BIOLOGICAL NITROGEN FIXATION

BNF BULLETIN

Spring 1988 Volume VIII, Number 2

Demand for Inoculants Increasing in Zambia

The demand for *Rhizobium* inoculants is increasing in Zambia at a rate of 10% per year. Leadership for meeting this demand is in the hands of Ronnie Nyemba, soil microbiologist in charge of inoculant production at Mount Makulu Research Station (Ministry of Agriculture and Water Development, P.B. 7, Chilanga, Zambia). Nyemba received an M.S. at the University of Hawaii through sponsorship by University of Illinois ZAMARE Project and NifTAL. His training is in soil microbiology/agronomy with emphasis on production and handling of rhizobial inoculants.

Mongu peat being processed. The acid peat is neutralized with lime prior to packaging and autoclaving.

Specialized training at NifTAL and at a joint FAO/NifTAL BNF Resource Center/Thai Department of Agriculture Inoculant Production course held in Bangkok, Thailand, 1986, prepared him for his present work in his home country. Nyemba supervises inoculant production and quality control, conducts field testing of new products, trains extension agents, and is devising a marketing strategy for the inoculants.

Currently, the Mount Makulu facility is producing 30,000 (150 gram each) bags of inoculant for alfalfa, *Leucaena*, peanut, *Phaseolus*, and soybean. Inoculants

In the lab with rhizobial cultures which will be diluted then injected into injected peat.

are produced using locally mined peat from Mongu which is processed for carrier use at Mt. Makulu. The peat is steam sterilized in autoclavable bags, then injected with a dilution of a broth culture of *Rhizobium*.

Quality control measures are instituted throughout the process from an initial purity check of the stock culture to a final plate count of the inoculants before they are marketed. Viable numbers of *Rhizobium* are in excess of one billion cells per gram of inoculant when they leave the factory. This quality is equal to or better than commercial inoculants produced in the USA.

Continued on Page 8

New Initiatives in Training

The scope of NifTAL's training program has been broadened to include current techniques in biotechnology.

The expanded program will continue to offer the Basic Rhizobium Technology and Inoculant Production and Fermentation courses (each 6 weeks) and host visiting scientists from developing countries (3-12 months). New courses in the curriculum are: Monitoring Microorganisms in the Environment (4 weeks); Establishing and Operating an Inoculant Production Enterprise (3 weeks); and *Rhizobium* Microbiology and Genetic Technology (6 weeks).

As an example of the contents of a new course, the 4-week Monitoring Microorganisms course, teaches participants an array of techniques which can be used to track microorganisms introduced into the field. Topics to be covered are serological, biochemical, and genetic techniques, and bacteriophage typing.

NifTAL also plans to hold 1-week workshops on *Rhizobium* technology for extension workers, 3-day workshops for administrators and policy makers, as well as a 3-day workshop on planning and organizing a BNF training course.

All courses are modular and can be tailored to meet specific participant needs. The next scheduled course will be on inoculant technology. Unlike previous courses which emphasized the production aspect, this particular

Continued on Page 4

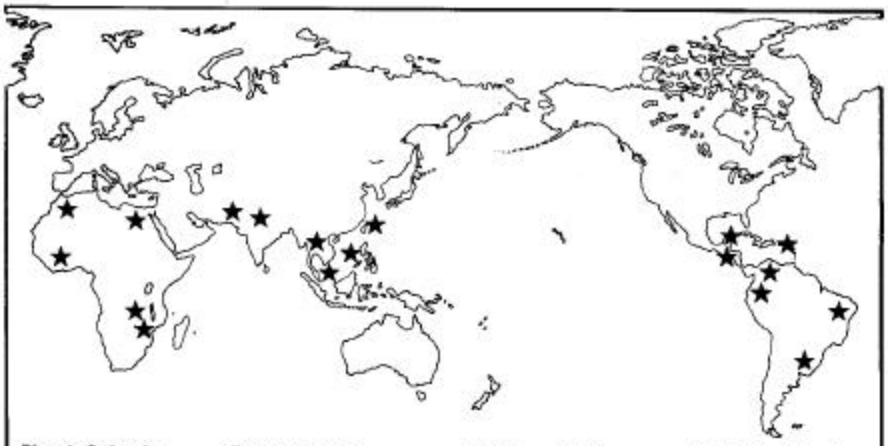
WREN: Worldwide Rhizobial Ecology Network

What determines a legume's response to inoculation? Since a 1979 planning workshop, NifTAL has addressed this problem. First, through the INLIT (International Network of Legume Inoculation Trials) experiment which was conducted by over 200 BNF researchers in more than 50 nations. The data from these experiments indicated that a response to inoculation can be predicted with a high degree of certainty for species such as soybeans. But, other species like dry beans were highly variable in their inoculation responses.

