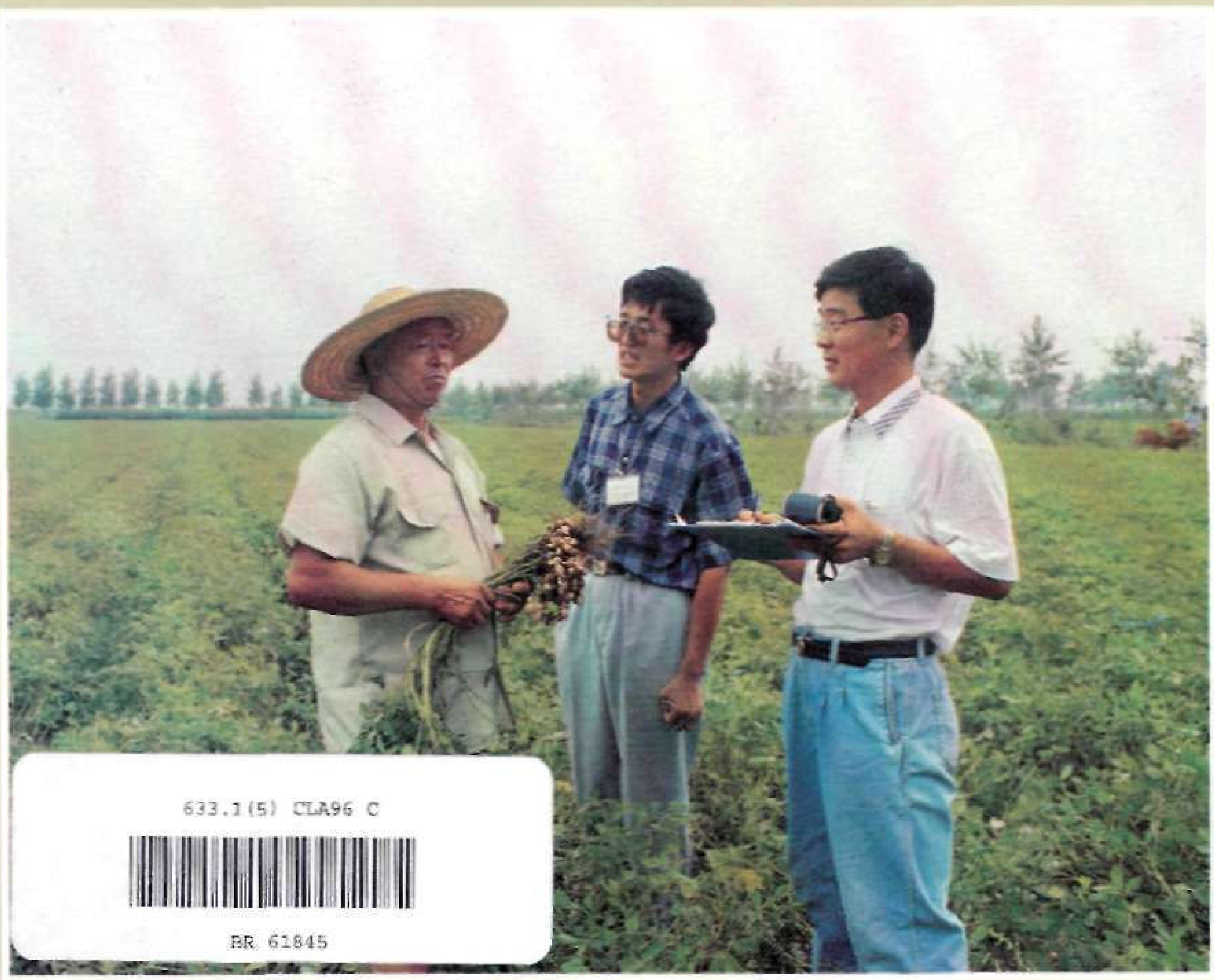
CLAN Collaborative Research in Asia
Needs and Opportunities



International Crops Research Institute for the Semi-Arid Tropics

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Abstract

This publication reports the deliberations of the Steering Committee Meeting of the Cereals and Legumes Asia Network (CLAN). The CLAN Country Coordinators reviewed the activities of the network of 1993-95, and identified the needs and opportunities for future collaborative research and technology exchange. The role of ICRISAT's research project and research support programs was sketched and discussed, as were potential contributions from regional and international institutions.

The recommendations of the meeting include enhanced cooperation and linkages among member countries for research and technology involving sorghum, pearl millet, chickpea, pigeonpea, and groundnut, and related natural resource management in the production systems where these crops are grown.

Résumé

La recherche collaborative en Asie: besoins et perspectives d'avenir. Comptes rendus de la Réunion du Comité de direction des coordonnateurs des pays membres du CLAN. Cette publication présente un compte rendu des délibérations de la Réunion du Comité de direction du Réseau asiatique sur les céréales et les légumineuses (CLAN). Les activités du réseau pendant la période 1993–95 sont passées en revue; les besoins et les perspectives d'avenir pour la recherche collaborative et l'échange de technologies sont identifiés. Le rôle des projets ICRISAT de recherche ainsi que des programmes soutenant cette recherche au sein du réseau est présenté en bref et discuté. Sont examinées également, les contributions éventuelles des institutions tant internationales que régionales.

La réunion présente diverses recommandations, dont la coopération approfondie et des liens plus étroites parmi les pays membres du réseau en ce qui concerne la recherche et la technologie impliquant le sorgho, le mil, le pois chiche, le pois d'Angole, et l'arachide, ainsi que la gestion des ressources naturelles associées au sein des systèmes de production où ces cultures sont pratiquées.

CLAN Collaborative Research in Asia
Needs and Opportunities

Summary Proceedings of the CLAN Country Coordinators' Steering Committee Meeting

4-6 Dec 1995
ICRISAT Asia Center

Edited by

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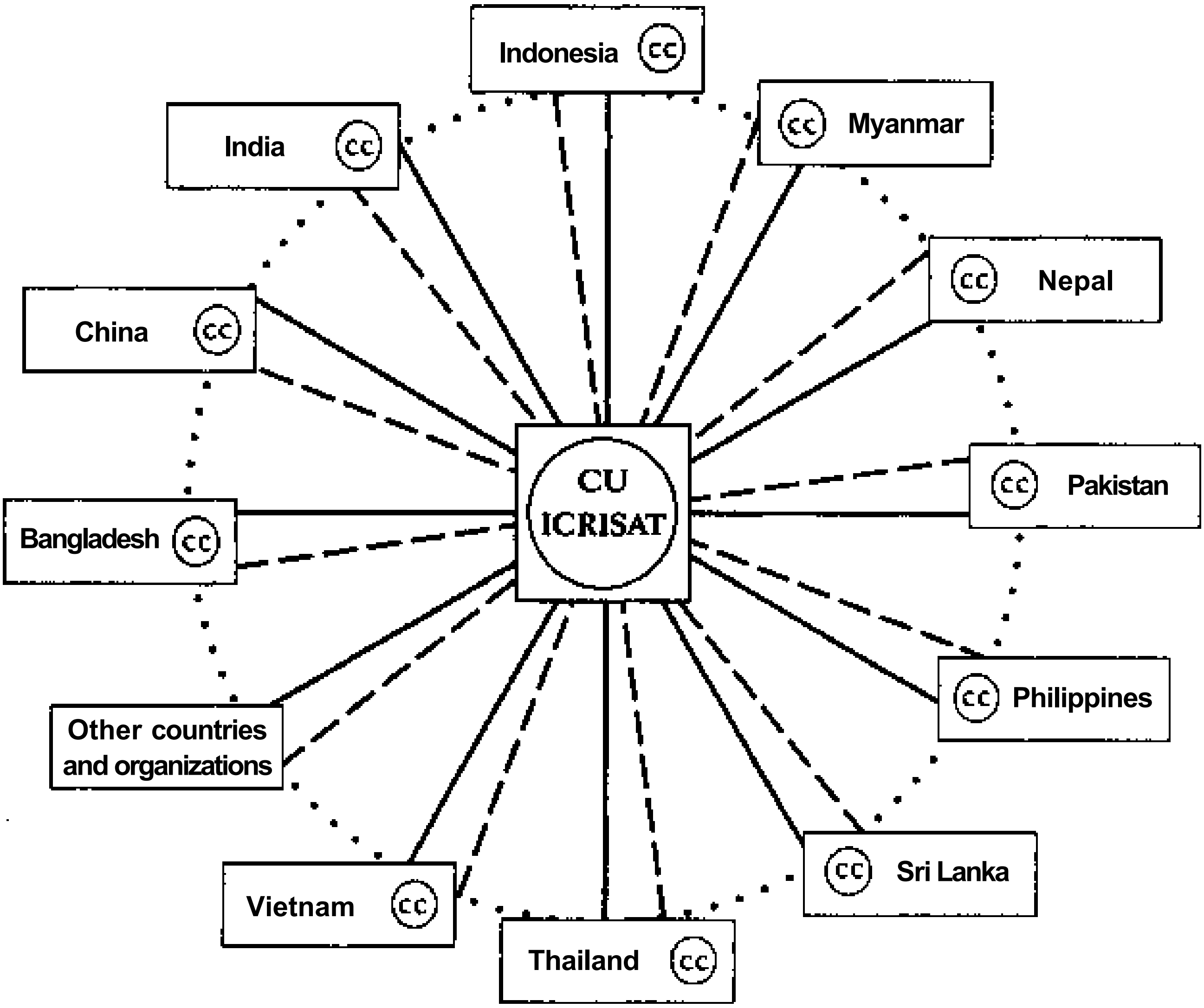
International Crops Research Institute for the Semi-Arid Tropics
Patancheru 502 324, Andhra Pradesh, India

1996

Structure of Cereals and Legumes Asia Network



— — — MOU (administrative-facilitative) and Work Plans (research: scientist to scientist)

——— Contacts (facilitative)

• • • • • • Workshops, meetings, training, visits (multilateral links)

CU = Coordination Unit

CC = Country Coordinator (research administration)

Contents

Introduction

Opening Remarks

Y L Nene[1]

Let me extend a hearty welcome to you to this Steering Committee Meeting, not only on my behalf, but also on behalf of the Director General, Dr J G Ryan, who had to go to Nairobi for an important meeting; otherwise he would have been delighted to be with you this morning.

We are happy to note that representatives from 10 out of 11 CLAN countries are participating. We had made every effort to get Dr Bashir Malik from Pakistan; the required clearances were obtained but there must have been some last minute hitch because of which Dr Malik could not make it. We also have participation from the International Rice Research Institute (IRRI), and from the Food and Agriculture Organization (FAO). The representative from the International Center for Agricultural Research in the Dry Areas (ICARDA), will arrive a little later.

The last CLAN Coordinators' Meeting was held over two years ago. During this period ICRISAT has undergone many changes, just as many other international organizations have. These are the times when changes become necessary to address to the ever-increasing demand for more food. ICRISAT went through a big change in its organization and management as well as in its research focus. Patancheru was the headquarters of ICRISAT (and it is still the headquarters), but the Center is now called ICRISAT Asia Center. Although in the past we spent 50% of our budget in Africa, and 50% in Asia, the visibility of our African programs was not fully clear. It became necessary to make our operations in Africa very explicit. Therefore we have the ICRISAT Asia Center here, the Western and Central Africa Center in Niamey, Niger, and the Southern and Eastern Africa Center in Bulawayo, Zimbabwe. The headquarters of ICRISAT continues to be at Patancheru, and is called the Corporate Office. This Corporate Office has the Director General, the Deputy Director General, the Associate Director General (Research), Associate Director General (Finance and Administration), and Assistant Director General (Liaison) to deal with governmental matters. The Associate Director General (Research) coordinates all research in order to ensure that the three ICRISAT centers function in a coordinated fashion, and that there is no duplication of effort and resources. ICRISAT continues to have the same mandate as before, but the research focus had to be changed. ICRISAT was operating on a commodity basis (six crops), and in the area of resource management. The activities in West Africa and Southern Africa were to a great extent regional in operation with minimal coordination between the work in Asia and in Africa. But, with the reorganization, the entire research is consolidated into 22 global research projects. In this process, disciplinary research is not ignored; after all, the international centers were established not only to serve farmers, but also to serve as centers

1. ICRISAT Asia Center, Patancheru 502 324, Andhra Pradesh, India.

of scientific excellence. Thus, the global projects are multidisciplinary. With the matrix management system ICRISAT ensures that there is disciplinary-cum-production systems interaction in its research.

All ICRISAT projects involved consultations with the national programs. You have often heard the acronym NARS-national agricultural research system (s). It is not accurate to use the word 'NARS' for 'developing' countries only. We should use NARS for the 'developed' countries also. ICRISAT is looking for synergies at various levels. There are mentor institutions in the developed world as well as the developing countries. On the one hand, ICRISAT works very closely with the NARS of developing countries, and on the other hand it takes help from advanced institutions in both developed or developing countries. Many of our links are in the developed world with mentor institutions so that we gain from them and both, i.e., the national programs and ICRISAT, are benefited. You have perhaps often heard in recent years that the international centers are expected to do more of basic and strategic research and less of applied and adaptive research. Regardless of this classification, ICRISAT is looking for complementarities and synergies in meaningful research programs.

Twenty years ago, I remember it was common to say that ICRISAT was working for 'client' countries. A big change has occurred since then; the countries are no more our clients, they are partners, in the true sense of the word. This means working together with mutual respect and understanding; i.e., working together from the planning, through the execution, obtaining and publishing of results, to impact assessment. International centers such as ICRISAT have accepted this mode of working and do not wish to 'run the show'.

You will recall that ICRISAT wanted NARS to take the leadership of CLAN, but ICRISAT was requested to support the Coordination Unit and we agreed to do so. ICRISAT wants this network to be run by the network member countries, and we will be a partner in that effort. The leadership has to come from the region. I am sure that this is going to happen.

Dr R B Singh, who is here, worked for FAO in Bangkok; he, and later on, Dr R S Paroda, have strengthened the Asia-Pacific Association of Agricultural Research Institutions (APAARI). ICRISAT is looking towards the APAARI umbrella and wishes to link CLAN to APAARI as a subnetwork. Partnership brings with it responsibilities such as resource sharing. If we all want to be true partners as in any concern or in any business, partnership would mean inputs from all the partners. This means member countries have to generate resources both in cash and kind. This will provide a sense of owning the network, which is a prerequisite to be able to function effectively as a partner in the network. Therefore, it will be in the interest of all of us to share resources. Future support from donors and from other countries will depend a lot of how we function in the next few years. After all, the supply of money from donors is not unlimited. Many donor countries have reduced their contributions to international agricultural research in the last few years, and the trend is likely to continue. Therefore, developing countries will have to find ways and means not to depend as much as they did in the past on the donor agencies. The donors and IARCs will be looking for impact of the work that we do. Without demonstrating impact we are unlikely to get support either from NARS governments or from other international donors. Therefore, a deliberate focus on impact would be essential.

I have shared a few of my thoughts in this opening address. I hope these will stimulate you to think about important aspects of collaborative research.

Thank you very much.

Keynote Address: Sustaining Research Network Activities

R B Singh[1]

I must apologize to you for not having a structured keynote address; time was too short to prepare one. However, it strikes me that there are a few prerequisites to sustain any network activity. First, the commodity being worked on should be important for that geographical region. Second, there should be a commitment among the network cooperators to run that network. Third, the resources-both financial and human-must be available to run that network.

The cereals that are the mandate of CLAN form a very important part of human caloric intake in Asia; and, of course, the legumes in CLAN will continue to play an important role in human protein needs, and to maintain soil fertility and sustainability.

The Green Revolution, hitherto based on rice and wheat, will have to be a somewhat different one, henceforth. If it has to sustain itself, it has to be 'greener', cover more commodities, be poor-friendly, and must be ideal for rainfed agriculture. Obviously, coarse grains (such as sorghum and pearl millet) and legumes are outstanding candidates to fill these requirements. CLAN's importance in the years to come in diversifying Asia's food basket, and sustaining the 'Second Green Revolution', as many of you understand the term, is therefore obvious.

The interest of various countries in having a collaborative research network is evident in your very presence at this meeting. The *compulsion* to have a network stems from the undeniable force of numbers: seventy-five out of every hundred people on this planet live in the Asian region. The problem will only become more acute: very soon, in terms of population, every year the Asia region will add two Australias to itself! Further, this is a land-hungry region, with an ever-declining per capita availability of land.

While we often see on our television screens the hunger in Africa, the silent hunger in Asia is as disturbing. The numbers too are daunting. Thus, our task is far from over: there are still large pockets of hunger all over Asia.

The potential of the Asia region is tremendous both in terms of genetic resources and trained manpower. In terms of natural resources like water and sunlight too, this region should be able to share its treasures.

While resources are shrinking everywhere, there are problems of sustainability, equity, management of scarce resources, and an increasing competitiveness in the global market. These call for a new set of research agendas: a new breed of people and implements to transform these constraints into opportunities. While we will still persuade donors to come forward to fund research, this is an opportunity to do more: we must pool our resources synergistically, with shared responsibilities and enhanced

1. Indian Agricultural Research Institute, New Delhi 110 012, India.

efficiency. Also, all donors, whether governments or nongovernmental agencies must begin to see themselves as partners in a greater cause. It is no longer a matter of the 'haves' and the 'have-nots', nor a matter of research institutes and 'clients'.

There are many on-going initiatives in this region: FAO's Farmer-centered Resource Management (FARM) Program, ICRISAT's CLAN, CIMMYT's Tropical Asia Maize Network (TAMNET), IRRI's International Network on Genetic Evaluation in Rice (INGER) and Crop and Resource Management Network (CREMNET) are some examples. These initiatives must be reviewed to avoid duplication, and mechanisms of linkages where possible should be instituted.

Equally important in making these linkages real, are mechanisms of management and coordination of these linkages. Permit me therefore to outline how APAARI, the Asia Pacific Association of Agricultural Research Institutions, came into being. In the early eighties we felt that agricultural research managers from the Asia Pacific region needed to have a common voice which could prioritize research, and the sharing of information. It took us three years to even get the research managers of the various national agriculture institutes to see that there was a need for such a coming together.

At the initial meeting a background paper was circulated outlining the aims and objectives of the proposed network. But it took us another three years to convince the members that they needed to contribute funds to run the association. Presently, the member countries themselves came forward to contribute to the functioning of APAARI. APAARI now plays a catalytic role in bringing institutions together to exchange and extend technology and knowledge. FAO initially contributed US$ 50000 to the running of the network; however the core money now comes from the 17 member countries themselves. It is their APAARI now.

APAARI is now in a position to offer partnership to other networks in Asia, such as CLAN to achieve its aims. However, these coordinating units can only play a supporting role. I therefore urge the member countries to commit resources, no matter how small, to the networking activities. We need to make provisions in our budgets towards network activities. Thus, on behalf of the Government of India, I assure CLAN of all support that they think appropriate. Let me urge you all once again to make CLAN a successful network.

(Editors' note: This is a condensed version of the address delivered by the author.)

Collaborative Research: Needs and Opportunities

Coordinator's Report

C L L Gowda[1]

Introduction

The Cereals and Legumes Asia Network (CLAN) has now completed 3.5 years, since its inception in April 1992, as a research and technology exchange network involving sorghum, pearl millet, chickpea, pigeonpea, and groundnut, and the related natural resource management. During the period there have been substantial changes in organization and management, both at ICRISAT and in some of the member countries.

Funding for agricultural research is decreasing, and International Agricultural Research Centers (IARCs) are being advised to reorganize and/or downsize some projects to overcome budgetary constraints and to utilize funds efficiently. The situation in many National Agricultural Research Systems (NARS) is no different. Therefore, it is imperative that IARCs and NARS pool their resources, and share research responsibilities. I would like to emphasize that the network belongs to, and is driven by, the members-the NARS. However, I often find that scientists and research administrators tend to equate the network with ICRISAT. It is at the request of member countries that ICRISAT supports and hosts the Coordination Unit (CU), as its contribution to the network. CLAN is not ICRISAT, but belongs to all members including ICRISAT. All members in the network have an important role in determining the research needs, priorities, and comparative advantages, and in execution of the agreed programs of the network. One of the objectives of this meeting is to review past activities, and plan future in-country research, and collaboration among member countries. Members comments, suggestions, and guidance is essential for the effective functioning of the network.

Action on earlier recommendations

Funding for CLAN activities

Based on the recommendations of the earlier meeting, ICRISAT submitted a proposal to the Asian Development Bank (ADB) for a funding support of US$ 1.2 million for a 3-year period to support network activities. However, the ADB indicated its willingness to provide only US$ 600 000 to CLAN and therefore a revised proposal was submitted. The ADB approved the Technical Assistance grant entitled 'Strengthening Collaboration on Cereals and Legumes Research in Asia' in Mar 1995.

1. ICRISAT Asia Center, Patancheru 502 324, Andhra Pradesh, India.

Collaborative research, human resource development and linkage mechanisms

The network has attempted to strengthen activities related to (i) Working Groups, (ii) On-farm adaptive research, (iii) Information exchange, (iv) Human resource development, and (v) Linkages between network members. These will be elaborated upon later.

Coordination

The Country Coordinators had recommended that ICRISAT should continue to support the CLAN-CU for the next 3-5 years. The group needs to reconsider whether member countries are willing to contribute towards coordination.

Steering Committee

Currently, the Steering Committee comprises all the 11 Country Coordinators, and they collectively guide the coordination of network activities.

Progress reports

Following the recommendations of the last meeting, the CLAN-CU has sent half-yearly progress reports to all the Country Coordinators and network cooperators, starting Jan 1994, for feedback and suggestions.

Activities during 1994-95

A summary of the major activities of the network during 1994-95 (up to Oct) are given below. The details are given in the Appendices.

Exchange of germplasm and breeding material

The Genetic Resources Division (GRD) and Genetic Enhancement Division (GED) of ICRISAT provided substantial quantities of germplasm and breeding material to the national programs for evaluation, and use as parents in breeding programs, or for direct adaptation testing and release as improved cultivars.

GRD supplied 5938 seed samples to scientists in 10 countries in Asia between Jan and Sep 1995. This includes 2046 seed samples of sorghum, 518 pearl millet, 369 chickpea, 1055 pigeonpea, 1750 groundnut, and 200 minor millets (Appendix 1).

From 1972 to 1995, Asian countries contributed 47 875 germplasm accessions to the Gene Bank at ICRISAT (Appendix 2). These accessions are held in-trust by ICRISAT, and are supplied to scientists worldwide for research and development.

Scientists in GED supplied large quantities of early and advanced generation breeding lines, and breeders' seed of identified and released varieties. Details of breeding material supplied to different national programs are in Appendices 3-7. A summary is given below.

