainat 60, after varietal selection and trial under Thai conditions. Two varieties of groundnut from Peanut-CRSP (Moket and NC 7) were released as Khon Kaen 60-1 and Khon Kaen 60-3 in 1987. Many promising varieties of pigeonpea and cowpea gave high yields. Among these were QPL 42, a pigeonpea variety introduced from Australia, and the cowpea varieties Red cowpea 6-1US, CP4-3-2-l and BS6, and IT81D 1228-14, from IRRI and IITA. However, these varieties have still not been recognized officially because the domestic market is so small.

Suggestions for Improving Collaborative Research Links

To strengthen collaborative research links, seminars or workshops should be held every 2 years between AGLN member countries. To facilitate participation in meetings, the international agencies should take turns to provide financial support for AGLN members to attend meetings.

Japan

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Introduction

In Japan most of the major grain legumes in the world, apart from lathyrus, horse gram, and moth bean, are consumed in various forms. They are produced domestically or imported.

The total area sown to grain legumes in Japan is about 250 000 ha, of which about 50% is occupied by soybean; this represents about 3% of the total cultivated area in the country (about 5.4 million ha). Soybean is the most important traditional legume, having been grown in Japan for over 1000 years. It has been developed to meet various non-fermented and fermented food needs, and is a major field crop in shifting cultivation systems and as an intercrop with rice. Production during the past 5 years amounted to between 220 000 and 290 000 t, which is only 30% of peak production during the pre-war years.

In its attempt to reduce surplus production of rice, the government subsidizes soybean and other crops as substitutes for rice; in 1987 former rice-growing areas accounted for about 80% of the total soybean area. Despite this policy, domestic production still meets only 5% of total demand (estimated to rise to about 5 million t in 1990), partly because of the lack of incentives for farmers. Domestic production has decreased considerably since 1961, when the government liberalized the import of soybean.

Before the Second World War, groundnut did not develop as an oilseed crop in Japan. Even now, it is regarded largely as a horticultural crop and is used mostly in confectionery. Adzuki bean is one of the oldest grain legumes found in Japan. Although its origin is not clear, it seems to have entered Japan from southern China, and is now appreciated for its beautiful red testa color. It is grown in northern Japan but its unstable yields, caused by climatic variability, make it a speculative commercial crop. Broad bean and pea were introduced to Japan in ancient times, and are now grown and consumed as vegetables, snacks, and confectionery. However, domestic production is falling owing to competition from imports. About 40 000 t of mung bean and black gram are consumed per annum, but 90% or more of this is imported from Southeast Asia.

Groundnut Production Constraints

Production of groundnut in Japan has been affected by low profitability, adverse environmental and/or biological factors, and socio-economic problems. Concentrated in central Japan, groundnut production meets only about 50% of total demand (estimated to rise to about 180 000 t in 1990). Imports will be liberalized in the near future, and this will lead to a further decline in domestic production. Already, increasing imports of processed groundnut products are inflicting losses on small-scale processors dealing in the domestic Virginia type.

Research Priorities

Most national research is devoted to soybean; research on groundnut has a lower priority. Since 1980, mung bean, black gram, and chickpea have been added to the research agenda. Cultivation and seed production of pigeonpea, horse gram, mung bean, and guar are being studied at Kochi in southwestern Japan, for the use of their foliage and/or as soil-improvers. However, research interest in tropical grain legumes is generally low, being limited to work in universities on biological nitrogen fixation and nutrient uptake, and to agronomic studies at the Okinawa Branch of the Tropical Agriculture Research Center, located in subtropical Japan.

Soybean. Research in various areas (including breeding, physiology, biological nitrogen fixation, introduction into fallow rice fields, cultivation technology, role in mixed cropping systems, environmental constraints, processing, and quality) is conducted by the Ministry of Agriculture, Forestry and Fisheries (MAFF). Between 1939 and 1988 a total of 91 cultivars were released, and there are many local recommended cultivars suitable for diverse uses. Average yields are not very high (<2000 kg ha^{-1}). Research on postharvest technology and biotechnological improvement of amino-acid and fatty-acid composition started in 1985.

Groundnut This is valued as a low-input food crop in rotation with vegetables and forage crops, and has wide adaptability in different environmental conditions throughout Japan. Eight higher-yielding cultivars with good processing qualities were bred in the 1950s. Cultivars Norin 6, 7, and 8 are early maturing and large seeded. The physiological characteristics of new cultivars and some local ones are being investigated at Kochi Research Institute. Studies on somatic embryo formation from mature seed started in 1987. During 1989, new cultivars Norin 9 and 10, which are high yielding, widely adaptable, and more palatable than earlier cultivars, will probably be released.

Conclusion

As food self-sufficiency declines in Japan, grain legume imports are likely to increase to meet demands for use in traditional foods and in new products created by the food industry. Because of this increasing reliance on grain legume imports, Japan welcomes the continued exchange of information on grain legume research among AGLN countries.

ICRISAT REPORTS

Research on Groundnut by ICRISAT with Special Emphasis on Problems in Asia

D. McDonald and S. N. Nigam

Legumes Program

Over the 10-year period from 1976 to 1986, groundnut production in Asia increased by about 6 million t, reflecting an average annual growth rate of 5%. Nearly half of this increase came from expansion of the area cultivated. Demand for groundnut in Asia is expected to increase at a compound rate of about 4% annually, and as the prospects for increasing the cultivated area are limited, it will be necessary to increase yield per unit area. Fortunately, there is considerable scope for increasing farmers' yields, as the present average yield of just over 1 t ha^{-1} dried pods is well below the potential 6 to 8 t ha^{-1} that can be achieved on research farms when yield constraints are removed.

Constraints to production have been identified as:

- Damage by diseases and pests
- Unreliable rainfall patterns, with recurring drought
- Nutritional stresses
- Poor agronomic practices, with limited use of fertilizers
- Lack of high-yielding adapted cultivars

At ICRISAT we are integrating plant breeding, plant pathology, entomology, microbiology, physiology, and cytogenetics research to produce high-yielding adapted cultivars with stable resistance or tolerance to the major stresses presently limiting production. Our groundnut scientists cooperate with economists, cropping systems specialists, and agronomists to develop crop management systems suited to small farmers. The world collection of groundnut and wild *Arachis* germplasm provides the basis for improvement of the crop.

Drought and several of the major diseases and pests of groundnut are worldwide problems and are being studied intensively at ICRISAT. Problems more specific to particular regions are being worked on in ICRISAT regional programs or through cooperative research with national programs. The program at ICRISAT Center works closely with the ICRISAT Regional Groundnut Program for Southern Africa, set up in Malawi in 1982, and the West African Program, set up in 1986. There is a regular flow of improved germplasm between the Center and the regional programs, and effective variety evaluation networks have been established.

In Asia, variety evaluation is coordinated through the AGLN. Links have been established with national scientists in most groundnut-growing countries of Asia, and there is cooperation with other international and regional organizations. Information is exchanged through the *International Arachis Newsletter,* meetings are held, and visits are arranged.

Diseases

Foliar diseases. The world collection of over 12 000 accessions has been screened for resistance to rust and late leaf spot diseases. There are 78 lines with good resistance to rust, 34 lines with resistance to late leaf spot, and 31 lines with resistance to both diseases. Interspecific hybrid derivatives with high resistance to rust and/or late leaf spot have also been bred. The sources of rust and late leaf spot resistance have been used in a breeding program, and lines combining the resistances with good agronomic characters are now in international trials. Two cultivars, ICG (FDRS) 4 and 10, are likely to be released soon in India.

An epidemic of early leaf spot at ICRISAT Center in 1987, and the establishment of a collaborative field resistance screening project at Pantnagar in northern India, have accelerated work on this disease. Significant levels of resistance have been found in 15 germplasm lines, and some interspecific hybrid derivatives are showing promise in preliminary trials. Some lines also show resistance to rust and late leaf spot. Several of the sources of resistance have been used in a breeding program.

Studies continue on the influence of environmental factors and agronomic practices on the development of foliar diseases. Stability of resistance to early leaf spot, and possible occurrence of different races of the pathogen, will be studied through collaborative research with the Institut de recherches pour les huiles et oleagineux (IRHO) in France in 1989.

Diseases caused by soil fungi. Field screening of germplasm lines under naturally occurring outbreaks of a pod rot complex caused by *Fusarium* spp, *Macrophomina phaseolina, and Rhizoctonia solani* has identified several resistant lines, some of which also have resistance to pod and seed invasion by *Aspergillus flavus.*

More recently, field screening of germplasm and breeding lines against *Sclerotium* *rolfsii* with artificially enhanced inoculum levels has identified susceptible and moderately resistant material; *S. rolfsii* stem and pod rots are most serious in groundnuts grown on Vertisols, and it is important that advanced breeding lines be checked to eliminate unduly susceptible material before release.

Aflatoxin contamination. Factors influencing the invasion of groundnut pods and seeds by the aflatoxigenic *A.flavus* have been studied in relation to genetic resistance and cultural control measures. The importance of drought in relation to preharvest contamination has been confirmed, and drought stress has been used to enhance resistance screening methods. Several germplasm lines with resistance to seed invasion by *A.flavus* have been identified and used in a breeding program, and some breeding lines have good levels of resistance. Crosses have been made to combine seed-coat resistance to *A. flavus* infection with low capacity to support aflatoxin production. A data base on published information on aflatoxin in groundnut is in preparation.

Bacterial wilt. In cooperation with Indonesia, the People's Republic of China, and ACIAR, an international collaborative approach to research on bacterial wilt disease will be initiated.

Virus diseases. Bud necrosis disease (BND) caused by tomato spotted wilt virus (TSWV) is economically important in South and East Asia. Several high-yielding germplasm and breeding lines with resistance to the thrips vector of BND have been tested for resistance to TSWV, and lines ICGV 86029 and 86031 were shown to be tolerant. Peanut mottle virus (PMV) is distributed worldwide and can cause significant yield losses. Several germplasm and breeding lines showing non-seed transmission and tolerance to PMV have been identified. Serological tests have been developed for the detection of peanut clump virus. Solarization was found to be effective in controlling this disease. PStV is currently recognized as one of the most important groundnut diseases in Southeast Asia. Screening for resistance to PStV through international cooperation is in progress in Indonesia.

Pests

Particular emphasis has been placed on the development of pest control strategies that do not involve the use of pesticides, or at least rationalize their use. The primary aim is to introduce pest resistance into zonally adapted varieties. Germplasm lines with resistance to the major pests that attack the leaves and stems of groundnut plants (jassids, thrips, and leaf miner), and to some soil insects that attack below-ground parts (termites and pod borers), have been identified and are being used in breeding programs. Progress has been made in defining the mechanisms of pest resistance.

Investigations on the feasibility of combining host plant resistance and natural control by the use of parasites and predators are under way, the aim being to keep pest populations down to levels that do not reduce yields. The effects of cropping patterns (monocrop, multicrop, intercrop, etc) on pest populations are also under investigation. Studies are being conducted to determine the damage thresholds of *Spodoptera litura.* Collaboration between entomologists and virologists has led to an increased understanding of the role of thrips as the vector of TSWV. Bruchid *(Caryedon serratus)* is a serious storage pest of groundnut in peninsular India, and all lines prepared for release are screened against this pest.

Drought

Research on the physiological basis for genetic differences in drought response has had considerable impact on drought screening at ICRISAT Center. Drought-tolerant lines have been identified and used in breeding for improved drought resistance. Some lines with resistance to foliar diseases have also shown drought tolerance. The greatest opportunity for improving genotypes for use in drought-prone areas lies in capitalizing on the ability to recover from mid-season drought. This attribute is therefore being used in screening breeding materials. Research is focused on root respiration and growth, the mechanisms determining recovery from drought, and water use efficiency. Photoperiod also influences drought responses, and genotypes are being screened for photoperiod insensitivity.

Nutrient Stresses

Biological nitrogen fixation is not usually a limiting factor to groundnut production in locations with a history of groundnut cultivation. Genotypic differences in the rate of nitrogen fixation are dominated by leaf area effects (90% of variance); the differences directly attributable to genotypes are small (2-6%).

Iron chlorosis has been shown to be caused by two mechanisms, high soil pH and periodic waterlogging. Genotypic differences in susceptibility to iron deficiency exist, and limited screening of breeding lines has been initiated.

Calcium deficiency is a major limiting factor for groundnut production in some countries. Research was initiated to investigate reported genotypic differences in the calcium uptake efficiency of pods. Consistent and significant genotype x drought x gypsum interactions have been demonstrated.

Breeding for Adaptation to Specific Environments

Breeding for adaptation to specific environments is still the major breeding activity at ICRISAT Center. Most of the progress so far has been made in breeding cultivars under non-stress situations, or where stresses can be overcome by management. Using these cultivars as base material, and other improved breeding lines with resistance/tolerance to single-stress factors, it is now intended to develop lines with multiple resistances.

Early-maturing varieties are advantageous in areas where the growing season is short, or the crop is grown under a residual soil-moisture regime or in multiple cropping systems. Time-to-maturity is dependent upon temperature regime, solar radiation, moisture, and other factors during the growth period. Use of cumulative heat units (degree days) has been effective in determining maturity. Several early-maturing cultivars have been developed, and are being evaluated in international trials. In addition to supplying stable cultivars, the ICRISAT program also supplies segregating populations from crosses made to combine desired traits with adaptation factors from cultivars bred in client scientists' countries.

Progress has been made in the development of medium- and late-maturing cultivars. Two lines, ICGS 11 (ICGV 87123) and ICGS 44 (ICGV 87128), have been released for postrainy-season cultivation in India. Cultivars awaiting release for rainy-season cultivation are ICGS 1 (ICGV 87119), ICGS 5 (ICGV 87121), and ICGS 11 (ICGV 87123). Progress has also been made in developing cultivars for confectionery purposes, and several lines have shown good performance in international trials.

Agronomy and Crop Production

Scientists in ICRISAT's Groundnut Group cooperate with those of the Center's RMP in providing cultivars and advice to enable national program scientists to put together management systems appropriate to local conditions. Practical experience in this area will be provided in the report by the Legumes Program's LEGOFTEN unit.

Chickpea Research at ICRISAT

C. Johansen

Legumes Program

Chickpea research at ICRISAT aims to enhance the capabilities of national programs to increase the production and profitability of chickpea, particularly for low-income farmers. Efforts are directed towards both genetic and management improvement. ICRISAT staff contributing to this research are not only from the relevant disciplines within the Legumes Program (breeding, agronomy, entomology, and pathology) but also from the RMP (economics, soils, and agronomy), the Genetic Resources Unit (GRU), and the Biochemistry Unit Much of the research is done collaboratively with national programs, mainly in India but also in other countries.

The basis for genetic improvement efforts at ICRISAT is provided by the germplasm collection maintained by the GRU. This collection currently comprises over 15 000 accessions of chickpea and related species. In addition to standard characterization of all accessions by GRU scientists, the various disciplines make extensive use of this collection in screening for desirable traits. Priority is increasingly being given to germplasm enhancement, primarily of pest and disease tolerances. Seed material and associated information (the latter available from a computerized data base or from a recently published chickpea germplasm catalog) are made available on request to all chickpea researchers.

Perhaps the major reason for low and unstable yields of chickpea is susceptibility to particular pests and diseases. *Helicoverpa armigera* is a major insect pest of chickpea, particularly in South Asia. ICRISAT's research efforts have concentrated on identifying host plant resistance to this pest, and several tolerant genotypes have been identified. Studies are continuing on the mechanisms of this resistance. Fusarium wilt is the most important disease of chickpea worldwide, and many sources of resistance have been found after screening of chickpea germplasm in extensive wilt-sick field nurseries at several locations. The breeding program has successfully incorporated this resistance into a wide range of otherwise desirable plant types, including kabuli types, which were hitherto considered to be susceptible to wilt Sources of resistance have also been identified for other important yield-reducing diseases, such as root rots and stunt virus. The breeders are combining these sources to produce cultivars with multiple disease resistance (e.g. ICCC 37). Importantly, increased efforts are being made to combine wilt and *Helicoverpa* resistance, a particularly difficult task because, for unknown reasons, *Helicoverpa* resistance appears to be linked with wilt susceptibility.

In South Asia less progress has been made in developing varieties with stable resistance to the major foliar diseases, ascochyta blight and botrytis gray mold. Despite extensive screening, only low levels of tolerance have been found, and even this appears unstable across locations and over time. In trying to develop resistance to ascochyta blight we are working closely with scientists in the Indian national program, with scientists in a project in Pakistan funded by ADB, and with ICARDA in Syria. There has been more success in identifying ascochyta blight resistant cultivars at ICARDA for the Mediterranean region. Work on integrated management of the foliar diseases in South Asia is in progress. Recently, work has begun on nematode diseases of chickpea, involving surveys, estimates of yield loss, and identification of host plant resistance.

Although our emphasis is on exploiting host plant resistance against the major pests and diseases, these efforts are complemented by research on ecology, epidemiology, genetics, and management.