BNF researchers continued to ask why many legume species show highly variable inoculation responses. What determines response to inoculation by legumes? And could additional information increase the reliability of predictions about inoculation response? In 1986, NifTAL scientists undertook a basic research project to answer these questions.

The overall goal of the project is to develop a deeper understanding of the ecological dynamics of *Rhizobium* and *Bradyrhizobium* as free--living soil microorganisms and when in symbiotic association with legumes. One specific objective is to identify which abiotic and biotic factors determine rhizobia ecology, in general, and inoculation response, in particular. This information is being used to construct a predictive model of inoculation response which can be used not only to explore other basic research questions but also to help farmers decide whether to use inoculants.

To obtain the large database required to construct and verify a predictive model of legume response to inoculation, the WREN was established. Member scientists from 19 nations are linked by their interest in rhizobial ecology. Most members contributed to initial network activities by reviewing and refining the standard experimental protocols for the laboratory and greenhouse studies.



Ricardo S. Araujo
Goiana, Brazil

Robert Abaidoo
Kumasi, Ghana

Dr. Kauser Malik
Faisalabad, Pakistan

Dr. Carlos Labandera
Montevideo, Uruguay

Dr. Rosemary Bradley
Cali, Colombia

Dr. Juan Carlos Rosas
Tegucigalpa, Honduras

Dr. Eduardo Schroder
Mayaguez, Puerto Rico

Dr. Vernon Chinene
Ronnie Nyemba
Lusaka, Zambia

Dr. Carlos Ramirez
Turrialba, Costa Rica

Dr. S. V. Hegde
Bangalore, India

Dr. C. C. Young
Taichung, Taiwan

Dr. Paul Davis
Marondera, Zimbabwe

Sra. Consuelo Estevez
Quito, Ecuador

Dr. Zulkifli Shamsuddin
Sedang, Selangor, Malaysia

Dr. N. Boonkerd
Dr. P. Wadisirisuk
Bangkok, Thailand

Dr. Hassan Moawad
Dokki, Egypt

Dr. Ali Hilali
Rabat, Morocco

Dr. Erlinda Paterno
Dr. Mercedes Ulmali Garcia
College, The Philippines

WREN members are using the most probable number (MPN) technique to enumerate the rhizobial population in soils for diverse species of legumes. This information will be used to identify, for subsequent greenhouse and field inoculation trials, which legume species have different rhizobial populations available to them.

Greenhouse pot experiments are designed to determine whether results from pot studies are similar to those obtained from field studies. Species that show different responses to inoculation in the greenhouse study will be selected for subsequent field experiments. These field experiments will initially test the hypothesis that the magnitude of an inoculation response is a function of the size and effectiveness of the native rhizobial population. In addition, the field study will generate information on competition between inoculant and native strains for nodulation in different environments.

Following completion of the field study, WREN members will join in formulating a predictive model using data collected by the whole network and then validate the model under conditions prevailing in their home countries. The WREN research network includes training as an important part of its activities. Students are conducting the standardized experiments as part of their graduate education, thus enhancing the research capabilities of their home institutions.

This activity is being supported by a grant from the National Science Foundation (NSF) and NifTAL's Cooperative Agreement with USAID/Science & Technology Bureau.

World Food Prize

In recognition of those men and women who have made outstanding contributions to expanding and improving the quality, quantity, and availability of food throughout the world, the General Foods World Prize was initiated in 1987. The purpose of this prize is to honor men

Continued on Page 4

Commentary

Scientists are using a variety of methods to explore the possibilities of changing non-nitrogen fixing plants into fixers. Dr. Nancy E. Kyle of Oregon State University (Department of Horticulture, College of Agricultural Sciences, Corvallis, Oregon 97331-2911) has used an interesting micrografting approach. Below she comments about her work.

