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BNF BULLETIN

TEN YEARS OF BNF TECHNOLOGY
1980-1990

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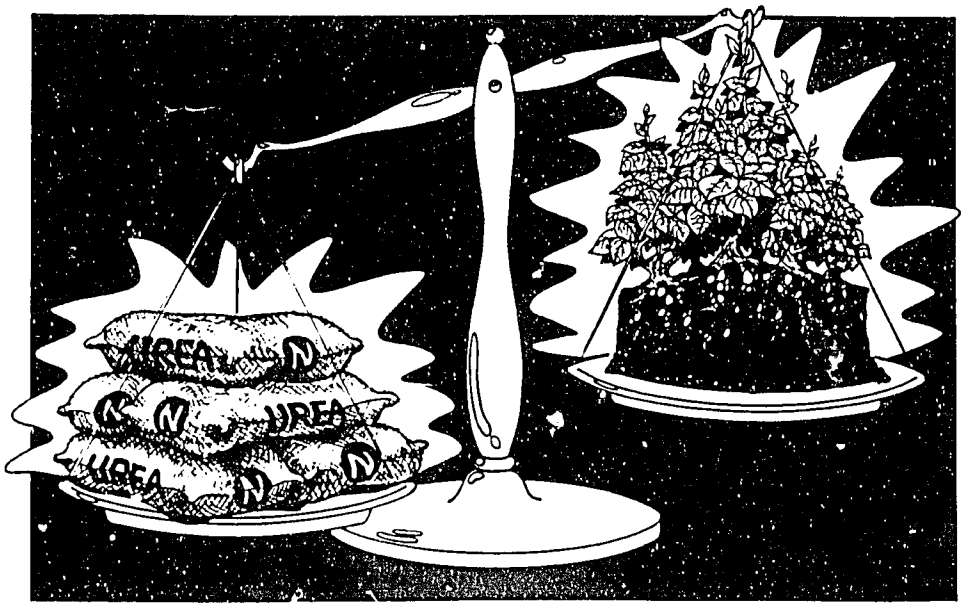
BNF BULLETIN

Nitrogen From Bugs; Not Bags

For certain crops, a few ounces of peat carrying the right strain of Rhizobium, *a beneficial bacteria, applied to each acre along with the seed, can replace 200–1000 lbs. of commercial nitrogen fertilizer.* In fact, it has been estimated that natural bacteria and blue-green algae are already responsible for the production of the equivalent of approximately 170 million tons of nitrogen fertilizer every year. And scientists think this amount can be greatly increased.

Very large financial and energy investments are being made in commercial nitrogen fertilizers. Farmers in tropical countries alone are presently investing over five billion dollars each year to buy commercial nitrogen fertilizer. *In comparison, the potential for utilization of biological nitrogen fixation can be developed with relatively small investments—investments manifestly justified by the potential increase in both the quantity and quality of the resultant crops.*



The rising price of N fertilizers combined with decreasing availability of petroleum from which they are derived, make the cost of bag fertilizer heavy in comparison to biologically-fixed N.

Basically, there are two principal types of nitrogen-fixing organisms. There are rhizobia, a group of bacteria which act in symbiosis with legumes, and free-living algae—microscopic plant organisms in both soil and water which benefit companion organisms (i.e. crop plants).

The first type of nitrogen fixation, where both organisms are simultaneously and intimately involved in the growth process, is called "symbiotic nitrogen fixation." The second, more indirect type, where both plants and bacteria gain an advantage by co-existence, is called "associative nitrogen fixation."

Both are important, because of the different crops involved. Rhizobia in symbiosis with legumes can fix approximately 50–200 lbs. of N per acre per season while legumes offer an additional advantage as a cheap protein-rich food. The free-living organisms fix about 9–20 lbs. per acre, though even this small amount is of great importance in tropical rice paddies.

While rhizobia are significant as nitrogen fixers, there are problems. Many are highly specific in their relationships with the host plants with which they interact. None will interact with grain or cereal crops.

Continued on page 3

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BNF BULLETIN is sponsored by the U.S. Universities Consortium for Biological Nitrogen Fixation in the Tropics and the NifTAL Project and is funded through Cornell University, North Carolina State University, University of Hawaii, University of Puerto Rico, and the United States Agency for International Development. Although funding is received from a number of sources, news and opinions are solely those of the authors.

BNF BULLETIN

VOLUME I, NUMBER 1

JANUARY—MARCH, 1980

Editor: **Susan C. Harris**
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The research teams at the four institutions which sponsor the ***BNF BULLETIN*** are keenly aware of, and strongly support, the desirability of improved communication of the need for, the value of, and the results obtained in research in the area of biological nitrogen fixation. The ***BNF BULLETIN*** will highlight the economic and agricultural value of BNF and the ways in which many BNF researchers worldwide contribute to the enhancement of those values.

The ***BNF BULLETIN*** will contain articles on BNF activities of interest to non-technical audiences, items with an international focus, research highlights, conference announcements and reports, letters, personnel news, travel highlights, and other news.

BNF BULLETIN will be issued quarterly with interim ***BNF Briefs*** after 6 weeks—a quick production newsletter for distribution to workers in the BNF field. ***BNF Briefs*** will contain practical, research-oriented articles, a "Jcb Market," and other such items.

To submit items to ***BNF BULLETIN*** or ***BNF Briefs,*** mail copy or informative materials to Susan Harris, NifTAL Project, 3190 Maile Way #300, University of Hawaii, Dept. of Agronomy and Soil Science, Honolulu, Hawaii 96822, USA.

University of Hawaii NifTAL Project
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ANNOUNCEMENTS

Subscriptions Offered

One-year paid subscriptions to the *Rhizobium Newsletter,* the Australian publication for *Rhizobium* research workers, are available to tropical researchers who, for reasons of financial constraint or currency problems, cannot subscribe to that communication. The U. S. Consortium for Biological Nitrogen Fixation in the Tropics will finance the subscriptions, as part of its effort to promote the utilization of BNF in the tropics.

Anyone interested in the subscription offer should apply to:

Dr. R. J. Davis—Asia
Dr. J. Halliday—South America
Dr. P. Somasegaran—Africa

in care of the NifTAL Project, P. O. Box "0", Paia, Maui, HI 96779 USA.

Second SISA Upcoming in Tanzania

The Second Symposium on Intercropping for Semi-Arid Areas (2nd SISA) will convene at Morogoro, Tanzania, August 4–7, 1980. The SISA will be held under the auspices of the University of Dar es Salaam, the Tanzania National Scientific Research Council and the International Development Research Centre (IDRC) Canada.

The theme of the Conference is "Current Research on Intercropping Semi-Arid Regions of the World." The program will include crop production techniques, variety testing under mixed cropping ecosystems, fertilizer responses, nitrogen fixation and plant protection using improved cultural methods and resistant varieties.

Colombia Conference Scheduled For 1981

CIAT (Centro Internacional de Agricultura Tropical) and the University of Hawaii NifTAL Project will sponsor a major Conference in February of 1981 at CIAT headquarters in Colombia. The five-day Conference will be entitled "The Use and Development of BNF Technology in Tropical Agriculture." Practical aspects of BNF research will be emphasized.

Training Course Slated for Cairo MIRCEN

Rhizobium Technology will be covered in a training course for participants from Africa and the Arab states through cooperation between NifTAL and the Cairo MIRCEN (Microbial Resources Center) at Ain-Shams University in Cairo, Egypt. Applicants should direct inquiries to the MIRCEN Director, Dr. Ahmed Gibriel, Cairo MIRCEN, Faculty of Agriculture, Ain-Shams University, Shobra-Khaima, Cairo, Egypt.

Dates for the course are September 8–22, 1980.

Stalking the Wild *Rhizobium*

When Walton Gregory, a peanut breeder from North Carolina State University (NCSU), went to South America to collect wild peanuts, he added a novel step to his approach. For the first time ever, a conscious effort was made to collect the nodules on the roots of the plant.

Microbiologist Gerald Elkan took the nodules collected by Gregory and began, with a reasonable degree of success, to isolate the infective strains of *Rhizobium* involved. Now Elkan and NCSU co-worker John D. Wynne, a peanut breeder, along with Peter Dart and Ron Gibbons at ICRISAT in Hyderabad, are testing the strains on commercially-available varieties of *Arachis hypogaea.* Testing includes both field and laboratory experimentation to determine the nature of the very interesting interactions between the domesticated host cultivar and the wild *Rhizobium* strains.

Forage Legume Research Offers Unique Challenges

D. S. Chamblee, a forage ecologist at North Carolina State University, has focussed his research efforts on the inoculation of forage legumes. Because in Chamblee's area, as in many others, there are no native rhizobia for a number of forage legumes, he is seeking effective strains for common host varieties. These "best strains" vary according to the legume in question and the type of soil and environment. Methods applicable to minimum-tillage cropping systems, which can be used where the terrain is very steep, are emphasized.

In another approach to problems encountered in legume cropping systems, Chamblee is looking for feasible techniques of reinoculation. These are particularly needed in light, sandy soils that are hot, acid, and dry—as are many soils of the tropics. Traditional problems in legume inoculation can be accentuated by the small size of most forage legume seeds, a factor which forage legume agronomists must take into account.

U.S. BNF Consortium Promotes Collaboration

The U.S. Universities Consortium on Biological Nitrogen Fixation in the Tropics has been awarded an AID/211-d grant entitled "Biological Nitrogen Fixation for Food Production in the Tropics." Four universities: Cornell, Hawaii, North Carolina State and Puerto Rico, all past members of the Consortium on Soils of the Tropics (CST) and deeply involved with major assistance programs in international agriculture, have accepted the responsibility for strengthening the the capacity for improved efficiency of nitrogen fixation in tropical cropping systems. Their aim is to broaden the BNF knowledge base through research, to increase collaborative linkages between BNF researchers, to offer technical assistance in projects involving research or practical application of BNF technology, and to utilize the training capacity of the Consortium universities to meet the need for trained personnel.

N From Bugs. . .

Continued from page 1

They invade the roots solely of legumes (peanuts, cowpeas, beans) to form nodules which fix N. Some "promiscuous" rhizobia will form nodules on the roots of many host legumes. However, most rhizobia will form effective symbioses only with specific legumes, often only specific varieties. Therefore, accurate matching of host and rhizobia is essential.

Once an effective strain of *Rhizobium* has been determined for a particular legume crop and set of environmental conditions, the bacteria can be supplied in appropriate inoculants to be mixed with the seed before planting. These can be produced with relatively low levels of capital investment but require considerable technological expertise for they are living organisms requiring trained handling to produce and maintain.

Each legume crop and environment presents an individual set of conditions for which N fixation must be maximized. ***For the tropical legumes there has been a scarcity of this basic and applied research, of training for technicians in inoculation methods and the culture of legumes, and of reliable inoculants.***

"Good things come in small packages," says the old proverb. The small bag of inoculant at the top of the pile will inoculate soybeans at a cost of 40 cents per acre, while nitrogen fertilizer to provide the same amount of N to the crop, would cost between $90/acre and $115/acre.

The benefits to be gained from increased knowledge and technology for the improved utilization of biological nitrogen fixation are so great that there is now a worldwide research effort to learn more about the process and to train the necessary technicians and extension personnel to make use of BNF. In the more developed countries, widespread research and use of commercial inocula of the *Rhizobium* bacteria has influenced the production of soybeans, an important source of protein, to make considerable gains. In the U.S. soybeans now occupy a greater acreage than any other crop—solid evidence that biological N sources can be very effective in producing food for a hungry world.

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MIRCEN Broadens IPAGRO/UFRGS Research Thrust

Research activity on the legume/*Rhizobium* symbiosis was initiated at IPAGRO (Instituto de Pesquisas Agronomicas) in 1950 by IPAGRO's Soil Microbiology Team. Several years ago the Department of Soils, Faculty of Agronomy, at UFRGS (Universidade Federal do Rio Grande do Sol) joined with the IPAGRO team to form an integrated program to promote biological nitrogen fixation (BNF) by legumes.

Then, in 1978 UNESCO/UNEP/ICRO and the Brazilian government agreed to establish a Microbial Resources Center (MIRCEN) at UFRGS in cooperation with IPAGRO. The development of this MIRCEN was, according to Dr. J.R. Jardim Freire, Director of the Faculty of Agronomy and the MIRCEN, "the natural consequence of the integration that had existed for a long time in the research activity."

Not only do staff members share research objectives and cooperate in experimentation, but the directorship of the units overlaps and the institutional objectives are very similar.

Dr. J.R. Jardim Freire heads the group. He is currently Director of the Faculty of Agronomy and of the MIRCEN, but despite a heavy administrative burden maintains a strong involvement in the soil microbiology groups of UFRGS and IPAGRO. Dr. Caio Vidor is Executive Director of UFRGS/IPAGRO and Assistant Director of the MIRCEN with responsibility for *Rhizobium* ecology.

Dr. Joao Kolling is full time with IPAGRO and handles field selection of *Rhizobium* strains, soil fertility, and limiting factors. Dercio Sholles of UFRGS has responsibility for field selection and tropical forages. Pedro Selbach of UFRGS works on soil limiting factors and soybeans.

Maria Helena Pedroso of IPAGRO is in charge of inoculant production, control, and technology, and the supply of inoculant strains to commercial producers. Jessie Soares Pereira of IPAGRO looks after serology and the culture collection. Iara G. Kolling of IPAGRO runs gas chromatography and is also involved in the technology of inoculation.

Edemar Brose of IPAGRO is involved with the Culture Collection and the symbiotic capacity of soybeans and beans. Ney Mendes of IPAGRO works on the Culture Collection and strain selection. Two MIRCEN-funded positions include a microbiologist and an extension specialist.

Main crops of interest are soybean, common bean *(Phaseolus vulgaris)* and alfalfa. Research has been fairly site specific in that it relates to the somewhat unique subtropical climate of Rio Grande do Sul. For example, tropical forages such as green leaf desmodium, perennial soybean and siratro are being evaluated for use as summer legumes in pastures. Selection of strains of *Rhizobium* and plant lines for high temperature tolerance plays an important role. Although soils of the region are very acid, liming to pH 5.5 is economically feasible, and thus selection of acid tolerant rhizobia has not been pursued. However, the group recognizes the need to broaden their future research interest as part of their international responsibilities in the role of MIRCEN. Because the MIRCEN is not commodity restricted, it can be considered the most important center for *Rhizobium* research in Latin America.

The exchange of *Rhizobium* cultures at the Brazil MIRCEN has markedly increased. Besides exchange for research, inoculant factories in Brazil receive the recommended strains each year.

DISSEMINATION UPDATE

If you or your associates wish to be added to the distribution list for the *BNF BULLETIN*, or if your address has changed, please fill out the following and mail this form to: NifTAL Information Section, 3190 Maile Way #300, Honolulu, Hawaii 96822, USA.

Name/Title

Address

Please check the appropriate box:

☐ Add name ☐ Change address ☐ Delete

Newman Retires; Miller Moves To USDA

Art Newman, of USDA/SEA/CR, retired on Dec. 31, 1979, after 22 years with that agency. He will be succeeded by Robert Miller, formerly of the Department of Agronomy at Ohio State University.

Newman received his Ph.D. from Iowa State University. Retiring after 38 years of federal service, he will continue to work with the projects for which he has had responsibility as time and interest allow.

Miller, a graduate of the University of Minnesota, has been at Ohio State approximately 15 years. He is especially interested in ecology of rhizobia in soils. His work at USDA will include administration of small grants under USAID—USDA/SEA/CR and other activities.

Soybean Conference Draws Good Response

A Conference on Irrigated Soybeans was held September 1–6, 1979 at the Conference Center in Cairo, Egypt. In attendance were numerous prominent representatives of tropical countries involved in research for food and feed production centered on irrigated soybean cropping systems.

Continued on page 6

African Symposium Highlights Problems

An August, 1979, Symposium on Grain Legume Improvement in Eastern Africa held at the University of Nairobi, in Kenya, brought agricultural scientists from many African countries together with representatives from other parts of the tropical world. The progress in grain legume research was notable, but many opportunities for problem-solving are still in evidence.

The need for increase in production was underlined by dwindling exports of grain legumes in several countries, including Kenya and Malawi and others. Several countries are even importing pulses at present.

Insects, diseases, and fertility problems are all major factors in increasing production. Inoculants of high quality must be made available. And participants were interested in whether beans *(Phaseolus)*, which respond well to fertilizer N, can be made to function as nitrogen-fixing legumes

Future meetings will focus on these and related research opportunities.

High quality inoculants are one of the major needs facing Africans working on grain legume improvement. Here a researcher from the Sudan receives training in the production of inoculants.

Herbicides/Insecticides Can Aid N Fixation

Current research at Martin Alexander's Cornell University laboratory is concentrated on factors that limit nitrogen fixation by soil microorganisms. Special attention has been focussed on the negative effect of competition by poor- or non-nitrogen-fixing organisms with effective nitrogen fixers.

Experimenting with *Phaseolus vulgaris*, the team has examined the possibility of increasing nitrogen fixation by inoculating the seeds with a fungicide-resistant mutant of an effective *Rhizobium* strain and using fungicide to kill the competitive poor-nitrogen-fixing organisms in the soil. Three treatments were applied to the beans: inoculation with fungicide-resistant mutant plus fungicide treatment of soil; no inoculation plus fungicide treatment of soil; no inoculation plus fungicide treatment of soil; and inoculation with *Rhizobium* and no fungicide applied.

Plants receiving Treatment 1 had greater dry weights and higher seed pod yields, and fixed more nitrogen. Similar trials are scheduled using soybeans and cowpeas.

Although data are preliminary, the results obtained to date suggest that fungicides may be useful in increasing the quantity of N fixed by selected soil microorganisms by overcoming the competitive effect of other microorganisms.

One factor that limits nitrogen fixation by effective blue-green algae in low-land rice production is competition from poor-nitrogen-fixing algae. There is a possibility of decreasing this competition effect by treating the field with an insecticide and inoculating the paddy with an insecticide-resistant mutant of an effective nitrogen-fixing alga. Preliminary laboratory investigations have shown that nitrogen fixation is increased when the insecticide plus insecticide-resistant alga inoculant are applied to a bio-system.

Another factor that limits nitrogen fixation in paddy rice is the predation on the algae by invertebrates such as ostracods and daphniads. Laboratory work has shown that alga development can be enhanced by killing the predators with insecticides. Thus, both herbicides and insecticides may be useful in increasing the quantity of nitrogen fixed in low-land rice.

Lumpkin in China to Further *Azolla* Research

Azolla is a genus of small ferns that grow on the surface of still, fresh water. While it is looked on as a weed in some areas, it can be used as food by chickens, ducks and pigs and to control mosquito breeding. Its major contribution to agriculture is that, in symbiosis with the blue-green algae that thrive in the cavities of the *Azolla* leaves, nitrogen is taken from the air, "fixed" by the algae, accumulated in the plant, and upon decay of the *Azolla*, released into the paddy to benefit the rice crop.

This nitrogen source is widely used in China and northern Vietnam, but has not been widely recognized in other developing countries which could greatly profit from the increased food potential. Tom Lumpkin, Junior Agronomist with the University of Hawaii Agronomy and Soil Science Dept., is involved in work which consists of taxonomic investigations, chromosome counts and chromatography.

Azolla, *shown here with the rice for which it is an N source can fix 9–20 lbs. of N per acre in association with* Anabaena.

In the Spring of 1979 Lumpkin made a world tour to collect *Azolla* species and consult with researchers in other countries. His stops included Kew Gardens, London, the Museum of Natural History, Paris, the Central Rice Research Institute in India, and collecting stops in Kenya and the Sudan, the Galapagos Islands, Thailand and Japan.

In the Summer, Lumpkin and James Walker, UH Program Manager for BNF (biological nitrogen fixation) Programs, took a one-month trip, funded by the Interamerican Development Bank, which included stops at agricultural research institutions and investigations of rice cropping systems in Argentina, Uruguay, Brazil, and Peru.

On the return trip, Lumpkin stopped in Central America to collect samples of *Azolla* species in an attempt to verify the existence of *A. microphylla*, a species which he has not yet been able to find.

Then in the Fall, Tom and his family travelled to the People's Republic of China on an NAS research fellowship. They will spend one year at the Zhe Jiang University in Hang Zhou. Zhe Jiang Province is the leading area of the world for *Azolla* research. Lumpkin will be involved in applied research with the Institute of Fertilizers and Soil Science for Zhe Jiang Province.

International Network Tests Inoculation Response

The University of Hawaii's NifTAL Project reports excellent progress in the establishment of an International Network of Legume Inoculation Trials. The purpose of the USAID-funded project is to determine, under realistic field conditions, whether tropical legumes will respond to inoculation with *Rhizobium*.

The Network Coordinators: Dr. Jake Halliday in the Americas, Dr. Padmanabhan Somasegaran in Africa, and Dr. Robert Davis in Asia, have received favorable response to requests for national and international cooperation in Network trials. Numerous positive replies have been received from African, Middle East, South American, and South and Southeast Asian countries.

Network trials initiated in 1980 are being conducted in three stages: (1) a general trial of inoculation response with the best available *Rhizobium* strains at two fertility levels, designated Experiment A; (2) a pot study of strains isolated locally, designated Experiment B; and (3) a further trial to field test superior strains from Experiment B, designated Experiment C.

NifTAL will assume an active role in the experiments to ensure that each of the Cooperators in the Network has the necessary support services. Arrangements will be made for production and supply of inoculant and seed, if necessary. When necessary, key personnel from tropical regions will receive training in legume/*Rhizobium* technology, through NifTAL's training programs.

NifTAL is now able to provide the antisera developed for those strains that will be recommended in the Network trials, and for additional species as well, when given adequate lead time. These antisera are essential for monitoring infectiveness by introduced strains and for determining the long-term persistence of the strains at the experimental site.

Soybean Conference

Continued from page 3

Reports from many countries involved in growing soybeans under irrigated conditions indicated yield achievements of up to 4 tons/hectare. Responses to nitrogen fertilizer were frequently reported, in some cases even when inoculants were also used. Some participants reported that inoculation failed to produce nodules. However, excellent nodulation in the ISVEX and ISRIE trials at Menofeia University resulted with use of granular Nitragin inoculant. Seeding into dry soil with later irrigation resulted in the most severe inoculation problems. Pests and poor phosphorus fertility often limited growth (and nitrogen fixation.)

BULLETIN

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Busy Week In Rome

Intensified field research into biological nitrogen fixation is confirming its potential for improving agricultural production in the tropics. Awareness of this prompted FAO and UNEP to call together 30 of the world's most active researchers at FAO headquarters, Rome, in June.

The researchers were encouraged by FAO interest, as expressed by Dr. D.F.R. Bommer (Asst. Director-General, Agriculture Department), in increasing the yields and incomes of small-scale farmers through soundly-applied BNF technology. UNEP's role in stimulating regionally-coordinated field research in Latin America and Africa, through the Microbiological Resources Centers (MIRCENs) implemented by UNESCO, was acknowledged by the group.

Considering, also, UNDP funding for major BNF programs in the International Agricultural Research Centers, it is clear that the UN family of agencies fully recognizes the value of BNF for agricultural development and sound environmental management in developing countries.

The consensus of the group was that the time has come to put BNF technology to work at the farm level. But it was emphasized that this is not a simple undertaking. Convincing demonstration of the benefits from using effectively-nodulated legumes in the tropics will be needed. Industrial plants for large-scale production of legume inoculants are also necessary. Personnel have to be trained in production, testing, and field use of inoculants.

Working groups, depicted at right, developed recommendations on the role that FAO could play in field experiments and demonstrations (top), training programs (middle), and rhizobial inoculant production (bottom).

Photos by D. McNeil

Top (from left): Krastanov (Bulgaria), Siegel (Germany), Ayanaba (Nigeria), Dart (India), Obaton (France), Frederick (USA), Hood (UK), and Drevon (France). Middle (from left): Halliday (USA) da Silva (France), Verniau (Italy), and Patil (India). Bottom (from left): Skinner (UK), Freire (Brazil), Burton (USA), and Musa (Sudan). Notably absent is Fernando Riveros of FAO who, at the time of the meeting, was making a courageous recovery from severe back injuries incurred in a fall.

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University of Hawaii
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UNITED STATES OF AMERICA

ANNOUNCEMENTS

Conference Features Many Topics

The Sixth International Conference on the Global Impact of Applied Microbiology (GIAM VI) is scheduled to take place in Lagos, Nigeria, August 31 to September 6, 1980.

There are six major areas listed in the program:

- Food and Agriculture (includes the role of *Rhizobium*/legume interrelationships);
- Biofuels and Biofertilizers from Organic Waste;
- Medical Microbiology;
- Contributions of Microbiology to Sustainable Development (including the role of the existing network of MIRCENs);
- Training in Microbiology;
- Applied Microbiology (frontiers and opportunities).

Soybean Seed Studied

A Conference on Soybean Seed Quality and Stand Establishment has been scheduled for January 25–31, 1981, at the Agrarian Research Training Institute in Colombo, Sri Lanka. Sponsors include the Ministry of Agricultural Development and Research, INTSOY, and Mississippi State University. FAO and USAID are collaborators.

India Pigeonpea Workshop Slated

The International Crops Research for the Semi-Arid Tropics (ICRISAT) and the Indian Council of Agricultural Research (ICAR) announce an International Workshop on Pigeonpeas to be held December 15–19, 1980.

The 1980 workshop, which will be sponsored jointly by ICRISAT and ICAR, will bring together people with an interest in the research and development of the crop. It is hoped that this international meeting of breeders, pathologists, entomologists, microbiologists, agronomists, utilizers, and agricultural administrators—and the consequent published proceedings—will focus attention on new developments. Plans are to identify the problems which remain to be solved if the production of this crop is to be substantially increased, with subsequent benefit to the farmers and to the diets of the rural and urban poor.

X RELAR Planned

ALAR (Asociacion Latino-Americana de Rhizobiologos) announces that the next RELAR (X) will take place in Maracay, Venezuela at the end of 1980.

Three seminars are planned in order to integrate and synthesize advances in basic and applied rhizobiology. The central program will consist of the traditional exposition and discussion of research.

N-Fixation Symposium To Be Held

The Fourth International Symposium on Nitrogen Fixation will be held at Canberra, Australia from November 30–December 5, 1980. The Symposium will be sponsored by the Australian Academy of Science, the Charles F. Kettering Foundation, and the Tennessee Valley Authority. The program will feature synthesis papers (critical reviews of current developments), specialist papers, plenary discussions, poster presentations, and specialist discussion groups. Topics to be covered include the chemistry, biochemistry, genetics, physiology, biology, and agronomy of nitrogen fixation. A number of tours are also available in connection with the Symposium.

Boyce Thompson Program Works With IITA, IRRI Researchers

A number of pathways in BNF research are being forged by BNF research staff at Boyce Thompson Institute at Cornell University in the Nitrogen and Crop Yields Program. Tom LaRue, Ali Szalay, Allan Eaglesham, and Al App are the senior members of this program, but there are approximately thirty junior, post-doctoral, and senior staff members in the program. Al App is the current Director and Martin Alexander, of the Agronomy Department at Cornell University is an adjunct Distinguished Scientist with this program.

Tom LaRue is studying soybean nitrogen fixation in conjunction with Ed Pulver of the International Institute of

Continued on page 5

ICRAF Challenges BNF Research Community

On every continent of the developing world there are areas of ecological crisis. At a time when food demands are urgent, man is wasting his land resources either through mismanagement or because of sheer neglect. The rehabilitation of these wasted lands is the primary concern of the International Council for Research in Agroforestry (ICRAF).

ICRAF is an autonomous, non-profit, international institute governed by a Board of Trustees with equal representation from the developed and the developing world. It is supported by voluntary financial contributions from governments and international private and public organizations and agencies.

The objective of ICRAF is the promotion of agroforestry systems designed to result in better land-use without detriment to the environment. To achieve this end ICRAF encourages and supports research and training in agroforestry systems, facilitates the collection and dissemination of relevant information, and assists in the international coordination of agroforestry development.

Agroforestry systems which fulfill the goals of ICRAF research programs will likely be those that will include woody species which are biological nitrogen fixers. Preliminary work has shown that many tropical trees and shrubs have substantial N_2-fixing capabilities.

One of these leguminous trees is the black wattle (*Acacia mearnsii*) which, according to S. O. Keya (*Soils Research in Agroforestry*, H. O. Mongi and P. A. Huxley, eds.) is an excellent multipurpose tree. The bark is a rich source of vegetable tannin. The wood can be used for fuel, construction timber, hardboard, parquet blocks, charcoal, rayon, and paper.

Another multipurpose woody legume is *Leucaena leucocephala*. This underexploited legume has recently attracted attention in the U.S., Philippines, and Thailand for its versatility and its ability to prosper under soil and climate conditions which would not be adequate for most other crops. The tree produces forage, timber, fuel, biomass for energy, paper products, and seed which can be used for decorative products.

ICRAF has pointed out that, although legumes feature prominently among the list of trees to which they are giving priority, information is generally lacking on the rhizobial relations, extent of nodulation, and nitrogen fixation of these species. They have challenged the BNF community to undertake studies with these admittedly difficult, but potentially very important, woody legumes.

Leguminous trees in agroforestry systems will be expected to persist over many years with virtually no inputs after initial transplanting. Under such conditions, ensuring effective rhizobia and mycorrhizal symbioses could be the key to sustained productivity.

Trainees Get Most From Cooperative Effort

Nuno M. de Sousa Costa, a Portuguese agronomist with EPAMIG in Brazil, recently spent two months in the U.S. learning *Rhizobium* technology in a cooperative training program. He was selected by NifTAL's Regional Coordinator as a "key person" to become an intern trainee from within his institution and his region.

At EPAMIG, Sousa Costa has been very active in the collection of seed from native legume species in the state of Minas Gerais. His training ensures that he can collect rhizobia as well as plants, and assure that, when the seeds are introduced to a new area, the N-fixing symbiosis that contributed to their success in their original environment is reconstituted.

Sousa Costa is a key participant in a collaborative research project between EPAMIG and NifTAL in which native rhizobia from acid soils will be collected, isolated, and tested. *Rhizobium* strains from *Stylosanthes guianensis* and *Leucaena leucocephala* will be cultivated in acid media and field tested as part of the International Network of Legume Inoculation Trials.

Many institutions contributed to his training. He was at NifTAL headquarters for a two-month period. He then travelled to Beltsville where he worked with Deane Weber and Harold Keyser of the USDA *Rhizobium* Collection. Next he consulted with Lloyd Frederick and Michael Benge of USAID in Washington. Then he continued to the University of Florida where he was acquainted with the research of Gerry Mott, Ken Quesenberry, David Hubbell, and Al Kretschmer.

Photo by P. Nakao

Nuno M. de Sousa Costa looks at roots of a legume/grass association growing at Hamakuapoko, Maui.

Individual itineraries are made up for each intern trainee to enhance to the greatest extent possible the overall training experience. Normally this experience can be obtained at minimal cost to NifTAL. However, it is contingent on the generous support, in time, of other institutions working in BNF research.

The U.S. *Rhizobium* Germplasm Collection

The U.S. Department of Agriculture (USDA) at Beltsville, Maryland, has since 1912 maintained a large *Rhizobium* Collection under the auspices of the Cell Culture and Nitrogen Fixation Laboratory. Recently, realizing the need for a single, recognized source of rhizobia in the U.S. and for a comprehensive collection of rhizobia used to inoculate tropical and temperate agricultural legumes, USDA and the Agency for International Development (AID) entered into a cooperative project: The World *Rhizobium* Study and Collection Center (WRSCC).

The primary goal of this collaborative effort is to provide the assurance that the latest rhizobial strains will be available to BNF researchers, world-wide. This is implemented through a steadily accelerating germplasm exchange program. The Project also provides for applied research on the legume-*Rhizobium* symbiosis and sponsors a training program in practical *Rhizobium* methodology.

A new strain catalog of holdings in the collection is now available to all interested parties.

For more information contact the Project Leaders:

Drs. Deane F. Weber and Harold H. Keyser
U. S. Department of Agriculture,
SEA, AR, CCNFL
Room 309, Building 001, BARC-West
Beltsville, Maryland, 20705, U S A

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Thai Project Seeks to Improve Watershed Management

Promotes U.S. BNF Training

Jessada Kaewchote, a graduate of Kasetsart University and FAO Fellow, was in the US in the Winter of 1979 to learn legume inoculation techniques as part of a program designed to teach range management techniques that will promote ecologically sound forest and watershed management.

Sixty percent of the land holdings in Northern Thailand average below one hectare. Population increase of about 2.5% per annum is forcing Thais to occupy land in forest areas and indulge in indiscriminate forest destruction, thus upsetting the hydrological regime. Besides the incoming Thais, a population of about 300,000 tribespeople of various ethnic groups occupy the forest area. Sixty percent of these practice bush fallow cultivation while the remaining forty percent, being opium cultivators, indulge in "swidden cultivation" turning the valuable forest land to savannahs in about five years. They then shift to felling new areas of virgin forest for their new cycle. Such savannahs are taken over by *Imperata cylindrica*, which exposes forest areas to fire hazards. The Mae Sa Integrated Watershed and Forest Land Use Project has been established to deal with these problems, including an area of 42,000 ha in a mountainous region of northern Thailand.

The fellowship program was designed to offer Jessada a chance to learn grazing and range management techniques for suppression of *Imperata cylindrica* and for forest watershed and agricultural development, techniques of introducing adaptable tropical legume/grasses as applicable to the climatic conditions in the highlands of Northern Thailand, techniques of multiplying tropical legume/grass seeds, biological methods of conserving highland soils, and techniques of introducing legumes in agricultural crop rotation.

Malaysia Course Announced

Applications are now being accepted for a six-week intensive course in *Rhizobium* technology for tropical Asia. The course will be sponsored by MARDI (Malaysian Agricultural Research and Development Institute) and NifTAL.

Dates for the course, to be held at Serdang,Selangor, West Malaysia, are November 3–December 13, 1980.

Mexico Course Planned

A non-degree training course in legume/*Rhizobium* technology for Mexico and Central America participants will be held at Chapingo, Mexico in May and June of 1981. Host institution for the course will be the Colegio de Postgraduados at Chapingo, Mexico. Sponsors are the Colegio de Postgraduados and NifTAL.

The aim of this course is to augment the pool of individuals in tropical Latin American who have the technical skills for using rhizobia in research, development, and production programs involving legumes.

Cairo Course Upcoming

Rhizobium technology will be covered in a microbiology course for African and Arab participants through cooperation between NifTAL and the Cairo MIRCEN (Microbiological Resources Center) at Ain-Shams University in Cairo. Dates for the course are Sept. 8–22, 1980.

Please consider the participation of your staff in these two introductory courses.

Peru Training Offered

North Carolina State University (NCSU) and the Instituto Nacional de investigacion Agraria (INIA) will sponsor two short courses entitled "Symbiotic Nitrogen Fixation and Legume Inoculation," in Lima during June and July, 1981.

These non-academic courses will be conducted in Spanish. In this pilot course, only applicants from Peru will be accepted. Each course can accomodate 15 participants.

One (from June 1–June 19) will be for field technicians who have had no formal training in legume or *Rhizobium* management. The second (June 22–July 20) will be for professionals who have an interest in, or responsibility for, legume management projects, but who may not be trained legume agronomists.

The courses will be practical in nature. They may be considered as preparatory to courses offered by MIRCEN or NifTAL. They assume no formal background in the discipline; they do assume active involvement in legume-management/research/demonstration.

Assistance in support of participation may be provided where need is demonstrated.

Interested parties may obtain more information by contacting:

Dr. H. D. Gross
Dept. of Crop Science
North Carolina State University
Raleigh, North Carolina 27607
U.S.A.

SHORT COMMUNICATIONS

The application of the *Azolla-Anabaena* symbiosis holds substantial promise to increase agricultural production in lowland tropics of Mexico. Dr. Ronald Ferrera-Cerrato, Chief of the Microbiology Section, Edaphology Center of Postgraduate College at Chapingo, Mexico, carried out preliminary studies on nutritional requirements, aeration, and temperature on *Azolla* spp. isolated in the state of Tabasco.

The *Azolla* grew larger in Jensen solution than in Harris medium. Under conditions of aeration with a common tank pump, no difference of growth was observed in plus- and minus-nitrogen treatments in the Jensen solution. It was concluded that aeration was inhibitory on nitrogen fixation by the *Anabaena*.

Two field trials comparing four different strains of *Rhizobium* were also carried out by Ferrera-Cerrato with *Glycine max* cultivar Cajenne at acid soil sites near Tepeitic and Yohualichan, Puebla. Neither site had previously been sown to soybeans. The strain CP21 increased yields over the uninoculated control and proved about equal to the uninoculated, plus-nitrogen control at Tepeitic. The strain CP8 increased yield over the uninoculated control at Yohualichan. At both sites there was a yield response to 60 kg/ha of P205. Such studies are important to Mexico, where soybean cultivation has increased from 300 ha in 1958 to 300,000 ha in 1974.

R.S. Smith

R. Bradley

J. Walker

ARRIVALS AND DEPARTURES

Smith Joins Nitragin Co.

R. Stewart Smith has joined The Nitragin Company, Inc. as Director of Research and Development. He comes to the Milwaukee, Wisconsin firm after spending 2½ years with the University of Illinois-INTSOY Program in Puerto Rico.

Smith's INTSOY research concerned proper inoculating rates and methods to achieve adequate nodulation with soybeans when introduced into tropical soils. He also established two international inoculant trials with cooperators around the world.

Smith will continue his research with applied inoculant production and use with the Nitragin Company, Inc., a leading manufacturer of legume inoculants for domestic and international agricultural markets. He will replace Joe C. Burton who has been with the company for over 40 years and is recognized as one of the leading authorities in the world on legume inoculation and effective host-strain evaluations.

Smith earned his B.S. and M.S. from Michigan State University and his PhD in soil microbiology from Ohio State University in 1972. He was Research Director with Agricultural Laboratories, Inc. in Columbus, Ohio before joining the University of Illinois international program.

Bradley Moves to CIAT

Rosemary Bradley, who has been at Brazil's Instituto Nacional de Pesquisas da Amazonia (INPA), has been appointed as a new member of CIAT's team of tropical pastures specialists, continuing the work begun by Jake Halliday. She will be involved in selecting and testing *Rhizobium* strains and evaluating their N-fixing efficiency with legumes shown to be promising for cattle grazing on the acid soils of lowland savannas.

At INPA, Bradley created a soil microbiology laboratory and trained Brazilian scientists who will now continue to work on mycorrhizas, phosphate-solubilizing bacteria, rhizobia, and other N-fixing bacteria associated with the roots of plants used in Amazonian agriculture.

In a collaborative project with EMBRAPA, the Brazilian national agricultural research organization, Bradley carried out research on recuperation of degraded pastures in Amazonia. This led to her particular interest in *Rhizobium* for tropical pasture legumes.

Bradley received her PhD from the Edinburgh University School of Agriculture where she studied with A.J. Holding. She also spent a year at the Max Planck Institute of Immunology at Freiburg-im-Breisgau.

Walker With USAID

James L. Walker has been appointed Agricultural Research Network Specialist for the U.S. Agency for International Development (AID). He will be the Associate Director (Research) of the Office of Agriculture and the senior agricultural research scientist for the Agency.

Walker will be responsible for the evaluation and approval of all interregional and centrally-funded agricultural research projects; for the coordination of the total office portfolio of research activities; and for the management of AID's substantive and funding contributions to the Consultative Group for International Agricultural Research (CGIAR), which includes all of the major international agricultural research centers. He will also provide support and technical guidance to AID's regional bureaus and field missions in all matters related to the direction, strengthening, coordination, and utilization of agricultural research in the less developed countries.

Walker's most recent position was that of Program Manager of the University of Hawaii's Nitrogen Fixation Program. He has over sixteen years of international agricultural research and development experience in thirteen countries.

Collaborative Ag At Boyce Thompson

Continued from page 4

Tropical Agriculture (IITA) at Ibadan, Nigeria. This research is aimed at developing techniques for selecting for enhanced N-fixation in soybean and cowpea.

Allan Eaglesham (working with Abe Ayanaba of IITA) is responsible for another component of the IITA project. Rhizobia isolated from about 450 genetically diverse lines of cowpea planted in several locations in West Africa are being screened at BTI for diversity of type as well as effectiveness and competitiveness. Preliminary work indicates a potential to improve nodulation and fixation by field-grown cowpeas, and elite strains identified at BTI will be used in inoculant trials in Africa.

Al App, in conjunction with I. Watanabe, Soil Microbiologist at the International Rice Research Institute (IRRI), Los Baños, Philippines, and Martin Alexander are studying nitrogen fixation in flooded rice in the tropics. App has been conducting nitrogen balance studies in both the field and greenhouse at Los Banos.

The interest of Ali Szalay's laboratory is focused on three topics: structural organization and evolution of the nif genome; expression of the nif genes in procaryotic and eucaryotic cells; and cloning of plant genes.

McNeil Now at NifTAL

David L. McNeil, who was most recently at Boyce Thompson Institute, is the NifTAL Project's newest legume agronomist. His research at NifTAL will stress selection of *Rhizobium japonicum* with soybean for continued fixation in the presence of NO_3. Additionally he will work with chickpea nodulation under saline conditions.

A second aspect of McNeil's work will involve training interns in basic microbiological methods and strain selection techniques. His third major function will be to serve as Coordinator of West African trials in the International Network of Legume Inoculation Trials.

McNeil received his PhD in 1978 from the University of West Australia, where he worked with transport of nitrogen and minerals in *Lupinus albus*. At Boyce Thompson he continued to research N transport, working with glass-house and field-grown soybeans to determine how nodulation and fertilizers affect the transport processes and excretion of N to the environment.

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On his return to the Royal Forestry Department's Division on Watershed Management, Jessada will be evaluating the potential use improvement of grazing areas and rangelands suitable for individual or small community development in watershed areas, providing guidelines for a forest grazing and range improvement plan for livestock production compatible with forest and watershed development, and carrying out trials on introduction of legumes in the agricultural crop rotation and experiments on grazing management and range improvement for converting undesirable grasses/weeds into palatable, nutritious, and adaptable legume/grass forage plants.

Refugees in a Thai village fetch wood from the surrounding forest. Reforestation is one element of watershed management.

Photo by M. Sundhagul

EDITORIAL

Two courses which offer a novel strategy for communicating the benefits of BNF technology are being offered by North Carolina State University (NCSU) and the Instituto Nacional de Investigacion Agraria (INIA), the Peruvian agricultural research institute. Project Managers and Mission Directors will be interested in considering potential participation by members of their staff—whether technical or professional—in these introductory courses. See page 3, column 1, for more information.

Letters to the Editor

I was recently privileged to get a copy of the BNF Bulletin (Vol. I, No. 1). An article entitled, "Herbicides/Insecticides Can Aid N Fixation" (p. 4) attracted my attention. I noted that the two investigations reported were on fungicides and insecticides; yet the concluding sentence ran as follows: "Thus, both herbicides and insecticides may be useful in increasing the quantity of nitrogen fixed in low-land rice."

Have herbicides played any role in these findings or is it a case of a wolf in sheep's clothing? It is not unusual for herbicides to get the publicity meant for insecticides and other pesticides.

I. Okezie Akobundu
Weed Scientist, IITA

The original copy provided by Dr. Alexander provides the following information. Dr. Alexander can be reached at the address on page 2.

Nitrogen fixation by inoculated algae as well as by indigenous species is often low. One reason is competition by non-nitrogen-fixing algae, either greens or blue-greens. The approach used to overcome this problem is based on the susceptibility of algae to herbicides. An active nitrogen-fixing alga is first obtained, and this is made resistant to a specific herbicide by mutational techniques.

This resistant alga is then introduced into flooded soils together with the herbicide. The pesticide serves to suppress the indigenous species, and the inoculum alga, which is resistant to the toxic chemical, then flourishes. Preliminary studies under laboratory conditions indicate that appreciably greater algal growth and nitrogen fixation can often be obtained by these techniques.

Tom Lumpkin, now at the Zhejiang Academy of Agricultural Sciences in China (See BNF BULLETIN 1(1):6) sent this update on his research.

In a field experiment with five temperate and one sub-tropical variety of *Azolla* grown as green manure for spring-summer rice, three management practices will be applied: *Azolla* grown as basal manure before transplanting seedlings; *Azolla* as intercrop topdressing during the 25 days following transplanting; and *Azolla* as both basal manure and topdressing. Rice yields will be compared with yields from N-fertilized, no-*Azolla* treatment, and an unfertilized, no-*Azolla* control.

From preliminary results, *Azolla* treatments are expected to supply 60–200 kg N/ha.

A second experiment will repeat the above design for the summer-fall crop while substituting tropical species of *Azolla* for the temperate varieties. At present, no country has a suitable *Azolla* species for summer cultivation. I'm hoping that one of the varieties will help fill this need.

Please refer your readers to this recent publication: Lumpkin, T. A. and D. L. Plucknett, 1980. *Azolla:* botany, physiology, and use as a green manure. *Economic Botany,* 34(2):111-153.

DISSEMINATION UPDATE

If you or your associates wish to be added to the distribution list for the *BNF BULLETIN,* or if your address has changed, please fill out the following and mail this form to: NifTAL Information Section, 3190 Maile Way #300, Honolulu, Hawaii 96822, USA.

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Please check the appropriate box:

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BIOLOGICAL NITROGEN FIXATION BULLETIN

VOL. I, NO. 3, SEPTEMBER 1980

BNF's "Black Box"

Still A Mystery...

Researchers whose careers are dedicated to illuminating the mysteries of biological nitrogen fixation (BNF) poked fun at each other in a recent cartoon in the *Rhizobium Newsletter*. The cartoon depicted the current knowledge of the metabolic steps occurring in legume root-nodules as a mysterious "black box." This is perhaps a case of over-modesty, as more pieces of the puzzling sequences of processes that occur in nodules come to light through intensified research into BNF. What is still lacking, though, is an understanding of the whole picture.

Fortunately, not having the whole picture is not an impediment to deriving enormous benefits from the BNF processs in agriculture. A Brazilian researcher calculates that her country is saving US$1 billion per year through BNF. Biological nitrogen fixation technology is already a tried and proven formula for reducing the nitrogen fertilizer requirements of crops, even while our understanding of the entire process remains incomplete.