		Number of samples			
Crop	Trials and Nurseries (No. of sets)	Varieties/ Breeders' seed	Segregating populations	Advanced lines	Others
Sorghum	393	146	-	322	165
Pearl millet	144	817	-	9464	-
Chickpea	338	246	1105	610	537
Pigeonpea	98	192	244	620	2429
Groundnut	103	369	264	1658	1706
Total	1076	1770	1613	12674	4837

From 1994 to 1995, the national programs in Asia released one pearl millet, six chickpea, three pigeonpea, and four groundnut cultivars based on material supplied by ICRISAT.

Review and planning meetings

These meetings were held in the member countries. Although annual meetings are preferable, some countries prefer to hold these meetings in alternate years for various logistic reasons. A list of review and planning meetings held between Jan 1994 and Oct 1995 is given in Appendix 8. The Country Coordinators organized these meetings, in which all the concerned research and extension staff from that country participated, along with a few ICRISAT scientists. Work Plans for the next one or two years were prepared at these meetings based on the needs, requirements, and capabilities of the national program. These Work Plans became the basis for action plans for both bilateral and multilateral network collaborative research. Research priorities of each member country were provided to Country Coordinators compiled in the form of a booklet entitled 'CLAN Research Priorities', to identify linkages and explore the possibilities for regional collaboration in specific areas.

Some countries adopted the format of Review and Work Plan meetings for their national research planning. This should be encouraged to ensure integration of network activities with the work plans of national systems. In some cases, collaborative research agreed upon in the work plan were not conducted without valid reasons. Hence, there is a need for greater accountability. Since the CLAN-CU needs to submit progress reports regularly to donors, data, results, and reports from member countries must be available in time.

Regional workshops and meetings, and study tours

The CLAN-CU assisted in the planning and organization of a few regional workshops and meetings to cater to the needs of NARS scientists and extension staff in Asia. For the most part, these meetings covered applied research areas (some covered basic research) that are of priority to the national programs. A detailed list of workshops conducted between Jan 1994 and Oct 1995 is given in Appendix 9. Proceedings of these have been published (or will be published). In these workshops and meetings, network members interacted and exchanged information on research methods and technologies.

A study tour of the high-yield groundnut production technologies in Shandong province, China, was organized, 25-29 Aug 1995. Scientists from the other Asian countries acquainted themselves with high input technologies which achieve yields up to 7 t ha^{-1}.

CLAN-CU staff and NARS cooperators also benefited from interaction with scientists from other networks and research consortia by participating in conferences and meetings organized by other organizations/institutions (Appendix 10).

Working Groups

A Working Group (WG) consists of scientists willing to work together and commit resources to address and tackle high priority regional problems. WG meetings review past research and prepare plans for future collaboration. Research responsibilities are shared among members, and the activities are harmonized by a Technical Coordinator. This concept has succeeded well in addressing a few regional problems, generating new scientific information, and enhancing research partnership. There is need for increased involvement of NARS in the coordination of WG activities, and for enhanced allocation of resources. A list of WG meetings conducted between 1994 and 1995 is given in Appendix 11.

A summary of the activities/achievements of Working Groups in CLAN is given below:

Botrytis gray mold (BGM) of chickpea

- Field screening methods for disease resistance screening were developed.
- Field experiments were initiated to develop management options for control of BGM; the options include varieties, spacing, fungicidal sprays, and time of sowing.
- Research on biological control of BGM using bioagent *Trichoderma* was started.
- Demonstration of BGM management in farmers' fields is going on.

Drought tolerance in legumes

- Field screening methods developed at IAC for drought tolerance in chickpea, were evaluated in NARS locations.
- Tolerance to drought in cultivars ICC 4958 and 10448 was confirmed, and putative new sources of tolerance were identified.
- Members met in Aug 1995 at IAC to share current emphasis, awareness, and knowledge on drought research, and basic and applied research methods.

Bacterial wilt of groundnut

- An Information Bulletin on Bacterial Wilt of Groundnut was published, containing information on disease epidemiology, races and biovars of *Pseudomonas solanacearum,* serological testing for pathogen, glasshouse and field screening technology, and disease management options.
- A Technical Manual dealing with techniques for diagnosis of *Pseudomonas solanacearum,* and for resistance screening against groundnut bacterial wilt was published.
- Proceedings of the third Working Group meeting, held in China, 4-5 Jul 1994, with abstracts in Chinese (for the first time), containing the latest research results of the collaborative research were published.

Biological nitrogen fixation in legumes

- Proceedings of the first meeting of the Asia Working Group on Biological Nitrogen Fixation in Legumes (AWGBNFL, now called NiFLA) held in Dec 1993 were published. This book reviews on-farm use of inoculants, the influence of cropping system and other factors on rhizobial populations, and the improvement of biological fixation in legumes by host-plant selection. Plans for future collabora ive research were outlined.
- Trials were conducted on (i) performance of high nodulating selections of chickpea at seven locations, and (ii) on-farm rhizobial inoculation at four location... Nodulation capacity (high or low nodulation) was not affected by environment and appeared to be genetic. The on-farm trials confirmed that rhizobial inoculations do increase yields.
- High nodulating lines produced more yield than low nodulating selections of the same cultivars, and also fixed a higher amount of nitrogen per hectare.
- AWGBNFL Notes (five issues) were published and distributed to exchange information among members.

Cytoplasmic-genic male sterility (CMS) in pigeonpea

- The WG met twice (Jul 1994 and Apr 1995) to review and plan joint research. Methodology and protocols for search and development of CMS in pigeonpea were circulated to members.
- Increased emphasis is being laid on interspecific hybridization, and mutagenesis to search for CMS.

Groundnut viruses in Asia-Pacific region

Opportunities for collaboration between WGs on groundnut viruses in Asia and Africa were identified.

- A proceedings (1994) entitled 'Recent studies on peanut bud necrosis disease' gives state-of-the-art information on the disease.
- A training course on 'Identification and detection of viruses in legumes, with special emphasis on groundnut' was conducted, Feb-Mar 1995, in Thailand.
- The fourth Working Group meeting held in Khon Kaen, Thailand, 13-15 Mar 1995, reviewed the progress made on detection, identification, characterization, and management of major groundnut viruses in the Asia-Pacific region. Future research emphasis will be on studies directed towards host-plant resistance (conventional and nonconventional), cultural practices, biological control of vectors, variation in virus, and use of virus-free seed.

Working Groups on sorghum

Four WGs were initiated in 1994 after a consultative meeting held in Sep 1993. The following were undertaken in 1995.

- Sorghum shoot pests: Nurseries containing germplasm and breeding lines resistant to shoot pests were sent to Myanmar, Pakistan, and Thailand for evaluation.
- Drought tolerance: A questionnaire about drought tolerance was sent to interested sorghum scientists. Responses were summarized and circulated to respondents for comments. Drought tolerant lines nurseries were sent for evaluation to the scientists who wanted them.
- Sorghum grain mold: Sorghum grain mold nurseries were distributed to interested scientists.
- Forage sorghums: Forage sorghum (single and multicult) nurseries were distributed to interested scientists.

Activities were limited in the WG on acid soil tolerance in legumes due to funding constraints.

On-farm research

The Asian Grain Legumes On-farm Research (AGLOR) project activities were continued in Indonesia, Nepal, Sri Lanka, and Vietnam. Farmer-perceived constraints to production were identified through rapid rural appraisal, and prioritized by a joint team of scientists from these countries and ICRISAT. Experimental plans were prepared to address the priority constraints. Based on 2 to 3 years of farmer-participatory on-farm research, researchers and extension staff in these countries have identified improved production technology options. These are now being disseminated to other farmers in the target areas on a large scale. Farmers' days, seminars, and workshops to disseminate information, and in-country training on on-farm research methodologies to train young scientists and technicians, were taken up jointly with NARS partners. A video on 'AGLOR: On-farm research with Asian farmers' was produced and distributed to the network member countries as a training-cum-information tool.

Human resource development

There has been a shift from production-oriented long term (6-month) training to skill development and specialized short-term training in the Training and Fellowship Program (TAFP) of ICRISAT (a report by TAFP is presented later). During 1994-95, there were 93 Asian participants in different TAFP programs (Appendix 12). Most of these were Visiting Scholars. Four regional training courses, and four in-country training programs were conducted to cater to the specific needs of member countries (Appendix 13).

Monitoring tours and surveys

Collaborative research activities in each country were monitored closely by the Country Coordinators, respective scientists and extension staff. Joint monitoring tours involving both national program and ICRISAT scientists were conducted to enhance interaction and exchange of ideas, and better understanding of local situations. A list containing monitoring tours and surveys conducted between Jan 1994 and Oct 1995 is given in Appendix 14. Surveys on bacterial wilt, aflatoxin, and pests on groundnut in Vietnam; and on peanut clump virus in Pakistan, have added to the database on the pest and disease incidence and distribution. These surveys have enhanced NARS perceptions on the importance of the diseases-a fact that can assist in research prioritization. For example, a survey in Vietnam indicated that aflatoxin contamination is higher in Ha Bac province than in Nghe An, and that market samples had higher levels of aflatoxin than farmers' field samples; indicating the importance of postharvest factors in aflatoxin contamination.

Exchange of scientists

Visits of national program scientists to ICRISAT Asia Center and to other countries to participate in workshops, meetings, and study tours have assisted the scientists from member countries to interact, discuss, exchange information, and develop cooperative research endeavors. Similarly, visits of IAC staff to member countries has enhanced the interaction, and helped to develop good rapport with national program scientists to strengthen research and technology exchange mechanisms in the Asia region. During 1994-95, 169 Asian national program scientists participated in the workshops and meetings and interacted with scientists from other countries and regional research institutes, and ICRISAT (Appendix 15). On the other hand, IAC scientists made 134 visits to 15 Asian countries and spent 1550 person days participating in meetings, workshops, monitoring tours, surveys, and consultancies.

Future plans

- Review and Work Plan Meetings will continue in each country as they provide an excellent opportunity to review past research and to prepare future research plans for in-country and collaborative research. Currently, meetings are organized in alternate years in some countries, but if needed these could be held annually. The national programs are requested to partially fund these meetings.
- Regional Workshops and Meetings will be organized to meet the needs of NARS and ICRISAT projects. Suggestions on topics/themes for these meetings, and possibilities for co-sponsoring these meetings are welcome. Such regional meetings held in the past brought Asian NARS scientists together to interact, and CLAN will endeavor to enhance such interactions. Member countries should consider hosting future events to enable increased involvement and participation of NARS.
- Collaborative breeding programs between NARS and ICRISAT scientists have been planned in the new ADB project. The network will encourage these with support from Genetic Enhancement Division at IAC by supplying early generation segregating material and unfinished products such as populations and advanced breeding lines. However, national programs need to identify research areas that involve two or more countries for mutually beneficial endeavors, to augment crop improvement efforts.
- Working Groups are becoming increasingly effective and economical in addressing specific problems or research themes. The network will strengthen the existing WGs and encourage new ones on themes such as aflatoxin contamination in groundnut. Since the WGs address priority problems of the member countries, the national programs should consider committing more resources to WG research for effective and smooth functioning of the Working Groups.
- On-farm adaptive research (OfAR) will continue to be a major thrust area in all member countries. We have initiated research plans for OFAR in some countries, and plan to do so in other member countries depending on their needs and interest. In-country training courses and diagnostic surveys will be undertaken before initiating the on-farm research to ensure that OFAR will address the farmer-perceived production constraints.
- Natural resource management research has not been explicitly mentioned in earlier Work Plans. However, research aimed at sustainability of production systems, and conserving and maintaining natural resources needs to be incorporated in future Work Plans. The following are possible themes:
  - Resource characterization in various production systems
  - Integrated soil and water management
  - Integrated nutrient management
  - Sustainable cropping systems
- Information exchange is vital for research and development. Information flow is currently from ICRISAT to national programs. This trend needs to be reversed. The network concept will be fully realized only when there is exchange of information between the network member countries directly or through the Coordination Unit.

Human resource development is a dynamic activity, and TAFP and CLAN-CU will continue to respond to the needs and requests of member countries. CLAN and ICRISAT will try to accommodate requests within the budgetary limits, for Visiting Scholars and Research Scholars, and to a limited extent, for in-service training. In-country training courses are cost-effective and meet the training needs of large groups of technical staff. As the funds available are limited, member countries should co-sponsor these by providing the necessary funding support.

Conclusions

Overall, the network had an eventful and productive initiation phase. The momentum should be maintained and accelerated to benefit the farmers in member countries. Involvement of NARS in regional activities, and coordination of Working Groups needs to be increased. Similarly, greater participation of member countries is requested in in-country and regional training programs, and in information exchange. Member countries should seriously consider sustaining the network coordination by providing the resources required. Comments and suggestions from the group are solicited.

Collaborative Research in Bangladesh: Needs and Opportunities

M A Malek[1]

Introduction

Chickpea

Chickpea ranks third in area (99 543 ha) and production (69 308 t), and contributes more than 13% of total pulses in Bangladesh. Over 85% of the crop is grown in loam or clay-loam soils with a pH of 6.5-7.5. The cropping pattern is either rainfed upland rice jute-fallow-chickpea (60%), or transplanted *aman* rice-chickpea-fallow (40%) under late-sown conditions. In recent years, a high soil moisture has led to excessive vegetative growth in chickpea, making the crop susceptible to botrytis gray mold (BGM) disease resulting in drastic yield reduction. Though chickpea has the highest yield potential among the pulses (>4 t ha^{-1}), its mean yield is only 0.7 t ha^{-1}. The crop has a great potential in the Barind area of the north western part of the country, where 0.8 million ha remain fallow in winter, after the harvest of rice.

Pigeonpea

Pigeonpea is a minor pulse in Bangladesh grown on 5584 ha, producing only 3248 t of grains. Long-duration, tall varieties are grown, along the roadside, in backyards or as a bund crop in rice fields. Recent research shows that short-duration varieties can be grown as an intercrop with black gram in the northern parts of the country. Medium-duration varieties are a potential crop for the slopes of the hill tracts of Bangladesh.

Groundnut

Groundnut ranks third among the oilseed crops after rape seed and mustard. The crop is sown to 17 512 ha with an average yield of 1.17 t ha^{-1}. In recent years, it has emerged as a potential crop in the riverbed (*char*) areas where very short-duration varieties are needed.

Sorghum and millets

Sorghum is grown in some pockets as a fodder crop along the borders of rice fields. At present it has no prospect as a cereal crop. Proso millets and foxtail millets are grown in some marginal lands or riverbed areas as minor cereals.

1. Bangladesh Agricultural Research Institute, Joydebpur, Gazipur 1701, Bangladesh.

Collaborative research

Until 1978 there was no systematic research conducted on chickpea, pigeonpea and groundnut. Linkages between BARI and ICRISAT were established in 1978. Since then, BARI has received germplasm, advanced lines, and segregating populations of these crops, particularly chickpea. From these materials six improved chickpea varieties have been released by BARI. These are: Nabin (1987), Barichola-2 and-3 (1993), and Barichola-4, -5, and -6 (1995). Half a dozen improved chickpea lines that were found promising are in the pipeline.

A short-duration pigeonpea line, ICPL 76012, has been selected which can give yields upto 2.5 t ha^{-1} in 125-130 days. Another promising line, ICPL 151, can be intercropped with black gram. These two lines are being registered for general cultivation by the farmers. Some suitable lines are being selected for the hill slopes of Chittagong hill tracts.

From 1982 to 1995, about 400 germplasm lines, segregating populations, yield and disease nurseries of groundnut were received from ICRISAT. From these materials, ICGS (E)-55, (18% higher yield and matures 7 days earlier than the local check, DA-1), is ready for release. Five other advanced lines are in the pipeline for registration.

Priorities for collaborative research

Chickpea

- Search for multiple disease resistance
- Germplasm screening against BGM, collar rot, and dry root rot to identify resistant sources
- Identification of cultivars suitable for late sown conditions in rice-based cropping systems
- Cultivars that can emerge in limiting soil moisture ensuring optimum plant stand
- Cultivars with restricted vegetative growth in light-textured soil
- Cultivars suitable for high input conditions
- Development of high yielding kabuli chickpeas

Pigeonpea

- Short- or medium-duration varieties with high yield potential and tolerance to *Helicoverpa* pod borer and sterility mosaic
- Medium-duration varieties suitable for Chittagong hill tracts

Groundnut

- Breeding short-duration varieties with high yield potential, and resistance to late leaf spot and rust
- Search and incorporation of cold, thrips, and jassid tolerance
- Varieties with seed dormancy of 20-30 days with long viability beyond 4 months under ordinary storage conditions
- Resistance to *Aspergilus flavus* infection and aflatoxin contamination

Information and technology exchange

Information and technology exchange has expanded considerably in the past two years. Annual reports, newsletters, books, bulletins, and some important publications were received and distributed to the concerned scientists. An Information Bulletin on 'Growing Chickpea in Bangladesh and Eastern India' has been printed in both Bengali and English. The BARI Newsletter also covers ICRISAT-BARI collaborative activities.

Review and work plan meetings

Scientists from ICRISAT participated in the Pulses and Groundnut Annual Review and Program Planning Meetings. Their interaction with local scientists was of immense help in planning collaborative research program.

Monitoring tours

Joint teams of BARI and ICRISAT scientists monitored farmers' fields of the major pulse growing areas, particularly the Barid, and identified problems related to pulse cultivation. The team's report on the 'Constraints of Pulses Production in Bangladesh' contains some specific recommendations.

Regional research activities

The Crop Diversification Program (CDP) funded by the Canadian International Development Agency (CIDA) supported a state-of-the-art 'mist irrigation system' for field screening of BGM. The Pulses Research Centre, BARI, can serve as a lead centre for the region in developing lines resistant to this disease.

Support to the national program

The first phase of CDP which funded the pulses and groundnut research program ended in June 1995. The second phase is as yet uncertain. This may affect the implementation of the 1995-96 research program. Since the support that CLAN is providing is small, we are seeking additional funding from CLAN or from ICRISAT.

Equipment and supplies

Pulse seeders, cultivators, weeders, threshers, groundnut shellers, and some laboratory supplies could be of immense help in strengthening research.

Human resource development

Unlike in the past, short training and visiting programs were well organized in the 1994 and 1995. Many middle-level scientists benefited from them.

Barind initiative

Bangladesh and ICRISAT took initiative in 1991 to expand chickpea area in the rice fallows of Barind. This was successful, and there is tremendous interest among the farmers in this area. The cropping pattern of green manure-transplanted *aman* rice-chickpea is fast becoming popular. Hopefully other rabi crops like linseed, short-duration mustard, etc., will also emerge as profitable winter crops to generate income, food and employment in this resource-poor area. The initiative is helping sustainability of agricultural productivity, and will make, the Barind green in the rabi season.

Suggestions for improving linkage and participation

- The Bangladesh-ICRISAT Collaboration has yielded positive results. Now the need is for targeted germplasm and breeding materials, and improvement in the training activities both at ICRISAT and within the country.
- Country Coordinators of CLAN could visit member countries as a group to have a regional perspective of research and development activities on the mandate crops. There should be greater efforts for inter-institutional cooperation, in which ICRISAT should assume leadership role.
- Senior scientists and planners could visit ICRISAT to see the research activities and learn from each other's experience. These activities should be coordinated through the country coordinators.

Collaborative Research in China: Needs and Opportunities

Hu Jiapeng and Yang Yan[1]

Introduction

The role and importance of the CLAN mandate crops (sorghum, pearl millet, chickpea, pigeonpea and groundnut) are varied in China. Groundnut and sorghum are more important than chickpea, pigeonpea, and pearl millet.

Current research priorities

Groundnut

- Germplasm has been collected, characterized, and preserved. Good germplasm materials with valuable agronomic characteristics, disease and pest resistance, and high seed quality have been provided for genetic improvement.
- Research has emphasized genetic improvement for high-yield, disease resistance, short-duration, and good seed quality. Several short-duration, high-yielding varieties have been released e.g., Zhonghua No.3, and 4.
- Biotechnology methods are being used for embryo rescue and to transfer genes for disease resistance from wild *Arachis* accessions to cultivated groundnut. Cross and backcross generations between cultivated varieties and the wild relative, *A. glabrata,* have been obtained. A short-duration line 95-G35 has been selected. Of two other lines, 95-G34 is resistant to late leaf spot, and S9 is tolerant to drought. These strains are being evaluated further for identification and release.
- Research on pest control has been concentrated on integrated control of groundnut virus diseases, nematode diseases, bacterial wilt, and fungal leaf diseases.
- The physiological basis of high yield and improved methods of high yield cultivation are being studied.

Sorghum

- Germplasm research has concentrated on the identification of grain quality, and stress tolerance, and some lines with high resistance and good grain quality have been identified.

1. Chinese Academy of Agricultural Sciences, 30 Bai shi Qiao Road, Beijing 100081, China.

- Genetic improvement to enhance sorghum quality for brewing liquor and as animal feed are being explored. A few hybrid cultivars with high yield, multiple-resistance, and good grain quality have been released.
- Population improvement, non-milo cytoplasmic sterility line development, two-line hybrids, apomixis, tissue culture, and DNA transformation are being studied.
- The other three crops, chickpea, pigeonpea, and pearl millet are of minor importance in China. Foreign germplasm has been introduced into China to carry out adaptability tests, in order to utilize them directly or as parents to improve the local varieties.

CLAN activities and impact

Exchange of germplasm and breeding materials

About 2000 accessions of germplasm of groundnut were introduced from ICRISAT. More than 100 accessions were identified as virus and aphid resistant, and two as nematode-resistant germplasms. About 40 germplasm were used in breeding programs. With NcAc 17090 as resistant-source, a high-yield and disease-resistance variety, Shanyou 523, was released. It has been extended to 650 000 ha in southern China. With the EC 76446(292) as resistant-source, a high-yield and disease resistance variety, Yueyou 223, was developed. It has been extended to 100 000 ha in Guangdong province. Three other high-yield and disease-resistant varieties, Yueyou 26, Yueyou 25, and Yueyou 24, which are derived from CX 9, are being tested in farmers' field.

Some 4000 sorghum germplasm materials were introduced from ICRISAT. These include varieties, breeding materials, and other germplasm lines. Some materials were directly used in breeding, e.g., SPL 132A, MR 724, 421B, and TAM 428. Hybrid cultivar Liaoza No.4 (developed by using SPL 132A) has been extended to 100 000 ha. It has a high yield potential, good grain quality, and multiple resistance; its top yield was 13.55 t ha^{-1}. Two other lines, derived from SPL 132A, will soon be extended for farmers' cultivation. The variety Longsi No. 2, which used MR 724 as parent, is being cultivated in northern China. Three new male sterile (ms) lines 7050A, 7009A, and 7038A have been derived from the cross involving 421B and TAM 428. These ms sterile lines have stable fertility restoration, high combining ability, and good resistance, and have been used in breeding, e.g., the hybrid between 7050A and LR9198 with high yield, head smut resistance, leaf disease resistance, and aphid tolerance has a good prospects. These introduced materials have provided many special traits which helped the breeding programs in China. These materials greatly enriched Chinese sorghum genetic diversity. At the same time, China provided some germplasm to ICRISAT, and plans to increase the exchange of germplasm and breeding materials, especially of early generation materials so that the new varieties can be selected and released.