Three rosaceous genera that provide unique opportunities for actinorhizzal research are the desert shrubs *Cowania, Purshia,* and *Fallugia. Cowania* and *Purshia* are nodulated by *Frankia* but *Fallugia* is not. Several of the species are related closely enough to allow hybridization, suggesting possible compatibility as graft partners. Plants in which fixers are grafted with nonfixers could provide a system for studying rootstock vs. scion effects in nodulation and fixation.

Preliminary trials with grafting these species in the field and greenhouse were unsuccessful. Therefore, we modified the micrografting technique of Murashige, et. al., for use with our system. Micrografting uses materials grown in tissue culture. Grafts are performed under a dissecting microscope. The plants are then grown in aseptic conditions for 4 weeks or until significant shoot growth is observed, when they are transferred to the greenhouse and gradually acclimated to life outside the test tube. Tissue culture provides a controlled environment in which moisture, temperature, and nutrient stresses are minimized and allows the successful grafting of these slow growing plants.

Plants which have fixing scions grafted onto nonfixing rootstocks, or the reciprocal combination, or combinations of plants with varying degrees of efficiency of fixation or nodulation could provide a valuable system for studying the processes of fixation and nodulation. In most cases, the rootstock can be made to sprout and the scion can be made to root. This produces plants that have shoots or roots of more than one species. These plants could prove to be useful tools in nodulation studies.

Much work has been done to extend nitrogen fixation capabilities to new species using genetic engineering. Most workers agree that practical application of this technology is a long way off, if indeed possible at all. Grafting may provide an alternative method of extending the range of nitrogen fixation. The Rosaceae include many horticultural crops in which grafting between different species and even genera is common. The possibility exists that some of these crops could be grafted onto fixing root stocks, thereby reducing their need for nitrogen fertilizer.

Purshia tridenta scion on Fallugia paradoxa rootstock 7 months after grafting.

To date, the success rate of micrografts between *Cowania mexicana, Fallugia paradoxa, Purshia glandulosa,* and *P. tridentata* is low (~ 20%). This may be due to many factors. The micrografting requires considerable manual dexterity as these tissues are quite fragile. These plants are slow growing and have a quiescent or dormant phase even in the greenhouse. This difficulty may be overcome with the use of a growth chamber. More studies are necessary to determine whether there is an optimum time of year

Continued on Page 7

BNF Research in China

Legume BNF research in China began in the mid-1930's. Its initiators were professors Chang Xian-wu, Chen Hua-Kui, and Fan Qing-sheng. In 1950, Professor T.S. Hu first introduced and modified the U.S. legume inoculation technology originally developed by Dr. J. C. Burton. The inoculants prepared in Hu's laboratory were applied to thousands of hectares of peanuts.

Since that time, *Rhizobium* inoculant production has reached nationwide proportions. Strain selection, inoculant production technology, research on inoculant application, and strain competition have advanced considerably.

Scientists of all ages came together to review this history and to discuss current problems in the field of BNF at a national meeting in the People's Republic of China. The National Conference on *Rhizobium*/Legume Symbiosis was organized by the Chinese Society of Soil Science, hosted by the Si-chuan province Soil Science Society, and held in Chengdu from 21-26 May, 1987. The 73 participants from 30 different provinces and cities represented 33 research institutes and universities.

The meeting's main topic of discussion was how to best utilize the potential of BNF. The participants agreed that more emphasis should be placed on agronomic aspects and greater efforts are needed in theoretical and basic research in the area of transforming non-fixing into nitrogen fixing plants.

"China is a large country with vast resources," writes Professor Hu, "and there are wide diversities of plant species with N-fixing capabilities. We should continue to focus on investigating and developing our natural resources. Our research team in BNF is continually growing and we should strive for improved communications and collaboration in order to promote and further our research."

For further information, contact T. S. Hu, Soil Microbiology

Continued on Page 4

Continued from Page 1
course will address factors affecting legume response to inoculation with *Rhizobium* under tropical field conditions.

The course will be held at the BNF Resource Center, Bangkok, Thailand, in June 1988. Interested persons should contact H. Hoben, NifTAL Project, 1000 Holomua Avenue, Paia, HI 96779-9744 USA.

