

Sorghum Research and Development Network for Asia



International Sorghum Research Institute for the Semi-Arid Tropics

Abstract

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This publication is a report of a consultative group meeting of Asian National Scientists and Administrators to discuss sorghum production constraints in Asia, and the means to alleviate them. Selected participants from Asian countries led discussions and prepared summaries on utilization of end products, common production constraints and future prospects, research priorities, and transfer of varieties and technologies to farmers. Following the presentation of summaries, the group resolved to establish a Sorghum Research and Development Network for Asia to enable rapid progress in technology generation, adaptation, and adoption by pooling resources and expertise. The overall goal of the network is to elevate the status of sorghum from that of a mere subsistence crop to a high-value crop. The group recommended that ICRISAT should initiate and coordinate the activities of this network.

Résumé

Réseau pour la recherche et le développement du sorgho en Asie : rapport de la Réunion du groupe consultatif sur l'établissement d'un réseau pour la recherche et le développement du sorgho en Asie, 16-19 septembre 1991, Centre ICRISAT, Inde. La présente publication est le rapport de la réunion d'un groupe consultatif des chercheurs et des administrateurs nationaux d'Asie. Les discussions portaient sur les contraintes entravant la production du sorgho en Asie et les moyens de les contrôler. Quelques-uns des participants ont mené des débats et ont préparé des rapports sur précisément ces contraintes, l'utilisation du sorgho, les perspectives, les priorités de recherche, et le transfert des techniques et des variétés. A l'issue de la présentation des rapports, le groupe a décidé de constituer un réseau pour la recherche et le développement du sorgho en Asie par la mise en commun des ressources et des compétences. Ceci va accélérer les processus de l'évolution des techniques, de l'adaptation et de l'adoption. Le but final du réseau est de promouvoir le sorgho, culture de subsistance jusqu'ici, en tant que culture à haute valeur. Le groupe a proposé que l'ICRISAT se charge de l'initiation et de la coordination des activités du réseau.

Resumen

Una red de investigación y desarrollo del sorgo en Asia: un reporte de la reunión del grupo consultivo para considerar el establecimiento de una red de investigación y desarrollo del sorgo en Asia, 16-19 septiembre 1991, ICRISAT Center, India. Esta publicación es un reporte proveniente de la reunión del grupo consultivo constituido por científicos y administradores provenientes del continente asiático, para discutir sobre las adversidades del sorgo en Asia y los medios para aliviar las mismas. Un selecto grupo de participantes de países asiáticos llevaron a cabo discusiones y prepararon sumarios sobre los productos finales del sorgo, utilización, limitaciones comunes de la producción, así como también perspectivas futuras, prioridades de investigaciones y transferencia de variedades y tecnologías a los productores agropecuarios. Luego de la presentación de los sumarios, el grupo resolvió establecer una red de investigación y desarrollo del sorgo en Asia para permitir un rápido progreso en la generación, adaptación y adopción de tecnología a través de la concentración de recursos y experiencias. El objetivo principal de la red de investigación y desarrollo es elevar la jerarquía del sorgo de ser simplemente un cultivo de subsistencia a un cultivo de alta rentabilidad. El grupo consultivo también ha recomendado que ICRISAT debería iniciar y coordinar las actividades de esta red.

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Sorghum Research and Development Network for Asia

**Report of the
Consultative Meeting to Consider the
Establishment of a Sorghum Research
and Development Network for Asia**

held at

**ICRISAT Center
16-19 Sep 1991**

Edited by

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Introduction

A consultative meeting was held at ICRISAT Center, 16-19 Sep 1991 to:

- define clearly the constraints to sorghum production in the Asian region, in order to provide sharper focus for sorghum research and germplasm distribution at ICRISAT, and
- investigate the interest in and potential of a sorghum research network for the region to assist in overcoming the constraints.

Participants included senior policymakers and sorghum research workers from Asia (Appendix I). In addition, donor nations and organizations with particular interest in the Asian region, and strengths in sorghum research, were invited to send representatives.

At the meeting, participants reported on the status of sorghum production, utilization, constraints, and research activities in their countries. Representatives from ICRISAT and other scientific research organizations presented reports of their ongoing research activities (Appendix 2). Asian participants were requested to lead discussions and prepare summaries of the Proceedings under headings such as utilization of end products, common production constraints and future prospects, research priorities and cooperative research, transfer of varieties and technologies to farmers, and technology exchange (workshops, monitoring tours, etc.). To assist in this process, informal surveys were conducted in which participants were asked to prioritize their countries' interests. These priorities were further discussed. The resulting summaries were presented by the discussion leaders and finally recommendations were made. This document summarizes the proceedings of the meeting and the subsequent recommendations.

Opening Address

J.M.J. de Wet, Director, Cereals Program
International Crops Research Institute for the Semi-Arid Tropics
Patancheru, Andhra Pradesh 502 324, India

Welcome to the International Crops Research Institute for the Semi-Arid Tropics. I am pleased to note that most of the sorghum-growing countries of Asia are represented at this Workshop, as are USAID Title XII Collaborative Research Support Program on Sorghum and Pearl Millet (INTSORMIL), Food and Agriculture Organization of the United Nations (FAO), United Nations Development Programme (UNDP), United States Department of Agriculture (USDA), and the private industry.