The farming community was using BNF technology long before it became the object of scientific study. It was common practice to transfer some soil from a field in which legumes had previously been grown to any new area to be planted—a process called "teaching the new soil to grow beans." BNF technology is really just a refinement of this simple approach.

It was not the soil itself that improved the farmers' chances for a good crop of soybeans in a new area. Rather it was the bacteria (rhizobia) in that soil. Rhizobia are essential for soybeans to form nodules, special structures on their roots that enable them to be self-sufficient for the nitrogen required for their growth. Some strains of rhizobia are better at forming nitrogen than others. Some legumes require very specific strains. Methods exist for selecting the correct strains, producing them on a large scale, incorporating them in a carrier material for marketing and distribution, and for applying the rhizobia to the soil, either directly or as a seed coating.

As research uncovers more of the mysteries of the BNF process, improvement and refinement of BNF technology can be anticipated. The possibility that nitrogen-fixing capabilities typical of leguminous plants might be transferred to other species, even the cereals, is no longer as remote as at one time as it might have seemed.

Continued on page 5

Photo by J. Halliday

The processes that occur in the tiny root-nodules of leguminous plants remain a mystery. The bacteria housed in these organs perform the conversion of gaseous nitrogen to a form in which the plant can use it for growth. Yet the equivalent process can only be achieved industrially with extremely high temperatures and pressures at a huge energy cost. Fortunately, it is not essential to understand these processes fully before benefitting from them in agriculture. Many countries which would otherwise have to import additional nitrogen fertilizer are saving millions of dollars through nitrogen fixed biologically in the root-nodules of legumes.

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UNITED STATES OF AMERICA

ANNOUNCEMENTS

Trinidad Workshop Coming Up

A Workshop on Biological Nitrogen Fixation in the Tropics is scheduled at the University of the West Indies, St. Augustine, Trinidad, from January 4–8, 1981. The purpose of this workshop is to bring together experienced researchers in all aspects of biological nitrogen fixation in the tropics. Major emphasis will be on grain and forage legume production. Topics will include inoculum production, and distribution, and competitiveness, survival, and effectiveness of *Rhizobium* strains.

It is anticipated that the proceedings of the Workshop will be published in the journal *Tropical Agriculture,* probably as a special issue.

For more information contact Dr. S. K. Mughogho, Univ. of the West Indies, Dept. of Soil Science, St. Augustine, Trinidad, WEST INDIES.

Soya Processing Perused

A World Conference on Soya Processing and Utilization is slated for November 9–14, 1980 at Acapulco, Mexico. This Conference will be bilingual (Spanish/English), and is designed to transmit practical knowledge and technology related to processing and use of soybean to improve nutritional value of foods. It is sponsored by the American Oil Chemists Society (AOCS).

No registration deadline is given for the Conference. Interested persons should immediately contact AOCS, 508 South Sixth Street, Champaign, Illinois 61820, USA. TELEX 404472.

5th GIAM in Print

Copies of the Proceedings of the 5th International Conference on the Global Impacts of Applied Microbiology are available for purchase from the GIAM-V Secretariat in Thailand. The 1979 Proceedings contain 600 pages of papers with over 1000 figures, photos and color plates. Six papers address the issue of microbes and nitrogen economy.

Cost is US$30 or, paperbound, US$25 (discount to students). Postage is US$2.50 for surface mail. Make remittance payable to "GIAM-V Secretariat only."

Mail orders to the Secretariat at the Microbiology Dept. of Mahidol University, Rama 6 Rd., Bangkok 4 THAILAND.

Scholarships Offered

Fixation Biologique de l'Azote

The Universite Claude Bernard Lyon at Villeurbanne and the Institut National de Agronomique (INRA) will offer a course on N_2 fixation from September 7 to October 2, 1981. The course offers both theoretical and practical information for agronomists, agricultural engineers, technicians, and advanced students.

Topics include the N cycle, N nutrition, biochemistry of fixation, genetics, ecology, physiology of legumes and non-legumes, and agronomics. Practical experiences will involve mass spectrometry; isolation, observation, culture, and techniques of studying microorganisms; and inoculant production.

The French government will offer sponsorship to foreign students wishing to attend the course. Scholarships will cover tuition, travel, and accomodations. Applications should be directed to the French Embassy in the student's home country or to the *Mission Francaise de Cooperation.*

For further information contact Dr. M. Obaton, Head of Research, INRA, 34060 Montpellier cedex, FRANCE.

Sri Lanka *Psophocarpus*

The Second International Winged Bean Conference has been scheduled for January 19–23, 1981 at Colombo, Sri Lanka, the Sri Lanka Foundation Institute. This Conference will be sponsored by the Sri Lanka Ministry of Agricultural Development and Research and the International Council for Development of Underutilized Plants.

Six state-of-the-art papers, ten "country" papers and fifty research papers will be presented. Technical sessions will feature physiology; germplasm, genetics and breeding; agronomy; entomology and pathology; nutrition, processing, and utilization; and economics and marketing.

Other highlights include meetings of the Winged Bean Steering Committee, the Sri Lanka Winged Bean National Committee, a Public Forum, and tours.

This Conference will preceed a Conference on soybean seed and establishment.

For further information, contact: Prof. Walter Herath, Faculty of Agriculture, Univ. of Peradeniya, Peradeniya, SRI LANKA or Dr. Louis Lazaroff, ICDUP, 18 Meadow Park Court, Orinda, CA 94563, USA.

Rice—the cereal crop that feeds half the world's population—can benefit significantly from biological nitrogen fixation with proper management. However, many questions remain unsolved.

N_2 Management

IRRI Publication Lists Priorities For Rice Research in the Eighties

As with most of the world's farmers, the small rice farmers of the tropics need low-cost nitrogen. Over 60% of the N used by the rice plant comes from the soil, and soil N is especially important during late stages of growth. Even modest grain yields require N fertilization. But financial constraints limit the quantity of N the small farmer can purchase. Improved management of nitrogen resources in wetland rice culture could greatly enhance food production for all of Asia.

While most BNF work has centered on processes that take place in well-aerated dryland soils, many scientists are doing productive research in nitrogen-fixing relationships in submerged paddy soils. IRRI, the International Rice Research Institute, has recently published *Nitrogen and Rice,* a 500-page volume devoted to the results of this group of researchers. The output of an IRRI-sponsored symposium in 1979, the documents represent a broad-based investigation of the most essential nutrient in the farming system that feeds fifty percent of the world's population.

One of the valuable contributions of this symposium and its proceedings is the definition of research priorities in the area of BNF for rice production.

A summary of research needs for managing N_2 fixation (by Al App and I. Watanabe) brings out the need for definition of the relative contribution of phototrophs and heterotrophs. Do N volatilization losses outdistance N-fixing potential of algae? If so, the accumulation of information on heterotrophic fixation becomes even more important.

There is a need to know how much biologically-fixed N is lost, by what processes? The effect of N fertilization on three separate N_2 fixation sites must be considered.

Analysis of the environmental conditions and requirements for successful inoculation with algae must accompany response studies. Possibilities of cropping arrangements which would allow intercropping rice, azolla, and blue-green algae also require investigation.

Green manuring with legumes can return large amounts of N to the soil. However, multiple cropping specialists must determine the economic feasibility of these schemes. Additionally, extension specialists must be able to deliver a practical technology for nitrogen fixation which fits in with existing rice farming systems.

Many factors pertinent to these and other issues are discussed in *Nitrogen and Rice,* edited by I. Watanabe and Walter Rockwood and published by IRRI.

Rio Hosts BNF Trainees

The Universidade Federal Rural do Rio de Janeiro (UFRRJ) was host to an Advanced Course on Biological Nitrogen Fixation during July, 1980. This was the third time for the course, which is a regular biennial, post-graduate offering of the University, produced in cooperation with the Programa Fixaçao Biologica de Nitrogenio (EMBRAPA-CNPq).

Local staff for the course is reinforced by two to three foreign lecturers. In previous years Ben Bohlool (University of Hawaii), Alan Gibson (CSIRO, Canberra), Carlos Neyra (Rutgers University) and Dietrich Werner (University of Marburg) have been visiting lecturers.

This year Geoffrey Yates (ARC Unit of Nitrogen Fixation, Sussex), Frank Minchin (University of Reading) and Phillip Chalk (University of Melbourne) were invited to join the team of Brazilian lecturers which included Manlio Fernandes, Luis Antonio Castro, Edna Rienke (all from UFRRJ), and Johanna Döbereiner, Maria Jose Amstalden M. Sampaio, Fernando Faria Duque, Robert M. Boddey and Sebastiao M. Souto (PFBN-EMBRAPA). While Avilio Franco has been in charge of the organization of the past courses, Maria Cristina Prata Neves was responsible this year.

The courses have always been organized within limited availability of funds under bilateral convenia of CNPq, the Royal Society, and the NAS. Attempts to obtain support from International Agencies (FAO, UNESCO, UNDP, OEA) have so far failed, and many foreign students come with their own funds.

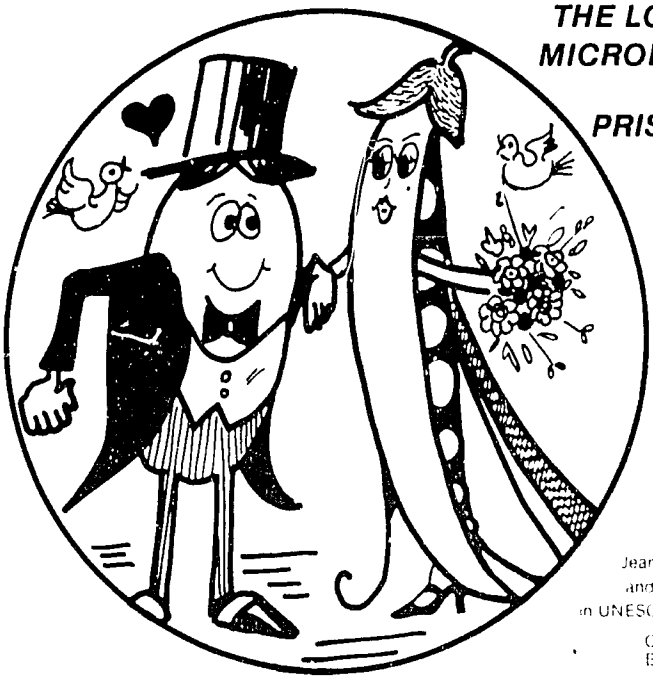
Lectures this year covered a wide field ranging from bacteriology, physiology and biochemistry to plant breeding, and agronomy. Free-living systems and the rhizocoenoses with grasses were discussed as well as the legume symbiosis.

Emphasis was on practical aspects of research, and the students developed small but original research projects in their areas of interest. Colleagues from the research team of PFBN collaborated in the experiments, transmitting their experience in methodology.

As usual, the course ended with a Brazilian *churrasco* (barbecue). The Brazilians and their visitors can now count many new friends and a few more convinced nitrogen fixation adepts.

The next course will be in July 1982. Interested parties should write to Dr. Johanna Döbereiner, PFBN-SNLCS-EMBRAPA, 23460, Seropedica, Rio de Janeiro, BRAZIL.

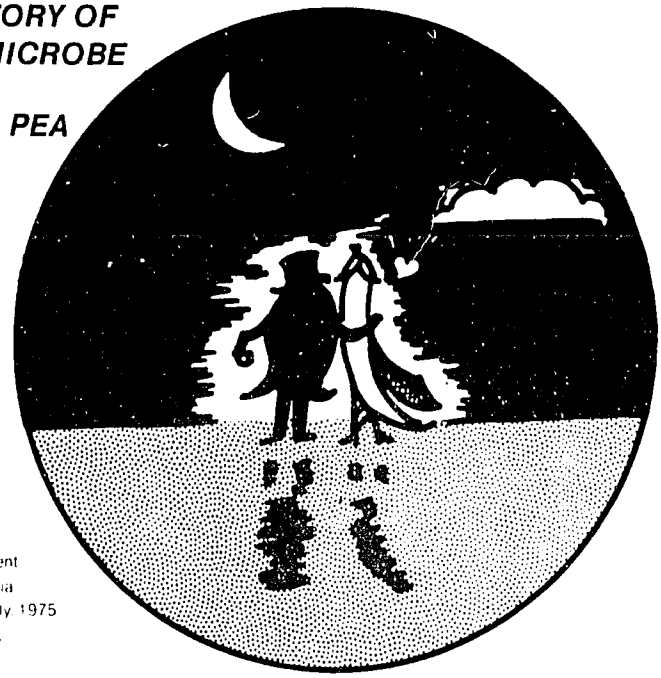
THE LOVE STORY OF MICROBIUS MICROBE AND PRISCILLA PEA



"With me, you'll never go short of ammonia, honey!"

Concept
by
Jean-Marie Clement
and Safouria Assia
in UNESCO Courier, July 1975

Contributed by
Edgar da Silva



"And I'll feed you plenty of sugar!"

Contributions Sought

The Philippine Council for Agriculture and Resources Research (PCARR) in collaboration with the International Development Research Center (IDRC) of Canada has a new publication called *Leucaena Forum*. International in scope, this newsletter aims to provide a forum through which researchers can channel results, opinions, policies and observations on various aspects of *Leucaena* research, production and use.

The editors are asking *Leucaena* experts worldwide to send articles and contributions for publication in succeeding issues. Mail contributions to Petronila Payawan, Editor, *Leucaena Forum*, PCARR, Los Banos, Laguna, PHILIPPINES.

Proceedings Reprinted

Copies of the Sixth Australian Legume Nodulation Conference (Perth, August, 1979) are available following a reprinting. This publication contains 46 papers and a report from the Australian Inoculant Research and Control Service (AIRCS). Abstracts of the papers appeared in *Rhizobium Newsletter*, Vol. 25, No. 1.

The cost of the volume is $Aust.4 plus postage. Postage costs are as follows (in $Aust.): Surface mail—$1.85; Airmail—New Zealand, Papua New Guinea, $3.45; Indonesia, Malaysia, Thailand, Philippines, $4.70; USA, Canada, Middle East, $7.00; Africa, South America, $7.95.

Checks or bank drafts should be made out to: Sixth Australian Legume Nodulation Conference. Send orders to Dr. D. L. Chatel, Dept. of Agriculture, Jarrah Road, South Perth, W.A. 6151, AUSTRALIA.

EDITORIAL

Azolla Bibliography Available from IRRI

A welcome addition to research resources is the *International Bibliography on Azolla*, compiled by Dionisia T. Capaya of the Library and Documentation center at the International Rice Research Institute, Philippines.

Spanning 1783 to 1979 there are 671 entries, each with complete bibliographic information and arranged in broad subject categories—anatomy/morphology, physiology/biochemistry, taxonomy, ecology, agronomy, plant protection, and non-agronomic uses. Author and keyword indexes provide additional access.

Non-English literature is included, with both original and translated titles if known; translations held by the Documentation Center are also indicated. Much of the literature recorded in this publication is available directly from the Center for a fee.

Although lacking abstracts, this splendid listing of literature on a currently important topic is fully up to the standard of other bibliographic works produced by the Library and Documentation Center of IRRI.

Letters to the Editor

Dear Editor,

A legume is not so much a plant as a symbiotic association. For more than twenty years, an essential feature of the paraphenalia carried by Australian plant introductionists seeking the new (or old) and interesting legume, in both foreign and local climes, has been a box of small, tight-capped vials. These vials contain calcium chloride, or silica gel, and cotton wool. Whenever seeds are collected, nodules from the same plants are placed in these vials to desiccate, for subsequent transport to the "stuck-at-home" microbiologist colleague who then isolates the endophyte. Many of the common CB and CC rhizobia were 'fathered' by a plant introduction officer and spent a gestation period *"in vialo"* before birth as strains in their own right on the ubiquitous, albeit multi-formed, YMA. We can even tell the story of F.W. Hely, A.O.M., who travelled the Mediterranean region collecting strains of rhizobia for *Trifolium* and *Medicago* species, but carefully remembering to collect seeds of the host plants where possible.

Hence your claim for a first by Dr. Gregory, in collecting nodules for peanuts ("Stalking the Wild Rhizobium") may be a first for a US worker, and it may be a first for a collector of peanut germplasm, but it is surely not the first time that a collector of legume germplasm has considered the associated rhizobia as important as the host.

May we all BeNiFix from our mistakes.

Alan H. Gibson

It appears I've been overenthusiastic. Apologies to the intrepid Australians, and to any other Rhizobium *"stalkers" I overlooked.*

—Ed.

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?ulse Breeders)n New Track

The Pulse Improvement Program at 'unjab Agricultural University is a co-rdinated effort of 22 scientists includ-ıg plant breeders, agronomists, micro-iologists, plant pathologists, and ento-ıologists for the improvement of chick-ea *(Cicer arietinum)*, mungbean *(Vigna ıdiata)*, urdbean *(Vigna mungo)*, lentils *.ens culinaris)*, and pigeonpea *(Cajanus ajan)*. The Program Leader is T. S. andhu, who hopes to breed pulses ıth better N-fixing capacity by in-oducing *Rhizobium* technology into reeding projects.

The efforts of the research 'eam have ıus far resulted in the development nd release of five cultivars of chickpea: :214, G130, G543, *Hare Chhole* No. 1 ıreen shaded) and *Kabuli* type L550. he *Kabuli* type L550 has also been ıleased for cultivation under irrigated onditions throughout India by the ıdian Ministry of Agriculture because f its consistent superior performance ı all-India coordinated chickpea varie-ıl trials. This type has also given top erformance in international chickpea ıals conducted by ICRISAT, Hyderabad.

Two varieties of mungbean, ML5 and 1L131, have been released for general ultivation in Punjab, and ML5 is in use ıroughout India. A new variety of peas, G3, has also been released for general ultivation.

According to Sandhu, specificity be-veen *Rhizobium* strains and genotype f the host plant needs to be considered ı developing new high-yielding strains f the legumes responsive to inocula-ɔn with effective and efficient strains.

Photo by P. Nakao

T.S. Sandhu is working with chickpea to develop genetic strains with improved potential for N_2 fixation. He will also work with mungbean.

Knowledge of *Rhizobium* technology will make it possible to exploit the variation available in host plants for responsiveness to inoculation by effective and efficient strains of rhizobia. In the long term, both the legumes and rhizobia may have to be worked with for improving them by genetic engineering. A non-destructive, quick, efficient, and cheap method of identifying plants right in the field with effective and efficient nodulation of economic importance may have to be developed. Sandhu believes that systematic breeding programs designed in collaboration with the microbiologists can achieve these objectives.

USDA Awards BNF Grants

Eleven competitive grants totalling $925,000 were awarded in August to support basic research in biological nitrogen fixation, according to US Secretary of Agriculture Bob Bergland. Another six were awarded in September.

Of the competitive grants recently awarded by the US Department of Agriculture for research in plant biology, twenty-five percent were for research in BNF. "Research aimed at understanding nitrogen fixing mechanisms in both symbiotic and free-living organisms is of high priority because nitrogen is the most common limiting nutrient for plant growth," said Anson R. Bertrand, Director of USDA's Science and Education Administration. SEA is responsible for administration of the grants.

Institutions receiving grants were Indiana Univ. ($45,000), Johns Hopkins Univ. ($120,000), Purdue Univ. ($150,000), Michigan State Univ. ($110,000), Middlebury College ($65,000), North Carolina State Univ. ($75,000), Rockefeller Univ. ($35,000), Rutgers Univ. ($35,000), Univ. of California, Davis ($100,000), Univ. of Chicago ($135,000), Univ. of Texas ($75,000), Univ. of North Dakota ($160,000), Univ. of Wisconsin ($70,000), USDA/SEA, Oakland, Calif. ($94,000), and USDA/SEA Peoria, Ill. ($95,000).

Funding levels for BNF research were generally higher than those for other types of research, reflecting the high level of importance USDA attributes to the potential for increased agricultural production through biologically fixed nitrogen.

SHORT COMMUNICATIONS

ıIAM VI

A strong contingent of African and ther rhizobiologists presented their ork and exchanged ideas during the ixth International Congress on the lobal Impacts of Applied Microbiology eld at the University of Lagos, Nigeria, uring August 30–September 4, 1980. significant proportion of papers in the ɔod and Agriculture Sessions were on NF. In a plenary session dedicated to hizosphere Biology, Jake Halliday Iniversity of Hawaii NifTAL Project) ıd Aba Ayanaba (IITA) presented apers highlighting that specificity in rhizobial requirements by species and individual cultivars of tropical legumes is greater than generally acknowledged; that responses by tropical legumes to inoculation with *Rhizobium* are common when inoculants of assured quality are used; that it is difficult to predict correctly the response to inoculation at different sites; and that commonly the application of nitrogenous fertilizers to tropical legumes depresses their yield.

X RELAR

Maracay, Venezuela, was the venue for the tenth Latin American *Rhizobium* Meeting (X RELAR). There were forty participants representing eleven countries. Some thirty-five papers were presented including invited seminars by Maria Cristina Prata Neves (Brazil), Jake Halliday (USA), and Carlos Labandera (Uruguay). Dr. Luis B. Ayala of CENIAP was coordinator of the meeting held during 15–19 September 1980.

The rhizobiologists convened in a business session and moved another step closer to formalization of the ALAR (Associacion Latinoamericana de Rizobiólogos) by naming an executive committee to draw up an appropriate constitution and receive nominations for office bearers.

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Photo by H. Hoben

One of leucaena's most avid supporters, James Brewbaker shows an experimental stand of the tree legume to EPAMIG researcher Nuno M. de Sousa Costa. Brewbaker's studies show that leucaena is one of the best sources of high-protein feed and fuel in the tropics.

Leucaena Enthusiasts Get New Outlet

Volume I of a new information organ, the *Leucaena Newsletter*, is in distribution. This is the first of a series of annual collections of research notes and technical reports.

The current volume contains reports from Australia, South America, Central America, India, Indonesia, Africa, Philippines, U.S., U.K., and Taiwan. It also contains a six-page bibliography.

The newsletter is edited by James L. Brewbaker, Hawaii horticulturist, who is active in research with the tree legume and its genetic improvement and general agronomy.

More than 50 countries throughout the world share Brewbaker's interest in leucaena, including the government of Taiwan, which produced volume one of the *Newsletter*, a collection of research notes and brief technical reports on leucaena and other tropical leguminous trees. K. Y. Tai, the newsletter's managing editor, is director of the Department of Agricultural Resources in Taipei.

"Taiwan's interest in leucaena is for use in their pulp and paper industry," Brewbaker explains. Taiwan has already planted 2,000 acres of the tree legume and is readying 2-million seedlings for plantings.

"The degree of interest in leucaena increases as new uses are discovered for this versatile tree legume," Brewbaker said. Manoa researchers are currently identifying varieties of leucaena for fuelwood and forage crops, windbreaks, as a source of charcoal and organic fertilizer.

"'Hawaiian Giant' is a huge koa," Brewbaker said. "Its high protein leafmeal is marketed for feed and averages 28 percent protein content." Brewbaker estimates an annual yield of 2.1 tons of crude protein per acre per year. The tree grows to a height of 13½ feet in six months and 30 feet in two years. Trunk diameters average 8½ inches in 6 years.

"The young seeds and leaflets of leucaena make a good addition to soups and stews," he explains. "In Mexico, for example, the pods are folded into tortillas with chili for a nutritious snack."

Leucaena has few natural enemies. Its wide adaptibility and ease of growth are legendary. It's one of the most versatile and fastest-growing trees in the tropics.

Still a Mystery

Continued from page 1

An even greater mystery than the intricacies of the BNF process is why more countries in the tropics, having so much to gain from BNF technology, have so far not fully tapped this important source of nitrogen. With this mystery in mind, the scientific community is balancing investigations on the process of biological nitrogen fixation with research on the constraints to widespread acceptability and implementation of BNF technology in the tropics at the farm level.

Trinidad Teacher Pushes Pigeonpea Production

Pigeonpea *(Cajanus cajan)* is a very popular vegetable in the West Indies. The dry peas are used to make dahl, a tasty soup-like curry of Indian origin.

Most pigeonpeas are imported to the West Indies at present. But the market potential for local use and regional consumption makes commercial production of pigeonpea attractive.

Alfred Donawa, who teaches microbiology at the University of the West Indies in the Soil Science Department, is also researching the response of *Cajanus* to inoculation. Historically, pigeonpea has not responded to fertilizer N, according to Donawa. If good nodulation could be achieved production potential would be much improved. Donawa is testing a number of *Rhizobium* strains isolated from West Indies soils in an attempt to identify those that are most effective in producing nodules. Imported strains are also being evaluated and field tested.

The commercial potential of intercropping pigeonpeas with corn is another interesting possibility, and experiments with sequential and mixed cropping systems are planned for this year.

It's a Soy World After All

SoyWorld, a publication of the American Soybean Association, offers the following information about worldwide use of that versatile legume.

In the US, there are over 200 products on the supermarket shelf made from soybeans. . . US soybean producers planted 71.3 million acres this summer... India imports 197,000 metric tons of soy oil. Officials in government and industry are working with ASA representatives in promoting a soybean crushing industry based in India. . . Mexico is working on improved transport and grain handling infrastructure to facilitate utilization of soybean products. . . Thailand, Indonesia, and the Philippines have infant soybean industries with great potential for expansion. At Bogor Agricultural University the Food Technology Development Center is developing equipment for small village soybean processing industry. A new soybean crushing plant capable of producing 1000 metric tons per day is being built in Manila. . . Feeding trials are convincing Egyptian farmers that soy meal is an economical and efficient feed ingredient.

BIOLOGICAL NITROGEN FIXATION BULLETIN

VOL. II, NO. 1, MARCH, 1981

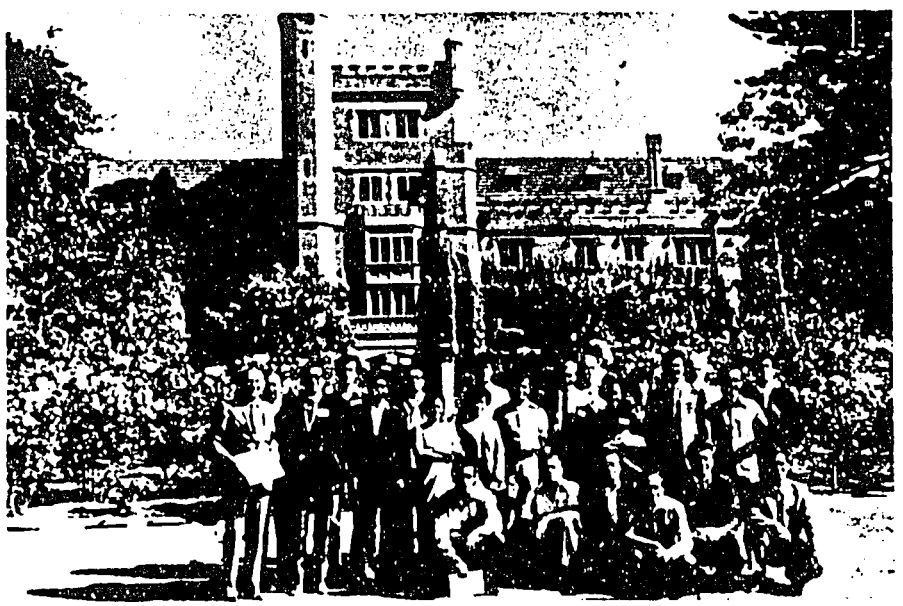
Australia Is Host To World's N-Fixers

IV International Symposium On Nitrogen Fixation

Four hundred of the world's foremost experts on nitrogen fixation gathered during the first week of December on the campus of the Australian National University to divest, systemize, and increase their state-of-the-art knowledge on the process of nitrogen fixation. The symposium displayed the worldwide interest in and commitment to BNF. Over seventy percent of the attendees were international visitors who represented 47 nations around the globe. The number of participants from tropical nations which have recognized the possible benefits of this type of research was impressive. A diversity of interest in nitrogen fixation was also demonstrated by the sponsorship list, which included scientific foundations, Australian wool, wheat, rice, and meat boards and other marketing organizations as well as several commercial, industrial and agricultural organizations.

The program stressed the theoretical and long term 'state-of-the-art' aspects of nitrogen fixation. Major sessions were devoted to nitrogenase action, energetics of the symbioses and components, genetics and molecular genetics of both partners, chemical aspects of nitrogen fixation, and regulation and recognition processes. General diazotroph ecology and non-rhizobial nitrogen fixation were also discussed. However there were also sessions (e.g. on measurement of nitrogen fixation), discussion groups, and posters aimed at immediate practical

Continued on page 7



Participants at the ADAB/ Univ. of Sydney Seminar on Nitrogen Fixation: Kneeling: Khan, Bhuiya, Homchan, Saono, Li, Zou. Front standing: Vincent, Chee, Htwe, Maskey, Jose, Dadarwal, Chaudhary, Paterno, Athar, Shamsuddin. Back standing. Min, Kim, Vangnai, Chandra, Fan, Strickland, Lim, Davis, Ge.

ADAB Seminar For Asian Researchers

A seminar on Nitrogen Fixation for Tropical Agriculture, sponsored jointly by the Australian Development Assistance Bureau (ADAB) and the University of Sydney, was held 18 November to 12 December, 1980. This seminar, one of ADAB's Research for Development series, was organized by Prof. J. M. Vincent. Participants were Asian research workers, generally those with 5–10 years post-graduate experience whose major interest is legume nodulation. The program, scheduled around the Fourth International Symposium on Nitrogen Fixation, included visits to all the major laboratories in Australia doing work on *Rhizobium*, with demonstrations and lectures by the Australian *Rhizobium* workers.

Seventeen research workers from abroad and four who are now graduate students at Australia universities were with the seminar for the entire time. Other Asian workers joined for selected sessions. Bob Davis, Asian Regional Coordinator, NifTAL, accompanied the seminar as an observer.

Each participant presented a discussion on legume inoculation research in his or her own country. In Canberra the participants had several sessions with ADAB officials.

BNF BULLETIN
VOLUME II, NUMBER 1
MARCH 1981

Editor **Susan C. Harris**
Editorial Assts.: **Judy Rothenberg**
Carol King

This issue of the BNF BULLETIN begins volume II. Volume I had three numbers. We regret that back issues are no longer available for Volume I.

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Cornell University
North Carolina State University
University of Hawaii
University of Puerto Rico
and by the University of Hawaii **NifTAL Project.**

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News and opinions are solely those of the authors and or the editor and do not necessarily represent the views of the institutions and agencies involved.

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University of Hawaii NifTAL Project
USAID Contract number [illegible]

ANNOUNCEMENTS

Conference Announced

The Eighth North American *Rhizobium* Conference will be held at the University of Manitoba, August 2–7, 1981. Topics planned for presentation include: evaluation of *Rhizobium* cultures, inoculant evaluation, biochemistry and genetics of *Rhizobium*; host plant genetics and enhancement of N_2 fixation; ecology and biochemistry of the symbiosis; field studies; natural legume associations; and vesicular-arbuscular mycorrhiza in association with the legume *Rhizobium* symbiosis.

For more information, contact: Dr. K. Clark, Plant Science Dept., Univ. of Manitoba, Winnipeg, Manitoba, Canada, R3T 2N2.

ALAR Formalized

The organization of the Asociacion Latinoamericana de Rhizobiologia (ALAR) was formalized at the Tenth Latin American Rhizobiology Reunion in Maracay, Venezuela, in September, 1980. Participants at the Reunion named Uruguay the seat of the association for its first two-year period. Carlos Bathyany was elected President.

The Executive Committee also includes Carlos Labandera, Vice-President; Anibal Alvarez, Secretary; and Gloria Martinez de Drets, Treasurer. The Committee's mailing address is: Laboratorio de Microbiologia de Suelos y Control de Inoculantes, Plan Agropecuario Bulevar Artigas 3802, Montivideo, Uruguay.

Casuarina Workshop

In 1978, ICSU (the International Council of Scientific Unions) established an inter-union Commission, CASAFA (Commission for the Application of Science to Agriculture, Forestry and Aquaculture). CASAFA aimed to involve scientists in some scientific aspects of major needs of the developing world. In July 1980 CASAFA met in Paris and resolved to promote a project on the genus *Casuarina* as a contribution to the fuelwood needs of semi-arid tropical regions.

To this end, the CSIRO Division of Forest Research is organizing a small conference to collate current knowledge on the botany, uses and silvicultural requirements of *Casuarinas*. Support for the meeting has been promised by the US National Academy of Science and the Canadian IDRC. The Australian Academy of Science has agreed to sponsor the meeting. The *Casuarina* workshop is to be held in Canberra, Australia, 17–19 August, 1981 immediately preceding the 13th International Botanical Congress.

Those interested should contact Dr. M. F. Day, CSIRO, Division of Forest Research, P.O. Box 4008, Canberra, A.C.T. 2600.

INTSOY Short Course

Dates for the two soybean training courses offered by INTSOY in 1981 have been set. Technical and Economic Aspects of Soybean Production will be held May 18 to August 14. Soybean Processing for Food Uses will be held April 27 to June 12.

The training cost per participant, *not* including living expenses or international travel, is US$3,295 for the production course, and US$1,810 for the processing course. The suggested living allowance for the production course is US$3,000 and US$1,700 for the processing course. Additional information is available from J. W. Santas, INTSOY, Univ. of Illinois, 113 Mumford Hall, Urbana, Ill. 61801, USA.

Time to Enroll for Bat Sheva Workshop

The Bat Sheva Workshop in Biological N_2 Fixation is scheduled for September 1–10, 1981, at Rehovot, Israel. The event, which is to be organized and hosted by the Faculty of Agriculture of the Hebrew University of Jerusalem, will be sponsored by the Bat-Sheva de Rothschild Foundation of Advancement of Science in Israel.

The workshop is intended for graduate students and scientists interested in biological nitrogen fixation and will include introductory and review lectures in genetics and genetic engineering, symbiotic and associative systems, the biochemistry of nitrogenase, and the efficiency of the process. The second week of the workshop will feature presentations of recent research results.

Proceedings will be published by the *Israel Journal of Botany*.

Participation is limited, and applications must be submitted to Dr. E. Tel-Or, Dept. of Ag. Botany, The Hebrew Univ., P.O. Box 12, Rehovot 76-100, Israel, immediately.

MARDI/NifTAL Trainees Finish Course

Fourteen trainees from eight Asian and Pacific countries attended the MARDI/NifTAL training course in legume/*Rhizobium* technology at Serdang, Selangor in West Malaysia. The six-week session began the first week in November.

Lectures and practical sessions covered general *Rhizobium* microbiology, recognition of strains of rhizobia, strain selection methodology and inoculation technology, using the NifTAL training manual. On completion of the course, trainees are prepared to conduct appropriate back up technology in their respective countries.

Staff for the course were: Joy Sundram (MARDI), Deane Weber (USDA), and Joe Burton, Bob Davis, Heinz Hoben, and Padma Somasegaran (NifTAL).

MARDI went all-out to provide the trainees with an interesting social program in addition to their educational experience. A sumptious dinner at the home of the Director General, Dato Md. Tamin Bin Yeop, was a highlight of the course. Each trainee was presented with an engraved pewter mug to commemorate the occasion.

A trip to the Cameron Highlands was also organized by MARDI. Although this venture was primarily recreational, trainees got a first-hand view of agricultural practices in Malaysia: legume cropping systems, tea plantations, orange orchards and an attempt to establish an apple orchard.

Photo by P. Nakao

Trainees at the MARDI/NifTAL course in Rhizobium *technology participated in both field and lab work. They will offer technical support to BNF programs in eight Asian and Pacific nations.*

Photo by H. Hoben

Dairy Farms Targeted by Costa Rica Researcher

Carlos Ramirez, having recently completed his PhD program at Cornell University, is back in his Costa Rica home with some very practical research plans and some hopes in the area of basic research. He wants to work with legumes: primarily forages but also as food crops and tree crops. And, if possible, he wants to continue his basic research in survival and ecology of rhizobia and bacterial antagonists of soil borne plant pathogens.

Ramirez believes *Desmodium intortum* would offer upland dairy farmers in Costa Rica an alternative to imported high-cost cattle feed while reducing the need for costly N fertilizers. No legumes are common as forages, at present. Fish and bone meal are imported as protein sources. As a result, milk is very expensive.

A team of soil scientists, agronomists, and soil chemists would be best equipped to deliver a package that might interest dairy farmers in established lines of legumes, according to Ramirez. The limiting factors are in the area of management practices: fertilizer use, grazing load, rotation period, etc. The Costa Rica dairy industry has the capital to fund research and change management practices where necessary.

On the side, Ramirez hopes to further his research to improve colonization of rhizobia. The numbers of rhizobia around the roots of legumes are crucial at the initial stages of inoculation. Any improvement in survival rates will have a practical application. But more materials and trained technicians are needed for this work.

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Attention Focused On *Cajanus cajan*

Pigeonpea is common throughout the semi-arid tropics. About 90 percent of the world's recorded crop is grown in India where, as the second most important pulse, it is consumed in the form of *dhal* and provides an important source of protein for many millions of people.

The legume is also important in the Caribbean, where it is eaten as a green vegetable and is exported both frozen and canned. Pigeonpea is a commercial crop in East Africa, but in most tropical countries it is a minor crop, often grown as hedgerows or in small garden patches.

Much of this crop is consumed by the producer, but it is also found in local markets in small quantities. The statistics of its production and importance appear to be grossly underestimated.

Pigeonpea has many advantages for the small farmer in the semi-arid tropics. It requires few purchased inputs: it fixes its own nitrogen and will generally produce a worthwhile harvest without the use of pesticides. It is relatively drought tolerant, will grow well on relatively poor soils, and is a very useful intercrop with the quicker growing cereals.

The potential for pigeonpea as a major pulse crop both in India and internationally is graphicall

Pigeonpea's relatively low ranking in international trade statistics and the fact that it is seldom grown as a sole crop in large areas has resulted in relatively low investment in research and development. ICRISAT has a mandate to improve this crop, particularly at the small-farmer level in the semi-arid tropics.

Much of ICRISAT's work on this crop is carried out in cooperation with the national scientists in many countries, particularly with the pulse workers in the Indian Council of Agricultural Research. An International Workshop on Pigeonpeas was sponsored by the two institutions December 15–19, 1980.

Approximately 150 research workers attended the five-day program. Both contributed and invited papers explored, among other topics, measurement of nitrogen fixation by pigeonpea, response to inoculation and measurement of the response, inoculant production, and evaluation of *Rhizobium* strains.

Pigeonpea Production Up in Punjab

A new cropping system is emerging in the Punjab and Haryana states in India, according to J. S. Kanwar, Director of Research at ICRISAT. While rice is still the primary crop in this area, pigeonpea is being grown more and more frequently as a sole crop and in rotation with wheat. The demand for pigeonpea *dahl* by migratory laborers who work in the rice fields has been a stimulus for the development of increasing numbers of pigeonpea crops.

Farmers are receptive to replacing crops that have been suffering from diseases: mosaic virus in the kharif pulses, downy mildew in pearl millet, and stump viral disease in groundnut.

ICRISAT is responsive to the needs of the farmers in raising this new crop. Some good genetic material is already in the pipeline. Short duration pigeonpeas are being developed at Hissar. Other breeding goals include varieties that are high yielding, photononsensitive, and will grow with minimal irrigation and pesticide application. It is also felt that a really efficient rhizobial strain could revolutionize production of this crop.

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trated by the number of researchers who attended the workshop at Patancheru.

NSF Report Stresses Nitrogen Fixation

In a recently published report, the U.S. National Science Foundation assessed agricultural priorities for the immediate future. *The Five-Year Outlook: Problems, Opportunities, and Constraints in Science and Technology* (Vol. I) is written as an information source to facilitate decision making by Congress and the Executive Branch. Nitrogen fixation is discussed as one of four highly promising fields of scientific inquiry that will be pursued during the next five years. The objective, according to the NSF report, is "breeding foodcrops that are more energy and fertilizer efficient," and reducing "agriculture's heavy dependence on fossil fuel."

BNF Notes From All Over . . .

A small-scale inoculant production plant is on the verge of coming into production in Senegal. Soybean, cowpea, peanut and stylosanthes are the major legume crops . . . At ORSTOM, in Senegal, research is underway on interactions between mycorrhiza and nodulation in soybeans and cowpeas. Other interests in the area of BNF include desiccated and polymer inoculants, promiscuity of soybeans, and non-legume fixation . . . At CNRA, also in Senegal, results to date suggest that peanuts require inoculation for the first year on new land, but rhizobia build up in the soil after several years to the point where further inoculation does not give *significant* yield response . . . In India power breakdowns and fuel shortages led to a 600,000 MT drop in production of nitrogenous fertilizers in the first half of 1980. Last year's gap between indigenous consumption and production of N fertilizers was 1.27 million MT. The gap has been widening . . . In Egypt, an INLIT (International Network of Legume Inoculation Trials) experiment at Cairo University has shown an impressive visual response to inoculation, particularly in view of the present recommendation in Egypt for a 160 kg/ha N application to soybeans . . . At IITA in Nigeria experiments with cowpea have not shown a response to inoculation. Some increases in nodule mass and early growth have resulted, but no yield responses . . . Soybeans have responded well to inoculation at most Nigeria locations with rhizobia surviving in the soil from one year to the next . . . At present all *Rhizobium* inoculants are imported to West Africa. Some persist in the soil and others fail. Abateni Ayanaba of IITA is visiting the University of California at Davis where he will work with indigenous African rhizobial strains in relationship to high aluminum/low phosphate soil conditions. He'll compare *R. japonicum* and cowpea rhizobia that nodulate soybeans to the indigenous African strains, selecting the most effective for incorporation into inoculants that can be produced in Nigeria . . . Joe C. Burton, past Vice-President of Research for the Nitragin Company, has retired from his position after 30 years. Burton has supplied *Rhizobium* cultures to many of the scientists and researchers working in BNF, and his expertise has been sought in both US and international arenas. Burton will work as a consultant in inoculant production and training for the Univ. of Hawaii NifTAL Project . . . Sonchai Patiyuth of the Department of Agriculture and cooperatives in Thailand has returned to her work after three months at Beltsville in the *Rhizobium* laboratory. She will be in charge of inoculant production and quality control of *Rhizobium* inoculants.

• • •

Nodulated and non-nodulated soybeans (back and front rows, respectively) show significant differences in growth response. This difference is eventually reflected in higher yields.

23

SOURCES AND RESOURCES

Practical Publications

We have had a number of requests for source materials for more information on biological nitrogen fixation for the non-specialist. Included here are citations to some publications aimed at providing practical information to agricultural development workers, scientists who are not specialists in this area of research, and administrators involved in agriculture or agricultural research.

This is by no means a definitive list. Additional publications will be featured here as they attract our attention.—Ed.

Berkum, P. van and B. B. Bohlool. (1980) Evaluation of nitrogen fixation by bacteria in association with roots of tropical grasses. Micro. Reviews 44(3):491–517.

Bouldin, D. R., S. Mughogho, D. J. Lathwell and T. Scott (1979) Nitrogen fixation by legumes in the tropics. Cornell Univ. Int. Ag. Mimeo 75. 40 pp.

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Green, J. T. Jr., J. P. Mueller and D. S. Chamblee. (1979) Inoculation of forage legumes. N. Carolina Ag. Ext. Svc. No. AG-226. 15 pp.

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Available at no charge upon request to local USAID Missions or

Dr. L. R. Frederick
Agency for International Development
DS/AGR/RNR—Room 420, SA-18
Washington, D.C. 20523

Technical Series Bulletins

12-The Contribution of Legumes to Continuously Productive Agricultural Systems for the Tropics and the Sub-Tropics. 42 p. mimeo

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14-Characteristics of Economically Important Food and Forage Legumes and Forage Grasses for the Tropics and Sub-Tropics. 110 p. mimeo

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21-Management of Rangelands and other Grazing Lands of the Tropics and Sub-Tropics for Support of Livestock Production. 84 p. mimeo

Attention – USAID Missions

The Consortium for Biological Nitrogen Fixation in Tropical Agriculture and the NifTAL Project serve as a resource for AID programs dealing with utilization of biological nitrogen fixation in the tropics. This newsletter seeks to keep you informed of developments relevant to problems that concern you. If you have specific problems in maximizing the potential for utilizing BNF, contact one of the project leaders listed on page 2 or contact the DSB Washington, D.C.

Available at no charge to public bodies in countries eligible for US Aid are the following upon request to:

Commission on Int. Relations (JH215)
National Academy of Sciences—NRC
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Washington, D.C. 20418 USA

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Underexploited Tropical Plants with Promising Economic Value. 188 p.

Microbial Processes: Promising Technologies for Developing Countries. 198 p.

Leucaena: Promising Forage and Tree Crop for the Tropics. 115 p.