Continued from Page 3
Branch, Soils Division, Chinese Academy of Agricultural Sciences, Beijing 81, PRC.

Continued from Page 2
and women whose work has made an important difference in the process of providing food for people--from policy development to research, from production to processing, from distribution to human nutrition. Dr. Swaminathan, former director of the International Rice Research Institute (IRRI) in the Philippines, was the first recipient of this $200,000 award in October 1987.

Any recognized institution or organization may make nominations. Nominees should be those individuals whose efforts have contributed in a material way toward improving the quality, quantity, or availability of food. The call for nominees is made annually. December 31 is the deadline for nominations for the award to be presented the following October. Nominations remain active for three years.

For information, write to Edward L. Williams, Administrator, General Foods World Food Prize, Winrock International, Petit Jean Mountain, Morrilton, Arkansas 72110, USA.

Recent NifTAL Visitors

Dr. Tejpal Gill, USAID, Science & Technology Branch, Washington, D.C., shares ideas with Dr. Peter Goldsworthy, International Service for National Agricultural Research, the Hague, Netherlands, and Dr. Ben Bohlool, NifTAL Project Director. The conversation occurred during a recent visit by both to NifTAL's Maui Headquarters.

Meeting Notes

3rd AABNF

The 3rd conference of the African Association for Biological Nitrogen Fixation (AABNF) will be held at the Hotel Meridien, 7-12 November 1988, in Bambey, Senegal. It is being organized by the West Africa MIRCEN in collaboration with the Ministry of Rural Development of Senegal and the Senegalese Institute of Agricultural Research (ISRA).

The conference theme is "Maximizing BNF for agricultural and forestry production in Africa." Poster and paper sessions and workshops will be held. The workshops are being organized on the following specific topics: Improvement of symbiotic N-fixation through soil management practices; Improvement of symbiotic N-fixation through plant selection; Inoculation - inoculant production and inoculation trials; Measurement of N-fixation; BNF in grain legumes; BNF in pasture legumes; BNF in trees; Associative N-fixation; Azolla/Anabaena association; and N economy in intercropping and agroforestry systems. Also planned are a round table on the role of United Nations Organizations and NGO's in BNF technology in Africa and a session for general considerations and recommendations.

To receive the second announcement containing the call for papers, instructions for submitting abstracts, conference program, registration, accommodations, and tour information, mail requests to the following address: Secretariat, IIIe Conference AABNF, MIRCEN - CNRA, B.P. 53, Bambey, Senegal (West Africa); telex: 3117 ISRA SG, telephone 73.60.50.

Biotechnology Symposium

An invitation is open for interested persons to participate in the 8th International Biotechnology Symposium. BNF workers will be interested in many symposium sessions including one on nitrogen fixation.

Venue for the meeting is Paris, dates are 17-22 July 1988, and organizers are the French Society of Microbiology in connection with the European Federation of Biotechnology (EFB) under the auspices of the International Union of Pure and Applied Chemistry (IUPAC).

Deadline for registration is 31 March 1988. To register and for general information, contact 8th International Biotechnology Symposium; c/o S.O.C.F.I.; 14, rue Mandar; 75002 Paris, France; telex: 214403 F.

Molecular Genetics of Plant-Microbe Interactions

The Fourth International Symposium on the Molecular Genetics of Plant-Microbe Interactions will be held in Acapulco, Mexico, from 15-20 May, 1988. The goals of the meeting are to give an overview of the field, to review unpublished results, and to stimulate integrative discussions on the new avenues that research could take in the future. Most work will be presented as posters. These will be displayed throughout the meeting and time will be provided for person to person interactions.

Registration should be done as soon as possible. For information, contact the meeting organizer: Rafael Palacios, Centro de Investigacion Sobre Fijacion de Nitrogeno (U.N.A.M.), Apdo Postal 565-A, Cuernavaca, Mor Mexico; telephone (73)13-9877; Telex CIFNME 173425.

N-Fixation with Non-Legumes Meeting Held

The 4th International Symposium on Nitrogen Fixation with Non-Legumes was held from 23-29 August in Rio de Janeiro, Brazil, jointly organized by the National Program for Soil Biology Research of EMBRAPA (Brazil) and the Biophysics Department, University of Hannover (Federal Republic of Germany). The meeting hosted 119 participants from 24 countries.