Information and technology exchange

The publications provided by ICRISAT, such as research and information bulletins, and newsletters, were very useful. Some have been co-published in Chinese. More Chinese scientists would like to get ICRISAT publications. They also hope to increase the exchange of visits of Chinese and ICRISAT scientists.

Human resource development

Since 1980, more than 70 Chinese scientists have been trained in ICRISAT. These training programs enhanced the professional level and the English proficiency of Chinese scientists. Many of them are now the backbone of scientific and technological teams, and play an important role in the agricultural research of China. However, ICRISAT could help further in training middle-level and senior Chinese academics, especially in the fields of biotechnology, drought, and disease resistance research.

Contributions to national research program

The contributions of ICRISAT to China national research program are as follows:

Groundnut bacterial wilt. Groundnut bacterial wilt research has focused on screening for resistance sources, genetic enhancement, resistance mechanisms and genetics, pathogen identification, and inoculation methods. Scientists at the Oil Crops Research Institute (OCRI) took part in the Groundnut Bacterial Wilt Working Group (GBWWG) coordinated by CLAN/ICRISAT since 1990. The third GBWWG meeting and a training workshop were held at OCRI in Jul 1994. An information Bulletin and a Technical Manual on groundnut bacterial wilt were published by ICRISAT with assistance from OCRI and other cooperators. Several important bacterial wilt-resistant groundnut genotypes were sent to ICRISAT.

Groundnut virus diseases. Four virus diseases of economic importance for groundnut in China were identified: peanut stripe virus, cucumber mosaic virus, peanut stunt virus, and groundnut bud necrosis. Their distribution and epidemiological features were worked out. Integrated management of the virus through using virus-free seeds, tolerant varieties, polythene mulch cultivation, and control of aphids was shown to be effective. Preliminary work was done on the molecular basis of some virus strains.

Groundnut breeding. The cross and backcross generations of wide hybridization between cultivated and wild relatives were successful. Chinese researchers have overcome cross sterility and obtained many interspecific cross derivatives. Seven new short-duration, high-yield breeding lines were acquired (D1, D2, D3, D4, D5, D11, and D14, and their yields are higher than that of the check cultivar Baisha 1016.

Chickpea introduction and adoption. High-yielding varieties of chickpea were introduced. Advanced evaluation of the high-yielding lines was undertaken. The national research program, supported by ICRISAT, made great progress. China would benefit greatly if some of the latest research equipment is provided by ICRISAT.

Coordination of regional research. The working groups coordinated by CLAN/ICRISAT, such as the GBWWG, and Asia-Pacific Working Group on Groundnut Viruses have played an important role in sharing of research responsibilities and in enhancement of research levels. We hope that ICRISAT will continue to coordinate research in other areas such as groundnut drought resistance, yield improvement, etc.

Future collaborative activities

In Jul 1994, a new agreement of collaboration between China and ICRISAT was signed. The cooperation in CLAN between China and ICRISAT entered a new phase. We hope CLAN will:

- increase the funding support to the key research programs indicated in the agreement
- sponsor graduate student training (MS and PhD), short-term training, and in-service training
- sponsor workshops on groundnut and sorghum, and other CLAN priority crops in China
- increase the exchange of germplasm and visits of Chinese scientists, especially in the groundnut and sorghum collaborative research

Collaborative Research in India: Needs and Opportunities

J P Tandon[1]

Introduction

The priority crops of CLAN, sorghum, pearl millet, chickpea, pigeonpea and groundnut are very important in India. Sorghum and pearl millet together account for nearly 10% of the 122 million ha of cultivated area in India, and 9% of its 192 million t of food grain production. Chickpea and pigeonpea constitute around 45% of the area under pulse grain production in the country, and 58% of its production. Groundnut is the most important oilseed crop, accounting for 45% of the area and 55% of the total production of oilseeds in India.

These primarily rainfed crops are important for food security in India; the cereals, particularly, are crucial to the weaker sections of society in the semi-arid regions where they form the staple food.

Sorghum

It is grown on about 13 million ha producing 11.5 million t at an average of 0.9 t ha^{-1}. The area under the crop has declined over the years from 18 million ha in the 1960s but productivity has increased considerably from the 1960s level of 0.5 t ha^{-1}.

Pearl millet

During 1993, 9.53 million ha was sown to pearl millet with a production of 5.02 million t at an average productivity of 0.51 ha^{-1}. The area under the crop has declined from around 12 million ha in late 1960s. While crop productivity fluctuates greatly with rainfall, it has shown some increase. Average yield increased from about 0.3 t ha^{-1} in the 1950s to above 0.5 t ha^{-1} in the 1990s.

Chickpea

During 1993, 6.44 million ha was sown to chickpea with a total production of 4.9 million t at an average productivity of 0.71 ha^{-1}. The area under the crop has declined from around 10 million ha in late 1950s; total production has also declined. However, there has been some increase in productivity, from about 0.55 t ha^{-1} in the 1950s to about 0.7 t ha^{-1} in the 1990s. Only one fifth of the cropped area is irrigated.

1. Indian Council of Agricultural Research (ICAR), Krishi Bhavan, Dr. Rajendra Prasad Road, New Delhi 110 001, India.

Pigeonpea

Pigeonpea is grown on 3.58 million ha with a production of 2.70 million t at an average productivity of 0.75 t ha^{-1}. The area under the crop increased from about 2.5 million ha in the 1970s to 3.5 million ha in the 1990s.

Groundnut

Currently 8.38 million ha are sown to groundnut, the total production being 7.76 million t, and a productivity of 0.93 t ha^{-1}. The area has increased from around 7 million ha in the 1970s. Nearly 20% of the crop is irrigated.

Network related activities

India collaborates closely with CLAN/ICRISAT activities in exchange of germplasm and breeding materials, publication and information exchange, joint workshops, group meetings, conferences, and training programs.

Research activities

Sorghum: The collaborative research aims at diversification of genetic base for male sterility, development of dual purpose (grain and forage) strains, breeding for grain-mold resistance and drought tolerance. The research includes studies on feasibility of management of insect pests and diseases, and investigations into grain textural profile as influenced by genotype and agroecological situations.

The work carried out and the materials developed have proved very useful in identification of sources of resistance to *Striga* and anthracnose, development of improved germplasm, and diversified genetic base. A2, A3, A4 cytoplasms have been used to diversify cytoplasmic base of male sterile lines. This research has helped in identification and release of hybrid CSH 13R.

Pearl millet: The research aims to develop drought- and heat- tolerant materials, genetic and cytoplasmic diversification of male sterility sources, breeding of high yielding hybrids, varieties and gene pools, and research on nature of resistance to downy mildew.

Several successful, collaborative trials were conducted. The germplasm supplied by ICRISAT was used extensively in development of improved pearl millet varieties; some of these are in large scale cultivation, and others are in the final stages of testing under the All India Co-ordinated Millet Improvement Project. Recently, one composite variety named Raj 171, developed from the materials received from ICRISAT, has been released for general cultivation in Rajasthan.

Chickpea: The research includes development of ascochyta blight resistance, identification of botrytis gray mold resistance, high-temperature tolerant genotypes, and breeding for adaptation to late-sown conditions in rice-based cropping systems.

A large amount of germplasm was exchanged and evaluated. Genotypes possessing the above characteristics have been identified, and are being used in breeding programs.

Pigeonpea: The research involves exploitation of hybrid vigor, development of short-duration genotypes for varying latitudes and rice fallows, studies on wilt, alternaria blight, and sterility mosaic, and development of genotypes with stable yield. Most of these projects achieved their objectives to a fair extent.

Groundnut: The collaborative research aims to develop genotypes with foliar disease resistance, bud necrosis disease resistance/tolerance, reduced aflatoxin contamination risk (in HPS types), cold tolerant and short-duration bunch varieties, drought tolerance, and resistance to insect pests. Progress has been good and appropriate genotypes have been identified for further testing.

Proposed intensification

Since the research on all these crops has proved very useful, it should be continued. An emphasis on the following aspects will help to strengthen these activities further.

Sorghum

- Identification/development of rabi (winter) materials with increased levels of resistance to shootfly and drought,
- Development of types with greater tolerance to grain mold in kharif (rainy season) crop.
- Breeding for multicut forage sorghum varieties.

Chickpea

- Identification of more stable donors for resistance to botrytis gray mold.

Groundnut

- Development of materials tolerant to saline conditions, acid soils, cold temperature, and heat.

Information exchange

The publications made available to the collaborators have useful information on methodologies for crop improvement, production technologies, and have been helpful in updating knowledge. Awareness about ICRISAT activities has also increased. This dissemination must be pursued more vigorously.

Exchange of visits/Field days

Joint visits by ICRISAT and Indian NARS scientists offered excellent opportunities for discussion while examining the materials in the fields. This has clarified various issues and identified promising materials, and new areas of collaboration. Field days organized by ICRISAT have proved particularly useful in this regard.

Meetings/Conferences/Workshops

These activities provided a good opportunity to Indian collaborators to interact with reputed international scientists. As this results in greater cohesiveness among the partners, these activities must be encouraged.

Training programs

Since the level of training programs was generally elementary, this activity has been of limited interest to India. There is a need to emphasize on more specialized training such as new approaches to crop improvement, disease and insect pests' management, biotechnology, and other advanced areas of research.

Suggestions for further improvement

- Since on-going programs, including exchange of germplasm and breeding materials, field visits, meetings, conferences, and field days, and supply of publications have proved very useful, they should be continued and strengthened.
- A special emphasis should be laid on short- and long-term visiting scientist programs under which experienced scientists in the national programs work with ICRISAT scientists on projects of mutual interest thereby generating specialized information and advancing technical competence.
- In the same context, positions for postdoctoral fellows could be considered.
- Feasibility of supplying specialized equipment, to enhance research capabilities of the national programs and to improve quality of data generated should be considered.
- Technical programs under AICRPs and ICAR-ICRISAT collaborative projects should be integrated so that these strengthen the ongoing programs. The annual workplans for collaborative research should be finalized at the All India Workshops/ Meetings rather than at separate meetings.
- ICRISAT must channelize all materials/supplies through the concerned national crop coordinator, and should not approach the cooperating centers directly.
- Since most centers operate under financial constraints and available funds hardly meet the committed national program needs, any additional activity/responsibility/ work allotted to these by ICRISAT, which is outside the planned center programs, must be financially supported.

- CLAN meetings should be held more frequently since this is one of the mechanisms by which cooperators interact, share information, experience, and expertise leading to development of programs of mutual interest. The feasibility of holding these meetings at locations other than ICRISAT should also be explored.

Collaborative Research in Indonesia: Needs and Opportunities

Sumarno[1]

Introduction

After the agricultural research reorganization of 1 Apr 1995, research on cereals is done at the Research Institute for Maize and other Cereals (RIMOC), Maros; and on legumes at the Research Institute for Legumes and Tubers (RILET), Malang. Adaptive research is carried out by Institute for Agricultural Technology Assessment (IATA), located throughout Indonesia. Research at the RILET and RIMOC is more basic, and applied to produce technology components, while that carried out at IATA is more applied and adaptive focusing on location-specific technology.

Grain legumes

Current research on groundnut

Research on varietal improvement is aimed at the developing high-yielding varieties, with disease resistances (rust, leafspot, bacterial wilt, viruses, stem rot), short-duration (90-110 days), and good seed quality (medium-large seeds, 50 g 100-seeds^{-1}) of Spanish type. Resistance to major pests (thrips, red mites, aphids, and jassids) is also being sought. The progress on improving yield potential to over 2 t ha^{-1} dry kernel is slow; two Valencia type varieties with long pods, having 3-5 small seeds, were released for their high yield potential, but have not been widely adopted by farmers because of their irregular seed shape, and small seed size.

Agronomic research is aimed at providing optimum growth media for groundnut on:

- drylands, including soil moisture conservation using mulch, raised beds, using organic manure, and chlorosis prevention on calcareous soil
- wetlands, including drainage improvement, weed control, and soil moisture conservation during reproductive stage
- plant protection, including control of rust and brown leaf spots, using minimum amounts of fungicide, and the control of major pests (jassids, thrips, mites, and leaf feeders) using minimum amounts of insecticide

1. Assessment Institute for Agricultural Technology, Karangploso, Malang, Indonesia.

Current research on pigeonpea

Since pigeonpea is a minor crop, research on this crop is aimed at identifying mixed and intercropping patterns, and the study of adaptation of pigeonpea as a second or third crop after rice. Technology components of research include:

- varietal testing, using material introduced from ICRISAT, and local strains
- crop management (pest control, agronomy, etc.)

Impact and usefulness of the network

- Exchange of germplasm and breeding materials in groundnut, sorghum, and pigeonpea
- Enhancement of research activities, especially those of on-farm research and transfer of technology involving participation of researchers, extension workers, and farmers
- Interaction between national and international scientists
- Exchange of publications and other information

Suggested future collaborative activities

- Dissemination of research results, through on-farm research, with participation of farmers
- Farmers' participatory breeding of groundnut, to produce varieties readily adoptable by farmers
- On-farm research on the application of IPM in groundnut and pigeonpea
- Exchange of breeding materials and germplasm
- Training of NARS scientists at ICRISAT or at national research institutes, in collaboration with ICRISAT
- Study and monitoring tour of groundnut and pigeonpea in the major producing countries

Collaborative Research in Myanmar: Needs and Opportunities

Mohein[1]

Introduction

Myanmar is an agricultural country. Rice occupies 70-80% of the 9 million ha of the cropped area. Sorghum is the most important cereal after rice, cultivated in about 190 000 ha, with an average yield of 0.67 t ha^{-1}. Sorghum stalks (green and dry) are used as fodder, and grain is used both as feed and as human food. Pearl millet is a minor crop. Among food legumes, groundnut (600 000 ha) is the most important. Pigeon-pea area has increased to 233 600 ha (in 1994) because of higher market prices, as it is one of the export crops. Area under chickpea in 1994-95 was 220 000 ha with an average yield of 1 t ha^{-1}. Chickpea is grown mostly as a sequential or relay crop with rice, and also following upland crops such as maize, sorghum, and sesame. Although most chickpea is sole cropped, some of it is mix cropped with wheat, sunflower, etc.

Current research thrusts

Human resources for research are limited, hence only major production constraints are addressed at the Central Agricultural Research Institute (CARI), Yezin, and its substations across the country.

Groundnut

- Short-duration lines with limited seed dormancy
- Management of diseases and pests, including host-plant resistance
- Develop lines suited to acidic soils (in the hilly and delta regions)

Chickpea

- Short-duration, wilt, root rot, and *Helicoverpa*-resistant desi and kabuli types
- Varieties suitable for relay cropping; and heat-tolerant varieties suited to acidic soils in delta region
- Moisture and nutrient management in paddy soils

1. Pathology Division, Central Agricultural Research Institute (CARI), Yezin, Pyinmana, Myanmar.

Pigeonpea

- Large-seeded, short-, medium-, and long-duration pigeonpea varieties for different cropping systems
- Insect pest management including *Helicoverpa, Maruca,* and podfly
- Ensure existing levels of wilt, sterility mosaic, and *Phytophthora* resistance in new varieties

Sorghum

- Dual purpose varieties with medium-duration (100-110 days), and good fodder storage quality
- Pest and disease resistant varieties including resistance to *Striga* and shootfly

Pearl millet

- Varieties with higher fodder yield, ratooning ability, lodging resistance, and better fodder quality

Collaboration with CLAN

Collaborative breeding

Most of the germplasms, breeding materials, and varietal trials from ICRISAT were very useful in addressing the production problems encountered in Myanmar. Foliar disease resistance cultivars of groundnut from ICRISAT are promising, and are used as parental lines. Breeding for multiple resistance, drought tolerance, high shelling percentage, and short duration with high yield was started using local and ICRISAT varieties in 1994-95.

In sorghum, mass selection of two extensively grown local cultivars is underway at two CARI farms. In an advanced nursery of stem borer resistant lines in 1994,12 out of 19 entries were selected for further investigation. Most of the entries from shootfly resistance advanced lines were selected for retesting in 1995. Lines in dual purpose bold grain nursery, red grain restorers, shootfly resistance nursery, stem borer resistance nursery, and *Striga* resistance 'B' lines are under observation at CARI farms. A breeding program between a landrace and M 90904 was initiated to develop dual purpose (grain-and-fodder) varieties at CARI. The progenies are being screened at three locations.

Varietal demonstration of ICSV 804 and ICSV 758 was conducted in 2-ha blocks at two locations each in Sagaing and Mandalay Divisions last year. The promising dual purpose variety, ICSV 804, was tried again in 0.4 ha plots at five locations. Breeder seeds of Yezin White Grain-1 and ICSV 804 were multiplied at two CARI farms.

Four sets of chickpea root rot, and wilt nurseries were tested last year. Selected entries of short- and medium-duration kabuli and desi chickpea nurseries will be sown in next season.

Very promising short-duration and medium-duration pigeonpea entries are being tested at five locations this year. Short-duration lines, ICPL 87, ICPL 151, ICPL 86005, and ICPL 83024, and one medium-duration line, ICP 7035, were found quite adaptable to the central dry zone in various cropping patterns.

We are yet to do our best in exchange of genetic materials with member countries. Segregating populations of groundnut will be helpful in identifying our specific needs.

Working Groups

The working group approach is an effective method of exchanging views, problem identification, research prioritization, and problem solving. NARS scientists with in-depth knowledge on agronomy, pest and disease management, and crop improvement, should be tapped for their expertise.

On-station research

A detailed study of qualitative and quantitative improvement of crops, and their agronomic management is usually done in collaboration with different disciplines. A great deal of basic and applied research still needs to be conducted on-station to find solutions and component technologies before these are tested in farmers' fields.

On-farm research

Most on-farm research calls for the cooperation of local extension personnel; this saves time and expenditure, and accelerates technology transfer to farmers. The researcher alone cannot implement the objectives of the on-farm research trials. This aspect needs increased emphasis in network activities.

Information exchange

Research articles not easily available in Myanmar have been received through ICRISAT's Semi-Arid Tropical Crops Information Service (SATCRIS), with a promptness, that is widely appreciated. Papers appearing in the Myanmar Journal of Agriculture Science (MJAS) will be made available at IAC, and if possible, to member countries by a mutual information exchange program.

Human resource development

In-country training on production of the mandate crops for the staff of Research, Seed and Extension Divisions is conducted annually by the Crop Division concerned at CARI and elsewhere. Laboratory chemicals and other equipment is also provided as and when necessary. Such training programs need to be continued.

Review and planning meeting

A review and planning meeting between CLAN/ICRISAT and MAS was held at CARI, 18-20 May 1994. Research priority and targets were laid down and objectives formulated for the mandate crops.

Personnel from the Seed and Extension Divisions were invited to this meeting. Future research programs were formulated and priority areas of research and/or implementation were then fixed as short-term programs in each discipline. Long-term programs were also discussed for different research areas. Detailed plans were then worked out in the group discussions, and plan implementation was discussed in quarterly meetings. Overall findings and those that can be transferred to the farmers were presented at the annual research meeting at CARI. On-station and on-farm research trial sites were chosen for implementation.

Coordination Unit

Support by ICRISAT of the Coordination Unit is essential for smooth functioning of the network. Such efforts will be willingly supported by NARS.

Steering Committee

The Steering Committee with all the Country Coordinators should be continued in order to extract concrete information from each country, and for fruitful coordination and cooperation.

Collaborative Research in Nepal: Needs and Opportunities

G P Koirala[1]

Introduction

Many summer and winter legumes are grown in different agroclimatic regions of Nepal. Grain legumes occupy about 13% of the total cultivated area and rank fourth in terms of area and production, after rice, maize, and wheat. Area, production, and productivity of pulses have all increased from 1985/86 to 1993/94 (Table 1). The increase in production is mainly due to increase in area. Oilseed crops are also important, since they provide oil for consumption and generate farmers' income. The area under oilseed crops has increased by about 50% percent, production has been doubled, and productivity has also increased during the last three decades (Table 2).

Among the mandate crops of ICRISAT, chickpea, pigeonpea and groundnut are important crops in Nepal requiring research and development. Pigeonpea is the most important legume after lentil. It accounts for 12% in area and 11% in production of grain legumes grown in Nepal (Table 1). Pigeonpea area and production have increased by almost 50% in the last few years.

Table 1. Area, production and productivity of grain legumes in Nepal from 1985/86 to 1993/94.

	Year	Area (10^3 ha)	Production (10^3 t)	Productivity (kg ha^{-1})
Grain legumes	1985/86	253.66	146.16	576
	1989/90	268.54	163.23	608
	1993/94	321.90	195.48	607
Pigeonpea	1985/86	16.05	12.17	758
	1989/90	18.87	13.30	705
	1993/94	22.56	16.40	727
Chickpea	1985/86	29.39	18.18	619
	1989/90	28.19	16.52	590
	1993/94	24.01	13.56	663

1. Oilseed Research Program, Nawalpur, Sarlahi, Janakpur Zone, Nepal.

Table 2. Area, production, and productivity of oil-seed crops in Nepal.			
Year	Area (10^3 ha)	Production (10^3 t)	Productivity (kg ha^{-1})
1964/65	108	51	472
1974/75	113	66	583
1984/85	128	84	657
1994/95	170	102	600

Chickpea is the most important grain legume after lentil, pigeonpea and grasspea (*Lathyrus sativus*) in terms of area and production. Both area and production of chickpea have declined from 1985/86 to 1993/94 (Table 1) despite considerable efforts on production technologies.

Groundnut is an important cash crop in some parts of the country. While exact area and production of groundnut are not known, about 7000 ha is estimated to be sown to the crop. Estimated area under groundnut in high- and mid-hills is 0.8%, and in the *terai* and Inner *terai* is 1.7% of the total oilseed crop. Productivity was estimated to be 0.9 t ha^{-1} in the hills, and 0.86 t ha^{-1} in the *terai.*

Chickpea, pigeonpea, and groundnut research

Research on chickpea in Nepal began in 1973; that on pigeonpea in 1977, and on groundnut in the late 1970s. Exchange of materials and literature with ICRISAT also began in the early 1970s. Local landraces of chickpea and pigeonpea were collected during 1978/79 in collaboration with ICRISAT. Oilseed Research Program (ORP) was started in 1976. Research on grain legumes was strengthened after the Grain Legume Research Program (GLRP) was established in 1985.

In 1987, a Memorandum of Understanding between Nepal and ICRISAT was signed. This was followed by a letter of agreement for Nepal-AGLN/ICRISAT work-plan for 1987/88. Since then, GLRP and ORP have been receiving operational funds for cooperative research between Nepal and ICRISAT in chickpea, pigeonpea, and groundnut.