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The Scientific Secretariat (Publication)
Tropical Products Institute
56/62 Gray's Inn Road
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TPI Crop and Product Digests:

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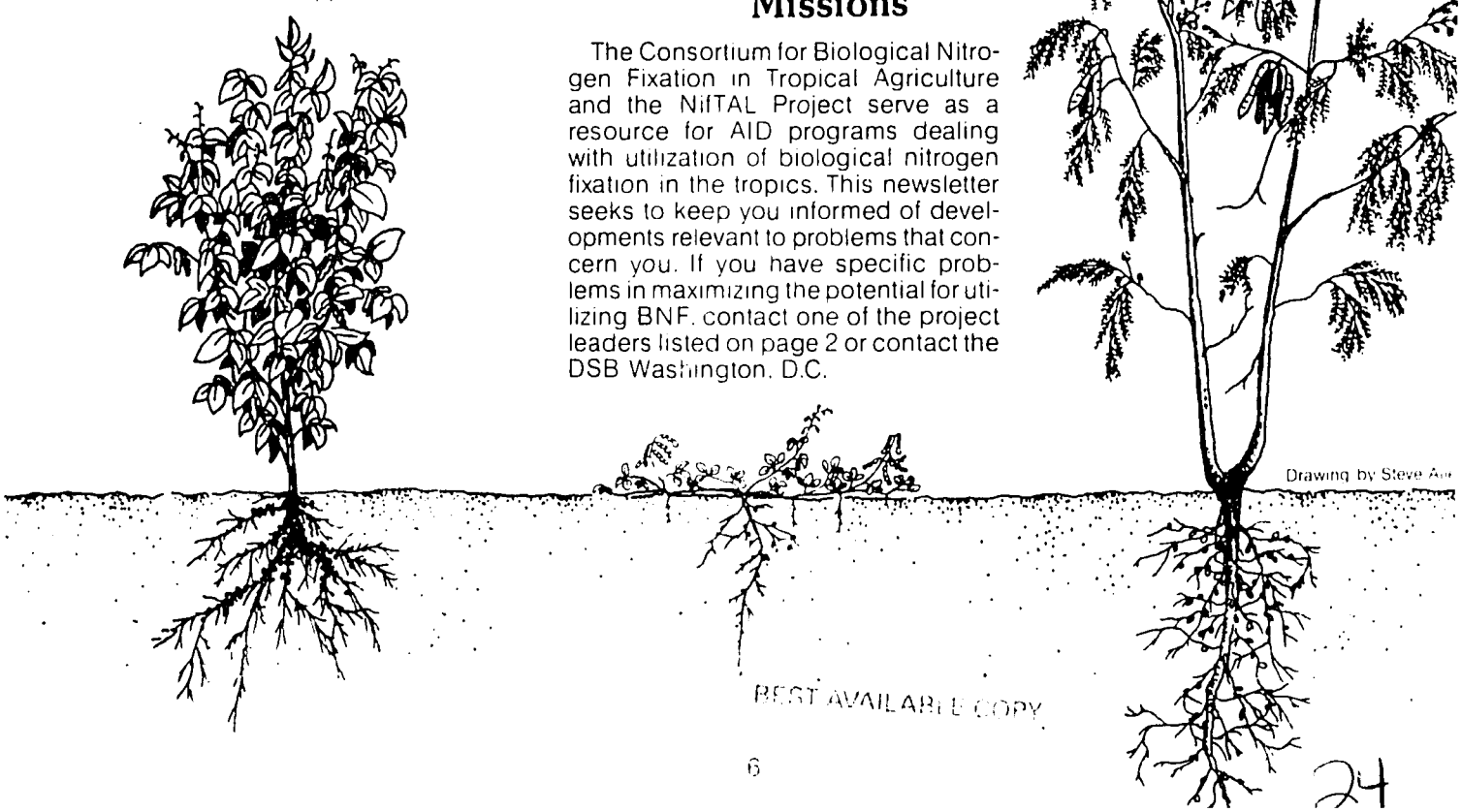

Drawing by Steve Ar

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24

SHORT COMMUNICATIONS

Pulse Planters Plan New Trials

The All India Coordinated Project on Improvement of Pulses (AICPIP) held its *rabi* workshop from 16–18 September, 1980, at the Rajasthan College of Agriculture, University of Rajasthan, under the sponsorship of the University of Udaipur and the Indian Council of Agricultural Research (ICAR). Pulse workers from all Indian research institutions gathered to exchange information and plan All India Coordinated trials for the coming season.

The program consisted of general sessions for reporting data and general planning with individual group sessions for agronomy, genetics and plant breeding, plant pathology, entomology, plant physiology and microbiology. The individual groups planned trials for the coming season after which each group chairman made a brief report to the general session so that any points in dispute could be settled.

Congratulations for the smooth operation of the workshop go to Sudhir Kumar, professor and head of the Dept. of Genetics and Plant Breeding, University of Rajasthan. Dr. Kumar was the one-man local arrangements committee and was responsible for the problem-free week for all participants. H. S. Sahambi, Acting Director of the AICPIP, was responsible for coordinating activities necessary to get the program together and the delegates to Udaipur. L. M. Jeswani, Asst. Director General, ICAR, represented ICAR throughout the workshop. S. P. Ramanujum, formerly Pulse Coordinator and now head of the Division of Genetics at the Indian Agricultural Research Institute (IARI), also played an active part in the proceedings.

West Indies Workshop Stresses Strategies

The Regional Workshop on Biological Nitrogen Fixation in the Caribbean was held January 4–8, 1981, at St. Augustine, Trinidad, West Indies. The workshop was co-sponsored by the Department of Soil Science of the University of the West Indies (UWI) and the Cornell University Department of Agronomy. Review papers and reports of research were presented at sessions covering: Better Utilization of BNF in the Tropics, Manipulation of *Rhizobium*, Inoculant Production in the Tropics, and BNF in Cropping Systems in the Caribbean.

Forty-five delegates from institutes in the Caribbean and the United States participated in the workshop. Local organizers were A. L. Donawa and Spider Mughogho. Other participants from the United States included Martin Alexander/Cornell, Allan Eaglesham/Boyce Thompson Institute, Joe Burton and Bill Kerrey/NifTAL, Gerry Elkan/North Carolina State University, Doug Gross/North Carolina State University, and D. J. Lathwell and Chris Stearn/INTSOY.

The participants expressed strong support for a coordinated BNF program for the Caribbean. A preliminary program of objectives and strategies is being developed by the UWI and CARDI (Caribbean Agricultural Research and Development Institute). Further discussion of the regional program will take place at the International Workshop on Biological Nitrogen Fixation for the Tropics sponsored by CIAT, NifTAL and ICRISAT, March 9–13, 1981, at Cali, Colombia.

Nitrogen Fixation Symposium

Continued from page 1

problems involved in utilizing and increasing nitrogen fixation. Interest in both the "basic" and "applied" facets were apparent often by the same individuals.

The last three days of the symposium were devoted to a series of highly productive discussion groups. These groups created intense debate on the problems and bottlenecks of both practical and theoretical BNF research —surely the primary purpose of any such gathering. The opportunity to visit Australian *Rhizobium* inoculant quality control laboratories was greatly appreciated by those who attended.

This international symposium, especially in conjunction with the forthcoming complementary NifTAL/CIAT/ICRISAT workshop on the applied aspects of nitrogen fixation, is a major link in the systemization and dissemination of the entire spectrum of present knowledge on nitrogen fixation.

What Do We Know?

How much do we know about seed distribution by foraging animals? Can *Rhizobium* survive this process?

OECD Workshop on BNF Produces Thought-Provoking Discussion Groups

The First OECD Workshop on Nitrogen Fixation took place December 6–8, 1980 following the Fourth International Symposium on Nitrogen Fixation at Canberra, Australia. Richard T. J. Clarke is Coordinator for the Nitrogen Fixation Project of the Organization for Economic Cooperation and Development, which sponsored the workshop.

Open group discussions proved particularly valuable in the small group atmosphere of the workshop. Some of the best centered around John Brockwell, who led the discussion relating to documenting methods, media and intrastrain variation in *Rhizobium*.

T. A. Lie spoke of the agronomic value of germplasm collected at the center of origin for both native legumes and rhizobia when looking at characteristics useful in breeding resistance to disease. John Beringer reported that after plasmid transfer, fast-growing rhizobia produced nodulation where they had previously been ineffective. Strains from the center of origin were also useful in this respect.

Joe C. Burton's results with selection of competitive, efficient strains from native strains were exciting as well as unique, since problems with indigenous rhizobia have resisted success in the past.

Tropical Application of Nitrogen Fixation by Legumes

Drawing by Jill Fitzpatrick

Four French institutes cooperating with various tropical countries are attacking problem areas in BNF research from four directions. INRA (Institut National de la Recherche Agronomique) and IRAT (Institut de Recherches Agronomiques Tropicales) have been collaborators for ten years, with INRA concentrating on temperate and IRAT on tropical crops. More recently their quest has been joined by ORSTOM (Office de la Recherche Scientifique et Technique Outre-Mer) and IRHO (Institut de Recherches sur les Huiles et Oleagineux).

Once the importance of inoculation became established for soybean and alfalfa, INRA proposed similar work for the tropics. Inoculation is stressed particularly where the effect is obviously beneficial and visible to the farmer without weighing.

In Senegal INRA has cooperated in soybean inoculation. In Upper Volta similar work has been done in connection with IRHO and in Rwanda with the Faculty of Agronomic Sciences, *Gembloux-Belgique*.

Limiting factors in tropical application of nitrogen fixation by legumes are studied where inoculation does not increase yield in poor-growing plants. This work has been carried out in Senegal and Upper Volta, where groundnut and cowpea are targets, and in Haiti, where the common bean is targeted. In Mediterranean climates, constraints to nitrogen fixation are being sought out with the aim of finding efficient N-fixing species that are tolerant to high temperature soils, salinity, and drought.

As a first step in the establishment of an inoculant/culture base, IRAT and INRA maintain a *Rhizobium* culture collection. Inocula are supplied to several countries.

In support of this work, two kinds of training courses are organized by INRA. A biennial course for advanced students is held in collaboration with Lyons University. A new course, scheduled for 1982 will consist of one month of work for agronomists and extension workers. Co-sponsor of that course will be the Groupe de Recherches sur les Techniques Rurales (GRET) in Paris.

At INRA, Michele Obaton is in charge of: collection of *Rhizobium*; inoculum production; influence of environment on nitrogenase and nitrate reductase activities. Jean-Jacques Drevon handles: physiology of nitrogen fixation (hydrogen evolution) and global analysis of limiting factors of fixation in tropical countries. Jean-Claude Cleyet-Marel works with the ecology of *Rhizobium* in soils and rhizosphere (immunofluorescence, antibiotic resistant mutants, etc.). At IRAT, Herve Saint-Macary is responsible for collection of *Rhizobium*; inoculum production; and physiology of nodulation (mist culture of plants).

Winged Beans for the Ivory Coast

1979 was the third year in which the Nestle Foundation for the Study of the Problems of Nutrition in the World promoted the winged bean as a protein source for the Ivory Coast. The team from the "Psophocarpus Project" reports some successes, but they have had some problems too.

In the village of Didakouadiokro, where trials are being conducted in family gardens, the village women are in charge of the plots. About one-quarter of the women do not participate, largely because the cutting and planting of the stakes to hold the plants erect is too much extra work. Still, seventy to eighty percent of the women do participate, and the results of the trials have been satisfactory.

Two team members have taught the village women how to use grains and pods in traditional recipes. This raises the nutritional level of the traditional foods. Acceptance of winged beans is particularly good during the dry season when even tiny quantities of smoked fish or meat are economically out of reach.

In plantation-based variety trials a different set of problems arose. About half the plants succumbed to fungal and viral diseases. Then stakes and trellises were attacked by termites, and their average life-span was reduced to one year or less. But with fertilization, grain yield improved by twelve percent, giving Project members seed for next season's trials and hope for the future of winged beans.

The Unique *Psophocarpus*

The winged bean is both a good nitrogen fixer and a good source of protein. Experts believe it is the most promising of the underexploited legumes. The tuberous roots are also edible.

Photo by P. Woomer

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26

BIOLOGICAL NITROGEN FIXATION BULLETIN

VOL. II, NO. 2, JUNE 1981

Tropical Institutions Combine Resources

BNF Researchers Join Forces

Almost 200 research scientists from 39 countries, most of the agricultural research institutions of the world, met in March at the "International Workshop on Biological Nitrogen Fixation Technology for Tropical Agriculture" at Cali, Colombia. During the five days of the workshop, issues were delineated, the latest research results—especially for field-oriented research—were exchanged, and development strategies were put forward, argued, and reformulated.

The participants focussed on those factors that have limited the translation of improved understanding of BNF processes into viable agrotechnologies that will work in farmers' fields. Since these constraints are not all scientific, but include socio-economic, cultural, and political factors, the program managers, agricultural economists, and representatives of development agencies joined with research scientists in the search for integrated and comprehensive stategies for development and delivery of better BNF technologies.

The sponsorship of the workshop by most of the major development institutions that support tropical agricultural research demonstrated their recognition that gains in agricultural production through implementation of BNF technology must keep pace with our increasing understanding of the biochemical, genetic, and microbiological processes of biological nitrogen fixation.

While major financial and organizational responsibility fell on CIAT, NifTAL, and ICRISAT and on International Organizing Committee members, Peter Graham, Jake Halliday, and Peter Dart, other collaborators that provided substantial sponsorship included ADAB, Unesco, USDA, and USAID. Also cooperating were Boyce Thompson Institute, Cornell, East-West Center, ICARDA, IITA, INTSOY, IRRI, North Carolina State Univ., Overseas Development Agency (UK), and the Universities of Hawaii and Puerto Rico.

PHOTOS BY D. MCNEIL

Top: ICRISAT's John Thompson argues a point regarding methodology on the third day of the BNF Workshop.
Bottom: Don Plucknett of World Bank reminds participants that national and international programs need coordinated strategies if BNF technologies are to make an impact on food production problems in the developing world.

27

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University of Hawaii NifTAL Project
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ANNOUNCEMENTS

IITA/UNDP Course Set for Spring

The International Institute for Tropical Agriculture (IITA), with financial assistance from the United Nations Development Project (UNDP), has announced a six-week training course in Nitrogen Fixation Technology for Research Workers assigned to the improvement of soybean and cowpea in tropical countries. The course will be conducted at IITA in Ibadan, Nigeria from 25 May to 3 July 1981.

The course is practical in orientation and will emphasize both laboratory and field work. Laboratory work will include: isolation, characterization and preservation of rhizobia; enumeration of rhizobia in soils; inoculant production and methods of inoculation; and ecological techniques (antibiotic resistance, serology). Field exercises cover: soil sampling and analysis; land preparation and cultivation; layout and planting of field trials; weed and pest control; measurement of N_2 fixation; and collection, recording and interpreation of field data.

Microbial Ecology at Michigan State

The Third International Symposium on Microbial Ecology will be held August 7–12, 1983, at Michigan State University. This symposium is an official meeting of ICOME, the International Committee on Microbial Ecology. The aim of the symposium is to assemble microbial ecologists with interests in a wide range of habitats so they can discuss the interactions of microorganisms and the underlying processes that regulate these interactions. The symposium program will include lectures by keynote speakers, plenary sessions, contributed papers (both oral and posters), and roundtable discussions.

Those wishing to receive more information should write to Third International Symposium on Microbial Ecology, the Kellogg Center for Continuing Education, Michigan State University, East Lansing, Michigan 48824, USA. A call for papers will be issued in the Spring of 1982.

UPR Plans *Azolla* Workshop

The University of Puerto Rico is organizing an International Workshop entitled "Practical Applications of *Azolla* for Rice Production," planned for December 1981. The workshop will be hosted by Puerto Rico at Mayaguez. Eduardo C. Schroder of UPR's BNF program is the coordinator.

Training and Workshop Slated in Peru

Rutgers University will sponsor a course for advanced students in biology and agronomy and for interested professionals in Lima, Peru, in August. Nitrogen fixation in legumes and grasses will be the subject. At the same time, a workshop on "Implementation of Nitrogen Fixation Programs in Peru" will be organized. Coordinators for the two activities are Carlos A. Neyra of the Dept. of Biochemistry and Microbiology at Rutgers and Ruben M. Vallenas of the Universidad Nacional Agraria (UNA) in La Molina.

28

Search for Energy Goes On

Scientists at the Charles F. Kettering Foundation have been studying the processes of photosynthesis since 1930 when "Boss" Kettering first set up his research project on photosynthesis and chlorophyll. Kettering's dream was to find the way to unlimited supplies of energy through understanding how plants convert solar radiation to energy. Although his goal has not been achieved, that path logically led to the field of BNF research.

According to a recent Foundation report, Kettering scientists have shown that when purified capsular polysaccharide from the correct *Rhizobium* species is added to the roots of soybeans before the N-fixing bacteria are introduced, infection occurs immediately rather than after several hours. They are attempting to discover how bacterial polysaccharide primes the root hairs of soybean seedlings for bacterial infection.

Other Kettering scientists have produced evidence that glutamine synthetase in *Rhizobium* is present in two distinct forms. One form, GS II, appears to be present only in free-living rhizobia and to have a catalytic function. The other, GS I, which exists in both free-living rhizobia and in root nodules, serves both a catalytic and a regulatory role. More research is needed to understand all the relationships in this enzyme function.

In another study, Kettering scientists have developed a medium in which the N-fixing symbionts of a specific variety of *Alnus*, the Alder tree, can be grown quickly. The Alder-type inoculants are being tested in such diverse locales as Canada and Senegal.

PHOTO BY D. McNEIL

Gerry Elkan (left) and Jose Pereira (center) explain their program to eliminate some of the problems that plague peanut growers in Venezuela's savannas to Susan Harris during the BNF Workshop at Cali. While Pereira describes a few of these, Elkan ponders the lack of consistency in peanut inoculation trials.

Savanna Soils Targeted For Peanut Production

Savannas, areas of the tropics where native vegetation is dominated by grasses and shrubs, cover approximately 28% of the American tropics. These savannas represent the largest available area in the world where modern agriculture could be extended without destroying forests.

Among the problems preventing efficient utilization of the savannas are that the soils are highly acid, high in exchangeable aluminium, low in available phosphorus, and have little holding capacity for potash and nitrogen. Some of this nitrogen deficit could be remedied through biological nitrogen fixation, according to Gerry Elkan of North Carolina State University and Jose F. Pereira of the Universidad de Oriente in Venezuela.

The native savanna vegetation is abundant in well-nodulated legumes, in spite of low pH and Al toxicity. But by adding lime, Elkan and Pereira believe they could create excellent ecological conditions for growing peanuts and cowpeas.

Peanuts, cowpeas, and soybeans are often planted in limed savanna soils of Venezuela, usually without inoculation. There is a high percentage of failure to nodulate, in spite of the fact that many of the native flora are legumes nodulated by the 'cowpea miscellany." Frequent failure to nodulate is also experienced with commercial inoculants. On the other hand, the addition of phosphorus has improved nodulation.

Elkan and Pereira hope to look at some of the constraints to successful peanut production. They also want to evaluate the need for inoculation with locally adapted peanut cultivars in field tests in the savanna. Past experiments in inoculating peanuts have given inconsistent results.

NifTAL Given MIRCEN Status

Following the recommendations of the UNEP/Unesco/ICRO Panel on Microbiology, Unesco has named the University of Hawaii NifTAL Project as a member center in the global network of Microbiological Resources Centers (MIRCENs).

NifTAL maintains an important microbial germplasm resource (*Rhizobium* collection and antisera) and seeds and also offers research, training, and technical support to researchers in the tropics in the technologies associated with preservation and use of that germplasm. In the past NifTAL has collaborated with the MIRCENs at Bangkok, Cairo, Porto Alegre, and Nairobi, in the field of biological nitrogen fixation.

According to Sidney Passman, Director of the Scientific Research and Higher Education Division of Unesco, NifTAL will receive professional, technical, and financial assistance from Unesco, in accordance with the approved resolutions of Unesco's 21st General Conference.

Jake Halliday, NifTAL Project Director, stated, "It is with great pleasure that I accept this designation, and I look forward to rewarding professional interaction with our colleagues in other MIRCENs, with Unesco, and with the UNEP/Unesco/ICRO Panel on Microbiology."

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29

SOURCES AND RESOURCES

Educators Can Share Training Insights

Jim Sims, editor of the *Journal of Agronomic Education* (JAE), reports that the journal invites manuscripts dealing with training programs in BNF technology (national and international) that are aimed at teaching university students. Course design, teaching techniques, and new communications or education concepts are of particular interest.

Specialized, often short-term, lab- and field-oriented courses in BNF technology offer unique challenges to the educators who design them. Since few teaching aids with this particular subject matter are available, most course organizers are producing their own manuals, handbooks, field guides, and audio-visual materials. The valuable insights gained in this education process should be passed along, via JAE.

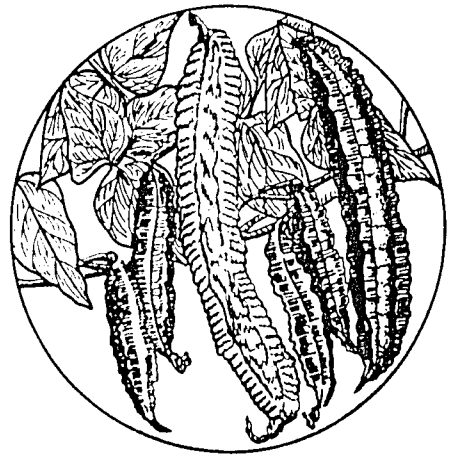
The *Journal of Agronomic Education* is published by the American Society of Agronomy. Course organizers and instructors will also find the journal is a valuable resource.

Please *Do* Eat the Leaves

According to *Edible Leaves of the Tropics*, published by USDA/SEA, many leguminous trees found in the tropics have edible green leaves. Among the more important genera are *Erhthrina, Gliricidia, Cassia, Sesbania, Leucaena, Bauhinia,* and *Pterocarpus.* Young leaves, flower buds, flowers, seeds, and pods of various species are eaten as vegetables, either raw or cooked. Some species, however, are deadly poisonous and must be carefully prepared or avoided completely.

Winged Bean Bibliography

The winged bean, a formerly little-known tropical legume grown only as a backyard crop, has been drawing international attention in the past few years (see *BNF BULLETIN* Vol. I, No. 3, and Vol. II, No. 1). It appears to have great potential for easing the protein malnutrition problem throughout the tropics.



When the International Council for Development of Underutilized Plants (ICDUP) was organized in 1978, one of its priorities was winged bean documentation. Thus, the Agricultural Information Bank for Asia (AIBA), a project of the Southeast Regional Center for Graduate Study and Research in Agriculture (SEARCA), was designated as the International Documentation Center for the Winged Bean.

The Center produces a bibliographic series (Asian Bibliography Series No. 4) on the winged bean, consisting of an initial issue in 1979 and yearly supplements. Subject areas include economics, plant production, plant ecology, taxonomy, soil science, food science, and utilization.

For more information contact AIBS, SEARCA, College, Laguna 3270, Philippines.

Rehydration Causes *Rhizobium* Death

Manase P. Salema, of the University of Dar es Salaam Dept. of Soil Science, has discovered, in research conducted at the University of Western Australia, that there is a relationship between free water and the death of rhizobia on inoculated seed. Salema first noticed this relationship while testing a mathematical model designed to explain what could happen to a rhizobial cell in an inoculum when it was first dried on seed and then rewetted or rehydrated.

Rhizobial cells died relatively slowly on seed while the seeds remained moist, but shortly after the point at which there was no visible moisture, the cells died very rapidly. This phase of rapid death was followed by another period in which the death rate decreased.

One of the main causes of *Rhizobium* cell death, according to Salema, is that the cell envelopes of rhizobia that have been inoculated onto seed rupture when the cells are rehydrated, causing loss of cellular material. He emphasizes that the ruptures are caused by the combined process of drying and rehydrating, and not by the drying itself.

This drying-and-wetting process is a normal one in on-farm practice. But injuries can be reduced by management practices that reduce these cycles. Use of liquid inocula, directly applied to the seedbed, is also an alternative.

PHOTO BY M P SALEMA

Negatively stained cell of Rhizobium trifolii *oozing after rupturing. The rupture causes the death of the cell.*

Turkish Lentil Research Underway

D.F. Bezdicek, of Washington State Univ., and Lutfu Cakmakci, of the University of Ankara, have been funded to look at the extent of nodulation and nitrogen fixation by lentils in various geographic areas of Turkey. The pair spent three weeks in the field in April evaluating nodulation and collecting *Rhizobium* isolates for greenhouse evaluation on local Turkish host legumes. Later, the most successful strains will be tested and compared to recommended strains of lentil *Rhizobium.*

Lentils have been grown in rotation with various cereals in Turkey for hundreds of years. The highly edible beans are used in a multitude of local dishes.

Before this, no work had been done on the inoculation response of lentils in Turkey. This study is designed to complement efforts to establish an inoculant industry in Turkey.

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30

Short Takes

Researchers at UPLB and IRRI in the Philippines have reported their discovery that *Elaeagnus philippensis* Perr., a species that is endemic to the Philippines, is an N-fixer. The endophyte is believed to be a *Frankia*. This report of the occurrence of nodule-bearing, nonleguminous, dinitrogen-fixing angiosperms in the Philippines, has aroused the interest of scientists who hope to use *E. philippensis* as vegetative cover in highly eroded areas.

• • •

According to figures from FAO, World Bank, IRRI, and IFDC, the international price of fertilizer N has just about doubled since 1965. Comparisons of prices, in US dollars per metric ton at the port of origin, show bagged ammonium sulphate increasing in price from $47 to $85 by July, 1980. The same comparison for bagged urea looks even worse, with prices increasing from $5 to $172. This information from figures recovered by Al App.

• • •

Due to current emphasis on world food problems, more development-oriented researchers are looking at "dual-sex development planning." In many traditional societies, a large share of subsistence agriculture and food production activities, as well as food preparation, processing, and storage activities, are the responsibility of women. Since it is often considered inappropriate for strangers, especially male strangers, to teach these women, it is important that information about improved technologies is directed to the women through socially acceptable channels.

• • •

PHOTO BY R WOOLFENDEN

Nodule Storage Examined

The recent proliferation of legume inoculation trials has emphasized the need for a simple, reliable method of treating legume nodules to be serologically typed for long-term storage and transit. Dr. Padmanabhan Somasegaran, Rob Woolfenden, and Dr. Jake Halliday, of the Univ. of Hawaii NifTAL Project, examined several nodule storage treatments in an effort to identify superior methods of preservation for storage and transit. Oven-drying nodules at 70°C for 48 hours, followed by storage in airtight vials, was found to be the most effective nodule storage treatment on the basis of immunofluorescence, immunodiffusion, and agglutination. Oven-drying is also among the simplest of nodule storage techniques, and is routinely done prior to nodule dry weight determinations. Drying methods are particularly well suited to developing countries, where alternative legume nodule storage techniques are not available or are prohibitively expensive. Drying also facilitates the centralized serological typing of nodules. The nodules need only be protected from moisture during transit, and a simple screw vial cap is suitable for this purpose. Drying methods are also equally applicable to both large and small nodules.

High temperature and saline-alkali soils adversely effect symbiotic efficiency of cowpeas and their rhizobial partners. Victoria Marcarian, at the University of Arizona, reports good success with granular inoculants placed 10–15 cm below seed level, where soil temperatures and salinity are significantly lower than at the soil surface. According to Marcarian, in arid or semi-arid environments, an effective symbiosis can be achieved by manipulating inoculation procedures for the avoidance of stress.

• • •

The latest from *Leucaena News Notes:* •Asian Development Bank reports that India will import 12 tons of leucaena seed, probably from the Philippines ... Formosa Chemical and Fiber has imported (to Taiwan) 4000 MT of wood from the Philippines. The company will be an active participant in national efforts to plant 2000 ha of leucaena this year ... The Nitrogen Fixing Tree Association (NFTA) has been established in Honolulu. Board members include John Mussner, of the General Service Foundation; Albert Ravenholt, of American Universities Field Staff; K.Y. Tai, Council for Agricultural Planning and Development, Taiwan; and James Brewbaker, University of Hawaii.

DISSEMINATION UPDATE

If you or your associates wish to be added to the distribution list for the *BNF BULLETIN*, or if your address has changed, please fill out the following and mail this form to: NifTAL Information Section, 3190 Maile Way #300, Honolulu, Hawaii 96822, USA.

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31

PHOTO BY ICRISAT

Potted chickpea plants are covered with polyethylene bags (left). After four to five days, the covers are removed (right) when plants establish.

Counting *Rhizobium* at ICRISAT

For counting chickpea rhizobia with the MPN (most probable number) technique, only chickpea plants can be used, because of specificity. Normal chickpea plants are too large to be grown successfully in tubes.

Seeds of a promiscuously nodulating cultivar are sterilized in 0.2% mercuric chloride, washed thoroughly with sterile water and germinated on 1% agar plates, in the dark, for two to three days until the radicles are three to five cm long. The cotyledons are then excised aseptically with a scalpel, and the seedlings are planted in 25 x 200 mm tubes filled with 30 cc of sand or sand:vermiculite (1:1 v/v). Plants do not nodulate reliably when agar is used..

The plants are then placed in a light chamber (≅ 12,000 lux, 20–25° C, 16 h day and 8 h dark). Seedlings establish in 2 to 3 days, and should be inoculated after one week, but before 10 days.

Toomsan, Rupela, Dart, and Mittal, of ICRISAT, report that counts of pure cultures of *Rhizobium* by direct dilution plating and by the dilution-plant infection MPN method correlate very well. The MPN method has been used successfully to count chickpea *Rhizobium* in contaminated backgrounds such as soil and non-sterile inoculants.

Mexico Scientists Form National BNF Committee

The concern of microbiologists in the Republic of Mexico for the lack of coordination between national BNF programs was translated into positive action during a two-day seminar at the Center for Advanced Studies in Mexico City last January.

The original aim of the coordinators, Carlos Casas Campillo of the Center for Advanced Studies at the Nacional Polytechnic Inst., Joel Espinosa de los Monteros of CREGIT, Veracruz Regional Technological Inst., and Ronald Ferrera-Cerrato of the Edafology Center at the Postgraduate College, Chapingo, was to establish a forum for discussion of advances in national programs investigating diverse aspects of biological N_2 fixation. This goal was successfully realized, and participants presented 35 reports and 6 seminars. Themes included symbiotic fixation by legumes, grasses, and azolla; free-living N-fixers; inoculant technology; and ecological considerations.

Participants than unanimously resolved to establish a National Committee of Biological Nitrogen Fixation invested with the responsibility of coordinating activities at the national level and representing Mexico's BNF research programs at the international level. Officers were named: Ronald Ferrera-Cerrato, President; Rosa Maria Ramirez Gama, Secretary; and Antonio Moreno Quiroz, Treasurer.

A Second National Seminar on Nitrogen Fixation is planned, according to Ferrera-Cerrato. It will be held in 1982 at the Postgraduate College at Chapingo.

Woody Tropical Legumes Show Potential for Soil Enrichment

Realizing the urgent need for low-technology solutions to the problems of forage, firewood and fertilizers in the tropics, Joann P. Roskoski, Jorge Montano Velasco, and Guillermo Castilleja Gonzalez of the National Institution of Investigations on Biological Resources undertook a study to determine the multi-use potential of woody legumes in the state of Veracruz, Mexico. The species selected for study included: *Acacia pennatula, Albizia lebbek, Caesalpinia cacalaco, Cassia fistula, Erythrina americana, Gliricidia sepium, Inga jinicuil, Parkinsonia aculeata* and *Pithecellobium lanceolatum.*

The nine selected species were subjected to several tests in order to determine their potential. As part of these tests, an investigation of the N-fixing capacity of each species, and quantification of its annual fixation under field conditions, was conducted.

The N-fixing activity of seven-month-old woody legumes was determined using the acetylene reduction technique. Six of the nine species assayed exhibited N-fixing activity, which ranged from a high of 44 micromoles of N_2 fixed per gram of nodule per hour for *G. sepium* to a low of about 2 micromoles N_2 per gram per hour for *I. jinicuil.*

I. jinicuil is a common shade tree in the coffee plantations in the Xalapa area. In one such plantation, annual fixation by this species equaled 35 kg N_2 per ha per yr. *A. pennatula* and *G. sepium* are also used as shade trees and living fences, and have a potential use as forage.

The magnitude of nitrogen added annually via fixation suggests that tree legumes could make a significant nitrogen input to an agro-ecosystem. However, intercropping studies are needed to assess the actual amount of nitrogen made available in crop species.

32

BIOLOGICAL NITROGEN FIXATION BULLETIN

Not a critique

Volume II, Number 3

BNF Technology Assessment Underway

BNF and its associated technologies have been the ocus of a wide number of studies and discussions. Recent articles in such magazines as *Time, Scientific American*, and *Current Contents* attest to a growing public awareness of BNF. This general, increased attention has been preceeded, of course, by research from the scientific community and funding from government agencies and private organizations.

Building on the scientific base, BNF technology has moved toward widespread adoption and now is close to becoming a practical component in many a developing country's agricultural policy. As the technology moves into fuller use, it is coming under the watchful eyes of policy and decision makers in non-agricultural sectors who have many unanswered questions regarding the impact of BNF technology on their societies.

As it has been in the past, the application of any technology has a variety of consequences on a society. Some of these results are intended; they are specific, planned outgrowths of the technology. Other developments are unintended, unproposed, and unplanned. As a result, a technology not only strikes the target sector, agriculture in the case of BNF, but also impacts on other areas — economic and governmental to name but two.

One way of examining these impacts is a process called technology assessment.

Of particular interest to the BNF community is the technology assessment currently being mounted by the East West Center in Honolulu, Hawaii, which will examine the impact and future of BNF technology in agriculture. This 18-month study is attempting to answer many questions relating to the effects BNF technology will have in 10 to 20 years.

"The assessment is designed to find out where the greatest promise lies . . ."

"The assessment is designed to find out where the greatest promise lies in BNF technologies and to promote an interaction between the technology and the possible problems," said Dr. Bob Randolph, principal investigator/project manager of the study.

The expected results of the project will be improved information for decision making by research administrators, technology support system managers, and policy makers who are now or will be dealing with BNF questions in the future.

This assessment is not a critique of the BNF technologies but rather takes as a given that BNF technologies are in place . . .

This assessment is not a critique of the BNF technologies but rather takes as a given that BNF technologies are in place and that they have overcome the research and social constraints to their implementation. Acknowledgement of BNF's application and utilization is the basis of the technology assessment now underway at the Center.

In general, the technology assessment parallels similar studies in the private sector. When business and industrial organizations want to project and gauge the economic and social conditions they will face in the future, the organizations often employ methodologies of futures research. These take the form of trend analysis, scenarios, cost benefit analysis, and cross impact studies.

Technology assessment is a type of futures policy study which systematically examines the effects on society that might occur when a technology is introduced, extended, or modified. The East-West Center project will explore, analyze, and evaluate the most crucial trade-offs and policy issue areas surrounding BNF research, dissemination, and utilization. Three phases will make up the study: information gathering on BNF technology currently in place, descriptions of alternative futures using BNF technology extrapolation, and evaluation and dissemination of the findings.

In the information gathering phase, questions range from the fanciful question of whether BNF technology will become so extensive that a dangerous amount of nitrogen will be fixed from the air to the serious questions of how new BNF technologies interface with indigenous knowledge systems, i.e., traditional farming practices and accumulated understanding about agro-climatic, ecologic, and demographic environments.

Continued on page 7

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Chapingo Training Stress Techniques

Thirteen participants from nine Latin American countries attended the NifTAL/Colegio de Postgraduados training course in *Rhizobium* techology held in Chapingo, Mexico, from 15 June to 24 July, 1981. Local organizer for the course was Dr. Ronald Ferrera-Cerrato, Chief of the Soil Microbology and the Biochemistry Section of the Edaphology Center. The course was presented in Spanish and was designed to impart techniques currently practiced in *Rhizobium* technology and to give scientists tools to do their work.

Four areas were covered in the course. General *Rhizobium* microbiology discussed the isolation of rhizobia, authentication, and preservation of cultures, growth/cultural characteristics of *Rhizobium*, and quantification of growth. Serological methods and antibiotic marker techniques were presented in the course's strain recognition section.

Participants also studied *Rhizobium* strain selection: tests for genetic compatibility between *Rhizobium* and the legume; selection of effective strains of rhizobia in leonard jars; and field experiments to test the response of a legume to inoculation; preparation and set-up of small scale fermentors; inoculant preparation; evaluation of carrier materials/ seed inoculation with different stickers and survival of rhizobia on inoculated seed; and inoculant quality control methods.

Guest lecturers and staff instructors included Dr. P. H. Graham, CIAT; Dr. D. Gross, NCSU; Dr. D. Hubbell, University of Florida; Dr. E. C. Schroeder, University of Puerto Rico; Dr. C. Vidor, UFRGS, Porto Alegre, and Dr. J. C. Burton, Dr. J. Halliday, Dr. P. Somasegaran, H. Hoben, and B. Kerrey of NifTAL.

North Carolina State Teaches Course in Peru

During May and June, 1981, North Carolina State University (NCSU) field-tested a new AID-sponsored BNF course in Lima which INTSOY intends offering to its soybean researchers in Peru early in 1982.

This exercise is one of a suite of capabilities for advancing BNF in countries of the tropics that have been developed in the U. S. University Consortium on BNF in the Tropics with support from USAID under a 211-D grant.

This course is designed for research or extension field specialists who have responsibility for legume work, but who have had little or no formal training in legume symbiosis and inoculation. The course leads into the more advanced offerings of NifTAL and the MIRCEN.

The two-week course was presented to two groups of technicians; one was composed mainly of village extension workers and the other of university graduates (agronomists, biologists, and animal scientists) with either research or extension responsibilities. There were about seventeen participants in each group. Students had backgrounds with crops that included both tropical and alpine forages, beans, soybeans, tarhui (*L. mutabilis*, an edible lupin), and miscellaneous grain legumes.

Each course opened with a field trip. This served as both an ice-breaker and an opportunity to observe and collect soils, plants, and nodules for use in the course that followed. The courses, taught by Peruvian specialists, had sections devoted to plant physiology, soils and microbiology. Emphasis was on the practical aspects of BNF with each session being introduced by a short presentation of theory and closing with a discussion of the subject.

NCSU also held a one-day workshop for decision-makers based on the assumption that scientists depend on supportive adminstrators to fund their programs. There were about eighty participants representing the Ministry of Agriculture's branches, the University community, FAO, the Agricultural Bank, and the Peruvian equivalent of the Commodity Credit Corporation. Invited speakers discussed the importance, globally and locally, of concerted utilization of the symbiotic fixation of nitrogen and the opportunities for further training and support linkages in BNF. Speakers included Dr. Carlos Batthyany, Argentina; Dr. J. R. Freire, Brazil; Dr. Jake Halliday, NifTAL; Dr. Carlos Labandera, Uruguay; and Dr. B. E. Caldwell, NCSU.

Evaluations of the course by participants and instructors were enthusiastic. Comments indicated that the course should be expanded and that more BNF training of this type be offered.

A laboratory manual, prepared for the course, is being revised. It is accompanied by an extensive Bill of Materials that may be used as a checklist prior to presenting the course. The NCSU team of Drs. G. H. Elkan, A. G. Wollum, and H. D. Gross are prepared to consider any reasonable request to present this course elsewhere.

Argentinian BNF Meeting Held

A wide range of BNF topics were discussed and papers presented at the National Meeting on Biological Nitrogen Fixation held at La Plata, Argentina, 11-13 November 1981.

The meeting was organized by the Center for Investigation and Development of Industrial Fermentation Processes (Conicet, UNLP, CIC) and sponsored by the Undersecretariat of Science and Technology. The scientific committee was made up of Dr. A. P. Balatti, Dr. C. Batthyany, Dr. L. A. Mazza, Ing. J. Mussini, and Dra. N. Nunez.

The program began with presentations on the importance and applications of BNF in Latin America and the future promise of legumes in Argentina. Many topics specific to Argentina were presented. Among them were nitrogen fixation in soil and Gramineae in the Patagonica region, the present state of control of inoculant in Argentina, and intercropping of *Melilotus alba* on meadowland in *Cenchrus ciliaris* in East central Santiago de Estero.

During the free communication period some intriguing subjects were offered. Titles presented were "Application of one spectrophotometric technique for determining nitrogenase activity in *Azotobacter chroococcum*," "New culture for isolate *Azospirillum* spp.," and "New inoculants for legumes, processed in tablets."

Uruguayan *Rhizobium* Society

The Uruguayan *Rhizobium* Society was established in August, 1981. Carlos Labandera is the president; other local officers include: A. Alvarez, G. Martinez, A. Baribar, Daniel Formoso, A. Castells, and A. Pereira.

Drs. Richard Date and Carlos Batthyany were designated Honorary Life members.

The fundamental objective of the society is the promotion of *Rhizobium* research and utilization in Uruguay. For further information, contact the Society at Bulevar Artigas 3802, Montevideo, Uruguay.

34

Thirteenth International Congress on Microbiology

Interested scientists are invited to attend and participate in the XIII International Congress on Microbiology to be held 8-13 August, 1982, in Boston, Massachusetts.

The Congress will be held under the sponsorship of the American Society for Microbiology.

The programs (lectures, symposia, round tables, and verbal and poster sessions) will consist of an Intersectional Program; the Bacteriology Section Program; the Mycology Section Program; and the Virology Program.

Obtain further information by writing The Congress Secretariat, XIII IAMS Congress, ASM, 1931 I St., N. W., Washington, D.C. 20006, USA.

TVA Symposium

"Nitrogen in Crop Production" is the title of an upcoming symposium sponsored by the TVA's National Fertilizer Development Center, American Society of Agronomy, Crop Science Society of America, and the Soil Society of America. Sheffield, Alabama, near Florence and Muscle Shoals, will be the site of the 24-27 May, 1982, meeting.

Responsible nitrogen use for maximum production will be the focus of the symposium. Presentations will have a practical orientation and will emphasize ways to improve plant use of nitrogen in different cropping systems. The topics will be of interest to farm managers, agronomists, soil and crop scientists, and agricultural extension specialists.

Areas to be covered include sources and functions of agricultural nitrogen, managing plants for efficient nitrogen use, managing soils and fertilizers for effective nitrogen use, modifying fertilizers for efficient use, responsible use of nitrogen fertilizers, and influence of climate and soils on nitrogen management.

The proceedings will be published by the ASA in late 1982.

For registration information, contact Ms. Helen Baugh, T-7B, National Fertilizer Development Center, Tennessee Valley Authority, Muscle Shoals, AL, 35660, USA.

Eleventh Latin American *Rhizobium* Meeting

The Latin American *Rhizobium* Meeting (ALAR) takes place from 24-29 October, 1982, at Lima Peru. These biennial meetings are the main activity of the Latin American Association of Rhizobiologists for advancing BNF in the region. Dr. Jose Gomes Carrion is organizing the meeting and can be contacted at: Universidad Mayor de San Marcos, Museo de Historia Natural "Javier Prado," Avda. Arenales 1256 APtdo. 1109, Lima, Peru.

Limiting Factors Meeting

Principal Investigators in the USDA/CSRS/AID sponsored "Limiting Factors" grant program are reminded of their 1982 workshop. The Workshop will identify and document strains of *Rhizobium* spp. for the major tropical food, feed, forage, and tree legumes, lines of these legumes adapted to tropical soils, and experiences of the P.I.'s that have resulted in cooperative linkages.

Venue is Washington, D.C. and dates are 21-24 February 1982. Doug Gross, NCSU is coordinating

ANNOUNCEMENTS

Inter-African Conference on Bio-fertilizers

Cairo will be the site for the first Inter-African Conference on Bio-Fertilizers 22-26 March, 1982. The meeting will focus on renewable sources of energy, increased crop production, and lower pollution levels through the utilization of bio-fertilizers. Biological Nitrogen Fixation features prominently in the program.

It is sponsored by the Executive Secretariat of the Scientific, Technical and Research Commission of the Organization of African Unity. For further information, contact: Dr. M. N. Alaa EL-DIN, c/o International Organizations and Conferences, Foreign Relations Department, Ministry of Agriculture, Dokki – Cairo – Egypt.

Nitrogen-Fixing Tree Germplasm Workshop

A special group is being called together for a workshop organized by the Rockefeller Foundation, the Nitrogen Fixing Tree Association, and the NifTAL Project. Invitations for this event, slated for 19-25 September, 1982, at The Rockefeller Conference and Study Center, Bellagio, Italy, will be sent out in January, 1982.

Second International Symposium on N_2 Fixation with Non-Legumes

The 2nd International Symposium Banff, Alberta, Canada. The symposium is sponsored jointly by the Agricultural Institute of Canada and the Canadian Society of Microbiologists. The theme is "Putting N_2 Fixation to Work" and will concentrate on N_2 fixation in association with non-legumes and trees.

The proceedings of the symposium will be published as a special issue of the Canadian Journal of Microbiology. For further information contact Dr. R. J. Rennie, CAN-FIX, Box 7000, Lethbridge, Alberta, Canada, T1J 4A9, Telephone: (403) 327-4561, Telex: 03-849343.

Azolla Workshop Rescheduled

The University of Puerto Rico has rescheduled its workshop on "Practical Applications of *Azolla* for Rice Production," to November, 1982. Dr. Eduardo C. Schroder of UPR's BNF program is the coordinator.

35

Workshop Step Toward National BNF Program

National Chung Hsing University, Taichung, Taiwan, R.O.C., was the site of the recent International Workshop on Biological Nitrogen Fixation and Crop Production, 29 September - 3 October, 1981.

Basic and applied aspects of BNF research were presented and discussed by scientists from Thailand, Korea, the United States, and Taiwan. Topics included measuring DNA biosynthesis in plant or in bacteriods of soybean nodules, selection and application of *Rhizobium* in Taiwan, N_2 fixation by legumes under stress in tropical soils, problems and prospects of BNF and crop production in Korea, characteristics of a new isolate of dinitrogen fixing cyanobacteria, subtropical *Rhizobium*/legume symbiosis, and the possibilities of using *Azolla*.

The four day workshop was sponsored by The Ministry of Education, The Council for Agricultural Planning and Development, The Food and Fertilizer Technology Center for the Asian and Pacific Region, and National Chung Hsing University. It was a preliminary step in the development of an integrated national program on BNF.

Dr. Tzo-Chuan Juang presided and can be contacted for further information: Department of Soil Science, National Chung Hsing University, 250 Kuo Kuang Road, Taichung, Taiwan, 400.

National Academy of Sciences Grants for Research on Fast Growing, Nitrogen-Fixing Trees

The Committee on Research Grants of the Board on Science and Technology for International Development of the National Academy of Sciences has initiated a research grants project on fast growing nitrogen-fixing trees. This project is designed to identify and categorize promising tree species for various purposes in different ecological zones, in order to provide a base of information for application in developing countries. Grants are available only for developing country institutions.

This project will have two phases. The first phase will involve a detailed inventory of less widely known local species that will include information on present and potential uses, ecological characteristics including phenology, nitrogen-fixing and nitrogen-cycling characteristics, aspects of growth and development relevant to interaction with other plants, and management techniques. A detailed methodology is being prepared to standardize data collection.

The second phase will entail comparative field trials and testing of selected species in different soils and ecological zones as a cooperative effort among institutions in different countries. Species will be selected by agreement among grantees and should include those that have not been extensively studied previously. The field trials will provide opportunities to develop and test management techniques for fast growing trees and to offer a framework for economic assessments.

General services will be offered to grantee institutions for development of methodologies, evaluation of rhizobia, testing of toxicity and analysis of plant parts, provision of seed and inoculants, and coordination of data collection and evaluation. All grantees will be expected to participate in periodic coordination meetings and such exchanges of germplasm and data as are agreed among them.

The Committee on Research Grants would be pleased to communicate with developing country institutions interested in participating in either or both phases, in providing central services, or in other related research activities. Of particular interest to the Committee is assessment of economic feasibility and incentive schemes.