There were 54 oral and 46 poster presentations on work ranging from the *Parasponia, Frankia*, and *Azolla* symbioses to the less well-defined associations of grasses and cereals with *Azospirillum* and other N_2-fixing bacteria.

Dr. Janet Sprent of the University of Dundee, Scotland, opened the Symposium with a talk on the major theme of the Symposium - The comparison of the sites and modes of infection of plants by different N_2-fixing microorganisms. The only non-legume genus known so far to nodulate with *Rhizobium* is *Parasponia* and Dr. Sprent pointed out the similarities in its nodule structure with primitive tree legumes (e.g., *Mimosa scabrella*) showing an exciting new bridge between plant families which is beginning to clarify evolutionary steps which led to the emergence of the highly sophisticated *Rhizobium*/legume symbiosis. In some of the more primitive tree legumes, as well as in *Parasponia* nodules, the bacteria are not released from the infection thread, but even so these symbioses show highly effective N_2-fixation. *Parasponia* was shown to be able to fix at least 280 kg N/ha/year.

Two major advances were reported in research into the *Azolla/Anabaena azollae* symbiosis: a - Using the decapitated megaspore technique, it is now possible to construct heterologous *Azolla/Anabaena azollae* symbioses permitting the study of the relative contributions of the two partners, and; b - on the practical side, the spore germination technique reported by Dr. Boonkerd from Thailand may prove immensely valuable in the development of inocula.

In the last three years, several new species of root-associated N_2-fixing bacteria have been discovered such as *Bacillus azotofixans*, *Herbaspirillum seropedicae* and *Azospirillum halopraeferans*. Information on the genetics and physiology of these organisms was presented. The discovery of a new diazotroph isolated in high numbers from sugarcane stems and roots was reported. The bacteria, provisionally named *Saccharobacter nitrocaptans*, can fix N_2 at very low pH (< 3.0), is tolerant to very high (30%) sucrose concentrations, has a high O_2 tolerance for N_2-fixation and lacks nitrate reductase.

A comparative study on the physiology of different species of *Azospirillum* and *Herbaspirillum* showed differences in their metabolism of sugars and organic acids, their capability to mobilize iron, and a possible role of siderophores in iron mobilization.

Most genetic studies on *Azospirillum* so far have been performed on the type strain of *A. brasilense* Sp7 but some new data on strains isolated from roots (e.g., Sp245) indicate differences in the organization of the nif genes between strains. The isolation of mutants of *A. brasilense* capable of excreting ammonium during growth on N_2 raises the exciting prospects for improving BNF contributions to cereal crops if these strains can be established within the root. The degree of interaction between *Azospirillum* spp. and plant roots has been a topic of considerable controversy but the discovery that various strains of these bacteria can complement non-nodulating (*exo*-) mutants of *Rhizobium meliloti* suggests that *Azospirillum* is well equipped to infect plant roots.

Evidence was presented to show that there are significant differences in chemotactic behavior and O_2 tolerance between the different N_2-fixing organisms isolated from the root surface and the root interior of grasses and cereals. While data presented at the Symposium confirmed that various diazotrophs can invade the root tissues and cause plant growth responses, few studies proved that these responses were caused by BNF inputs. The production of nitrite from nitrate by *A. brasilense* was shown to apparently mimic auxin activity in wheat roots which probably explains the observed effects on nitrogen metabolism in these plants. When strains and inoculation methods (oil or peat) were compared under field conditions, responses to inoculation were only observed when the inoculated strain could be established in the roots.

While responses of cereal crops to inoculation with diazotrophs may not always be due to BNF, quantification of nitrogen fixation using ^{15}N techniques showed that kallar grass and various genotypes of sugarcane and *Panicum maximum* are able to obtain considerable contributions from plant-associated nitrogen fixation. The use of the natural abundance ^{15}N dilution technique now seems to be coming of age and was shown to have considerable potential for use with non-legumes if carefully applied.