The major abiotic constraint faced by chickpea in the Asian tropics is drought stress. Our first approach to this problem is to identify genotypes that can escape drought stress by reaching maturity before soil moisture is exhausted. A particularly promising example developed by breeders is the short-duration ICCV 2. Under peninsular Indian conditions it matures within 75 days; it is also a kabuli type with wilt resistance. Within the short-duration maturity group, drought-tolerant genotypes have also been identified and there is a breeding program to specifically enhance drought tolerance. It seems that a more extensive root system is the main character conferring drought tolerance.

We have also demonstrated that, in peninsular Indian environments where there is no threat of foliar disease, judicious application of irrigation, in relatively small amounts compared to the requirement for crops such as wheat, can result in high and stable yields (>2 t ha^{-1}). However, as chickpea is likely to remain predominantly a rainfed crop, we are concentrating our efforts on the genetic enhancement of drought tolerance. In addition to seeking plants that are better able to exploit receding soil moisture, we are also screening for genotypes that establish better where seedbed moisture conditions are limiting — often a major constraint to obtaining satisfactory plant stands in farmers' fields. In subtropical environments, where long-duration genotypes are normally grown, cold temperatures delay pod set, and thus pod-filling is postponed to a period when high temperatures and drought become limiting. By identifying genotypes capable of setting pods during the cold period we are hoping to develop cultivars that mature earlier. Such genotypes would be less prone to lodging, have a higher harvest index, and better avoid foliar diseases, *Helicoverpa* damage, and terminal heat and drought stresses.

Studies on the ecology of chickpea rhizobia have revealed that, even though these bacteria specifically nodulate chickpea, once introduced to the soil they colonize it effectively, even in the absence of the chickpea host. This in part explains why in many instances chickpea does not respond to rhizobial inoculation. At ICRISAT we also maintain an extensive germplasm collection of chickpea rhizobia, for which a catalog will soon be available, and have developed methods of multiplication, distribution, and inoculation appropriate to tropical conditions.

Mainly through the use of ^{15}N techniques, we are hoping to detect genotypes with improved nitrogen-fixing capacity, not only to meet the nitrogen needs of the chickpea plant throughout its growth period but also to increase the quantities of nitrogen fixed for use by subsequent crops. Non-nodulating genotypes of chickpea have now been identified. These are being used as non-fixing controls to quantify fixation by different chickpea cultivars.

Of the other plant nutrients besides nitrogen, we have studied only iron and phosphorus in any detail. There are large genotypic differences in susceptibility to iron chlorosis. In the breeding program, susceptible types are visually selected against because progenies are normally grown on alkaline soils, where this problem is prevalent, and iron chlorosis symptoms are quite distinct. Detailed studies on phosphorus responses of chickpea are being conducted by a special project funded by Japan. Even in soils of low apparent phosphorus status, chickpea is often able to meet its phosphorus requirements without the addition of phosphorus fertilizer because of its well-developed root and mycorrhizal system and its ability to produce acid exudates which solubilize phosphorus in alkaline soils.

Many chickpea-growing regions are subject to soil salinity. We have been screening chickpea genotypes and related wild species for salinity tolerance but, as yet, have been unable to identify any substantial sources of tolerance.

Work is in progress to increase chickpea productivity through improved cropping systems. A particularly successful example of this has been the development of winter sowing for the Mediterranean region by the ICARDA/ICRISAT collaborative effort This depended on the identification of genotypes tolerant to ascochyta blight and cold stress as well as developing an appropriate agronomy for the system. In South Asia, we are trying to adapt chickpea for rice fallows, late sowing in subtropical environments, and early sowing in the peninsular Indian environment. For the latter case, we have demonstrated the yield advantage of sowing earlier than the normally recommended time, and have identified genotypes better suited for this.

Through our international trials network we supply elite breeding materials as well as segregating populations. This has resulted in the identification for release of 11 cultivars in India, Nepal, Bangladesh, Burma, Ethiopia, and Kenya. For example, cooperation with the AH India Coordinated Pulses Improvement Project (AICPIP) has led to the release in India of ICCV 1 and ICCV 6. These trials also provide knowledge on genotype x environment interactions. These are generally large for chickpea, and their interpretation depends on detailed agroclimatic analysis, an area where we are increasing our research emphasis.

Studies are continuing on the development and refinement of methods appropriate to the genetic enhancement of chickpea. Examples include inheritance of disease resistance, early-generation testing, desi x kabuli introgression, use of male sterility, mutation breeding, diversified bulk population breeding, and biotechnological techniques. For better definition of desirable plant types, we are conducting studies on appropriate canopy structure, capacity for rapid early growth, and podding characteristics.

ICRISAT's Biochemistry Unit compares genotypes for various quality characteristics, such as milling properties, cooking characteristics, and chemical contents. Although genotypic differences in seed protein can be detected in chickpea, environment has a large effect on this parameter. In the past we have not given enough emphasis to demand-related aspects of chickpea production, but we hope in the future to become more involved in market analysis and plotting of economic trends in chickpea production.

All scientists in the chickpea improvement group at ICRISAT actively participate in the activities of the AGLN and the LEGOFTEN unit, and in the technology transfer process in general. There is regular exchange of knowledge and information with scientists of national programs through seminars, workshops, meetings, visits, and the *International Chickpea Newsletter.* ICRISAT collaborates closely with ICARDA in the improvement of the kabuli chickpea for Mediterranean environments; two ICRISAT scientists, a breeder and a pathologist, are stationed at ICARDA headquarters in Syria. An ICRISAT scientist is also stationed at the ADB-funded project in Pakistan. At ICRISAT Center, chickpea scientists are regularly involved in training courses for in-service and other trainees.

Pigeonpea Improvement Research at ICRISAT

Laxman Singh

Legumes Program

Pigeonpea improvement research at ICRISAT aims to enhance production per unit area/ time, promote multiple uses (dry grain, green vegetable, fuel, and fodder), and ensure adaptation to various cropping systems, ranging from commercial mechanized production to intercropping and alley cropping. The stability and sustainability of enhanced production is ensured through the identification and incorporation of tolerances or resistances to biotic stresses (diseases and pests) and abiotic stresses (drought, salinity, and waterlogging). A multidisciplinary team of scientists contributes to the development of cultivars in short-, medium-, and long-duration phenological groups. The disciplines involved are agronomy, breeding, entomology, and pathology. Pigeonpea scientists also cooperate with ICRISAT's Biochemistry Unit, GRU, and RMP.

In this paper, we highlight available technology for improving pigeonpea production and consider how to meet the needs of national programs in AGLN countries. The adaptation of known technology and the identification of priorities for future research will, however, require critical analysis of production systems, environments, and utilization/ market potential in target areas.

Genetic resources. Over 10 000 accessions of pigeonpea are available in the gene bank at ICRISAT, which contains land races from all over the world, as well as improved genotypes with special characteristics such as high protein content (25-28%), tolerance to drought and salinity, and large seed and pod size for vegetable purposes. We supply genetic material free of charge to national research programs on request. It must be emphasized, however, that for proper use of material a thorough understanding of environments and production systems is necessary. The AGLN assists national programs and ICRISAT scientists in bringing cooperating scientists together for such a collaborative activity.

Improved cultivars and management. We will first consider available improved cultivars according to the time they take to reach maturity.

Extra-short-duration cultivars mature in 90 to 95 days at 17°N latitude, and are relatively insensitive to photoperiod and temperature variations. They are suitable for multiple cropping systems at higher latitudes (up to 40°N) and altitudes. Mean productivity over several environments (different sowing dates and locations) ranges from 1.5 t ha^{-1} to 4.0 t ha^{-1}. Particularly promising genotypes are ICPL 84023, 83006, 86009, 83015, and 85030.

Short-duration cultivars mature in 100 to 120 days at 17°N latitude. They are suitable for multiple cropping (as in wheat rotations) and multi-harvest (good ratoonability). Particularly promising genotypes are ICPL 87, 151, 87109, 87107, 86012, and 85027 (determinate), and ICPL 87114, 87115, and 85058 (indeterminate). As these short-duration varieties have not been previously available we have developed a package of agronomic practices to go with them.

Medium-duration cultivars mature in 160 to 180 days. Lines which are resistant to fusarium wilt and/or sterility mosaic disease, are tolerant to *Helicoverpa* pod borer, and have white seeds for vegetable and grain purposes are available. They are suitable for intercropping with sorghum and millets. Particularly promising genotypes are ICPL 270, 227, 84060, 870666, 87088, ICP 8863, and 7035.

Long-duration cultivars that perform well when grown as a perennial crop mature in 250 days or more. Lines which are resistant to sterility mosaic disease and/or fusarium wilt and are suitable for intercropping and alley cropping are available. Particularly promising genotypes are ICPL 366 and ICP 8094.

We have male sterile lines that have produced hybrids with more than 20% hybrid vigor for grain yield. These lines have been used by the private seed sector in India to produce commercially viable short-duration pigeonpea hybrids.

Work is in progress to understand and develop improved plant types with better assimilate partitioning capacity, higher growth rate, and improved biomass production potential, Short-statured types are also being developed for each maturity group.

Useful levels of salinity tolerance have been identified in pigeonpea (ICPL 227) and in *Atylosia albicans,* a related wild species. We have also found large genotypic differences in medium- and short-duration groups, providing opportunities for genetically enhancing drought tolerance. A special project group funded by the Government of Japan is studying phosphorus nutrition of pigeonpea under water-limited conditions and has observed that pigeonpea can efficiently use soil phosphorus through the solubilizing effects of root exudates. Short- and medium-duration pigeonpea fix enough atmospheric nitrogen to leave 40 kg ha^{-1} N in the soil for subsequent crops.

Field, greenhouse, and laboratory techniques for screening for resistance to fusarium wilt *(Fusarium udum),* sterility mosaic disease, phytophthora blight, and alternaria blight have been developed. Sources of stable genetic resistance are available for fusarium wilt, sterility mosaic disease, and alternaria blight The search continues for stable sources of resistance to phytophthora blight

Epidemiological studies have shown that fusarium wilt fungus is internally seedborne in some varieties. F. *udum* is specific to pigeonpea and survives in the diseased stubble for about 3 years. In susceptible genotypes, intercropping with sorghum results in reduced wilt incidence (20%) when compared to sole pigeonpea (90%). Rotation of pigeonpea with sorghum and tobacco reduces wilt incidence from 90% to 16% over a 4-year period. Solar heating of the soil by polythene mulching in the hot summer months was found to reduce the incidence of fusarium wilt. Seed dressing with benomyl + thiram (Benlate T®) eradicates pigeonpea wilt pathogen from the infected seed. Tolclofos-methyl (Rizolex®) gives good protection against *Sclerotium rolfsii* when used as a seed dressing. Phytophthora blight can be effectively controlled by seed dressing, foliar application with metalaxyl (Ridomil®), and good drainage.

Several sources of tolerance or reduced susceptibility to two important pests of pigeonpea — pod borer *(Helicoverpa armigera*) and podfly *(Melanagromyza obtusa)* — have been identified, including ICPL 187-1, ICP 45-2, and 1903 E for pod borer and ICP 909 E3 and ICP 7050 E1 for podfly. In the light of resistances being developed by pod borer to particular insecticides, alternate sprays with different insecticides are available.

Integrated pest management techniques have been suggested to overcome the resistance to insecticides caused by excessive use. The techniques include:

- Restriction of the use of synthetic pyrethoids
- Careful monitoring of fields and spraying at economic threshold levels, based on counts of eggs and very small larvae
- Development of improved spraying techniques to obtain good insecticide coverage
- Avoidance of continuous cropping of *Helicoverpa* host crops

In addition, there is a need to make carbamate insecticides, especially methomyl (Lannate®), available for use on pigeonpea, and research is needed to examine the relationship between climatic conditions, *Helicoverpa* numbers, and crop phenology to enable infestations to be predicted.

Short-duration pigeonpea is being introduced and tested in several AGLN countries, in new cropping systems and different seasons. It is important that pest complexes are assessed in the different agroecological zones of Southeast Asia into which extra-short- and short-duration pigeonpea genotypes are intended to fit. This will help design relevant integrated pest management strategies.

Nematologists responded from 13 countries and seven states in India to a questionnaire on nematode diseases of pigeonpea. The root-knot nematodes *(Meloidogyne* spp), the lesion nematodes *(Pratylenchus* spp), and the reniform nematode *(Rotylenchulus reniformis)* are considered important in many countries. Pigeonpea cyst nematode *(Heterodera cajani)* is considered most important in four out of seven states in India. Work has also begun on the survival of parasitic nematodes, biological and chemical control, and host plant resistance.

Cropping systems. Agroclimatic analysis and an understanding of the existing cropping systems, coupled with studies on utilization and market potential, will assist in identifying new potential cropping systems and in the endeavors to improve existing ones. Cropping systems targetted by our research include:

Cropping systems	Phenology groups being studied
Pigeonpea-wheat rotation	extra-short-duration
Multiple-harvest monocrops	extra-short/short-duration
Contingency cropping	extra-short/short-duration
Rice-pigeonpea rotation	medium/short-duration
Intercropping with tall cereals	medium/long-duration
Intercropping with coconut/rubber	short/medium/long-duration
Intercropping with upland rice, groundnut, soybean, cotton	short/medium-duration
Alley cropping	medium/long-duration

Perenniality and ratoonability of pigeonpea, with combined resistance to wilt and sterility mosaic disease, have been found useful in agroforestry/alley cropping for grain, fodder, and fuelwood production with annual food crops in interspaces. Future work will explore the uses of pigeonpea as a perennial on more marginal lands, including hillsides and areas in which shifting cultivation is practiced.

ICRISAT's Resource Management Program: Its Relevance to AGLN Countries

C. K. Ong

Resource Management Program

The broad objective of the RMP at ICRISAT is to increase the productivity of farms and boost the income of farm households in the SAT by developing systems of farming that use scarce resources to better exploit the potential of ICRISAT's mandate crops. RMP is organized as three groups: the Agronomy Group (agroclimatology, microclimatology, cropping systems, and crop production); the Soil Group (soil physics, chemistry and fertility, plant nutrition, and land and water engineering); and the Economics Group. The major reason for creating such a strong diverse program is the realization that we need interdisciplinary teams to develop better management practices for increasing crop productivity and the incomes of SAT farmers. The work of RMP complements and is closely related to the crop improvement programs at ICRISAT.

Approach

The initial task is to assess the resources of the SAT. This is done through extensive village-level studies carried out by the Economics Group in India and West Africa, and through the detailed analysis of climatic records in Asia and Africa. The program then examines the factors that limit the use of these resources by farmers. Special emphasis is given to understanding the mechanisms that control the interactions between different production factors, and to analyzing the major constraints to increased productivity. The program then develops and tests production systems which minimize constraints through the use of better practices and improved technology. The adoption and consequences of new technology are studied, and policy changes conducive to enhanced impact are sought where necessary.

Research Areas

The research areas of RMP relevant to the needs of AGLN countries are outlined here.

Agroclimatology and modeling. In addition to analyzing climatic records in detail, especially for AGLN countries, RMP evaluates and develops crop models. These integrate the main physical and physiological determinants of crop yields, allowing us to determine the major reasons for low yields. Efforts are currently devoted to groundnut and pearl millet, and focus on abiotic factors. However, work will soon be extended to cover biotic factors and other crops.

Cropping systems and production agronomy. Work initially emphasized intercropping as a strategy to increase cropping intensity, diversity, and yield stability. An important intercropping system is the sorghum/pigeonpea system traditionally found in central and peninsular India. Our studies showed that a "full" yield of sorghum could be realized even when both crops are sown at their respective sole crop optimum populations.

Current efforts are concerned with the introduction of grain legumes into rice-based systems, either as sequential crops after lowland rice or as intercrops with upland rice. The most suitable sequential legumes in the lowland production systems of central India are chickpea and groundnut, which respond well to supplementary irrigation. In upland rice systems, intercropping with cowpea or pigeonpea is promising, and a "full" yield of upland rice can be obtained with a 5:1 row arrangement. Cowpea is relatively tolerant of anaerobic conditions, but pigeonpea cannot recover during the postrainy season to exploit stored soil moisture.

Recently, pigeonpea grown as a perennial crop has received considerable attention at ICRISAT as a multipurpose species for agroforestry systems. It provides food, fodder, and fuel, has high productivity, and enhances nutrient cycling through its deep rooting system and its shedding of leaves. Preliminary studies have shown it to have many of the beneficial characteristics of the grain pigeonpea used in sorghum/pigeonpea systems. These include negligible competition with sorghum or groundnut during the rainy season, combined with the ability to produce 70 to 80% of the amount of pods it produces when grown as a sole crop, plus additional fodder and fuel wood. Its deep rooting system and its efficient use of off-season rainfall account for its ability to produce higher biomass than grain types.

These two areas of cropping systems research offer substantial scope for collaboration with national agencies in AGLN countries. Already, perennial pigeonpea is being tested in several areas for its effectiveness in stabilizing terraces and bunds on sloping lands. The crop is also included in the All India Agroforestry Trials.