Asian Grain Legume On-farm Research (AGLOR) was started in 1991 to accelerate the pace of on-station research, and strengthen on-farm activities on these three crops.

Chickpea

Research on varietal improvement has resulted in the release of two local cultivars, 'Dhanush' and 'Trishul' in 1980. In 1987, two more varieties, Sita (ICCC 4) and Radha (JG 74) were released. Two other cultivars, Kalika (ICCC 82108) and Koseli

(ICCC 32, kabuli type) were released in 1990. Selections from crosses between Dhanush and K 850 have performed well in all test locations and show tolerance to botrytis gray mold (BGM). Some of them are likely to be released soon.

Research priorities

- To develop and identify short- and medium-duration cultivars with high yield and large seed size
- Incorporate resistance to BGM and fusarium wilt, and to *Helicoverpa* pod borer
- Develop appropriate management practices to minimize BGM incidence
- Conduct adaptive on-farm trials to tailor existing technology to farmers' needs, and to offer a basket of technology options

Pigeonpea

Varietal improvement led to the release of two local cultivars in 1991 'Bageshwari' (PR 5147), a long-duration variety, and 'Rampur Rhar - 1 ', a short- to medium-duration variety. Several promising short-duration lines (e.g. ICPL 146, ICPL 151, UPAS 120) have been selected, and are in the process of release for general cultivation. Some genotypes, such as ICPL 84072 and ICPL 87133 are resistant to wilt and sterility mosaic, and produce higher yields in farmers' fields than local varieties.

Research priorities

- Identify medium- and long-duration cultivars with large seed, and high and stable yield for rainy season sowing
- Identify extra short duration, high-yielding cultivars with large seed for rainy season, and short- and medium-duration lines for postrainy season planting
- Incorporate resistance to sterility mosaic, fusarium wilt, stem canker, and to pod borer and podfly
- Evaluate pigeonpea for intercropping with cereals and other legumes
- Develop and conduct adaptive on-farm research to develop technology to meet farmers' needs

Groundnut

Varietal improvement led to the release of two varieties, B-4 and Janak (NCAc -343) for commercial cultivation in 1980 and 1989 respectively. A few other promising lines have also been identified. Among normal maturing types, AH-144 and M-13 have been the top yielders. Among short-duration lines ICGS-36, ICGS(E)-52, and ICGS(E)-56 are in the pipeline for release.

Research priorities

- Identify short-duration cultivars (110-115 days) with high yield potential
- Screen for and incorporate resistance to diseases (early leaf spot, late leaf spot, rust,

and bud necrosis disease) and to insects (thrips, termites, white grub and hairy caterpillar) into high-yielding lines

- Identify genotypes adapted to spring (Feb) sowing
- Demonstrate high-yielding materials and technology in farmers' field to obtain increased pod yield

Exchange of germplasm and breeding materials

The exchange of genetic material through CLAN has been very useful in selecting and developing genotypes suitable for specific environments. Most breeding materials received from ICRISAT have performed well under Nepalese conditions. This collaboration has strengthened the crop improvement activities of the related commodity programs.

Information and technology exchange

Nepalese translations of three Information Bulletins were supported by CLAN/ICRISAT. Exchange of visits of ICRISAT scientists has improved the quality of Nepalese research programs; the frequency of such visits should be increased.

Human resource development

In-country training programs, and those organized by CLAN at IAC helped field-level research and extension workers. Such practical training courses should be continued. In addition, short-term refresher courses would keep Nepalese researchers up-to-date in research techniques. ICRISAT should also consider initiating training programs leading to a formal degree, to help strengthen commodity research programs in Nepal.

Support to the national program

The review and planning meetings, working group meetings, monitoring tours, and workshops have been instrumental in identifying major research areas, developing or improving appropriate research methodologies, and establishing research priorities. The network should adequately address diagnostic services support.

Coordination of regional research

The current trend of increased levels of funding is clear evidence of the Government of Nepal's commitment to improve agriculture research management. The NARC, which was granted autonomy in May 1991, consists of 12 disciplinary divisions, 14 commodity programs, 4 regional stations, and 16 research stations. NARC will develop, strengthen, and operationalize a relationship with the Department of Agriculture Development for on-farm research activities. Thus, coordination with NARC is sufficient for instituting any collaborative research programs in Nepal.

Collaborative Research in the Philippines: Needs and Opportunities

Ester L Lopez and Jocelyn C dela Torre[1]

Introduction

Rice and corn continue to remain the main cereal crops in the Philippines. Sorghum and pearl millet are considered minor crops. While rice and corn are the main sources of carbohydrates for the Filipinos, legumes provide a cheaper source of protein. Among the legumes, groundnut has a high demand. Of the total groundnut production, during 1978 to 1993, 75% was used for food, 6% for feed, 2% for seeds, and 17% for other non-food uses. The per capita consumption in the country was 0.55 kg.

In spite of its many uses, groundnut production in the country has remained low, and even declined, over the years. From 1984 to 1993, the area sown to groundnut fluctuated between 39 060 (1991) to 53 610 (1987) ha $year^{1}$ with an average of 47 588 ha for the period. Almost 50% of this area is found in the Cagayan Valley. Groundnut production over the past ten years varied from 31 400 million t to 43 000 million t annually, and averaged 37 800 million t during the whole period. Similarly, the mean yield fluctuated from 0.76 million t ha^{-1} to 0.86 million t ha^{-1}.

To meet domestic requirements, the Philippine government imports raw, roasted, preserved, and prepared groundnuts amounting to around US$ 4 million every year.

Current research thrusts

In the Philippines, legumes research is focused on soybean, groundnut and mungbean. Of the total research budget in 1994 amounting to Peso 106 million (US$ 25 million) for various commodities, 12% was allotted to legumes of which soybean got the highest share (31%) followed by groundnut (12%). Resources allocated for pigeonpea (0.89%) and chickpea (0.23%) were the least. For groundnut, the emphasis is on increasing its productivity to 1.5 t ha^{-1} by the year 2000. The major research areas for groundnut and the other CLAN-mandate crops emerged from the National Legumes Research Team Meeting (Oct 1994), the Philippines-CLAN/ICRISAT Review and Planning Meeting (30-31 Jan 1995), and the CLAN/ICRISAT-PCARRD-DA-Region 2 In-country Training Course on On-farm Adaptive Research (17-20 Oct 1995). They are:

1. Crops Research Division, Philippine Council for Agriculture, Forestry and Natural Resources Research and Development (PCARRD), Los Banos,Laguna, Philippines.

Groundnut

- High-yielding varieties with tolerance to drought, pests and diseases (white grubs, bacterial wilt, and *Sclerotium*)
- Integrated pest management, including seed treatment techniques that effectively control white grubs and *Sclerotium*
- Agronomy and cropping systems
- Improvement of seed production and distribution system
- Mechanization, postharvest handling, and improvement of groundnut products and byproducts

Pigeonpea

- Socioeconomics of production, and marketing studies
- Adaptive research on utilization (for food and feed) of dry seeds
- High yielding (large seeded) short- and medium-duration pigeonpea for different cropping systems for green peas and dry seeds

Chickpea

- Evaluation and selection of short-duration, white seeded (kabuli types) for cultivation in Northern Luzon

Sorghum

- Dual purpose medium-duration (100-110 days) varieties for sole and intercropping
- Adaptive research on feed and food utilization of grain sorghum

Impact of network activities

Exchange of germplasm and breeding materials

The breeding lines from ICRISAT serve as valuable source for the national legumes breeding program to develop cultivars suited for different agroecological environments.

As stipulated in the 1995-1997, CLAN-PCARRD Work Plan for Collaboration, all germplasm and breeding materials sent by ICRISAT to the Philippines will pass through PCARRD. This will enable PCARRD to effectively monitor the status of materials received from ICRISAT.

Information and technology exchange

Recent publications by ICRISAT on biotic and abiotic constraints to pulses and their production technologies have been of great value to Filipino legume researchers.

Training programs, workshops, and working group meetings have generated new ideas, and developed linkages and interactions among local researchers and their counterparts elsewhere. This should be done on a regular basis.

Human resource development

The support/assistance provided by CLAN/ICRISAT contributes to the strengthening of the conduct of on-station and on-farm research. From 1993 to 1995, three researchers from the Philippines were able to avail of the training programs sponsored by CLAN/ICRISAT. Two were trained on crop production, and one in geographic information system (GIS).

In addition, 16 researchers and extensionists from seven agencies benefited from the in-country training course on on-farm adaptive research held at Ilagan, Isabela, in Oct 1995.

Support to national research program

The PCARRD-CLAN/ICRISAT Review and Planning Meeting enabled to firm up the strategies for future collaborative work to accelerate the research and development of cereal and legumes in the Philippines.

Additional financial support is required to effectively implement and monitor the ongoing projects.

Future collaborative activities

The approved Work Plan for collaboration between PCARRD and CLAN/ICRISAT is an important document that outlines areas of research collaboration.

Among other things, it is anticipated that CLAN/ICRISAT will continue to actively contribute to the research and development of the CLAN-mandate crops in the Philippines in terms of:

- supplying germplasm materials and improved varieties
- providing technical assistance and relevant information/ publications to enhance technical knowhow on CLAN priority crops
- organizing and supporting training and fellowship programs to upgrade skills of local researchers

Five CLAN/ICRISAT-PCARRD collaborative projects dealing with pilot testing of JL-24 groundnut variety, on-station and on-farm trials of chickpea and pigeonpea, and evaluation of early and advanced selections of groundnut are being implemented in

1995-1996. In addition, working groups on groundnut will be fprmed with a task to find solutions to production problems caused by viruses, bacterial wilt, and mycotoxin-producing organisms.

Collaborative Research in Sri Lanka: Needs and Opportunities

K D S M Joseph[1]

Introduction

Cereals and legumes are a major source of energy and protein for many Sri Lankans. Collaborative research on pigeonpea and groundnut has been going on for the past few years. Although chickpea is common in Sri Lankan diet, its entire requirement (9700 t) is imported annually at a cost of US$ 3.2 million. Past research on chickpea production indicates that the varieties tested were not suitable because of various reasons such as high incidence of pests, high temperature, excess moisture during early part of the maha (wet) season and terminal drought.

Sri Lanka has been associated with CLAN activities since 1986 (when it was the Asian Grain Legumes Network—AGLN). The present program to popularize pigeonpea in Sri Lanka was initiated as a collaborative activity with ICRISAT/AGLN in the late 1980s. The network has facilitated the exchange of germplasm, information, and technology among member countries, especially through ICRISAT. Collaborative work plans are prepared annually based on the needs, which include germplasm exchange, research activities, joint monitoring tours, surveys, meetings, workshops, and in-country training.

Research progress

The Field Crops Research and Development Institute of the Department of Agriculture is responsible for all research activities of pigeonpea, groundnut, and chickpea. Of these, pigeonpea gets the highest priority because of its potential to replace imported lentil (*masoor*) *dhal.* At present groundnut is mainly used as a snack in Sri Lanka, as there is no oil-extracting industry. Chickpea is a new crop; a research program is being initiated to test the suitability of heat-tolerant ICRISAT varieties. These priorities were arrived after consideration of factors such as

- area presently sown, and likely to be sown, to these crops, and value of the crops to growers, processors and consumers
- magnitude of researchable problem, and feasibility of technical solutions
- research findings that the target groups will adopt and benefit from

1. Field Crops Research and Development Institute, Department of Agriculture, Maha Illuppallama, Sri Lanka.

The several attempts to increase commercial production of pigeonpea in Sri Lanka failed largely because of

- high incidence of insect pests and inability of farmers to control them
- lack of short-duration short-statured varieties
- lack of small-scale processing machines

A large number of pigeonpea germplasm accessions from ICRISAT were tested under AGLN. Based on these tests, Phase I of the Sri Lanka-ADB ICRISAT Pigeonpea Project was initiated in 1990. Three potential varieties, ICPL 2 and ICPL 84045 (indeterminate), and ICPL 87 (determinate) were identified and several on-farm trials and demonstrations were conducted. These trials showed that pigeonpea has a great potential in the dry and intermediate zones of Sri Lanka. Pest management practices, especially to control *Maruca testulalis* and *Helicoverpa armigera* (pod borers), have also been developed.

Phase II of the project was initiated in 1994 and will continue to popularize pigeonpea in Sri Lanka. A significant achievement in the first year of the second phase of the project is the improvement of the pigeonpea-processing machine by the Farm Machinery Research Centre of the Department of Agriculture. This machine can now produce good quality *dhal.* In addition, significant progress has been made in pest management practices, identification of breeding material showing tolerance to *Maruca,* intercropping of pigeonpea with maize, and fertilizer management.

Research activities of CLAN on groundnut in the past were mainly on germplasm exchange and evaluation, and testing of different diagnostic treatments to understand the factors that contribute to low yields. The confectionery groundnut variety HYQ-(CG)-S-49, an introduction from ICRISAT, was released as 'Walawe'. This variety is suitable for high-input environments where supplementary irrigation is available.

Another introduction from ICRISAT, ICGS 11, has also performed well in multilocational trials and the Department of Agriculture has recommended this variety to the National Seeds and Planting Materials Committee for release.

Chickpea research in Sri Lanka was initiated in the 1974/75 season but was unsuccessful. However, research was revived in 1987 with the support from AGLN. Chickpea could not compete with high-value crops such as vegetables and potato, which grow in high elevation areas with cool temperatures. However, with the availability of heat-tolerant varieties researchers feel that chickpea has a place in the dry and intermediate zones of Sri Lanka.

Research priorities

Pigeonpea

- Varietal introduction, evaluation and adaptability testing of promising short-duration varieties
- Studies on the possibility of growing extra- short-duration varieties in rice fallows
- Identification of Maruca-tolerant germplasm, combining *Maruca* resistance to different sources and development of suitable insect management practices

- On-farm demonstrations on cultivation, insect management, and processing
- Studies on intercropping and cropping systems
- Evaluation of pigeonpea varieties for drought tolerance
- Economic assessment of pigeonpea cultivation in Sri Lanka
- Product development, consumer preference evaluation, and processing studies

Groundnut

- Screening of varieties for major pest and diseases
- Studies on nutrient management
- Varietal introduction, evaluation, and adaptability testing
- Field surveys on disease incidence
- On-farm evaluation of new production technologies

Chickpea

- Summarize information from previous trials, and evaluate potential
- Evaluation of germplasm and breeding material for yield and adaptation
- Agronomy studies to develop appropriate cultural practices

Suggestions for future collaborative activities

The overall direction and guidance provided by the network has helped to achieve success in many priority areas, especially germplasm introduction, exchange of information, and technical advice. However, direct interaction among member countries was poor. All assistance came from ICRISAT. Therefore, it is necessary to develop bilateral contacts among member countries, but ICRISAT should continue to act as the facilitator of these activities.

Value addition to cereals and legumes is a high-priority area. However, the emphasis given by the network on this important area is very limited. Some workshops and training programs were organized but this alone will not help to promote industry (especially, medium-scale industry) in countries like Sri Lanka. The food habits of people in many Asian countries is changing with people opting for processed products over grain/seeds. Therefore, it is important to discuss what assistance the network can provide in this matter.

Collaborative Research in Thailand: Needs and Opportunities

Narongsak Senanarong[1], Nipon Iamsupasit[2], and Peaingpen Serawat[3]

Introduction

Thailand's national program for field crops conducts research on many crops. Three of these, sorghum, groundnut, and pigeonpea, are mandate crops of ICRISAT. An overview of these crops follows:

Sorghum

Sorghum has been grown in Thailand for several decades. In the early period, many lines were introduced from the USA and evaluated under farmer-growing conditions. Consequently, Hegari and other introduced varieties were released and recommended. This led to an increase in area and production. Many varieties have been released from organizations such as Department of Agriculture, Kasetsart University, and private seed companies. Currently, the total area sown to sorghum is about 160 000 ha, and annual production is around 250 000 t. The grain is normally used as animal feed and the green stalks as fodder. The major abiotic constraint is lack of water and the chief biotic constraints are shoot fly and grain mold.

Groundnut

Groundnut is an important food legume in Thailand providing both cash income and dietary protein to rural population throughout the country. The production areas are mainly in north and northeast Thailand. Seventy percent of groundnut is grown on uplands under rainfed condition, and 24% is grown as a postrice crop under irrigation. The current production is 150 000 t obtained from 112 000 ha. The average yield is approximately 1.37 t ha^{-1}, a 12% increase from the last decade. Most production is used for domestic consumption in the form of fresh boiled pod, roasted pod, and confectionery. The demand for groundnut production is increasing due to novel product development and marketing. However, 100 000 t of groundnut meal is annually imported for feeding livestock.

1. Field Crops Research Institute, Jatuchack, Bangkok 10900, Thailand.
2. Suphan Buri Field Crops Research Centre, Suphan Buri, Thailand.
3. Khon Kaen Field Crops Research Center, Khon Kaen, Thailand.

Pigeonpea

Although pigeonpea has high potential, because of low demand it is sown only in a small area in the northern part of Thailand at present. The alternative use of pigeonpea is to rotate it with sugarcane as a green-manure crop. In addition, the crop is also good to break disease cycles, and improve soil. Another possible use is to grow it as fodder.

Current research activities

Sorghum

Basic and applied research has been conducted not only to eliminate the constraints to sorghum production but also to look for alternative uses such as for animal feed. The national sorghum research program (of the Department of Agriculture) is aimed at producing high-yielding, disease and insect-resistant varieties, and improving cultural practices and pest control. Thus, four research programs of sorghum improvement have been set up:

- for better grain quality
- for animal feed
- for pest control (shoot fly and grain mold)
- for drought resistance

Most of this research is conducted at Suphan Buri Field Crops Research Center (SFCRC), 130 km west of Bangkok. The Department of Livestock is working on forage sorghum.

Other institutes, such as Kasetsart University and Khon Kaen University, also conduct research on sorghum. Three plant breeders and two agronomists are responsible for sorghum research activities at SFCRC.

Sources of high-yielding and pest-resistant lines have been introduced from ICRISAT and USA (Texas A & M University). Selection is carried out for desirable characteristics in those populations, and pure line varieties will be released to farmers.

After the extensive research, new technologies and cultural practices were developed for pest control. At present, on-farm trials are being emphasized.

Groundnut

Groundnut varietal improvement is aimed at developing confectionery types for high yield, and adaptation to varied production environments. Both the long-pod type (for boiling), and the medium- seed size type (multiple purpose) have been improved for high yield, short-duration, resistance to foliar diseases, resistance to viral diseases, and tolerance to drought. Crop production research lays emphasis on finding suitable technologies for improving yield not only in the upland paddy fields before or after rice, but also in poor soil areas. Crop protection research is aimed at finding suitable management options for leaf spots and rust, bud necrosis disease, stem rot and aflatoxin. Research on pest management is mainly targeted at viral diseases vectors.

Future research will focus on integrated management for bud necrosis disease, and identifying production techniques suitable for specific locations, based on both agroclimatic and socioeconomic factors. The evaluation and testing of genotypes will be carried on, with greater emphasis on crop quality.

Pigeonpea

Research on pigeonpea is aimed at testing ICRISAT-developed genotypes for grain yield (short-duration), and for biomass production (medium- and long-duration). In addition, crop management for both grain and biomass is being studied. Pigeonpea production is hampered by pod borer and podfly infestation. Therefore, the future research will aim at the integrated management for these pests.

Usefulness of network activities

Exchange of germplasm and breeding materials

Many germplasm and breeding materials for sorghum, groundnut, and pigeonpea come from ICRISAT. Some sorghum lines, such as IS 13958, have been used as a source of grain mold resistance, and IS 23585, the most promising line for high stalk yield, may be used directly as dual purpose variety.

Some groundnut genotypes provided by ICRISAT/CLAN since 1991 show high yield, and resistance to important diseases, but they are not generally accepted because of pod appearance, seed size and seed coat color. Nevertheless, they have been used as parental materials in breeding programs. The set of groundnut genotypes received in 1995 is expected to meet the requirements for both quality and high yield.

Information and technology exchange

A great deal of crop information comes from ICRISAT. Publications and the SAT-CRIS-SDI service are very useful, as are meetings and workshops. A more active exchange of visiting scientists will intensify technology exchange. Annual meetings should be continued, either in Thailand or at IAC. Workshops and Working group meetings on specific research topics should be held more frequently.

Four working groups on sorghum were set-up and work plans for each group were proposed. However, no activities have been followed up for those plans except the request for germplasm testing. Proposals to make the working groups practicable should be discussed. All activities organized by CLAN/ICRISAT should be put on the calendar of all CLAN members beforehand. This will help them to arrange for appropriate persons to attend.

Human resource development

Earlier, many Thai scientists involved in sorghum, groundnut and pigeonpea research were trained in long-term courses at ICRISAT. Now there is need for training in more specific areas, and short-term courses. These should be fully supported by CLAN/ICRISAT.

Support to national program

To cope with the constraints, e.g., in sorghum, CLAN/ICRISAT should support through the working groups by means of clear work plans. The groundnut working groups are very active at present and there have been many benefits.

It would be a great help if CLAN/ICRISAT could provide research equipment developed by ICRISAT but not available in the member countries.

Coordination of working groups and special research projects

The working group on bacterial wilt of groundnut has been useful. It should extend its scope to other constraints. Thai scientists are interested in involvement in the working group on aflatoxin, integrated pest management in both groundnut and pigeonpea, bud necrosis disease management, on-farm research methodology, seed production, and mechanization to reduce production costs and other areas of interest.

Future collaborative activities

Sorghum

- Continuation of working groups
- Short training courses for specific areas such as screening techniques for major pests, drought and salinity resistance, and RFLP-marker and RAPD for plant breeding
- Support for on-farm adaptive research

Groundnut

Characterization and utilization of germplasm

- Evaluation and testing of breeding material
- Integrated management of groundnut bud necrosis disease
- Effect of groundnut on succeeding rice crop N requirements
- Mechanization to reduce production costs

Pigeonpea

- Evaluation and testing of germplasm and breeding materials
- Integrated pest management

Collaborative Research in Vietnam: Needs and Opportunities

Ngo The Dan[1] and Nguyen Xuan Hong[2]

Introduction

Groundnut is the most important among the CLAN priority crops, and fifth among all food crops, grown in Vietnam. Groundnut is an important cash crop, and a vital export commodity. In recent years there has been substantial increase in groundnut area (from 200 000 ha in 1990 to 240 000 in 1994); average pod yields area 1 t ha^{-1}. Pigeonpea and sorghum are minor crops in Vietnam. Tall, long-duration local pigeon-pea varieties grown along roadsides and on field boundaries are used mainly for green vegetable, fuel, and lac production. Short-duration grain-type pigeonpea varieties are being tested for adaptability in different ecological areas in Vietnam. Sorghum is grown in small pockets in some mountain provinces where severe, lengthy droughts prevent upland rice and maize from being successfully grown.