Sorghum is an important world cereal but its production has not been keeping pace with the demand. During the next decade, a steady increase in the demand for sorghum as an animal feed is expected to continue in developed countries. In Latin America, this increase in demand is presently balanced by an almost 10% annual increase in production. Asia is, therefore, in an ideal position to capture part of this export market. However, in order to fill the gap between the expected demand and production, major production constraints need to be removed. For sorghum to reach its full potential, high-yielding cultivars with resistance to regionally important diseases and insect pests are needed.

ICRISAT has an effective network of regional research programs and networks to cooperate with NARS in Africa. But such networks do not exist in Asia. This Workshop is designed to determine whether there is a need for ICRISAT to develop close research ties with sorghum-growing countries in Asia. This will be your decision. If you decide that research cooperation on sorghum is needed, ICRISAT suggests the development of a network. For such a network to be successful, it will have to be a research-oriented one, involving scientists of ICRISAT and National Programs as equal partners in cooperative research of regional significance. It is also necessary for National Programs to accept responsibility for such regional research in areas where they have comparative advantages over ICRISAT.

To achieve an effective research structure, it will be necessary to identify regional and local research priorities. We need to develop research projects within the framework, and assign responsibilities to solve specific production constraints. The Cereals Program at ICRISAT will try to implement your recommendations.

ICRISAT's Role in Cereals and Legumes Research in Asia

Y.L. Nene, Deputy Director General
International Crops Research Institute for the Semi-Arid Tropics
Patancheru, Andhra Pradesh 502 324, India

ICRISAT's mandate is both global and regional — global in crop mandate and regional in area mandate. ICRISAT Center in Patancheru, India, is the global center where mainly strategic and applied research, and advanced training activities are undertaken. It also supports regional activities for legumes, cereals, and resource management in Asia. The current geographic focus of ICRISAT's total research efforts indicates substantial focus on Asia. At present basic, strategic, applied, and adaptive research are being carried out at ICRISAT Center. ICRISAT plans to increase its basic and strategic research and reduce applied and adaptive research since most Asian NARSs are strong enough to carry out applied and adaptive research.

There is an increasing interest in growing sorghum in several countries in Asia. In the past, ICRISAT's activities in Asia have been channeled mainly through two research networks—Asian Grain Legumes Network (AGLN) and Cooperative Cereals Research Network (CCRN). Recently it has been decided to merge the activities of these two networks under a single network—Cereals and Legumes Asia Network (CLAN). This network will bring national programs and ICRISAT scientists together to work on common problems and to share technology, ideas, and materials.

This meeting has been called to consider establishment of a regional sorghum research network for Asia. I request you to focus your attention on (1) potential of sorghum as a food, fodder, and/or feed in your country, (2) level of interest in sorghum research that the policymakers in your country have, (3) whether your country can fulfill commitments made towards the network, (4) research and training needs of your country, and (5) in what way you can help ICRISAT and vice versa, as true partners in this joint endeavor.

Summaries of Presentations and Discussions

Utilization of End Products

Discussion Leader: Lu Qing-Shan (China)
Moderator: V. Subramanian (ICRISAT)
Rapporteur: V. Mahalakshmi (ICRISAT)

The following areas were considered important for research into utilization of end products in the Asian region:

Processing. Dehulling sorghum is important to make food products, because of its coarse, thick pericarp. Dehulling and the right type of milling improve the palatability of sorghum foods, particularly traditional foods.

Foods. Sorghum continues to be used to make traditional foods such as *roti*, noodles, and rice-like products, and these still need to be considered. However, there was increased interest in the use of sorghum for bread, biscuits, and in snack foods.

Industrial Uses. Sorghum grain has good potential for a variety of industrial uses. Production of starch and starch-based products such as glucose and fructose syrup generally seem to be important.

Sweet Stalk Sorghums. Sweet stalk sorghums can be used to make sugar, syrup, alcohol, and gasohol. Interest in sorghums for sugar production seems to be greatest in the high latitudes where sugarcane has not been adapted.

Forages. In general, the participants felt the need to intensify research on forage sorghums. They felt that the requirements for silage production also need to be addressed.

Feeds. Sorghum could be considered as feed for ruminants and non-ruminants, especially poultry. It can partly replace maize in poultry rations. However, grain processing for feed uses did not assume importance during the discussions.

Table 1. Views of the participants of the Consultative Meeting on the establishment of a Sorghum Research Network for Asia, as revealed by a survey on end-product utilization — processing, food, industrial uses, sweet sorghum, forage, and feed.