For more information and proposal formats and procedures, please contact Dr. Michael P. Greene, Executive Secretary, Committee on Research Grants, Board on Science and Technology for International Development, National Academy of Sciences, National Research Council, 2101 Constitution Avenue, Washington, D. C. 20418, USA.

Harris Accepts Position at CIAT

Susan Harris, former Editor of the *BNF Bulletin*, has taken a position as head of the Library and Documentation Services at CIAT in Cali, Colombia.

She now directs CIAT's comprehensive, agricultural sciences library and responds to information needs of CIAT professionals and researchers in institutions throughout the Latin American Region.

36

New *Rhizobium* Strain for Inoculating Leucaena

Leucaena nodulates poorly in acid soils and a special rhizobial strain (CB81) has been available for use in such soils. Now, a strain is emerging that warrants more widespread testing.

This strain is presently known as TAL 1145 in the NifTAL collection and was obtained originally from Dr. R. A. Date under the designation ST 71/4/4 (and is held at CIAT as strain 1967).

It multiplies well in acid (pH 4.5) media; nodulates leucaena early in growth tubes; fixes nitrogen fully effectively in leonard jars; and has given increased yields compared to uninoculated plants at two acid soil sites in Colombia. In each of these screening steps TAL 1145 outranked CB81.

Just completed is a study in which TAL 1145 out-competed CB81, other inoculant strains, and native strains as well, to form close to 100% of the nodules examined from leucaena growing in a pH 4.5 soil in Hawaii. Interestingly, this high rate of nodule occupancy by TAL 1145 has been sustained into the 18th month of the field trial. This strain and antisera for detecting it are available to researchers willing to assist in testing the strain more widely.

Contact Dr. J. Halliday, NifTAL, P. O. Box 0, Paia, HI, 96779, USA.

Soybean Nodulation with Indigenous *Rhizobium*

A recent study by F. Javaheri and R. Nyemba in Zambia found in excess of 50 soybean varieties including agriculturally superior lines which were capable of effective nodulation with the indigenous *Rhizobium* spp.

Over 400 varieties of soybeans were tested at three sites---Magoye, Lusaka, and Mkushi. By way of preliminary analysis, the varieties with more than 100 nodules per plants and with more than 80% of the nodules colored red or pink were selected from each site. The study found that those selected varieties from each site had a similar genetic background to that of two previously discovered soybean varieties noticed to have nodulated profusely in virgin land without artifical seed inoculation. Previously identified varieties are Hernon 147, released in 1940 and "Magoye," released in 1981. The last variety is a cross between older East African cultivars.

Work continues to select cultivars and test them with and without seed inoculation. Possibilities of a breeding program using such cultivars is being examined. For further information on this work: contact F. Javaheri, FAO Agronomist, Mount Makulu Central Research Station, Private Bag 7, Chilanga, Zambia.

Opuntia - A New Nitrogen Fixing Genus

B. Venkateswarlu and A. V. Rao report on a survey to identify nitrogen fixing plants, other than legumes and grasses, from the Thar Desert in India. The survey was undertaken in order to improve the fertility of arid soils through BNF.

Several succulent Xerophytic plants, genus *Opuntia*, were screened for their N_2 fixing ability by the acetylene reduction technique.

Azospirillum lipoferum was isolated from within the roots of *Opuntia coccinellifera, O. Dellina, O. ficus-indica, O. microdays*, and *O. vulgaris*.

These isolates are more efficient in N_2-fixation as compared to isolates made from the tropical grasses. N_2-ase activity of these isolates varied from 36.5 to 273.6 n moles of C_2H_4/hr, with maximum activity for the isolate from *O. vulgaris*.

The association of *A. lipoferum* with many species of *Opuntia* might be attributed to the accumulation and root exudation of organic acids, especially L-malate, in these plants having crassulacean acid metabolic (CAM) pathway of carbon-dioxide assimilation. *Opuntia* spp. appears to be potential genus for enriching the soils in the desert ecosystem which otherwise are very low in nitrogen.

For further information contact B. Venkateswarlu, Division of Soil-Water-Plant Relationship, Central Arid Zone Research Institute, Jodhpur - 342003, India.

Production of Inoculants

Rhizobia are delicate, living organisms and must endure storage, handling, and shipment to be effective. Agricultural use of selected strains of rhizobia that are highly effective at fixing nitrogen is dependent on the availability of an inoculant technology. This technology cultures the strain to a high population density and into a carrier material in which the rhizobia will survive distribution and marketing. The rhizobia are then introduced into the soil in adequate numbers to nodulate sown legumes.

The most important aspects of rhizobial production are to increase cell population to sufficiently high numbers and to do this without contamination. An example of a production time scale, based on information from Dr. Thomas J. Wacek, Director of Inoculant Research, North American Plant Breeders, is as follows: (1) inoculation of gallon bottles (carboys) with selected *Rhizobium* cultures from petri dishes—these cultures are grown approximately one week; (2) inoculation of stainless steel fermentation vessels with the bottled culture—grown for 5-7 days; (3) mixing of fermentation tank culture with finely ground humus or with humus granules; (4) curing of the impregnated humus at specified temperatures for one week or more; and (5) packaging in appropriate containers.

Each step has its specifications and peculiarities which are watched closely so that the process ends with the number of rhizobia and quality of inoculant which are necessary. Such things as the state of cell growth at which harvest is commenced, the proper mixing of bacterial culture and humus, the pretreatment of the humus, the proper curing time and temperature and the proper packaging are important criteria which must be constantly monitored.

Growth media are evaluated to find those which will give the greatest growth and greatest viability of the product. Time and temperature variables are also examined to find the optimum conditions for the maximum production of rhizobia and the proper production of mixed strain inoculants.

Specific growth media are often required by particular strains of *Rhizobium*.

37

The Bean/Cowpea CRSP

October 1981 marked the beginning of the second year of the Bean/Cowpea Collaborative Research Support Program (CRSP).

CRSP is a coordinated research effort between U. S., African, and Latin American institutions and addresses the issues of hunger and malnutrition. Beans and cowpeas are dietary staples in CRSP-associated countries where these crops provide a source of high quality protein and of B vitamins.

To date, 14 of the 18 planned projects have been started or will begin soon. The projects include research partnerships between: Brazil-EMBRAPA/Boyce Thompson Institute, Dominican Republic/University of Nebraska, Dominican Republic/University of Puerto Rico, Guatemala-ICTA/Cornell University, Guatemala-INCAP/Washington State University, Kenya-University of Nairobi/University of California at Davis, Nigeria-Universities of Ibadan & Jos/Michigan State University, Nigeria-University of Nigeria at Nsukka/University of Georgia, Senegal-ISRA/University of California at Riverside, Tanzania-University of Dar es Salaam/Washington State University, Brazil-EMBRAPA/University of Wisconsin, Cameroon-IRA/University of Georgia, Ecuador-INIAP/Cornell University, and Honduras-EAP/University of Puerto Rico.

CRSP has attacked some factors limiting availability of beans and cowpeas by directing its resources toward supporting close collaboration within individual projects and a graduate training component in each project for host country nationals. Other activities will emphasize multidisciplinary research and will identify means for distribution of research findings in ways which can benefit families in all bean/cowpea consuming countries.

The impact of research on farming families (women and children, along with men, have an important role as producers, processors, and consumers of beans and cowpeas) are serious concerns of CRSP.

". . . This concern is reflected in recognition of the impact any change could make on all family members; on the uniqueness of families from culture to culture; and the need to see the farm family in a farming system perspective . . ." wrote Nancy W. Axinn, CRSP's women-in development specialist, in the CRSP COMMUNIQUE.

Emphasis is placed upon using research sites in traditional settings including field trials on small farms. Problems which limit crop performance for subsistence farmers in their traditional settings include physical environment, pests and plant diseases, inherent plant response limitations, farming practices, and storage.

CRSP expects to make important contributions to the resolution of the difficult and persistent problems associated with bean and cowpea production and utilization.

CRSP Newsletter

CRSP produces an occasional newsletter. The *BEAN/COWPEA Communique* is distributed by CRSP, Room 200, Center for International Programs, Michigan State University, East Lansing, MI, 48824, U. S. A.

All India BNF Project

An All India Coordinated Research Project on BNF has been launched by the Indian Council of Agricultural Research with eleven centers all over India. The coordinating unit is located at the Indian Agricultural Research Institute, New Delhi-110012, India, with Dr. N. S. Subba Rao, Head, Microbiology Division, Project Coordinator.

Six objectives for the project have been developed: 1) to intensify research on biological nitrogen fixation in a coordinated manner; 2) survey and ecology of N_2 fixing microorganisms, evaluation of benefits of inoculation and interaction with host germplasm pesticides, and inorganic fertilizers; 3) genetical studies to enlarge host spectrum by mutation, conjugation, transduction and transformation; 4) somatic hybridization, tissue culture techniques and fusion of protoplasts using host plants and microbial cultures; 5) physiological studies to exploit knowledge at the fundamental level on nitrogen fixing and relating enzymes to the applied side; and 6) to gain basic knowledge on nitrogen fixing and related enzymes involved in *Azolla* symbiosis with a view to harnessing the knowledge at the field level.

For more information on past work and future activities, contact Dr. Subba Rao.

King at NifTAL

James W. King joins the NifTAL staff as the project's new Information Specialist. His work at NifTAL will center on communication, specifically on the development and production of BNF training materials. Small group processes, self-instructional methods, and audio-visual modules will be used in future training packages.

Additionally, King will supervise the production of the *BNF Bulletin* and the administration of library services. Under his guidance, development of a computerized bibliographic system for materials dealing with legume/*Rhizobium* symbiosis in tropical agriculture is now underway.

King received his Ed.D. in 1981 from Indiana University in Instructional Systems Technology. He brings to NifTAL experience in the areas of training, evaluation, diffusion and adoption, and media production.

Lumpkin Receives Azolla Grant

Tom Lumpkin has received funds for a project assessing *Azolla* use in tropical countries. The program is intended to stimulate the introduction of *Azolla* cultivation as a source of organic nitrogen into rice farming systems.

The *Azolla* program will consist of three training workshops---one each in Latin America, Africa, and Asia---and will provide training for key scientists on the practical use of *Azolla*. This training will be based on a modified version of Chinese *Azolla* technology. The workshops will be coordinated through linkages with international institutions involved in rice research.

Objectives of Lumpkin's program are to (1) train scientists who will serve as instructors in their home rice regions; (2) produce *Azolla* handbooks in regional languages; and (3) write a comprehensive review of Chinese *Azolla* technology.

Lumpkin has extensive experience in *Azolla*. See BNF Bulletin, Vol. 1, No. 1, March, 1980, page 6.

The program is being coordinated by Lumpkin through NifTAL and he has joined the NifTAL staff. For further information contact T. A. Lumpkin, *Azolla* Project, University of Hawaii, NifTAL Project, 3190 Maile Way, #300, Honolulu, Hawaii, 96822, USA.

Continued from page 1

The technology assessment team, headed by Randolph, Assistant Director of the Resource Systems Institute of the East-West Center, spent the first months of the study identifying the concerns and questions which would be covered. They also reviewed the existing literature and met with scientists in the Philippines and United States in order to become more thoroughly immersed in BNF techniques and technologies currently in practice.

This 18-month study is attempting to answer many questions relating to the effects BNF technology will have in 10 to 20 years.

To give the study a manageable focus, a small set of case crops, corn and rice, were chosen and a geographic limitation, the United States and the Philippines, imposed.

Though rice and corn are not currently thought of as having BNF capabilities of their own and their choice might surprise BNF researchers, the reasons for studying them are their preeminent place in human nutrition and their significant role in world nitrogen fertilizer consumption. (The U.S. adds 10 million metric tons of nitrogen to its soils annually.) A third reason for focusing on corn and rice is their potential to benefit from a wide range of BNF technologies--legume intercropping and green manuring with corn, the use of *Azolla* with rice, and gains from association with nitrogen fixing organisms by both crops.

The choice of countries was based on considerations such as information availability, their present and potential role in the world system for corn and rice, and the existence of major economic and scientific/technical linkages between the two countries.

Already the choice of crops has been criticized as being too narrow, and the study is expected to address BNF questions in an overall perspective.

These concerns and others will be raised in January, 1982, when an international, technology assessment workshop will be held in Honolulu. It will examine the relationships of BNF technology, development, and policy. The Honolulu workshop and a BNF symposium in the Philippines the following March will mark the termination of the assessment's first phase.

The second part of the technology assessment will be aimed at describing alternative technical, socio-economic, and policy-institutional futures which will be affected by BNF technologies. Specific activities will emphasize data consolidation through further interaction with collaborating individuals and institutions engaged in BNF research. An international and interdisciplinary team of scientists, convened at the East-West Center, will conduct an intensive analysis with input from overseas colleagues. A draft of the final report will then be prepared.

Having described the potential futures in the report, the researchers in the third phase of the study will evaluate and reconsider the assessment, incorporating the initial questions as a review. Implications of the BNF study will be debated and a plan will be developed to monitor the real-world tracking of the assumptions that underlie the entire assessment. As a result, the monitoring will be a form of extended validation. Two evaluation panel meetings are planned for Manila and Washington, D.C., with representatives from significant stake-holder groups.

Completion and publication of the study's final report will be the last activity of the assessment process, although the dissemination of results is complicated by the large number of interested groups. A formal report will be directed to the National Science Foundation for future policy making purposes. The report will also be appropriate for agricultural policy makers and those at ministerial levels.

For the BNF research community, the technological assessment will have indirect results. Particular BNF topics may surface as important research areas; BNF and potential policy issues may be shown to warrant further examination; research dissemination could take on new importance; new funding sources may be identified; and hopefully, more people will become aware of and convinced of BNF's value and role in the future, both agriculturally and socioeconomically.

Some Policy Issue-Areas and Questions

Technology Support Systems

How will existing economic policies, designed as they generally are for other purposes (e.g., monetary stabilizations), affect the scope and rate of BNF utilization?

How and by whom will BNF be integrated into each country's farming systems: Who will bear the risk of failure? Who will benefit from success?

Land Use Policy

If BNF technologies reduce the costs and economic risks of growing crops on more marginal soils, in effect making such lands more valuable, who gains and who loses?

May the soils themselves suffer long-term degradation through more intensive short-term use?

Technology Transfer

How will BNF technologies fit into the evolving issue of proprietary rights in agricultural biotechnologies ("breeders' rights," life-form patenting, etc.)? Will developing countries, for instance, honor such rights?

Will developing countries be satisfied to let farmers bear any risks which may emerge (e.g., variations in inoculant performance), or will there be pressures to shift such risks elsewhere? If the latter, what effect will this have on prices and hence on accessibility?

What role in BNF technology will be played by multilateral assistance agencies such as Development Banks.

For further information contact
Dr. Robert Randolph, Assistant Director, Resource Systems Institute, East-West Center, 1777 East-West Road, Honolulu, HI

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Contents

1 BNF Technology Assessment
2 Chapingo Training
2 NCSU Course
3 Announcements
4 Taiwan Workshop
4 N-Fixing Trees Grants
5 Short Communications: Research
6 Bean/Cowpea CRSP
6 India BNF Project
6 Lumpkin Receives *Azolla* Grant

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The Remarkable 32H1

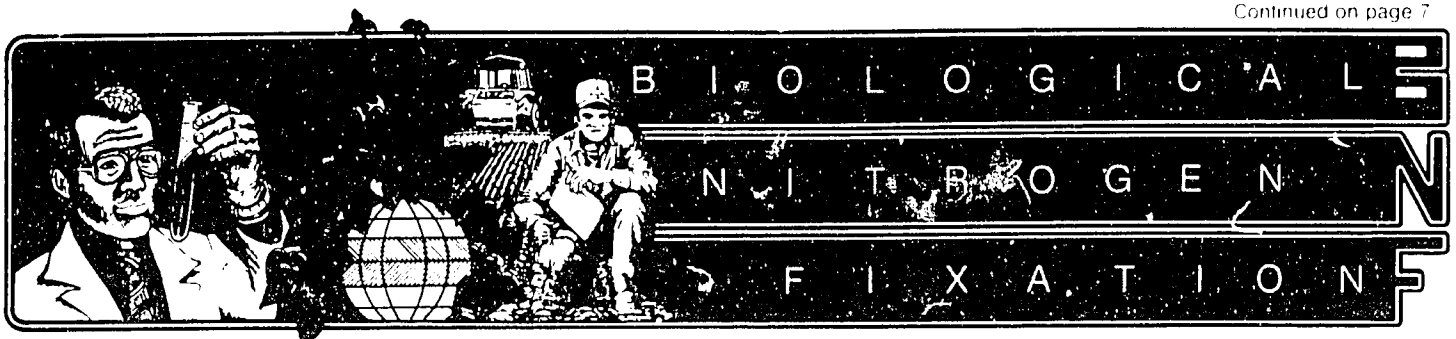
One of the $1M *Rhizobia*

This article by Joe Burton starts a series on what have been called the million dollar Rhizobium. These are strains which have helped fix incalculable amounts of nitrogen, saving untold millions of dollars in the mining, processing, distribution, and application of fertilizers. Thanks go to Lloyd Frederick who suggested this series.

Editor's Note

Strain 32H1, *Rhizobium* sp. cowpea type, has frequented the global literature on Biological Nitrog Fixation (BNF) since 1974 because of its part in upsetting the long-held theory that neither the leguminous plant nor its microsymbiont, the rhizobia, can fix nitrogen N_2 independently of the other. The flaw in this theory was disclosed almost simultaneously by a team of Canadian scientists, Child and LaRue, and a team of Australian scientists at a *Rhizobium* conference in Australia in 1974.

Continued on page 7



BULLETIN

27 Years of Service

Volume III, Number 1

Rhizobium Newsletter

For over 25 years, the *RHIZOBIUM NEWSLETTER* has been a source of information for researches, worldwide, and we must now report that the *RHIZOBIUM NEWSLETTER* has ceased publication. Originally edited by Kevin Marshall, the *NEWSLETTER* continued under Jim Vincent's guidance, assisted by L. M. Waters and Peter Graham. Recent issues have been edited by John Brockwell, Dick Date, Alan Gibson, and G. Turner. Thanks to them and the many abstractors and contributors throughout the years. With gratitude for the *NEWSLETTER's* pioneering efforts, we reprinted here the editorial from the silver anniversary issue of the *RHIZOBIUM NEWSLETTER*. (Some adaptations have been made and permission to reproduce the editorial has been given by the *NEWSLETTER's* editors.)

THE PAST

The *RHIZOBIUM NEWSLETTER* was born in the latter half of 1955, during a meeting of interested research workers at the University of Sydney. It followed a series of inoculant problems, and the intention was to provide a means of communication between the workers. The rest is history – the *NEWSLETTER* went to nearly 500 laboratories located in more than 50 countries.

And what have been the major research achievements in that 25 years? At the practical level, there has been a marked improvement in the quality of inoculants, not only in Australia but in many other countries. In no small way, the quality control service which started under Jim Vincent's guidance (U-DALS) has had a major influence, serving as the model to be adopted in a number of areas. Inoculant application technology has also improved, initially with the use of pelleting techniques and more recently through the use of liquid inoculant applications. Strain collections have become a favorite preoccupation in many laboratories, although it is reasonable to question their usefulness unless the associated strain testing is both thorough and realistic. At the basic research level, few areas have been left untouched, and the bank of knowledge is much richer now than 25, or even 5, years ago.

The major events in the period were the observations, by Dilworth and by Schollhorn and Burris (both in 1966) that nitrogenase reduced acetylene to ethylene. This has had a tremendous impact on research into all forms of nitrogen fixation, although more caution should be adopted in its use and in interpreting the results. Root hair infection is better understood, even though not everyone is in accord on the significance of lectins. Electron microscopy has provided a clearer understanding of nodule structure and there is a degree of agreement on the role, if not the location, of leghemoblobin, in nodule function. Bacteroids have been shown definitively as the site of nitrogen fixation, and more recently, for some strains at least, it has been shown that the genes responsible for nitrogenase synthesis and function, are

> **" . . . the bank of knowledge is much richer now than 25, or even 5 years ago."**

carried in the bacterial genome. Advances are being made in understanding the regulation of nitrogenase in rhizobia, but there are still many mysteries to unravel as to why nitrogenase is induced and the physiological significance of the host. The products of N_2 fixation, both with regard to synthesis and transport, are better understood, but energy utilization, both in form and quantity, is still a major research area. Considerable research has gone into defining the environmental limitations to nodulation and nitrogen fixation; the major task now is to put this knowledge to use in defining workable managment systems to get the most from the legume-*Rhizobium* association. Among the many other significant findings in the past 25 years is the observation that some strains of rhizobia can form N_2-fixing nodules on a non-legume, namely *Parasponia rugosa*. This, and the increasing amount of work being done on *Alnus*-type nodules, should help clarify the limitation to possible extension of N_2-fixing nodules to agronomically-useful species currently dependent on mineral N.

Continued on page 6

pH, Moisture and *R. phaseoli*

Studies in acid broth showed that the *R. phaseoli* strains have differential sensitivity to pH. Some strains have inherent ability to grow at pH less than 5.0 but the majority of them grew at a pH between 5.0 and 7.2. An acid-tolerant selection (S-442) was identified from the parent strain of 442 (P-442) during strain selection studies in acid media. This acid-tolerant selection combines acid-tolerance with improved aluminum and manganese tolerance.

Survival studies of P-442 and S-442 were done in Santo Angelo (Haplorthox) and Bom Jesus (Hamplumbrept) using the fluorescent antibody (FA) technique. Acid and/or aluminum tolerance was demonstrated by S-442 in the Bom Jesus but not in the Santo Angelo soil, probably due to the high (5.0 6.0 me) and low (0.8 me) exchangeable aluminum contents of the soils, respectively. In the Bom Jesus soil, survival of both strains at a population greater than 10^5 cells/g of soil after 30 days suggests that survival of *R. phaseoli* would not limit nodule initiation or dinitrogen fixation.

Plate count and FA studies showed that there was significant differential effect of moisture on the strains studied. Survival was excellent under both sterile and non-sterile conditions. Short-term flooding of soils did not affect the survival and symbiotic dinitrogen-fixing capacity of the bacteria. In fact, this treatment appeared to have stimulated the activity of the *Rhizobium* strains, as indicated by the increase in nodulation and yield. However, excess moisture stress severely reduced dinitrogen fixation.

Differences exist between *R. phaseoli* strains in their ability to withstand desiccation. In sterile soil, the order of resistance was: P-442 equal to S-442 and over—in descending order—C-05, QA 1062, and CIAT 255. A similiar order was obtained in non-sterile soil, with P-442 over CIAT 255. The decline in population occurred during periods of severe desiccation, i.e., at moisture tensions greater than 15 bars.

Data obtained from these studies led to the conclusion that nodulation failures associated with stress conditions like pH, high aluminum, and moisture stress in the tropics may be more an effect on nodule initiation and the symbiosis, or on the host plant, than on the survival of the specific *Rhizobium*.

For further information on this article, contact Dr. Denis Amara, Dept. of Agronomy, Njola University College, Private Mail Bag, Freetown, Sierra Leone. Amara is a recent graduate of Ohio State University and a former intern trainee in BNF technology at the NifTAL Project.

INLIT Data Procedures

Data handling procedures for "A" experiments in the International Network of Legume Inoculation Trials (INLIT), coordinated by NifTAL, have been completed.

The completed analysis will be conducted on the main harvest. Occasionally, yield of both grain and forage crops will be taken off the same plot. When this is so, a separate analysis will be made for both, unless the NifTAL network coordinator has indicated otherwise. Forages will generally have more than one harvest. The total of all harvests will be combined and the analysis run on the total yield of dry matter per hectare. Yield of both grain and forage will be calculated from amount and area harvested. Some *Leucaena* experiments will have both a forage yield and a wood yield; both will be analyzed.

Data analysis will also be conducted on early sample data, including total dry matter per plant at early harvest, fresh weight of nodules per plant, cholorophyl, acetylene reduction, and SNA.

NifTAL will print means of all or any of the following observations taken by the cooperators (all observations will not be taken by all cooperators): 1) nodules per plant at thinning, 2) nodules per plant at early harvest, 3) percentage of pink or red nodules at thinning, and 4) foliage color (average value on scale of 1 - 5). Any data reported in non-standard units will be noted by the network coordinator. If data is recorded in units that cannot be converted to standard units, the data will not be stored in the composite file. Whether or not to analyze such data will be the prerogative of the network coodinator, but there will be no discretion as to whether or not the data is stored for composite analysis.

Analyses will be run with missing values, even when they are excessive. It is anticipated that some cooperators will have many plots with no data, either scattered randomly or as complete replications.

For further information on the INLIT program contact Dr. Robert Davis, Director of International Programs, NifTAL Project, P. O. Box O, Paia, HI 96779, USA.

BNF Grant Program

The Committee on Research Grants, Board on Science and Technology for International Development, National Academy of Sciences (NAS) supports research in developing country institutions on selected scientific questions. The NAS proposes to fund research grants on BNF and would be pleased to communicate with institutions interested in basic BNF research, or applied research on *underexploited or local legumes, azolla,* and *free living or associated nitrogen fixing bacteria* in any of the following areas, as appropriate:

1. relationships among microorganisms (rhizobiz, mycorrhizae, etc.) and host plants; ;development of inoculation techniques;
2. quantity and fate of nitrogen fixed;
3. effects of environment on fixation (problem soils, stressed conditions, etc.);
4. management and cultural practices; use as green manure in cropping systems; and
5. nutritional analysis of nitrogen-fixing species for food or forage.

Collection identification, and evaluation of local nitrogen-fixing species may be included as part of a broader study. Grant funds may be used for support of scientists and technicians, purchases of grant-related equipment, research expenses, and travel. Long-term training and purchase of vehicles should not be included.

Grants are for less developed country institutions only; middle income countries may participate if their proposal (a) involves collaboration with other grantee institutions, or (b) provides a scientific component otherwise inaccessible to the project.

For further information and proposal preparation guidelines and procedures, please contact Dr. Michael P. Greene, Executive Secretary, Committee on Research Grants, giving a brief description of the area of interest. Dr. Greene is at the National Academy of Sciences, 2101 Constitution Avenue, Washington, D. C. 20418, U.S.A.

42

N Fixing Tree Association

Membership is open to all persons interested in nitrogen-fixing trees in the Nitrogen Fixing Tree Association (NFTA) whose purpose is "to encourage international development communication, and utilization of nitrogen fixing trees to provide fuel, fertilizer, forage, feed, fiber, forests, and other products."

NFTA will be promoting scientific publications and will also occasionally promote conferences and workshops on nitrogen-fixing trees.

Persons interested in membership may obtain information from Mr. Rick Van Den Beldt, Executive Secretary, NFTA, Box 680, Wainanalo, HI 96795, USA.

Leucaena Research Reports

The name of the *Leucaena Newsletter* has been changed to *LEUCAENA RESEACH REPORTS* in order to more accurately describe its intent. This annual publication contains a worldwide collection of research notes and brief technical reports on *Leucaena*.

Over 500 scientists and institutions in 70 countries are receiving the *Reports*. Interested contributors should request "Guide to Contributors" from the *Reports'* editor, Dr. James L. Brewbaker, University of Hawaii, 3190 Maile Way, Honolulu, HI 967822, USA. The annual submission deadline is June 1.

Winged Bean Book in 2nd Edition

The second edition of *THE WINGED BEAN: A HIGH-PROTEIN CROP FOR THE TROPICS* has been released by National Academy Press, Washington, D. C. Initially compiled by Louis Lazaroff of the ICDUP, the book discusses the agronomy, the food use and nutritive value, and the pests and diseases of the winged bean. An extensive reading list is also provided.

This report is based on contributions received from 32 winged bean researchers and includes many new findings. However, it remains an introduction of the plant and not a detailed review of all winged bean knowledge. Its main purpose is to acquaint administrators and uninitiated researchers with the plant and its promise.

Thailand BNF Course

NifTAL and the Bacteriology and Soil Microbiology Branch, Division of Plant Pathology, Department of Agriculture, Kasetsart University Campus annouce a six week training course in Legume/*Rhizobium* technology to be held 1 November to 10 December 1982.

The purpose of the course is to provide training in techniques of applied *Rhizobium* research for workers in Southwest Asia and to prepare them for participation in a cooperative research network.

This practical training course aims to augment the pool of individuals in tropical Asia who have the technical skills for using rhizobia in research, development, and production programs involving legumes.

Prospective participants should write, providing a resume and including information on present responsibilities and prior experience, prior training in bacteriology, proficiency in English language, and expected responsibilities after completion of the course.

Candidates from Thailand should contact Mrs. Yenchai Vasuvat, Bacteriology and Soil Microbiology Branch, Division of Agriculture, Bangkhen, Bangkok 9, Thailand. All others contact Dr. James W. King, Director, Communication and Training Systems, NifTAL Project, P. O. Box O, Paia, HI 96779, USA. Application closing date is 15 July 1982.

ANNOUNCEMENTS

Soybean Course at INTSOY

An INTSOY course of interest to BNF researchers will be held 17 May to 6 August 1982, at the College of Agriculture, Urbana-Champaign, Illinois. The course is titled "Technical Aspects of Soybean Production."

The course begins with the seed supply and continues through marketing of the crop. The course is especially appropriate for people who will give leadership to the establishment and expansion of soybean production in their countries. The BNF process will be discussed.

INTSOY offers no scholarships and all enrollees are expected to understand, read, write, and speak English. For information write to INTSOY, College of Agriculture, University of Illinois, 113 Mumford Hall, 1301 West Gregory Drive, Urbana, IL 61801, USA.

BGA and Rice

The relationship between blue green algae (BGA) and rice is the topic of a publication by IRRI, Los Banos, Laguna, Philippines. BLUE-GREEN ALGAE AND RICE presents a compilation of the relevant international research on the ecological, physiological, and agronomic aspects of BGA in flooded rice paddies. Authors Drs. P. A. Roger and S. A. Kulasooriya have also included an extensive bibliography as well as an analytical listing of references, both of interest to BNF researchers.

Information will be useful to microbiologists concerned with algae from a scientific viewpoint and to agronomists and field workers interested in the practical value of BGA's nitrogen supply to the rice plant.

Warning on Winged Bean Seeds

With the increased interest in winged beans and the almost casual exchange of seeds, NAS has noted the following warning: In the Ivory Coast, Indonesia, and elsewhere, virus diseases and nematodes that severely limit winged bean yields have been discovered. The viruses are seed-borne, and until uncertainties over the potential spread of these diseases are resolved, precautions should be taken with seed introductions and the widespread exchange of uncertified seed should be curtailed.

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43

Nitrogen Cycling in West Africa

The SCOPE/UNEP International Nitrogen Unit has released *NITROGEN CYCLING IN WEST AFRICAN ECOSYSTEMS*, proceeding of a workshop (1978) held at the International Institute for Tropical Agriculture, Ibadan, Nigeria.

The major part of the book is devoted to discussions of present knowledge of nitrogen cycling in three major ecosystem types in West Africa—savannas, forests, and agro-ecosystems. Of interest to BNF researchers are reports from Mali—native legumes and *Rhizobium* isolation; Senegal—soya bean inoculation and *Acacia senegal* and a soil-tree system; Ivory Coast—presence and distribution of *B. japonicum* and *B. cowpea*; Nigeria—*Arachis hypogaea* and nitrogen chlorosis and local inoculant production; and Sierra Leone—weed control and N restoration with legumes.

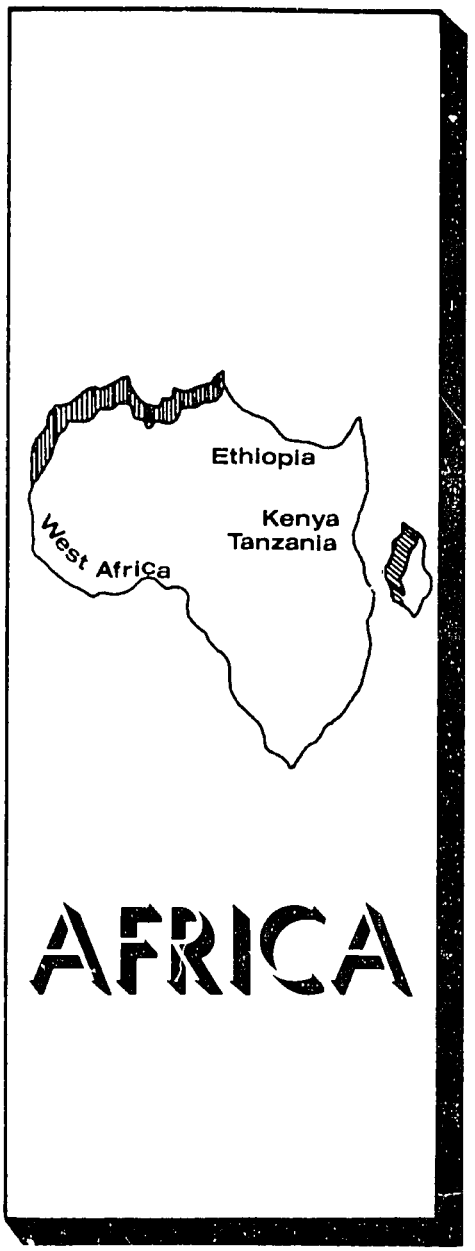
For further information, write SCOPE UNEP International Nitrogen Unit, Royal Swedish Academy of Sciences, Box 50005, S-104 05 Stockholm, Sweden.

Nairobi MIRCEN

S. O. Keya of the Nairobi MIRCEN reports an 80% increase in the number of farmers supplied with *Rhizobium* inoculant in 1982. Over 180 farmers received inoculant compared to 101 farmers for the same months in 1981.

This increase is due to demonstration plots, a national show, and successful application by the farmers themselves. Inoculant was supplied for beans, soybeans, cowpeas, pigeon peas, and some forages.

Activities of this MIRCEN include training, culture collection, inoculant production, information dissemination, regional cooperation, and demonstration efforts. Dr. Keya can be contacted the University of Nairobi, P. O. Box 30197, Nairobi, Kenya.



Nodulation Research in Ethiopia

In many tropical production systems the presence or absence of naturally occurring legume nodulation is not well documented. Preliminary observations on nodulation in farmers' fields can therefore be a useful beginning to identifying problems which may be solved by inoculation or other agronomic methods. Such a preliminary survey was recently carried out by researchers at the Wolayta Rural Education Project in Soddo Wolayta Province, Ethiopia.

T. Teka, D. Balcha & J. C. Gires found very poor and erratic nodulation in *Phaseolus vulgaris*. Other crops, such as *Pisum sativum*, *Cicer arietinum*, and *Vicia faba*, tended to be better, but still showed erratic nodulation. The study suggests that improvement in N fixation by legumes is needed in the area. Low P seemed to be a major limitation on nodulation, prompting the suggestion that, for developing countries, rhizobia capable of acting in low fertility soils are needed.

Tanzania Soybean Research

B. B. Singh and J. K. Mligo reported recently on the free nodulation of local soybean lines in Tanzania. Fourteen soybean varieties were evaluated for their ability to form nodules with and without *Rhizobium* inoculation. The experiment was conducted in a field where soybean had never been grown before. Nine varieties including Bossier and Hardee formed good nodules only when inoculated but showed very little nodulation without inoculation. Five varieties, 3H/1, T-49, 1H/192, 7H/101, and 2120, showed moderate to good nodulation irrespective of inoculation. All these varieties are of tropical origin. These data indicate that the tropical, local soybeans have specific genes which permit recognition and consequent nodulation by the natural *Rhizobium* present in tropical soils. Apparently, the temperate varieties lack such genes.

The researchers are grain legume breeders at IITA/USAID/Tanzania Crop Research Project, A.R.I. Ilonga, P/B. Kilosa, Tanzania.

MIRCEN NEWS: Promoting Cooperation

The MIRCEN NEWS offers information of regional activities dealing with Unesco's programs in applied environmental microbiology and biotechnology. Microbiological Resources Centers (MIRCENs) are concerned with the use and preservation of microbial strains for deployment in environmental management.

Published twice a year, MIRCEN NEWS provides information on management, distribution, and utilization of the microbial gene pool, relates efforts on the conservation of microorganisms (with emphasis on *Rhizobium* gene pools), discusses new inexpensive microbial technologies, notes applications of microbiology to rural economies, and reports training efforts.

Individuals, university departments, and research institutes desirous of using the MIRCEN network will find useful contact points and addresses in MIRCEN NEWS.

Persons interested in receiving the MIRCEN NEWS should address requests to Dr. T. Rosswall, Secretary, UNEP/Unesco/ICRO Panel on Microbiology, Department of Microbiology, Swedish University of Agricultural Sciences, S-75007 Uppsala, Sweden.

Rhizobium MIRCENs are located in Brazil, Kenya, the U.S.A., and at the NifTAL Project. Other MIRCENs are in Thailand, Egypt, Australia, Sweden, and Guatemala.

44

DIRECTIONS IN COMMUNICATION

After all is said and done, it will be our ability or inability to communicate information about BNF that will directly influence the impact we seek—to increase agricultural productivity throughout the tropics while minimizing dependence on costly, non-renewable energy sources. This issue of the BNF BULLETIN will begin a series of articles on the communication process and its relationship to BNF technology and BNF dissemination.

Communication comes from the words community and common. Community can be thought of as participation in common or interests in common. Community of interests imparts the feeling of sharing. The other word, common, is defined as shared by all, belonging equally to everyone, prevalent, and widespread.

Both community and common are derived from the Latin for "exchange" or "share." Thus communication is rooted in an exchange or sharing of commonalities. Communication of BNF information can be thought of as "the process of sharing meanings."

"The process . . ." Process implies ongoing development, continuous activity; communication is a process because it is always developing, depending on the experiences of the people involved.

". . . of sharing meanings." Communication also implies an exchange or sharing, not only speaking but also listening, not only writing but also reading. What is shared by people engaging in the communication process is meaning, an intent or purpose to words, visuals, or actions.

As the exloration into the world of BNF continues, the communication process will expand. BNF efforts to communicate are attempts to inform, develop attitudes, and shape behavior by sharing information with specified audiences. This information is coded in special words and precisely designed visuals. Problems arise when the intended audiences do not share or understand the meanings used in words or visuals. This is one reason BNF is in the realm of science—the precision involved in the definitions of the language, and while these definitions may not be perfect, their use fosters an environment in which better communication can be attained.

However, as BNF research becomes more widely diffuesed into practice, communication problems will increase. Our audiences are now being enlarged and are changing from solely other researchers to policy makers, field workers, extension agents, and of course, the farmers themselves. How will meanings be shared between such diverse groups of individuals? NifTAL and FAO are meeting this challenge through the joint development of a pocket field guide on legume inoculation for extension workers worldwide.

Communication processes will be used to bridge the gap between audiences and messages by creating shared meaining. When meanings are shared between and among people, communication occurs.

Further columns in this series will suggest ideas to improve the communication process, and will offer ways to avoid Fetridge's law, "Important things that are supposed to happen do not happen, especially when people are looking." We want BNF technology to be disseminated and adopted, especially when people are looking.

– James W. King

BNF Bulletin

The *BNF Bulletin* is now an established vehicle for communicating the highlights of BNF programs and research to the agricultural community worldwide.

There will be three issues per year and these will be distributed in April, July, and December. The *Bulletin* is being expanded to include a bibliography on *Rhizobium* research. This bibliography will be consecutive to that previously offered in the *Rhizobium Newsletter* and can be accumulated as a chronological file of published work on Rhizobium.

Researchers in developing countries wanting copies of individual papers in the bibliography can request these from the NifTAL Project.

Panel Meets on BNF Technology

As part of the BNF technology assessment being conducted by the East/West Center, a panel session on Long-Term Prospects and Policy Issues was held in Honolulu, January, 1982.

Presentations by S. Ahmed, R. Grossman, and R. Randolph of the East/West Center provided the context of the discussions and offered BNF researchers alternative scenarios. Working groups discussed the forces guiding BNF, trends and prospects, socio-economic impacts, information delivery, and BNF support systems.

Participants included M. Alexander, B. Bohlool, J. Burton, R. Davis, L. Frederick, M. Greene, D. Gross, M. Habte J. Halliday, T. Lumpkin, D. McNeil, E. Schroder, P. Somasegaran, N. Shaw, D. Weber, and S. Whitney. For further information on the assessment, see the BNF BULLETIN, Vol. II, No. 3.

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45

IARI BNF Symposium

Dr. G. S. Venkataraman, Project Coordinator, All India Coordinated Project on Algae reports that a wide range of BNF topics ranging from genetics to field application were discussed and papers presented at the National Symposium on Biological Nitrogen Fixation held at the Indian Agricultural Research Institute (IARI), New Delhi, 25-27 February, 1982.

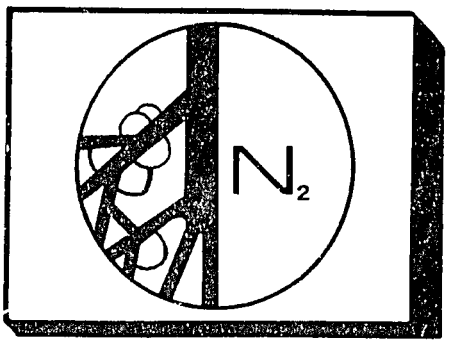
The Symposium was organized by the Food & Agriculature Committee of the Department of Atomic Energy (DAE).

The program began with a theme session on Biotechnologies for Nitrogen Fixation including presentations of future approaches to photoautotropic nitrogen fixation, heterotropic nitrogen fixation, national strategy for *Rhizobium* inoculant production, prospects and problems in the use of genetic engineering, and perspectives in nitrogen fixation technology: biochemical and genetic aspects.

Over 50 research papers were presented. During open forum sessions, details of research, development, and extension methodologies were critically discussed and evaluated for the transfer of BNF from lab to land.

The Symposium recommended the following short and long term approaches at the national level: a) instituting an effective extension program for popularizing existing blue-green algae, *Azolla*, and *Rhizobium* technologies with suitable infrastructural support, b) assessing available BNF technologies, c) instituting a licensing procedure for biofertilizer manufacturers, d) identifying and domesticating new nitrogen fixing microorganisms, e) plasmid mediated technology to transfer genes coding for N_2 fixation, genetic manipulation of strains derepressed for N-fixation, and to enlarge host spectrum for *Rhizobium*, and f) establishing a National institute for BNF, culture collection, and quality control center.

The proceedings will be published by the DAE in late 1982. Contact Dr. Joseph Thomas, Biology & Agriculture Division, BARC, Trombay, Bombay-400 085, India.



Argentinian Course on Fermentation

The Centro de Investigacion y Desarrollo de Fermentaciones Industrailes (CINDEFI) is one of the few institutions in the world capable of conducting research in fermentation and related aspects of production. CINDEFI now plans to provide training in *Rhizobium* fermentation for workers in South and Central America.

The 3-week course will be held at Universidad Nacional de La Plata from 7 - 27 June 1982. Sponsors are UNEP, Unesco, CINDEFI, and the Universidad Nacional de Investigaciones Cientificas y Tecnicas.

Rhizobium workers can obtain information from Prof. Antonio P. Balatti, Rhizobium Fermentation Training Course, Facultad de Ciencias Exactas UNLP, 47 y 115, La Plata, Republica Argentina. Enrollement is limited to 15 persons and the application deadline is 30 April 1982.

Vienna BNF Research Meeting

The Joint International Atomic Energy Agency/Food and Agricultural Organization (IAEA/FAO) Program for Isotopes in Agriculture Research Coordination Meeting on Biological Nitrogen Fixation was held from Jan. 24-29 in Vienna, Austria. NifTAL Senior Agronomist Dr. A. Sheldon Whitney, along with Dr. S. Verniau of the FAO BNF program, represented outside organizations at the meeting.

Program contractors presented reports on experiments conducted during past years. Reports were made on varieties times N levels (1981), P levels (1980), and non-fixing controls (1979). Experiments in 1982 will involve the factors of varieties (2 or 3 selected from the previous experiments) versus rhizobia inoculation and/or P levels.

Two new programs being undertaken are measurement of N_2 gains as a result of incorporating legumes in cropping systems and intercropping experiments designed to achieve greater efficiency of N uptake by the non-legume. N fixation by the legume will also be measured.

Continued from page 1

Rhizobium Newsletter

THE FUTURE

The rapidly increasing cost of nitrogenous fertilizers, and the increase in world demand for protein, ensures a bright future for nitrogen fixation research, and naturally for studies on legume nodulation. A major problem will be the production of reliable, high count inoculants capable of maintaining their viability under conditions of adverse storage and transport in developing countries. There is also a need to develop easy-to-use and reliable inoculant application procedures for poorly-educated farmers in these countries. Anyone able to devise a suitable seed pre-inoculation procedure, able to withstand the many environmental stresses to which such seed would be exposed, would be making a major contribution to legume nodulation research.

Another major area in need of urgent attention is the ecology of rhizobia. Among the problems involved is the quest for strains able to effectively nodulate plants growing in soils of low pH. There is also a need to understand the factors affecting survival of rhizobia, and of the factors that enable introduced strains to compete with indigenous strains in forming nodules. All this will involve basic microbiological research, but before this can be undertaken in depth it will be necessary to define the essential characters in the rhizobia determining these attributes. Bacterial genetics is likely to play an increasingly important part in these studies – in fact the application of genetics to this work is likely to be more fruitful than seeking to increase host-range, or improving the effectiveness, of existing strains.

The host plants should not be forgotten; already we are seeing an increasing interest in host genetics, both for studies on the understanding of nodulation and for attempts to increase productivity. While such work is more time-consuming than bacterial genetics, the results are likely to be just as, if not more, significant than that with the bacteria. In this connection, it should be appreciated that breeding for attributes other than increased nodulation per se could lead to greater increases in nitrogen fixation than breeding for increased nodulation and/or nitrogen fixation!

The next 25 years will undoubtedly achieve a better understanding of the physiological/biochemical/genetical basis of the legume-*Rhizobium* association. In addition, this will also help the quest for extending N_2-fixing associations to other corps. Much has been written about genetic engineering being able to put *nif* genes into plants – perhaps it would be more feasible to consider

Vh

Continued from page 6

Rhizobium Newsletter

introducing the ability to form symbiotic associations to such plants. Who knows, only two or three characters may be involved, and there would not be the worry of having to locate the *nif* genes in plant organelles in which they are capable of expression.