Soil fertility research. This has focused on rotation experiments and on the problems deriving from iron deficiency.

Several rotation experiments are in progress to investigate the role grain legumes can play in maintaining soil fertility, especially soil nitrogen status. On a deep Vertisol, a pigeonpea/cowpea intercrop provided substantial residual benefits to a subsequent rainy season sorghum crop; the latter yielded about 3.51 ha^{-1}, which was over double the yield of 1.5 t ha^{-1} obtained under a continuous non-legume cropping system (both systems without fertilizer). The maximum yield of sorghum as a sole crop with fertilizer-N was 4.5 t ha^{-1}. The residual effect of the double legume crop was equivalent to about 40-60 kg N ha^{-1}. Double crops containing one legume and one non-legume gave about half the residual effect of the pigeonpea/cowpea intercrop. Other experiments are in progress on Alfisols to assess the residual effect of pigeonpea and groundnut in various cropping systems.

Groundnut grown in alkaline soils may suffer from iron deficiency (iron chlorosis). This deficiency has presented considerable problems for research because its occurrence varies both within a field and during a season. Past research has identified a tissue test for assisting in diagnosis, and current research is investigating the complex factors that promote development of the disorder, which is accentuated by cold, wet conditions.

Low-cost implements. Improved cultural practices for groundnut have been developed at ICRISAT based on the broadbed-and-furrow (BBF) system. Low-cost, bullock-drawn implements are now available to enable farmers to form BBFs easily and carry out subsequent cultural operations. The designs are simple enough for the implements to be made in small workshops from locally available material. The central component common to all implements is a T-bar made from either iron or wood.

Other implements include a fertilizer application/row-marking attachment, an inter-row weeding attachment, a four-row planter, and a groundnut digger. A twin spinning-disc knapsack sprayer was developed for applying pre-emergence herbicides and spraying other pesticides on groundnut Details of these implements are available from RMP.

Pigeonpea cropping in northeast Thailand. ICRISAT economists have conducted a joint survey with the ACIAR and the Thai Department of Agriculture to investigate the potential of new, short-duration pigeonpea cultivars in northeast Thailand. Major conclusions from this study are:

- Pigeonpea will not replace cassava production at present (kenaf is the crop most likely to be replaced by pigeonpea)
- Pigeonpea is unlikely to be adopted if it affects farmers' capacities to produce rice for home consumption
- Even if pigeonpea is profitable in certain farming systems it will not revolutionize crop production in the foreseeable future
- There are no obvious technical or agronomic constraints to pigeonpea production in northeast Thailand

Training Opportunities

RMP provides training opportunities in all its research areas. Opportunities in agroclimatology and crop modelling consist of analysis of records from specific regions, with access to computer facilities at ICRISAT Center. The results of these analyses are used to determine water requirements and potential and actual productivity. The Economics Group has already provided three in-service training programs with the following objectives:

- To enhance understanding of the constraints to agricultural development in the SAT and of the means of alleviating them through technological and institutional change
- To develop familiarity with practical principles and methods used by economists in interdisciplinary agricultural research

The Soil Group also provides training opportunities in such areas as soil fertility enhancement and land and water management.

Training at ICRISAT

B. Diwakar

Training Program

The name of our institute, the International Crops Research Institute for the Semi-Arid Tropics, reflects our research mandate, but equal emphasis is laid on training activities. The extension of research results to the farming community depends critically on the expertise of those involved in the transfer of technology. Earlier surveys had clearly indicated that trained manpower was in comparatively short supply in SAT countries, a fact which led to the inclusion of training activities in ICRISAT's program from the inception of the institute. In 1974, the Center's Training Program trained the first group of four trainees from Nigeria; by the end of November 1988 it had trained 1600 people from 82 countries, including 313 Asian training participants in the Legumes Program (Table 1).

Table 1. Legume trainees at ICRISAT from Asian countries since 1974.

Country	Postdoctoral research fellows	Research scholars	In-service fellows	In-service trainees	Appren-tices	Total
Bangladesh	-	2	4	5	-	11
Burma	-	-	-	7	-	7
China	-	1	8	17	-	26
India	27	26	27	68	4	152
Indonesia	-	-	4	6	-	10
Korea	-	-	3	-	-	3
Nepal	-	1	3	6	-	10
Pakistan	-	-	3	14	-	17
Philippines	-	-	8	14	-	22
Sri Lanka	1	7	9	8	-	25
Thailand	-	1	5	17	-	23
Vietnam	-	1	-	6	-	7
Total	**28**	**39**	**74**	**168**	**4**	**313**

The aim of any training program is to provide opportunities for gaining academic qualifications and/or to improve job performance. Training at ICRISAT is designed to meet both objectives, but with most emphasis on the latter. Training ranges from postdoctoral fellowships and research scholarships to in-service training and short-term courses.

Training Categories

Postdoctoral fellowships. Academic training leading to a Ph.D helps in learning research techniques, but the scope is often fairly narrow in order to fulfil degree requirements. Many postdoctorates need more field experience and a broader perspective involving team work. We therefore provide postdoctoral fellowships. These are awarded initially for a period of 12 months, which may be extended for another 12 months if needed. Announcements inviting applications for postdoctoral fellowships are made through advertisements in leading newspapers and agricultural journals.

Research scholarships. The foundations for conducting research using appropriate techniques and procedures are laid during academic training leading to a university degree. ICRISAT encourages those who would like to pursue their studies to qualify for an M.Sc and/or a Ph.D through research scholarships. Research scholars may be from any part of the world, but they must have an interest in semi-arid agriculture. After completing their coursework at a university they come to ICRISAT to do their thesis research work, using the facilities and expertise available at ICRISAT. The ICRISAT scientist who guides and supervises the scholar's research will be a member of the advisory committee for that scholar.

In-service fellowships. These fellowships are offered to mid-level scientists with B.Sc, M.Sc, or Ph.D degrees who are working in SAT country programs relevant to ICRISAT's mandate. They participate for periods of 1 week to 6 months in an ICRISAT program to learn specific research methods or practical skills related to state-of-the-art technology.

In-service training. Most research operations at ICRISAT and in NARS are carried out by research associates/technicians, supervised by scientists. These technicians need to be knowledgeable about research methods and to be efficient practitioners of research techniques. To provide training in these important areas an in-service training program is organized in two cycles every year, each cycle covering a cropping season of 6 months. The first takes place in the rainy season (15 May-15 November); the second is during the postrainy season (15 September-15 March). Trainees from non-English-speaking countries undergo an 8-week course in English from 15 March each year in cooperation with Osmania University, Hyderabad. In-service training emphasizes individual training in crop improvement, crop production and resource management.

Apprenticeships. Under the apprenticeship program, undergraduate and graduate students are given work/study opportunities to obtain practical experience and to learn research skills and procedures. They work for periods of up to 12 months with ICRISAT research scientists, engineers, and service staff.

Short-term courses. These courses are arranged from time to time on the basis of need. Increasingly, they will be organized in different SAT countries.

Organization

Screening of applicants. Responsibility for establishing training policies and screening candidates for training is vested with ICRISAT's Training Advisory Committee. ICRISATs Deputy Director General is Chairman of this committee; the Principal Training Officer is Secretary; and the Directors of ICRISAT's research programs, the Heads of the Genetic Resources and Biochemistry Units, and a Senior Training Officer are members.

The committee recommends the acceptance/rejection of trainees, taking into consideration the candidate's experience, education, geographical location, and potential to serve in SAT programs, and the research facilities available at ICRISAT. To qualify for consideration for training at ICRISAT, each candidate must:

- Be employed or recommended by a national agency or international institution
- Be working or intending to work in the SAT or have an aptitude to do so
- Be among the four highest ranked applicants nominated by any country
- Present records of academic training and experience, including capability in the use of English, to show that he/she could profit from training at ICRISAT Center
- Indicate a willingness to do practical field work and to study and conduct laboratory and field research in areas compatible with ICRISAT's mandate and the objectives of the sponsoring agency's programs

Allowances. Training participants are provided with an allowance to cover incidental expenses, a dormitory room or a furnished flatlet (including laundry), board, insurance (local group health and accidental health benefit), book allowance, recreation facilities, educational visits, training-related transport, excess baggage, rail/air freight for book shipments, transit allowances, training supplies, and experimental facilities.

Follow-up. ICRISAT's Training Program keeps in touch with former participants to identify their progress and future needs. Participants are kept informed about the latest developments and achievements at ICRISAT through the Center's publications.

Conclusion

The Training Program will continue to keep pace with new approaches to agricultural research, including biotechnology, agroforestry, and computer applications. We will provide opportunities to SAT research scientists for training in these new subject areas.

The Semi-Arid Tropical Crops Information Service

L. J. Haravu

library and Documentation Services

ICRISAT's capacity to provide information is used not only to keep its own scientists abreast of the latest developments in their fields of interest but also to satisfy the information requirements of many others who are working on its mandate crops in laboratories and fields located in areas where information resources are either nonexistent or meager. The first specialized information service launched by ICRISAT was the Sorghum and Millets Information Center (SMIC), started in 1976. The project was partially financed by the IDRC.

A project proposal to expand SMIC to cover all five ICRISAT mandate crops was made in 1986. The project, known as the Semi-Arid Tropical Crops Information Service (SATCRIS), was approved in November 1986 and is funded in part by IDRC.

A major departure of SATCRIS from its predecessor, SMIC, is its emphasis on the use of machine-readable products of global data base producers such as the Commonwealth Agricultural Bureaux International (CABI) and the Food and Agriculture Organization's Agricultural Information Service (AGRIS) for in-house data base development, and on the provision of information retrieval and dissemination services.

Objectives

SATCRIS has several tasks and objectives. These are to:

- Participate in global information networks
- Develop a comprehensive data base which is relevant to the crops mandated to ICRISAT
- Strengthen information-handling capabilities at the ICRISAT Sahelian Center (ISC) in Niamey, Niger
- Provide a package of information services to clients throughout the SAT who have research and development responsibilities for the crops mandated to ICRISAT
- Use modern tools and techniques to provide access to the information required

SATCRIS data base. The central resource of SATCRIS is its machine-readable data base. This is being developed by obtaining monthly subsets of the CABI and AGRIS data bases. CABI was chosen for its excellent coverage of primary journal literature, and AGRIS for its coverage of nonconventional literature. A comprehensive profile of SATCRIS interests has been communicated to CABI so that it can generate a relevant monthly subset of its data base.

A versatile software package called BASIS is used to derive data from the two data bases. These data are integrated with locally generated inputs to create a single, multidisciplinary data base on ICRISAT's mandate crops. The existing SMIC data base will also be integrated into the SATCRIS data base, using BASIS software.

Selective Dissemination of Information (SDI) service. This is a fully automated service. The selection of items for a given individual is based on a user profile. The emphasis is on meeting the current awareness needs of individual scientists. A two-level service is provided. The first is based on macro-profiles, designed to serve a small research station, while the second provides for specific personal profiles. The service is based on the monthly inputs received from CABI and AGRIS. BASIS modules are used to store the user profiles and produce SDI outputs.

SDI service outputs are backed up by document delivery services. SATCRIS uses its own resources as well as those of other services, such as India's National Agricultural Library (NAL), the British Lending Library Division (BLLD), and the faster Dialorder services wherever necessary.

Literature search services. Between 1984 and 1987 SMIC responded to more than 300 requests for literature searches. SATCRIS continues to promote this on-demand search service, using its data base wherever possible. Where access to a broader spectrum of information is required, searches are done using external data bases in an on-line mode, using the DIALOG system in the USA.

Experience has shown that data derived from searches carried out for one individual is often found useful by others. Dissemination of information on completed searches (e.g., through ICRISAT's Research and Development Leaflet Services distributed with our newsletter *At ICRISAT,* and through items in our other newsletters), has made the output of searches available to many others who would otherwise not have used them.

Collaboration with CABI and AGRIS. SATCRIS provides inputs of conventional and nonconventional literature generated by ICRISAT to AGRIS and CABI, and also provides inputs of nonconventional literature captured at ICRISAT Center and at ISC to CABI.

An important objective of SATCRIS is to collaborate with CABI in the production of specialist abstract journals on ICRISAT's mandate crops. These CABI abstract journals are available free of charge to key libraries and individuals in SAT countries. The information thus disseminated is more comprehensive and current than that provided from local sources. The advantages of using the expertise and infrastructure of a major disseminator of bibliographical information such as CABI more than compensate for the costs incurred. The *Sorghum and Millets Abstracts, Chickpea and Pigeonpea Prompts,* and *Groundnut Prompts* are the three abstracts services being produced by CABI in collaboration with SATCRIS.

Information analysis services. Scientists at ICRISAT will be involved in the choice of topics and subjects for information analysis, leading to reviews of the literature on specific topics. In choosing topics, the emphasis will be on the usefulness of the repackaged information to scientists, researchers, and others working in Africa, where such information is most needed. The reviews will be written by subject specialists, whose services will be contracted for periods ranging from a few weeks to several months, depending on the nature and *scope* of the subject. This project provides for short-term sabbaticals for scientists for this purpose. Information scientists at SATCRIS will provide literature search services and document delivery. They will also attempt to identify key papers on the chosen topic, using a citation-based approach.

Microcomputer data bases. An important objective of SATCRIS is to strengthen the information handling capabilities at ISC. In the long run, it is hoped that SATCRIS will be involved also in strengthening information handling capabilities in other national and regional agricultural research systems in the SAT.

One approach that SATCRIS is exploring is the development of specialized data bases for decentralized use on microcomputers. The idea is that SATCRIS will create and maintain useful specialized data bases and make them available to national and regional centers in the SAT.

SATCRIS will also provide appropriate software and, wherever necessary, training to national and regional centers to enable them to use the data bases. SATCRIS will periodically provide data base updates on diskettes. In addition, SATCRIS will offer information retrieval and dissemination services in the subject areas of the specialized data bases.

We believe that such an approach will serve two purposes: it will deliver useful information to SAT centers in a form that is easily accessible; and it will introduce relevant information technology into national and regional centers.

Two specialized data bases on which some work has already begun are 'Aflatoxins' and *Striga.* Information on a variety of primary documents, both conventional and nonconventional, is being entered on the data bases.

ICRISAT Publications

In addition to SATCRIS, ICRISAT has a publications program which is implemented by Information Services. For each of the grain legumes for which ICRISAT has a mandate, a biannual newsletter is produced; these newsletters are devoted to the exchange of information on ongoing work on different facets of the grain legume. Although they are edited and produced within ICRISAT, the newsletters contain contributions from scientists throughout the world and are distributed worldwide to relevant libraries as well as to individual scientists.

Other ICRISAT publications include workshop proceedings, research and information bulletins, and specialized bibliographies.

Scientists who wish to be kept up to date with new publications produced by ICRISAT should ask for the ICRISAT publications catalog, which is printed annually.

In addition, the newsletter *At ICRISAT* lists all new publications brought out each quarter, and *ICRISAT in Print* lists all publications by ICRISAT scientists in journals, workshop proceedings, and theses. The latter is indexed by author, and a yearly supplement provides updates.

Legume Genetic Resources at ICRISAT

Melak H. Mengesha

Genetic Resources Unit

One of ICRISAT's major objectives is to serve as a world repository for the genetic resources of its mandate crops. The GRU implements this objective by:

- Collecting landraces and their wild related species from priority areas of origin and diversity
- Characterizing and evaluating the germplasm at one or more locations
- Documenting passport and evaluation data
- Conserving landraces in medium (active) and long-term (base) cold storages
- Distributing the germplasm for both present and future use in crop improvement programs

As regards the AGLN, we are concerned with the germplasm of chickpea, pigeonpea, and groundnut, which represent approximately one-third of the 96 124 accessions contained in the world collection of germplasm of mandate crops conserved in the gene bank of ICRISAT.

With the exception of India, AGLN member countries have so far contributed less than 4% to ICRISAT's grain legume germplasm collection, as shown in Table 1. National programs have an important role to play in this area, and a much more concerted effort needs to be made both in collecting and in conserving grain legume germplasm which is Asian in origin.

ICRISAT is prepared to collaborate in these collection missions, as well as to offer training in genetic resources activities. Trainees can be trained in the field during collection missions.

The pace of national, regional, and international crop improvement programs in Asia is accelerating. In view of this, it is essential to collect landraces before they are replaced by new high-yielding cultivars.

The main beneficiaries of germplasm collections are those countries where germplasm is collected. Not only is their germplasm preserved for present and future use, but also the new high-yielding cultivars developed from this germplasm are likely to be better adapted there.

Table 1. Legume germplasm from AGLN countries maintained at ICRISAT Center, October 1988.