The fact that funding in some areas of research on non-legume BNF has been drastically reduced in recent years does not seem to have dampened the enthusiasm of many scientists to work in this area. The results presented at this Symposium suggest an exciting future and many possibilities for the manipulation of the N_2-fixing symbioses and associations for the benefit of agricultural production. The majority of the oral presentations will be published in a special edition of the journal Plant and Soil in 1988.

Submitted by: Bob Boddey and Johanna Dobereiner

Joseph C. Burton

BNF workers throughout the world will be dismayed to hear of the death of one of our major pioneers. Dr. Joseph C. Burton, retired Vice-President, Research and Development, Nitragin Company, Inc., and *Rhizobium* Inoculant Specialist, NifTAL Project, University of Hawaii, died October 6, 1987. He was 73.

Born in Due West, South Carolina, USA, Dr. Burton received his B.S. from Clemson University in 1935; and his M.S. in Bacteriology and Biochemistry in 1937 and his Ph.D. in Agricultural Microbiology and Soils in 1952 from the University of Wisconsin. He is survived by his wife Mary and four children.

Dr. Burton whose expert consultancy was sought from countries across the globe was employed by Nitragin from 1937 until 1980 except for the years between 1942 and 1946. During this time, he served in the U.S. Army from which he was honorably discharged with the rank of Major.

The author of nearly 50 scientific papers and book chapters and an invited speaker at numerous meetings, Dr. Burton had an unsurpassed knowledge of legume inoculation technology and was a renowned authority on *Rhizobium* inoculant production and biological nitrogen fixation in the legume/*Rhizobium* symbiosis. In 1984, Dr. Burton authored an FAO/NifTAL Handbook: **Legume Inoculants and their Use.** It is a popular pocket manual used worldwide which has been translated into French, Spanish, and Thai.

Dr. Burton was an elected fellow of the American Society of Agronomy, a member of the American Academy of Microbiology, and a member of the Board of Directors of the American Society of Agronomy for three years.

A man of uncommon modesty, Dr. Burton rarely shared his renown. Therefore, the **BNF BULLETIN** welcomes his many friends and the recipients of his assistance, advice, and knowledge to write to us sharing some of the ways he touched your lives and work. The complete texts will be forwarded to Joe's wife Mary, and a synopsis will be published in a future issue of the **BNF BULLETIN**. We will miss Dr. Joe Burton greatly.

COMMERCIAL CORNER

A new type of *Rhizobium* inoculant for soybean will soon be commercialized by Agracetus, a joint-venture in agricultural biotechnology of W.R. Grace & Co. and Cetus Corporation. This vermiculite-based, hopper-box inoculant contains genetically improved mutant strains of *Bradyrhizobium japonicum*. The mutants have improved nitrogen-fixation ability and are derived from competitive indigenous isolates capable of high levels of nodule occupancy. Fermentation of the inoculant is done directly in the point-of-sale container using a proprietary fermentation technology (Appl. Environment Microbiol. 53:2138, 1987).

The use of the inorganic vermiculite base eliminates the risk of producing undesirable organic toxic substances during the sterilization process prior to fermentation. The product is microbiologically pure and contains the various polysaccharides, which are essential for the nodulation process, synthesized by the rhizobia during fermentation. The moist multilamellated vermiculite carrier provides a uniform seed coating without added water or seed sticker and remains stably adhered to the seed. The gold color of the inoculant allows easy monitoring of the seed coating process to ensure even coating. The inoculant is appropriately named **Gold Coat**.

We worked with many farmers to develop this inoculant. Although most farmers previously used commercial hopper-box inoculants, we noticed many of them calibrated the seeding-rate of their planters with uncoated seeds and then used the planters to plant seeds coated with various commercial (peat- or oil-based) inoculants and seed treatments. Since all seed treatments alter the surface properties of the seed, this practice often does not allow the farmers to achieve the desired plant population with the treated seed. On the **Gold Coat** label, farmers are specifically instructed to set seeding-rate with the treated seed. It seems advisable that other inoculant producers should also include such instruction in the labels of their products.

Alan Paau
Agracetus

Pakistani Graduate Student Earns M.S. Degree

Naseer Mirza, Pakistan National Agricultural Research Center, earned his M.S. from the University of Hawaii at the end of 1987 by successfully completing a study on the use of leaf chlorophyll measurements in rhizobial strain selection programs.