Regardless of the various directions the research will take, the next 25 years are sure to produce some exciting research. However, it is vital that this research produce results of practical significance if the continued support of fund-granting administrators is to be maintained. The gap between basic and applied research is widening, not narrowing. One of the prime objectives of the RN was to try and effect a reversal in this trend by keeping everyone informed of latest developments and providing avenues for expression of research requirements that others, better situated, can perhaps satisfy.

Infection of white clover root hairs lead to the formation of nitrogen-fixing nodules. In this photo the deformed root hair is markedly curled at the root hair tip ("shepherd crook" can be seen). Rhizobium trifolii 0403 has entered the root hair producing the infection thread (can be seen). The infection thread branched at the root hair base, entered the cortex, and stimulated the formation of the nodule (seen) on which this infected root hair resides. (Photo by Dazzo and Truchet, manuscript in preparation, Journal of Membrane Biology.)

Continued from page 1

The Remarkable 32H1

Working with cells of rapeseed (*Brassica napus* L.), bromegrass (*Bromus inermis* Leyss) and wheat (*Triticum monococcum* L.) in association with strain 32H1 (*Rhizobium* sp. cowpea type), Child and LaRue demonstrated nitrogenase activity by acetylene reduction. Scowcroft and Gibson, at this same meeting, demonstrated that strain 32H1 in association with tabacco cells (*N. tabacum*) produced nitrogenase which reduced acetylene to ethylene and fixed nitrogen using istopic $^{15}N_2$. It should be pointed out, however, that D. A. Phillips, working at Indiana State University, had noted nitrogenase activity by strain 32H1 in association with soybean cells (*Glycine max* L. Merr.) (Personal communication with the author). This was not too surprising since various workers have reported that certain strains of cowpea rhizobia can induce nodulation of the soybean. The real significance of this finding was overlooked.

ORIGIN OF 32H1

Like most early Americans, *Rhizobium* strain 32H1 was an immigrant. The late Prof. O. N. Allen visited South America in 1967 as a guest and advisor of various groups of scientists with mutual interest in the *Rhizobium*: leguminous plant associations. One of Prof. Allen's objectives on this trip was to collect rhizobia germ plasm. The nodules collected were sent to me for isolations. Strain 32H1 was isolated from a nodule on the roots of a leguminous weed (*Crotalaria paulina*, Schrank) found growing in a red acid soil near Porto Alegre in Rio Grande do Sul, Brazil, where it was growing vigorously and had deep green leaves. Nodules were collected and dried over silica gel and forwarded to Milwaukee for isolations.

Following purification, the isolate was tested on the cowpea (*Vigna unguiculata* L. Walp) for its ability to nodulate and fix nitrogen on the cowpea. Fortunately, the strain not only produced many nodules but it brought about excellent nitrogen fixation. If the latter had not occurred, the culture, like many others, would have been discarded without further testing.

After a rhizobia isolate has shown good nitrogen fixation on its parent host, the next step is to test it on other important leguminous plants which are nodulated by the same species, variety, or kind of rhizobia. Broad-spectrum strains of rhizobia are very desirable for inoculant producers and this is particularly true in the cowpea miscellany, which embodies so may diverse species. Strain 32H1 was tested on other commercially important leguminous crops. It proved highly effective on several of these: peanut (*Arachis hypogaea* L.), mung bean (*Vigna radiata* L. Wilcek), annual lespedeza (*Lespedeza stipulacea* Maxim. and *L. striata* Thunb.), guar (*Cyamopsis tetragonoloba* L.), and velvet bean (*Mucuna deeringiana* Bort. Small), and *Indigofera* spp. It was only moderately effective on *Albizia julibrissen*, Darazz; *Desmanthus* spp. and the perennial lespedezas (*L. sericea* Thunb. Beatty; *L. virgata D.C.; L. capitata;* and *L. daurica* Schindl). It was poor on tepary bean (*Phaseolus acutifolius* Gray) and only fair on the winged bean (*Psophocarpus tetragonolobus* L. D. C.).

A WORLD TRAVELER

The wide spectrum of leguminous hosts which respond effectively to strain 32H1 made it a prime choice for use in commercial inocula for the cowpea cross-inoculation group. It has been a component of the cowpea inoculum for almost 9 years. Undoubtedly, it has numerous descendents all over the United States and in many other countries. The strain has also proven very competitive with many other cowpea rhizobia in tests of this quality. This has undoubtedly improved its ability to survive in soils once it has been introduced.

Strain 32H1 has also been widely spread to scientific laboratories in all continents. Publication of the remarkable ability of this strain to generate nitrogenase independent of the host opened the door for new avenues of research, and it continues to receive honorable mention in scientific publications the world over.

– Joe Burton

47

BNF Bulletin
Volume III, Number 1
April 1982

Staff: Dr. James W. King
Princess Ferguson
Jill Fitzpatrick

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Contents

1 Rhizobium Newsletter
$1M Rhizobia
2 INLIT Data Procedures
pH, Moisture & *R. phaseoli*
BNF Grant Program
3 Announcements
4 BNF in Africa
MIRCEN News
5 Directions in Communication
6 IARI BNF Symposium
8 Short Takes

SHORT TAKES

Dr. **Charles Simpkins**, formerly of DS/AGR USAID, Washington, has been assigned to the AID office in Rangoon, Burma. Simpkins will serve as the agricultural officer in charge of AID sponsored agricultural projects, in particular the oilseed program currently underway.

■ ■ ■

Dr. **Alva App** will be assuming the duties of Deputy Director at the International Center for Insect Physiology and Ecology, Nairobi, Kenya. App will be on a two year leave of absence from his position at Boyce Thompson Institute and IRRI.

■ ■ ■

Jaime Mora Celis, director of research at the Nitrogen Fixation Research Center (Cifnoi, Mexico, and a specialist in the metabolism of nitrogen, was recently awarded the prestigious Elias Sourasky Prize in science. Mora has studied the mechanism by which a plant fixes nitrogen, the elimination of excess ammonia in animals and the enzyme cycle that regulates that vital function and biosynthesis of urea. This carried him into research of certain nitrogen, high amino acids, the biosynthesis of arginine, the genetic analysis of a plant and the metabolism of nitrogen in relation to the metabolism of carbonydrates.

William R. **(Bill) Kerrey**, NifTAL Associate Director, left the Project in early 1982 to return to his home in Nebraska. Kerrey now assumes the duties of campaign manager for his brother who is running for the office of State Governor.

■ ■ ■

NifTAL and INTSOY have just completed a "Statement of Understanding." The two projects will exchange informational materials, communicate future research trends, disseminate research products to each other for use with their respective cooperators, coordinate international trials programs with *Rhizobium* and explore possible cooperation to reinforce each other's training programs. INTSOY was represented by Drs. Chris Stearn and H. E. Kauffman and NifTAL by Drs. David McNeil and Jake Halliday.

■ ■ ■

Vesicular Arbuscular Mycorrhiza Research for Tropical Agriculture, a state of the art report by Dr. **Barbara Mosse** on vesicular-arbuscular mycorrhiza from 1930-1978 has been published. For copies of this report, Research Bulletin 194, contact the College of Tropical Agriculture and Human Resources Order Desk, Room 108, Krauss Hall, 2500 Dole Street, Honolulu, HI 96822, USA.

Dr. **Eugene Kron**, consultant to the government of Gabon, reports the beginning of an agroforestry project using *Leucaena*. Sites near Libreville and Franceville have been selected for the first trials. Korn can be reached at the Ministere De La Plantification, Du Development et Des Participations, B. P. 3918, Libreville, Gabon.

■ ■ ■

The October 1981 issue of **TROPICAL AGRICULTURE** (the Journal of the Faculty of Agriculture, University of West Indies) featured papers and workshop discussion presented at the Regional Workshop on BNF held at the University from 4 to 8 January 1981. The issue included papers by J. Burton, R. Eaglesham, R. A. Graham, and G. Elkan.

■ ■ ■

ICRISAT distributes the **INTERNATIONAL PIGEONPEA NEWSLETTER**, issued yearly in August, as a communication link for researchers interested in development of *Cajanus cajan*. Information on the newsletter may be obtained from Dr. Donald G. Faris, Principal Pigeonpea Breeder, Pulse Improvement Program, ICRISAT Patancheru P. O., Andhra Pradesh 502 324, India.

BIOLOGICAL NITROGEN FIXATION BULLETIN

Volume III, Number 2

To Study or To Construct

Why study associative and biological nitrogen fixation instead of incorporating the nitrogen fixation genes directly into the plant genome? Dr. K. T. Shanmugam offers one response in the accompanying article. Shanmugam, Associate Professor, Department of Microbiology and Cell Science at the University of Florida, Gainesville, FL 32611, discusses his reasons for avoiding genetic engineering in BNF systems at this time. Readers' views on this article are welcome; please address your letters to the BNF Bulletin. *Thanks to Dr. Shanmugan for sharing his information with us and for allowing us to print his comments.*

Editor

We believe there are highly cogent and compelling reasons for avoiding, at this stage, emphasis on genetic engineering efforts as a substitute for research to improve existing biological nitrogen fixation systems. The idea of developing plants with nitrogen fixing capability is highly appealing but the task is far more complex (and probably will require far more time) than implied by many people.

Nitrogen-fixation genes (*nif*) have been genetically transferred to other non-nitrogen fixing organisms. Recipient species include *Escherichia coli*, *Salmonella typhimurium*, *Pseudomonas sp.*, *Erwinia sp.*, *Agrobacterium sp.*, *Proteus mirabilis* as well as the yeast, *Saccharomyces cerevisiae*. Among the bacteria-*nif* hybrids, nitrogenase synthesis and activity can be detected in some (at low levels) and not in all organisms. The yeast-*nif* hybrid, the only eukaryotic *nif* hybrid studied so far, failed to produce any detectable nitrogenase activity. In short, despite extensive effort no one has yet produced a new nitrogen-fixing hybrid *bacterium* (outside the naturally occurring genera) or an eukaryote (yeast) capable of growth when dependent on N_2 as sole source of nitrogen.

> The idea of developing plants with nitrogen fixing capability is highly appealing . . .

Developing nitrogen fixing *plants* is going to be far more difficult than the production of nitrogen fixing bacteria. In *Klebsiella pneumoniae* (the only organism studied in detail) 17 or 18 genes constitute the *nif* complex, and all are essential for nitrogen fixation by the cell. These include structural genes for nitrogenase and nitrogenase reductase, activators and modifiers of the nitrogenase and nitrogenase reductase as well as (possibly unique) specific electron transport proteins. Nitrogenase requires at least 18 moles of ATP and about 9 moles of reducing power (including H_2 production by nitrogenase) per mole of N_2 reduced. This is the minimum energy value required for N_2 fixation. If one considers the amount of energy utilized by the cell in maintaining active N_2 fixation at an optimum level, this value may go as high as 40 moles of ATP (i.e., twice the requirement for nitrogenase activity alone). An aerobic or microaerobic organism can produce this amount of ATP from a mole of glucose (1 glucose = 38 ATP). Nitrogenase itself would consume ½ mole of glucose to produce the reductant (20 pairs of electrons, per mole of glucose). Based on *K. pneumoniae* values, one can reasonably say that the aerobic cell would use about 1½ moles of glucose in the production of 2 moles of NH_4^+.

> "Genetic engineering works with single genes, but plants are good or bad because of many genes, so improving a plant is not trivial . . ."

This energy requirement must be met, for any production of NH_4^+, regardless of the biological nature of the organism, or organisms involved (bacteria, plant, plant-bacteria symbiotic or associative relationships).

To maintain active nitrogen fixation in any new system, the organism would need the following: 1) nitrogenase, 2) availability of reductant at low potential (−450 mV), 3) availability of ATP at high concentration, 4) regulation and expression of *nif* genes, 5) oxygen protection, and 6) assimilation of NH_4^+.

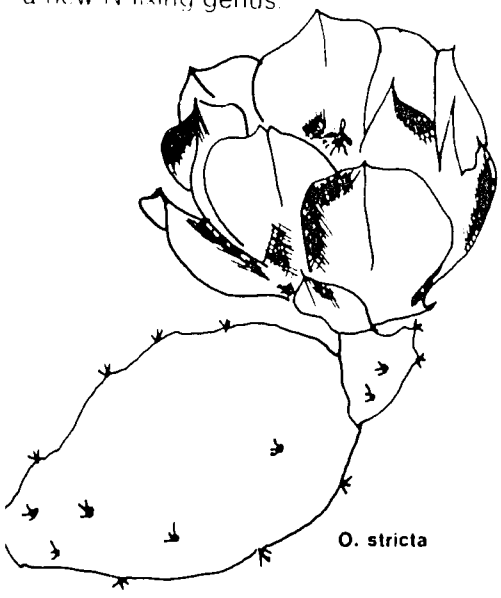
Since an eukaryotic cell is compartmentalized, one has to consider the appropriate location for introducing and/or maintaining the *nif* genes and products. Considering the requirements for *nif* genes, the chloroplast may be the best possible location because of a) availability of energy, b) availability of e⁻ at low redox potential, c) O_2 protection. There are oxygen-sensitive proteins already present in the chloroplasts, although membrane-bound. The soluable nature of nitrogenase may present problems. However, in *Azotobacter*, nitrogenase is protected from O_2 inactivation

Continued on page 7

Opuntia -- Not an N-Fixer in Queensland

The following information was received from A. and G. Diatloff, Dept. of Primary Industries, Meiers Road, Indooroopilly, and Alan Fletcher Research Station, Magazine Street, Sherwood, Queensland, Australia.

"We read with some interest the report in BNF Bull. Vol. 2 (3) of *Opuntia* as a new N fixing genus.



In no country has *Opuntia* been so maligned in the past as in Australia where at the height of infestation of agricultural land in 1925, some 23 million hectares were affected. In Queensland, dense growth of prickly pear (*Opuntia inermis* and *O. stricta*) was almost unbroken for hundreds of miles with scarcely any habitation, a cultivated field or head of cattle or sheep. Two vegetation types were invaded (a) open savannah forest with sparce growth of trees or shrubs of mainly *Eucalyptus* and (b) in dense stands of brigalow (*Acacia*) and belah (*Casuarina*) trees. The dense prickly pear occurred on fertile soils while on poorer soils on timbered ridges, growth was stunted and chlorotic. The epic destruction of the pear by the introduced insect *Cactoblastis* has been well documented (Dodd 1940, 1959) as an unrivalled success in biological control of a pest.

The first years following the clearing of the pear produced record grain yields in the restored areas (Skerman 1959) and farmers began to query whether or not the ill wind had blown some good. Had the pear, in fact added nitrogen to the ecosystem which was subsequently released by the decomposition of the pear?

For our study of the N fixing ability of *Opuntia inermis* samples were collected from relic populations of pear occurring in these areas previously covered by dense infestation of *Opuntia*. From each site, green and chlorotic plants were assayed for acetylene reduction. Young intact plants were also compared with detached roots from older plants. Samples were incubated in 10% acetylene in air mixture for 1 hour at 28 C before injection into a Shimadzu GC 6AM gas chromatograph.

No ethylene production was detected in either green or yellow plants irrespective of whether the cladode was detached or not. These findings suggest that any association of *Azospirillum* with *Opuntia* must be of a highly specific nature since *Azospirillum* from other grass associations found in these areas did not form a field association with *Opuntia* carrying nitrogenase activity. Fam. *Cactaceae* is poorly represented in the native Australian flora so perhaps there was little opportunity for the evolution of such a specific association.

As for the beneficial effects of the colonising *Opuntia* the explanation must lie in other directions than in an *Opuntia-Azospirillum* association. N fixation by *Acacia* spp. and *Casuarina* in the brigalow scrubs, its subsequent release through decaying vegetation and the rapid absorption by the *Opuntia* is a more likely explanation.

Reports of "yellow pear" deficient in N on poor soils resistant to destruction by *Cactoblastis*, (Dodd 1940) further supports the belief that N fixation by *Opuntia inermis* and *O. stricta* was not a widespread phenomenon in Queensland."

Dry Bean Trials

In the USA the number of acres planted to dry edible beans, such as Pinto, Kidney, and Navy beans, increased during 1980 and 1981, according to Dr. T. Wacek of NAPB (North American Plant Breeders), particularly in the Northern and Southwestern U. S. *Rhizobium* inoculants have played an important role in many of these areas as the following 1980 field trial results show.

Location: Navajo Agricultural Projects Industry (NAPI)
Farmington, New Mexico

Block II, Field 49 - Not Inoculated
1037.6 lbs/acre

Block II, Field 50 - Inoculated
1759.1 lbs/acre

Block IV, Field 8 - Not Inoculated
1019.7 lbs/acre

Block IV, Field 9 - Inoculated
1654.4 lbs/acre

At that time, NAPI was growing approximately eight thousand acres of pinto beans. They were able to reduce the level of nitrogen fertilizer from 90 lbs/acre without inoculant to 20 lbs/acre as a starter level when an inoculant was used, resulting in a significant savings.

Farmer Trials in 1981

The following trials were conducted in farmers' fields under normal growing conditions.

Location: Paul Henneck Farms, Greeley, Colorado

Variety UI 114 Pinto - Not Inoculated
38 bu/acre

Variety UI 114 Pinto - Inoculated
44 bu/acre

Location: Farmer's Elevator Co., Ovid, Colorado

Variety UI 114 Pinto - Not Inoculated
30.5 bu/acre

Variety UI 114 Pinto - Inoculated
33.1 bu/acre

One variable examined in these trials was the rate of granular inoculant

Continued on page 4

Viable Diluted Cultures

Experiments conducted by P. Somasegaran and J. Halliday were undertaken to test whether peat-based legume seed inoculants, which are prepared with liquid cultures that have been deliberately diluted, can attain and sustain acceptable numbers of viable rhizobia. Liquid cultures of *Rhizobium japonicum* and *R. phaseoli* were diluted to give 10^8, 10^7, or 10^6 cells/ml using either deionized water, quarter-strength yeast mannitol broth, yeast sucrose broth, or yeast water. The variously diluted cultures were incorporated into gamma-irradiated peat and the number of viable rhizobia determined at intervals.

In all of the inoculant formulations the numbers of rhizobia reached similarly high ceiling values by one week after incorporation, irrespective not only of the number of cells added initially, but also of nature of the diluent. During the first week of growth, similar multiplication patterns of the diluted liquid cultures were observed in two different peats. Numbers of rhizobia surviving in the various inoculant formulations were not markedly different after six months of storage at 28 C. The method of inoculant preparation did not affect the nitrogen fixation effectiveness of the strains of *Rhizobium*.

Somasegaran can be reached at the NifTAL Project-MIRCEN, P. O. Box 0, Paia, HI, 96779, USA.

50

MEETING NOTES

All persons interested in attending the XI Reunion Latinoamericana de Rhizobium (11th RELAR) to be held in Lima, Peru from 24-29 October 1982 should register immediately with Dr. Jose Gomez Carrion, Universidad Nacional Mayor de San Marcos, Museo de Historia Natural "Javier Prado," Av. Arenales 1256, Apartado 1109, Lima, Peru.

The 9th North American Rhizobium Conference will be held in Ithaca, New York, 19-23 June 1983. Registration and abstract forms will be distributed in December, 1982. Address information requests to Rhizobium Conference, Boyce Thompson Institute for Plant Research, Tower Road, Ithaca, N.Y. 14853, USA.

Inter-African Conference Held

The first OAU/STRC Inter-African Conference on Bio-fertilizers was held in Cairo 22-26 March 1982. Five technical sessions were held and issues discussed included: 1) The *Rhizobium*/legume symbiosis—the need for inoculation, nitrogen fixation under legumes, response to inoculation, isolation and maintenance of strains, and development and production of legume inoculant; 2) Blue-green algae—isolation and maintenance, assessment of nitrogen fixation capacities, development and application of biogas, and response of rice to inoculation; 3) *Azolla*—introduction and adaptation of *Azolla* under local conditions, growth rate/nitrogen fixation rate, and response of rice to *Azolla*; 4) Associative nitrogen fixation—potential of natural flora, isolation of nitrogen fixing strains, assessment of biological nitrogen fixation, and response of cereals to inoculation; 5) Critical evaluation of the contribution of legumes to subsequent crops in the cropping systems in member states; and 6) Cost benefit analyses conducted to evaluate the economic use of bio-fertilizers in member states, especially where raw materials are available.

A conference recommendation to OAU/STRC stated that BNF training courses and workshops be organized in cooperation with Unesco, FAO, UNEP, and NifTAL. Egypt was proposed as a possible host of the sessions.

The Fifth International Symposium on Nitrogen Fixation is scheduled for 6-13 August 1983 at the Leeuwenhorst Congress Centre in the Netherlands. Tentative costs for this 8-day meeting will be U.S. $300 registration and accommodations.

"Putting N Fixation to Work" is the theme for the Second International Symposium on N Fixation with Non-Legumes to be held at Banff, Canada, from 5-10 September 1982.

Sessions will be held on 1) microbiology of the association (isolation, enumeration, identification); 2) genetics of the host plant and the bacteria; 3) the site and process of the association; 4) techniques of measuring N_2 fixation; and 5) application and exploitation of these associations.

For information, contact Dr. R. J. Rennie, CAN-FIX, Lethbridge, Alberta, Canada T1J 4A9.

The Instituto Colombiano Agropecuario (ICA) and INTSOY will be holding a three-week course in soybean production beginning on 24 November 1982 in Palmira, Colombia. The course will be taught in Spanish and is designed for people in research, extension, and production. The fee, which does not include international travel or a living allowance is U.S. $1,000 per person. For information, write INTSOY, University of Illinois at Urbana-Champaign, 113 Mumford Hall, 1301 W. Gregory Drive, Urbana, IL 61801, USA.

Attendance at the International Workshop on Practical Applications of *Azolla* for Rice Production to be held at the University of Puerto Rico, Mayaguez Campus, from 17-19 November 1982 is open to participants for SE Asia, Africa, Europe, and Latin America.

The workshop will consider current research dealing with basic aspects of *Azolla*, rice nitrogen requirements, and economic impacts of using *Azolla* in rice production. Further information can be obtained from Dr. Eduardo C. Schroder, BNF Project, Dept. of Agronomy and Soils, University of Puerto Rico, Mayaguez, Puerto Rico 00708.

ANNOUNCEMENTS

PCARR/NifTAL Agreement Signed

Recently, NifTAL and PCARR (Philippine Council for Agriculture and Resources Research) signed a memorandum of agreement to undertake a cooperative BNF project. Utilization of microbial inoculation technology to increase legume production in the country and adoption of low cost technology for crop production are the goals of this cooperative project.

Conference Proceedings Available

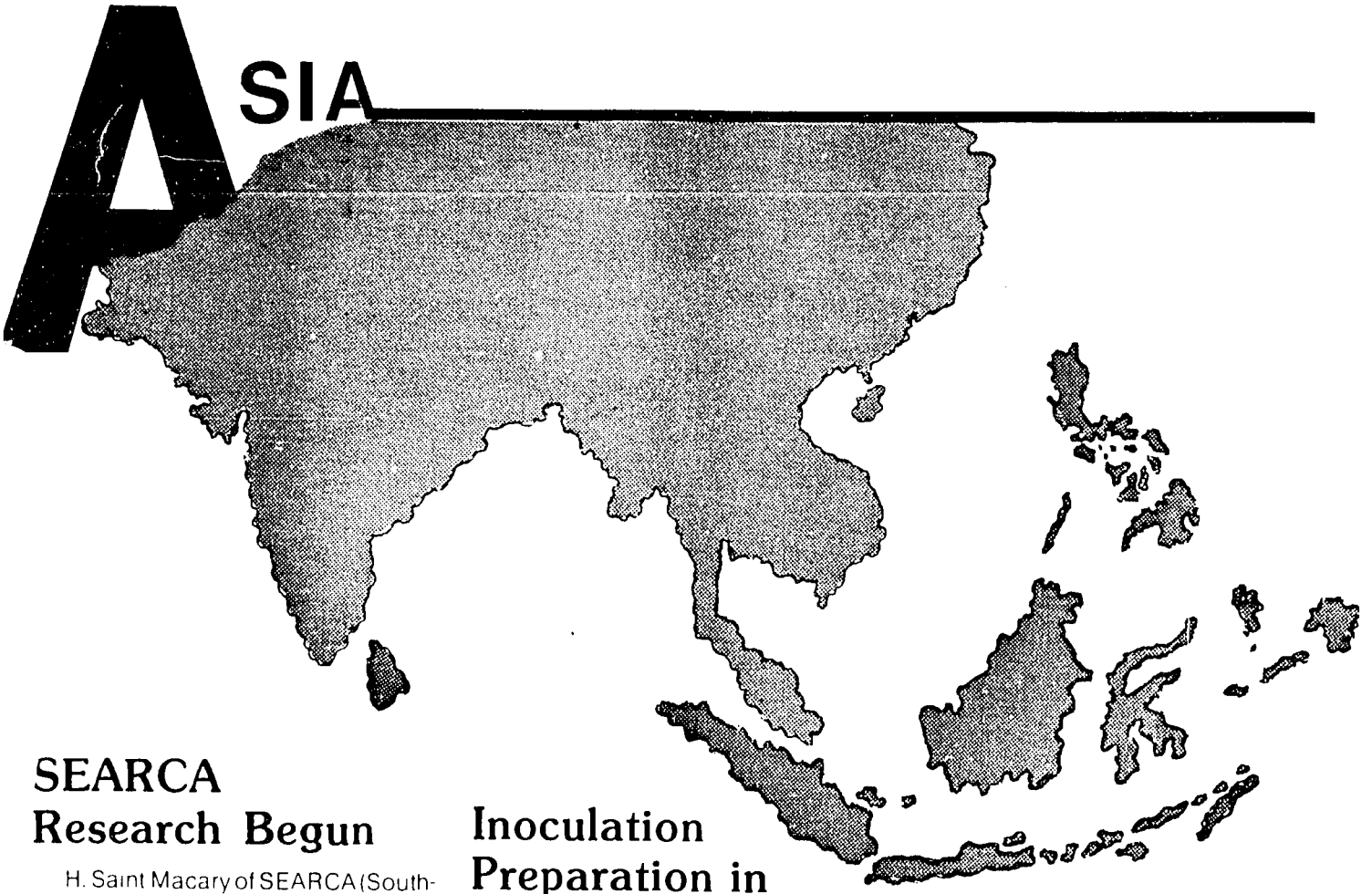
The proceedings of the 8th North American *Rhizobium* Conference held in August 1981 are now available. Constituting a collection of manuscripts (580 pages with 111 illustrations, hard cover), the book covers topics ranging from *Rhizobium* genetics and physiology to agronomic considerations and methodologies. Cost is approximately $50 U.S. Address orders to Rhizobium Proceedings, c/o Prof. K. W. Clark, Dept. Plant Science, University of Manitoba, Winnipeg, Manitoba, Canada R3T 2N2.

Bagasillo Inoculant

From Zimbabwe, Dr. P. M. Grant reports on soybean inoculant based on bagasillo (bagasse winnowings) from sugar mills. To reach the high populations of rhizobia needed for proper inoculation, Grant recommends incubating the inoculant for two weeks before use. The bagasillo powder was found much more suitable than bagasse for the growth and survival of *Rhizobium* inoculants. For further information, write Department of Research and Specialist Services, Ministry of Agriculture, Soil Productivity Research Laboratory, Private Bag 3701, Marandellas, Zimbabwe.

51

ASIA



SEARCA Research Begun

H. Saint Macary of SEARCA (Southeast Asian Regional Center for Graduate Study and Research in Agriculture), College, Laguna 3720, Philippines, reports that GERDAT and SEARCA are starting a new research project on studies of nitrogen cycle and nitrogen fixation in cropping systems including legumes. The aim is to determine—as far as possible—how much nitrogen is fixed by legumes in the fields, what the limiting factors are, and whether improvements can be made using agricultural practices

Indonesian Subsidies Underway

Through the Indonesian extension service, that government is providing subsidies to farmers for seeds and fertilizers, reports Dr. Omar Hidayat of the Agency for Agricultural Research and Development, Sukamandi Research Institute for Food Crops, Sukamandi – Subang, West Java, Indonesia. Distribution of legume inoculant is also underway.

The extension program subsidies are part of a transmigration program relocating farmers to less populated islands of Indonesia and are aimed at establishing an ongoing agricultural effort. Legumes and inoculants are expected to play a big part in this Indonesian program.

Inoculation Preparation in Burma

One million packets of inoculant (each suitable for one acre) are produced annually at the Agricultural Research Institute (ARI), Yezin, Burma. Under the direction of U Hla Than, these 250 metric tons of inoculant are produced using all indigenous materials and a minimum of sophisticated equipment, eliminating dependence on imported parts and expertise.

This report was made by Dr. R. J. Davis following his mid-1982 visit to Burma. At the request of the government of the Socialist Republic of the Union of Burma, he provided consultation on production, distribution, and use of legume inoculants. Before leaving the country, Davis prepared and presented a written report of his evaluation of the inoculant unit, along with suggestions for further development of the operation without destroying its low technology nature.

Over the next five years, the Agricultural Corporation, through its Maize and Oilseeds Production Project (MOPP), intends to introduce soybeans as a major crop with concurrent introduction of complementary inoculants.

Following Davis's visit, a delegation of officials from the Agricultural Corporation and the Ministry of Agriculture traveled to the U.S. visiting the NifTAL Project and the University of Hawaii enroute from the mainland USA.

(From left) Dr. Tun Saing, Assistant Director of ARI (Agricultural Research Institute), Dr. R. J. Davis (NifTAL), and U Mya Maung, Director of MOPP (Maize & Oilseed Production Project), are photographed during the *Rhizobium* Production & Application Workshop in Yezin, Burma. The Workshop was attended by 75 participants consisting of researchers who will be extending *Rhizobium* research and extension workers who will carry information on the need for and proper use of inoculants to districts throughout Burma.

Contact may be made with U Mya Maung, Director, MOPP, Agriculture Cooperation, Rangoon, Burma.

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52

DIRECTIONS IN COMMUNICATION

Communication of scientific information in the area of BNF is an extremely important process if we are to bring about change. There are three major ideas which underlie the communication process and are vital to improving our communication efforts. These three ideas deal with influence, meaning, and subjectivity, and BNF communicators need to be aware of each of them.

The first idea is that "the purpose of communication is to influence people." Needs and problems exist and BNF research groups have devised programs to identify and solve special concerns. Communication plays a part in these programs and is used to influence special audiences which are somehow involved with a particular program.

It needs to be noted that communication is more than simply concocting a message. The message is a means of influencing a particular outcome, and is not an end in itself. Communication encompasses the effect of that message—its influence in bringing about change.

A second idea guiding communication attempts is that "meanings are in people, not in words or visuals." While dictionaries provide definitions and scientists generally agree upon specific meanings, in actuality each member of the audience supplies his own individual interpretation for each word or visual. Meanings, therefore, will vary widely from one person to another.

In planning communication efforts, BNF communicators should try to predict the meaning an audience will find in certain messages. Communicators will then choose words and visuals that are most likely to influence particular audiences to support the responses the BNF program seeks.

The third communication idea is that "reality is subjective; people create their own realities." Many scientists often assume that what exists for them is interpreted in precisely the same way by the audience. Actually, audiences tend to distort, ignore, or avoid messages that do not conform to their own points of view, even in the scientific community. And since meanings are in people and not in words or visuals, it follows that each person's reality is subjective. For BNF programs, communicators must try to see the world through the intellectual, emotional, and physical "eyes" of the audience.

As professionals, we must constantly keep in mind these three ideas about communication: 1) we communicate to influence people, 2) meanings are in people, not words or visuals, and 3) reality is subjective, people create their own realities. With this background and the emphasis on the audience analysis, BNF communication efforts are more likely to have the desired impact—to bring about change.

– James W. King

Starter N

Ruben Campo of EMBRAPA, the Brazilian agricultural research organization, questions the value of "starter N" for soybean. This practice involves application of 10-15 kg/ha of N at planting and is based on some research reports that low doses of "starter" result in greater total nitrogen fixation and crop yield. But yield is not increased from starter N use with soybeans in Brazil, reports Campo, based on the findings of Dr. J. R. Jardim Freire of UFRGS at Porto Alegre. So, in effect, we would be throwing away 85,000 tons of N or $36 million (U.S.) worth of fertilizer if starter N were used on the entire Brazilian soybean acreage.

NifTAL Collaborative Workshop Held

A group of graduate students and research scientists listen as Dr. Jake Halliday describes field experiments at one of the NifTAL field sites. The group gathered for the Collaborative Workshop on Future Roles and Research with NifTAL on 24 and 25 June. The participants were graduate students working on NifTAL's subcontract with Dr. D. Munns at UC/Davis and NifTAL graduate students who work with Dr. Ben Bohlool and Dr. Mituku Habte of the University of Hawaii. The purpose of the meeting was to share research goals and catalyze and gain the enchancement of working as a team.

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53

New Genus for Slow Growers?

In a recent article, D. C. Jordan suggests that the slow-growing, non-acid-producing root nodule bacteria of leguminous plants be placed in a new genus, separated from the fast-growing, acid-producing strains. Jordan argues that the division is necessary based on numerical taxonomy, deoxyribonucleic acid base ratio determinations, nucleic acid hybridization, ribosomal ribonucleic acid cistron similarities, serology, composition of extracellular gum, carbohydrate utilization and metabolism, bacteriophage and antibiotic susceptibilities, protein composition, and types of intracellular inclusion bodies in the bacteroid forms.

He suggests that the genus be named *Bradyrhizobium*, and that the type species is *B. japonicum* (Buchanan 1980) comb. nov. (basonym: *Rhizobium japonicum* Buchanan 1980), and the type strain is ATCC 10324. Jordan's article appeared in the International Journal of Systematic Bacteriology, Jan. 1982, Vol. 32, No. 1, p. 136-139, and he can be reached at the Microbiology Department, College of Biological Science, University of Guelph, Guelph, Ontario, Canada, N1G 2W1.

The proposed change would be included in the new edition of *Bergey's Manual of Determative Bacteriology* and would amend the work of D. C. Jordan and O. N. Allen on Rhizobiaceae. The proposed reclassification is presented below.

Division I The Bacteria

Part I Gram negative, aerobic rods and cocci

Family III *Rhizobiaceae*

Genus I *Rhizobium* – fast growers

Genus II *Bradyrhizobium* – slow growers

Genus III *Agrobacterium*

Genus IV *Phyllobacterium* – leaf nodule bacteria

Within genera I and II, the following is proposed:

Genus I

Rhizobium leguminosarum – *type species*

Rhizobium leguminosarum – biovar trifolii

Rhizobium leguminosarum – biovar phaseoli

Rhizobium leguminosarum – biovar viceae

Rhizobium meliloti

Rhizobium loti – fast growing cowpea type

Genus II

Bradyrhizobium japonicum – soybean and slow-growing cowpea rhizobia

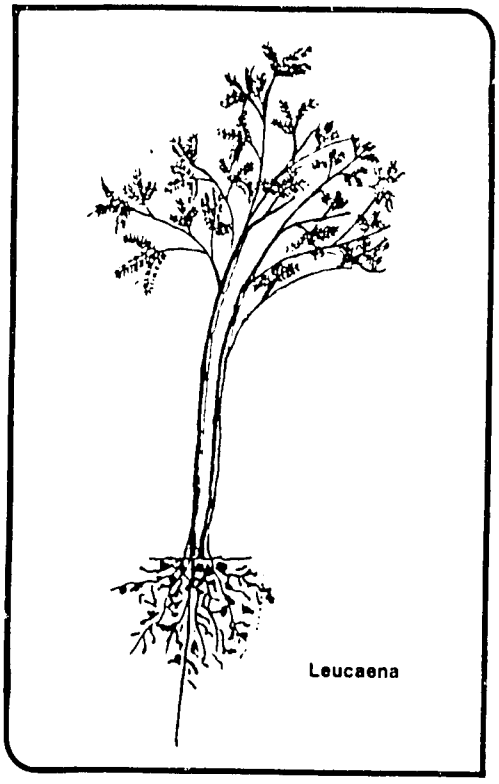
B. japonicum (ATCC strain?) is the type species

NFTA Trial Design Data

The Nitrogen Fixing Tree Association (NFTA) coordinates biomass productivity trials that evaluate outstanding nitrogen fixing trees of the tropics for growth and utility as fuelwood, pulpwood, and forage.

The basic trial is an augmented block design of about ¼ ha in size, including ten or more NFT species. Primary data are on heights and diameters on 6-month cycle.

The experimental design is planned as follows: 1) small plots (e.g., 42 trees with 20 internal data trees); 2) field size



– 0.2 ha including border; 3) augmented block with four (4) replicates of outstanding species and single (1) rep of other species or varieties; 4) population density of 10,000/ha or 5,000/ha if preferred; and 5) data – heights and diameters on 6-month cycle. NFTA will assist in computerization and analysis data.

Species entered in the trials include: A) replicated – *Acacia auriculiformis*, *Acacia mangium*, *Calliandra calothyrsus*, *Gliricidia sepium*, *Leucaena diversifolia*, *Leucaena leucocephala*, and *Sesbania grandiflora* (plus others as desired); B) unreplicated – *Acacia mearnsii*, *Albizia falcataria*, *Albizia procera*, *Cassia siamea*, *Casuarina equisitifolia*, *Dalbergia sissoo*, *Enterolobium cyclocarpum*, *Eucalptus* ssp. ("Check"), *Mimosa scabrella*, and *Samanea saman* (plus others as desired). For further information and seeds, write: NFTA, Box 680, Waimanalo, Hawaii 96795, USA.

McNeil Returns to Australia

Dr. David McNeil, agronomist and Assistant Project Director of the NifTAL Project, left NifTAL for Canberra, Australia, in early July. He assumes there duties as a research fellow in the Botany Department of Australia National University. He will be working on an Agrogenetics-sponsored research project. His responsibility will be on the plant branch of a three-pronged (plant, microbiological, and molecular genetic) project aimed at elucidating the genetics of *Rhizobium* N-Fixation in legumes and non-legumes. Specifically, he will be researching the genetics behind the infection process and attempting to identify things which inhibit development of effective symbioses.

NifTAL is currently recruiting for three staff positions that require individuals with experience in biological nitrogen fixation by tropical legumes. Candidates with either a soils, agronomic or microbiological background can obtain details from Dr. Jake Halliday, NifTAL Project, P. O. Box 0, Paia, Maui, HI 96779, USA.

Bean Trials Continued from page 2

used per acre. Basically, it was found that in certain hot, arid regions, a double or triple rate of granular is beneficial while in more moderate soils, the normal 6 oz. per 1,000 lineal feet of row was sufficient for maximum yield.

Dr. Bill Lindemann of New Mexico State University has set out plots near Demming, New Mexico, to determine what rate and form of inoculant is most beneficial, plus what level of nitrogen fertilizer is optimum. He recently completed one year of a multi-year study. All inoculant treatments increased yields but not statistically significantly at the 5% level. Lindemann is continuing his work which is expected to generate information on the inoculant, soil, and fertilization variables which determine maximum yield. University personnel in North Dakota, Wyoming, and Colorado are also setting out trials in 1982.

These results from dry bean trials emphasize that inoculants are providing the benefits researchers have always said are most important; namely, that *Rhizobium* bacteria can provide useable nitrogen to a legume and save the farmer fertilizer money. In short, the farmer can use relatively inexpensive bacteria rather than high levels of nitrogen fertilizer to obtain maximum yields with legumes.

54

BNF & GENETICS

Continued from page 1

by complex formation (besides the high rate of respiration) with a nonheme iron protein from *Azotobacter* together with the *nif* genes may help protect nitrogenase from O_2 inactivation. d) the chloroplast transcription translation machinery is prokaryotic and as such can be used for expression of *nif* genes also. However, the genetic controls operating on *nif* genes should be removed before transferring the DNA to the plant: e) an efficient NH_4^+ –assimilation system is already present in the chloroplast for NO_3^- –assimilation and can be used for assimilating the NH_4^+ produced from N_2.

The chloroplast is probably the organelle of choice for *nif* genes. Getting the *nif* genes or gene products into the chloroplast may be difficult in itself.

Although a modified Ti-plasmid vector system can be used to introduce DNA into plants, no vector or genetic transfer system to introduce a foreign gene or gene product into the chloroplast is known at the present time. A greater problem still remains. Virtually nothing is known about how nitrogen-fixing cells regulate the synthesis and activity of nitrogenase (in the relatively simple *K. pneumoniae* or in any other organism). Without this knowledge an active nitrogen-fixing plant probably cannot be made. In our judgement, many years' work are likely to be required before the obstacles can be overcome. It is most important to study them, but we believe it is prudent at this time to continue developing naturally occurring plant bacterial associations. A thorough understanding of the energetics and regulations of these systems will provide new concepts for developing agriculturally useful nitrogen-fixing cereal plants in the future. We believe, however, that this future is considerably more distant than many people have been led to think. Our attitudes are similar to that expressed recently by Dr. Nina Fedoroff, as quoted in the Jan-Feb., 1982 issue of *Genetic Engineering News*. In noting her belief that agricultural genetic engineering has been "oversold," she made this remark: "Genetic engineering works with single genes, but plants are good or bad because of many genes, so improving a plant is not trivial. You can't clone genes you know nothing about."

U.S. Guar Acreage Growing

The guar bean *(Cyamopsis tetragonoloba)* is a low-input, soil-building crop that a number of U.S. farmers are beginning to use in crop rotation, reported THE FURROW magazine recently. A drought-tolerant, rank-growing legume that is produced primarily as a seed crop in the U.S., guar seeds yield a gum used chiefly as a food thickening agent and as a sizing material for paper and textiles.

Currently, prices are rising and demand for guar is outrunning the supply. In 1981, one seed company contracted guar for 20 cents/lb or $400/ton. Yields have been running from 1,200 to 2,000 lbs/acre making guar profitable because it only costs $7-$8/acre to plant and other inputs are mostly limited to herbicides and water. (One grower reported irrigating a guar crop four times with level basin flooding. Also, guar crops are reported to produce seed with less than 20 inches of water.)

Guar is sometimes double-cropped behind wheat with cotton being planted the following year since guar seems to reduce cotton root rot. Growers in the U.S. usually plant guar between mid-June and mid-July, generally planting 40,000 to 50,000 seeds per acre, and trying everything from solid stands to 40-inch rows. Many farmers wait for a frost to dessicate the crop naturally before harvesting. (From FURROW Magazine)

C. tetragonoloba

Limiting Factors

The Nitrogen Fixation Limiting Factors Project has demonstrated that a research award of as little as $75,000 can produce success in increasing the capacity for BNF in beans *(Phaseolus vulgaris)*. Through a research agreement, scientists at University of Wisconsin found that the potential for higher levels of BNF was heritable. Using a modified backcross system, lines were selected for high fixation and yield. On low nitrogen fields, the experimental high-fixing lines yielded as much as if approximately 40 kg N as fertilizer were added per hectare. Even with approximately 40 kg N/ha, the standard variety "Sanilac" only yielded about half as well. Under a new cooperative project with Escuela Agricola Panamericana in Honduras, these lines will be further tested and improved.

55

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Contents

1 To Study or To Construct
2 Viable Diluted Strains
2 U.S. Dry Bean Trials
3 Meeting Notes
3 Announcements
4 Burmese Inoculant Production
5 Directions In Communication
7 Guar Acreage Growing
8 Short Takes

SHORT TAKES

Dr. Erlinda Paterno, Institute of Plant Breeding, University of the Philippines at Los Banos. **Mrs. Ampan Bhromsiri**, Faculty of Agriculture, Chiang Mai University, Thailand, and **Dr. Hussein Maksoud,** Egyptian Agricultural Research Center, Giza, are now at NifTAL working as visiting scientists. Paterno will be testing the feasibility of using diluted broth cultures of *Rhizobium* for inoculant production. Peat autoclaved in polypropylene bags will be used along with five tropical rhizobia.

Bhromsiri's main effort will be directed toward the testing of Chiang Mai peat for its suitability as an inoculum carrier. She will also be studying serological and antiserum identification techniques.

Maksoud will be studying the competition of *Leucaena* rhizobia (TAL 1145, TAL 582, and TAL 800) for nodulation sites on three/four species from the same cross inoculation group as *Leucaena*.

Amare Abebe, Agricultural Research Institute, Nazareth, Ethiopia, and **Mursidi Sediyarso,** Central for Soil Research, Bogor, Indonesia, have recently completed training in legume/*Rhizobium* technology. Both participated in laboratory and field work, with emphasis on the legumes chickpea, soybean, and peanut.

Dr. R. J. Summerfield of the Plant Environment Laboratory of the University of Reading succeeds **Professor J. P. Hudson** as editor of EXPERIMENTAL AGRICULTURE. Summerfield has conducted extensive collaborative research with IITA, ICRISAT, and ICARDA on symbiotic dinitrogen fixation. EXPERIMENTAL AGRICULTURE publishes research carried out in the warmer regions of the world.

Dr. Joe C. Burton, inoculant production specialist at the NifTAL Project, has been awarded the 1982 Agronomic Service Award by the American Society of Agronomy. He has spent many years finding more efficient strains of *Rhizobium* and developing better methods of utilizing these bacteria in food production.

The Egyptian Major Cereals Improvement Program, a collaborative effort between New Mexico State University and the **Egyptian Agricultural Research Center** at Cairo, has hired **Dr. Ken Cassman** as a grain legume agronomist. Cassman will be studying soybeans, lentils, and faba beans with a goal toward identifying factors which limit higher yields and N fixation.

An experiment using drought-resistant legumes has been undertaken by **Dr. C. Auer** of the Centre d'Action Regional pour Develoment Rural de la Province du Zou in **Benin.** The experiment is aimed toward improvement of natural pastures during the dry season. He expects to make gains in answering questions relating to viability and improved production under traditional conditions.

Dr. Peter Graham, long time leader of the Bean Program at CIAT, has been appointed to a position at the Department of Soil Science at the University of Minnesota.

Current **BNF activities in Pakistan** have been noted by Dr. Kauser A. Malik. He reports that the main legume crops are chickpea—more than half the edible leguminous seed production— and mungbean.

Currently there is no inoculant industry, although inoculant research is underway. Research interests center on ^{15}N techniques, effect of K on BNF, and associative N fixation. Malik is at the Nuclear Institute for Agriculture and Biology, Jhang Road, P. O. Box No. 128, Faisalabad, Pakistan.