	Priority ¹											Mean ²
	Aus- tralia	China	India	Indo- nesia	Iran	Myan- mar	Nepal	Phili- ppines	Thai- land	Viet- nam	Russia	
Processing												
Dehulling	5	2	1	1	3	2	3	1	3	-	-	1.9
Dry milling	5	-	-	-	3	-	-	-	-	-	-	3.0
Food												
Traditional	5	1	3	2	3	3	1	1	1	-	1	1.9
Novel												
Bread	3	2	3	1	1	2	1	1	-	-	2	1.6
Cookies	3	3	2	1	1	2	1	1	5	2	3	2.0
Snacks (pops, flakes, etc.)	3	-	2	1	1	2	1	1	-	1	1	1.3
Industrial Uses (grain)												
Starch	3	2	1	3	1	-	2	1	-	1	1	1.6
Liquor	3	1	1	4	5	3	2	1	-	1	2	2.3
Glucose syrup	3	3	1	4	1	-	2	1	-	1	1	1.9
HFSS (High Fructose Sorghum Syrup)	3	-	1	4	1	-	2	1	-	1	1	1.7
Malt (food)	3	-	1	3	3	-	2	1	-	1	3	1.8
Malting/brewing	3	-	1	4	5	4	2	1	3	1	2	2.6
Sweet Sorghum												
Syrup	-	2	2	4	1	-	1	1	1	-	1	1.7
Sugar	-	3	1	4	1	-	1	1	-	-	2	1.8
Alcohol	2	2	2	5	3	-	1	1	-	-	3	2.3
Gasohol	2	2	1	5	5	-	1	1	1	-	5	2.3
Forage												
Stem/leaves	3	2	1	3	1	1	2	2	1	3	2	1.8
Ensilage	3	2	1	3	1	-	2	2	-	4	1	1.9
Milling	-	4	2	-	1	-	2	2	-	-	3	2.2
Feeds												
Milling	2	4	2	2	5	-	5	2	-	2	1	3.1
Steam flaking	2	4	1	-	5	-	5	-	-	-	2	3.8
Rolling	2	4	2	-	5	-	4	2	-	-	4	3.4
Micronizing	2	4	2	-	5	-	4	2	-	-	4	3.4
Alkali treatment (to reduce tannin)	-	-	-	1	5	-	4	2	-	-	-	3.0

1. In a scale of 1-5, where 1 = high priority, and 5 = low priority.

2. Mean excludes rating by Australia and Russia.

3. - = No priority indicated.

The views of the participants as revealed by a survey are given in full in Table 1 and in summary form.

Clear overall preferences were indicated for research on food uses of sorghum (notably for novel preparations), industrial uses of the grain, sweet stalk sorghums, and forage sorghums. Processing needs and use of sorghum in feed received low priority (Table 2).

Table 2. Priorities for end-product utilization in the Asian region.

Area	Priority ¹
Food	1.7
Industrial uses of grain	2.0
Sweet sorghums	2.0
Forages	2.0
Processing	2.5
Feed	3.3

1. In a scale of 1-5, where 1 = high priority, and 5 = low priority.

It was also clear, however, that there were marked differences in the interests of different countries which would be masked if only an average priority was considered. The following listing indicates the countries which accorded highest priority to the various categories of end-product utilization:

- Processing : India, Indonesia, and Philippines.
- Food
 - Traditional : China, Nepal, Philippines, and Thailand.
 - Novel : Indonesia, Iran, Nepal, Philippines, and Vietnam.
- Industrial uses : India, Iran, Philippines, and Vietnam.
- Sweet stalk sorghums : India, Iran, Nepal, Philippines, and Thailand.
- Forage : India, Iran, Myanmar, and Thailand.
- Feed : India, Indonesia.

Common Production Constraints and Future Prospects

Discussion Leader: Subandi (Indonesia)
Moderator: L.K. Mughogho (ICRISAT)
Rapporteur: R.P. Thakur (ICRISAT)

As an outcome of the presentations and discussion of the country reports, the sorghum production constraints common in the region and the future prospects for the crop are summarized below:

Production Constraints

Land

Sorghum is usually grown in the rainfed marginal lands with erratic rainfall resulting in drought or sometimes waterlogging, low fertility, and salinity. This is probably why sorghum development has been given a low priority in most of the national research programs. When there is improvement of moisture availability or fertility of the land, farmers generally shift to rice, wheat, or maize.

Farmers

Sorghum farmers are usually small land holders. They are poor with limited resources. Their farms are widely dispersed. Many are located in remote and less-developed areas with poor communication facilities, and little access to both information and inputs for crop production. These factors lead to low adoption of improved technology.

Availability of Specific Improved Technologies

New technologies have been generated through research in some of the Asian countries. However, in general, it is felt that specific technologies for production and utilization are still lacking, which contributes to the low comparative advantage of the crop.

Farming Practices

A majority of farmers in the region grow sorghum using traditional methods of cultivation with low inputs such as:

- low quality seeds,
- unimproved low-yielding local varieties,
- no or low doses of fertilizer,
- no protection against pests and diseases,
- improper plant densities, etc.

Farmers usually feel that improved technology is expensive.

Utilization

A major part of the sorghum grain produced in the region is used for human consumption by poor farmers when the more-preferred cereals, rice, and wheat, are not available or are in short supply. There has been a decline in the recent past, in the use of sorghum as food in India, China, and Myanmar. Sorghum is also used for industry, particularly the feed industry. However, as a source of carbohydrate, it is usually a second choice, after maize.

Government Support

Government support for research, extension, seed multiplication, credit, and marketing of sorghum is weak, in line with its ranking, which is fourth or lower. As research is the backbone of development, this leads to slow progress.

Priority of Problems

Priority scores of production problems in individual countries, as evaluated by a survey of the participants' opinions, are shown in Table 3.