AGLN country	Number of germplasm accessions		
	Chickpea	Pigeonpea	Groundnut
Bangladesh	167	73	-
Burma	10	68	21
China	-	1	215
Indonesia	-	12	139
Nepal	80	116	-
Pakistan	153	14	1
Philippines	-	58	29
Sri Lanka	3	71	23
Thailand	-	17	6
Total outside India	413	430	434
India	6 564	9 084	3 050
Worldwide	15 564 (42)[1]	11 034 (52)	12 160 (89)

There is a need to establish a comprehensive collaborative program in germplasm evaluation and the subsequent utilization of germplasm, in which ICRISAT and AGLN member countries together evaluate all the germplasm accessions in the region. Such a program will help national scientists identify useful germplasm from their region as well as from other parts of the world.

The program would also offer a unique opportunity for trainees from AGLN member countries to participate in the evaluation of germplasm. This exercise could be planned on the basis of a multilocational evaluation scheme; that is, the materials would be sown both at ICRISAT Center and at various locations in AGLN member countries.

Trained collectors from the member countries and from ICRISAT Center could participate in the subsequent evaluation programs which would be implemented at ICRISAT Center and at one or more other locations.

Biochemistry and *Use* of AGLN Food Grain Legumes

R. Jambunathan and U. Singh

Biochemistry Unit

In the Biochemistry Unit we carry out analyses of grains of ICRISAT's mandate crops, and evaluate the processing and food quality attributes of selected cultivars. The components of grain quality include visual quality, nutritional quality (digestibility and availability of nutrients), antinutritional factors, processing characteristics, food quality, and storage stability. Our main observations on chickpea, pigeonpea, and groundnut are described here.

Chickpea

Analyses of chickpea grains have revealed that the protein content of chickpea is highly variable according to environment, soil, and other factors. However, chickpea germplasm accessions did not show any substantial variability in the amino acids, methionine and cystine, in which chickpea is deficient. After detailed investigations on desi and kabuli chickpea types, we observed that they can be distinguished from each other by the fiber and calcium contents of their seed coat, and by the coat thickness. Also, starch from kabuli chickpea is more viscous than that from desi. Dehulling leads to losses of calcium and iron, suggesting that these are concentrated on the outer portion of the cotyledons, and in the seed coat

Our advanced cultivars are analyzed for their chemical composition, amino acid composition, and cooking quality. Protein quality is evaluated using biological assay.

Pigeonpea

High-protein pigeonpea genotypes have been developed using wild species. These new genotypes were biologically evaluated for their protein quality. We investigated the nutrient losses resulting from dehulling. Cooking quality tests and chemical composition analyses are carried out on all our advanced genotypes. Some of the characteristics of vegetable pigeonpea have been investigated to determine their quality attributes. We have prepared noodles from whole seed and *dhal* samples of pigeonpea and compared them with those from mung bean; the results showed that pigeonpea starch can be used to prepare noodles of acceptable quality. We have also prepared *tempeh* from pigeonpea, and have observed that pigeonpea *tempeh* is comparable to soybean *tempeh.* Further detailed investigation is in progress.

Groundnut

Over 8000 germplasm accessions have been analyzed for their oil, protein, and moisture contents. Accessions with a high oil content have been identified. We have determined the fatty acid composition of about 250 genotypes, several of which had a much higher than normal ratio of oleic to linoleic acid (an indicator of oil stability). We are investigating the factors that are reported to contribute to confectionery groundnut quality.

Training

In August 1988 we conducted a 2-week training course on Evaluation of Grain and Food Quality of Legumes, cosponsored by the FAO and the ADB. Participants from Bangladesh, Indonesia, Nepal, Pakistan, the Philippines, Sri Lanka, Thailand, and Vietnam attended.

Collaborative Research

We propose holding a meeting in March 1989 to discuss the current uses of chickpea, pigeonpea, and groundnut, and to identify researchable ideas for new uses. We hope areas for collaborative research and additional training needs will be identified at this meeting.

We have initiated a collaborative research project with scientists in Bangladesh, Burma, Nepal, and Pakistan on grain quality and utilization of chickpea. Our first aim is to standardize the research techniques used. A collaborative project in Thailand and Indonesia will explore new pigeonpea food uses (e.g., starch noodle in Thailand; *tempeh* in Indonesia).

Strengthening Chickpea Research in Pakistan

M. S. Rahman

Pakistan Agricultural Research Council/
Asian Development Bank/ICRISAT Program, Islamabad

Chickpea is the major pulse crop in Pakistan, where annual production is just over 0.5 million t. Pakistan trails behind India and, more recently, Turkey in terms of output.

Ascochyta blight afflicted the crop in 3 successive years (1979-82), prompting the government to seek technical assistance from ICRISAT and financial assistance from the ADB.

The resulting project was entitled Strengthening Chickpea Research in Pakistan. It was conceived in 1982 and became operational 2 years later, in November 1984, after the ADB had approved it as a regional project. The ADB funded it through ICRISAT with a grant of US$ 300 000 which was to extend over a period of 2 years. The objectives of the project were:

- To introduce superior chickpea germplasm into Pakistan
- To breed for superior resistance to ascochyta blight in Pakistan
- To multiply and distribute to local farmers the seeds of the higher-yielding lines so developed
- To train Pakistani scientists at ICRISAT or ICARDA

In view of the progress made during the first 2 years, the Government of Pakistan and ICRISAT requested the ADB to fund Phase II of the project for a further period of 3 years. The ADB introduced the condition that the project should become a national one.

Phase II came into operation in May 1987. It was approved for 3 years with a grant of US$ 350 000. However, the resident scientist was to be funded for only 2 years; the project would then be managed by local scientists during the third year. The objectives of Phase II were:

- To consolidate and expand upon the achievements of Phase I, so that a full breeding cycle could be completed and that certified, high-yielding, locally adapted, disease-resistant varieties could be made available to farmers
- To ensure that collaborative research between Pakistani and ICRISAT scientists would continue, and that Pakistan would acquire sufficient expertise to carry on chickpea research at the conclusion of the project

The project has:

- Strengthened the research infrastructure at Islamabad, Dokri, Chakwal, Faisalabad, Karak, and Kallurkot
- Developed facilities for growing chickpea off-season at Kaghan Valley
- Introduced germplasm and breeding material from ICRISAT and ICARDA
- Identified sources of resistance to ascochyta blight, and used these in crosses with adapted high-yielding lines
- Tested a number of advanced generation breeding lines for adaptation at different locations
- Multiplied promising lines with high yield potential and resistance to ascochyta blight for large-scale testing in Pakistan

ICRISAT's Experience in the Introduction of Improved Groundnut Technology in India

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Legumes Program

Groundnut contributes about 60% to the total edible oil production of India. The area under this crop (7.2 million ha) is the largest in any country of the world. However, groundnut productivity is low (600 kg to 970 kg ha^{-1} per annum). The present level of edible oilseed production is inadequate to meet increasing demand, necessitating large-scale imports. India has spent US$ 800-1000 million per annum on edible oil imports over the past 5 years.

In 1987, the Indian Government asked for ICRISAT's help in increasing productivity. At a meeting in April 1987, trials in six Indian states were planned. The LEGOFTEN Unit was formed at ICRISAT to coordinate and monitor the trials, which started in the 1987 rainy season and continued through 1988, including the postrainy season. The six states represented a wide range of climatic and rainfall conditions, soils, and pest and disease incidence.

Before the trials started, a meeting of the extension workers responsible for them was held at ICRISAT to discuss basic and applied aspects of groundnut research. Soils from trial sites were analyzed, disease and pest history was discussed, varieties were identified, and a package of practices was formulated for each location. The government provided funds for conducting the trials, while ICRISAT provided seeds of improved varieties. The trials were monitored frequently by a multidisciplinary team provided by LEGOFTEN consisting of a breeder, an agronomist, and a plant protection specialist. The data from three seasons' trials on government farms and farmers' fields are given in Table 1. The trials provided an opportunity to study the influence of two contrasting rainy seasons — there was a drought in 1987 but excessive rainfall in 1988.

Yields obtained through a combination of improved varieties and improved management were consistently high. Even with small modifications in cultivation practices, farmers could obtain higher yields than normal. The improved practices suggested by ICRISAT resulted in better pod filling (Table 2). During the trials, several constraints on yields in the traditional system were observed. Traditional varieties were less responsive to improved management Further problems included: poor stand establishment; improper use of fertilizers; inadequate control of diseases, pests, and weeds; excessive irrigation; and improper drying methods. Constraints on inputs included: inadequate supply of fertilizers, gypsum, and micronutrients; poor quality of pesticides and fungicides; labor-intensive and relatively ineffective pesticide appliances; shortage of low-cost implements; and shortage of labor. Despite these constraints the dramatic improvements in yields resulting from low additional investment levels (Table 2) and sustained extension work have led to the spread of the new technology over large areas (Table 3). The steps involved in introducing the new technology are given in Figures 1 and 2. To overcome adoption problems farmers have developed their own techniques and equipment, including modified ridgers to make two-row beds to facilitate better irrigation and save water. The government has provided incentives in the form of subsidies on fertilizers, pesticides, local seed/fertilizer drills, and pesticide appliances, and has taken up large-scale multiplication of improved varieties.

Table 1. Effect of improved cultivation methods on groundnut yields, 1987/88.

Trial locations	Number of trials	Season	Method of cultivation	Variety	Irrigation	Average yield (t ha^{-1})
Government farms	11	1987 rainy	Improved	Improved	Yes	3.3
	9	1987 rainy	Local	Local	Yes	1.2
	2	1987 rainy	Improved	Improved	No	2.2
	2	1987 rainy	Local	Local	No	0.6
	14	1987/88 postrainy	Improved	Improved	Yes	3.8
	14	1987/88 postrainy	Local	Local	Yes	2.3
	11	1988 rainy	Improved	Improved	No	1.9
	11	1988 rainy	Local	Local	No	1.1
Farmers' fields	122	1987 rainy	Improved	Local	Yes/No[1]	1.7
	17	1987 rainy	Improved	Local	Yes/No	1.6
	17	1987 rainy	Local	Local	Yes/No	1.2
	18	1987/88 postrainy	Improved	Local	Yes	3.0
	14	1987/88 postrainy	Local	Local	Yes	2.1
	31	1987/88 postrainy	Improved	Local	Yes	2.0
			Local	Local	Yes	1.6

1. Some trials irrigated, others not

Table 2. Effect of improved cultivation practices on yields, shelling percentage, kernel mass, and oil content of groundnut, postrainy season, 1987/88.

	Cultivation practices			
	Improved		Unimproved	
Parameters[1]	Improved variety	Local variety	Improved variety	Local variety
Dry pod yield ($t\ ha^{-1}$)	3.8 (2.3-5.3)	2.7 (0.7-3.6)	3.0 (1.6-4.3)	2.3 (0.5-3.2)
Shelling (%)	74.7 (69-82)	72.8 (63-80)	70.7 (65-78)	71.6 (64-76)
1000-kernel mass (g)	517 (461-603)	399 (349-520)	444 (313-558)	363 (300-443)
Oil content (%)	47 (44.4-50.6)	46.7 (44.0-48.8)	46.6 (42.8-52.2)	46.4 (42.4-49.0)
Cost of cultivation ($Rs\ ha^{-1}$)	9316	9073	8251	8019

1. Average of 14 trials; ranges are given in parentheses.

Table 3. Transfer of groundnut production technology in Maharashtra and Karnataka States of India.

Parameter	Maharashtra	Karnataka
Yield demonstrations		
on research farms		
1987	3	3
1987/88	4	3
1988	3	3
on farmer's fields		
1987	122	-
1987/88	several	600
Farmers' days	16	4
total farmers attending	12600	>2000
women farmers attending	300	?
Media coverage[1]		
TV programs	1	-
newspaper articles	25	5
farm magazine articles	3	1
extension bulletins	7	4
Extension staff trained		
at ICRISAT Center	17	14
at trial locations	>200	>200
at meetings	several	several
Area covered (ha)[2]		
1987	5	4
1987/88	8000	10
1988	?	750
1988/89	>50 000	20 000

1. Without invitation from ICRISAT.
2. Includes partial adoption of the technology, i.e. with some local varieties still grown.

Figure 1. Approach followed in testing new groundnut cultivation technology.

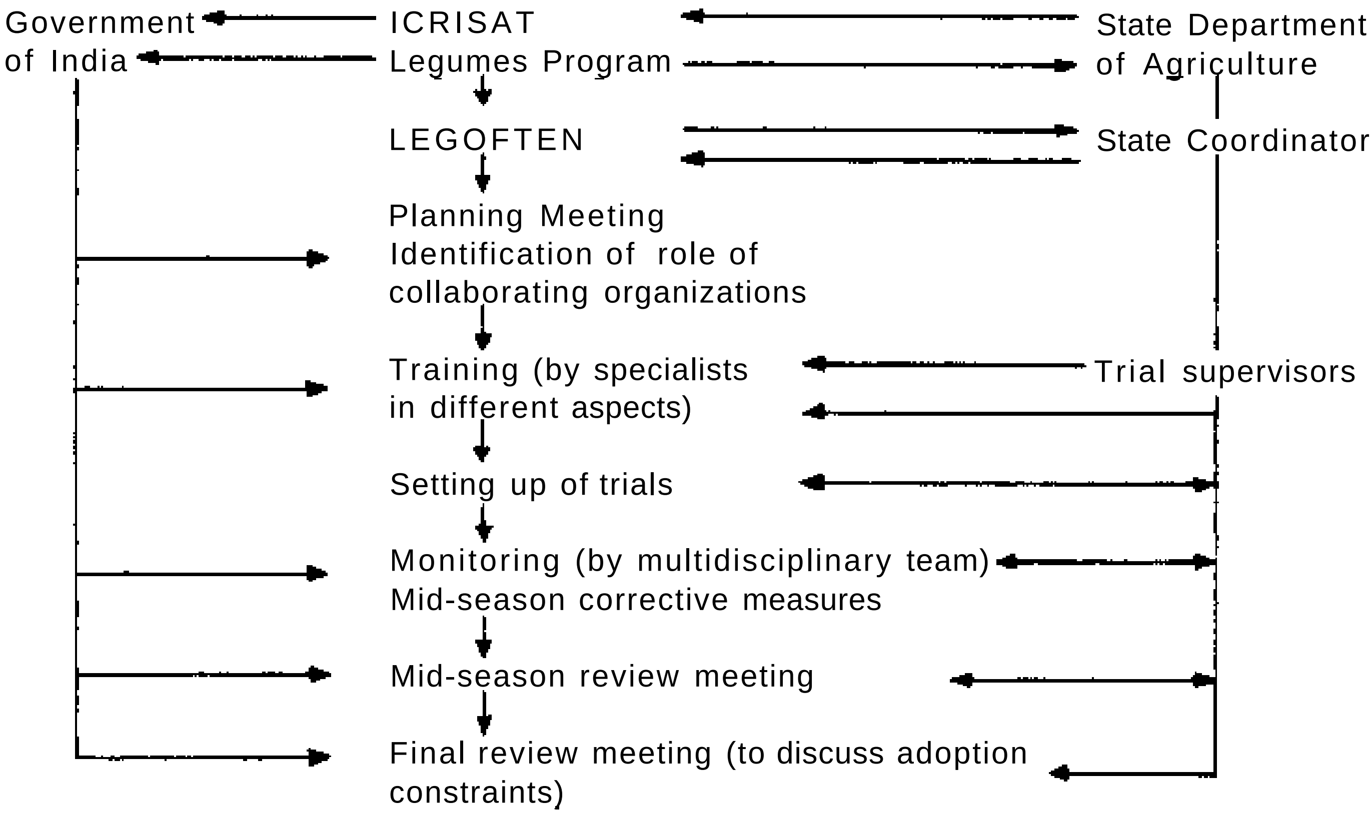
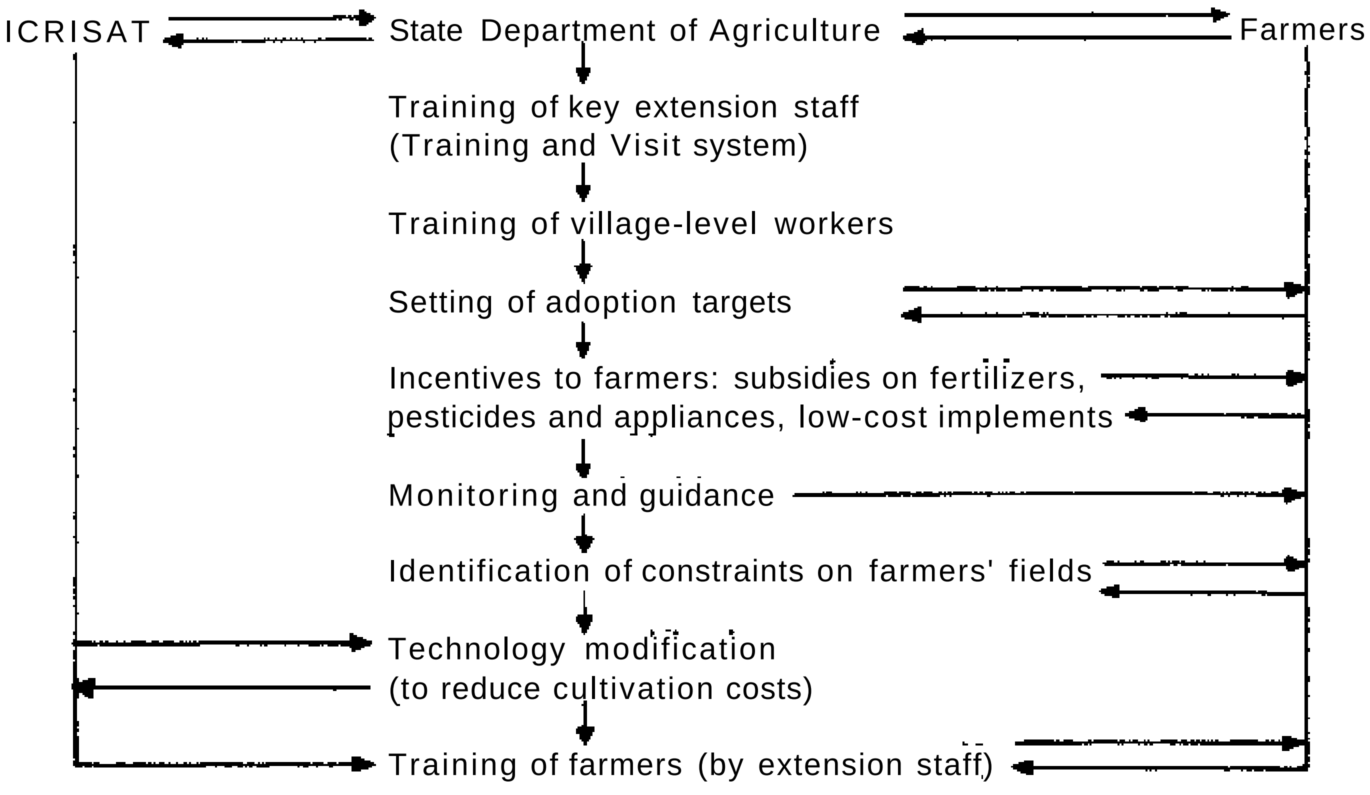


Figure 2. Steps involved in transfer of technology.