56

BIOLOGICAL NITROGEN FIXATION BULLETIN

Volume III, Number 3

BNF Technology Course Held in Thailand

One approach to tackling manpower shortages is training. In its continuing commitment to providing the developing world with workers trained in the skills of legume/Rhizobium technology, NifTAL recently organized its 4th regional training course.

The NifTAL Project in conjunction with the Thailand Department of Agriculture held a six-week training course in legume/*Rhizobium* technology, 1 November – 10 December, 1982, in Bangkok. Seventeen participants from eight Southeast Asian countries were trained in technical skills for using rhizobia in research, development, and production programs involving legumes. The course was practical in nature and emphasized not only the microbiological skills for handling rhizobia, but all those laboratory, greenhouse, and field procedures for testing, producing, and using rhizobia in tropical agriculture.

Participants included Dilwara Begum and A.R.M. Solaiman, Bangladesh; Nwe Nwe Aung and Khin San Wai, Burma; Nurhayati Purwantari, Indonesia; Muhammad Akmal Siddiqi, Pakistan; Nora T. Armones, Crisanto Lopez, and Visitacion Z. Perdido, Philippines; Wasantha Lakshmi Ratnayake, Sri Lanka; Kietsurak Bhokasawat, Chutip Chanasent, Arawan Chutsirung, Wichian Magtoon, Suganya Soontaros, and Banyong Toomsan, Thailand, and Ngoc Quyen Nguyen, Vietnam.

Sponsors of participants included USAID, the Thailand Department of Agriculture, The University of New England, Armidale, Australia, and The American Committee for Scientific Cooperation with Vietnam.

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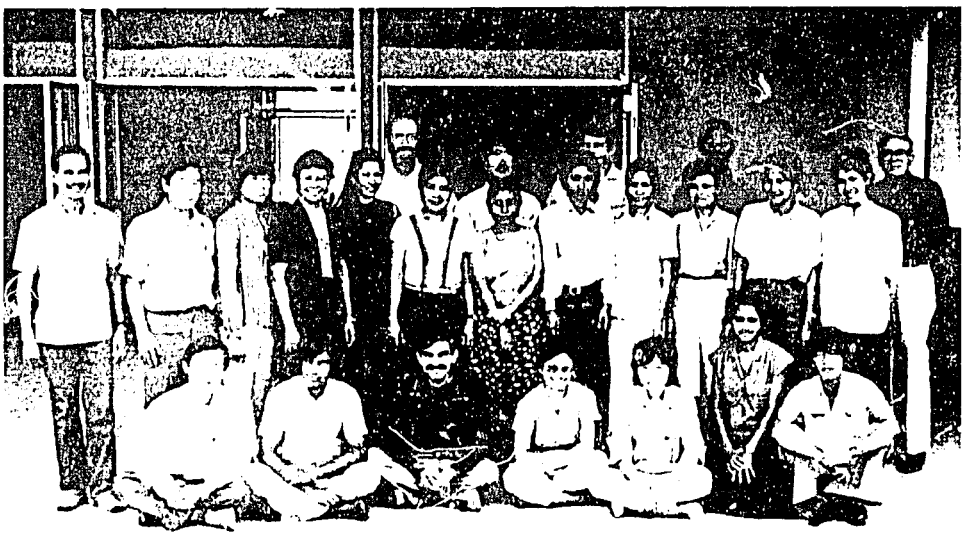

Participants and instructors pause for a photograph.

Bhokasawat injecting diluted culture into a growth flask.

Lopez checks growth of soybeans in Leonard jars.

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57

Strain Specific Nitrate Effects

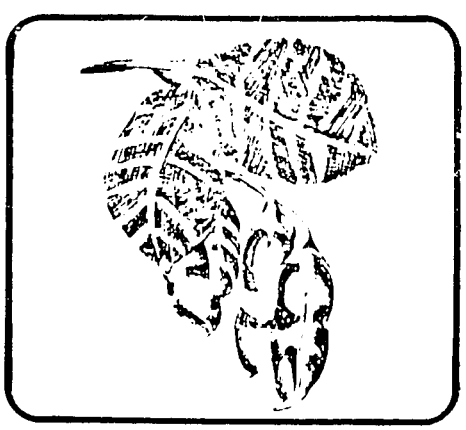
Dr. David McNeil, recently of NifTAL and now with Australia National University, investigated differences in sensitivity to nitrate of soybean (*Glycine max* cv. Davis) symbioses arising from 16 different *Rhizobium japonicum* strains.

He found that when nitrate (20mM) was added to established symbioses there were no significant differences in the degree of inhibition of acetylene reduction for all 16 strains. When nitrate was present during establishment of nodules, high levels of nitrate (10mM) were equally inhibitory on all symbioses whereas specific strain effects appeared at low (0.5mM) to medium (2.0mM) levels of nitrate. At 1.5mM nitrate in solution culture, the days to emergence of nodules varied from less than 10 (CB:1809, Nif61 A118) to more than 126 (11 of 16 strains).

In a pot trial maintained at the low nitrate level (0.5mM), symbioses arising from CB: 1809 increased total nodule mass by 30% relative to nitrate free controls. CB: 1809 maintained total nodule mass in the presence of 2.0mM nitrate. With the remaining 6 strains tested, total nodule mass decreased to below the levels of the nitrate free controls.

In a separate pot trial, CB: 1809 increased its competitive ability relative to USDA: 110 when nitrate was added. CB: 1809 occupied—if no nitrate was added—0.97 times as many nodules as USDA: 110. When 10mM nitrate was added, CB: 1809 occupied 1.75 times as many nodules as USDA: 110.

McNeil found that attempts to select 'nitrogen adapted substrains' of *R. japonicum* through sequential isolation and infection of plants grown on nitrate were not successful. This report was reported in *Applied and Environmental Microbiology*. For reprints write D. L. McNeil, NifTAL Project and MIRCEN, P. O. Box 0, Paia, Maui, HI, 96779.



Jones Research Seeks Solution

Mimosine Toxicity Problem

Recently, NifTAL's Maui Headquarters has been the host laboratory for some very interesting research being done by Dr. Ray Jones. Jones, Officer-in-Charge, Division of Tropical Crops and Pastures, and Senior Principal Research Scientist, Pasture Agronomy and Ecology – Tropical North Eastern Australia, Davies Laboratory, Townsville, Queensland, Australia, has been continuing his work aimed toward isolating an organism in the rumen (stomach) fluid of Hawaiian goats which will alleviate the bad effects that a diet largely composed of Leucaena has on livestock in Australia.

Jones in the laboratory transferring cultures.

Goats in Hawaii are often feed 100% Leucaena with no ill effects. In Australia, however, for goats, as well as cows and sheep, eating large quantities of Leucaena can result in serious physical problems.

These physical problems are caused by the toxic amino acid mimosine. This amino acid occurs in highest concentration in actively growing tissues. The shoot tips, for example, contain about 10%, young leaves 4%, and young pods 4.5% mimosine. This toxic amino acid stops growth of the hair follicle resulting in hair loss from the tail and other parts of the body.

In cattle, rumen microorganisms capable of breaking down mimosine are usually present and, provided cattle are gradually introduced to Leucaena, these organisms will increase and effectively prevent problems arising from direct mimosine toxicity. However, the breakdown product of mimosine in the rumen (di-hydroxy pyridone) known as DHP is also toxic to cattle.

The effect of mimosine is apparent within a few weeks whereas the effect of DHP is delayed for 3-6 months. DHP is a goitrogen which depresses the production of the thyroid gland leading to depressed appetite, excessive salivation, listlessness, hair and weight loss. Thyroids may enlarge to ten times their normal size. Effects of eating more than a 30% diet of Leucaena can even result in death for the animals.

Jones has been working toward a solution to the problem for several years. He conducted experiments in Indonesia using Hawaiian goat rumen specimens. Experimental results indicted that it is possible to reverse the effects of the toxicity when the correct microorganisms are introduced into the rumen fluid of affected goats. Dramatic results were achieved as weakened goats with poor appetites were cured by the introduction of this microorganism or microorganisms which apparently degraded the DHP which was previously broken down from the mimosine.

While on Maui, Jones removed a specimen of rumen fluid from a Maui goat and painstakingly attempted to isolate one specific organism to take back to Australia. He worked under the constraint of not being able to expose his cultures to oxygen. Transferring fluid from a flask to tubes in order to obtain a subculture of the organisms had to be done using carbon dioxide gas and a careful suction technique.

To meet strict Australian quarantine restrictions, Jones will immediately regrow the imported cultures into a high dilution and destroy the slants imported from Hawaii. This work will be important to the development of Leucaena as a forage crop worldwide.

■ ■ ■

Reforestation Project

Howard Heiner and others with Interchurch Response are engaged in an integrated program of agriculture and forestry to reduce the amount of desertification currently taking place in Somalia. Over 140,000 refugees have been placed on a restricted land base causing extreme firewood and grazing pressures.

Leucaena leucocephala and many other tree species are being planted to attack this serious problem. Write to Heiner care of Ms. Elizabeth Enloe, C/O Lutheran World Relief, 360 Park Ave. S., NY NY 10010.

58

MEETING NOTES

ALAR Meeting Held

The 1982 meeting of the Asociacion Latinoamericana de Rhizobium was held in Lima, Peru in late October. There were 60 presentations on screening, physiology, biochemistry, agronomy, and ecology of *Rhizobium* and production, use, and management of inoculants. Representatives of most Latin American countries attended the meeting.

According to Evangelina Cuautle-Fabian, the information presented at the round table discussion was very useful to students and researchers. One participant pointed out the necessity of conducting round tables and workshop-type meetings to better communicate experiences and experimental results of individual researchers.

Information presented stressed the necessity to give priority to research according to the necessities of developing countries, extensions services to farmers, solving problems related to socio-economic levels, and working in an interdisciplinary forum rather than in isolated research situations.

The need to determine the more productive legumes in each region and introduce new species was addressed by one speaker. He suggested that to assure that symbiotic activity was exploited to the optimum, there is a need to screen strains and utilize controls in inoculation procedures.

Also stressed was a need for coordination in research and establishment of norms in quality control and production of inoculants.

The next ALAR meeting will be held in 1984 in Brazil.

■ ■ ■

Peanut Production Publication Available

World Peanut Production, Utilization and Research, edited by D. G. Cummins and C. R. Jackson, is now available from the Peanut CRSP, University of Georgia, Georgia Experiment Station, Experiment, Georgia 30212, U.S.A. as publication No. 16.

Supported by the USAID Peanut Collaborative Research Support Program, this document reviews peanut research and production worldwide and lists publications and institutions with an emphasis on peanuts and provides specific country information.

N-Fixing Tree Workshop

A conference on "Acquisition and Management of Germplasm of Nitrogen-fixing Trees with a potential role in development" was held during September 1982, at the Rockefeller Foundation's Bellagio Study and Conference Center, Lake Como, Italy.

The workshop was in furtherance of a continuing goal, namely, "to provide for improved human welfare in the tropics and subtropics by assuring the long-term availability of comprehensive stocks of germplasm of nitrogen-fixing trees."

Two sets of tasks faced the expert group. The first was development of a set of recommendations for both policy makers and the scientific community with respect to nitrogen-fixing trees. The second was the assembly of a series of resource documents to be maintained current and distributed annually as a service of the Nitrogen Fixing Tree Association.

The expert group offered recommendations in the following areas: the need for future germplasm collecting; the geographic areas and species of

Continued on Page 7

2nd N_2 Symposium

The Second International Symposium on N_2 Fixation with Non-Legumes was held at Banff, Alberta, Canada in September. Approximately 150 registrants from 20 countries attended.

Technical presentations were made on microbiology, site, and process of the association; genetics of the bacterium and the host plant; techniques of measuring N_2 fixation, and forestry.

Some highlights of the presentations are below:

- R. Boddy reported good responses to inoculation by grasses have been obtained in Brazil. However, an emphasis on the need for soil nitrogen balance experiments, importance of methods, and better quantification of N_2 Fixation are needed. Also, more experimentation is necessary in new areas where soils are not likely to bear significant numbers of N_2 fixing bacteria. He also suggested that more information is needed on how infection of roots occurs, where the organisms are located, and what they do other than fix N_2.
- P. Dart reported that the low content of N in Indian soils (0.01% N in many areas) and yet, these soils produce

Continued on Page 7

ANNOUNCEMENTS

Nitrogen Cycling

Nitrogen Cycling in South-East Asian Wet Monsoonal Ecosystems, edited by R. Wetselaar, J. R. Simpson, and T. Rosswall, has been published by the Australian Academy of Science as part of the SCOPE/UNEP Workshop held at Chiang Mai, Thailand, in 1979.

The major part of the book is devoted to papers regarding rice and nitrogen cycling. Other topics include plantation systems, natural communities, environmental problems, modelling and methodology, and rainwater.

Of interest to BNF researchers is the section on "Legumes and *Casuarina*" with papers on *Neptunia oleracea*, *Centrosema pubescens*, and *Casuarina*.

For further information, write to The Australian Academy of Science, P. O. Box 783, Canberra City 2601, Australia.

Advances in Agricultural Microbiology

N. S. SubbaRao has edited "Advances in Agricultural Microbiology." The book is in three sections: the role of microorganisms in the mobilization of nitrogen and phosphorous to plant growth, management of pathogens, pests and weeds through microorganisms, and new strategies in bioconversion.

Articles on "Microbial Genetics and BNF" by Beringer, "Physiology and Biochemistry of BNF in Legumes" by Atkins and Rainbird, and "N Fixation in Nodulated Plants other than Legumes" by Becking will be of interest to BNF researchers.

The book is available from Oxford and IBH Publishing Co., 66 Janpath, New Delhi 110 001, India.

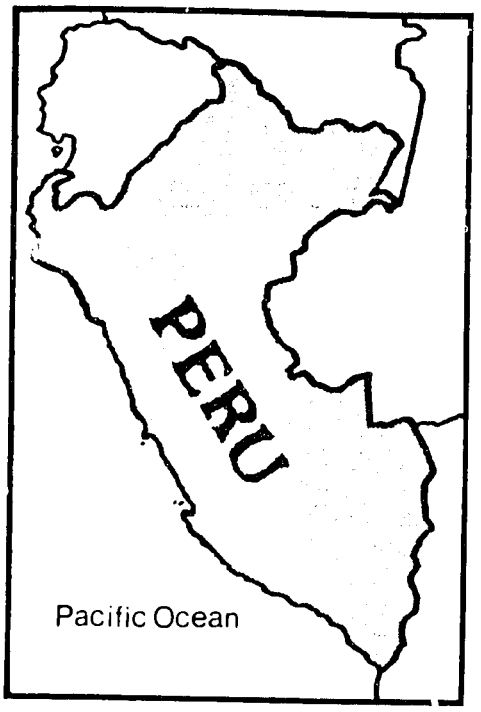
59

Legume Research in Peru

Various development projects in range and pasture legumes are being undertaken at INIPA in the Small Ruminant CRSP. Research scientist Al Schlundt reports that alfalfa and white clover have been planted and have proved to be highly palatable to sheep and other ruminants.

■ ■

A New Zealand research team has completed a project using alfalfa and white clover and rye grass associations in intensive pasture establishment. The pastures, which proved to be very productive, were grazed by sheep, alpaka and cattle. In another project in the northern desert region, growth of Leucaena was examined for its digestability compared with other legumes.



including another leguminous tree, *Prosopis spp.*

■ ■

Near Arequipa there is an irrigation research project being carried out by Dutch and Israeli research teams. The research centers on growing alfalfa as green chop dairy cattle feed. In Lima, alfalfa is raised and used as fresh feed for guinea pigs that are raised in the home for human consumption.

■ ■

Carlos Valverdes, Director of Planting, Instituto Nacional de Investigacion y Promacion Agropecuaria (INIPA), is interested in investigating the response of peanuts, rice and cowpea to acid soils. He is also interested in developing cooperative training activities and facilities at Yurimaguas.

He reports that management of acid soils in the tropics will be studied at Yurimaguas, a low ph. ultisol site, by the Soil Management CRSP in cooperation with North Carolina University.

Urea Effects on Leucaena

While conducting an INLIT (International Legume Inoculation Trial) trial on *Leucaena leucocephala* using TAL582, Eduardo Schroder of the University of Puerto Rico discovered that urea fertilization just prior to planting had a serious effect on seed germination. Use of 100 kg/ha of Urea significantly depressed seed germination and may be related to excessive NH_3 upon urea hydrolysis.

Other results of the trial indicated that TAL582 is very competitive. However, no increase in forage production was noted due to inoculation.

■ ■ ■

Continued from Page 1

Dr. Padmanabhan Somasegaran was the course director and Mr. Heinz Hoben was training director. Mrs. Yenchai Vasuvat, Director of the Thai Dept. of Agriculture's Rhizobium and Inoculant Production Project, and Dr. Nantakorn Boonkerd, Soil Microbiologist, made the training arrangements in Thailand and provided logistical support during the course. Visitors and guest lecturers included Dr. Joe Burton, Inoculation Production Specialist at NifTAL, Dr. John Thompson, Chief Pulse Microbiologist at ICRISAT, Dr. Doug Gross, Professor, Crop Science, North Carolina State University, Dr. Lloyd Frederick, Project Manager, USAID, and Dr. Benjavan Rerkasem, Lecturer, Faculty of Agriculture, Chiang Mai University.

Waste Material as Rhizobial Carriers

The Uttra Pradash, National Science Research Center Culture Collection Group in India has been studying the suitability of bagasse, filter mud, and sawdust in combination with soil as rhizobial carriers using two strains of *Rhizobium* at 26-28 C. The growth rate of the two organisms in each carrier is affected by the nature of the carrier, the time of storage, and specific physical factors such as moisture loss, temperature, and relative humidity. Filter mud in combination with soil supported higher numbers of viable rhizobia than the other tested carriers after the six months' period of storage. The ability of the organisms to fix molecular nitrogen did not vary significantly when plant inoculation tests were conducted.

■ ■ ■

New NifTAL Staff

Two soil scientists have joined the NifTAL staff. They are Doug Beck and Paul Singleton. Beck, who assumes the duties of Assistant Soil Scientist, received his Ph.D. in Soil Science from University of California at Davis. He studied with Dr. Don Munns. Singleton, Assistant Agronomist with NifTAL, received his Ph.D. in agronomy and soil science from the University of Hawaii where he worked with Dr. Ben Bohlool.

Sri Lankans Produce Inoculant

In-country prepared inoculant will be available for Sri Lankan farmers for the 1983-84 maha season reports the September 1982 issue of Soyanews.

This inoculant production is the result of research which began in 1980 aimed toward relieving dependency on foreign producers. In 1980 alone, 5040 eight ounce packets of inoculants were ordered for use by Sri Lankan farmers. Former NifTAL trainee Thiru Kumuran is a key researcher in the project.

In strain selection research, it was found that *Rhizobium* strains were not widely distributed in the country. Only Maturata showed some evidence of indigenous strains, but whether these are truly indigenous or not is to be determined by future tests. Not all strains were found to be effective nitrogen fixers. The effective strains were selected after pot and field trials. Farmers who were given some of the local *Rhizobium japonicum* strains for testing were delighted with the results —an increase in yields.

A combination of filter mud and local peat are used as the carrier for the *Rhizobium*. Powdered coconut shell was tried as a carrier and found to be toxic.

60

DIRECTIONS IN COMMUNICATION

Perhaps the real issue in the discussion of communication and scientific information is knowledge transfer and utilization. As scientists and communicators, we are just now beginning to admit to the integration of the sciences and to the interdependence that integration requires.

This concern for knowledge transfer and utilization of scientific information, especially BNF information, is mounting due to exacerbating world problems. It is of particular concern when 90% of the world's scientific and technical research potential is currently concentrated in the industrialized countries. Transfering research results to areas of need and placing them in the hands of practitioners should be of highest priority; this offers a tremendous communication challenge.

Let us begin with a definition of scientific information from the communication perspective: scientific information is data that reduces uncertainty about science. Data—in whatever form it takes—helps us understand the world in a more predictable manner; when data reduces uncertainty, it becomes information.

By itself, scientific information serves only a few individuals, usually other scientists close to the research which generated the original data. At this point in its life, the scientific information is in a convenient form for other scientists; because of this, the information is timely and credible. In its raw state, however, the information is generally unmanageable. The numbers and results are not always in a convenient form for busy researchers to assimilate. Thus, the scientific publication and presentation process begins.

As the communication process moves from ideation to publication or presentation, the original scientific information changes form and at some point becomes accessible to large numbers of individuals, some of whom are print and electronic media journalists. And while professional scientific journals are refereed and articles reviewed by peers, the information developed by print and electronic media are not specifically subjected to scientific review. At any point when data is being changed into other forms, inaccuracies and lack of comprehensiveness may occur. These problems are not intentional or planned; they are simply intrinsic in the information transfer process.

In some instances, efforts to communicate scientific information have unwittingly contributed to a negative image of science and technology. Criticisms levied include poor readability, selectivity in inclusion of relevant studies, and failure to delineate and synthesize key issues.

When the process of scientific information transfer is flawed, problems have been found in communication from scientist to scientist and from scientists to general audiences. These communication problems are particularly evident when a "scientific incident" occurs. The Three Mile Island accident exemplifies this.

Acquisition and retention of information by an audience poses a challenge to those who seek to communicate information of a scientific nature. Previous "Directions in Communication" have discussed communication variables and audiences.

All these difficulties seem to intensify when an area of agrotechnology is discussed, and in particular, BNF agrotechnologies. Agrotechnologies based on BNF by legumes have several constraints which impact on the communication process. These constraints relate to the delivery and acceptability of the technology, and have been identified as cultural, political, socioeconomic, and, to a lesser extent, scientific in nature.

For example, two studies report that many farmers in the tropics do not know or understand that legumes fix nitrogen. Nevertheless, most tropical farming systems include legumes. Over time, farmers have recognized the value of legume cultivation as a component in their farming systems, and not from an intentional exploitation of BNF *per se*.

The complexity of these issues is such that the communication process may not reduce uncertainty among all target audiences, may result in confusion, and may create audience expectations which cannot be met. There is a need for communication programs based on systematic planning, and for inclusion of such programs in BNF projects.

– James W. King

Proceedings Now Available

Participants from 39 countries, representing most of the world's agricultural research institutions with an involvement in BNF met in March 1981 at CIAT to join forces in the NifTAL coordinated workshop focused on those factors that have limited the translation of improved understanding of BNF processes into viable agrotechnologies. *Biological Nitrogen Fixation Technology for Tropical Agriculture* contains 84 of the papers presented, covering all aspects of BNF technologies as they are applied to agricultural productivity.

Orders should be sent to Publications CIAT, Apartado Aereo 6713, Cali, Colombia, S.A. Cost is US $20 plus postage (Americas US $10.50 and others US $15.50). Participants will be receiving their complimentary copy from NifTAL in the near future.

■ ■ ■

The Mungbean

"*The mungbean (Vigna radiata* (L.) Wilczek), also called mung, moong, and greegram in India, and mungo in the Philippines, is a leguminous pulse crop, prized for its seeds, which are high in protein, easily digested, and consumed as food."

Thus begins *The Mungbean*, a recently published state of the arts report from the College of Agricultural Sciences, Department of Agronomy and Soils, University of Puerto Rico, written by J. F. Morton, R. E. Smith, and J. M. Poehlman. This bulletin describes the agronomic, economic, and nutritional aspects of the mungbean. A 39-page reference section will be particularly useful to BNF researchers.

Prepared as part of a program to study BNF for Food Production in the Tropics, the report was cosponsored by USAID. For further information, contact Dr. Eduardo C. Schroder, BNF Project Leader, Dept. of Ag and Soils, University of Puerto Rico, Mayaguez, Puerto Rico, 00708, USA.

61

FARMING SYSTEMS

Crop Rotation

Legumes provide nitrogen to following crops through crop rotation. Though nitrogen from legumes is cheaper than fertilizer nitrogen, the expense involved in growing legumes that are not to be used or sold may be restrictive.

Innovative ideas aimed at solving this problem are appearing. One method experimented with at the University of Georgia, that of planting Crimson and Arrowleaf clover in October and plowing it down the following April, contributed significant nitrogen to corn planted in May. Corn after these legumes did almost as well as corn after fallow with 90 lbs. of N fertilizer per acre.

Another possible method under discussion is planting vetch in maturing corn in August and September. The vetch produces a reasonable growth before frost and also contributes nitrogen for the next year's crop. Planting winter crops of legumes also provides good ground cover and prevents erosion.

The nitrogen contribution in a soybean-corn rotation reportedly varies from 40 to 120 lbs. of N per acre. Most is carried off the field in the soybean seed; however, since most of this nitrogen came from the air via BNF, the nitrogen in the soil, obtained from the continual decomposition of organic matter, remains available for next year's corn.

The possibilities for crop rotation and other farming systems to increase the value of BNF deserves continued research.

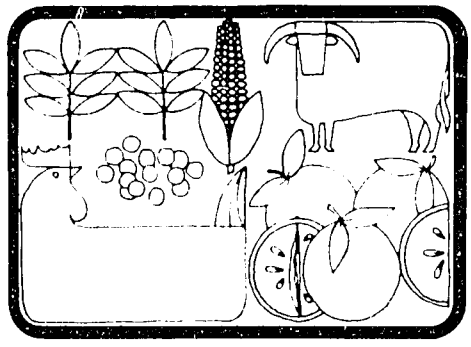
This report on the legume option from Tom Wacek.

Polyculture

In the tropics, polycultures have long been an important component of small-farm agriculture. Farmers with limited resources traditionally intercrop their land to minimize risks and provide a stable source of income and nutrition while maximizing economic and energy returns using primarily local technology.

Among potential advantages of intercropping systems are weed suppression through shading or natural plant toxins (allelopathy), reduction of insect damage by improving the balance of insect pests and associated natural enemies, better use of available soil nutrients, water conservation, erosion control, and greater productivity per unit of land. The study of such traditional systems has provided information useful as a basis for experimentation on sustainable cropping systems and less resource-intensive management technologies for developed countries.

Some California farmers use polycultural arrangements by interplanting beans, snow peas, and other legumes among established apple, walnut, or almond trees. Some use fava or bell beans as cover crops in apple orchards or produce crops in various mixes, such as pears and grapes, corn and squash, cotton and alfalfa.



In 1981, two researchers conducted experiments at three locations to compare polycultures of collards and green beans (Santa Cruz), brussels sprouts and fava beans (Albany), and corn and cowpeas (Davis) with corresponding monocultures in terms of incidence of pest insects, performance of natural control agents, weed competition, and yield potential. All treatments were replicated three times, and at each site monoculture and polyculture plots received the same fertilization and irrigation regimes.

They found that interplanting of nonhost crop plants or allowing limited weed population levels in polycultures significantly reduced numbers of plant-feeding insects *P. cruciferae* and *B. brassicae*.

Before polycultures can be more widely used, more research is needed to determine optimum crop combinations, management techniques in relation to planting densities, time of planting, varieties, weeding regimes, and various agronomic practices. Also, mechanisms of pest and weed regulation need to be defined more precisely. Legumes will play a major role in polycultures.

(Adapted from "Polyculture Croppin has Advantages," S.R. Gliessman, M.A. Altieri, California Agriculture, July, 1982.)

Agriculture: Toward 2000

By year 2000 a world population of more than 6 billion will require an agricultural output some 50 to 60% greater than 1980. Demand for food and agricultural products in developing countries will double. It is essential, within the next few years, to make many of the decisions which will determine the world food situation in 1990, or even in 2000.

So begins a new publication *Agriculture: Toward 2000* from FAO, available from FAO booksellers and agents around the world.

In this short, highly compact, and readable document, brimming with colorful charts presenting the complex of agricultural variables, FAO summarizes the agricultural trends and lists issues which may persist into the future. The book then develops alternatives for sustainable growth in agricultural production.

Social and institutional frameworks are described and the international dimensions of food production are discussed in that framework.

IITA Research Highlights

Highlights of IITA's (International Institute of Tropical Agriculture) 1981 research have been released in book form. Information on cowpeas, soybean, and high temperature tolerant Rhizobia for tropical inoculants will be of interest to BNF workers.

Research Highlights for 1981 can be obtained from IITA, Oyo Road, PMB 5320, Ibadan, Nigeria.

62

Continued from Page 3

NITROGEN FIXING TREE

higher priority; the standardization of collection site information and characterization procedures; quarantine concerns; an international network for the conduct of standard species trials and for information exchange; an institutional network for the conservation of NFT germplasm in perpetuity; strategies for future funding of research and development; and the need for training for the young researchers increasingly being attracted into this area.
area.

The resource documents compiled were as follows: Master list of Nitrogen-fixing trees; priority list of some 50 species; short lists for multiple uses in differing agroclimatic zones; list of existing arboreta and herbaria with coverage of nitrogen fixing trees; list of centers of NFT research worldwide; list of seed sources; lists of bibliographies and informational newsletters; list of *Rhizobium* research centers; list of seed sources.

A booklet presenting and substantiating the experts' recommendations is being published and will be available from Dr. Jake Halliday, NifTAL Project, P. O. Box 0, Paia, Maui, Hawaii 96779. The first edition of the computer-managed resource documents is in circulation and will be updated and redistributed annually.

The organizers were: Dr. James L. Brewbaker, Nitrogen-Fixing Tree Association, Dr. Jake Halliday, University of Hawaii NifTAL Project, and Dr. Judith M. Lyman, Rockefeller Foundation. Participants were senior international scientists from an array of disciplines involved with NFT development.

The workshop was sponsored by NifTAL, through a grant from the Donner Foundation and the National Academy of Sciences, and NFTA, through a grant from the Rockefeller Foundation.

– JH

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Continued from Page 3

Second N_2 Symposium

about 680 kg of millet per hectare. The soils provide about 30 kg N/ha and 50 kg N/ha must be supplied as mineral N. He pointed out the very large hectarage planted to cereals as compared to grain legumes and the impact modest N_2 fixation could have on world food supplies. Responses to inoculation in India have been small and inconsistent. Experiments are needed to select hosts and bacteria with good potential for fixing N_2.

– M. Lalonde reviewed progress of fixation in non-legumnious trees nodulated by the actinomycete, *Frankia* spp. Nodulation and nitrogen fixation has been confirmed for approximately 30 species. The endophyte has been isolated from many of these species and is being cultured successfully in the laboratory. Since the endophyte produces spores, the inoculants are long lived and easy to handle. Water suspensions of the spores remain viable for months and can withstand 40 degrees C. There are indications also that the *Frankia* can be combined with Mycorrhiza needed by many forest species for optimum nutrition and growth.

– Y. Okon reported that good responses have been obtained from inoculating C3 and C4 plants with *Azospirillum* sp. in Israel both in winter and in summer. Significant increases have been obtained in well-replicated field experiments. He pointed out the need for a method of measuring biomass of microorganisms colonizing the root. It was suggested that a measure of B-hydroxy butyrate which characterizes the microsymbiont might be a good approach.

– A. P. Ruschel noted that sugar cane does work symbiotically with soil microorganisms that fix N_2. Acetylene reduction activity occurs in the root tissue of sugar cane and doesn't occur in the surrounding soil. Experiments were suggested to determine the need for or response to inoculation.

– I. Watanabe offered conclusive evidence that both wetland and dryland rice obtain nitrogen from association with microorganisms. Blue-green algae can provide up to 50 kg N/ha per crop of rice. The Azolla-Anabaena association can also provide up to 50 kg N/ha per year. N Fixation is brought about by phototropic and chemotropic bacteria in wetland rice. About 80% of the heterotropic bacteria isolated from the rhizoplane of rice roots are able to fix N_2. Varieties of rice vary in their ability to effectively associate with microorganisms to fix N. Lengthy study is needed since it has taken 5 years to study 4 varieties out of the 40,000 varieties of rice available. A more rapid method of screening cultivars would be a big asset.

Proceedings of the symposium are to be published as a special volume of the Canadian Journal of Microbiology, which should be available in two or three months. The Third International Symposium will be held in 1984 in Finland.

– JB

SHORT TAKES

Dr. Luis Materon, recent graduate of Mississippi State University has accepted a post-doctoral fellowship at the Department of Soil and Crop Sciences, Texas A&M University.

Dr. David Hubbell of Florida State University has just completed an FAO consultancy in India working with the Department of Agricultural Microbiology, Tamil Nadu. His cooperator there was **Dr. D. Purushothaman**.

Dr. Maurice Fried is retiring from the International Atomic Energy Agency, FAO, in Vienna. He carried on N_2 work and developed the "A" value of calculating biological nitrogen fixation.

While **Tom Lumpkin** was in India working with FAO, he participated in discussions with Azolla researchers from Tamil Nadu and Pondicherry states of India. The discussion were held during the "Group Discussion on Azolla Research" held during November, 1982.

Dr. G. Oblisami reports that the workshop was organized by the Centre of Advanced Studies in Agricultural Microbiology, Coimbatore. The various problems and prospects of Azolla research in South India were discussed and future research areas planned.

The **10th North American Rhizobium Conference** will be held at the Boyce Thompson Institute, Ithaca, New York, in June 1983.

Also in June 1983, the **Canadian Society of Microbiology** will be meeting.

Dr. Anson Bertrand is the new Director, Office of Agriculture, USAID's Science and Technology Bureau. He comes to USAID from his position as Director, Science and Education, USDA.

The importance of reforestation was recently commemorated by a Nigerian stamp illustrating tree planting and proclaiming "Reafforestation concerns all."

Tom Lumpkin and **Don Plucknett's** book "Azolla as a Green Manure" Westview Press, is now available.

J. S. Hohenberg is now at IITA working on a grain legume project. She will be studying acid and aluminum tolerance of cowpeas.

63

Letter to The Editor

Since the BNF Bulletin gave prominence to the splinters among rhizobial taxonomists, it is, I believe, only fitting that those in favor of the status quo be given equal time. In fact, I believe it would have been better to have given equal time in one issue.

The suggestion for splitting the genus *Rhizobium* is not a new idea based on newly acquired knowledge (as the newsletter article seemed to imply—at least to me). The present ascendency of the idea is due to the chance occurrence of a splinter being on the committee for revising the "bible" of bacterial taxonomy. This is reinforced by the fact that most rhizobiologists are too busy with more important work to get deeply involved in the quibble.

One point that the splinters have been using for the past two decades is that the present classification (formation of nodules) is an operational one not solidly based on a phylogenetic basis. This is true but we do not have enought knowledge at this point to have a true phylogenetic characterisation of any of the Protista. In fact, people are still arguing over whether the Protista are really Protista and not plants. And, the basis for classifying them as plants rather than animals is the rather spurious one that they should be one or the other and they are obviously more like plants than animals!

The above quibbling ignores one very important point. Many, if not most, genera of bacteria are operational ones (fixes N, oxidizes N compounds, causes diseases of plants, causes severe diarrhoea and ferments lactose, etc). While none of these characteristics implies any phylogenetic relationship, they are extremely useful to the persons working with the bacteria concerned. And, in general, people are only working with these organisms because they are economically important. If bacteriology had started out as a basic science, we sould undoubtly have had by now a completely different set of systemics and applied workers would have had to devise a system of trivial names to designate their organisms.

Since bacteriology was from its inception an applied science it evolved a classification scheme based largely on operational genera, something that has served bacteriologists very well, although the general controversy has not been limited to the *Rhizobium* and rhizobiologists. In fact, hardly any major group of bacteria has escaped the controversy generated by the presence of genera defined operationally, rather than on supposedly more fundamental factors which imply a true phylogenetic relationship.

Despite the controversy, most bacteriologists continue to go about their work in a professional manner. They can tell a bacterium when they encounter one. What's more, they can recognize, by direct or indirect means, their own favorite organisms, and are able to make them do what people want them to do, or the reverse in the case of deleterious organisms.

Respectfully submitted,
Robert J. Davis

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November, 1982

Staff: Dr. James W. King
Princess Ferguson
Carla Valarik

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64

BIOLOGICAL NITROGEN FIXATION BULLETIN

Volume IV, Number 1

NAS Grants Awarded

TITLE	COUNTRY	PRINCIPAL INVESTIGATOR
Effects of Environmental Factors on N-Fixation	Kenya	S. O. Keya
Associative BNF in Grasses Growing in Saline Environments	Pakistan	K. A. Malik
Interactions in Legume-Non-legume Intercropping Systems	Thailand	B. Rerkasem
Quantification and Mechanisms of Associative N-Fixation in Tropical Gramineae	Brazil	J. Dobereiner
Evaluation and Testing of Fast-Growing, Nitrogen-Fixing Tree (FGNFT) Species for Semi-Arid Regions	Chile	E. M. Elena Torres
Technical/Scientific Back-up	Kenya	P. A. Huxley
Selection and Testing of FGNFTs for Use in Farm Woodlots and Agroforestry Combinations	Kenya	F. Owino
Native FGNFTs in Upland and Lowland Sites as a Source of Fodder, Fuelwood and Soil Enrichment	Mexico	E. Pardo Tejeda
N Fixation and Multiple Uses of *Albizzia falcataria*, *Gliricidia sepium*, and *Sesbania grandiflora*	Philippines	R. G. Escalada
N-Fixation Potential of Some Woody Chilean Plant Species	Chile	O. Balboa
Determination of Best Species, Provenances Rhizobia, Mycorrhiza in the Congolese Savannahs	People's Republic of the Congo	D. Diangana
FGNFT in Agroforestry: Effect on Crop Yields and Soil Properties	Malawi	O. T. Edje
Soil Factors which Limit BNF in *Leucaena leucocephala* in Panamanian Soils	Panama	B. C. de Hernandez
Field Trials and Testing of Selected Species of FGNFT	Thailand	N. Chomchalow

The Board of Science and Technology for International Development (BOSTID) Committee on Research Grants of the National Academy of Sciences has approved several grants for BNF and Nitrogen Fixing Trees (NFT).

The biological nitrogen fixation projects include both basic and applied research. The emphasis is on developing understanding and new technologies related to underexploited legumes, azolla-anabaena systems, and free living or associative nitrogen-fixing bacteria.

The fast growing, nitrogen-fixing trees project has two phases: (1) an inventory of less widely known native species, compiled in accordance with a commonly agreed methodology; and (2) comparative field testing of selected species to provide a basis for tree selection and development of management techniques for different purposes. Economic and social assessments form an integral part of the second phase. Grantees meet periodically to exchange information and coordinate trials.

Grants average close to $100,000, and they may be carried out over a 2, 3, or 4 year period. Grant funds may be used for salaries, travel, equipment, and research expenses. The grant recipient will contribute to the research by providing partial support of the research staff, laboratory and/or field testing facilities, vehicles, and administive services.

Announcements for the fast-growing, nitrogen-fixing trees and biology nitrogen fixation projects, setting forth project guidelines, are available from Dr. Michael P. Greene, Executive Secretary, Committee on Research Grants, BOSTID, National Research Council, 2101 Constitution Avenue, Washington, D. C. 20418.

65

New Clover: Fresa

The Agronomy Department and Agricultural Experiment Station of New Mexico State University recently annouced the release of Fresa strawberry clover (*Trifolium frangiferum* L.).

As a species, strawberry clover has shown tolerance to moderately saline soil conditions. It is reported to withstand a wide range of temperatures and soil moisture conditions, including flooding, and has been reported to withstand short drought periods.

Fresa has a lower plant height than other cultivars tested and is considerably lower growing than white clover. It also has a lower clipping yield and can be infrequently clipped and still maintain a satisfactory ground cover.

This N-fixing legume is being used in the Southwest U.S.A. as a ground cover where there is little expected traffic, where little or no applied N is used, and where infrequent mowing is desired. It may also find use as a ground cover in newly-established orchards in the Southwest.

For further information write to New Mexico State University Agricultural Experiment Station, Las Cruces, New Mexico 88001.

Cicer - A Trap Host

ICRISAT researchers are currently publishing their findings on "Counting Cicer *Rhizobium*."

B. Toomsan, O. P. Rupella, S. Mittal, P. J. Dart, and K. W. Clark note that chickpea (*Cicer arietinum* L.), a large seeded pulse legume, is nodulated only by a very specific group of *Rhizobium* strains which do not nodulate plants other than *Cicer* spp. If the cotyledons are removed just after germination, subsequent seedling growth is dwarfed and plants will reliably grow and nodulate in large test tubes (25x200 mm) under axenic conditions with either sand or sand + vermiculite as the root medium. These dwarfed seedlings can be used as a 'trap host' for counting *Cicer Rhizobium* in pure cultures and contaminated materials by a most probable number, serial dilution-plant infection technique.

The authors stress the value of such a plantlet as a 'trap host' for studying *Cicer Rhizobium* ecology, strain authentication, and inoculum quality control.

Toomsan can be reached at: Khon Kaen University, Faculty of Agriculture, Khon Kaen, Thailand.

Legume Inoculant Training

ICRISAT and NifTAL, along with several other organizations, will conduct a legume inoculant training course. It will be held at the ICRISAT Centre 4 September - 14 October 1983.

The purpose of this course is to provide training in *Rhizobium* culture, inoculant production, and quality control procedures for approximately 12 participants.

The main requirement for participants is that they be involved in commercial scale inoculant production. NifTAL and ICRISAT will set up correspondence with the potential participants and their employers to assure that there will be opportunity for the technologies learned in the course to be applied in their own manufacturing process.

Applicants are requested to provide personal details, academic background, other training or experience, employment history, and publications. Descriptions of current work, facilities available for such work, facilities available or projected for inoculant production, and the administrative scheme under which production will operate are also requested.

This will be a practical course with work in the laboratory, greenhouse, and field, supplemented by lectures and readings. The course will be conducted in English.

Applications should be sent to: Indian applicants, Dr. J. A. Thompson, ICRISAT, Patancheru P. O., Andhra Pradesh 502 324, India; all others, Dr. J. W. King, NifTAL Project, P. O. Box O, Paia, Maui, HI 96779 USA, or FAO in-country representatives for forwarding to NifTAL.

Course Content

Trainees will carry out all the procedures discussed. The main topics of the practical course will be as follows:

A. General Microbiology

1. Collection of nodules and isolation of *Rhizobium*
2. Observation of the infection process
3. Study of cultural and morphological properties, characteristics and nutritional requirements of *Rhizobium*
4. Quantification of *Rhizobium* populations
   (a) direct methods and planting
   (b) indirect methods especially plant infection test

B. Strain identification

1. Development of antisera
2. Agglutination test. Further tests including ELISA and fluorescent antibody will be demonstrated.

C. Strain selection

1. Host-*Rhizobium* specificity
2. Screening for N_2-fixation
3. Pot tests
4. Field trials
5. Soil fertility interactions

D. Inoculation Technology and Quality Control

1. Growth of broth
2. Evaluation and preparation of carriers
3. Preparation of inoculant
4. Quality control of inoculant
5. Inoculant storage tests
6. Methods of inoculation
7. Survival of rhizobia on seed

Special discussion sessions will deal with trainees' future plans for equipment and personnel requirements for producing high quality inoculum.

A. J. Norman, In Memorium

Dr. A. Geoffrey Norman, University of Michigan professor emeritus of botany and the University's vice president from 1964 to 1972, died November 14, 1982, at the age of 76, after a year long illness. He was born and educated in England and first came to the United States in 1930 as a Rockefeller Fellow at the University of Wisconsin.

Dr. Norman provided guidance in the development of BNF reviews that were produced by the University of Puerto Rico (The Mungbean and Pigeonpeas); North Carolina State University (Criteria for Selecting Strains of *Rhizobium*, Guidelines for Evaluation of Need to Inoculate, and Leguminous Inoculant Quality); University of Hawaii (*Azolla*, Vesicular-Arbuscular Mychrrhiza, and Use of *Desmodium*, *Centrosema* and *Stylosanthes* in Pastures); Cornell University (Nitrogen Fixation by Legumes in the Tropics, BNF in Flooded Rice Fields, and Survival of Rhizobia in Soil).

He developed the basic framework for "A Primer on Biological Nitrogen Fixation" and a tantalizing glimpse of the material available in each of the reviews.

His incisive views and constructive suggestions contributed a great deal to the BNF Program in USAID. His personal concern and willingness to go beyond the required effort will long be remembered.

- LRF

MEETING NOTES

BNF Training in Pakistan

The National Agricultural Research Centre in Islamabad was host for the 1st National Training Course on BNF, 19-21 October 1982.

Researchers in the field of crop production were trained in the various options available for research and popularization of BNF. Topics included inoculation of legumes, quality control of rhizobia, eco-physiological factors affecting nodulation and N-fixation, Azolla, associative symbiosis, acetylene reduction, and Use of N_{15} isotopes. The 24 participants were trained by A. Mahmood, A. Hussain, K. H. Sheikh, A. H. Chaudhary, G. R. Sandhu and K. A. Malik.

Mexicans Meet

The Second Mexican Conference on BNF was recently held at Chapingo, Mexico. Twenty-nine papers were presented at the 10-11 March meeting. The organizing committee included R. Ferrara Cerrato, R. M. Ramirez Gama, D. Munoz Gonzalez, A. Espinosa and J. Espinosa de los Monteros.

Promoting Nitrogen Fixation

The seminar, Promoting Nitrogen Fixation in Agriculture, was held in November, 1982, with scholars from the Republic of China and Japan. BNF was discussed in relationship to rice paddies, acidic soils, and pesticides. For more information on the conference, write to Dr. Kun-Huang Houng or Dr. Liang-Ping Lin, Department of Agricultural Chemistry, National Taiwan University, Taipei, Taiwan, R.O.C.

Azolla Researchers Meet

The First International Workshop on Practical Applications of Azolla for Rice production was held at the University of Pureto Rico, 17-19 November 1982.

Some of the papers presented were: G. A. Peters, Determining N^2 fixation and N input in Azolla grown with and without combined N sources; Keeping the acetylene reduction assay in the proper perspective; A. Moretii, Comparative study of the six species of Azolla in connection with their utilization as a green manure for rice; H.F. Diara, Azolla in West Africa; and C. Kanareugsa, Azolla for rice production in Thailand.

Others presenting papers included T. Lumpkin, P. A. Reynaud, T. Ton That, S. Talley, M. C. Margheri, S. A. Kulasooriya, and F. Abruna. E. C. Schroder, BNF Project Leader, was the Workshop organizer.

ANNOUNCEMENTS

INIA/MSU Link

The final of eighteen CRSP projects has been approved. Entitled "Improving Resistance to Environmental Stress in Beans Through Genetic Selection for Carbohydrate Partitioning and Efficiency of Biological Nitrogen Fixation," the project will be coordinated between the Instituta Nacional De Investigaciones Agricolas in Mexico and Michigan State University (MSU).