Current research thrusts

Groundnut research is being given high priority. The emphasis is on increasing productivity, quality, and economic efficiency of groundnut production. The thrust areas of groundnut research are:

- breeding for high-yielding, high exportable quality, and short-duration varieties with drought tolerance, pest and disease resistance
- germplasm introduction, and varietal evaluation of groundnut introduced mainly from/through ICRISAT and Southeast Asian countries
- plant nutrition and biological nitrogen fixation
- agronomic practices and cropping systems
- integrated pest and disease management
- development of screening techniques for pest and disease resistance
- on-farm research to test adaptability of different advanced varieties/ technologies

Major institutions conducting research on groundnut are: Vietnam Agricultural Science Institute, Hanoi; National Institute of Plant Protection, Hanoi; Hanoi Agricultural University; Institute of Agricultural Sciences for South Vietnam, Ho Chi Minh City; and Oil Plant Research Institute, Ho Chi Minh City.

1. Ministry of Agriculture and Rural Development, 2 Ngoc Ha, Ba Dinh, Hanoi, Vietnam.
2. Vietnam Agricultural Science Institute , Van dien, Thanh tri, Hanoi, Vietnam.

Pigeonpea and sorghum research is focused mainly on the testing of ICRISAT - developed genotypes for adaptability to different agro ecological conditions. Studies are also in progress on the possibility of intercropping short-duration pigeonpea varieties with other crops especially industrial and fruit crops for biomass, soil erosion control, and grain in the middle and high-land regions of Vietnam.

Usefulness of network activities

Exchange of germplasm and breeding materials

Materials for groundnut breeding and improvement in Vietnam are mostly from CLAN/ICRISAT. Groundnut germplasm from ICRISAT is a major source of drought tolerance and resistance to diseases (especially foliar diseases and bacterial wilt) and insect pests. Many ICRISAT-developed groundnut lines are used extensively in various breeding programs. Several ICRISAT groundnut lines/varieties have been found to be promising with high yield, suitable quality, short-duration, and resistance to diseases. They are now being multiplied and extensively tested for possibility of release for large-scale production in the near future.

Although local, Vietnamese groundnut varieties have also been available in ICRISAT germplasm collection, their number is still very limited. To promote a two-way germplasm exchange, funding support is required. The possibility of providing members with funds to collect and conserve local germplasm should be considered by CLAN/ICRISAT.

Information and technology exchange

The major source of information on groundnut and other CLAN crops is ICRISAT. Vietnamese scientists regularly receive information and publications on technologies from ICRISAT. This activity is very useful and should be continued. The publication of a Vietnamese translation of Field Diagnosis of Groundnut Diseases (Information Bulletin no. 36) with CLAN support was very helpful to Vietnamese researchers and extension workers. Interaction between ICRISAT and Vietnamese scientists has been significantly improved by the exchange of visits and through meetings/workshops organized by CLAN/ICRISAT. During their visit to Vietnam, ICRISAT scientists often organized seminars on specific problems of interest to Vietnamese researchers; this is a practical way of information and technology exchange.

Human resource development

In recent years, CLAN/ICRISAT has trained 40 Vietnamese researchers who are now actively engaged in research and extension on groundnut and other CLAN crops in Vietnam. Training programs at ICRISAT have allowed Vietnamese scientists to improve their knowledge and acquire specialized new skills. There is a need for support from CLAN for more opportunities for short-term training/fellowships and scholarships leading to the award of a degree. In-country training courses need to be continued and intensified with financial support.

Support to the national program

The on-farm adaptive research project (AGLOR) identified suitable production techniques for groundnut in major groundnut-growing areas of Vietnam. Improved production technologies identified through AGLOR indicated the possibility of increasing groundnut yields in farmers' fields by more than 50% with minimal inputs. These production practices are well-received by farmers. On-farm research has proved to be a good model for technology transfer in Vietnam. Joint surveys, monitoring tours, and farmers' days organized in the framework of AGLOR have been useful in improving research and extension methodologies which are now followed by Vietnamese scientists in different crops.

During 1994-95, two ICRISAT scientists were posted for 6-8 months in Vietnam to assist researchers in solving specific problems. An ICRISAT pathologist also visited Vietnam to work for 1-2 months on bacterial wilt and aflatoxin. This form of collaboration should be encouraged. Recently, a collaborative program on resource management was initiated and a benchmark site was identified. However, additional funding support from the network is needed.

Future collaborative activities

While future collaborative activities will be on similar lines as the existing programs mentioned above, help from ICRISAT/CLAN is needed particularly in the following priority areas of research on groundnut:

- Breeding (for high yield, high quality, short duration, drought tolerance, cold tolerance, resistance to pest and diseases)
- Bacterial wilt and aflatoxin
- Pest and disease integrated management
- On-Farm adaptive research and pilot testing

Vietnamese scientists are eager to continue their involvement in existing working groups on regional problems, and also participate in other newly established working groups addressing constraints to CLAN priority crops' production in Vietnam.

The Vietnam national research program will benefit greatly from a strengthening of infrastructure with CLAN/ICRISAT support. We would like CLAN to contribute to the upgrading of facilities and equipment not available at Vietnamese agricultural research institutes.

Collaboration with Regional and International Institutions

Opportunities for Collaboration between ICARDA and CLAN/ICRISAT

W Erskine and M C Saxena[1]

Introduction

The International Centre for Agricultural Research in the Dry Areas (ICARDA) started in 1977 with worldwide responsibility for research and training in the improvement of barley, faba bean, and lentil, and a regional responsibility for the improvement of pasture and forage, kabuli chickpea, (in association with ICRISAT), and wheat in association with Centro Internacional de Mejoramiento de Maiz y Trigo (CIMMYT). Following the recommendations of the Technical Advisory Committee of the Consultative Group on International Agricultural Research, research on faba bean improvement has been discontinued. Research for the improvement of kabuli chickpea, wheat, barley, lentil, and forage legumes is now concentrated within the Germplasm Program at ICARDA.

The objective of CLAN is to assist national programs in Asia to improve ICRISAT mandate crops by providing a forum for technology and information exchange. The aim of this brief discussion paper is to explore common areas of interest where the two IARCs can cooperate.

Previous collaboration

Links between the Asian Grain Legumes Network (AGLN), a precursor to CLAN, and ICARDA were forged through cooperation on food legumes in the fields of training, travelling seminars, breeders' meets, and workshops. This type of cooperation should continue.

Future collaboration

It is particularly in the field of lentil improvement that ICARDA is looking to increase collaboration. Approximately half of the sown area of lentil in the world is in the countries of South Asia - Bangladesh, India, Nepal, and Pakistan, where ICRISAT operates (Table 1).

Bilateral interaction of ICARDA with the NARS of S. Asia has been strong in the fields of germplasm exchange, the development of tailored breeding material, docu-

1. Germplasm Program, International Center for Agricultural Research in the Dry Areas (ICARDA), P O Box 5466, Aleppo, Syria.

mentation, and training, in lentil, in particular. The value to NARS of such bilateral interaction has fuelled the felt need for more support to regional activities on lentil improvement. An ICARDA/ICAR sponsored seminar, Lentil in S. Asia, was held in New Delhi in Mar 1991 to summarize lentil improvement to date, and collectively define the need and scope of a regional network to improve lentil. Participants from S. Asia were enthusiastic about the need and value of such a network and its potential for the development of the crop in their individual countries.

Table 1. Average sown area, seed yield, and production in the countries of South Asia, 1990-92.

	Sown area			Yield	Production		
Country	10^3 ha	% of S. Asia	% of World	(kg ha^{-1})	10^3 t	% of S. Asia	% of World
Bangladesh	209	13.6	6.6	740	155	15.1	6.2
India	1140	74.2	35.8	670	764	74.7	30.6
Nepal	120	7.8	3.8	620	75	7.3	3.0
Pakistan	66	4.3	2.1	435	29	2.8	1.2
S. Asia	1535	-	48.2	666	1023	-	41.0
World	3180	-	-	784	2493	-	-

Source: FAO (1992)

ICARDA has been trying to secure funding support from donor community for such a regional initiative on lentil. Project submissions were made to the Asian Development Bank (ADB), the Philippines, and to Der Bundesministerium fur Wirtschaftliche Zusammenarbeit (BMZ), Germany, without success. Recently, ICARDA was catalytic in securing funding for a project entitled 'Improvement of drought and disease resistance in lentils from the Indian Sub-continent' from the Australian Centre for International Agricultural Research (ACIAR). However, despite its name, the project only covers Nepal and Pakistan, and is limited in scope. At present ICARDA is planning to re-submit a revised regional project proposal on lentil to ADB.

It is in the context of the development of a network on lentil that the value of cooperation with ICRISAT, as a partner, becomes apparent. The CLAN is addressing grain legumes such as chickpea, pigeonpea, and groundnut. National grain legume teams are engaged in the improvement of many legumes. In most cases the NARS staff working on legumes are common. It is, therefore, and administratively efficient for both NARS and IARCs that a subnetwork on lentil is formed in CLAN. Additionally, donors are also now encouraging for increased cooperation among IARCs.

Reference

Food and Agriculture Organization (FAO). 1992. Food Production Yearbook. Rome, Italy: FAO. 281 pp.

Opportunities for Collaborative Research with CLAN in Rice-Legume Farming Systems

V P Singh[1]

Rice is grown under both irrigated and rainfed conditions. Irrigated rice is generally grown in the dry season and under favorable conditions. In irrigated areas the water requirements of the crop are at least partially met by rainfall during the rainy season. Under rainfed conditions, rice is grown mainly in the rainy season in upland, lowland, and deepwater regions.

In both seasons, a considerable area is also sown to other cereals, vegetables, and legumes. Maize, millets, sorghum, pigeonpea, cluster beans, mungbean, black gram, and groundnut are important crops in the wet season and chickpea, pea, lentil, linseed, mustard, rapeseed, *Lathyrus,* oat, barley, vegetables, and wheat in the dry season. Rice-legume systems appear to be more diverse in rainfed lowland areas than in upland or deepwater environments. Legumes in rice farming systems in Asia are grown for a variety of purposes: grain, fodder, green manure, etc.

Rice research programs in Asia cut across irrigated, upland, lowland and deepwater situations in different countries. Collaborative rice research programs of IRRI in Asia are as follows:

- Upland—Indonesia, India, Lao PDR, Myanmar, Philippines, Thailand
- Lowland—Bangladesh, China, Cambodia, India, Nepal, Philippines, Sri Lanka, Thailand, Vietnam
- Deepwater—Bangladesh, India, Thailand
- Irrigated—China, India, Malaysia, Pakistan

Collaborative research is being carried out with NARS, IARCs, and laboratories in advanced countries. Such partnerships help to identify and solve production constraints and develop methodologies and improved production technologies by sharing technical infrastructure and other resources. The partners in the collaborative research share concerns, goals, and objectives. Many have common work locations and address common generic issues, often in the same or similar production systems. Collaborative research thus provides a number of opportunities for joint research in rice-legume farming systems in Asia.

One of several approaches could be used:

- System-based research
- Commodity-specific research
- Discipline-specific research
- Issue-specific research
  - Enhanced resource-use efficiency
  - Sustainability in low-input systems
  - Value addition

1. International Rice Research Institute (IRRI), P O Box 933, 1099 Manila, Philippines.

There is a need to further explore and utilize the existing mechanisms for effective collaboration with particular emphasis on participatory research, and the sharing of responsibilities and resources for cost effective productive research output.

Opportunities for Collaboration between the UNDP/FAO RAS/89/040 Project and CLAN/ICRISAT

S Partohardjono[1]

Introduction

The UNDP/FAO project RAS/89/040 is a regional cooperative program, which started in 1990, for improvement of food legumes and coarse grains (FLCG) in Asia. The project is designed to assist countries in the tropics and subtropics of Asia in the creation and operation of a cooperative network for research and development of FLCG on the basis of technical cooperation among developing countries (TCDC).

The primary function of the project is the networking at the regional level— to consolidate, expand, improve capability, and sustain the existing cooperative research and development network, and to sensitize the governments to support and promote national research and development programs of FLCG crops. There are 14 member countries in the network, and the activities cover aspects of production, postharvest handling, marketing, and transfer of technology. Other activities are training courses, study tours, and exchange of germplasm. The RAS/89/040 project primarily targets research and development of underutilized grain legumes and coarse grains.

The secretariat of the project coordinates all activities and services, to create an effective management and implementation mechanisms of FLCG network. The project envisages to forge strong working partnerships with national programs of the member countries, and with the relevant regional and international agencies, to integrate FLCG network with the other projects and networks operating in the region, with similar objectives.

This paper highlights the collaborative activities of the UNDP/FAO RAS/89/040 project and IARCs.

Collaborative programs

The Coarse Grains Pulses Root and Tuber Crops (CGPRT) Centre, Indonesia and ICRISAT were designated as the Associated Agencies to the Executing Agency, the FAO, Rome for executing the RAS/89/040 project.

The socioeconomic component of the project, subcontracted to the CGPRT Centre, concentrated on the marketing, processing, and employment-generation aspects of the crops, particularly on generating information for policy and planning purposes. The ICRISAT component of the project, the Asian Grain Legumes On-farm Research

1. FAO RAS/89/040, FAO of the United Nations, Jl. Merdeka 145, Bogor 16111, Indonesia.

(AGLOR), is titled 'Testing and adaptation of technology for increased and stabilized groundnut, pigeonpea, and chickpea production in South and Southeast Asia', which will be discussed further.

The AGLOR project is implemented in Indonesia, Nepal, Sri Lanka, and Vietnam. The activities of these on-farm researches have been reported in the meetings of RAS/89/040 project. Salient points are discussed here.

Methodology

Selection of target areas. Target areas were selected in each country, representing typical agroecological conditions in which the improved production technologies will be tested and recommended to the farmers. In Indonesia, a major rainfed groundnut growing area in East Java (Tuban district), and an irrigated area where groundnut is grown after rice in West Java (Subang district) were selected. In Nepal, major groundnut growing districts of eastern and central *terai;* and major chickpea and pigeonpea growing districts in western and central *terai* were selected. Three target areas were selected in Sri Lanka: rainfed, low-input groundnut growing areas in southern and central provinces; irrigated, high-input groundnut growing areas in Mahaweli irrigation system; and the dry zone areas suitable for pigeonpea in central and southern provinces. Two target areas were selected in Vietnam: rainfed, spring season groundnut growing areas of central and northern provinces; and irrigated, winter-spring season groundnut growing areas of southern provinces.

The existing information was reviewed, available technologies were documented, and test sites were determined within the target areas in each country.

Diagnostic surveys. Diagnostic surveys were carried by interdisciplinary teams of scientists from NARS and ICRISAT using rapid rural appraisal (RRA) methods and individual and group interviews in each target area. Farmer-perceived production constraints were identified, prioritized, and potential solutions to alleviate the identified production constraints were formulated.

Planning of experiments. Once the production constraints were identified and prioritized, diagnostic trials to address and alleviate the production constraints for on-farm research were proposed. Based on the results obtained from single- and multi-factor diagnostic trials, improved production practices were developed for each target region. The on-station backup research needed to develop solutions before on-farm application was also conducted. However, the type of on-farm trials varied across the project countries, depending on available technology and needs of the country.

On-farm trials, monitoring tours, and follow-up surveys. The NARS scientists, extension staff, and farmers implemented on-farm trials. Joint monitoring of trials and experiments was undertaken by a team of scientists from NARS and ICRISAT to provide technical backup, as well as to obtain feedback from farmers. Suggestions received to improve the conduct of the trials from time to time were given due priority. The NARS scientists identified suitable varieties and management practices to enhance productivity and profits to farmers. These improved technologies were compared with farmers' practices in on-farm trials on larger plots of 0.1 ha with 16-20 farmers in each village cluster.

On-farm trials carried out in Indonesia, Nepal and Vietnam enabled farmers to select technology options that can be adopted to realize high yield. Improved cultural practices in groundnut gave 32-57% higher pod yield in Indonesia, and 26% higher pod yield in Vietnam, compared with farmers' practices. Improved production practices in Nepal yielded 71% higher yield for chickpea and 66% higher for pigeonpea. Some of these technologies are being disseminated in large areas in these countries.

Study tours, workshops, in-country training and farmers' days

Information exchange among scientists from member countries is one of the objectives of the project; study tours and workshops accomplish this. Training courses on on-farm research methodologies enhanced the capabilities of scientists.

To speed up the transfer of technology, farmers and extension personnel are invited to visit different on-farm trials.

Concluding remarks

This collaborative undertaking is an example of research and development between two networks with common objectives on food legumes and coarse grains. Improved production technologies developed in the NARS and ICRISAT were extended to farmers via extension systems. On-farm research trials also train scientists and extension personnel in the process of technology development from on-station research through on-farm research to the adoption by farmers. Participation of farmers in the whole process of technology transfer will be facilitated through proper policy and support services.

ICRISAT's Research Thrusts in Asia

ICRISAT's Genetic Resources Research and Program Highlights

J W Stenhouse[1]

Background

As part of the reorganization of ICRISAT research portfolio, the activities of the Genetic Resources Division have received fresh scrutiny. In particular, the balance of germplasm collection, characterization, and conservation vis-a-vis germplasm research has been re-examined.

Like other IARCs, ICRISAT recently placed its germplasm collections under the auspices of FAO. This agreement entails new responsibilities for ensuring long-term conservation and safety duplication of germplasm to ensure adequate protection. It also involves new arrangements to ensure that users of germplasm do not claim ownership, and respect any future international agreements that might be reached regarding sharing of benefits derived from the use of germplasm.

Genetic resources research project

A single genetic resources research project that includes all routine collection, characterization, and conservation activities as well as research aimed at adding value to existing collections has been developed. The project comprises four subprojects with the objectives outlined below.

- Germplasm collection, characterization, and documentation
  - Collection and assembly of new germplasm accessions
  - Characterization and documentation of new germplasm accessions
- Germplasm maintenance and ex-situ conservation of mandate crops at IAC and other locations
  - Germplasm rejuvenation and seed increase
  - Transfer of germplasm to long-term conservation
  - Duplicate safety conservation
  - Genebank database management
- Germplasm distribution for crop improvement
  - Distribution of germplasm and maintenance of distribution databases
  - Training in genetic resources

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- Genetic resources research
  - Preliminary evaluation of germplasm
  - Identification of core collections
  - Biodiversity studies
  - Studies of seed longevity and genetic stability

Changes in genetic resources activities

- Decreased emphasis on collection (with the exception of wild relatives)
- Increased emphasis on research activities that add value to the germplasm collections, streamline their maintenance, or increase their utilization
- Increasing role in support of NARS in genetic resources activities, through networks (including CLAN and other regional networks)
- Special requirements as part of the agreement with FAO to place collections in long-term and duplicate conservation

ICRISAT's Pearl Millet Research in Asia

C T Hash[1]

Pearl millet (*Pennisetum glaucum* (L.) R. Br.) is grown for grain, stover, and green fodder on about 11 million ha in Asia, primarily in India [Production Systems (PS) 1, 2, 3, 4, 6, 7, 8, and 9], Pakistan (PS 1 and 3), and Yemen (PS 12). It also finds use as a minor green forage crop in Thailand and the Republic of Korea, and there is considerable potential for expansion of this use elsewhere in Asia. Pearl millet is grown as a grain or dual-purpose (grain/stover) crop in drier areas of India and Yemen, and is often used as the staple food grain. It is the only cereal that reliably provides grain and/or fodder under dryland conditions on shallow or sandy soils of low fertility and low water-holding capacity in these hot and dry production environments. In more favored areas of Asia where pearl millet grain is produced, it is often used in rations for draft and milch animals, and for poultry. Stover is used for dry season maintenance rations for cattle in areas where sorghum stover is not readily available.

Downy mildew, caused by *Sclerospora graminicola* (Sacc.) J. Schrot., is the major biotic constraint to pearl millet production in Asia targeted by ICRISAT research. This disease is especially important on single-cross hybrids in India. It is of relatively little importance at present elsewhere in Asia where the disease is either not present (Korea and Thailand) or hybrids are not yet cultivated (Pakistan and Yemen). Improving tolerance to heat stress during seedling establishment and tolerance to mid-season and end-of-season drought stress, in order to improve stability of grain and fodder yields, are also areas where ICRISAT pearl millet research in Asia is active. At present ICRISAT's pearl millet research relies on conventional screening in appropriate environments in breeding for tolerance or resistance to these production constraints, but marker-assisted selection systems are under development and/or evaluation.

Both open-pollinated and hybrid cultivars of pearl millet are used extensively in Asia. At ICRISAT Asia Center (IAC), the focus is on improving yield and yield stability, for both grain and stover. At IAC inbred parental lines of hybrids are bred by pedigree-bulk or limited backcrossing methods, and by selfing within population progenies. Hybrid cultivars are bred in collaboration with NARS cooperators in both public and private sectors by crossing elite cytoplasmic male-sterile lines with elite inbred and population restorers. Population improvement based on cyclic evaluation of progenies (often in collaboration with national program breeders) is followed by modified mass selection within population bulks or development of experimental open-pollinated varieties by national program breeders. The research is also being focussed on hybrid parental lines (based on diverse and stable systems of cytoplasmic male sterility) for favorable production environments, and population progenies and cycle bulks for a broader range of environments.

1. ICRISAT Asia Center, Patancheru 502 324, Andhra Pradesh, India.

As the strength of public and private sector pearl millet research in India has grown, ICRISAT pearl millet research has moved upstream to conduct strategic research to understand downy mildew pathogen variability and host plant resistance, diversity of cytoplasmic male-sterility systems, and mechanisms and inheritance of seedling heat tolerance and terminal drought tolerance. Some of this work involves development and use of molecular markers for gene blocks contributing to these traits. In harsher production environments where adoption of improved cultivars is low, the work is carried with local agencies to more actively involve farmers in breeding and evaluating materials appropriate to their needs. Opportunities exist for interested national program scientists to associate themselves with this research, receive training in the techniques, and apply them to relevant problems in target environments they serve.

ICRISAT's Sorghum Research and Program Highlights

Belum V S Reddy and J W Stenhouse[1]

Background

The Medium Term Plan (MTP) of ICRISAT prioritized research themes on the basis of efficiency, internationality, equity and sustainability parameters. In this exercise, 12 sorghum themes of relevance to Asia emerged among the 93 priority research themes that the Institute recognized. These were: *Striga,* grain and stover yield, stem borer, grain molds, earhead bug, anthracnose, midge, drought, leaf blight, foliar diseases, shoot fly, and forages. The NARS were consulted during MTP planning to factor their perceptions into the prioritization of research themes.