REGIONAL GROUP REPORTS: COLLABORATION WITH THE AGLN

International Links with the AGLN

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Introduction

Food legumes are an important component of the farming systems of Asia, both ecologically and in terms of human and animal nutrition. At least 18 species are considered important at various locations throughout the region, and they differ markedly in their agronomic traits, cultural needs, uses, markets, and roles in farming systems. As a result, the food legume crops present special difficulties in the planning and organization of research programs.

The AGLN has activities involving ICRISAT's three mandate legume crops — groundnut, pigeonpea, and chickpea. Of these crops only groundnut is of major importance throughout the region, although chickpea and pigeonpea are important in South Asia, and pigeonpea has shown agronomic potential in parts of Southeast Asia.

Collaborative Research Links

At a number of recent regional food legume meetings, the representatives of national programs have stressed the need for increased cooperation and coordination both nationally and regionally. In spite of increased support for food legumes from the IARCs and donors, there is little formal coordination or networking. The establishment of the AGLN provides an opportunity to increase these.

The complexity implied by the number of crops involved is compounded by the number of interested research institutions and donors operating in the region. These include the Association of South East Asian Nations (ASEAN) Crops Post Harvest Program (ACPHP), as well as AVRDC, CGPRT, FAO, ICRISAT, IRRI, IITA, ACIAR, IDRC, Peanut-CRSP, and NifTAL.

National agricultural researchers working in food legumes in the region, particularly in Southeast Asia, have expressed the need for a coordinating mechanism which covers all food legumes. National food legume researchers are few in number, and the same individuals are often working on a number of crops. The activities of donors, IARCs and other international organizations often result in excessive demands on the resources of NARS. This can lead to the duplication of variety trials, meetings, training programs, project reviews, etc. Informal collaboration and interaction of research staff occur and are useful, but there does appear to be a need for a more formal coordinating mechanism.

The authors of this paper have tried to solicit feedback on what the structure of such a coordinating mechanism should be. The response from NARS, most IARCs, and donor agencies has been positive. The structure is still under discussion, and its implementation may be difficult. However, with the cooperation of all the involved organizations the potential benefits are great.

Achievements in Collaborative Research

The collaborative research undertaken through the AGLN has brought many gains. These include the exchange of information (through newsletters, etc), the exchange of germplasm, and visits by AGLN scientists to NARS in the region to inspect research and participate in planning the future activities of projects funded by other donors.

The most tangible successes so far have occurred when additional funding, specifically aimed at improving the collaborative effort, has been provided. An example of this is the use of special-purpose AIDAB and ACIAR grants to fund research on groundnut and pigeonpea improvement in Indonesia and Thailand. Particularly important has been the identification of PStV and the launching of screening for PStV resistance, using the genetic resources of ICRISAT and employing scientists from Indonesia, ICRISAT, and Australia.

Other achievements include the joint funding of workshops and/or training courses by ICRISAT and various other agencies, including IDRC, FAO, and ACIAR.

The major reason for establishing effective collaboration among the various institutions in the region is to strengthen the national programs. This principle must continue to receive the highest priority.

Priorities for Research

In general, the use of food legumes in existing farming systems needs to be improved. In lowland rice-based systems this requires cultivars with appropriate duration, tolerance to waterlogging, and disease and pest resistance. In upland systems tolerance to drought and to acid soils is an additional requirement, but waterlogging tolerance is seldom required. Appropriate soil management techniques for food legumes in upland farming systems must be developed. Marketing and socio-economic studies remain priorities for all food legumes.

Specific research priorities for groundnut are:

- Disease resistance, particularly PStV in Southeast Asia and bacterial wilt resistance in Indonesia and the People's Republic of China
- Performance in conditions where lack of water is the prime factor limiting production

Specific research priorities for pigeonpea are:

- Insect control through a combination of management and host plant resistance
- Utilization of the plant and its products in countries new to the production of pigeonpea
- Socio-economic assessment of production and marketing potential

The specific research priority for chickpea is:

- Disease and insect resistance in South Asia (in Southeast Asia chickpea has no priority)

Improving Links

The AGLN operates at present mainly in South Asia, where external funding has been obtained for Bangladesh, Nepal, Sri Lanka, and Pakistan; in Southeast Asia only Burma is involved. Membership of the AGLN has been sought far more widely, and it is vital that these aspiring members participate fully in ALGN activities. This will take time and the provision of additional support.

A mechanism to improve collaboration among international organizations and donors for the benefit of NARS was proposed at a meeting in Bangkok in April 1988. The mechanism would cover not only the three AGLN crops but also most of the other important food legumes. ICRISAT would play a pivotal role, because of its role in the AGLN. It is suggested that this mechanism takes the form of a series of groups (probably commodity groups), members of which would form a steering committee to assist the coordination of such activities as common varietal evaluation trials, workshops, joint or linked meetings, and monitoring tours. These would allow more efficient use of time, money, and people.

The implementation of this or any other model will be difficult, but the potential benefits to the NARS are considerable.

The CGPRT: Aims and Activities

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Regional Co-ordination Centre for Research and Development of Coarse Grains, Pulses, Roots and Tuber Crops in the Humid Tropics of Asia and the Pacific, Bogor

Mandate

The CGPRT Centre initiates and promotes research, training, and dissemination of information on socio-economic and related aspects of CGPRT crops in Asia and the Pacific. The Centre aims to serve the needs of institutions concerned with planning, research, extension, and development in relation to CGPRT crop production, marketing, and use.

What are CGPRT Crops?

CGPRT stands for coarse grains, pulses, roots, and tuber crops. The coarse grains include maize, barley, and millet, while the pulses include food legumes, such as soybean, mung bean, chickpea, groundnut, and pigeonpea. The root and tuber crops include cassava, sweet potato, potato, taro, and yam.

What these botanically diverse food crops have in common is that their production lags behind that of the major cereals (rice and wheat) in Asia. While yields and area under rice and wheat increased significantly in the period 1975-1985, resulting in food self-sufficiency in several countries, the development of other food crops has been less positive. This has been attributed to expansion of the area under rice or wheat, pushing CGPRT crops to more marginal lands. The lack of public investment and policy concern for these crops, and the more isolated areas in which they are grown, are also contributing factors.

Yet CGPRT crops remain the main source of livelihood for an estimated 700 million people in the Asia-Pacific region, about 45% of which is sown to these crops. CGPRT crops are important in the non-irrigated upland areas of the Asia-Pacific region, and also as secondary crops in irrigated areas. Moreover, they are very important in home gardens.

The per capita availability of arable land in the region fell from 0.287 ha in 1972 to 0.270 ha in 1982, the lowest land-person ratio in the world. However, this general picture masks a startling contrast: since the start of the Green Revolution, the area of irrigated land per capita has risen 6.5% from 0.077 ha in 1972 to 0.082 ha in 1983, whereas the non-irrigated area per capita fell 10.5% from 0.210ha in 1972 to 0.188 ha in 1982. These facts, combined with the stagnant or even diminishing yields of CGPRT crops, explain the growing income disparity between farmers on irrigated and non-irrigated lands, and the vast problem of inequality in rural development throughout the region.

Subsistence and Commercialization

In the early 1980s, when self-sufficiency in food had not yet been achieved in Asian countries, the primary rationale for CGPRT crop development was thought to be the improvement of rural and urban diets. While the contribution of CGPRT crops to human nutrition in upland and remote areas remains vital, the recent achievement of self-sufficiency in many Asian countries means that the importance of CGPRT crops is now defined rather differently at national level: they have become important as raw material for agricultural processing and as sources of rural employment. The growing animal feed industry, which uses large quantities of CGPRT crops, has increased imports of soybean in several countries. Furthermore, with the emergence of a middle class in Asia, changing consumption patterns include significant volumes of snack foods derived from CGPRT crops.

The continuing importance of CGPRT crops as semi-subsistence crops and their increasing importance as commercial crops is gradually being reflected in agricultural policies. Until recently, these dealt almost exclusively with rice and wheat; now, they are becoming more diversified.

Research

As a result of the increased food self-sufficiency of Asian countries in the 1980s, our original approach to research on CGPRT crops, which consisted of seeking to increase production in order to augment rural and urban diets, has had to change to studies focusing on demand and use. Topics such as price policy and input supply have become increasingly crucial. Global surpluses of maize, soybean, and groundnut have led to low world market prices, a difficult test for Asian production systems.

The research program has five components:

- Crop production system studies
- Crop demand, consumption and utilization studies
- Crop markets, prices, and trade studies
- Commodity studies
- Policy and social studies
- Crop studies in the Pacific region

Potential for Pigeonpea in Indonesia, Thailand, and Burma. A study on pigeonpea potential in Southeast Asia was completed in 1987. The general conclusions were:

- Evaluation of promising genetic and breeding material and appropriate management systems should continue, with the emphasis on pest management
- Studies of production costs for a range of farming systems are required
- The influence of changes in production systems on adoption by farmers must be monitored
- Research into the potential markets for pigeonpea surpluses and into the most appropriate product specifications for particular markets should be conducted as soon as possible

Specific conclusions for Thailand and Indonesia were:

- Further research into the production and marketing of pigeonpea-based *tempeh* and other fermented products is a high priority because of the higher market demand for these products in Indonesia
- Further studies should be carried out in northeastern Thailand and on the outer islands of Indonesia in order to confirm the promising experimental yields of pigeonpea in these regions; initially, emphasis should be given to production systems on marginal lands
- Trials on commercial farms should be initiated
- Although the prospects for including pigeonpea in feeds for intensively raised poultry are not encouraging, the potential role of locally produced pigeonpea in poultry nutrition in remote rural communities warrants further study

Specific conclusions for Burma were:

- Identification of improved varieties which are resistant to the major diseases and pests in traditional production systems should receive highest priority
- Investigations aimed at ensuring adequate crop establishment in farmers' fields are required
- Evaluation of early-maturing, large-seeded cultivars is warranted both in traditional areas of production and in the delta region following rice
- Systematic germplasm collections of landrace varieties of pigeonpea should be carried out before these resources are eroded and possibly lost altogether

As a follow-up to the survey on pigeonpea, the CGPRT Centre will assist the Bogor Research Institute for Food Crops (BORIF) in assessing the potential for marketing pigeonpea in Indonesia.

Groundnut: Ongoing and Future Activities. Groundnut is by far the most important grain legume crop grown in Southeast Asia, and in view of this the CGPRT Centre is seeking assistance from donors to enable it to carry out a survey on groundnut potential in Indonesia, the Philippines, and Thailand.

We hope to secure donor support during 1989, after which the survey will begin. The survey will probably involve agronomy and economics, emphasizing market identification, market growth, production, and utilization.

The Centre has assisted the Directorate of Farm Management, which falls under Indonesia's Ministry of Agriculture, in carrying out an analysis of the quality characteristics and the price structure of secondary crops in the country. Groundnut was included in this study.

Tentative conclusions are that moisture content is the major quality characteristic at all market levels. The private sector uses a grading system, which includes moisture content, grain size, and foreign matter. Significant rewards are occasionally given for specific characteristics, a practice which, if it became more widespread, might induce growers to tailor their production more adequately to market requirements. The state of private sector involvement in the marketing and processing of groundnut is still transitional, and because market differentiation has not yet fully evolved, there are no product-specific incentives for growers.

Data Base on Food Crops

The Centre is presently finalizing its data base on seven major food crops, including groundnut, in Southeast Asia. By mid-1989, the data base will be operational for Indonesia, Thailand, and the Philippines. It contains time-series data going back 20 years, and uses a large number of in-country sources.

The aim of creating this data base is to provide information of importance to policy makers and planners as well as to national and international researchers. Data on production, prices, demand, marketing, and trade are included.

Manpower Development: Relevant Methods

Working in collaboration with researchers at CIMMYT and at Stanford University USA, the CGPRT Centre has further developed a training package on domestic resource allocation. The package offers methods for making decisions on the choice of crops that should be grown in different regions, and it takes into account the concept of comparative advantage.

This method, which has generated widespread interest, is applicable wherever mutually exclusive development options have to be considered. It is especially useful for upland agriculture in Asia, given the increasing commercialization of such areas and the importance of the income-earning opportunities associated with certain crops. The Centre has already trained a number of agronomists and economists from South Asia in the use of this method, and will continue its thrust in this field under its Human Resources Development Programme.

IDRC Support for Grain Legumes Improvement

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Introduction

Research to improve grain legumes has been, and continues to be, a concern of IDRC. Since 1973, IDRC grain legume support has exceeded Ca$ 18 million to more than 35 projects worldwide. This support is justified by the importance of grain legumes in many farming systems as well as by the scope for improving these crops to provide benefits for the poorest farm families.

The bulk of support has been for increasing the productivity of grain legumes in improved and more sustainable farming systems, but support has also been provided for postharvest processing and storage (in Bangladesh) and for information dissemination *(Lentil Abstracts* and *Faba Bean Abstracts* through CABI).

Support for the temperate legumes has concentrated on chickpea, lentil, and faba bean in North Africa and Asia. Some support for pea has been provided to Burundi. More recently, support has been provided to the Indian Council for Agricultural Research (ICAR), and to Agriculture Canada and the University of Manitoba, to develop improved varieties of lathyrus containing lower levels of neurotoxin safe for human consumption. A Lathyms Improvement Network is being developed that will include Bangladesh, Nepal, Pakistan, and Ethiopia.

The tropical grain legumes comprise a wider spread not only of crop species but also of IDRC-supported activities. Projects in West Africa primarily support cowpeas and phaseolus beans. In South and Southeast Asia, mung bean, groundnut, and soybean receive the most support, but pigeonpea, black gram, and cowpea also receive some.

Since 1973, IDRC has provided support to IARCs for grain legume research. This support has included several projects with ICARDA on lentil and faba bean improvement ICRISAT received IDRC support from 1973 to 1978 while its chickpea and pigeonpea programs were starting up. More recently, IDRC support has enabled the Philippines national legume program to develop and test improved varieties of groundnut, soybean and mung bean through ARFSN, the network coordinated by IRRL

IDRC has also contributed to research on specific grain legume problems and in cooperative projects between a Canadian institution and an IARC or a national program.

Examples are projects on faba bean diseases, carriers for chickpea rhizobia, dihaploid breeding in lentil, and pollination control in faba bean — all with the University of Manitoba. More recently, the Agriculture Canada Research Station at Lethbridge, the Thailand Department of Agriculture, and the AVRDC have cooperated in using ^{15}N to improve nitrogen fixation in soybean.

National Grain Legume Program Support in Asia

Most IDRC support goes directly in grants to strengthen grain legume research in national programs. These grants provide for the purchase of equipment and supplies, local travel, international travel to attend meetings, consultancies, and training. Training has involved both postgraduate degrees, and short-term training, primarily for junior scientists and technicians to attend courses at ICRISAT, ICARDA, and IRRI.

At present, IDRC supports legume improvement in national programs in Bangladesh, Pakistan (two projects), Nepal (two projects), Sri Lanka, Indonesia, Thailand, the Philippines, and the People's Republic of China.