Table 3. Priority¹ of sorghum production problems in individual countries, as evaluated by a survey of the participants of the Consultative Meeting on the establishment of a Sorghum Research Network for Asia.

Problem	China	India	Indo-nesia	Iran	Myan-mar	Nepal	Phili-ppines	Thai-land	Viet-nam	Region ²
Abiotic										
Seedling emergence	- ³	5	2	1	4	4	3	3	1	2
Drought	3	1	2	4	1	2	1	1	2	1
Soil nutrient	3	3	2	3	1	1	4	2	4	2
Soil toxicity	-	3	3	3	5	3	4	2	3	4
Biotic										
Shoot fly	-	1	3	5	2	2	2	2	2	1
Stem borer	1	4	4	2	5	1	2	2	2	1
Midge	-	3	5	5	5	3	4	5	2	5
<i>Striga</i>	-	3	5	5	2	5	3	5	5	5
Storage insect	-	3	1	3	5	1	2	3	2	2
Leaf diseases	4	4	3	4	5	5	2	3	3	4
Stalk rot	4	1	3	4	5	4	2	4	3	3
Grain mold	-	1	2	5	2	3	1	1	2	1
Panicle diseases	2	1	4	3	5	5	2	2	3	2
Others										
Quality seed	-	1	2	1	2	1	1	3	2	1
Marketing	-	1	2	3	5	1	1	1	2	1

1. In a scale of 1-5 where 1 = high priority, and 5 = low priority.

2. Regional scores are based on the frequencies of high priorities for the problem in different countries on a scale of 1-5, where 1 = ≤ 5 of priorities 1-2, 2 = ≤ 5 of priorities 1-3, 3 = ≤ 5 of priorities 1-4, 4 = ≤ 5 of priorities 1-5, and 5 = ≤ 5 of priorities 3-5.

3. - = No priority indicated.

Future Prospects

Prospects of Sorghum in Asia

Although there are many interacting constraints in production, prospects for the expansion of sorghum crop in Asia have been identified as being good for several reasons:

- population growth is leading to increasing demand of all food crops, including sorghum;
- as the economies of the Asian countries continue to improve, the demand for animal protein is increasing, and with it the demand for feed and fodder which sorghum can supply more cheaply than other staple grains;
- technologies exist to increase production and utilization of sorghum which can be adapted to diverse conditions in the region. Availability of these technologies will further reduce production costs;
- sorghum can be used for industrial products such as starch, beer, alcohol, sugar, high fructose syrup, bread, biscuits, noodles, plywood, etc.; and
- sorghum is more adapted to ecological conditions not appropriate to rice, wheat, or maize cultivation, and so provides a way to extend the area of cropping; and in association with food legumes, it improves farmers' income and soil fertility.

Generation of Improved Technologies

Production constraints could be overcome by: (a) the generation of specific improved technologies for rainfed marginal lands and land with insufficient irrigation to grow prime crops; and (b) the promotion of utilization to increase the demand for sorghum.

Establishment of an Asian Sorghum Research Network

In most of the Asian countries, sorghum is a minor crop; thus it is given low priority, leading to poor resource allocation for research and development. To use efficiently all the available resources for sorghum research and development in different countries of the region, it is recommended that a flexible Sorghum Research and Development Network be established.

The network should provide a structure to:

- promote research collaboration and associated activities between ICRISAT, the national programs in the Asian region, and other international or regional programs;
- act as a regional center of information on sorghum research; and
- promote the exchange of information, knowledge, experience, germplasm, technologies, and expertise among scientists of the region.

Research Priorities and Cooperative Research

Discussion Leader: B.S. Rana (India)
Moderator: J.W. Stenhouse (ICRISAT)
Rapporteur: K.N. Rai (ICRISAT)

Elevation of status. The group felt that productivity of sorghum in Asia was very low in spite of the fact that it is an important source of food, feed, and fodder in drier areas. Thus, it is essential to elevate the status of sorghum from a subsistence to a high value crop.

Diversification of uses. The group recognized that sorghum can provide raw materials for industrial production of starch, malt, beverages, sugar, novel food products, and feed. Hence, research on these aspects to diversify uses of sorghum should proceed simultaneously.

ICRISAT's contribution. The group felt that the progress made by various disciplinary research projects at ICRISAT was satisfactory. Hence, ICRISAT can now concentrate on those areas where more work needs to be done and thus further contribute to sorghum improvement in the region.

Transfer of resistance. The group recognized: (1) grain yield plateauing in rainy- and postrainy-season sorghums, and (2) the limited success in transferring resistances to shoot fly, stem borer, grain mold, and charcoal rot/lodging associated with drought into otherwise desirable cultivars. Since traditional breeding methods have limited success in dealing with such transfers, it seems appropriate to use modern biotechnological methods to attempt to transfer these resistances to desirable cultivars.

Role of ICRISAT. The group felt that ICRISAT Center should augment its research activities, and the dissemination of the results of such research, particularly in genetic enhancement, germplasm supply and utilization, upgrading of host-plant resistance in high-yielding backgrounds, and low-cost input management. The aim of such research should be to increase significantly the productivity and profitability of sorghum cultivation with focus on industrial uses of the crop in the region.