Related themes were grouped into six broader research areas. These were: integrated management strategies for *Striga,* integrated disease management, integrated pest management, adaptation to drought, adaptation to low temperature/high altitude tropical areas (not relevant to Asia), and development of improved genetic materials.

The idea of Production Systems (PS) was used to focus research. PS are defined based on soil and climate factors, farming systems, and socioeconomic factors. A total of 29 PS, were identified of which 12 are found in Asia.

Thus, a portfolio of five sorghum research projects emerged, each targeting different PS or groups of PS, and including various combinations of the six subprojects listed above that are relevant to those PS.

The five sorghum projects and the PS they target are:

- SGI Improving sorghum productivity and stability in low-rainfall areas (PS 19)
- SG2 Improving productivity and stability of sorghum in medium-rainfall areas (PS 4, 7, 9,14,15, 20, 21)
- SG3 Improvement of sorghum productivity and stability in high-rainfall areas (PS 16)
- SG4 Improving the productivity and stability of sorghum in high altitude/low temperature tropical areas (PS 23)
- SG5 Prospects of improving the productivity and stability of postrainy-season sorghum (PS 8)

1. ICRISAT Asia Center, Patancheru 502 324, Andhra Pradesh, India.

Sorghum research projects of relevance to Asia

SG2: Improving productivity and stability of sorghum in medium-rainfall areas

This project has PS 4, 7, and 9 in Asia as primary targets and PS 5 and 6 as secondary targets. Its major thrusts are:

Integrated *Striga* management. Improved screening techniques for *Striga* resistance; molecular mapping of resistance genes; development of *Striga* management methods; and development of resistant varieties and male-sterile lines through conventional breeding

Integrated disease management. Development of white-grain mold resistant sorghum for India, and red-grain mold resistant sorghum for Africa and other locations (including Thailand); identification of antifungal proteins active against grain molds; pathogen epidemiology and perennation studies of anthracnose

Integrated pest management. Diversification of sources of midge resistance; breeding of resistant parent lines for hybrid production; intensified research on screening techniques and breeding approaches for stem borer and earhead bug, including the use of transformation methods for stem borer resistance; emphasis on integration of host-plant resistance, and soil and crop management

Improved genetic materials. Breeding short-duration sorghum lines to escape terminal drought stress; studies on plant responses and traits associated with drought tolerance; use of adapted landrace materials in breeding for moisture-limited environments; study of interactions between cultivar and crop and soil management methods

Adaptation to drought. Studies on component traits which determine productivity; development of source materials (populations and intermediate products) and elite materials to broaden the base of breeding programs for grain and dual-purpose sorghum

SG5 Prospects of improving the productivity and stability of postrainy-season sorghum

The project has PS 8 in India as its primary target, and the adjacent PS 7 as a secondary target. Its main research thrusts are:

Integrated disease management. Incorporation of rust resistance into postrainy season adapted varieties and seed parents

Integrated pest management. Assessment of the importance of shoot fly as a limitation to postrainy season production; investigation of components and mechanisms of shoot fly resistance in postrainy season; evaluation of the effectiveness of traditional cropping practices in the control of shoot fly

Adaptation to drought. Determination of the control of flowering in postrainy season adapted landraces and its interaction with changes in sowing dates; evaluation of stay-green and osmotic adjustment as components of terminal drought tolerance; determination of G x E in postrainy season and its implications for breeding.

Improved genetic materials. Assessment of new approaches to improvement of productivity and stability of postrainy season sorghum (e.g., landrace hybrids)

Both SG2 and SG5 emphasize the analysis of constraints to productivity of sorghum in their production systems, and the acceptance and impact of their research findings.

Major shifts in the sorghum research portfolio

There is now increased emphasis on:

- specific adaptation to identified main PS, and through spillover to other PS
- strategic rather than adaptive research, intermediate rather than finished products (e.g., collection of information on constraints, production of segregating materials, value-added source materials)
- biotechnology (e.g., RFLP mapping for *Striga* and shoot fly resistance, transformation for stem borer resistance, antifungal proteins for grain mold resistance)
- integrated management of *Striga,* drought, pests and diseases, bringing together host-plant resistance, and crop management options
- diversification of breeding materials to include dual-purpose and forage sorghum, and to introgress new germplasm into grain sorghum breeding programs (e.g., formation of new tillering, dual-purpose, large grain, and shoot pest populations)
- assessment of constraints, adoption, and impact (or lack of impact) of sorghum research, and their feedback into research prioritization
- introduction of a more flexible individual approach to germplasm distribution and research collaboration (e.g., supply of a larger number of trait-based nurseries of improved breeding materials that allows collaborators to select only materials of direct interest, development of need-based bilateral or multilateral collaborative projects with Asian NARS through CLAN)

ICRISAT'S Collaborative Chickpea Research

H A van Rheenen[1]

Chickpea is grown on all continents, but Asia is the major producer. It ranks third among the pulses; accordingly, establishing sound work programs and good collaboration is a rewarding activity for which networks are helpful, and CLAN, in particular, has been most useful in Asia.

One approach in crop improvement is to focus on adverse effects and conditions for crop production in specific production systems in order to alleviate them. This was the approach followed when ICRISAT's Medium Term Plan for 1994-98 was developed.

For chickpea, three ecoregional production zones were distinguished, and subsequently three projects were formulated:

Project	Description of zone	Major constraints/themes
CP 1	Dry and hot	Drought, pests, fusarium wilt, root rot, (adoption of varieties)
CP 2	Moderately dry and cool	BNF, suboptimal yield, stunt, chilling cold
CP 3	Moderately dry and cold	Ascochyta blight, nematodes, freezing cold

Obviously, there is no geographical boundary to constraints and production systems. For instance, drought is not restricted to the zone of CP 1, but occurs wherever chickpea is grown on residual moisture, and that is the case in most production systems.

The production constraints are addressed by ICRISAT thourgh collaborative research on drought, cold, BNF research, disease nurseries, IPM projects, and breeding networks.

Drought

- A Global Grain Legume Drought Research Network (GGLDRN) was established in 1993 and an informal medium for communication called News and Views marked the beginning of its activities. There are active drought screening nurseries established in India, Bangladesh, Pakistan, and Myanmar.
- A number of collaborative breeding projects have evolved in which, apart from other desirable traits, drought tolerance and drought escape through earliness are enhanced.

Ascochyta blight

Ascochyta blight is a problem of particular interest in production systems of higher latitudes, for instance in Pakistan and India; collaboration in screening and breeding activities is on-going.

1. ICRISAT Asia Center, Patancheru 502 324, Andhra Pradesh, India.

Biological nitrogen fixation
The Asia Working Group on Biological Nitrogen Fixation in Legumes (AWGBNFL), established in 1992 has been active in Bangladesh, Pakistan, India, and Nepal.

***Botrytis gray mold* (*BGM*)**
There is a working group for joint research on BGM. The disease is mainly of importance in eastern India, Bangladesh, Nepal, and Pakistan where the disease can be devastating at some places in some years.

Integrated pest management
Increasing attention is being paid to IPM in chickpea. *Helicoverpa* is the main pest and IPM involves the application of nuclear polyhedrosis virus, host-plant resistance, host-plant resistance, predator stimulation, and timely spray of insecticides. The transfer of Bt and Ti genes is under investigation.

Other constraints such as fusarium wilt, root rot, nematodes, stunt, and cold are also important in collaborative crop improvement; some of global importance, while others of regional importance. Thus, collaborative and interactive research has had opportunities to develop, and there is ample scope for further strengthening under the new MTP.

ICRISAT'S Global Pigeonpea Research Portfolio

Laxman Singh[1]

After the research prioritization based on the Medium Term Plan, the global pigeon-pea research project has been organized in to five subprojects:

- Genetic enhancement of yield and stability of short-duration (SD) pigeonpea
- Enhancing climatic adaptation of SD pigeonpea to rainfed environments
- Enhancement of disease resistance
- Integrated Pest Management (IPM)
- Stimulated adoption of SD pigeonpea in new cropping systems

A multidisciplinary team develops and implements the work program in collaboration with NARS; close linkages are envisaged with ICRISAT's Integrated Systems Projects (ISP), and other institutions according to needs and opportunities.

A continuum of strategic, applied, and adaptive research on pigeonpea includes the following research thrusts in the Asia region:

- hybrid pigeonpea technology and the search for cytoplasmic-genic male sterility (CMS) through wide hybridization
- host plant resistance and other components of IPM for *Helicoverpa,* podfly and *Maruca:* mechanism of resistance in cultivated and related wild species; transformation studies to incorporate pest resistance
- resistance to wilt, sterility mosaic, and phytophthora blight in cultivated species, and introgression of tertiary genepool (e.g., *Cajanus platycarpus)*
- screening and selection for drought tolerance, waterlogging tolerance, and early growth vigour; analysis of G x E interactions and responses to photothermal variations
- catalyzing production of pigeonpea through SD pigeonpea in new cropping systems and environments, and sustaining production by linkages with marketing, agroprocessing, utilization, and improvement of degraded soils

A few examples of ongoing and suggested activities with relevance to Asia region are cited:

India SD pigeonpea in double cropping system in northern Telangana region of Andhra Pradesh state, variety ICPL 84031 (Asha) released in 1995; intercropping of SD pigeonpea with groundnut in Saurashtra region of Gujarat state; double-cropping with irrigated wheat in north-Indian alluvial plains; postrainy season pigeonpea in coastal belt and north-eastern plains

Nepal Postrainy season pigeonpea; wilt and sterility mosaic resistant pigeon-pea

Sri Lanka *Maruca* tolerant pigeonpea for maha season for ratoonability; drought tolerant SD pigeonpea for yala season; development of dehulling machines

1. ICRISAT Asia Center, Patancheru 502 324, Andhra Pradesh, India.

Thailand Contract farming of SD pigeonpea ICPL 151 by agroprocessing industry (Siamati Ltd.) for export of *dhal* in northern region

Vietnam Introduce SD and medium-duration pigeonpea and link agroprocessing and utilization for human food and livestock feed and firewood, and fertility enhancement of degraded soils

Other suggested collaborative research activities, subject to NARS concurrence:

- Multilocation evaluation of wilt, sterility mosaic and phytophthora blight resistant lines in India, Nepal, and Myanmar
- Determination of pathogenic variability in *Fusarium udum,* sterility mosaic pathogen and/or mite vector *Aceria cajani,* and *Phytophthora dreschsleri* f. sp. *cajani* in India, Nepal, Sri Lanka, and Myanmar
- Screening for drought tolerance in Sri Lanka and Indonesia
- IPM in Sri Lanka, Nepal, and India
- Testing and adoption of dehulling machines (developed in Sri Lanka) in Vietnam and Indonesia
- Testing of photothermal reponses at latitudes around 37°N in South Korea

Groundnut Research at ICRISAT and Its Relevance to Asia

S N Nigam[1]

Introduction

Groundnut is currently sown to 21.7 million ha in more than 100 countries with a total production of 28.5 million tons (FAO 1994). The world groundnut production has been increasing in recent years; the increase in production being largely confined to Asia. An increase in both productivity and area under the crop have contributed to the increased groundnut production in Asia. In 1994, the groundnut productivity in Asia increased by 29.98%, area under the crop by 24.40%, and production by 61.30% over the 1979/81 period. However, groundnut productivity in Asia (1.48 t ha^{-1}) still remains lower than south America (1.83 t ha^{-1}) and north and central America (2.63 t ha^{-1}). Currently, Asia produces 71.6% of the world groundnut production in 63.3% of the area. The leading groundnut producing countries in Asia are China, India, Indonesia, Myanmar, Vietnam, and Thailand.

Several constraints limit groundnut production in Asia. Among the biotic constraints are rust, leaf spots, aflatoxin, leaf miner, *Spodoptera,* white grub, peanut bud necrosis virus disease, peanut clump virus, peanut mottle virus, peanut stripe virus, and bacterial wilt. Among the abiotic constraints are drought, low soil pH, iron chlorosis, and low soil fertility. Because of these stresses, most of the currently grown varieties are poorly adapted.

Groundnut research at ICRISAT is currently packaged into three global groundnut projects, each addressing a distinct agroecology. These projects are:

GN 1 Improvement of medium- and long-duration rainfed groundnut productivity and stability

GN 2 Improvement of short-duration rainfed groundnut productivity and stability

GN 3 Improvement of irrigated postrainy season groundnut productivity and stability

While GN 1 largely targets subsistence levels of production, GN 2 focuses on areas where both subsistence and intensive farming are practiced, and GN 3 concentrates on high-input intensive commercial production of groundnut.

Research activities are grouped under seven subprojects which form the components of each project (except for management of drought, which involves only GN 1 and GN 2). These subprojects are:

- Management of foliar diseases
- Management of foliar pests
- Management of aflatoxin

1. ICRISAT Asia Center, Patancheru 502 324, Andhra Pradesh, India.

- Management of viruses and sucking pests
- Management of drought
- Yield and adaptation
- Information and technology exchange

All research activities are targeted in PS 5,6,8,9,10, and 11 with spillover to PS 2, 3, and 4 in Asia. These activities cover strategic, applied, and adaptive components of research. Some constraints such as bacterial wilt, low soil pH, iron chlorosis, and low soil fertility, which are important in Asia, do not rate high in priority on a global basis. These constraints are being dealt with under network activities, and complementary/ special funding is being sought for research activities related to them.

Significant outputs of collaborative research activities in Asia are as follows:

- During 1994 and 1995, 104 sets of international trials, 1625 advanced breeding lines, 267 segregating populations, and 320 other materials were supplied to cooperators in Asian countries. Further, 34 crosses were made at the request of our cooperators during the same period.
- Joint or ICRISAT assisted varietal releases since 1990 in the region include ICGV 87160 (as Sinpadetha 5) in Myanmar, ICGS(E) 56 (as BARD 92) and ICG 4989 (as BARD 479) in Pakistan, JL 24 (as UPL Pn 10) in the Philippines, ICGV 86564 (as Walawe) and ICGS 11 (as ANKG 2) in Sri Lanka, and ICGS(E) 56 (as HL 25) in Vietnam. In India, the Central Varietal Committee releases include ICGS 37 (ICGV 87187), ICGS 1 (ICGV 87119), ICG(FDRS) 10 (ICGV 87160), ICGV 86590, and ICGV 86325, and the State Varietal Committee releases include ICGS 1 as Konkan Gaurav in Maharashtra, ICGV 86143 as BSR 1, and ICGV 86011 as ALR 2 in Tamil Nadu.
- ICGS(E) 11 and ICGS(E) 55 in Bangladesh and ICGS(E) 52, ICGS(E) 56, and ICGS 36 in Nepal are included in on-farm trials.
- On-farm trials related to improved groundnut production technology were conducted in Indonesia, Nepal, Sri Lanka, and Vietnam. These technologies are now being extended to large areas in these countries.

Integrated Systems Projects at ICRISAT

C Renard and C Johansen[1]

Demographic compulsions and declining per capita natural resources in the semi-arid tropics (SAT) make it imperative for SAT farmers to produce more farm products from less land and water in the next century. Ecological considerations require that higher production needs technologies that are environmentally sound and sustainable. The objective of natural resource management research at ICRISAT is to address the broad question: can SAT agricultural systems satisfy the rising demands for food, fuel, and fibre at sustainable production levels and within acceptable economic and environmental costs? In line with the growing concern expressed by the FAO and the committee on Agricultural Sustainability for Developing Countries, ICRISAT believes that in the decades ahead most developing countries in the SAT will not be able to feed their rapidly growing populations unless there is a dramatic improvement in productivity which needs to be sustained.

Risks are high in SAT because of undependable rainfall and degraded soils. Farmers there are generally poor and their holdings small. The impact of productivity gains through widespread adoption of high yielding crop varieties and improved production systems, which occurred in irrigated agriculture, has largely remained marginal with rainfed crops. The natural resource management research at ICRISAT therefore, must make a concerted effort to anticipate problems through strategic and modelling research, and to devise management strategies through understanding principles and verifying the ideas with field research in close cooperation with NARS.

ICRISAT has proposed four integrated systems projects (ISPs) for enhanced and sustained productivity of rainfed agroecosystems of the SAT. The aim is to develop progressively a series of technologies for the production systems (PS) of the SAT in close collaboration with our NARS partners. ICRISAT now—sowing for the future (ICRISAT 1994) gives a brief description of the production systems.

ISP 1 Strategies for enhanced and sustainable productivity in rainfed short-season (60-100 days) millet/legume-based production systems.

The drier desert margin areas of the SAT (PS 1) are targeted by ISP 1. The principal objectives are to improve productivity in traditional agro-sylvo-pastoral systems and arrest the degradation of the natural resource base. Improved genotypes, better management of nutrient and drought stresses, sustainable resource management technologies, and integrated management methods for pests, diseases and weeds will be developed with extensive farmer participation. Other important components are crop-livestock interaction studies in collaboration with International Livestock Research Institute (ILRI), and systems modelling in collaboration with mentor institutions.

1. ICRISAT Asia Center, Patancheru 502 324, Andhra Pradesh, India.

ISP 2 Strategies for enhanced and sustainable productivity in short to intermediate season (100-125 days) rainfed millet/sorghum/legume-based production systems.

Agroecologies with predominantly soils of lesser water-holding capacity (PS 9, with spillover in PS 6), a wide range of farming systems, and large livestock populations are targeted by ISP 2. In these areas grain and stover yields are low, and sustainability is threatened by erosion of the resource base. The target production systems will be characterized in terms of physical, biological, and socioeconomic parameters. The project will focus on the introduction and evaluation of improved genetic materials, improvement of soil, water, and nutrient management, integrated management of pests, diseases, and weeds, and assessment of technology adoption and impact. Strategic research on productivity improvement and resource conservation will include modelling studies that will broaden the applicability of research results to other environments.

ISP 3 Strategies for enhanced and sustainable productivity in low-to intermediate-rainfall (90-150 days) production systems in the SAT.

The diverse environments in these PS (7 and 8) are characterized by relatively large yield gaps between research stations and farmers' fields. ISP 3 will develop and evaluate strategies for sustainable improvements in soil, water and nutrient management, and socioeconomic constraints to crop intensification in soils of high water-holding capacity; crop production on soils of low water-holding capacity; and integrated crop and soil management for postrainy season crops. The results will be modelled and subsequently extrapolated to other environments, and the long-term implications of new technologies will be analyzed. Much of the research will be conducted at benchmark sites and farmers' fields in partnership with NARS and specialized institutions.

ISP 4 Legume-based technologies for rice and/or wheat production systems in South and Southeast Asia.

Asia produces more than 90% of the world's rice and around 30% of its wheat. To keep pace with population growth, production of these staples must rise by 2.5% per year. This in turn requires more detailed studies on cropping sequences, particularly on legume benefits in crop rotations. ISP 4 operates in PS 2, 3, and 5, with spillover in PS 4,10 and 11. The four major objectives of ISP 4 are: characterization of the system in terms of increase in legume use; collaborative research with a systems focus in areas of special expertise and comparative advantage; on-farm evaluation of improved technologies; and studies on adoption and impact of technologies. Modelling of research results will help to generate spillover benefits to other situations, assess impact on sustainability, and guide the research agenda.

Conclusions

Both strategic and applied research in natural resource management are needed to provide knowledge on which to base the development of sustainable production systems. Natural resources management should concentrate on low-input agriculture, integrative biological methods, and weather-based systems for controlling diseases and pests (in close collaboration with commodity projects), and improved methods for dealing with edaphic and climatic stresses. The ultimate goal will be to provide farmers in developing countries with low cost sustainable technologies. At the same time, there is a need to recognize that natural resource management research requires long-term commitment. Robust indicators of sustainability are required that recognize the interdependence of economic and environmental sustainability and potential tradeoffs between them. Quantifying the impact of systems projects' research on welfare of small and marginal farmers in the SAT is of immense importance for efficient allocation of research resources, and to know the return on earlier investments in research by the donors.

Reference

ICRISAT (International Crops Research Institute for the Semi-Arid Tropics). 1994. ICRISAT Now—Sowing for the Future: ICRISAT Report 1993. Patancheru 502 324, Andhra Pradesh, India: ICRISAT. 88 pp.

Socioeconomics and Policy: ICRISAT'S Research Thrusts and Partnership with NARS

M C S Bantilan[1]

The Socioeconomics and Policy Division of ICRISAT is implementing two global projects: 'Research Evaluation and Impact Assessment' (ECONI) and 'Markets and Policy' (ECON2).

ECON1 Research Evaluation and Impact Assessment (REIA)

A range of technologies developed at ICRISAT are widely used in the semi-arid tropics (SAT), either directly by farmers or as intermediate technologies by NARS and other organizations. In order to account for past funding, justify continued donor support, and more importantly, provide information that will help scientists and research managers to target research and allocate resources, REIA is necessary. It integrates ex post impact assessment with ex ante priority setting in a dynamic framework, and undertakes systematic and comprehensive assessment of the benefits generated through research. Research evaluation methodologies and databases are developed for impact assessment and priority setting. Key research programs, networks and technologies are assessed in terms of their contributions to productivity, food security, poverty, equity, nutrition, risk and stability, sustainability, and gender-related issues. Three major outcomes are expected-a quantitative and qualitative demonstration of the impact of collaborative NARS/ICRISAT research; better targeting of research; and an information system to help scientists and research managers prioritize research objectives, and allocate resources among alternative options. The research activities are embodied in five subprojects:

- Research evaluation and impact assessment methodologies and adaptation to suit the requirements of ICRISAT
- Assessment of ICRISAT research programs and networks
- Impact assessment of ICRISAT/NARS genetic enhancement and resource management research
- Documentation and evaluation of ICRISAT parental material utilization by NARS and the seed sector
- Institutionalization of REIA through REIA modules embedded in the global single commodity, integrated systems and cross-commodity projects

1. ICRISAT Asia Center, Patancheru 502 324, Andhra Pradesh, India.

EC0N2: Markets and Policy

This project examines the supply and demand prospects of ICRISAT mandate crops and diagnoses product and input market constraints limiting the use of improved technologies for these crops. The project is organized into three major subprojects:

- Commodity and situation outlook
- Product markets and policy
- Input markets and policy

The commodity situation and outlook subproject examines production, trade and utilization trends of ICRISAT mandate crops in national, regional, and world economies. 'Facts and Trends' reports will be published every two years to provide summary information on each crop.

The products markets and policy subproject examines the impact of specific market policies on the trade and prices of ICRISAT mandate crops. In addition, this subproject considers price and non-price factors influencing the comparative advantage of ICRISAT mandate crops and assesses the determinants of medium to long-term supply and demand. Assessment of crop competitiveness in India and selected regions of Africa is of particular importance in the post GATT era. A final component of this subproject concerns the evaluation of preferred grain and plant quality traits of mandate crops.