N-FIXING TREE NOTES

The Centro Agronomico Tropical de Investigacion y Ensenanza (CATIE) and the Nitrogen Fixing Tree Association (NFTA) cooperated on a workshop which was held at CATIE, Turrialba, Costa Rica, 21-27 June. Workshop objectives were to: encourage communication among researchers working with *Gliricidia sepium*; assess the state-of-the-art regarding its genetic improvement, managment and utilization; identify research priorities; initiate collaborative research through networking; promote research funding; and prepare a practical manual for extension and development workers.

The workshop brought together 49 scientists from 21 countries who are actively working with this species. Thirty-six papers were presented on genetic improvement, fodder production and utilization, alley farming, agroforestry systems, wood production, and geographical experiences. Presented papers will be published as a special issue of the annual NFTA publication The Nitrogen Fixing Tree Research Reports with financial support from USAID/Science and Technology Office. An executive summary presents research priorites and the state-of-the-art. A final publication entitled **Gliricidia Production and Use** is expected to be available from NFTA this year.

Program organizers were Jan Bauer, Rolain Borel, and German Sanchez of CATIE; James Brewbaker and Nancy Glover of NFTA; Gerardo Budowski of the University of Peace, Colin Hughes of OFI; B. T. Kang of International Institute of Tropical Agriculture (IITA); and Freerk Wiersum of Wageningen Agricultural University, The Netherlands.

For information on publications, contact either NFTA, P. O. Box 680, Waimanalo, HI 96795, or CATIE, Turrialba, Costa Rica, Central America.

The enthusiastic staff of the Forest Research Institute in Samarinda, Indonesia, are conducting research relevant to forestry activities in East Kalimantan. The director of the Institute, Dr. S. Priasukmana, estimates that by the year 2000, most of the native forest in East Kalimantan will have been logged. Reforestation rates lag sadly behind harvesting rates with only 10% of cut over areas presently being replanted. A number of fast growing species are being evaluated for reforestation.

18-month old A. mangium. At right, standing Sharea species.

These and similar studies led to the promotion of *Acacia mangium*. Its seedlings show abundant nodulation and impressive growth even in the acid soils (pH 3.5) that abound in East Kalimantan. However, recent economic analyses indicate that *A. mangium* may be most valuable as a "nurse tree" for highly prized native Dipterocarp species, like Sharea.

The International Society of Tropical Foresters (ISTF) recently announced publication and availability of **Management of the Forests of Tropical America: Prospects and Technologies**, a major collection of papers from a September 1986 conference held in Puerto Rico. The conference attracted 180 leading tropical foresters from 26 countries.

Copies of the 469-page book are available free of charge to all present and new ISTF members while supplies last. The 32 papers contained in the book focus on natural forest management, plantations, social forestry, extension, and future markets for wood products.

Growing concern over the rapid changes occurring in the tropics led to the activation of ISTF in 1979. Since then, the organization has emerged as a leader in the transfer of technology and science to individuals concerned with the management, protection, and wise use of tropical forests. ISTF has established a communication network among tropical foresters and concerned individuals by publishing a quarterly newsletter (ISTF News) in English and Spanish, distributing publications and reports, sponsoring workshops and symposia, publishing directories of members addresses and technical interests, and maintaining a consultant skills roster.

Membership is open to all persons with special rates for developing country individuals and students. For information and membership applications, write International Society of Tropical Foresters, 5400 Grosvenor Lane, Bethesda, MD 20814 USA.

Continued from Page 3

for grafting to be performed. Nodulation is slow in the Rosaceae, taking about 12 weeks in the greenhouse, so that studies proceed slowly. Nevertheless, we are optimistic about the development of this technique for use in further studies.

- Nancy E. Kyle

Comments about Dr. Kyle's approach or any other suggestions along these lines are welcomed. This commentary section is open to all readers. Submissions should be of a general nature and not contain detailed results.

11th NARC a Success

The 11th North American Rhizobium Conference was held 9-15 August at Laval University, Quebec, Canada. More than 230 scientists representing 18 countries attended sessions on rhizobial taxonomy, physiology, genetics, ecology, and inoculation/agronomy.