Fodder. Since sorghum is the most important source of fodder for draft and milch cattle, it is essential to develop multi-cut forage genotypes with high regeneration and biomass productivity, combined with high nutritive value.

Collaboration among national programs. Expertise is available in tissue culture and protoplast fusion in India and in tissue culture in China and Russia. Therefore, mutual collaboration among national programs through a network is essential for rapid progress in each country.

Establishment of Network recommended. The group strongly recommended that a Regional Sorghum Research and Development Network should be established with adequate financial support and resources to develop an effective regional cooperative program. Links should also be established with sorghum improvement programs of Russia and Australia, INTSORMIL, USDA, and FAO/UNDP to provide an opportunity for global testing of improved germplasm and technologies.

Steering Committee. The group also recommended setting up a steering committee or advisory group to utilize existing expertise in the Asian region, and to participate in planning and monitoring progress of network activities.

Transfer of Varieties and Technologies to Farmers

Discussion Leader: W.B. Malacad (Philippines)

Moderator: K.F. Nwanze (ICRISAT)

Rapporteur: B.S. Talukdar (ICRISAT)

The procedures for varietal testing, release, seed multiplication, and technology transfer to farmers in various countries in the Asian region are variants of the same basic theme (Tables 4, 5, and 6). However, the degree of control through legislation, the nomenclature, and the competent authorities for the various stages in the process differ markedly from country to country.

In general, on-farm testing of cultivars and technologies is weak in the Asian region. Another weak area is on-farm research to diagnose farmers' problems, and suggest possible solutions, and to tap farmers' opinions about improved cultivars and new technology. Adequate formal testing mechanisms do exist to determine the cultivars suitable for release. However, there are bottlenecks to dissemination of cultivars in public sector seed multiplication and in the extension services.

Table 4. Procedures for varietal testing and release to farmers.

Council/Committee	Member	Activities	Cooperators
- National cooperative trial	Breeding research institutions,	Conduct multilocal field trials	- Research institutions
- Test trials	both government and private institutions		- Major sorghum-growing areas (farmers' fields)
- Regional technical working committee	- All breeding research institutions - Farm leader representative	- Workshop (yearly) - Identify variety for release	
- Central subcommittee	- National commodity team leaders	Approve, and recommend for release of a variety.	
- Approval committee			

Table 5. Procedures for seed multiplication and transfer/distribution to farmers.

Category	Agency involved	Additional comment
Breeder seeds	Breeding institution	} Both private and government institutions.
Foundation seeds	Breeding institution	
Registered seeds	<ul style="list-style-type: none"> - Seed-grower cooperatives - Seed cooperators - National farm cooperators 	} Responsible for variety distribution and transfer of certified seeds to the farmers.

Table 6. Procedures for transfer of technologies to farmers.

Strategies	Agency responsible
Farmer field test (verification)	Department of Agriculture/Department of Agriculture Extension/Onfarm Research Team
On-farm testing demonstration in major sorghum-growing areas	Department of Agriculture/Department of Agriculture Extension/Onfarm Research Team
Short training for farmers at regional research farm	Regional Research and Extension Division/Department of Agriculture/Onfarm Research Team
Farmers' field day (visit to regional research station)	Regional Research and Extension Division/Department of Agriculture/Onfarm Research Team
Publications	Regional Applied Communication Groups
Special organization	Technical spread station different levels: <ul style="list-style-type: none"> - National - Provincial - Villages
Onfarm Research Team to survey, diagnose farmers' problems, and identify solutions.	Directorate of Agriculture/Research institutions

Technology Exchange (workshops, monitoring tours, etc.)

Discussion Leader: Abbas Almodares (Iran)

Moderator: C.M. Pattanayak (ICRISAT)

Rapporteur: C.L.L. Gowda (ICRISAT)

Workshops. More emphasis should be given to general workshops covering all aspects of sorghum. Workshops on special problems (e.g., resistance to grain mold, drought tolerance, utilization, etc.) should be organized when necessary.

Meetings. Depending on the network's needs, meetings should be organized once in 2 or 3 years. Regional review and planning meetings, followed by consultative group meetings should be given priority over scientists' meetings.

Monitoring Tours. Monitoring tours were considered useful, but the relevance of the subject or technology in the country planned for such tours should be an important criterion. Multi-country tours were preferred to single-country tours.

Training. Training was rated as a high priority by most countries. Short-term training of mid-career scientists to upgrade their skills and learn special skills was rated highest. Some countries also favored, for junior technicians, general, short-term training, and long-term training from 6 months to 2 years.

Information Exchange. Participants said that they were able to share research results, but endorsed the need for more effective information exchange. They emphasized the need for a regional database for the network.

Working Groups. Participants indicated the need to establish working groups of interested scientists for special research topics; e.g., grain mold, drought tolerance, and utilization.

Steering Committee. Most participants felt the need for a Steering Committee that should involve policymakers, scientists from national programs, ICRISAT, and other interested bodies. The number of members should, however, be kept to a minimum. The functions of the Committee should include planning and evaluation of network activities. The need for a separate evaluation committee was also emphasized.