The third subproject, on input markets and policy, examines policy and infrastructural factors influencing the availability and use of inputs required for the production of ICRISAT mandate crops-particularly seed. The role of the formal seed sector, and the informal seed marketing channels (i.e., farmer-to-farmer) will be examined. A final component of this subproject considers factors constraining the demand for and use of fertilizers, insecticides and other agrochemicals by small-scale farmers in drought prone regions of the African SAT.

Linkages with NARS: REIA project

South and Southeast Asia: Assessment of technology adoption and impact assessment in Asian Grain Legumes On-farm Research (AGLOR) countries was incorporated in the approved workplans of five CLAN cooperating countries, Indonesia, Nepal, Sri Lanka, and Vietnam, and assessment of spread of chickpea cultivation in Bangladesh. These collaborative plans were established with: Research Institute for Legumes and Tuber Crops, Indonesia; Institute of Agricultural Economics, Vietnam; Nepal Agricultural Research Council, Nepal; Field Crops Research and Development Institute, Sri Lanka; and Bangladesh Agricultural Research Institute, Bangladesh.

In India, the following institutions collaborate in the various impact assessment activities:

Pearl millet research. Indian Agricultural Research Institute; Tamil Nadu Agricultural University; Gujarat Agricultural University; All-India Pearl Millet Improvement Research Project.

Pigeonpea research. Regional Research Station, University of Agricultural Sciences, Gulbarga; Gujarat Agricultural University, Sardar Krishi Nagar.

Chickpea research. Mahatma Phule Krishi Vidyapeeth, Akola; Andhra Pradesh Agricultural University, Hyderabad.

Watershed Technology in SAT Environment. Central Research Institute for Dryland Agriculture, Hyderabad; National Bureau of Soil Survey and Land Use Planning, Nagpur; University of Agricultural Sciences, Bangalore.

A collaborative study on Spillover Impact of ICRISAT Research on Australian Agriculture has also commenced with New South Wales Agriculture and ACIAR.

Role of ICRISAT'S Training and Fellowships Program in Asia

B Diwakar, S K Das Gupta, and Faujdar Singh[1]

Introduction

The Training and Fellowships Program (TAFP) of ICRISAT helps NARS to meet their training requirements through on-the-job training, postgraduate professional training, short-term scientific courses, research management training, and technical study programs. Before the MTP of 1995, TAFP was called Human Resource Development Program. The program is now a part of the Corporate Office.

A Training and Fellowships Program Advisory Committee formulates training policies, and procedures. All applications for study programs are evaluated by the concerned Divisions and Project Team Leaders with the approval of the Regional Executive Director.

Study programs

These are designed to accommodate persons with diverse education and experience. Individual programs are developed in association with scientists and training staff using the scientific resources available. Five study programs outlined here under serve a wide range of human capital needs of NARS.

Visiting scholarship. It provides opportunities to NARS scientists with MSc or PhD degrees or equivalent to work with ICRISAT research scientists on specific problems utilizing recent developments, techniques, and concepts. The length of the study programs may vary from a few weeks to one year. Two hundred and seventy nine Visiting Scholars have participated in this program from Asia.

Research scholarship. This program enables graduate students to complete coursework at universities and conduct their thesis research at an ICRISAT location under the joint supervision of a university-approved scientist and an ICRISAT scientist. Research Scholars are scheduled for 18 to 24 months training to conduct experiment, collect and analyze data for the partial fulfillment of a degree. So far, from Asia, 88 research scholars for PhD and *66* for MSc have completed their thesis research at IAC.

1. **ICRISAT Asia Center, Patancheru 502 324, Andhra Pradesh, India.**

Table 1. TAFP participants from Asia at ICRISAT Asia Center, 1974-1995.

Country	Research Fellows[1]	Visiting Scholars	Research Scholars PhD	Research Scholars MSc	In-Service Participants 6-month	Apprentices	Short-term In-Service Participants	Total
Bangladesh	-	13	2	-	7	-	8	30
China	-	17	1	-	52	-	4	74
India	39	145	77	43	4	73	114	495
Indonesia	-	9	2	-	15	-	10	36
Lao PDR	-	-	-	-	-	-	2	2
Malaysia	-	3	-	-	4	-	3	10
Myanmar	-	3	-	-	22	-	-	25
Nepal	-	14	2	2	10	-	9	37
Pakistan	-	10	-	-	13	-	6	29
Philippines	-	18	-	-	20	-	11	49
Sri Lanka	1	22	1	15	38	1	17	95
Thailand	-	19	3	2	57	-	30	111
Vietnam	-	6	1	3	26	-	6	42
Total	40	279	88	66	268	74	220	1035

1. Research Fellows in future will be recruited by the Research Divisions and will be under the control of REDs.

In-service training. In this category, junior scientists, technicians, research station managers, etc., are trained. Academic requirements are flexible, and vary from a certificate in agriculture to a BSc degree. This course is held at IAC for 6 months (May to Nov) during the cropping season. The course covers areas of crop improvement, production agronomy, and resource management. It is preceded by a 2-month English course in mid-Mar for non-anglophone participants. Two hundred and sixty eight participants took part in this training program from Asia (Table 1).

Apprenticeship. Apprenticeships of 1 to 6 months are offered to degree or diploma candidates completing BSc or MSc degrees, or to students doing vocational courses, in order to gain practical experience in administration, computer services, information and library services, and farm services. So far, 74 students were awarded Apprenticeships at IAC from Asia.

Short-term courses. Courses are conducted to share new technologies. They can also be on specialized subjects at the request of NARS, networks, donors, or cooperating institutions, thus providing an opportunity to individuals with specific requirement of a training area. Two hundred and twenty NARS scientists participated in different short courses. These courses can be held as in-country program, or at IAC.

Follow-up activities

Contact is maintained through correspondence and personal visits by ICRISAT staff working or travelling in areas where former participants are employed. Germplasm lines, trials, reports, publications, and newsletters are provided to former participants on request.

Future orientation

After the MTP, emphasis on short-term courses will increase induction of more degree-oriented training (research scholarship), whereas, the 6-month in-service training program may be devolved to NARS. However, if asked, TAFP will try to assist the NARS in conducting these courses in a phased manner.

Information Management and Exchange

L J Haravu[1]

Introduction

Editorial, translation, publications production, public awareness, and library, documentation and information retrieval services are integrated into the Information Management and Exchange Program (IMEP) within ICRISAT. This facilitates coordination between the different information specialties, promotes the sharing of resources, and the adoption of mutually compatible software and standards. Apart from providing support services to ICRISAT's research staff, IMEP provides products and services to the community outside ICRISAT.

The Library and Documentation Services Unit of IMEP provides access to worldwide sources of information on subjects of interest to ICRISAT and its collaborators, while the Editorial and Publishing Units are primarily concerned with the production of a wide range of scientific publications. These units are also involved with spreading the word about the value of ICRISAT's work (in collaboration with NARS), to encourage continued support from donor community.

SATCRIS

A project known as the Semi-Arid Tropical Crops Information Service (SATCRIS) has been in operation since 1986. Its objectives are to:

- maintain a comprehensive bibliographic database of scientific and technical information on ICRISAT's mandate crops
- provide current awareness services to researchers working on ICRISAT's crops
- provide information retrieval services on demand
- deliver documents needed by researchers working on ICRISAT's crops and natural resource management
- experiment with new information technologies such as expert systems, and electronic publishing, as means of disseminating useful information /

The central resource of SATCRIS is its database. It acquires monthly subsets of the Commonwealth Agricultural Bureau International (CABI) and International Information System for Agricultural Sciences and Technology (AGRIS) databases in machine-readable form. These databases have been integrated with ICRISAT-generated input to create a single, multidisciplinary database on ICRISAT's mandate crops.

1. ICRISAT Asia Center, Patancheru 502 324, Andhra Pradesh, India.

The SATCRIS SDI service

A monthly alerting service called Selective Dissemination of Information (SDI) is operated by IMEP. In this automated service, user interest profiles are matched against new data received from CABI, AGRIS, and local sources. The SDI output contains abstracts of papers that match a given user's interests. The idea is to provide outputs tailored to the individual user needs, enabling them to keep abreast of current literature in their interest areas. SDI has a built-in feedback allowing interest profiles to be modified if necessary to meet needs. The service also delivers the full text of documents users find relevant in their regular printed outputs. During 1994, for instance, Library and Documentation Services of IMEP provided copies of 6000 papers to the users of SDI service which now goes to 454 users in 51 countries of the SAT, including several in South and Southeast Asia.

In many research stations within the SAT which do not have the resources to acquire costly information sources such as journals and conference proceedings, the SATCRIS SDI service is often the only source of current-awareness. Further, since the service draws its information from two global sources, it ensures that a recipient's information is comprehensive.

Information retrieval services

Several requests come to IMEP for retrospective searches of information on crops of interest to researchers working on ICRISAT's mandate crops. Such requests are met by searching not only the SATCRIS database but also other databases accessible to IMEP, such as AGRICOLA (Agriculture Online Access) database of the U.S. National Agricultural Library, and the AGRIS database of FAO on CD-ROM (Compact Disc-Read Only Memory) to meet requests that cut across crops and are thus not suitable candidates for the SATCRIS database.

Expert systems

Expert systems are computer programs that mimic human experts in a narrow domain of knowledge. Such systems contain a knowledge base built with inputs from specialists in that particular field. A computer program provides the interface and inference capabilities which enables users to enter into a consultation with the computer 'expert'. This technique has particular applicability in diagnostic problem solving applications. Since 1992, IMEP has been working on the development of an expert advisory and diagnostic system on groundnut crop protection. This work has been conducted in close collaboration with crop protection specialists at ICRISAT and in research stations in India. The system is targeted at researchers and extension workers. IMEP is now close to the development of a prototype system which will be tested in India, other parts of Asia, and in anglophobe Africa. Following the feedback received from these tests, a fully-fledged product will be distributed to research stations and others working for or interested in groundnut improvement. IMEP is also considering the broad relevance of these 'expert system' technologies for workers in other aspects of SAT agriculture.

ICRISAT's publications program

The publications portfolio of ICRISAT includes a variety of publications aimed at communicating ICRISAT's research results, and meeting identified needs of researchers and others in the NARS. These include the ICRISAT Report, formal Research and Information Bulletins, Pest and Disease Identification Handbooks, Plant Material Descriptors, and the proceedings of ICRISAT-sponsored workshops. All types of publications are defined and described in IMEP catalog, copies of which are available to all interested scientists and research workers. Currently, three international newsletters are published each year: the International Arachis Newsletter, the International Chickpea and Pigeonpea Newsletter, and the International Sorghum and Millets Newsletter. These newsletters are intended as a worldwide communication link for all those interested in the research and development of these mandate crops of ICRISAT. These newsletters respond better to specific local and regional needs than other publishing channels. Their production is a collaborative effort across all ICRISAT locations and Divisions.

With help from NARS and CLAN, IMEP is actively pursuing a project to translate pest and disease identification handbooks into as many languages as are needed. IMEP is in the process of publishing a translation of a handbook in Chinese on high-yielding groundnut technology-valuable information for the benefit of CLAN members who do not read Chinese.

On request and by individual agreement, IMEP is willing and able to provide advice and guidance on publication planning, editing, using computer graphics and publishing systems, and in printing.

Electronic publications too are produced by IMEP. The aflatoxin database, the Union Catalog of Serials in IARCs, and ICRISAT in Print are diskette-based publications. The last mentioned is an electronic database of contributions by ICRISAT's authors to the literature. Plans are afoot to produce ICRISAT's germplasm catalog on CD-ROM. This will provide multidimensional access to germplasm information. Similarly, there are plans to produce computer-aided training materials which may have value for CLAN members.

Assistance to NARS in information management and exchange

Important objectives for IMEP are to be a significant provider of information to the NARS of SAT, and to help NARS to improve their own capabilities for managing information. Specific training programs are designed for NARS on aspects of publishing, library management, information storage and retrieval, computer-based tools for NARS.

Recommendations

Recommendations

Discussions were held in two groups: South Asia (Chairperson: M A Malek), and Southeast Asia (Chairperson: Sumarno). Both groups' reports were presented at the Plenary Session on 6 Dec for discussion and approval. It was agreed that both reports be combined to have a common set of recommendations from the whole group.

Linking activities

- After considerable discussion, the group agreed to have Steering Committee meetings annually. Myanmar agreed to host the meeting in 1996, and the 1997 meeting might be in China or at IAC. Review and planning meetings were considered useful, and it was recommended that these should be held annually, if possible. However, CLAN review meetings should be integrated with national planning meetings, to the extent possible, and preferably be conducted after the cropping season so that results can be reviewed.
- The group agreed that regional meetings and conferences to meet the needs of member countries should be continued. Country Coordinators agreed, in principle, to host these meetings, and also to bear the local costs wherever possible according to national policies/regulations. The following themes were suggested:
  - Resource characterization for sustainable production systems
  - Systems' Modeling—IRRI might take the lead in organizing this workshop
  - Seed production systems—China might take the initiative
  - Small-farm machinery and equipment
- Exchange of scientists was considered an important activity to broaden knowledge of researchers. It should be expanded to include visits by NARS scientists to other countries, and to work in other member countries. However, these should be need based. Monitoring tours should also be considered as possible means of scientists' exchange. We could also consider possibility of farmer-leaders accompanying the scientists to visit ICRISAT and other countries. Other avenues of funding can be explored for this.

Coordination

- The need to have Coordination Unit (CU) located at ICRISAT Asia Center was strongly endorsed. Locating the CU in a member country was discussed; it was felt that the time was not yet ripe for this move; this was also considered an expensive alternative. The CU should be supported by ICRISAT as its commitment to the network, until such time that NARS can support the CU.
- The NARS should explore possibilities of supporting coordination of the network through regional umbrella organizations, such as APAARI. It was felt, in earlier

discussions of the Steering Committee, that if many networks start demanding contributions from member countries it may be counter-productive. Hence, it is advisable to ask APAARI to consider CLAN as a subnetwork, and request APAARI to provide financial support by enlisting increased contribution of member countries to APAARI itself. These avenues should be explored by CLAN-CU, and Country Coordinators should be consulted on further action.

Information exchange

- Information exchange from CLAN and ICRISAT through IMEP at ICRISAT has been useful and satisfactory, and should be continued. The NARS should be encouraged to exchange publications to keep each other updated on research highlights, meetings, and other events.
- Information on research results and technology from member countries (in local languages) should be translated and circulated to other countries. The Country Coordinators should send a list of important publications in the country (with English titles and brief contents) to CLAN-CU. These can be compiled and circulated to all Country Coordinators to gauge the demand for translations and distribution of such publications.

  All NARS scientists, extension staff, and NGOs, should be encouraged to publish their research results in ICRISAT's newsletters-International Arachis Newsletter, International Chickpea and Pigeonpea Newsletter, and International Sorghum and Millets Newsletter.
- The CLAN Cooperators' Directory provides a means for direct communication among scientists, and should be used efficiently.

Human resource development

All the three levels of training (In-Service, Research Scholars, and Visiting Scholars) were considered important. The national programs will be willing to support local costs of in-country training courses, to the extent possible.

- Possible topics for future training could include: on-farm research, IPM, groundnut production technology, pesticide resistance monitoring, and legumes processing and utilization.
- Need for a special course was indicated on (i) nematode diseases in legumes, (ii) CIS based characterization of production systems, and (iii) impact assessment.

  Surveys on nematodes was requested in Bangladesh, Nepal, and Sri Lanka. Myanmar scientists requested for training and survey of viral diseases.

  Opportunities to send Visiting Scholars to IAC were explored by some NARS participants. Study areas such as IPM, germplasm management, drought tolerance screening, insect resistance screening techniques, pigeonpea hybrid production, biotechnology, etc., were suggested. The NARS programs were encouraged to seek partial funding for these programs through bilateral cooperation and donor agencies.

On-farm and on-station research

Since the Country Coordinators did not have time to study the booklet on 'CLAN Research Priorities', they agreed to send the list of common generic research areas that merit collaboration to the CLAN-CU for future planning.

It was recommended that CLAN should have formal linkages with other networks and consortia [such as Rice-Wheat Consortium (RWC), Crop and Resource Management Network (CREMNET), Rainfed Lowland Rice Consortium (RLRC), Rainfed Upland Rice Consortium (RURC), etc.] so that research agendas that address natural resource management and sustainability of the system can be shared.

All network members should explicitly plan research on natural resource management at their future review and planning meetings. Research plans of ICRISAT must link up effectively with NARS agendas in a production systems perspective.

Network should be proactive in considering issues such as legumes in the emerging agronomy of other crops (e.g., direct-seeded rice, and zero-tillage wheat, and vice-versa).

Working Groups

As the working group concept has been effective in encouraging interaction, effective use of resources, and sharing of expenses and experiences, new ones may be initiated depending on the need (e.g., Aflatoxin contamination in groundnut).

Other system-oriented Working Groups (e.g., pigeonpea in different cropping systems) can be formed based on the preliminary results of research in one or two countries, and the interest of the cooperating countries.

The Country Coordinators were requested to suggest names of NARS scientists who could be members and Technical Coordinators of some of the Working Groups. The suggestions should come to CLAN-CU, who in turn will liaise with the concerned scientists at IAC and in NARS for ratification of suggestions.

Collaborative breeding

Most NARS would like to get both early and advanced generation breeding lines from IAC for their breeding programs. It was emphasized that NARS should report the results of international nurseries/trials to ICRISAT scientists, and indicate the usefulness of the material, or provide suggestions to improve targeting of specific material.

Collaboration between NARS and ICRISAT scientists should be strengthened as a two-way traffic.

Most countries envisaged difficulties in exchange of germplasm and breeding material directly. Such exchange of ICRISAT mandate crops should be facilitated by CLAN/ICRISAT.

Country Coordinators of CLAN and scientists were requested to inform their colleagues in other countries on the availability of breeding material. List of released varieties for exchange can be sent to the CLAN-CU which will collate and circulate the list to all Country Coordinators.

Broader networking in Asia

The idea of lentil subnetwork in CLAN was appreciated and welcomed. Other such linkages with AVRDC and IITA should be explored.

The network should explicitly seek collaboration with like-minded consortia, such as Rice-wheat Consortium, Rainfed Lowland Rice Consortium, Rainfed Upland Rice Consortium, Farming Systems Research in Southern Asia Project, and other regional networks.

The CLAN-CU should collate research priorities and agenda of these consortia, and circulate these to all Country Coordinators for seeking collaboration.

Appendices

Appendix 1. ICRISAT germplasm material distributed to Asian countries, Jan-Sep 1995.

	No. of samples						
Country	Sorghum	Pearl millet	Chick pea	Pigeon-pea	Ground-nut	Minor millets	Total
China	-	-	-	-	4	42	46
India	1939	518	156	1040	1655	108	5416
Indonesia	76	-	-	-	-	–	76
Japan	-	-	-	-	12	–	12
Jordan	5	-	-	5	-	–	10
Pakistan	-	-	-	-		50	50
Sri Lanka	-	-	200	-	16	–	216
Russia	-	-	3	-	-	–	3
Thailand	10	-	10	10	63	–	93
Yemen	16	-	-	-	-	–	16
Total	2046	518	369	1055	1750	200	5938

Appendix 2. Germplasm in the ICRISAT gene bank from Asian countries as of 31 Oct 1995.

Country	Number of Accessions					
	Sorghum	Pearl millet	Chickpea	Pigeonpea	Groundnut	Total
Afghanistan	5	-	686	-	-	691
Bangladesh	9	-	170	73	-	252
Cambodia	-	-	-	-	1	1
China	380	-	24	1	217	622
Cyprus	-	-	44	-	-	44
India	5949	7655	7180	9981	3850	34615
Indonesia	33	-	-	17	214	264
Iran	7	-	4856	-	11	4874
Iraq	3	-	18	-	-	21
Israel	22	-	48	-	88	158
Japan	108	-	-	-	48	156
S Korea	78	1	-	-	90	169
Lebanon	360	108	19	-	-	487
Maldives	10	-	-	1	-	11
Myanmar	20	10	129	72	60	291
Malaysia	-	-	-	-	55	55
Nepal	8	-	80	116	35	239
Pakistan	70	160	445	14	3	692
Philippines	60	-	-	59	42	161
Russia & CIS	395	16	133	2	63	609
Saudi Arabia	22	-	-	-	-	22
Sri Lanka	25	-	3	77	24	129
Syria	4	-	203	-	1	208
Taiwan	6	-	-	3	48	57
Thailand	5	-	-	41	6	52
Turkey	50	2	449	-	7	508
Vietnam	-	-	-	-	67	67
Yemen	2129	290	-	-	1	2420
Total	9758	8242	14487	10457	4931	47875

Appendix 3. Sorghum trials, and breeding material distributed to Asian countries, Jan 1994-Oct 1995.

Country	Nurseries and trials	Breeding material				
		Breeder seed	Advanced lines	Male steriles	Germplasm Other lines	**Total**
China	13	-	322	-	-	322
India	240	146	5221	-	165	5532
Indonesia	8	-	159	-	75	234
S Korea	21	-	840	-	-	840
Lao PDR	1	-	-	-	-	0
Myanmar	12	-	635	-	-	635
Pakistan	49	-	1485	118	-	1603
Thailand	39	-	1634	-	-	1634
Vietnam	10	-	659	-	-	659
Total	393	146	10955	118	240	11459

Appendix 4. Pearl millet trials, and breeding material distributed to Asian countries, Jan 1994-Oct 1995.

Country	Nurseries and trials	Breeding material		
		Breeder seed	Advanced lines	**Total**
Bangladesh	-	-	6	6
India	126	817	9405	10222
Nepal	2	-	6	6
Pakistan	16	-	4	4
S Korea	-	-	41	41
Thailand	-	-	2	2
Total	144	817	9464	10281

Appendix 5. Chickpea trials, and breeding material distributed to Asian countries, Jan 1994-Oct 1995.

		Breeding material				
Country	Nurseries and trials	F_2 populations	Advanced breeding lines	Released varieties	Others	**Total**
Bangladesh	18	19	362	3	-	384
Bhutan	7	-	-	-	-	0
China	-	-	16	10	-	26
India	170	862	11	228	498	1599
Lao PDR	-	-	7	-	3	10
Myanmar	51	22	-	-	-	22
Nepal	5	-	18	36	-	54
Pakistan	65	202	196	-	-	398
Philippines	19	-	-	-	-	0
Sri Lanka	3	-	-	5	-	5
Total	338	1105	610	246	537	2498

Appendix 6. Pigeonpea trials, and breeding material distributed to Asian countries, Jan 1994-Oct 1995.