The outstanding organization of the conference can be credited to Conference President Dr. Hani Antoun of Laval University, and Program Director Dr. Lucien Bordeleau of Agriculture Canada. They were assisted by Nicole Bissonet, Roger Lalande, and Paul Venne.

Program highlights included invited talks by Dr. D.P.S. Verma of McGill University, Quebec, Canada - "Regulation and function of host genes involved in symbiosis with *Rhizobium*" and by Dr. J. Denarie, of CNRS-INRA, Castanet-Tolosan, France - "*Rhizobium meliloti* genes controlling relationships with plants - a survey". Dr. Carl Jordan, University of Guelph, Ontario, Canada, presented an excellent overview, "Taxonomy of the Rhizobiaceae". Other invited talks were by Dr. P. Olsen, Agriculture Canada, Alberta, on "Rhizobium strain analyses by membrane immunoblot ELISA", and by Dr. G. Elkan, North Carolina State University, "Carbohydrate metabolism of the Rhizobiaceae".

The NARC has consistently been a valuable opportunity for researchers of all aspects of the legume/rhizobia association to meet and interact; however, it was apparent from the participation in the genetics sessions at this NARC that the focus of interest in this field has shifted to studies on the molecular basis of the symbiosis. Since research on the host and microbial genes controlling the symbiosis is becoming increasingly specialized, some scientists suggested that in the future a separate conference should be held specifically for the genetics researchers. Other participants suggested that the genetics/ physiology sessions be held concurrently with the agronomy/ ecology sessions in order to give researchers in those respective areas a longer forum.

Finally, the prevailing opinion was that there was a mutual benefit for rhizobial researchers in both the field and laboratory to gain a perspective of each other's work. The 12th North American Rhizobium Conference will again feature sequential sessions of topics as diverse as the *nod* genes of bradyrhizobia to responses to inoculation of common beans in Tanzania.

From left, 11th NARC Organizers, Drs. Bordeleau and Antoun

Continued from Page 1

In farmers' fields, responses to inoculation have frequently been observed, especially on soybean. So far, all farmers requesting inoculants have been able to obtain them, but the dramatic yield response in farmers' fields has led to an increasing demand. Farmer education efforts by Nyemba through television and radio information campaigns, extension worker training, and farm demonstrations further stimulate demand for inoculants.

To meet the rising demand, Nyemba is experimenting with producing inoculants in non-sterile peat. Early results indicate that non-sterile Mongu peat can support a large rhizobial population. The Mt. Makulu facility will also be installing two, low cost, NifTAL-designed, 100-liter stainless steel fermenters supplied by NifTAL and the ZAMARE Project. These new fermenters will increase by 200% the facility's production capability.

Nyemba and his staff plan to take these and whatever future actions are needed to meet the rising demand for quality rhizobial inoculants in Zambian agriculture.

NifTAL PROVIDED SERVICES

OUTREACH

- Rhizobial germplasm
- Research quality inoculants
- Custom antisera
- Distribution of symbiotic plasmids and cloned genes
- Detailed field trial design for inoculation response studies
- Long-term rhizobia repository
- Methods for rapid, low cost screening of rhizobia for soil stress tolerance

TRAINING

- Basic 6-week courses
- Specialized extension and inoculant production courses
- Graduate degree support
- Short courses on genetic technologies, serology, and commercial inoculant production
- Training materials (manuals, slides, etc.)
- Visiting scientist s program

RESEARCH

- National research program design assistance
- Technical backstopping to support developing country entrepreneurs
- Documents and information on BNF and tropical legumes
- Technical assistance on inoculant production systems
- Advisory services on inoculant manufacture, distribution,and quality control

BNF BULLETIN

Volume VIII, Number 2
Spring 1988

BNF BULLETIN is sponsored by the NifTAL Project which receives funding from the United States Agency for International Development.

For information on the NifTAL Project and to request services, contact NifTAL Project Director, NifTAL Project, 1000 Holomua Rd., Paia, Hawaii 96779-9744. Submission to the BNF BULLETIN may be sent: Attention: Communication Section.

The views and interpretations in this publication are those of the author(s) and/or the editor and should not be attributed to the Agency for International Development or to any individuals acting on its behalf.

Editor: Princess Ferguson
Technical Editor: Dr. B. Ben Bohlool
Graphics: Richard Gabrielson