In all projects except the Chinese one, one or more of the ICRISAT legume crops are included. The IDRC-supported legume programs in the South Asian countries include at least five and as many as nine different legume species, the importance of which in diverse cropping systems has been demonstrated. Later phases of IDRC support often move towards more specific research aimed at overcoming specific constraints on fewer crops selected from those earlier identified. More emphasis on ensuring that research results reach the farmer through on-farm testing, or more attention to links between research, extension, and the farmer, is often a feature of later phases. For example, the second phase of the project in Pakistan is concentrating on on-farm testing of improved chickpea technology.

Links with IDRC-supported Grain Legume Programs

An important aspect underlying all IDRC-supported grain legume programs is that our contribution enables national programs to interact more effectively with each other and with the IARCs and the IDRC. Stronger programs are better able to identity research priorities, test material provided by the IARCs, and identify appropriate training needs, which IDRC or other organizations can meet Examples of such links involving ICRISAT are:

- The NODP in Nepal organized a national groundnut monitoring tour, with ICRISAT scientists participating; support for local scientist travel was provided by IDRC
- In Pakistan, the ICRISAT/ADB chickpea ascochyta blight project complements the support to the national food legumes program provided by IDRC
- In Sri Lanka, encouraging initial results from ICRISAT pigeonpea material tested in the national program have resulted in some of the IDRC project support being used for further pigeonpea testing

- A course on the identification of groundnut viruses was organized by ICRISAT in Indonesia, funded by FAO and IDRC

The need to increase grain legume research in Asia has been recognized by other donors besides IDRC, and also by IARCs, including ICRISAT. Several national and international workshops and symposiums on grain legumes in Asia held recently have helped define regional and national research needs. In April 1988 a meeting was held in Thailand to develop more effective coordination among donors and IARCs. Stronger coordination can help channel support without overburdening or biasing the activities of national programs.

Future Directions

We expect our broad-based support to several national programs to become more focused on specific constraints. The following future trends are discernible:

- A move towards the implementation of research results through on-farm testing, and the tackling of major constraints to adoption, such as seed production
- More widespread adoption, and more follow-up research, which may be supported by larger donors such as the Canadian International Development Agency (CIDA)
- Greater consideration of otherwise neglected legumes, such as lathyrus, black gram, and horse gram, through support in a cooperative network

Asia-Pacific Association of Agricultural Research Institutions

R.B.Singh

Food and Agriculture Organization of the United Nations, Bangkok

Introduction

The Expert Consultation on the Establishment of the Asia-Pacific Association of Agricultural Research Institutions (APAARI) was held at the Food and Agriculture Organization's Regional Office for Asia and the Pacific, in Bangkok, Thailand from 17 to 19 October 1985.

the meeting felt that there was a great deal of complementarity between the component sectors of agriculture in the region. In view of this, the participants considered that it would be desirable to set up a common regional association which would serve as an umbrella organization for the exchange of experience and know-how. It was decided that the association's headquarters would be in Bangkok, and that it would be supported by the FAO in its initial years.

The constitution of the newly founded association states its objectives, activities, membership, funding sources, and organization. The relevant excerpts, somewhat adapted, are presented in this paper.

Objectives and Activities

The overall objective of the Asia-Pacific Association is to foster the development of agricultural research in the Asia-Pacific region. More specifically, the aims of the association are to:

- Promote the exchange of scientific and technical know-how and information in agriculture
- Encourage the establishment of appropriate cooperative research and training programs in accordance with regional, bilateral or national priorities
- Assist in strengthening the management capability of member institutions
- Strengthen links between national, regional, and international research centers and organizations, including universities, through involvement in jointly planned research and training programs

In pursuit of these objectives, the association can undertake one or more of the following activities:

- Convene a General Assembly to discuss the association's administration, general program, policies, and priorities
- Organize working groups, meetings, and seminars to discuss specific problems or sponsor technical studies, training courses, and workshops
- Collect, collate, and disseminate research information
- Maintain effective links with agencies, organizations, institutions, and other entities, both within and outside the Asia-Pacific region, which are undertaking similar research activities
- Promote collaborative research among member institutions

Membership

Membership of the association is open to all national agricultural research institutions, councils, organizations, etc, in the countries of the region. In those countries where agricultural research is handled directly by a government department, the relevant unit/ bureau is eligible.

Funding

The annual subscription from each institution which is a member of the Asia-Pacific Association ranges from US$ 2000 to US$ 6000; the subscription is calculated according to the funding capability of each member institution. Among the other sources of funding are:

- Grants and donations from governments, national, regional or international organizations and development banks, and others
- Proceeds from the sale of publications issued by the association
- Fees, if any, collected from participants at technical meetings organized by the association

Organization

The organization of APAARI consists of:

- A General Assembly, at which each member institution is represented by one delegate; the General Assembly meets at least once every 2 years
- An Executive Committee, which is composed of a Chairperson, Vice-Chairperson, Executive Secretary, and four members; the Executive Committee meets at least once every year
- A Secretariat, headed by the Executive Secretary

Links with National and International Research

The meeting in Bangkok noted that the proposed association could facilitate the establishment of more effective links between national research institutions and the IARCs by providing guidance on national research priorities to the two representatives from the region elected to the CGIAR.

The association could also undertake specific activities; among these would be organizing inter-country workshops and studies. The Bangkok meeting supported more active participation in international information systems to strengthen national capacities to handle and use agricultural information.

In the light of these guidelines for the new association's activities, collaboration between APAARI and the AGLN would seem to be appropriate. However, it has yet to be developed.

Collaborative Links between FAO/UNDP's RAS/82/002 Project and the AGLN

Narong Chomchalow

FAO/UNDP RAS/82/002 Project, Bogor

Introduction

What is the RAS/82/002 project? Its full title is Technical Cooperation among Developing Countries (TCDC) for the Research and Development of Food Legumes and Coarse Grains in the Tropics and Sub-tropics of Asia. It aims to substantially increase production of these crops to meet the growing demand for them for export and for human and animal consumption. It is an FAO-executed, UNDP-funded regional project involving 10 Asian countries. RAS/82/002 is similar to the AGLN in that both projects have established a regional network to support NARS programs; both aim to help farmers increase food legume production; and both require coordination with regional and international organizations and donors to minimize efforts and avoid duplication. Minor differences between the two projects are shown in Table 1.

Table 1. Differences between FAO/UNDP's RAS/82/002 project and the AGLN.

Criteria	RAS/82/002	AGLN
Nature of organization	Coordinating/funding regional *project*	Research/coordination regional *program*
Approach regarding material and information (including technology transfer) and ICRISAT	Facilitating *exchange among* scientists of cooperating countries (a TCDC approach)	Facilitating *interchange between* scientists of NARS of cooperating countries
Mandate crops	*All food* legumes	*3 grain* legumes (groundnut, chickpea, pigeonpea)
Cooperating countries	10; East Asia: *Korea;* Southeast Asia: Indonesia, Philippines, *Vietnam, Lao PDR,* Thailand; South Asia: Bangladesh, Nepal, Pakistan, Sri Lanka	10; East Asia: *China* Southeast Asia: Indonesia, Philippines, Thailand; South Asia: Bangladesh, *Burma, India,* Nepal, Pakistan, Sri Lanka

The most important difference between RAS/82/002 and the AGLN is that the former covers all food legumes, whereas the latter is restricted to three. Given its broader mandate, RAS/82/002 has prioritized the legume crops grown in the Asian region as follows:

Priority 1: soybean, mung bean, black gram, groundnut
Priority 2: cowpea, pigeonpea, rice bean, chickpea, lentil, lathyrus
Priority 3: winged bean, adzuki bean, horse gram, lablab bean, asparagus bean, faba bean, common bean, jack bean, sword bean, lima bean

Only one AGLN crop, groundnut, is included as a first priority crop for RAS/82/002. The other AGLN crops, chickpea and pigeonpea, are rated as second priority.

Collaboration between RAS/82/002 and the AGLN

Since they have similar objectives and approach, including overlapping mandate crops and cooperating countries, collaboration between RAS/82/002 and AGLN has been fruitful.

Training has been regarded as a priority by both projects. Training activities were jointly planned, and RAS/82/002 provided funding while ICRISAT (as part of the AGLN) conducted the training. The following are training activities that have either already been conducted or are planned for the future:

- Training workshop on the Detection of Groundnut Viruses with Special Emphasis on Peanut Stripe Virus, 11 -26 July 1988, Malang, Indonesia (RAS/82/002 supported nine participants)
- In-service training on Analytical Techniques for the Evaluation of Nutritional Quality of Food Legumes, 1-14 August 1988, ICRISAT Center, India (RAS/82/002 supported eight participants)
- In-service training on the Integrated Control of Grain Legume Pests in Asia, 3-15 October 1988, ICRISAT Center, India (RAS/82/002 supported four participants)
- In-service training on Legume Pathology, 9-27 January 1989, ICRISAT Center, India (RAS/82/002 will support four participants)

At the request of RAS/82/002, ICRISAT hosted the project's Fifth Regional Coordination Committee Meeting, 23-27 November 1987. Two scientists from ICRISAT attended the project's Second Working Group Meeting and Workshop in Chiang Mai, held in Thailand, 1-5 August 1988. At this meeting they presented papers at the plenary sessions of the workshop.

The acting coordinator of the AGLN has been nominated as an international associate of RAS/82/002. He was present at the the Sixth Regional Coordination Committee Meeting, which was held in Bangkok, 3-4 October 1988, and accompanied a recent study tour to Vietnam. He has also been appointed as international referee for the RAS/82/002 *Food Legume and Coarse Grain Newsletter.*

FAO's Role in Strengthening National Legume Research in Asia

E. A. Kueneman

Food and Agriculture Organization of the United Nations, Rome

It is a pleasure to address this meeting of research coordinators. Let me make it very clear that the FAO is not a research institution per se, but a development institution. However, as such it is very interested in fostering relevant research. It is a key supporter of the IARCs, and also has a keen interest in helping national programs increase their capacity to develop appropriate technology and absorb technology developed elsewhere.

FAO is not a donor organization, but as part of the United Nations it is closely linked to donor organizations such as the UNDP and to loaning institutions such as the World Bank. Further, member countries of FAO are represented at FAO headquarters, and FAO can help by linking the assistance requirements of developing countries with the bilateral assistance available from donor countries through the offices of the country representatives.

On request from member countries, FAO can assist in the establishment of research and development policies and/or priorities. Similarly, we can help formulate projects for submission to donors, and, if requested, can assist in the implementation of projects in areas in which we have a comparative advantage. FAO feels it can play an important role as an "honest broker", providing guidance to national programs. FAO has a comparative advantage as a catalyst and, at times, functions as a coordinating body for international cooperation.

What specifically is FAO doing regarding legume research and development in Asia? We are the implementing institution for the UNDP-funded coarse grains and food legumes project (RAS/82/002), designed to foster technical cooperation among developing countries. The project is working well; we hope it will be extended for another 2 years.

FAO feels that national programs must be strengthened to be able to take more responsibility for meeting their own adaptive research and development needs. Cooperation among countries will accelerate this process, hence FAO's promotion of TCDC activities such as those in the RAS/82/002 project.

In pursuit of coordination at a regional level, FAO supports the proposal of the ACIAR and the IDRC for a regional steering committee as an umbrella structure to coordinate research and development activities.

Last but not least, FAO is eager to further strengthen its working relationships with IARCs such as ICRISAT, so as to provide better integrated services to national programs. Close cooperation and joint planning will be essential for effective use of limited resources.

There is an enormous task ahead to increase food legume production, and national programs, development organizations, and international research institutions need to work together if progress is not to be painfully slow.

Multilocational Trials on Groundnut under the South Asian Association for Regional Cooperation (SAARC)

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Under SAARC, programs were formulated to conduct multilocational trials on groundnut in the member countries. For this purpose, two meetings of scientists were held. The first meeting took place on 22 and 23 December 1986 at the Indian Agricultural Research Institute (IARI), New Delhi; the second meeting was held on 7 and 8 March 1988 at BARI, Joydebpur (Bangladesh). The first meeting was attended by representatives of Bangladesh, Bhutan, India, Nepal, and Pakistan, while at the second Bangladesh, Bhutan, India, Nepal, Pakistan, and Sri Lanka were represented.

Country reports were presented at the first meeting, at which the general constraints to the production of groundnut were identified and multilocational trials were planned.

The general constraints to groundnut production in the member countries of SAARC were identified as:

- Lack of high-yielding varieties with early maturity and resistance to diseases and insects
- Lack of quality seed
- Seed viability and dormancy problems
- Inadequate use of inputs

- Lack of marketing infrastructure
- Inadequate research and extension efforts
- Unavailability or inadequate use of machinery for mechanized groundnut cultivation

At the first meeting it was decided that the trials would be monitored by the country coordinator. He would compile the data and report to the regional coordinator by the end of January.

The group recommended that the annual meeting should be held in rotation in different SAARC countries in March each year.

Based on these discussions, a number of recommendations were made. These were that:

- Packages of technology for increasing the production of groundnut should be refined by sharing the experiences of member countries; each country should prepare a technology bulletin which would be distributed among member countries at the next meeting

- Member countries should explore the possibilities for extending groundnut cultivation into new areas

- Short- and long-term research and development strategies for groundnut production should be developed by each member country, and areas of collaboration should be identified

- Now that improved cultivars are available, multilocational trials should be conducted systematically from 1988 onwards

- The multidisciplinary approach should be further strengthened to solve the problems of groundnut production in member countries

- Member countries should exchange germplasm catalogs; ICRISAT should be contacted for specific requirements

- Standardized presentation of data and results should be followed, as agreed at the first SAARC meeting, and results should be sent to SAARC by 31 January each year (since the cropping season in Bangladesh is different, whatever data are available by that date should be sent)

- Exchange of literature on groundnut between SAARC countries should be strengthened

- The SAARC Secretariat should arrange funding for a short training course in groundnut hybridization at ICRISAT

Opportunities for Collaborative Research between the Asian Rice Farming Systems Network and the AGLN

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Introduction

The objective of ARFSN is to facilitate collaboration between national scientists and IRRI so as to increase food production in Asia by identifying more productive rice-based farming systems which are acceptable to small-scale farmers. The specific objectives of the network are to:

- Promote and coordinate collaborative research on farming systems, with major emphasis on problems common in Asia
- Provide mechanisms for sharing information, technology, and methods generated by IRRI, national programs, and other international programs
- Conduct collaborative research on major production systems at key sites, and component research at selected key sites and on research stations
- Provide a feedback mechanism to call the attention of IRRI and national programs to problems identified in the field

Fifteen countries are involved in the network: Bangladesh, Bhutan, Burma, the People's Republic of China, India, Indonesia, Madagascar, Malaysia, Nepal, the Philippines, South Korea, Sri Lanka, Taiwan, Thailand, and Vietnam.

To help the network accomplish its objectives, an Asian Rice Farming Systems Working Group was set up to provide guidance and direction. The group consists of leaders of national farming systems programs, a network coordinator from IRRI, and up to five Asian scientists. The group meets once a year.

Collaborative Research Links with the AGLN

At present, the ARFSN has no direct links with the AGLN. The links are through the NARS which collaborate with both networks. In addition, IRRI collaborates with ICRISAT in the following areas:

- Evaluation of pigeonpea in rice-based farming systems in both rainfed lowland and upland conditions

- Distribution of trial materials to national programs interested in testing promising varieties (such trials are being undertaken in Kampuchea, Vietnam, and the Philippines)

Achievements in Collaborative Research

The ARFSN has had a significant number of recognizable successes in collaborative research over the past 18 years, as evidenced in the growing number of countries and national institutions which are now undertaking work on farming systems within the network.

As a direct result of collaboration between the different ARFSN countries and between the ARFSN and IRRI, new technologies have been developed in several NARS, particularly in the Philippines (two crops of rice followed by a third crop in the rainfed areas of Iloilo), Thailand (mung bean after rice in the northeast region), Sri Lanka (two crops under minor irrigation), and Bangladesh (two rice crops). As a result of these technological developments, substantial increases in food production are now being reported from these countries.

Priorities for Research

By mandate, IRRI,s research priorities in Asia are rice-based. As regards legume crops, IRRI will collaborate on component and systems research at selected research stations and on-farm sites. The following systems with legumes as a component are included:

- Rice-groundnut cropping system (Pakistan and Indonesia)
- Rice-chickpea cropping system (Pakistan and Bangladesh)
- Rice-pigeonpea cropping system (the Philippines, Burma, and eastern India)

At present, activities are undertaken at one site in each country. Collaboration is concerned mainly with the exchange of materials for and information on the trials conducted.

Improvement of Links

Further strengthening of the links which have been established between the ARFSN, the AGLN, and NARS can be achieved through greater participation in joint research activities, as well as in the coordination of joint workshops and monitoring tours. These collaborative efforts will bring rice and legume scientists together, and this will promote closer cooperation, better exchange of information, and improved understanding of common problems.