The project established two field experiments at MSU in June 1982. One involved beans under low and supplemental levels of soil N, the objective being to screen for ability to grow on N deficient soil. The other involved beans previously screened for growth and yield under drought conditions, and grown under combinations of irrigated vs. rainfed and high and low N conditions.

An executive summary of the Bean/Cowpea CRSP FY-82 Annual Report is available from the Management Office, 200 International Center, Michigan State University, East Lansing, MI, 48824.

NFTA - Growing Fast

The Nitrogen Fixing Tree Association (NFTA) continues to grow with 600 associates now representing 66 countries.

NFTA's role will be expanding into other genera of NFTs in 1983. This will be done primarily by the publication of the NFT Research Reports. These reports will be published in cooperation with the Thailand Institute of Scientific and Technological Research.

Three workshops were conducted in 1982, with partial NFTA support—the Bellagio Workshop on NFT germplasm resources funded by the Rockefeller Foundation, a workshop in Saipan on Biomass Energy Options for Pacific Islands funded by the US Department of Energy, and the recent Singapore workshop on Leucaena funded by the IDRC, Canada. Proceedings from these conferences will be made available at cost to associates in 1983.

For further information write NFTA, P. O. Box 680, Waimanalo, Hawaii 96795, U.S.A.

INTSOY

Soybean Course

"Technical and Economic Aspects of Soybean Production" is an INTSOY course to be held from 16 May - 5 August 1983. It is designed to teach the basics of soybean production, beginning with the seed supply and continuing through marketing of the crop. This multidisciplinary course is appropriate for people who will give leadership to the establishment and expansion of soybean production in their countries. Begun in 1975, this course has been offered for the past eight years. It has been attended by 101 people from 42 countries. Anyone who wants additional information should write to INTSOY, College of Agriculture, University of Illinois, 113 Mumford Hall, 1301 West Gregory Drive, Urbana, Illinois, 61801, U.S.A.

NEW PUBLICATIONS

Soils Bulletin

FAO has released a new Soils Bulletin (No. 49), *Application of Nitrogen-Fixing Systems in Soil Management*.

This book, by Y. A. Hamdi, is an exhaustive review of the literature on the characteristics, production, and use of N-fixing systems. Hamdi covers BNF, the rhizobia-legume symbiosis, blue-green algae, free-living N-fixing bacteria, Azolla, and nodulated non leguminous plants. Apprendixes include methods of assessing BNF, recognition and characterization of rhizobia, and culture collections.

This bulletin is available through the FAO Sales Agents or directly from Distribution and Sales Section, FAO, Via delle Terme di Caracalla, 00100 Rome, Italy.

SOA: Pigeonpeas

A state of the art paper, "Pigeonpeas (*Cajanus cajan Millsp.*): A Valuable Crop in the Tropics," is now available free to scientists in developing countries.

Put together by J. F. Morton, R. E. Smith, M. S. Lugo-Lopez, and R. Abrams, the paper critically reviews the most important available literature on pigeonpeas with emphasis on the N economy of this crop. Information is presented on the economic importance, dietary value, factors affecting production, symbiotic N fixation, transfer of N to other crops in rotations and related cropping systems, and the response of pigeonpeas to fertilizers.

This paper provides a comprehensive source of knowledge on this increasingly important crop that will permit easy access to the literature. It allows the reader to ascertain pigeonpea's potential and limitations and provides reliable guidance for those interested in commercial or home garden production.

An updated bibliography containing 318 items dealing exclusively or in part with pigeonpeas is included.

For further information, write to either Dr. E. C. Schroder, BNF Project or to Dr. L. M. Cruz Perez, Head, Department of Agronomy and Soils, University of Puerto Rico, Mayaguez Campus, Mayaguez, Puerto Rico, 00708.

Proceedings Available

The Proceedings of the 8th North American Rhizobium Conference (held 3-7 August 1981, University of Manitoba) have been published.

K. W. Clark and J. H. G. Stephens edited the more than 35 papers covering genetics, physiology, ecology, agronomy, taxonomy, and methods.

For further information, contact Clark at Plant Science Department, University of Manitoba, Winnepeg, Manitoba, Canada R3T 2N2.

BOSTID Workshop Proceedings

Priorities in Biotechnology Research for International Development: Proceedings of a Workshop is the outgrowth of a BOSTID organized workshop to assess the implication of the "new biology" and to recommend priorities in international development.

For BNF, the workshop recommended support be given to research designed to optimize N-fixation by (1) cyanobacteria and the Azolla system in association with rice, and (2) the Legume-*Rhizobium* symbiosis.

Other recommendations included: 1) development of the trait in legumes that allows them to use fixed N simultaneously with soil nitrogen; 2) development of improved technology for production and use of legume inoculants, 3) development of fast-growing, N-fixing trees, and 4) evaluation of grass species and associated bacteria for their ability to promote N fixation and accumulation of dry matter.

Of particular interest to BNF researchers is M. Alexander's background paper, "Research to Enhance N Fixation: Misplaced Emphasis?" He argues that the factors limiting N-fixation "are nearly always the absence of (rhizobial or blue-green algae) strains adapted to ecologically significant stresses in soil or in paddy fields."

For further information, contact BOSTID, National Research Council, 2101 Constitution Ave. N.W., Washington, D.C. 20418 USA.

FAO Media Aids

The Food and Agriculture Organization of the United Nations (FAO), in cooperation with field projects in several regions of the world, is producing a series of audio-visual aids. These will be useful for training and extension work in soil and forest conservation and in crop and pasture improvement.

Filmstrips, cassette-tapes, and accompanying books with speaker's notes are the basic media selected for this program. Themes of interest to BNF workers are: agro-forestry; pasture improvement with fodder legumes and grasses; tree planting to check erosion and provide fuelwood and fodder; forest protection; and biological nitrogen fixation.

For further information contact: Distribution Section, United Nations, Food and Agricultural Organization (FAO), Via delle Terme di Caracalla, 00100 Rome, Italy.

Microbial Physiology

"Microbial Physiology and Genetics of Industrial Processes" edited by N. F. Millis and A. J. Pittard is now available for $A6 (plus postage) from The Department of Microbiology, University of Melbourne, Parkville, Victoria, Australia, 3052.

3 New Books

Several publications of interest to BNF researchers are now available.

Faba Bean Improvement edited by G. Hawtin and C. Webb. Chapters on N-fixation are by Y. A. Hamdi and M. M. Musa.

Microbiology of Tropical Soils and Plant Productivity edited by Y. R. Dommergues and H. G. Diem. BNF is covered by A. H. Gibson, B. L. Dreyfus, and Y. R. Dommergues, P. A. Roger and P. A. Reynaud, I. Watanabe, and J. H. Becking.

Nitrogen Cycling in Ecosystems of Latin America and the Caribbean edited G. P. Robertson, R. Herrera, and T. Rosswall. Articles by A. A. Franco and D. N. Munns, J. R. Jardim Freire, and J. P. Roskoski will be of interest to BNF researchers.

All books are from Kluwer Academic Publishers Group, Distribution Centre, P. O. Box 322, 3300 AH Dordrecht, The Netherlands.

DIRECTIONS IN COMMUNICATION

A respected researcher recently sat through several, oral scientific presentations. He listened while presenters spoke to the screen—and not to the audience, while soft spoken speakers fought against air conditioning and other background noises, and while poorly prepared speakers rambled. However, the quality of the visuals he saw really caused him to grimace.

The purpose of visuals in an oral presentation is to aid the speaker and assist in the transfer of information. However, many presenters do not have adequately prepared visual materials and many of these materials share similar problems. A few of these problems are 1) visuals too dark—the objects in the slide, for example, cannot be clearly seen, 2) visual too light—information in the visual cannot be read from the back of the room, 3) visuals with too many data points—large tables reproduced from typewritten copy or from journals are almost always impossible to read, let alone understand, and the speaker often has trouble making specific points because of too much data.

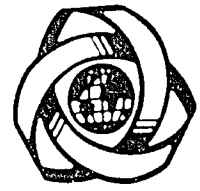
Some questions to ask when organizing a speaker's visuals and thereby alleviating some technical problems are:

1. Does this visual help me achieve my presentation objectives?
2. Is there good continuity between this visual and the previous one?
3. Does this visual add to my audience's knowledge of the subject?
4. Does this visual focus attention on one main idea? Is this idea clear?
5. Have I removed all unneccessaryelements without destroying the one main thought in this visual?
6. Have I presented the information in this visual in the most effective manner?
7. Are the titles legible and short enough to be read in the time they will be shown?
8. Does the commentary add anything to this visual? Does it distract?

There are many practical guidelines for developing visuals, e.g., the lettering should be 1/25 the height of the information area. The main idea is that a good presentation is organized. It has an introduction that leads into a well organized subject. Conclusions are then drawn which summarize the subject or present deductions drawn from the results presented. Much work and effort underlie a good simple appearing presentation.

The speaker must organize for the audience and consider the best ways to use visuals to communicate. At scientific meetings time is often very limited, and there is a need to maximize impact.

In communicating BNF to both scientific and general audiences, the same care should be given to prepare oral presentations that are logical and to the point. Visual materials have a very important role to play, and if utilized properly, complex subjects can be presented in interesting and attractive ways and can aid in conveying information transfer.



1983 has been designated as International Communication Year. And it is an excellent time for all of us to reexamine our attitudes toward communication, our role in the communication process, our communication skills, and to make efforts to keep improving.

– James W. King

WANTED

1 Peat Samples

The suitability of peat as a carrier for *Rhizobium* inoculants is well known. At NifTAL, research to elucidate in detail the special attributes of peat is in progress. Two peats (from USA and Australia) are being analysed. More peats need to be analysed to gather further information and make the study meaningful. If you have peat and want it to be included in our study, please send us at least 2 kg. The peat must be ground (around 200 mesh size, if possible) and non-sterile. If you have limed the peat, please indicate.

We will send you the results of our study. Please forward your sample(s) to P. Somasegaran at the NifTAL address. Thank you.

2 Inoculant Producers

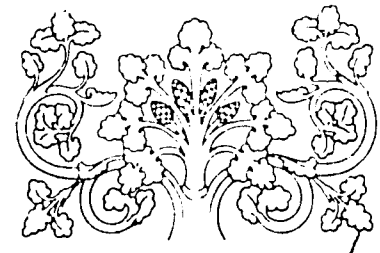
NifTAL has recently instituted a new project — an incentive program for inoculant producers aimed at improving the quality of legume inoculants for farmers in developing countries.

The project's main focus will be the endorsement of high quality inoculant products through a variety of public awareness methods. NifTAL is compiling a comprehensive inventory of all current or future inoculant producers. If you or your organization are involved in inoculant production and able to contribute to the development of our producer inventory, or interested in the promotion of high quality inoculants and would like information on the program, please contact Philip Giovannini at the NifTAL address.

To date there has never been a complete listing of inoculant producers. The compilation from this effort will be available to all interested parties.

SARIF Network

One group working with BNF in Indonesia is the Sukarami Agricultural Research Institute for Food Crops (SARIF) comprising a network of 12 experiment stations (some are now being established). They are responsible for the improvement of food crops throughout Sumatra. The main center and headquarters are located near Padang in West Sumatra. SARIF is organized under the GOI Agency for Agriculture Research and Development and the Central Institute for Research on Food Crops. The SARIF network also receives major support for development through a grant and loan from USAID.



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Nodulation Conference

The Seventh Australian Legume Nodulation Conference will be held at Sydney, New South Wales, 14-17 February 1984.

The conference program will promote informal information exchange on the many aspects of achieving effective and efficient N-fixation. A visit to the Australian Inoculant Research and Control Service will be included.

Topics to be covered include: 1) *Rhizobium* inoculant production and use, strain selection and various ecological factors including interactions between *Rhizobium* and mycorrhiza; 2) genetics, physiology and biochemistry of legume symbioses; 3) measurement of N-fixation and assessment of the contribution of legumes in agriculture and natural ecosystems; 4) the role of legumes in the development of soil acidity; 5) N-fixation by Australian native plants in forests and mining reclamation areas; and 6) non-legume symbioses such as in *Casuarina*, *Azolla*, and *Azospirillum*.

For further information contact: Dr. I.R. Kennedy, Department of Agricultural Chemistry, University of Sydney N.S.W. 2006, Australia.

Microbial Ecology

The third International Symposium on Microbial Ecology will be held 7-12 August 1983 at Michigan State University. The aim of the symposium is to assemble microbial ecologists with interests in a wide range of habitats so they can discuss the interactions of micro-organisms and the underlying processes that regulate these interactions. For further information write to Third International Symposium on Microbial Ecology, The Kellogg Center for Continuing Education, Michigan State University, East Lansing, Michigan, 48824, U.S.A.

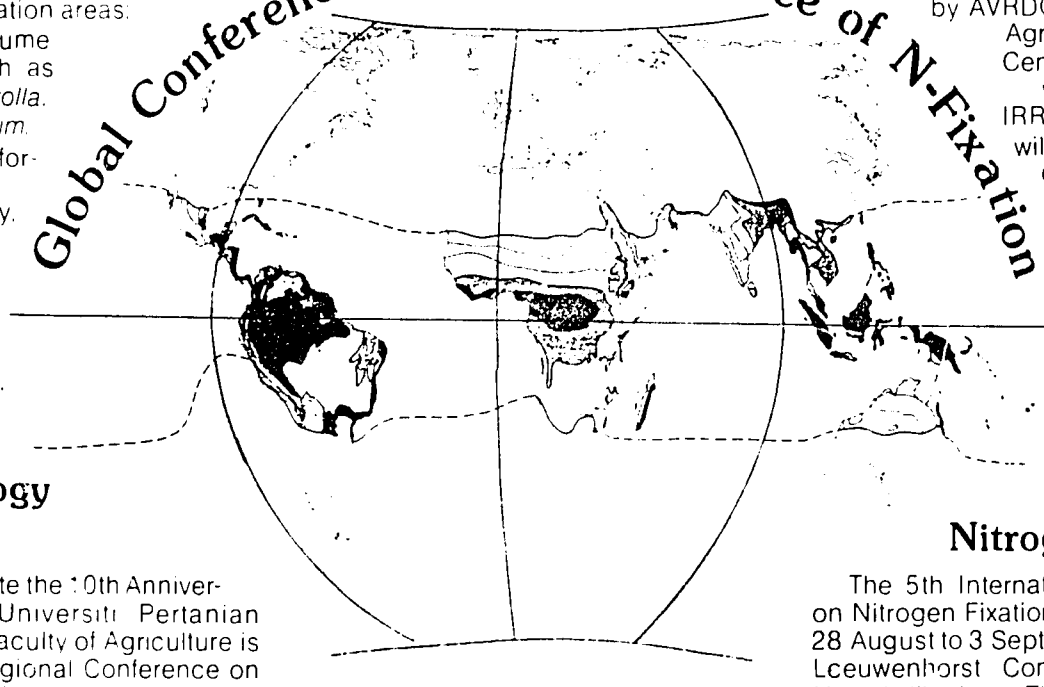
Food Legumes in the 80s

Following 5 years of development which stressed the importance of the N-fixing capabilities of its targeted crops, The Food Legume Improvement Program at ICARDA (International Center for Agricultural Research in the Dry Areas) is organizing a workshop entitled "Faba Beans, Kabuli Chickpeas, and Lentils in the 1980's." The 16-20 May workshop will be held at ICARDA headquarters in Aleppo, Syria. Goals are to review progress and identify priorities in production, research, and training.

Soybean in Cropping Systems

The First International Symposium on Soybean in Tropical and Subtropical Cropping Systems, sponsored by AVRDC and the Tropical Agricultural Research Center in cooperation with INTSOY, IITA, IRRI, and EMBRAPA, will be held 26 September – 1 October 1983 in Tsukuba, Japan. Details on the symposium can be obtained from AVRDC, P.O. Box 42, Shanhua, Tainan 741, Taiwan, ROC.

Global Conferences Stress Importance of N-Fixation



Microbiology Impact

To commemorate the 10th Anniversary of the Universiti Pertanian Malaysia, the Faculty of Agriculture is organizing a regional Conference on the impact of microbiology in tropical agriculture, 24-26 October 1983 in Serdang.

The objectives of the conference are: 1) to highlight the role of microorganisms in tropical agriculture; 2) to assess the contribution of microorganisms in boosting agricultural production (N-fixation, mycorrhizae, biological control); 3) to appraise agricultural losses and spoilage through microbial activities; 4) to evaluate the significance of microorganisms in food processing and preservation; and 5) to explore the potential of microbial transformation of agricultural products and wastes.

For further information, write to The Organizing Secretary, Regional Conference on the Impact of Microbiology in Tropical Agriculture, Universiti Pertanian Malaysia, Serdang, Selangor, Malaysia.

N-Fixing Trees

The National Research Program on Soil Biology (PNPBS) of EMBRAPA (Brazilian Agricultural Research Organization) in cooperation with the Federal Rural University of Rio de Janeiro (UFRRJ) will be organizing an International Symposium on Nitrogen Fixing Trees for the Tropics. The Symposium will be held at the UFRRJ campus from 19-24 September 1983.

Recognition that people all over the world are becoming conscious of their responsibility to preserve their environment and save fossil fuels through the use of native N-fixing trees prompted the organization of this symposium. The registration fee will be $25, including a copy of the proceedings. Contact Dr. Johanna Dobereiner, EMBRAPA, PNPBS, km 47, 23460 - Seropedica, RJ - Brasil.

Nitrogen Fixation

The 5th International Symposium on Nitrogen Fixation will be held from 28 August to 3 September 1983 in the Leeuwenhorst Congress Center at Noordwijkerhout, The Netherlands.

The Symposium will bring together scientists working in different fields of N fixation to stimulate interdisciplinary discussions about the basic principles of chemical and biological nitrogen fixation, and to evaluate possibilities for increased agricultural productivity through BNF. The major scientific disciplines involved in N fixation research —chemistry, biochemistry, microbiology, (plant) physiology, and genetics —are represented.

The Symposium will be organized in such a way that all delegates can participate in the discussions in each discipline.

All questions about the Symposium should be addressed to: 5th International Symposium on Nitrogen Fixation, International Agricultural Centre, P. O. Box 88, 6700 AB, Wageningen, The Netherlands.

To Study or To Construct: Another Opinion

BNF

GENETICS

GENETIC NOTES

Allied Corporation and Calgene, Inc., a genetic engineering firm, have signed a research contract to develop means of improving the nutrient efficiency of plants through genetic engineering. Research will be conducted at Calgene's Davis, California, laboratory.

Advanced Genetic Sciences, Inc., has formed an international company, Plant Genetic Systems NV, headquartered in Brussels, Belgium, and supported in part by the Belgian Government.

Their primary purpose will be to serve the European market by carrying out research and development aimed at improving crop plants, plant biosystems, and industrial microorganisms by means of genetic engineering techniques.

Letter to The Editor

Dear Editor,

We read with concern the recent BNFB article (Vol. 3, No. 2) by Dr. K. T. Shanmugam on the prospects for genetic engineering in N-fixation and his assessment of the achievements so far in this field. We agreed with his view that the development of new N-fixing plants will be a complex and time-consuming task. However, our present knowledge of the N-fixation (nif) genes and their regulation was seriously misrepresented in the article.

Firstly, it is wrong to state that new N-fixing bacterial hybrids have not been produced. The strains of *E. coli* and *S. typhimurium* not only synthesize nitrogenase, they grow diazotrophically and reduce acetylene at rates comparable with *K. pneumoniae*, their naturally-occurring diazotropic parent (Dixon, et al., 1976; Postgate and Krishnapillai, 1977). While the failure of other *nif*-hybrids to synthesize nitrogenase is not yet understood, it is quite likely that this is a consequence of the *nif* genes failing to be transcribed in their new environment. This could be due to the absence of the necessary regulatory signals (proteins or low molecular weight co-effectors).

The article stated that "virtually nothing is known about how N fixing cells regulate the synthesis of nitrogenase in *Klebsiella pneumoniae*;" however, a considerable amount is known about these control mechanisms from work in our laboratory and in many other research centers around the world.

The *nif*-specific regulatory genes *nifL* and *nifA* have been identified. Their functions – repressor and activator respectively – are known and their polypeptide products have been identified by cloning (Roberts and Brill 1980; Ausubel and Cannon, 1981; Buchanan-Wollaston, et al., 1981; Merrick, et al., 1982; Hill, et al., 1981). The regulation of the *nif* operons has been studied using *nif-lac* gene fusions (Dixon, 1980) and the DNA sequences of at least two *nif* gene promoters have now been determined which will allow further insight into *nif* regulation (Scott, et al., 1981; Sundarensa, Jones, Ow, and Ausubel, 1983; Drummond, et al., 1983). Furthermore, in recent months the N-control (ntr) genes which are involved in co-ordinating synthesis of a number of N-assimilation enzymes have also been identified and their roles in *nif* regulation have been partly elucidated (Espin, et al., 1982; Merrick, 1983). Knowledge of *nif* regulation in *K. pneumoniae* is now substantial and is providing the foundation for comparable studies of *nif* regulation in *Azotobacter* (Kennedy and Robson, 1983) and in *Rhizobium* (Sundaresan, Jones, Ow, and Ausubel, 1983).

It is true that the only present examples of the introduction of *nif* genes into a eukaryote (yeast) failed to result in nitrogenase synthesis. This is hardly surprising as no attempt was made to put these genes under control of the yeast transcription/translation machinery, so the experiments could not reasonably have been expected to lead to nitrogenase synthesis. They served solely to demonstrate that the prokaryotic *nif* cluster could successfully be conserved in a eukaryotic background. A recent report has in fact described transcription of a *nifH::lac* gene fusion in *Saccharomyces cerevisiae* (Zilberstein, et al., 1982) thus demonstrating that *nif* gene expression in a eukaryotic cell is possible.

In summary, we certainly support continued research on exploitation of naturally occurring plant associations but along with, not in place of, fundamental research on the molecular biology of N-fixation. Much present research in the symbiotic rhizobia has its foundations in our studies of the N-fixation genes in *K. pneumoniae* (Sundaresan, Jones, Ow, and Ausubel, 1983; Ausubel, 1982) and it is very likely that this will continue to be the case in the immediate future. The prospect of N-fixing cereals is undoubtedly still very far off but the situation is by no means as bleak as Dr. Shanmugam suggested. Our present knowledge gives us no reason to believe that *nif* gene expression in a eukaryote cannot be achieved in the future and with continued support such research may yet have much to offer BNF.

Yours faithfully,

R. A. Dixon, M. Drummon, S. Hill, C. K. Kennedy, M. J. Merrick, J. R. Postgate, R. Robson, Agricultural Research Council, Unit on Nitrogen Fixation, The University of Sussex, Brighton BN1 9RQ, England.

(A complete list of references cited in this letter is available by writing to the BNF Bulletin.)

SHORT TAKES

During February, 1983, **Dr. Carl Jordan** of the University of Guelph, Canada, conducted research at the NifTAL site. This research centered on an investigation of the nodulating ability, using tropical legumes as hosts, of a special group of fast-growing *Rhizobium* isolated in China. These bacteria have the unusual ability to *effectively* nodulate certain species of soybean (such as *Glycine soja* - a wild soybean progenitor) and to *ineffectively* nodulate most commercial soybean (*Glycine max*) cultivars. It is hoped that the nodulation data will help in relegating these bacteria to their proper place in the *Rhizobium* classification scheme.

• • •

Dr. M. Rangarajan of Tamil Nadu Agricultural University, Coimbatore, India, joined the NifTAL Project intern program as an FAO Fellow from January to July, 1983. Rangarajan will be conducting 3 research projects during his stay. They are 1) studying the occurrence of serotypes of *R. meliloti* strains in Hawaiian soils; 2) studying the antigenic difference between cultured cells and bacteroid forms of *R. japonicum* and *Rhizobium* sp. in homologous and heterologous hosts; and 3) studying variability in the formation of nodules by a multistrain *Rhizobium* inoculant at different growth stages in two *Leucaena* cultivars. He will also be studying serology with Dr. Ben B. Bohlool.

• • •

We have heard that **Carlos Batthany,** one of the fathers of Latin American rhizobiology, has been taken ill. All his friends wish him a speedy recovery.

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April, 1983

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University of Puerto Rico
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• • •

Fawzy Hashem, Agricultural Research Center, Giza, Egypt, is currently at the University of Maryland. He is working toward his Ph. D. with Dr. J. S. Angle and is studying rhizobiophages in soil and their relation to the cultivation of legumes.

• • •

Another NifTAL intern **James T. Chui,** an agronomic research officer with the Kenya Agriculture Research Institute, Nairobi, will be studying microbiological techniques in the legume/Rhizobium symbiosis. He received his M.S. degree in Agronomy from Iowa State University in 1982. Chui is supported by USAID/Kenya and NifTAL during his 3 month training session.

• • •

The University of Illinois is conducting a comprehensive agricultural project in Zambia. NifTAL is heading up the BNF component through **Dr. Seydou Sanogho.** He will be conducting research at and making contacts from the Mount Makulu Research Station near Lusaka.

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72

BIOLOGICAL NITROGEN FIXATION

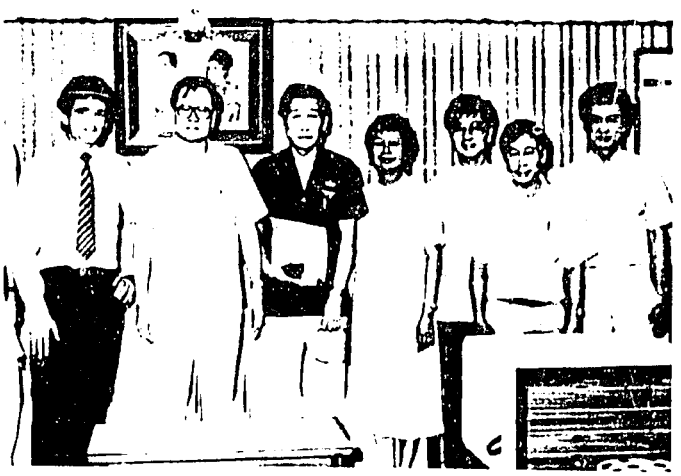
BULLETIN

Volume IV, Number 2

BNF Resource Center In SE Asia – A Reality

Over the past five years, NifTAL has grown into a tropic-wide program of research support, multi-tiered training, and a wide range of research and production services from its headquarters on the island of Maui, Hawaii. Its capability to provide needed support to developing institutions, however, has become limited by the complexities of distance and the rapid expansion of interest in BNF.

In May, 1983, NifTAL took the first step in the regionalization of its services when Jake Halliday, NifTAL Director, and Yookti Sarikaphuti, Director General of the Thailand Department of Agriculture, signed a Memorandum of Understanding establishing a BNF Resource Center for the Southeast Asia region. Services which will be extended from the Center include: a) adaptation of BNF technology to specific local conditions with resource/research support and response to assistance requests, b) BNF training programs oriented to regional needs – with emphasis on inoculum production and extension, and c) distribution of communication materials (including a regional BNF research newsletter, extension materials, publications, etc.) designed to link efforts in BNF research and promotion.



Jake Halliday, Yookti Sarikaphuti, and other Thai Agricultural representatives after Halliday and Sarikaphuti signed the Memorandum of Understanding.

Because this will be a regional Center with institution-building responsibilities to all countries in the region, input of ideas and direction from BNF researchers representing the various countries is important. The Resource Center's first project will be to host a BNF Resource Center Planning Workshop in Bangkok, Thailand from October 28–31, 1983. Attendees will be regional scientists and administrators; these participants along with the Resource Center staff will work toward establishing a workplan for the Center by outlining activities for the next three years.

Douglas Beck

Dr. Douglas Beck, staff soil scientist with NifTAL, will be stationed in Bangkok full-time as Resource Center Director, beginning in mid-September. Beck will be working within the *Rhizobium* group of the Soil Microbiology Branch, Division of Soil Science, Thailand Department of Agriculture. Other members of the NifTAL staff will be hosted as necessary for specific activities under the proposed workplan.

The Southeast Asia BNF Resource Center, with the goal of assuring that ultimately national institutions in developing countries can sustain their own effective BNF programs, is the first of three such centers proposed for Asia, Africa, and Latin America. The scope of support will not be limited to the *Rhizobium*/legume symbiosis, but will include the various forms of biological nitrogen fixation utilizable in farming systems of the tropics.

Persons interested in details of the S.E. Asia Center should contact Dr. Douglas Beck, Rhizobium Building, Soil Microbiology Branch, Div. of Soil Science, Department of Agriculture, Phaholyothin Rd., Bangkhen, Bangkok 10900 Thailand.

— DB

Inoculant Production in Zimbabwe

The production unit which our Government set up on Grasslands Research Station Marondera (previously called Marandellas) twenty years ago is the only producer of inoculants in this country. It supplies all national requirements and also exports some inoculants to neighboring countries. In the 1981 season about 72,000 units of soybean inoculant and 7,000 units of groundnut inoculant were produced; and in 1982, soybean packs increased to 85,000 units. Each unit is sufficient to treat 100 kg. of seed.

The soybean inoculant is by far the most important in Zimbabwe since the improved, high-yielding varieties do not nodulate with naturally occurring rhizobia. The groundnut inoculant on the other hand is only used for the irrigated crops on large commercial farms as the response to the cultures is negligible for the raingrown peasant crops which nodulate adequately with the natural cowpea strains. In addition, inoculants are produced in bulk for peas, beans, lucerne and pasture legumes. Special inoculants for other species of legumes can be prepared on request to the laboratory.

Until the 1980-81 season, all inoculants were produced on agar slopes in glass bottles. This was expensive and unsatisfactory for transport and it did not seem a very suitable material for the less sophisticated farmers who were beginning to use improved varieties. A number of alternative sources have now been tested over many seasons and the most satisfactory material has been found to be bagasillo from the country's sugar mills. Small scale tests at research stations and farms were successful. No reports of difficulty in application or nodulation were received during the first season in which about 60,000 units were issued to farmers in Zimbabwe. Therefore, production was increased.

Carved soapstone zebra from Zimbabwe (Courtesy of African Designs from Traditional Sources, Geoffrey Williams, Dover)

The bagasillo, which is the base of the solid medium, is a fine dust which separates from the bagasse in the mills, and is simply sieved once through a fine screen to remove any extraneous long fibers. It is not acid and lime addition is seldom necessary. It has a remarkably high water holding capacity of twelve to thirteen times its own weight. Sterilization is done by autoclaving for two hours, and while this prolonged autoclaving is rather a nuisance, it seems to improve the properties of the bagasillo medium as well as ensuring sterility. The packs contain 50 g. wet base at a final moisture content of 60% moisture holding capacity. The nutrient is yeast mannitol broth (Vincent 1970).

In preparing the packs, 5 or 10 kg of bagasillo is brought to 40% MHC with a solution of the required mineral salts. This gives a friable mixture which is then measured into high-density polyethylene bags. These are sealed, loosely rolled, and autoclaved for two hours at 121 degrees C. The racks are then placed under ultra-violet light to cool to room temperature before the bags are stored. The packs can be left for several weeks at this stage, thus large batches can be conveniently prepared and left for subsequent inoculation.

Cultures of the desired strain are grown in 1.0 litre of yeast extract mannitol broth with aeration at 28 degrees C for about five days. Each batch is purity tested before being released to the production unit. When a batch is to be inoculated, a yeast extract mannitol solution at three times normal concentration is dissolved in water equivalent to 20% MHC of the bagasillo. Therefore, when it is added

Continued on Page 7

Rhizobium Strain Identification

Legume root-nodules, dried at oven temperature (70 C for 48 hours) are suitable for *Rhizobium* strain identification by immunofluorescence and agglutination. This finding was reported recently by NifTAL scientists P. Somasegaran, R. Woolfenden, and J. Halliday.

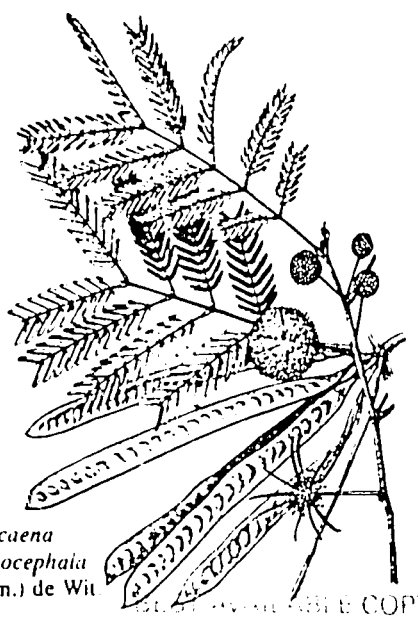
The fluorescence of bacteroids of *R. japonicum*, *R. leguminosaru*, *R. meliloti*, *R. phaseoli*, and *Rhizobium* spp. from oven dried nodules was the same as the fluorescence of bacteriods from nodules that had been frozen, desiccated, or dried at room temperature (28 C).

Oven dried nodules did not require further steaming for agglutination. Bacteroid agglutinations gave 2-16 fold lower titers than those of the cultured cells. Fresh and oven-dried soybean nodules from a mixed inoculation gave exactly the same results when identified by immunofluorescence or agglutination.

For reprints, request this document from the Information Section, NifTAL Project.

More Leucaena Uses

Dr R. L. Cook, Professor Emeritus at Michigan State, was in Taiwan early this year and found a trimmed *Leucaena leucocephala* hedge growing at the International Vegetable Research Center. He also learned that *Leucaena* is being grown in training courses held there.



Leucaena leucocephala (Lam.) de Wit

On the Island of Penghu in the Pescadores, he found Leucaena growing wild and surmises that it may have represented an attempt to plant something fast-growing as a protection against the strong winter winds.

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Mimosine Research Follow Up

Ray Jones reports that his transfer of rumen bacteria from Hawaii to Australia was a success; the bacteria has been multiplied and transferred to both a goat and a steer under strict quarantine conditions.

After 60 days, the rumen fluid was capable of degrading DHP (the toxic breakdown product of mimosine) very rapidly. This implies that the transfer will be permanent.

Plans are to use the cultures in field situations once the quarantined animals are released. Also, Jones plans to isolate the specific bacterium involved in the DHP degradation. Ray Jones is Assistant Chief of the Division of Tropical Crops and Pastures, CSIRO, Townsville, Australia.

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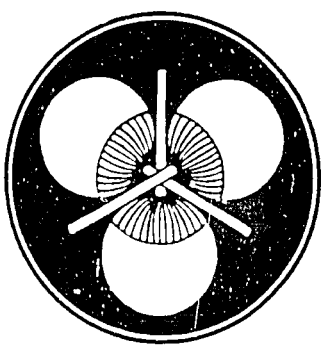
MEETING NOTES

NCSU/NifTAL Short Course

Joining forces, North Carolina State University and NifTAL presented a short course on Symbiotic Nitrogen Fixation and Legume Inoculation in Bangkok in early May.

The course was developed with an AID grant to NCSU and assumes little formal training in microbiology or legume ecology. It is aimed at extension or research workers who have legume-oriented responsibility at the field/farmer level.

Sponsored jointly by the Thai Rhizobium Inoculation Production Project, NifTAL, and NCSU, the course was held at the Thai Rhizobium Building. Drs. A. G. Wollum and G. H. Elkan were the NCSU instructors and Drs. D. Beck and J. Halliday represented NifTAL. Local arrangements were coordinated by Production Project Director Mrs. Yenchai Vasuvat, and Senior Scientist Dr. Nantakorn Boonkerd.



Though the 20 Thai participants had backgrounds more sophisticated than had been anticipated, the course was well received and participation was enthusiastic. One advantage of the course's modular design was that changes were easily made to meet Thai conditions and participants' needs.

The NCSU course has now been taught in two widely disparate locations, Peru and Thailand, at essentially three levels of intensity. Each experience has provided an opportunity to improve the Manual and to refine the Bill of Materials, both of which are supplied with the course.

The grant under which NCSU developed and field tested the course has now expired. However, the organizers are prepared to continue to offer it, given any reasonable proposal and sufficient lead time. Interested parties should contact Dr. H. D. Gross, Crop Science Department, NCSU, Raleigh, NC 27650. -HDG

N. American Rhizobium Conferences

The **9th North American Rhizobium Conference** held at Boyce Thompson Institute in June was attended by approximately 250 *Rhizobium* workers from throughout the world. Sixty-four papers and fifty-six posters covered the wide range of work currently being done with *Rhizobium*.

Hawaii has been selected as venue for the **10th North American Rhizobium Conference** scheduled to be held in June 1985. NifTAL, on the island of Maui, is pleased to be hosting the meeting. Maui's selection is expected to allow an enrichment from Asian and Pacific region colleagues.

Hawaii has two strong centers of basic (B. Ben Bohlool, et al) and applied (NifTAL) *Rhizobium* programs involving over 20 researchers and ongoing lab and field work with tropical legumes and their rhizobia.

Plans are already underway to select from the world class conference facilities available on Maui and to obtain group/charter air fares. More information will be printed in the next issue of the BNF Bulletin.

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Costa Rica Course

The Curso Regional De Entrenamiento Sobre La Symbiosis Entre *Rhizobium* Y Leguminosas Tropicales De Importancia Agricola Course, presented in Spanish was held in San Jose, Costa Rica, 2–27 May 1983. Nine Latin American countries were represented by 18 participants.

Course organizer was Dr. Carlos Ramirez, Faculty of Agronomy, University of Costa Rica. It was sponsored by Unesco, UNEP, IITA, NifTAL, ICRO, UDC, CONICAN, and ICRU. Lecturers included J. Freire, IPAGRO; J. Burton, NifTAL; and E. Schroder; University of Puerto Rico.

Participants were E. Borensten, M. Gravina de Moraes, J. M. Guerrero, A. K. Gardezi, V. M. D. R. Lopez, T. J. E. Luque, M. E. Mata, G. B. Mora, B. F. G. Padilla, J. Peisajovich, V. A. Penaloza, B. G. Prado, N. O. J. Rocha, R. O. Russo, B. P. J. Solis, Y. A. Velazquez, and L. Villalobos.

ANNOUNCEMENTS

World Soybean Research Conference III

Iowa State University is holding the World Soybean Research Conference — III on 12–17 August 1984. The conference will provide the opportunity to discuss recent advances in research on soybean production, marketing, and utilization. Scientists in all disciplines of soybean research from throughout the world are invited to attend.

Informtion about the conference can be obtained from Dr. Walter R. Fehr, Department of Agronomy, Iowa State University, Ames, Iowa 50011, U.S.A.

Seed Production

The Queensland Department of Primary Industries is conducting an international course on tropical pasture and fodder seed production. It will be conducted from 2 April to 1 June 1984. Request information by contacting Director-General, Department of Primary Industries, G. P. O. Box 46, Brisbane, Queensland, 4001, Australia.

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Soil Course en Francais

The role of microorganisms in soil fertility will be explored in a course being offered by the International Institute of Tropical Agriculture from 19 March to 27 April 1984. Among the topics covered will be *Rhizobium* and Mycorrhizae technology, ecology of soil microorganisms, and biological, physical, and chemical aspects of soil fertility.

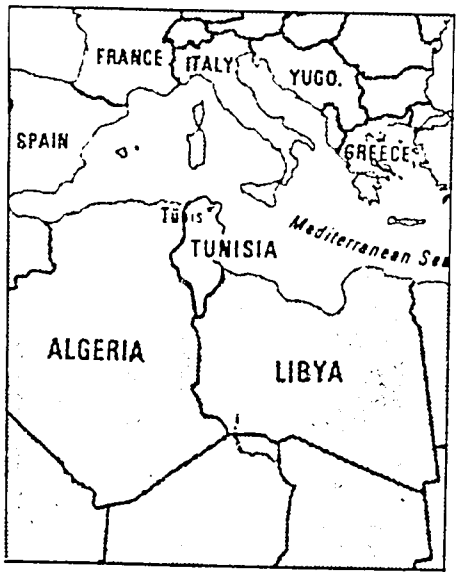
For information on admission to this French language course contact The Assistant Director, Training Program, IITA, Oyo Road, PMB 5320, Ibadan, Nigeria.

CSRS: Oregon State/Le Kef, Tunisia

Factors limiting BNF in developing countries are being explored in the CSRS (Cooperative States Research Service) Limiting Factors Grants. Lloyd Frederick of USAID is coordinator of these grants and Gerald Elkan of North Carolina is research coordinator.

One cooperative effort, Maximizing Nitrogen Fixation and Yield of Forage Legumes Grown in Tunisia, is underway between Oregon State University and Le Kef Institute in Tunisia with David Hannaway as the principal investigator.

Following a collection tour by Joe Burton, NifTAL Project, and Walt Graves, California Extension Service, San Diego, seed and *Rhizobium* collected in Tunisia are being evaluated for highly effective combinations. These are primarily from annual medics *Medicago* spp., sulla (*Hedysanium corinarium*), and subterranean clover (*T. subterraneum*).



Effectiveness tests are being conducted at Oregon State. Later, a subset of effective combinations will be evaluated for phosphorus and sulfur utilization efficiency (using response curves) and the most efficient combinations will be tested in field experiments at UC-Riverside by Wes Jarrow and at Le Kef by a local cooperator. Finally, training sessions will be held in Tunisia for research and extension personnel.

Recently, Hannaway spent several weeks at NifTAL developing training materials and coordinating his field trials to be compatible with NifTAL's INLIT trials.

NEW PUBLICATIONS

Tree Seeds Available

The CFI (Commonwealth Forestry Institute) has assembled a list of N-fixing trees and seed germplasm. Both are available free to researchers who are doing trials.

Interested persons should write to Colin E. Hughes, Research Officer, Unit of Tropical Silviculture, CFI, University of Oxford, South Parks Road, Oxford OX1 3RB, England.

Cowpea Abstracts

Cowpeas – Abstracts of world literature: Volume III, 1974-1980 is available from the International Grain Legume Information Centre, IITA, PMB 5320, Ibadan, Nigeria.

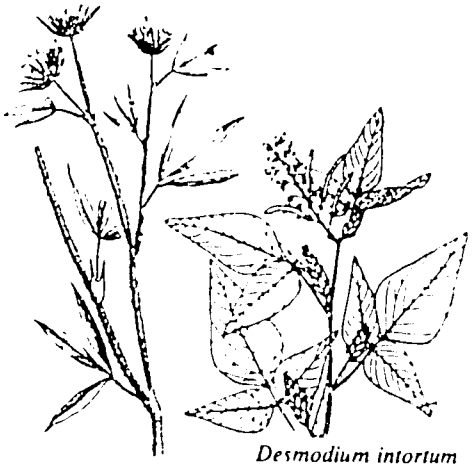
Cowpea Abstracts contains 1,850 entries by broad subject category including nodulation and nitrogen fixation.

Paddy Soils

Proceedings of Symposium on Paddy Soils, edited by the Institute of Soil Science, Academia Sinica, Beijing, The People's Republic of China, is now available. The 864-page book costs approximately $US 46 and is available from Springer Verlag, Heidelberger Platz 3, Postfach, D–1000 Berlin 33, Germany.

Pasture Legumes

The Role of *Centrosema*, *Desmodium*, and *Stylosanthes* in Improving Tropical Pastures is now available from Westview Press. The book is edited by R. L. Burt, P. P. Rotar, J. L. Walker, and M. W. Silvey.



This integrated collection describes the importance of forage legumes for pasture development and improvement in the tropics and subtropics. The three legumes are discussed in detail — information is presented on taxonomy, adaptation, distribution, productivity, and usefulness — and considerable emphasis is placed on *Rhizobium* germplasm resources for these genera.

$100 Bushel Legume Seeds

Farmers in the United States have been planting so much acreage in clover that the cost of red clover seed has risen from $70 to $100 per bushel and for sweet clover seed from $25 to $60. Suppliers have had their seed inventories almost wiped out by the demand.

Some farmers who usually grow only enough clover for their own use are harvesting more acreage to take advantage of the high prices.

Government programs like Payment-In-Kind have influenced the demand. Farmers find they are receiving many benefits from the planting of clovers and alfalfa. Among these benefits are natural weed control, improved soil structure, elimination of the need for

soil insecticides before the next corn crop, and fixed N in green manuring cycles.

This information reported by Fred Zahradnik in New Farm magazine.

DIRECTIONS IN COMMUNICATION

The quality of any communication effort is based on the quality of decisions regarding that effort. These decisions are built on identifying alternatives and on making judgments about those alternatives. Judgments are based on available information. The means necessary to provide this information for decision making comprise the area of evaluation. One particular type of evaluation is pretesting or formative evaluation.

Pretesting is an evaluation process that includes several activities aimed at collecting and interpreting information for the possible revision and improvement of communication efforts. One form of pretesting is geared toward revising communication products before they are developed and disseminated.

What can be pretested?

Communicators in BNF may be puzzled over exactly what can be pretested. Very simply, any message delivered by any channel can be subjected to revision, and thus pretesting.

The message being developed by a BNF program can be reviewed in any of its numerous stages of development. Message concepts, objectives, treatments, rough scripts, visuals, partially completed materials, alternative versions, and even final products may be pretested. Message components include:

1. Concepts – The ideas or key issues that underlie the topic to be communicated.
2. Objectives – The behaviorally specific outcomes the message will attempt to evoke.
3. Treatments – The suggested approaches to the content – dramatic – humorous, case history – fictitious.
4. Roughs – The early attempts at putting the message into an audience – presentable form.
5. Visuals – The pictorial images that will be used to convey or help convey the message.
6. Partially completed materials – The prototypes of the message.
7. Alternative versions – The numerous ways the message may be presented – layout, typeface, color, etc.
8. Final products – The final message may be tested to ascertain audience utilization patterns and alternative presentation modes.

Whatever message development process is used, pretesting can and should be injected into that process to bring improvements.

Messages, however, do not operate in vacuums. Messages are carried by channels, media such as printed pieces, audio-visual products, television or radio, or other media, including interpersonal channels. Pretesting methodology can be applied to every one of these presentation formats. Radio and television public service announcements, brochures, slide-sound shows, as well as logos and personal approaches have been pretested.

There is, of course, an interaction between the message and the channel that carries it. With the application of systems techniques, it is assumed that BNF communicators analyze prospective audiences and study media preferences and habits. Media selection, therefore, is not left to chance, but is based on the best available information.