Funding. It was recommended that all member countries should pledge personnel and resources for the conduct of trials, local transport, and local expenses for network activities in their own country; and that ICRISAT should support the coordination of the network. Additional support might be needed for meetings, international travel, and for special projects (e.g., biotechnology). ICRISAT should be given the authority to seek or arrange additional funding. Possible support for network activities might come from Australia or the USAID Title XII Collaborative Research Support Program on Sorghum and Pearl Millet (INTSORMIL). Specific mention was also made of the possibility of obtaining support through the existing FAO-RAS/89/040 project on Food Legumes and Coarse Grains.

Recommendations

Recommendation Committee:

Chairperson:	Beatriz P. del Rosario (Philippines)
Co-chairperson:	C.M. Pattanayak (ICRISAT)
Members:	B.S. Rana (India) Subandi (Indonesia) Abbas Almodares (Iran)
Rapporteur:	S.D. Singh (ICRISAT)
Resource persons:	J.M.J. de Wet (ICRISAT) D.G. Faris (ICRISAT)

The Recommendations Committee carefully considered all the presentations made at the meeting, especially those of the discussion leaders who drew together points of general concern on the special themes: utilization of end products, common production constraints and future prospects, research priorities and cooperative research, transfer of varieties and technologies to farmers, and technology exchange (workshops, monitoring tours, etc.). The reports of the discussion leaders under these headings were given in full in the previous section. In the plenary session, Dr Beatriz P. del Rosario presented the following report.

Report of the Recommendations Committee

Rationale

Population in the Asian region continues to grow and with it the demand for food. However, existing production frontiers have not been fully explored. There has been very limited utilization, particularly of marginal idle drylands, and their exploitation remains a challenge to the Asian region. In these agro-environments, sorghum has a comparative advantage over other crops such as maize.

At present, the major sorghum producers in Asia are India and China. In both countries, the area under production has decreased, and food consumption habits have changed. Preferences are being shown for novel food products and there is a growing interest in industrial uses of

sorghum (for example, in animal feeds, starch, alcohol, and sugar production). These trends, in these countries and in Australia and Russia, indicate that these are the growth areas in which to advance the sorghum industry in Asia. The example of Thailand, which has captured an export market for sorghum in Japan, shows the potential for commercialization of the crop.

In the other countries in Asia, such as Philippines, Indonesia, Myanmar, Nepal, and Vietnam, sorghum is a minor crop that has not benefited from major research efforts. But its potential for processed food products and industrial uses is tremendous, given the necessary technology and market adjustments. For these countries, appropriate technology needs to be developed to address production, postproduction, and processing constraints. Much suitable technology has already been developed in India and China and by international institutes such as ICRISAT and national institutions in Australia and Russia. Collaboration to pool expertise and resources from all these sources to adapt existing technology to new areas would lead to substantial savings in research efforts required. It would also shorten the time lag between technology adoption and eventually, its commercialization. This is particularly important considering that expenditure on research and development in Asia is well below the World Bank's recommended figure of 1% of gross value added (GVA) and seems likely to remain so.

Network

The Recommendations Committee strongly believed that there can be rapid progress in technology generation, adaptation, and adoption through pooling of resources and expertise. For this, a regional network is a necessity. The Committee wished to express that they were committed to setting up the network, and although the meeting was organized specifically to consider a research network, most participants indicated interest in conducting research in relation to development. The Committee therefore recommended that the network be named 'Sorghum Research and Development Network for Asia'.

Goal

The overall goal of the network is to elevate the status of sorghum from that of a mere subsistence to a high value crop. The potential for this exists and a strategy must be developed to achieve it through research, intercountry cooperation, and collaboration with international organizations such as ICRISAT, INTSORMIL, and others. It may take 5-10 years to achieve the goal, but it is important to have the right vision at the outset — that is, to work together through a network.

Objectives

The following objectives of the network have been identified:

- to exchange improved genetic material and germplasm;
- to conduct cooperative research and development on sorghum production and utilization;
- to upgrade research and development capabilities of the participating countries;
- to support and accelerate transfer of technology to farmers and industries; and
- to develop efficient databases and sharing of information.

Operational Strategy

For the network to be effective, an appropriate structure is necessary. The Committee recommended that the structure comprises a Steering Committee, a Technical Committee, and a Coordination Unit, which should continually liaise with each other. Their composition and responsibilities are outlined below.

Steering Committee. The Steering Committee is a policymaking body and, as such, its members should be policymakers nominated from national programs, ICRISAT, and donor agencies. The Network Coordinator should be an ex-officio member of this committee. A national representative should be elected chairperson for a period of 2 years. The terms of reference of the Steering Committee should be:

- to provide guidance and direction to the overall activity of the network;
- to advise the governments of the participating countries about the necessary inputs and funds; and
- to contact donor agencies for funding the network activities.

The Steering Committee should meet every 2 years to review progress reports presented by Country Coordinators and to provide future direction.

Technical Committee. The Technical Committee should comprise scientists nominated by member countries as Country Coordinators, and the Network Coordinator, who should act as convener. The Chairperson should be elected by the Country Coordinators every third year. The Technical Committee should advise on the scientific content of network activities, drawing on resource scientists from ICRISAT and other institutions as necessary.