Peanut-CRSP Collaborative Links in Southeast Asia

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University of Georgia, Experiment

Peanut-CRSP has been active in Southeast Asia since 1982. Its primary goal is to enhance the progress of NARS. Support is provided in terms of supplies, equipment, short-term and degree training, technical assistance in program planning and analysis, and in the application of results. Research programs in the USA should also benefit from the collaborative program.

Research in Peanut-CRSP involves breeding, integrated pest management and virus research (with the emphasis on PStV), and food and postharvest technology.

Collaborative links with the AGLN occur through Peanut-CRSP research in the Philippines and Thailand, where Peanut-CRSP supports extensive breeding programs. Peanut-CRSP and NARS efforts in integrated pest management and virus research support goals of interest to the AGLN. The Peanut-CRSP program in Thailand has had a long and mutually beneficial relationship with the IDRC of Canada, which has joined Peanut-CRSP in supporting the national program. Peanut-CRSP virus research is carried out in cooperation with the ACIAR, through a collaborative link in Indonesia, and with ICRISAT, which strengthens the regional impact of the program. Peanut-CRSP activities in the areas of food and postharvest technology provide quality and sensory evaluations of promising lines and cultivars.

Four cultivars have been released. Thailand released Khon Kaen 60-1 (high-yielding type) and Khon Kaen 60-2 (boiling type) in 1987, and Khon Kaen 60-3 (large-seeded type) in 1988. The Philippines released an improved, higher-yielding cultivar, UPL-Pn 6, in 1986. Lines with multiple resistance to insects have been identified. Breeding efforts are seeking to incorporate disease, insect, drought, and aflatoxin resistance into improved lines. Lines tolerant to shade and to acid soils are being developed in the Philippines.

Peanut-CRSP research will continue to focus on the Philippines and Thailand. Priority will continue to be given to breeding, integrated pest management, virus research, and food and postharvest technology. Links will be sought with other countries in the region where information resulting from the research ought to be disseminated. Funds for these additional links may be obtained through USAID missions in interested countries.

Discussions at the groundnut scientists' meeting, held in November 1988 in Malang, Indonesia, resulted in some suggestions for improving networking. Communication with

AGLN participants should be maintained to provide germplasm for testing that meets minimum requirements, and that has resistance to a prevalent disease or tolerance to acid soils. This should increase the probability of success in the program. Additionally, special interest groups should be developed as the need arises. An example is the Peanut Stripe Virus Working Group now active in the region. Other possibilities are an entomology group and a follow-up to the aflatoxin workshop. Finally, all researchers should take every opportunity to communicate results where appropriate, through journals or other media. The *International Arachis Newsletter* published by ICRISAT in cooperation with Peanut-CRSP encourages publication of preliminary research findings.

ICARDA's Testing Program on Lentil, Faba Bean, and Kabuli Chickpea

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Introduction

ICARDA was established in 1977 to undertake research relevant to the needs of West Asia and North Africa, and to strengthen NARS in the region. The overall objective of ICARDA is to improve agricultural productivity in the region. ICARDA's principal involvement is with rainfed agricultural systems. The ICARDA region extends from Morocco in the west to Pakistan in the east and from Turkey in the north to Sudan and Ethiopia in the south. As regards food legumes, ICARDA serves as an international center for the improvement of lentil, and as a regional center in collaboration with ICRISAT for the improvement of kabuli chickpea. Until recently, ICARDA was also responsible for the improvement of faba bean, but this work is now being transferred to national programs.

The testing of new varieties of these food legumes by national programs is coordinated by ICARDA. The main objective is to provide the necessary genetic material and production practices to national programs for testing, so that appropriate packages of technology can be identified locally.

The cooperative program started in 1977/78 with six different nurseries, including yield trials and screening nurseries. Later, as cooperators' needs diversified, the nurseries too were diversified to include yield trials, screening nurseries, segregating populations, stress tolerance nurseries, and agronomy trials. Over the years the emphasis has gradually shifted from yield trials, which essentially contained finished varieties, to nurseries with early-generation breeding material and sources of pest and disease resistance.

Nursery Distribution

The complete list of the nurseries available can be obtained by writing to the Food Legumes Improvement Program at ICARDA. Information about the available nurseries/trials is circulated every year to cooperators throughout the world. Scientists wanting to participate are urged to fill in and return their request to the program by June 15 each year.

The plant quarantine regulations of the receiving country are adhered to before material is despatched. All the material supplied through the Food Legumes International Testing Program is increased under disease- and pest-free conditions at ICARDA. Seed is regularly inspected by the scientists of ICARDA's Plant Quarantine Section.

All the seed supplied by cooperators for inclusion in the international testing program is also grown in a plant quarantine area, and is regularly inspected.

Monitoring Program

Scientists from national programs and ICARDA periodically review the progress of the Food Legumes International Testing Program. Conferences, travelling workshops, group meetings, and personal visits by scientists have been key activities, providing mechanisms for interaction which help in planning future research.

Looking Ahead

In the coming years the program intends to gradually transfer the responsibility for developing cultivars to national programs, and to concentrate more on crossing blocks and segregating populations.

SUMMARY AND RECOMMENDATIONS

Summary of Discussions

During the opening session of the Regional Legumes Coordinators' Meeting, a Summary Committee and a Recommendations Committee were elected, the former to summarize the main issues arising from the proceedings and the latter to make appropriate recommendations. In order to stimulate discussion among the workshop participants, a series of questions concerning the future development of the AGLN was drawn up by the organizers of the workshop. These questions were then raised at two discussion group meetings which were held concurrently — the groundnut group meeting and the chickpea and pigeonpea group meeting.

The Summary Committee and the Recommendations Committee considered the discussion and conclusions reached in both group meetings and compiled the summary presented here. In most cases no strong differences of opinion were expressed between the two groups, and even in cases where differences of opinion existed, it proved possible to reach a consensus.

Objectives of the AGLN

It was considered time to revise the objectives of the AGLN so that they reflect more accurately the current activities and stage of development of the network. The following key areas for the formulation of objectives were identified:

- Germplasm
- Training
- Collaborative research
- Visit program
- Information exchange

A set of objectives that addresses these key areas of activities for the AGLN should be drawn up as a matter of priority.

Structure of the AGLN

The meeting endorsed the establishment of a Steering Committee for the AGLN. The committee should be made up of AGLN country members. The AGLN coordinator will be a member-secretary of the Steering Committee, which will have an elected chairperson. If there are sufficient financial resources available to permit annual coordinators* meetings, then all country representatives of the AGLN should be members of the Steering Committee. If insufficient funds are available, then an elected subset of members should be considered. The following advantages in forming a Steering Committee were identified:

- Members of the AGLN will feel a stronger bond to the network if they are represented on a policy committee
- The case that can be presented to potential donors will be enhanced if the network is seen to be truly collaborative and representative in structure

It was not considered necessary for representatives of donors or other regional organizations to be formal members of the committee, although their input could be solicited on an ad hoc basis. In discussing priorities for the AGLN, the committee should consider the guidelines established by the International Service for National Agricultural Research (ISNAR) for setting national research priorities.

The Steering Committee should meet at least once a year, preferably in conjunction with another network activity (e.g., a meeting of national coordinators). In between meetings the committee should be consulted as frequently as necessary by telephone, telex, or post.

The current AGLN coordination system appears to be working satisfactorily. Clearly, this system could be further improved if additional funds were available to finance network activities.

Importance of AGLN and Non-AGLN Crops

The importance of AGLN crops varies in the Asian subregions. Groundnut is an important crop throughout Asia, particularly in East and Southeast Asia. However, this is not the case for the AGLN's other two mandate crops, chickpea and pigeonpea. Chickpea is an important crop in South Asia, but is scarcely grown at all in other Asian subregions, while pigeonpea is of some importance in South Asia, but is a minor crop in East and Southeast Asia.

Other legume crops (e.g., soybean, mung bean, and cowpea) often have a higher national priority in this region than do particular AGLN crops. This reflects consumer preferences, national development plans, and the large number of legume crops grown in the region. To date, AGLN interest in these crops has been restricted to their role in farming systems where AGLN crops are grown.

The existence of other legume crop priorities must be acknowledged by the AGLN, and efforts should be made to interact closely with other activities in the region to ensure that network members' priorities are not distorted by AGLN activities. This is particularly relevant because of the relatively small number of legume scientists in the region, such that often the same scientist is responsible for more than one crop. The development of effective links between the AGLN and other legume groups is important, but the mechanism for such links is not yet clear, and further deliberations will be necessary. The principles established at the foundation of the AGLN, in terms of strengthening NARS and avoiding the duplication of efforts, should be foremost in the AGLN's consideration of how to link up with other related programs.

The AGLN should seek to establish links with other international centers, such as IITA, AVRDC, and IRRI, which have relevant programs, including non-AGLN legume and cereal crops.

On irrigated land, cereal crops, especially rice and wheat, are generally more important than grain legumes. However, on rainfed land, grain legumes tend to be just as important, forming a vital part of crop rotations.

Major Constraints

The major constraints affecting the production and marketing of AGLN crops in different subregions of Asia, as summarized from the contributions of participants, are shown in Table 1.

Participants made a number of additional points regarding technical constraints. Botrytis gray mold, while an important disease of chickpea in Nepal and Bangladesh, might not be a high priority problem in other parts of South Asia. Ascochyta blight continues to be the major problem disease of chickpea in South Asia as a whole. Wilt affects chickpea throughout the area. In Bangladesh, *Sclerotium rolfsii* is a major problem in chickpea, especially when grown after rice.

In pigeonpea, sterility mosaic disease, not phytophtora blight, might be considered the major problem in South Asia.

Priorities in tackling the major constraints to production are addressed in the individual country papers presented at this meeting. However, this was not the only meeting held to discuss national research priorities. The chickpea coordinators from South Asia met at ICRISAT Center in 1987 to develop a regional work plan for chickpea improvement (Appendix 1). At a recent AGLN groundnut scientists' meeting held in Malang, Indonesia, a series of priority problems for this crop were identified, and proposals made for solving them (Appendix 2). National research priorities were also discussed at the Workshop on the Agroclimatology of Asian Grain Legume Growing Areas, held immediately before the current meeting (Appendix 3).

Table 1. Production and marketing constraints of AGLN crops in Asian subregions.

	South Asia			East and Southeast Asia		
	Chick-pea	Pigeon-pea	Ground-nut	Chick-pea	Pigeon-pea	Ground-nut
Socioeconomic						
Marketing	-1	-	-	-	***	*
Adoption	-	*	-	-	***	*
Seed availability	****	**	***	-	-	***
Management						
Irrigated	**	-	**	-	-	***
Upland	***	**	***	-	*	***
Soil factors						
Physical (drainage)	-	**	*	-	-	*
Chemical	***	**	***	-	*	***
Acidity	-	-	-	-	**	***
Salinity	****	*	-	-	-	-
BNF[2]	?	?	?	-	?	7
Diseases						
PStV[3]			*			****
Wilt	***	**	*		*	***
Foliar pathogens			****			***
PMV[4]			**			**
BND[5]			*			*
Botrytis gray mold	****	*		-	-	
Ascochyta blight	****			-		
Stunt	**			-		
SM[6]		***			*	
Phytophthora blight		****			*	
Pests						
Helicoverpa	***	****		-	****	
Podfly		****			**	
Maruca		***			***	
Weeds	***	*	***	-	*	***
Utilization						
Human	-	-	-	-	***	-
Animal	?	?	?	-	***	-

1. **** = great importance; * = little importance; - = not relevant; ? = unknown
2. biological nitrogen fixation
3. peanut stripe virus
4. peanut mottle virus
5. bud necrosis disease
6. sterility mosaic

Complete catalogs of ICRISAT germplasm resources for chickpea and pigeonpea have been published, and the catalog for groundnut will be published soon. These will help AGLN members identify potentially useful additions to their programs. Lists are also available of the international variety trials of the three AGLN crops and of subsets with particular attributes. These should be considered when work plans are developed.

The meeting recognized the importance of collecting local landrace varieties of AGLN crops before they disappear. Inter-country, sometimes regional, research is warranted when particular constraints are common. Examples of research topics suited to this approach were PStV, bacterial wilt of groundnut, acid soil conditions, and salinity. Member countries having a comparative advantage in a common problem should be requested to take prime responsibility for this problem on behalf of the network. This comparative advantage can arise either through a country's expertise or through the presence in it of conditions which make screening for a particular trait more efficient there than elsewhere. Additional funding may be required in such cases, as the risk of diverting resources away from national priorities is high.

A further area where activities could be warranted by the AGLN is in providing assistance to ensure that adequate quantities of high-quality seed of improved cultivars can be made available for seed multiplication and subsequent distribution to farmers. The AGLN might wish to collaborate with other agencies and donors already active in this area.

The role of on-farm testing in the AGLN was discussed. Although this was seen as the prime responsibility of national programs, a role for the AGLN in fostering this approach and providing training in appropriate methods was identified. It was suggested that a link to the ARFSN be considered, but other programs might also be able to contribute.

Participants made a number of specific points with regard to breeding. Chickpea crosses should be made by ICRISAT for national programs to combine resistance to botrytis gray mold and *Sclerotium rolfsii.* Breeding for high yields in groundnut, chickpea, and pigeonpea may not be as important as is normally supposed, given that these crops can already produce 3-5 t ha^{-1} in farmers' fields when appropriately managed. Providing true-breeding (F_5) populations to national programs for their own selection has proven useful, but many programs in the region are still interested in receiving finished products only.

Discussion on research and technology was far from exhaustive. Further aspects will be explored in more detail as country work plans are developed.

Training

The training component of the AGLN was considered a priority activity by all participants. It was agreed that not only should research scientists be trained (and subsequently become a national resource for training others with the support of the network), but also that research technicians and others involved in national legume improvement programs should be given opportunities to develop their skills.

Training could take the form of specialized training courses conducted by the AGLN at ICRISAT (or other appropriate centers) or of in-service training through in-country courses conducted by AGLN members. Individual training opportunities are also available at ICRISAT.

The view was strongly expressed by country coordinators that ICRISAT should identify specific training opportunities for AGLN members as a routine procedure. This would enable the selection of participants in training courses to be discussed and incorporated in AGLN work plans on an annual basis.

Several examples of the benefits of specialized courses to AGLN members were identified. Some courses are already in progress, such as those on disease resistance, virus identification, and integrated pest management; other courses for consideration in the future include on-farm research methods, farm management, equipment maintenance, statistical analysis, modeling, and analysis of genotype x environment interactions.

Invitations to apply to ICRISAT for postdoctoral research fellowships should be more widely circulated in AGLN countries than they are at present The international newsletters on chickpea, pigeonpea and *Arachis* might be one vehicle for achieving this.

Information Transfer

The relative importance of various types of meeting — coordinators' meetings, scientists' meetings, workshops, group discussions, and monitoring tours — was discussed. The chickpea/pigeonpea group did not rank the importance, as all were considered valuable. The groundnut group suggested that the priorities were:

1. Coordinators' meetings (once a year)
2. Scientists' meetings (by crop, every third year)
3. Workshops
4. Monitoring tours

The addition of the Steering Committee to the structure of the AGLN must also be taken into account when identifying priorities for meetings.

Besides the meetings already held by the network, "group meetings" on special important topics should be considered.

The high cost of publishing the full proceedings of meetings was recognized by all participants. The type of publication that should be prepared depends on the objective of the particular meeting. The use of summary proceedings (and in some cases extended summaries) was supported, although copies of the full papers should be kept by the AGLN and made available as photocopies to country coordinators for circulation to relevent AGLN members.

The present newsletters covering AGLN crops were commended by participants. It was felt that a formal AGLN newsletter was not needed. Instead, two cost-effective ways of increasing the dissemination of AGLN news to members were suggested: to expand the "news" sections of each crop-based newsletter to provide updated information on AGLN activities; and to include in the copies of at least one of the crop-based newsletters going to AGLN members a short mimeographed news sheet of AGLN activities.

AGLN members should be made aware of the range of newsletters concerned with AGLN crops produced by other institutions.

The SATCRIS data base was discussed. It appears that AGLN members have yet to take full advantage of this service. It was suggested that a demonstration of its value and scope should be made to AGLN country coordinators. This could be achieved by providing each coordinator with relevant output from SATCRIS for a trial period of 3 months. Country coordinators could then selectively expose other AGLN members to the system. Appropriate feedback could be provided to SATCRIS in order to refine the service.

The ICRISAT library should collect reports and other publications from AGLN countries that are presently not available through SATCRIS.

Work Plans

The development of country work plans was considered appropriate. As already mentioned, in some cases it may be advantageous to develop a regional work plan for particular common problems, in addition to the country-based plans.

Country work plans should be developed at, or in conjunction with, national program planning meetings. This will avoid the duplication of efforts, reduce travel costs, and provide a wider group for discussion of the work plan than would otherwise be possible. It will also enable the work plan adopted to become an integral part of the national program.