Country	Trials	Breeding material: Released varieties	Advanced lines	Hybrids	Male steriles	Others	Segregating materials	Germplasm accessions	Total
Bangladesh	–	8	21	–	–	2	–	2	33
Bhutan	4	–	–	–	–	–	–	–	0
Cambodia	–	–	4	–	–	–	–	–	4
India	52	160	441	7	32	112	222	2188	3162
Indonesia	11	5	23	3	–	6	–	8	45
Japan	–	2	3	–	–	–	–	5	10
Lao PDR	–	3	3	–	–	–	–	–	6
Malaysia	–	–	–	–	–	–	–	3	3
Myanmar	6	1	2	1	–	8	4	9	25
Nepal	11	4	29	–	–	11	11	10	65
Pakistan	2	2	7	–	–	–	–	1	10
Sri Lanka	1	2	64	–	3	15	7	–	91
Thailand	8	–	6	–	–	–	–	–	6
Vietnam	3	5	17	–	–	–	–	3	25
Total	98	192	620	11	35	154	244	2229	3485

Appendix 7. Groundnut trials, and breeding material distributed to Asian countries, Jan 1994-Oct 1995.

		Breeding material					
Country	Trials	Released varieties	Advanced lines	Others	Segregating materials	Germplasm accessions	Total
Bangladesh	1	–	99	1	24	–	124
China	–	–	–	1	–	–	1
Cambodia	1	–	–	–	–	–	0
India	26	369	1243	25	190	1342	3169
Indonesia	10	–	17	3	–	3	23
Japan	–	–	1	–	–	3	4
S Korea	–	–	20	–	–	–	20
Lao PDR	5	–	20	–	–	–	20
Myanmar	32	–	18	–	2	–	20
Nepal	4	–	–	–	–	–	0
Pakistan	7	–	–	–	5	–	5
Philippines	4	–	40	–	–	–	40
Sri Lanka	8	–	53	5	–	–	58
Thailand	5	–	40	–	20	–	60
Vietnam	–	–	107	–	23	323	453
Total	103	369	1658	35	264	1671	3997

Appendix 8. Review and Work Plan meetings held in CLAN member countries, Jan 1994-Oct 1995.

Country	Dates	Place[1]
Bangladesh	4-6 Jul 1995	BARI, Joydebpur
China	1-2 Jul 1994	CAAS, Beijing
India	25-26 Sep 1995	ICRISAT Asia Center, Patancheru
Indonesia	19 Jan 1994	CRIFC, Bogor
	20-21 Feb 1995	CRIFC, Bogor
Myanmar	18-20 May 1994	CARI, Yezin
Nepal	16-17 Jun 1994	GLRP, Rampur
	11-13 Jun 1995	GLRP, Rampur
Pakistan	9-10 Apr 1994	NARC, Islamabad
	28-30 Mar 1995	NARC, Islamabad
Philippines	30-31 Jan 1995	PCARRD, Los Banos
Sri Lanka	22-23 Jun 1995	ISTI, Gannoruwa
Thailand	22 Jan 1994	FCRI, Bangkok
	8 Mar 1995	FCRI, Bangkok
Vietnam	13-15 Feb 1995	MAFI, Ho Chi Minh City

1. BARI = Bangladesh Agricultural Research Institute; CAAS = Chinese Academy of Agricultural Sciences; CRIFC = Central Research Institute for Food Crops; CARI = Central Agricultural Research Institute; GLRP = Grain Legumes Research Program; ISTI = In-service Training Institute; NARC = National Agricultural Research Centre; PCARRD = Philippine Council for Agriculture, Forestry and Natural Resources Research and Development; FCRI = Field Crops Research Institute; MAFI = Ministry of Agriculture and Food Industry.

Appendix 9. Regional workshops in Asia, 1994-1995.

1994

- FAO-ICRISAT Expert Consultancy Workshop on Genetic Manipulation of Crop Plants to Enhance Integrated Nutrient Management in Cropping Systems, 1: Phosphorus. 15-18 Mar 1994, ICRISAT Asia Center (IAC), Patancheru, India.

  43 Participants-Australia (6), Bangladesh (1), Colombia (1), Germany (1), Italy (2), ICRISAT (24), Japan (6), New Zealand (1), and USA (1).

- FAO-ICRISAT Workshop on Increasing Biological Nitrogen Fixation and Yield of Grain Legumes, 7-11 Nov 1994, IAC.

  28 Participants-Australia (1), Austria (1), Bangladesh (2), China (3), Indonesia (1), Malaysia (2), Sri Lanka (2), Thailand (1), Vietnam (2), and ICRISAT (13).

- Workshop on Dynamics of Roots and Nitrogen in Cropping Systems of the Semi-Arid Tropics, 21-25 Nov 1994, IAC.

  55 Participants-Australia (3), Austria (1), Canada (1), Denmark (2), Germany (1), India (9), Indonesia (1), Italy (2), Japan (10), Netherlands (1), UK (2), USA (2), Vietnam (1), and ICRISAT (19).

- Workshop on Analysis and Exploitation of Plant Adaptation in Agricultural Crop Improvement Programs, 28 Nov-2 Dec 1994, IAC.

  27 Participants-Australia (8), Brazil (1), ICARDA (1), IRRI (4), and ICRISAT (13).

- Workshop on Integration of Research Evaluation Efforts of ICRISAT with NARS and other Research Institutions, 14-16 Dec 1994, ICRISAT Asia Center, Patancheru, India.

  84 Participants-Australia (2), India (28), Indonesia (1), Mali (1), Nepal (1), Philippines (4), Thailand (4), Vietnam (2), and ICRISAT (41).

1995

- Workshop on Role of Geographic Information System (GIS) in Developing and Transferring Sustainable Agricultural Technologies in the Tropics, 20 Feb-5 Mar 1995, Asian Institute of Technology (AIT), Bangkok, Thailand.

  49 Participants-Bangladesh (2), China (2), India (7), Indonesia (1), S Korea (1), Lao PDR (2), Nepal (2), Pakistan (1), Philippines (10), Sri Lanka (1), Thailand (4), Vietnam (1), IRRI (1), USA (5), AIT (1), FAO (1), and ICRISAT (7).

Continued...

- Decision and Policy-makers' Meeting on Present Status and Future Needs of GIS Databases and Remote Sensing for Developing Plans for Sustainable Agricultural Development, 6-7 Mar 1995, AIT, Bangkok, Thailand.

  17 Participants-India (1), Nepal (1), Philippines (1), AIT (2), IRRI (1), FAO (1), USA (5), and ICRISAT (5).

- Workshop on Development of Experimental Plans of Selected Benchmark Sites for Integrated Systems Project 3 in Asia, 25-28 Apr 1995, ICRISAT Asia Center, Patancheru, India.

  45 Participants-India (17), Thailand (1), Vietnam (1), and ICRISAT (26).

- International Workshop on Achieving High Groundnut Yields, 25-29 Aug 1995, Laixi, China.

  65 Participants-China (50), India (2), Indonesia (1), S Korea (1), Myanmar (1), Philippines (I), Thailand (2), Vietnam (1), Zimbabwe (1), and ICRISAT (5).

- Workshop and Monitoring Tour on Prospects and Problems of Growing Extra-Short-Duration Pigeonpea in Rotation with Winter Crops, 16-18 Oct 1995, Indian Agricultural Research Institute, New Delhi, India.

  77 Participants-Bangladesh (1), India (50), Nepal (2), Sri Lanka (8), and ICRISAT (16).

Appendix 10. CLAN participation in Meetings and Workshops organized by others, Jan 1994 - Oct 1995.

- FAO Regional Expert Consultation on Production of Pulse Crops, 2-6 Apr 1994, New Delhi, India.
- Asia Pacific Association of Agricultural Research Institutions (APAARI) Perspective Plan Discussion Meeting, 3-4 May 1994, Bangkok, Thailand.
- Regional Technical Coordination Committee Meeting of the Rice-Wheat Cropping Systems Initiative, 22-24 Nov 1994, Kathmandu, Nepal.
- Fourth FAO RAS/89/040 Regional Coordination Committee Meeting, 23-26 Jan 1995, PCARRD, Los Banos, Philippines.
- Global Conference on Advances in Research on Plan Diseases and Their Management, 12-17 Feb 1995, Rajasthan College of Agriculture, Udaipur, India.

Appendix 11. Working Group meetings in Asia, Jan 1994 - Oct 1995.

- Third Meeting of the Groundnut Bacterial Wilt Working Group, 4-5 July 1994, Wuhan, China.

  44 Participants-Australia (1), China (26), Indonesia (1), Malaysia (2), Thailand (1), Philippines (1), Vietnam (2), United Kingdom (3), FAO (1), IPGRI (1), and ICRISAT (5)

- First Meeting of the Working Group on Cytoplasmic-Genic Male-Sterility in Pigeonpea, 26-27 July 1994, ICRISAT Asia Center, Patancheru, India

  25 Participants-India (7) and ICRISAT (18)

- Fourth Meeting of the Asia Pacific Working Group on Groundnut Viruses, 13-15 Mar 1995, Khon Kaen University, Khon Kaen, Thailand.

  25 Participants-Australia (1), Bangladesh (1), Belgium (1), Cambodia (1), China (1), India (3), Indonesia (1), Lao PDR (1), Myanmar (1), Nepal (1), Pakistan (1), Sri Lanka (1), Thailand (1), UK (1), USA (1), Vietnam (1), Netherlands (1), and ICRISAT (6).

- Second Meeting of the Working Group on Cytoplasmic-Genic Male-Sterility in Pigeonpea, 4 April 1995, Punjabrao Krishi Vidyapeeth, Akola, India

  8 Participants-India (6) and ICRISAT (2)

- Chickpea Drought Research Working Group Meeting, 8-10 Aug 1995, IAC.

  25 Participants-Bangladesh (1), India (8), and ICRISAT (16)

Appendix 12. Human resource development activities involving Asian scientists, Jan 1994-Sep 1995.

Country	Research	Visiting Scholar	Research Scholar	In-Service Participant	Apprentice	**Total**
Bangladesh	-	5	-	2	-	7
China	-	3	-	3	-	6
India	3	6	22	-	15	46
Myanmar	-	2	-	1	-	3
Nepal	-	4	-	3	-	7
Pakistan	-	-	-	2	-	2
Philippines	-	-	-	1	-	1
Sri Lanka	-	3	-	7	-	10
Thailand	-	2	-	-	-	2
Vietnam	-	3	3	3	-	9
Total	3	28	25	22	15	93

Appendix 13. Regional and in-country training programs, 1994-95.

Regional training programs

- Training Course on Diagnosis and Detection of *Pseudomonas solanacearum* and for Resistance Screening against Groundnut Bacterial Wilt, 6-9 Jul 1994, Wuhan, China.

  17 Participants-China (13), Malaysia (1), Thailand (1), and Vietnam (2).

- Training Course on Identification and Detection of Viruses of Legumes with Special Emphasis on Groundnut, 27 Feb-11 Mar 1995, Khon Kaen University, Khon Kaen, Thailand.

  13 Participants-Bangladesh (1), Cambodia (1), India (1), Indonesia (1), Lao PDR (1), Myanmar (1), Nepal (1), Pakistan (1), Sri Lanka (1), Thailand (3), and Vietnam (1).

- Training Course on Host-Plant Resistance to Insects in Sorghum, 24 Oct-3 Nov 1995, IAC.

  22 Participants-Afghanistan (1), Egypt (1), Ethiopia (1), India (8), Iran (1), Kenya (1), Mali (1), Myanmar (1), Nigeria (1), Pakistan (1), Sudan (1), Syria (1), Tanzania (1), Thailand (1), and Yemen (1).

- Study Program on Methodology for Adoption and Impact Evaluation, 25 Oct-7 Nov 1995, IAC.

  9 Participants-India (5), Indonesia (1), Nepal (1), Sri Lanka (1), and Vietnam

In-country training courses

- Research Planning, Data Handling and Report Writing, 14-26 Feb 1994, Bangladesh Research Institute, Joydebpur, Bangladesh. 59 Participants.

- In-country Training Course on On-farm Research Methodologies, 26-27 Mar 1995, Grain Legumes Research Program (GLRP), Rampur, Nepal. 14 Participants.

- On-farm Adaptive Research, 20-21 Jun 1995, Gannoruwa, Kandy, Sri Lanka. 41 Participants.

- In-country Training Course on On-farm Adaptive Research, 17-20 Oct 1995, Ilagan, Isabela, Philippines. 16 Participants.

Appendix 14. Monitoring tours and surveys, 1994-1995.

1994

- Chickpea trials and demonstrations in the *Barind* region, Bangladesh, 3-11 Jan 1994.
- Pigeonpea on-station and on-farm trials in Sri Lanka, 24-27 Jan 1994.
- Groundnut on-station and on-farm trials in southern Vietnam, 20-25 Feb 1994.
- On-station trials and on-farm trials in Nepal and Bangladesh, 20-26 Feb 1994.
- Chickpea on-station and on-farm trials in Myanmar, 21 Feb-8 Mar 1994.
- Chickpea and pigeonpea on-station and on-farm trials in Nepal, 13-20 Mar 1994.
- Groundnut on-farm trials in northern Vietnam, 17-22 Apr 1994.
- Groundnut diseases in northern Vietnam, 16 Apr-10 May 1994.
- Groundnut on-farm trials in Indonesia, 7-11 May 1994.
- Groundnut on-farm trials in Nepal, 24 Sep-2 Oct 1994.
- Assistance in planning and planting of trials on botrytis gray mold at Parwanipur, Nepal 11-15 Nov 1994.
- Pigeonpea and chickpea on-station trials in Nepal, 26-27 Nov 1994.

1995

- Pigeonpea collaborative on-station and farmer field trials in Myanmar, 30 Dec 1994-6 Jan 1995.
- Pigeonpea collaborative on-station and on-farm trials in Sri Lanka, 5-12 Jan 1995.
- Chickpea research station and on-farm trials in Myanmar, 13-22 Feb 1995.
- Chickpea botrytis gray mold screening nursery in Bangladesh, 21-25 Feb 1995.
- Collaborative research trials on pigeonpea in Sri Lanka, 13-19 Feb 1995.
- Winter-spring groundnut on-farm trials in southern Vietnam, 16-18 Feb 1995.
- Chickpea botrytis gray mold management trials in Nepal and Bangladesh, 13-24 Mar 1995.
- Chickpea and pigeonpea on-station and on-farm trials in Nepal, 27-31 Mar 1995.
- Pigeonpea drought research trials in Sri Lanka, 28 Mar-6 Apr 1995.
- Assistance in collaborative breeding trials and future research planning on groundnut in southern Vietnam, 20 Mar-6 Apr 1995.
- Integrated Pest Management trials on groundnut in northern Vietnam, 2-4 May 1995.

Continued...

Appendix 14. *Continued...*

- Groundnut on-farm trials in northern Vietnam, 9-13 May 1995.
- Identification of benchmark sites for collaborative research under ISP 3 in northern Vietnam, 9-14 May 1995.
- Identification of benchmark sites for collaborative research under ISP 3 in Thailand, 16-18 May 1995.
- Groundnut diseases in rice-based production systems in northern Vietnam, 25 Apr-9 May 1995.
- Identification of benchmark sites for collaborative research under ISP 3 in central Myanmar, 22-28 May 1995.
- Virus diseases of groundnut in Pakistan, 15-23 Jul 1995.
- On-station and on-farm trials of pigeonpea in Sri Lanka, 23-25 Jun 1995
- Pigeonpea drought research trials in Sri Lanka, 9-16 Aug 1995.
- ISP 3 research activities and survey farmers' fields for upland crop performance in northern Vietnam, 28 Aug-5 Sep 1995.
- Identification of benchmark sites for collaborative experiments under ISP 2 in Myanmar, 2-8 Sep 1995.
- Aflatoxin contamination of groundnut in farmers' fields and markets in northern Vietnam, 20 Jun-24 Jul 1995.
- Collaborative pigeonpea trials in Indonesia, 17-23 Sep 1995.
- On-farm research village survey to collect data for adoption and impact analysis, 17-28 Sep 1995.
- Groundnut on-farm research trials in Nepal, 21-26 Sep 1995.
- Pigeonpea, groundnut, and sorghum collaborative trials in Myanmar and Thailand, 6-16 Oct 1995.

Appendix 15. Travel and visits of scientists associated with network activities, Jan 1994-Oct 1995.

Country	Trips by NARS scientists to ICRISAT or ICRISAT -supported Meetings/Workshops			Trips by ICRISAT scientists to Asian countries (other than India)		
	No. of trips	No. of visitors	No. of person days	No. of trips	No. of scientists	No. of person days
Bangladesh	7	8	78	7	10	133
Cambodia	1	1	18	0	-	0
China	7	21	210	6	13	142
India	12	65	458	-	-	0
Indonesia	7	7	73	8	12	63
Malaysia	1	2	20	-	-	0
S Korea	1	1	15	-	-	0
Lao PDR	2	3	48	1	2	14
Myanmar	2	2	26	6	13	132
Nepal	5	5	49	14	28	254
Pakistan	2	2	33	3	6	51
Philippines	6	15	174	3	4	52
Sri Lanka	8	17	200	9	13	204
Thailand	9	11	117	13	20	196
Vietnam	8	9	106	11	13	309
Total	78	169	1625	81	134	1550

Sitting (left to right): Don E Byth, S Partohardjono, Ester L Lopez, Ngo The Dan, R B Singh, Y L Nene, C Renard, C L L Gowda, W Erskine, Sumarno, Nipon Iamsupasit, Mohein, M C S Bantilan.
Standing (middle row): A Giridhar Rao, V P Singh, S L Dwivedi, Nguyen Xuan Hong, S M Virmani, Yang Yan, G P Koirala, J P Tandon, M A Malek, K D S M Joseph, S N Nigam, C T Hash.
Standing (back row): S B Sharma, R P Thakur, K F Nwanze, P K Joshi, Faujdar Singh, R P S Pundir, L J Haravu, J V D K Kumar Rao, C Johansen, N P Saxena, Suresh Pande, A Ramakrishna, Eric M McGaw, H A van Rheenen.

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Abbreviations and Acronyms

ACIAR	Australian Centre for International Agricultural Research
ADB	Asian Development Bank (Philippines)
AGLN	Asian Grain Legumes Network
AGLOR	Asian Grain Legume On-farm Research
AGRICOLA	Agriculture Online Access (USA)
AGRIS	International Information System for Agricultural Sciences and Technology (FAO)
AICRP	All India Coordinated Research Project
AIT	Asian Institute of Technology (Thailand)
AP	Andhra Pradesh (India)
APAARI	Asia Pacific Association of Agricultural Research Institutions (Thailand)
AVRDC	Asian Vegetable Research and Development Center (Taiwan)
AWGBNFL	Asia Working Group on Biological Nitrogen Fixation in Legumes
BARI	Bangladesh Agricultural Research Institute
BGM	Botrytis Gray Mold
BMZ	Bundesministerium fur Wirtschaftliche und Entwicklung Zusammenarbeit (Germany)
CAAS	Chinese Academy of Agricultural Sciences
CABI	Commonwealth Agricultural Bureau International (UK)
CARI	Central Agricultural Research Institute (Myanmar)
CDP	Crop Diversification Programme (Bangladesh)
CGPRT	Coarse Grains Pulses Root and Tuber Crops Centre (Indonesia)
CIDA	Canadian International Development Agency
CIMMYT	Centro Internacional de Mejoramiento de Maiz y Trigo (Mexico)
CREMNET	Crop and Resource Management Network (IRRI)
CRIFC	Central Research Institute for Food Crops (Indonesia)
CLAN	Cereals and Legumes Asia Network
CMS	Cytoplasmic-genic Male Sterility
CU	Coordination Unit
FAO	Food and Agricultural Organization
FCRI	Field Crops Research Institute (Thailand)
FLCG	Food Legumes and Coarse Grains
GBWWG	Groundnut Bacterial Wilt Working Group
GED	Genetic Enhancement Division (ICRISAT)
CIS	Geographic Information System
GLRP	Grain Legumes Research Program (Nepal)

GRD	Genetic Resources Division (ICRISAT)
IAC	ICRISAT Asia Center, Patancheru, India
IARC	International Agricultural Research Centers
IATA	Institute for Agricultural Technology Assessment (Indonesia)
ICAR	Indian Council of Agricultural Research
ICARDA	International Center for Agricultural Research in the Dry Areas
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IITA	International Institute of Tropical Agriculture (Nigeria)
ILRI	International Livestock Research Institute (Ethiopia and Kenya)
IMEP	Information Management and Exchange Program (ICRISAT)
INGER	International Network on Genetic Evaluation in Rice (IRRI)
IPM	Integrated Pest Management
IRRI	International Rice Research Institute (Philippines)
ISP	Integrated Systems Project (ICRISAT)
ISTI	In-service Training Institute (Sri Lanka)
MAFI	Ministry of Agriculture and Food Industry (Vietnam)
MJAS	Myanmar Journal of Agricultural Science
MTP	Medium Term Plan (ICRISAT)
NARC	National Agricultural Research Centre (Pakistan)
NARC	Nepal Agricultural Research Council
NARS	National Agricultural Research Systems
NiFLA	Nitrogen Fixing Legumes in Asia (IAC)
OFAR	On-farm Adaptive Research
OCRI	Oil Crops Research Institute (China)
ORP	Oilseed Research Program (Nepal)
PCARRD	Philippine Council for Agriculture, Forestry and Natural Resources Research and Development
RILET	Research Institute for Legumes and Tubers (Indonesia)
RIMOC	Research Institute for Maize and Other Cereals (Indonesia)
RLRC	Rainfed Lowland Rice Consortium (IRRI)
RURC	Rainfed Upland Rice Consortium (IRRI)
RWC	Rice-Wheat Consortium (ICRISAT)
SATCRIS	Semi-Arid Tropical Crops Information Service (ICRISAT)
SFCRC	Suphan Buri Field Crops Research Center (Thailand)
TAFP	Training and Fellowship Program (ICRISAT)
TCDC	Technical Cooperation among Developing Countries
WG	Working Group

About ICRISAT

The semi-arid tropics (SAT) encompasses parts of 48 developing countries including most of India, parts of southeast Asia, a swathe across sub-Saharan Africa, much of southern and eastern Africa, and parts of Latin America. Many of these countries are among the poorest in the world. Approximately one-sixth of the world's population lives in the SAT, which is typified by unpredictable weather, limited and erratic rainfall, and nutrient-poor soils.

ICRISAT's mandate crops are sorghum, pearl millet, finger millet, chickpea, pigeonpea, and groundnut; these six crops are vital to life for the ever-increasing populations of the semi-arid tropics. ICRISAT's mission is to conduct research which can lead to enhanced sustainable production of these crops and to improved management of the limited natural resources of the SAT. ICRISAT communicates information on technologies as they are developed through workshops, networks, training, library services, and publishing.

ICRISAT was established in 1972. It is one of 16 nonprofit, research and training centers funded through the Consultative Group on International Agricultural Research (CGIAR). The CGIAR is an informal association of approximately 50 public and private sector donors; it is co-sponsored by the Food and Agriculture Organization of the United Nations (FAO), the United Nations Development Programme (UNDP), the United Nations Environment Programme (UNEP), and the World Bank.

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