Coordinating Unit. The Coordinating Unit should be located at ICRISAT Center and all its functions should be executed by ICRISAT. The

Unit should consist of a coordinator nominated by ICRISAT, supported by the necessary scientific and secretarial staff and funding.

Funding Strategy

Funding support is essential for all activities of the network. The group recommends that:

- each participating national government supports and provides facilities for all network activities within that country; and
- ICRISAT supports all activities of the Coordinating Unit.

The overall success of the network depends on establishing effective collaborative activities between member countries and organizations, as well as on the steering and technical committee meetings, workshops, monitoring tours, equipment and supplies, specialist meetings, technical assistance, etc. For such needs, external donor support will be essential. Suggested donors are: United Nations Development Programme/Food and Agriculture Organization of the United Nations, Asian Development Bank, United States Agency for International Development, United States Department of Agriculture, INTSORMIL, Governments of Japan, Australia, and other agencies in developed countries.

Network Members

The members are: Australia, China, India, Indonesia, Iran, Myanmar, Nepal, Pakistan, Philippines, Thailand, Russia, and Vietnam. Although Australia and the Russia are not located within the region, they are invited to join the network because of their proximity to the region, and their rich experience of sorghum research and development. Their membership will enrich the network and will be of mutual benefit.

Activities for 1991–92

The Recommendations Committee requests ICRISAT to initiate network activities during 1991–92. The Technical Committee should meet to prepare a workplan during 1992. ICRISAT and member countries should explore possibilities of external funding.

Appendix 1: List of Participants

- Australia** R.G. Henzell
Principal Plant Breeder
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- China** Lu Qing-Shan
Deputy Director
The Sorghum Research Institute
Liaoning Academy of Agricultural Sciences
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Liaoning Province
- India** U.R. Murty
Director
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- B.S. Rana
Project Coordinator
All India Coordinated Sorghum Improvement Project
National Research Centre for Sorghum
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- Indonesia** Subandi
Maize Breeder
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- Iran** Abbas Almodares
Sorghum Research Coordinator
Institute of Horticulture
College of Science
University of Isfahan
Isfahan

- Myanmar** Toe Aung
Assistant Manager
Agriculture Research Station
Yezin
Pyinmana
- Nepal** D.B. Tamang
Agronomist
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Lalitpur
- Philippines** Beatriz P. del Rosario
Deputy Executive Director for Research and Development
Philippine Council for Agriculture, Forestry, and
Natural Resources Research and Development
Los Banos
Laguna
- W.B. Malacad
Agronomist
University of Southern Mindanao
Agricultural Research Center
Kabacan
North Cotabato
- Russia** Alia Sabirovna Kazakova
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- V.V. Metlin
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Coordinator (Sorghum Improvement)
Field Crops Research Institute
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India

ICRISAT**Administration**

J.G. Ryan, Director General
Y.L. Nene, Deputy Director General
S.P. Ambrose, Assistant Director General (Admn)
P.V. Shenoi, Assistant Director General (Liaison)
B.C.G. Gunasekera, Advisor to the Director General
for Donor Relations
B.K. Patel, Special Assistant to the Director General
for Planning

Cereals

J.M.J. de Wet, Program Director
G. Alagarwamy, Cereals Physiologist
Belum V.S. Reddy, Senior Sorghum Breeder
C.S. Busso, Associate Cell Biologist
V. Mahalakshmi, Cereals Physiologist
R.K. Maiti, Visiting Scientist, Cereals Entomology
L.K. Mughogho, Principal Cereals Pathologist
K.F. Nwanze, Principal Cereals Entomologist
C.M. Pattanayak, Principal Coordinator,
Cooperative Cereals Research Network
K.N. Rai, Senior Millet Breeder
K.V. Ranaiah, Principal Cereal Geneticist
H.F.W. Rattunde, International Associate Sorghum Breeder
N. Seetharama, Senior Scientist
H.C. Sharma, Cereals Entomologist
J.A. Sifuentes, PDF, Cereals Pathology
S.D. Singh, Senior Cereals Pathologist
P. Soman, Cereals Physiologist
J.W. Stenhouse, Principal Sorghum Breeder
Suresh Pande, Cereals Pathologist
B.S. Talukdar, Millet Breeder
S.L. Taneja, Cereals Entomologist
R.P. Thakur, Senior Cereals Pathologist
A. Thomas, PDF, Cereals Physiology
F. Wehmann, PDF, Sorghum Breeding

Crop Quality

R. Jambunathan, Program Leader
V. Subramanian, Biochemist

Genetics Resources

M.H. Mengesha, Program Leader
K.E. Prasada Rao, Senior Germplasm Botanist

Human Resources Development

D.L. Oswalt, Program Leader

Legumes Program

D. McDonald, Program Director
D.G. Faris, Principal Coordinator,
Asian Grain Legumes Network
C.L.L. Gowda, Senior Legumes Breeder

Library and Documentation Services

P.K. Sinha, Manager (Acting)
D. Jotwani, Library Officer

Resource Management

J.L. Monteith, Program Director
M.M. Anders, Principal Production Agronomist
T.G. Kelley, Assistant Principal Economist
Piara Singh, Senior Soil Scientist
R.P. Singh, Economist