Steps that could be taken to gain the support of national program administrators are:

- Involve them in AGLN activities, either in-country or at ICRISAT
- Have national coordinators liaise frequently with the appropriate administrators, and advise them on the progress being made through AGLN
- Consult administrators on memoranda of agreement, work plans, etc
- Encourage communication between the Steering Committee and administrators on the principles and activities of the AGLN

Financing

The benefits of additional financial support were universally recognized. It was also noted that additional funds need not be large; as long as there was flexibility in terms of how funds could be used to meet needs as they arose, significant progress was possible. Extra support is often forthcoming from bilateral programs, and a role for the AGLN in helping members obtain such funding was identified.

Miscellaneous

Participants felt that one possible role of AGLN members might be to act as consultants to other member countries.

The ranking of training, research, meetings, travel, and equipment, in terms of the relative importance of each, elicited considerable discussion.

The outposting of ICRISAT scientists in member countries (or groups of countries) as advisers was also discussed. No general principles could be established, as such placements require the identification of an appropriate need and the provision of funds to support them. However, ICRISAT should post more of its scientists for periods of between 1 and 12 months in national programs to strengthen the program and provide feedback to ICRISAT.

Two potential contributions to AGLN activities from the member countries were identified:

- Provision of access to particular "hot spots" for the screening of genetic material
- Access to statistical data on the production of AGLN crops, to assist in the setting of research priorities and in applications for bilateral funding

Prototypes and diagrams of equipment, such as small-scale groundnut diggers, can be provided by ICRISAT on request

Recommendations

The draft recommendations proposed by the Recommendations Committee were discussed by all participants in plenary session, after which they were amended by the committee. The committee's final recommendations were as follows:

- That the AGLN should remain a high-priority activity for ICRISAT, and that additional funding should be sought from donors to expand its activities.

- That the AGLN re-evaluate its current objectives in the light of progress made since its inception and as a result of discussions at this workshop.

- That the AGLN form a Steering Committee made up of representatives of the network membership. The final composition of the committee should be determined as matter of priority. This will be largely determined by funding available to the network.

- That the AGLN provide in its training program opportunities for all research staff to participate in personal development programs. This might include training of research technicians at ICRISAT or through AGLN in-country training courses.

- That the AGLN implement a program to train the trainers, and subsequently foster the conduct of in-country training courses.

- That the AGLN promote the use of SATCRIS among members, initially by providing country coordinators with relevant SATCRIS outputs.

- That the AGLN recognize the importance of other legume crops (e.g., soybean, mung bean and cowpea) in the region and facilitate links to other research institutions and other activities incorporating these crops. In addition, the AGLN should ensure that close collaboration is maintained between AGLN activities and those of other research organizations in the region working on AGLN crops.

- That the AGLN recognize that the provision of small amounts of funding that can be applied flexibly by AGLN members can make a substantial impact on research progress. Appropriate funding of this kind should be sought as a matter of priority.

Appendix 1

Highlights of the AGLN Chickpea Coordinators' Work Planning Meeting

4-6 August 1987, ICRISAT Center, India

The chickpea coordinators from Bangladesh, Burma, India, Nepal, and Pakistan developed detailed lists of constraints and work plans for the chickpea areas of Asia. Breeding of disease- and insect-resistant varieties was given high priority.

Of the biotic stresses, the soilborne diseases fusarium wilt and root rot were important in all countries. Ascochyta blight had been devastating in Pakistan and parts of India. *Sclerotium* collar rot was important in rice fallows throughout the region, while botrytis gray mold was important in Bangladesh, India, and Nepal. Among the pests, *Helicoverpa* pod borer was universal and could be severe. Ideas on screening methods to develop varieties resistant to these constraints were shared.

Of the abiotic stresses, drought resistance and poor plant stands were considered the most important. Breeding for low-input and even for high-input conditions, but particularly for stable yields, and demonstrating the material to farmers, were considered to be the most urgent tasks.

Flower and pod drop were identified as being widespread. Special research to resolve these problems should include input from pathologists, physiologists, and breeders.

Training needs were identified in detail for each country, including level of training, course content, and numbers of candidates.

The need to ensure mat minimum standard weather records are collected at all chickpea trial sites was agreed, as also was the need for surveys of production, uses, and marketing.

Appendix 2

Highlights of the Asian Region Groundnut Scientists' Meeting

14-17 November 1988, Malang Research Institute for Food Crops (MARIF), Indonesia

Of the biotic stresses, foliar fungal diseases (leaf spots and rust), bacterial wilt, and viral diseases, especially PStV, were considered important. Progress made by collaborative research on PStV was commended, and a similar approach was suggested for research on bacterial wilt. It was recommended that this should be coordinated by ACIAR.

Among the pests, aphids, thrips, jassids, leaf miners, and to some extent soil pests such as white grubs and termites were recognized as important. Collaborative pest surveys in the region were recommended, and the importance of integrated pest management practices was emphasized.

Photoperiod and irradiance effects on groundnut were debated. ICRISAT and the Queensland Department of Primary Industries (QDPI) will collaborate in sorting out some of the problems in this area.

Drought stress was considered to be an important limiting factor in rainfed groundnut crops, and both agronomic management and genetic improvement for drought tolerance were considered necessary.

For crop production and agronomy, although many problems were identified as being common throughout the region, it was considered appropriate that research on production and agronomy be conducted within national programs owing to their location-specific nature. However, the role of international/regional organizations in supporting this work through physiological research was important.

With regard to plant nutrition and soil-related research, studies on acid soils were considered an urgent necessity. Soil alkalinity was not identified as a major problem outside India. Suggestions for future activities were the compilation of detailed inventories of nutrient disorders, and the development of adequate diagnostic and predictive tests.

Problems related to postharvest handling, especially with regard to the development of products which are suited to national needs, were emphasized. The dangers of aflatoxin contamination were discussed, and ICRISAT was requested to help other countries by developing varieties resistant to *Aspergillus flavus.*

Common breeding objectives for groundnut were discussed, and several areas of potential collaborative activities were identified. India and Thailand both requested early generation segregating material, but the other countries preferred to receive advanced lines for use in replicated evaluation trials.

Quarantine regulations for seed exchange in the region were considered to be adequate. However, scientists were requested to take special care regarding seedborne viruses. National scientists were urged to avoid the duplication of imports by maintaining the germplasm sources and promoting exchanges within their own country.

The AGLN was considered to be a successful network in the region, obtaining good collaboration from other regional and international programs. The network was requested to include mung bean and soybean in its activities, as these crops were important in the region.

Among the different levels of training available through ICRISAT, most countries indicated a need for in-service fellowships (training in specialized research techniques), followed by research scholarships and in-service training.

The AGLN was requested to collate relevant information on groundnut from different annual reports and disseminate the information to interested scientists. The *International Arachis Newsletter* was suggested as an appropriate vehicle.

Appendix 3

Highlights of the Workshop on the Agroclimatology of Asian Grain Legume-Growing Areas

5-17 December 1988, ICRISAT Center, India

The elite germplasm supplied by ICRISAT should be carefully matched against the relevant agroecological zones of countries requesting germplasm.

Crop scientists, geographers, and cartographers should use standardized terminology when discussing agroecological zoning. In cooperation with FAO, ICRISAT should produce a glossary of terms used.

Increased cooperation between crop scientists and agroclimatologists is necessary to improve understanding of biotic and abiotic stresses.

A uniform minimum data set covering soil-, crop-, and weather-related information should be collected for AGLN experiments. Facilities for the collection of weather and soil moisture data are often non-existent at research locations, and ICRISAT should consider providing automatic weather stations at some key locations.

Pests and diseases should be regularly monitored on a regional basis using a standardized grid system and a uniform scoring scale.

An attempt should be made to incorporate socio-economic and marketing information with data on physical and biological stresses.

Training in crop modeling and the validation of existing models would be most useful.

In cooperation with FAO and IBSNAT, ICRISAT should take steps to incorporate the information collected on legume crop yields and areas in Asia into a standard geographical information system. FAO has a very large data base which can be tapped, while IBSNAT has developed/adapted appropriate software.

The AGLN should hold regular meetings to review progress on agroclimatic zoning and data collection. Still more useful would be hands-on training workshops, which could be held on acountry or regional basis to tackle specific problems.

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Acronyms

ACIAR	Australian Centre for International Agricultural Research
ACPHP	ASEAN Crops Post Harvest Program (Philippines)
ADB	Asian Development Bank (Philippines)
AGLN	Asian Grain Legume Network (ICRISAT)
AGRIS	Agricultural Information Service (FAO)
AICPIP	All India Coordinated Pulses Improvement Project
AIDAB	Australian International Development Assistance Bureau
APAARI	Asia-Pacific Association of Agricultural Research Institutions
ARFSN	Asian Rice Farming Systems Network (IRRI)
ARNETs	agricultural research networks
ASEAN	Association of South East Asian Nations
ASSP	Agricultural Support Services Project (World Bank)
AVRDC	Asian Vegetable Research and Development Center (Taiwan)
BARD	Barani Agricultural Research and Development Project (Pakistan)
BARI	Bangladesh Agricultural Research Institute
BBF	broadbed-and-furrow system
BLLD	British Lending Library Division (UK)
BNF	biological nitrogen fixation
BORIF	Bogor Research Institute for Food Crops (Indonesia)
CAAS	Chinese Academy of Agricultural Sciences
CABI	Commonwealth Agricultural Bureaux International (UK)
CGIAR	Consultative Group on International Agricultural Research

CGPRT	Regional Co-ordination Centre for Research and Development of Coarse Grains, Pulses, Roots and Tuber Crops in the Humid Tropics of Asia and the Pacific (Indonesia)
CIDA	Canadian International Development Agency
CIMMYT	Centro Internacional de Mejoramiento de Maiz y Trigo (Mexico)
CRIFC	Central Research Institute for Food Crops (Indonesia)
DOA	Department of Agriculture (Sri Lanka)
FAO	Food and Agriculture Organization, United Nations (Italy)
FLCGN	Food Legume and Coarse Grain Newsletter (FAO)
FSR	farming systems research
GRU	Genetic Resources Unit (ICRISAT)
IARCs	international agricultural research centers
IARI	Indian Agricultural Research Institute
IBSNAT	International Benchmark Sites Network for Agrotechnology Transfer (USA)
ICAR	Indian Council for Agricultural Research
ICARDA	International Center for Agricultural Research in the Dry Areas (Syria)
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics (India)
IDRC	International Development Research Centre (Canada)
IDS	Information and Documentation Service (CGPRT)
IITA	International Institute of Tropical Agriculture (Nigeria)
IRHO	Institut de recherches pour les huiles et oleagineux (France)
IRRI	International Rice Research Institute (Philippines)
ISC	ICRISAT Sahelian Center (Niger)
ISNAR	International Service for National Agricultural Research (Netherlands)
LEGOFTEN	Legume On-Farm Testing and Nurseries (ICRISAT)
MAFF	Ministry of Agriculture, Forestry, and Fisheries (Japan)
NAL	National Agricultural Library (India)
NARC	National Agricultural Research Centre (Pakistan)
NARS	national agricultural research systems
NARSC	National Agricultural Research and Services Centre (Nepal)
NCT	National Cooperative Testing (Philippines)
NGLIP	National Grain Legumes Improvement Program (Nepal)
NifTAL	Nitrogen Fixation by Tropical Agricultural Legumes (US AID)
NODP	National Oilseeds Development Program (Nepal)
NRDS	National Research and Development System (Philippines)
Peanut-CRSP	Peanut Collaborative Research Support Program (USAID)
PCARRD	Philippine Council for Agriculture, Forestry and Natural Resources Research and Development
PDAP	Peanut Development Action Project (PCARRD)
PRECODEPA	Programa regional cooperativo de papa (Central America, Caribbean)
QDPI	Queensland Department of Primary Industries (Australia)
RAPA	Regional Office for Asia and the Pacific (FAO)
RAS/82/002	TCDC for the research and development of food legumes and coarse grains in the tropics and subtropics of Asia (FAO/UNDP project)
RMP	Resource Management Program (ICRISAT)
SAARC	South Asian Association for Regional Cooperation (Nepal)
SADCC	Southern African Development Coordination Conference (Botswana)
SAT	semi-arid tropics
SATCRIS	Semi-Arid Tropical Crops Information Service (ICRISAT)

SDI	Selective Dissemination of Information (ICRISAT)
SMIC	Sorghum and Millets Information Center (ICRISAT)
TCDC	Technical Cooperation among Developing Countries (FAO)
UNDP	United Nations Development Programme
USAID	United States Agency for International Development
USDA	United States Department of Agriculture

Crop Names

Only the common names of crops are used in this report. Their Latin binomials are as follows:

Adzuki bean	*Phaseolus angular is*
Asparagus bean	*Vigna sesquipedalis*
Barley	*Hordeum vulgare*
Black gram, urdbean	*Vigna mungo*
Cassava	*Manihot esculenta*
Chickpea	*Cicer arietinum*
Coconut	*Cocos nucifera*
Common bean, phaseolus bean	*Phaseolus vulgaris*
Cotton	*Gossypium herbaceum*
Cowpea	*Vigna unguiculata*
Faba bean, broad bean	*Vicia faba*
Green gram, mung bean	*Vigna radiata*
Groundnut	*Arachis hypogaea*
Guar	*Cyamopsis tetragonoloba*
Horse gram	*Macrotyloma uniflorum*
Jack bean	*Canavalia ensiformis*
Kenaf	*Hibiscus cannabinus*
Lablab bean, hyacinth bean	*Lablab purpureus*
Lathyrus	*Lathyrus sativus*
Lentil	*Lens culinar is*
Lima bean	*Phaseolus lunatus*
Linseed	*Linum usitatissimum*
Maize	*Zea mays*
Moth bean	*Vigna aconitifolia*
Mucuna, velvet bean	*Mucuna pruriens*
Mung bean, green gram	*Vigna radiata*
Pea	*Pisum sativum*
Pearl millet	*Pennisetum glaucum*
Pigeonpea	*Cajanus cajan*
Potato	*Solanum tuberosum*
Rice	*Oryza sativa*
Rice bean	*Vigna umbellata*

Rubber	*Hevea brasiliensis*
Sorghum	*Sorghum bicolor*
Soybean	*Glycine max*
Sweet potato	*Ipomoea batatas*
Sword bean	*Canavalia gladiata*
Sugar cane	*Saccharum officinarum*
Taro	*Colocasia esculenta*
Urdbean, black gram	*Vigna mungo*
Wheat	*Triticum aestivum*
Winged bean	*Psophocarpus tetragonolobus*
Yam	*Dioscorea alata*

Diseases and Pests

Diseases, insects, and nematodes are referred to in the text by their common names. The following listing by crop gives the Latin binomials, but contains only pathogens mentioned in this report.

Common name or abbreviation	Latin binomial or full name

Diseases

Chickpea

Ascochyta blight	*Ascochyta rabiei*
Botrytis gray mold	*Botrytis cinerea*
Collar rot	*Sclerotium rolfsii*
Root rots	*Rhizoctonia bataticola* *R. solani,* and *Fusarium solani*
Stunt (CpSV)	Chickpea stunt virus
Wilt (fusarium wilt)	*Fusarium oxysporum* f. sp *ciceri*

Pigeonpea

Altemaria blight	*Alternaria alternata*
Phytophthora blight (stem rot)	*Phytophthora drechsleri* f. sp *cajani*
Collar rot	*Sclerotium rolfsii*
Sterility mosaic (SM)	Virus-like disease
Wilt (fusarium wilt)	*Fusarium udum*

Groundnut

Bacterial wilt	*Pseudomonas solanacearum*
Bud necrosis disease (BND)	Tomato spotted wilt virus (TSWV)

Clump (PCV)	Peanut clump virus
Early leaf spot	*Cercospora arachidicola*
Late leaf spot	*Phaeoisariopsis personata*
Peanut mottle (PMV)	Peanut mottle virus
Peanut stripe (PStV)	Peanut stripe virus
Pod rots	*Fusarium* spp, *Macrophomina phaseolia,* and *Rhizoctonia solani*
Stem and pod rot	*Sclerotium rolfsii*
Rust	*Puccinia arachidis*

Nematodes

Plgeonpea

Cyst	*Heterodera cajani*
Lesion	*Pratylenchus* spp
Reniform	*Rotylenchulus reniformis*
Root knot	*Meloidogyne* spp

Insects

Chickpea

Pod borers	*Helicoverpa armigera*

Plgeonpea

Pod borers	*Helicoverpa armigera* and *Maruca* spp
Pod fly	*Melanagromyza obtusa*

Groundnut

Aphids	*Aphis craccivora*
Bruchid	*Caryedon serratus*
Cut worms	*Agrotis* spp
Jassids	*Empoasca kerri*
Leaf miner	*Aproaerema modicella*
Pod borers	*Helicoverpa armigera*
Termites	*Microtermes* sp and *Odontotermes* spp
Thrips	*Scirtothrips dorsalis* and *Frankliniella schultzei*
Tobacco armyworm	*Spodoptera litura*
White grubs	Many species, e.g., *Lachnosterna* spp and *Maladera* sp

RA-00136

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ISBN 92-9066-173-9 ICR 89-0025