Appendix 2: Program

Monday, 16 September

0815–0855 Registration

Opening Session

Chair : J.M.J. de Wet

0900–0915 Opening address and objectives of the consultative meeting: J.M.J. de Wet

0915–0935 ICRISAT's role in cereals and legumes research in Asia: Y.L. Nene

Session I: Asian National Program Presentations

Chair : Beatriz P. del Rosario

Co-chair : J.W. Stenhouse

Rapporteur : G. Alagarswamy

1010–1025 China: Lu Qing-Shan

1025–1040 Discussion

1040–1055 India: U.R. Murty

1055–1110 Discussion

1110–1125 Indonesia: Subandi

1125–1140 Discussion

1140–1155 Iran: Abbas Almodares

1155–1210 Discussion

1210–1225 Myanmar: Toe Aung

1225–1240 Discussion

1240–1300 General discussion

Session II: Asian National Program Presentations

Chair : Lu Qing-Shan

Co-chair : K.F. Nwanze

Rapporteur : P. Soman

1400–1415 Nepal: D.B. Tamang

1415–1430 Discussion

1430–1445 Philippines: Beatriz P. del Rosario

1445–1500 Discussion

1515–1530 General discussion

1530–1615 Preliminary meeting of discussion groups

Tuesday, 17 September

Session III: Asian National Program and Other Institution Presentations

Chair	: Subandi
Co-chair	: L.K. Mughogho
Rapporteur	: Suresh Fande
0830-0845	Thailand: Julee L. Tippayaruk
0845-0900	Discussion
0900-0915	Vietnam: Dao Quang Vinh
0915-0930	Discussion
0945-1005	Australia: R.G. Henzell
1005-1020	Discussion
1020-1040	INTSORMIL: J.M. Yohe
1040-1055	Discussion
1055-1115	Russia: Alia Sabirovna Kazakova
1115-1130	Discussion
1130-1300	General discussion

Session IV: Activities at ICRISAT Center

Chair	: R.G. Henzell
Co-chair	: M.H. Mengesha
Rapporteur	: Belum V.S. Reddy
1400-1415	Cell Biology/Biotechnology: J.M.J. de Wet
1415-1430	Entomology: K.F. Nwanze
1430-1445	Pathology: L.K. Mughogho
1445-1500	Physiology: P. Soman and N. Seetharama
1500-1515	Breeding: J.W. Stenhouse
1530-1545	Germplasm Resources and Use: K.E. Prasada Rao
1545-1600	Crop Quality: V. Subramanian and R. Jambunathan
1600-1630	General discussion

Wednesday, 18 September

Session V: Activities at ICRISAT Center

Chair	: U.R. Murty
Co-chair	: D.L. Oswalt
Rapporteur	: H.C. Sharma
0830-1030	Field visit: K.E. Prasada Rao, M.M. Anders, and J.W. Stenhouse
1030-1045	Agroclimatological studies: Piara Singh
1045-1100	Research on production agronomy: M.M. Anders
1100-1115	Trends in sorghum production and utilization in Asia: T.G. Kelley and R.P. Singh
1115-1145	Discussion

1145–1155 Library and documentation: D. Jotwani
 1155–1205 Human resources development: D.L. Oswalt
 1205–1215 Discussion
 1215–1225 Cereals and Legumes Asia Network –
 Cereals: C.M. Pattanayak
 1225–1235 Legumes: D.G. Faris
 1235–1300 Discussion

**Session VI: Issues for Discussion on Regional Sorghum
 Research Network**

Chair : Julee L. Tippayaruk
 Co-chair : D.G. Faris

1400–1430 Utilization of end products — food, feed, fod-
 der, alcohol, syrup, and industrial use
 Discussion leader: Lu Qing-Shan
 Moderator : V. Subramanian
 Rapporteur : V. Mahalakshmi

1430–1500 Common production constraints
 and future prospects
 Discussion leader : Subandi
 Moderator : L.K. Mughogho
 Rapporteur : R.P. Thakur

1515–1545 Research priorities and cooperative research
 Discussion leader : B.S. Rana
 Moderator : J.W. Stenhouse
 Rapporteur : K.N. Rai

1545–1615 Transfer of varieties and technologies
 to farmers
 Discussion leader : William Malacad
 Moderator : K.F. Nwanze
 Rapporteur : B.S. Talukdar

1615–1645 Technology exchange (workshops, monitoring
 tours, etc.)
 Discussion leader : Abbas Almodares
 Moderator : C.M. Pattanayak
 Rapporteur : C.L.L. Gowda

Thursday, 19 September

Session VII: Recommendation Committee Meeting

Chair : Beatriz P. del Rosario
 Co-chair : C.M. Pattanayak
 Rapporteur : S.D. Singh
 Resource persons: J.M.J. de Wet and D.G. Faris

0830–1215 Preparation for recommendations

Session VIII: Plenary Session

Chair : Y.L. Nene
Co-chair : Abbas Almodares
Rapporteur : S.L. Taneja

1215–1300 Presentation of recommendations by the
Chairman of the Recommendation Committee
1500–1645 Individual meetings with ICRISAT scientists

Friday, 20 September

0830–1230 Visit to National Research Centre for Sorghum/
All India Coordinated Sorghum Improvement
Project, Rajendranagar, Hyderabad