– James W King

Call for INLIT Data

Cooperators in the International Network of Legume Inoculation Trials (INLIT) are urged to send in their data as soon as it has been collected to the Network Coordinator in their area.

Over one hundred "A" experiment results have been received, analyzed and returned to the cooperators. In addition, comparative analyses have been conducted on the four crops for which sufficient numbers of individual experiments have been received. Most of the data submitted so far is for "A" Experiments conducted in 1981.

Cooperators who conducted trials in 1982 are urged to submit their data and are reminded that data does not have to be submitted on the data sheets provided in the experiment booklet. Nevertheless, when recording original data, cooperators are encouraged to use these pressure sensitized sheets which make three copies at once. However, if a cooperator uses his own data collecting format, a photocopy will suffice. Caution is given that the individual plot data must be received – not merely an average of the 6 treatment means.

INLIT cooperators have the opportunity of contributing valuable information toward answering questions on the need for inoculation which varies with crops and agro-climatic conditions. These important trials will yield information which will be of use to policy makers in individual countries and by organizations worldwide.

Please send your trial results to your network coordinator at NifTAL. Network Coordinators are Paul Singleton – Sub-Sahara Africa; A. S. Whitney – North Africa/Mideast; Joann Roskoski – Latin America; and Robert J. Davis – Asia.

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Corrections

"Waste Materials as Rhizobial Carriers," a story in BNF Bulletin Volume III, Number 3, erroneously attributed this work. Crisanto Lopez, former NifTAL trainee, completed this study for his MS thesis while enrolled in the University of Philippines.

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New clover variety Fresa's scientific name is *Trifolium fragiferum* L., not *Trifolium frangiferum* L. as written in BNF Bulletin, Volume IV, Number 1.

BNF Program at FAO

Dr. R. N. Roy, Fertilizer and Plant Nutrition Research and Training Officer of the FAO (Food and Agriculture Organization of the United Nations), headquartered in Rome, Italy, recently visited NifTAL. His visit offered insight on FAO's BNF Program.

At FAO, the BNF work is done jointly by the Land and Water Development Division and the Plant Production and Protection Division.

"BNF has gained importance since the early 70s with the advent of the energy crisis," said Roy, "in that we are looking for alternative sources of plant nutrients — both renewable and cheaper sources — and for their efficient use. Over the last five years we have strengthened our BNF activity and are in the process of further strengthening it."

"FAO's mandate," he continued, "is not basic research (though to some extent they support basic research through International Research Centers and the FAO/IAEA joint division), but the transfer of economically viable technology to developing countries at the farmer's field, especially the small and marginal farmers."

Benchmark Survey

FAO's BNF (symbiotic) activities started with a bench-mark (state of BNF knowledge) survey in developing countries with the help of leading microbiologists from within each region, or from outside depending upon the need to assess their 1) present knowledge and state of development, 2) BNF's potential, 3) available staff and infrastructure, 4) need for applied research, 5) inoculant production capability and 6) assistance needed to develop and strengthen a viable BNF development program.

In the follow-up phase field programs are being developed gearing to their capabilities and requirements. These are: 1. conducting interface research through research contracts established with national organizations to collect more information on the legume/*Rhizobium* symbiosis process, (i.e., selection of cultivars, effective strains, response to inoculation, plant nutrition requirements, economic benefits, etc.);

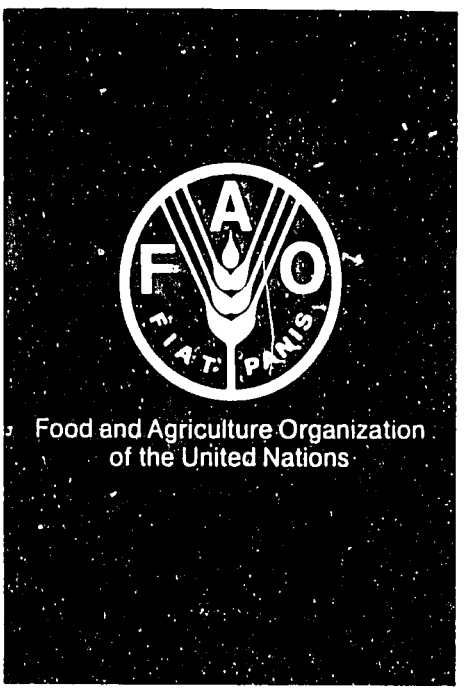
2. supporting national organizations by providing simple and inexpensive equipment and technical assistance for establishing and/or strengthening facilities for pilot scale inoculant production units, and inoculant quality control;

3. providing training at different levels:

A. International training of 3 to 6 months duration, depending upon need, for a select group.

B. Regional training courses (6 weeks duration) for BNF technicians so as to encourage discussion or exchange of experience among technicians from countries having similar agro-ecological characteristics within the framework of TCDC (Technical Cooperation among Developing Countries).

C. National training courses of varying duration for policy makers, technicians, extension workers, and farmers.



It is expected that persons trained at International and Regional courses would serve as resource persons for national courses and would develop suitable training structures for their countries. Each program would be different depending on the needs of the trainee. For instance, farmers would be taught – among other things – how to inoculate seeds, how to conserve inoculants, and the benefits and economics of BNF. FAO would assist in organizing such courses.

Another major component of the training program is development of appropriate training materials and aids, like manuals, leaflets, filmstrips, slide sets, and video modules. These are being produced centrally in FAO's official languages – English, French, and Spanish. These core materials would be translated in local languages and modified suiting local conditions and needs.

Under the auspices of the FAO/UNEP joint project, a meeting of the world's leading BNF specialists was held in June, 1980, to exchange experience, draw upon directions of future activity, delineate areas of cooperation with other organizations and avoid duplication. A similar meeting is foreseen in early 1984.

FAO's BNF (symbiotic) activity is supported by a combination of funds: FAO's regular program funds, funds made available under its Technical Cooperation Programme (TCP), a trust fund provided by the United Nations Environmental Program (UNEP), and trust funds provided by the governments of Finland and France.

Nutrition System

The BNF program is not seen in isolation but as one of the integral components of the Integrated Plant Nutrition System. This approach is being executed within the framework of FAO's well established 21 year old Fertilizer Program which is presently in operation in 17 developing countries. In this System Approach, the following are important components: 1) plant nutrients recommendation for a crop-pig system as a whole rather than for a single crop; 2) required total nutrients are supplied through three major sources: a) by organic recycling, efficient utilization, and tapping more potential sources; b) by the tapping of atmospheric nitrogen through BNF, especially symbiotic N fixation through the legume/*Rhizobium* symbiosis, a prerequisite being the introduction of legumes into the cropping system; use of blue green algae/Azolla in a rice based cropping system; and c) by the balance being met through mineral fertilizers; 3) increasing the nutrient usage efficiency through manipulation of several agro-techniques; 4) monitoring the crop yield levels, soil fertility and productivity levels, and overall the economic viability of the system for small and marginal farmers.

"NifTAL's excellent facility and achievements in BNF, especially in the field of training, is internationally recognized and an effective linkage between NifTAL and FAO already exists. The purpose of my visit to NifTAL is becoming familiar with their research and training facilities, finalizing the manuscript of the jointly prepared BNF manual, finalizing details of the proposed joint ICRISAT/NifTAL/FAO/UNEP regional training course on inoculant production being held in India, establishing a stronger linkage with BNF workers in NifTAL and delineating areas of future collaborative activity," Roy concluded.

For additional information, write Dr. Roy, AGL Division, Room: B-703, FAO of the UN, Via Delle Terme di Caracalla, 00100 Rome, Italy.

Continued from Page 2

to the moistened and sterilized pack, the final moisture content will be 60% MHC. The yeast extract/mannitol solution is autoclaved for 45 minutes and cooled before use.

Inoculum and yeast extract/mannitol solution are mixed just prior to inoculation. An automatic repeater syringe is used for inoculation and the needle hole is sealed by a self-adhesive label which can be previously marked with the batch number. The moist, sterile bagasillo and culture solution are mixed by working the bags individually. Trays of packs are incubated at 28 degrees C for 14 days. A lesser time of 12 days can be used.

Each unit contains 5.9 g bagasillo and 47.9 ml water (Vincent 1970) of which 32.9 ml are added as the solution of minerals plus 12.5 ml as the yeast/mannitol solution and 2.5 ml culture.

After incubation all packs are examined visually for contamination – although tht is a very rare occurrence if the initial sterilization was properly done. From each batch of 1,000 units, six sample packs are taken at random for checking. Serial dilutions are made from three packs. Microscope counts are done immediately on the 10^{-1} dilution as a preliminary check. The 0.2 ml aliquots from the 10^{-6} and 10^{-7} dilutions are plated onto yeast extract/mannitol agar with congo red (Vincent 1970). The plates are incubated at 28 degrees C for a week, the colonies counted, and plates examined for any contaminants.

The average values are about 650 x 10^{9} *Rhizobium* per unit as measured by the microscope count but about 10% less on the plates. This is about double the number per unit previously produced in the agar slope bottles.

Finally, the polyethylene bags are placed in waxed cardboard containers on which full instructions for their use are printed. They are stored in a cold room at 4-6 degrees C until required for issue. Persistence tests showed that the packs could be stored satisfactorily for a year at this temperature but, in practice, the maximum time in storage is probably four months. The inoculants are sold to users through co-operatives and the final checks for quality are done on samples taken periodically during inspections of these agents' stores.

Mary R. Ryder and Penelope M. Grant, Dept. of Research & Specialist Services, Ministry of Agriculture, P. O. Box 8108, Causeway, 5th Street, Extension, Harare, Zimbabwe.

N-Fixing Tree workers at the Leucaena Workshop which was held in Singapore from November 23-26, 1982.

Davis Reports on BNF In Peoples Republic of China

Dr. Bob Davis, Head, International Outreach and INLIT Network Coordinator for Asia, spent three weeks in mainland China in April and May 1983. He visited the Nitrogen Fixation Group at the Academy of Agricultural Sciences in Beijing which is headed by Professor T. S. Hu. Hu visited NifTAL under Unesco sponsorship during an international scholar exchange visit in 1981.

Davis traveled extensively in China accompanied by Professor and Mrs. Hu. This trip included indepth observations of leguminous crops and nitrogen fixation work in two provinces, Guangdong and Yunnan. Of special interest was research by provincial agronomists to establish leguminous crops in areas where slash and burn agriculture is practiced and on new small-holder rubber plantations in the area around Jinghong. This is on the Mekong immediately north of where the river forms the Burma and Laos borders.

While traveling, Davis was able to consult with NifTAL graduate student Stephen Dowdle who is doing his graduate research at Huzzhong Agricultural College, Wuhan, as an international exchange scholar.

N-Fixing Stem Nodules

A nitrogen-fixing bacterium in stem – not root – nodules is being genetically engineered by researchers at Cornell University. Drs. A. A. Szalay, and R. P. Legocki of Boyce Thompson Institute for Plant Research said that in July they expressed in nitrogen-fixing and photosynthesizing stem nodules of the nonfood legume *Aeschynomene scabra* the *Escherichia coli* gene for β-galactosidase.

"Compared with control nodules inoculated with unmodified stem *Rhizobium*, the nodules inoculated with recombinant *Rhizobium* showed a much higher level of β-galactosidase," Legocki says.

How did the researchers express the foreign protein? First, they sequenced in *Rhizobium* BTAil the nitrogen-fixing gene promoter nif H, which initiates synthesis of nitrogenase reductase, and attached it to the β-galactosidase gene. Then they spliced this stretch of DNA into the bacterium's chromosome and inoculated *A. scabra* stems. "Our goal," Legocki says, "is to develop our gene-transfer system so it uses *Rhizobium* to express and deliver to agronomic plants proteins for such properties as viral and fungal resistance."

Boyce Thompson Institute has filed for a U.S. Patent on its cloning process and is applying for a three-year, $450,000 grant from the National Science Foundation to continue the project.

(From Newswatch, McGraw-Hill)

SHORT TAKES

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The College of Agriculture in Jamaica is starting to work with the legume/*Rhizobium* symbiosis. The contact person there is **Dr. Donald Buddle.**

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Dr. Thomas Lumpkin has accepted a position as assistant professor in the Department of Agriculture and Soils of Washington State University at Pullman.

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Colin E. Hughes, Research Officer, Unit of Tropical Silviculture, Commonwealth Forestry Institute, is currently in Central America. He will be collecting seed germplasm from N-fixing trees and discussing current research.

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Joining the NifTAL staff as Head of the Research Section is **Dr. Joann Roskoski.** She has worked in Mexico and most recently at Arizona State University. Roskoski will also serve as coordinator of the Latin American region of the INLIT.

• • •

Dr. Michael J. Sadowsky will be leaving the University of Hawaii to take up a post-doctoral position at McGill University, Montreal, Canada. He will be working with Dr. D.P. Verma.

• • •

Dr. Abateni Ayanaba, formerly director of IITA in Ibadan, Nigeria, has joined the agricultural research staff of Allied, Inc., a New York-based corporation.

• • •

Dr. Winston Brill formerly with the Center for Studies of N-Fixation at the University of Wisconsin has joined the staff of Celsus.

• • •

U Hla Than of the Agricultural Research Corporation, Yezin, Burma, has returned home following an intern training program at the NifTAL Project. He completed research on several projects including collecting nodules and solating *Rhizobium* from native legumes on Maui, performing *Rhizobium* strain selection for tropical Lima (*Phaseolus lunatus*) and testing host strain interaction in the Lima bean on four cultivars of American Lima beans using six strains of *Rhizobium*.

Nearly completed are two other experiments. The first of these examines competition of three strains of *Rhizobium*, applied as a mixed peat based inoculum, for nodulation and N-fixing ability on four cultivars of Lima bean and the other tests the quality of ten batches of peat based *Rhizobium* inoculants produced in Burma. He will soon be conducting a field trial in Burma testing the effect of different methods of inoculation on the yield components and *Rhizobium* strain competition in Lima bean.

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Dr. Al App has been appointed Director for Agricultural Sciences, the Rockefeller Foundation, beginning 1 November 1983. App can be reached at 1133 Avenue of the Americas, New York, NY 10036 USA.

• • •

A one semester sabbatical begins in September for **Dr. B. Ben Bohlool** of the University of Hawaii. Among the many contacts he will make will be a visit with Dr. E. L. Schmidt of the University of Minnesota.

BNF BULLETIN
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For Information on the NifTAL Project contact Dr. Jake Halliday, NifTAL Project, P. O. Box O, Paia, Hawaii 96779. Submissions to the BNF BULLETIN may be sent: Attention: Communication Section, NifTAL Project.

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.

Editors:
Dr. James King
Princess Ferguson

Graphics:
Keith Avery

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S. K. Kothari is currently finishing his PhD research "Effect of symbiotic and non-symbiotic bacterial inoculation on the growth and yield of mung bean and its nitrogen economy over fallowing on the succeeding crop of fodder sorghum." He is working with Dr. C. S. Saraf of the Indian Agricultural Research Institute.

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BIOLOGICAL NITROGEN FIXATION BULLETIN

Volume IV, Number 3

New and Successful

BNF Technology Course

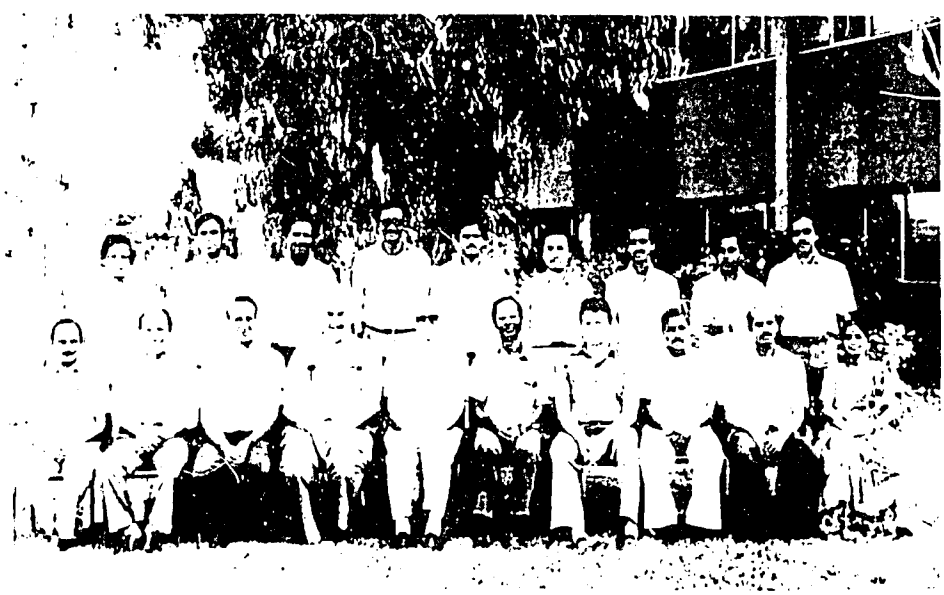
"Successful!" was the way course co-directors Drs. P. Somasegaran and J. Thompson and training coordinator Mr. H. Hoben described the results of the BNF Course.

Thirteen *Rhizobium* inoculant producers and researchers from four countries spent six weeks in September and October attending the training course in *Rhizobium* Technology with an emphasis on Inoculant Production and Quality Control.

The innovative content for the course included: (1) comparison of different *Rhizobium* inoculant carriers (lignite, ground charcoal, and Australian and USA peat); (2) sterilization (autoclaving) of carrier material in sealed polypropylene bags available in India; (3) small scale fermenters (glass and stainless steel) which could be adapted to the automatic syringe system for injecting presterilized packaged carries. Both types of fermentors will be adapted for use in India; (4) the plant infection (MPN) technique; and (5) purity check of broth cultures using agglutination.

Participants from India included Dr. G.R. Gajendragadkar, Dr. F. Chand Garg, Mrs. Krishna Gupta, Mr. P. Mohan Khosla, Mr. Dulare Lal, Mr. R.D. Mehta, Mr. B.A. Patel, Mr. V. Basava Raju, and Dr. S.K. Roy. Those representing other countries were Dr. Farouk M. Hammouda, Egypt; Mr. E. Santosa, Indonesia, and Drs. A. Ali Mahdi and A.G.E. El Shafie, Sudan, Sudan.

Held at ICRISAT in India, the course was sponsored by FAO, ICRISAT, and NifTAL. ICRISAT was represented by Drs. Thompson, Rupela, Nambiar, and Krishna; NifTAL by Drs. Somasegaran, Beck, Davis, and Mr. Hoben, and FAO by Drs. Roy and Riveros.



India/USA Scientific Exchange Agreement

BNF will be a prime area of scientific exchange in the newly formed Indo-U.S. Science and Technology Initiative. U.S. President Reagan and India's Prime Minister Indira Gandhi endorsed the plan in order to bring the two countries together in mutually beneficial scientific advancement. In the U.S., the National Science Foundation will administer the overall program and will coordinate research funded by the USDA, USAID, and others.

Collaborative research in the areas of fuelwood trees, nitrogen efficiency in crop production systems, the efficient use of fertilizers in irrigated lands will join nitrogen fixation as foci of agricultural research.

Earlier in 1983, discussions were held in Washington, D.C., on potential project areas that would benefit both countries. Some of these possible projects are: 1) to improve the *Rhizobium* – legume association by selecting highly efficient strains for legumes of economic importance to withstand environmental hazards of rain-fed cultivation; 2) to improve the efficiency and shelf-life of carrier based inoculants; 3) to design better seed and soil inoculation procedures; and 4) to develop an "Inoculant Quality Incentive Program."

The effort is expected to be a true exchange that will be beneficial to both countries.

BNF Workers Meet in Bangkok

In October, a planning workshop was held in Bangkok with the purpose of developing a workplan for the BNF Resource Center suited to the needs of regional researchers and program managers.

Scientists and administrators from South and Southeast Asia presented synopses of their BNF programs, expanding on their most pressing needs in terms of research and promotion.

These needs closely matched those which had been identified within the scope of NifTAL's BNF Resource Center's proposed plan. A major point was meeting the region's particular requirements for research, information, and training.

Continued on page 6

Inoculant Shipping Evaluation Results

Samples of granular soil inoculant were sent from INTSOY in Illinois to cooperators around the world in the International Inoculant Shipping evaluation (IISE). This experiment, conducted in 1979, resulted in cooperators returning seventy-six samples to the INTSOY lab in Puerto Rico for quality analysis.

Analysis of the samples indicated that the quality of the inoculant, which initially contained 1.0×10^{7} *R. japonicum* cells per gram, decreased during shipment from the effects of time, temperature, and moisture. These factors were measured in terms of shipping days, maximum exposed temperature, and final inoculant moisture, respectively. The effect of these three factors on final inoculant quality was determined by agar-plate counting of the live, colony-producing units in the inoculant.

The rhizobia population in 88 percent of the samples decreased to a level between 1.0×10^{7} and 9.9×10^{7} cells per gram. However, it is estimated that a granular soil inoculant with a population of 1.0×10^{7} cells per gram would deliver more rhizobia than would a seed-applied powder inoculant with a population of 1.0×10^{7} cells per gram. This suggests that most of the returned samples, when used as granular soil inoculants, would provide sufficient rhizobia to nodulate soybeans under favorable growing conditions even after being stressed by time, temperature, and desiccation.

The relationship between the *R. japonicum* population and the number of shipping days and temperature exposure were both significant. An inverse relationship was exhibited with each of these independent variables. While the relationship with the third independent variable, final inoculant moisture, was also significant, it was directly related to the final population of *R. japonicum*. While time, temperature, and moisture affected the final rhizobial population in the granular inoculant, the final inoculant moisture exerted the largest influence.

For further information on this work which was authored by R. S. Smith, W. M. Judy, and W. C. Stearn, contact INTSOY, College of Agriculture, University of Illinois, 113 Mumford Hall, 1301 West Gregory Drive, Urbana, Illinois, 61801.

More NAS Grants

Three more Biological Nitrogen Fixation grantees have been announced by BOSTID (Board of Scientific Technology for International Development).

New recipients include: Jean Fenel Felix, State University of Haiti, "Inoculation of Pigeonpea;" C.K. John, Rubber Research Institute, Malaysia, "Maximum Yield of Legumes in Rubber Plantations;" and Roberto de Leon, ICAITI, Guatemala, "Stress Inducing Factors on *R. phaseoli* as Related to Inoculatant Carrier Preparation."

Grants average close to $100,000 and they may be carried out over a 2, 3, or 4 year period. Grant funds may be used for salaries, travel, equipment, and research expenses. The grant recipient will contribute to the research by providing partial support of the research staff, laboratory and/or field testing facilities, vehicles, and administrative services.

Announcements for the fast-growing, nitrogen-fixing tree and biological nitrogen fixation projects, setting forth project guidelines, are available from Dr. Michael P. Greene, Executive Secretary, Committee on Research Grants, BOSTID, National Research Council, 2101 Constitution Avenue, Washington, D.C. 20418. The next grant submission deadline is May 31, 1984.

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Editors:
Dr. James King
Princess Ferguson

Graphics:
Keith Avery

ANNOUNCEMENTS

15th International Grassland Congress

Advances in Grassland Science for the Betterment of All Mankind will be the theme of the 15th International Grassland Congress. Kyoto, Japan will be venue for the August 1985 conference. For further information contact: The Secretariat, XV International Grassland Congress, c/o National Grassland Research Institute, Nishinasuno, Tochigi, 329-27, Japan.

N-Fixation & CO_2 Metabolism

The 14th Steenbock Symposium will be 17-22 June 1984 at the University of Wisconsin-Madison.

Topics will cover N-Fixation and CO_2 metabolism. This meeting will honor the scientific contributions of R.H. Burris.

Some of the scheduled sessions and speakers are: Biochemistry of the Legume Nodule (Evans, Klucas, Emerich, Newcomb, Dilworth); Genetics and Molecular Biology (Brill, Long, Haselkorn, Kondorosi); N-Fixation in Non-Legumes (Okon, Benson, Tjepkema, Quispel); Physiology of Free-living N-Fixers (Postgate, Stevens, Lidstrom, Kanemoto, Houchins).

For further information, write by February 28, 1984: Fourteenth Steenbock Symposium, Department of Biochemistry, University of Wisconsin, Madison, WI 53706, U.S.A.

2nd International Conference on Biological Agriculture

The Role of Microorganisms in a Sustainable Agriculture will be the title of the Second International Conference on Biological Agriculture. Venue will be Wye, England, September 1984. Topics of interest to BNF researchers will be nitrogen fixation and the nitrogen cycle in biological agriculture (J. Sprent and D. Patriquin) and the potential role of mycorrhizae (B. Mosse). For information, write Dr. I. M. Lopez-Real, Wye College (University of London), Wye, Ashford, Kent, TN25 5AH, England.

New Bulletin Feature: Calendar of Events

Beginning this issue, a calendar of upcoming BNF events will be printed on page 1 of each Continuing Bibliography insert of the BNF Bulletin. This calendar will list events of interest to BNF workers and will include events scheduled over the next three years.

Any items for the calendar should be sent to the BNF Bulletin, Attn: Calendar.

2nd Azolla Training Course

The second Azolla training course was completed this fall in Senegal.

Co-sponsored by NifTAL and the West African Rice Development Association, the workshop was led by Dr. T. Lumpkin with Drs. I. Watanabe (IRRI) and C. Van Hobe cooperating.

Newsletter Name Changed

The recently begun publication, BIOLOGICAL NITROGEN FIXATION NEWSLETTER, replaces the NON-SYMBIOTIC NITROGEN FIXATION NEWSLETTER. Plans are that the publication will facilitate the informal exchange of information on N-fixation, and will include items of news, bibliographies, and lists of publications, occasional reproduction of important journal articles (by permission of the journal), and original articles submitted by the readers.

These original articles are not refereed and may include preliminary results or laboratory procedures ("tricks of the trade") which are important for successful experimentation but not always acceptable for publication in formal scientific journals.

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XII Latin American Meeting

The Instituto Agronomico in Campinas, S.P., Brazil, will host the XII Latin American *Rhizobium* meeting from 21-26 October 1984. The meeting will promote ALAR (Associacao Latinoamericana de Rhizobiologistas) and the Sociedade Brasileria de Ciencia do Solo. Cooperating meeting sponsors are the Centro de Energia Nuclear na Agricultura, Piracicaba, S.P.; ESALQ, Piracicaba, S.P.; Instituto de Zootecnia, Nova Odessa, S.P.; PNPB - EMBRAPA, Seropedica, Km 47, R.J., and NifTAL, University of Hawaii.

For information, contact Eli Sidney Lopes, Instituto Agronomico, Cx. Postal 28, S.P., Brasil, 13.100 Campinas, S.P., Brasil.

Azolla Training

A 5-day Azolla training course for Asia will be held in Bangkhen Thailand from 22-28 February, 1984. The course will be held in the Thai Rhizobium Building under the auspices of NifTAL's BNF Resource Center. Dr. T. Lumpkin will supervise the course with additional lectures given by Drs. C. Van Hove and Kulasooriya.

The course, developed from previous courses, is expected to be the best yet. The course schedule includes a field trip to observe Azolla in rice production and one day for discussion and problem solving sessions.

For information on the course, contact the BNF Resource Center, Rhizobium Building, Soil Science Division, Department of Agriculture, Bangkok, 10900, Thailand.

3rd International Symposium With Non-Legumes

The Third International Symposium on Nitrogen Fixation with Non-Legumes will be held in Helsinki, Finland, 2-8 September 1984. Sessions will cover biochemistry, genetics and methods of measuring N-fixation, along with N-fixation by non-legumes in agriculture and forestry. Main speakers will include J. Balandreau, W. Brill, P. Dart, J. Day, R. Dixon, M. Lalonde, Y. Okon, I. Watanabe, and C. Wheeler. Write to: SITRA FIN-NIF, P. O. Box 329, SF-00121 Helsinki 12, Finland.

MEETING NOTES

Hundreds Review N-Fixation

The Fifth International Symposium on Nitrogen Fixation held 28 August to 3 September in Noordwijkerhout, The Netherlands, was attended by approximately 600 scientists from 50 nations. Despite the symposium's large size, excellent organization led to a very fruitful and remarkably personal experience for most participants.

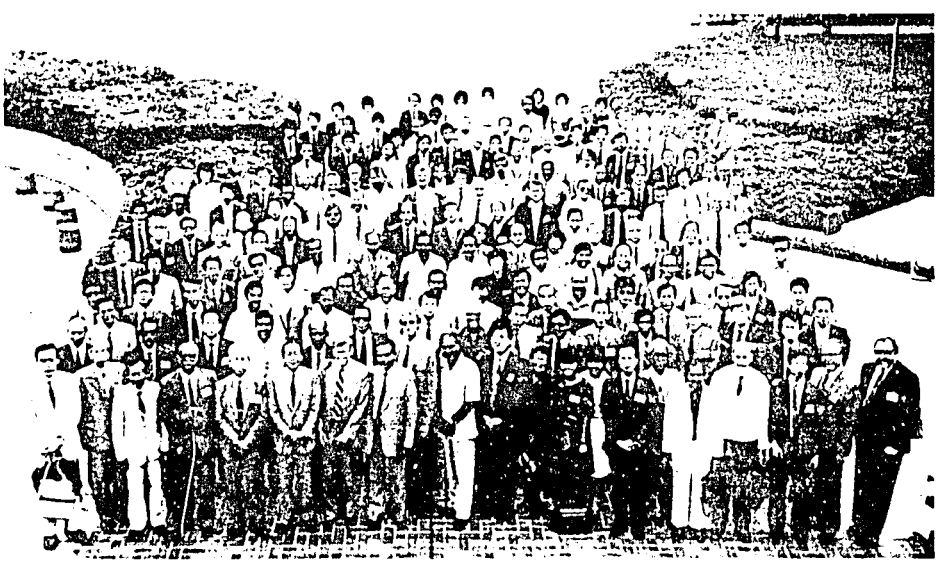
The organizers, desiring to give "new blood" the podium, invited young BNF experts to present the forty formal lectures. These were divided into the following areas: bacterial and plant genetics and physiology, chemistry, enzymology, rhizobial specificity and ecology, and application of BNF to agriculture and forestry.

Over 300 topically grouped posters formed the heart of the symposium. The poster format not only gave participants the opportunity to question—in depth—researchers working in their area of interest, but also provided the chance to establish collaborative associations and friendships.

Based on the formal presentations, posters, and discussion sessions, one could conclude: that much controversy remains on the "best way" to measure BNF; that our basic understanding of BNF is considerable—though not complete; and that our ability to apply potentially useful basic findings is lacking. Two fundamental questions that need to be answered are: how do we transfer basic BNF information into meaningful application? and, perhaps more importantly, who will do it?

Other meeting highlights included a testimonial honoring A. Quispel, editor of the first big book on BNF, on the occasion of his retirement, and an excursion mid-symposium which allowed participants not only to experience some Dutch history, scenery, and weather (especially those on the 30 km. bicycle excursion who rode in the rain), but also a chance to reenergize for the remainder of the conference.

Soybean Research Discussed



In late September, over 200 scientists representing 25 countries gathered in Japan to review soybean use in the tropics. The First International Symposium on Soybeans in Tropical and Subtropical Cropping Systems was held at Tsukuba, Japan.

The 76 presentations concerned numerous facets of soybean culture, crop management, and cultural practices in various countries. The proceedings are scheduled for publication in early 1984 by Asian Vegetable Research and Development Center, Taiwan, ROC.

Following the meeting, the participants were given a tour of the Tsukuba Science City. The center, built in 1980, includes a plant nutrition laboratory, *Rhizobium* laboratory, soil profile building, and germplasm preservation center.

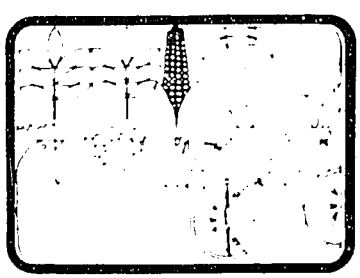
Cropping Systems Explored

A workshop, Nitrogen Cycling in Tropical Cropping Systems with Legumes, sponsored by NifTAL and hosted by Rodale Press, was held from 13-15 July at Rodale Research Farms, Emmaus, Pennsylvania.

Workshop sessions focused on the adequacy of existing data to construct a nitrogen model for a tropical cropping system; prioritizing the nitrogen cycling processes that should be assessed in nitrogen cycling studies; suggesting mixed-cropping systems for N-cycling work in Asia, Africa, and Latin America; and recommending that basic studies on BNF in mixed cropping systems be undertaken.

Participants included: L. Frederick, E. French, M. Fried, S. Gleissman, H. D. Gross, R. Harwood, E. Henzell, W. Liebhardt, E. Odum, E. Paul, J. Roskoski, O. L. Smith, J. Thompson, D. Welsch, and A. Whitney.

Discussions by the multi-disciplinary workshop group explored not only scientific, but economic, sociological, and anthropological issues. The group's views aired many factors pertinent to transferring cropping systems to developing farmers. The meeting proceedings will be announced when they become available in mid-1984.



Nitrogen Fixation in Tropical Trees

Dr. Johanna Dobereiner's group at Rio de Janeiro hosted the 19-24 September Symposium on Nitrogen Fixing Trees for the Tropics. A large number of new N-fixing trees were reported and working groups addressed priorities for research. Proceedings will be available as a special edition of Pesq. Agrop. Brasil. This meeting, during the 10th Anniversary of EMBRAPA, coincided with Tree Week in Brazil. Each participant planted a leguminous tree seedling on the grounds at "km 47"—great idea, Johanna!

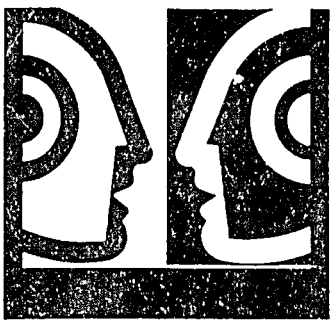
DIRECTIONS IN COMMUNICATION

Scientific Conferences – Face to Face Communication

A recent editorial in Science (Vol. 224 (4615) brought together some very serious and valid arguments against annual meetings of scientific societies.

The author, P. H. Abelson, noted several problems which he felt limited the value of such meetings: participant costs, impersonal settings, simultaneous sessions, formula talks, and illegible visuals. He mentioned a growing trend in opposition to the annual meeting, already well established within the BNF community, to hold smaller symposiums lasting a week, held in secluded spots free from working distraction, with time for the crucial personal interactions.

These smaller scientific meetings encourage face to face communication which is a most effective method to bring about



change. The symposium allows for direct presentation, questioning, and rebuttal. If we think of the scientific meeting as one communication technique to bring about the sharing of information, through personal interaction, we can see why BNF researchers have already captialized on the smaller symposium concept. BNF experts attending such meetings as the North American Rhizobium Conference and the International BNF Symposium can list specific advantages to such meetings. These are to hear prominent researchers who are creating new visions; to speak out on issues of concern; to learn new things and clarify old ones; to see exhibits of new technologies; to do business with funding agents and to check on contractees; to form new friendships with the growing number of emerging professionals, and to enjoy old friendships and enlarge them.

The growing networks of common interest and concern to BNF researchers are realized at these meetings, which also communicate to larger audiences, beyond the participants, through follow-up documents, requests for proposals, and proceedings. Recent examples are the International Workshop on BNF for Tropical Agriculture (1981, Colombia, sponsored by CIAT, NifTAL, and ICRISAT), the Workshop on Leucaena Research in the Asian-Pacific Region (1982, Singapore, sponsored by IDRC and NFTA) and the many NAS meetings on legumes.

Targeted meetings of BNF workers are effective mechanisms to communicate. They provide unique opportunities to discuss the advances in agrotechnology and biotechnology based systems that fix nitrogen biologically, opportunities that should not be missed and, in fact, made the most of.

– James W. King

Spanish N-Fixation Society Formed

Meeting organizer Dr. C. Rodriguez-Barrueco, Head of the Unit of Nitrogen Fixation, Consejo Superior de Investigaciones Cientificas (CSIC) Salamanca, reports that The 1st National Meeting on Nitrogen Fixation was held from 8-10 June 1983 in Salamanca, Spain. The meeting was sponsored by the CSIC and the Instituto Nacional de Investigaciones Agriarias (INIA).

Twenty groups from Spanish research institutions participated presenting 40 papers. Meeting sessions were held on physiology, genetics, agronomy, and ecology. Invited speakers were R. Dixon, (Unit of N Fixation – Sussex University, UK), and A. J .P. Burggraaf (Botany Department, Leiden University, Holland).

The meeting served to assess present interest and activity in N Fixation and to form the Sociedad Espanola de Fijacion de Nitrogeno (Spanish Nitrogen Fixation Society) which will promote N-fixation activities and collaboration among its members. The society's address is Unidad de Fijacion de Nitrogeno, CSIC, Apartado 257, Salamanca, Spain.

Internship Completed

Dr. Hago M. AbdelMagid recently completed an internship with NifTAL. During his internship, he conducted research in the following areas: 1. examining the interaction between *Rhizobium* strain effectiveness (5 strains), phosphorus nutrition (4 levels), and N yields in soybean; 2. examining the interaction between the mineralization rate of soil N and N-fixation with five strains of *Rhizobium japonicum;* and 3. a) testing the effectiveness of ten strains of *Rhizobium spp.* with six different *Sesbania* species, and b) selecting for soil salinity tolerance among *Sesbania* species using selected rhizobia.

Dr. AbdelMagid is on the faculty of the University of Khartoum, Shambat, Sudan.

NEW PUBLICATIONS

Soybean Production in the Tropics. K. Hinson and E.E. Hartwig, revised by Harry C. Minor. FAO Plant Production and Protection Paper. 1982. Available through FAO sales agents or directly from Distribution and Sales Section, FAO, Via delle Terme di Caracalla, 00100, Rome, Italy.

This is a useful reference for more fully exploiting the potential of soybean as a food and feed source and crop to improve the income of farmers in the tropics.

•

World Catalogue of Rhizobium Collections. Compiled by F.A. Skinner, E. Hamatova, and V.F. McGowan, edited by V.B.D. Skerman. 1983. Available from World Data Center for Microorganisms, University of Queensland, Brisbane, Australia.

This catalogue is a practical, useful resource document intended to help researchers, agronomists, and inoculant producers to obtain the cultures necessary for their work. The book is not intended to be a complete list of strains of *Rhizobium* held in culture collections throughout the world.

•

Leucaena Research in the Asian-Pacific Region. Proceedings of a Workshop held in Singapore, 23-26 November 1982. IDRC-211e, 1983. Available from International Development Research Centre, Box 8500, Ottawa, Canada K1G 3H9.

Included papers from 30 researchers clarify the capabilities and limitations of *Leucaena*.

•

Intercropping. Proceedings of the Second Symposium on Intercropping in Semi-Arid Areas, held at Morogoro, Tanzania, 4-7 August 1980. C.L.Keswani and B.J. Ndunguru, IDRC-186e, 1982. Available from International Development Research Centre, Box 8500, Ottawa, Canada K1G 3H9.

Several articles, such as those on agroforestry and legume intercropping, will be of interest to BNF researchers.

•

Calliandra: A Versatile Small Tree for the Humid Tropics. Report of an Ad Hoc Panel. National Academy Press. 1983. Request from Office of International Affairs (JH-217D), National Research Council, 2101 Constitution Avenue, Washington, D.C. 20418.

This report describes the tree legume, *Calliandra calothyrsus*, and reports on production and management, products and applications, and recommendations and research needs. A bibliography is also provided along with a list of researchers working with *Calliandra*.

•

Forestry for Rural Communities. FAO Forestry Department. Available through FAO sales agents or directly from Distribution and Sales Section, FAO, Via delle Terme di Caracalla, 00100, Rome, Italy.

This booklet describes in general terms what is involved, what needs to be done, and how to begin enabling people in rural areas to benefit from trees and forestry.

•

A Selected and Annotated Bibliography of Tropical Green Manures and Legume Covers. D.O. Evans, R.S. Yost, and G.W. Lundeen. UH Research Extension Series 028. 1983. Available from The Hawaii Institute of Tropical Agriculture and Human Resources, University of Hawaii, Honolulu, HI 96822.

This bibliography is intended as a reference to access what is known about green manuring and use of legumes as covers in the tropics. Green manure is used with annual crops and is commonly incorporated into the soil. In contrast, legume covers are usually grown simultaneously with perennial plantation crops

•

Legumes in Human Nutrition. W.R. Aykroyd, Joyce Doughty. Revised by Joyce Doughty and Ann Walker. FAO Food and Nutrition Paper 20. 1982. Available through FAO sales agents or directly from Distribution and Sales Section, FAO, Via delle Terme di Caracalla, 00100, Rome, Italy.

This paper looks at human nutrition research (since 1964) which stresses the many valuable elements that legumes contribute to human well-being.

Continued from page 2

BNF Workers Meet

The primary goal of the Resource Center is to insure that each country has one institute capable of offering research support, training, and information services tailored to national BNF priorities. Support will not be limited to the legume - *Rhizobium* symbiosis, but will include other forms of BNF usable in tropical farming systems.

A steering committee has been formed. It will meet yearly to evaluate past activities and orient the Center toward changing regional needs. This committee will be composed of two elected delegates - one each from a country of South and Southeast Asia, the Director General of the Thai Department of Agriculture, Head of the Thai Soil Microbiology Branch, the Director of the Resource Center, and the NifTAL Director. Regional delegates, who will be chosen by their peers, will serve a one year term and will represent the Center at various functions, as well as help to guide the operation of the Center.

BNF research and promotion are rapidly gaining momentum. Policy makers are recognizing the importance of this technology to their agricultural programs. This fact increases the need for cooperation between institutions to prevent overlap of effort and to gather the information necessary for full utilization of BNF technology.

COSTEF - Philippines Reforestation Program

In the Philippines, "billions of pesos have been appropriated for government reforestation programs in the last 25 years with very little to show in terms of reforested areas. By now, the total area of degraded forest lands must be around eight to ten million hectares (the Philippines has a total land area of 30 million hectare) with varying needs for rehabilitation or development into productive lands once more."

According to Dr. A. V. Revilla, Jr., Associate Dean and Director, Forestry Development Center, the proposed COSTEF System is a cost-effective and socially relishing new approach to reforestation/agroforestation (R/A) strategy.

For more information on the COSTEF system, contact Dr. Revilla at the College of Forestry, University of the Philippines at Los Banos, Philippines.

N-FIXING TREE NOTES

In India, leucaena, known there as subabul, is of interest to Bharatiya Agro Industries Foundation (BAIF). BAIF, under the directorship of Manibhai Desai, has been instrumental in organizing two national seminars on subabul and is a major supplier of seeds and saplings to various researchers in India. For information, write BAIF, Kamdhenu, Senapati Baput Road, Pune 411 016, India.

Recently beginning research with subabul in India is ASPEE (Agricultural Research and Development Foundation). ASPEE's address is Post Box 7602, Malad, Bombay 400064, India.

Forester Jerry Bisson has been assigned to USAID Manila. His work will be in the areas of watershed management, range improvement, agroforestry, reforestation, and wood production.

NFTA (Nitrogen Fixing Tree Association) has released Volume 1 of Nitrogen Fixing Tree Research Reports (NFTRR). The publication is a companion to Leucaena Research Reports and is available from: NFTA, P. O. Box 680, Waimanalo, HI 96795, USA.

The Forage Research Project in Indonesia is screening a range of tree legumes in key locations throughout the country. They are interested in contacting researchers to exchange information from the project's nurseries. Write Graeme J. Blair, Project Manager, Balai Penilitian Ternak, P. O. Box 123, Bogor, Indonesia.

Denis S. Amara, Researcher at Njala University College, University of Sierra Leone, and former NifTAL trainee, has signed a research agreement between UH NifTAL Project and his college. Under the agreement, he will establish an experimental leucaena seed production orchard to test a production system presently in use at NifTAL. The orchard will serve to meet requests for improved leucaena seed in Africa.

Available from the Reference Section, USDA, National Agricultural Library Building, Beltsville, MD 20705, is a 186 citation bibliography on N-Fixing trees. This publication, NAL-BIBL.—83-01 in the Quick Bibliography Series, is titled Selected Nitrogen-Fixing Trees: Energy Considerations 1970-1982.

SHORT TAKES

Dr. J.H. Stephens, microbiologist, has moved from Canada to ICARDA, the International Center for Agricultural Research in the Dry Areas, in Aleppo, Syria.

• • •

NifTAL and the Food & Fertilizer Technology Center for the Asian and Pacific Region, Taipei, Taiwan, have decided to formalize linkages that have existed between the respective staff members for several years. **Dr. T.C. Juang**, FFTC Director, visited with NifTAL Director **Jake Halliday** in Hawaii where the two signed a Memorandum of Agreement covering future collaborative ventures.

• • •

A. Balasubramanian of Tamil Nadu Agricultural University, Coimbatore, India, recently underwent 6-months of post-doctoral training in *Rhizobium* Genetics and N-15 Assay Techniques. He studied in the Department of Soil Microbiology, Rothamsted Experimental Station, Harpenden, England.

He worked with J. E. Beringer, P. R. Hirsch, and J. F. Witty on the following projects: determination of the intrinsic antibiotic resistance of some fast-growing cowpea *Rhizobium* strains; plasmid transfer between strains of *Rhizobium* and *E. coli;* methods of obtaining transposon mutagenesis in fast-growing cowpea strains; quantification of N2-fixation by *Azolla* under rice paddy conditions and by *Phaseolus* using N-15 techniques, and transfer of biologically fixed dinitrogen from *Azolla* to rice and from *Phaseolus* to maize.

• • •

Dr. John Thompson has returned to the Horticultural Research Station in Gosford, New South Wales, Australia, from ICRISAT in India.

• • •

Dr. Peter J. Dart has also left ICRISAT and can be reached at the Australian National University, Canberra, New South Wales, Australia, 2600.

Dr. W. Herath, Deputy Director General of the International Dambala (Winged Bean) Institute in Sri Lanka, reports that the Institute will soon be conducting its first field experiments with Winged Beans. During 1984, the Institute plans to collect and evaluate Winged Bean germination.

Dr. Herath also notes that **Dr. Shiva Shankar** at Bangalore University is working on a semi-dwarf Winged Bean Plant.

• • •

Dr. S. Asunuma has moved from IITA for the faculty of Agriculture, Kyushu Tokai University, Kawayo, Choyomura, Asogun, Kumamoto, 869-14, Japan.

• • •

Dr. Chris Stearn, INTSOY microbiologist, is now stationed at the Asian Vegetable Research and Development Center (AVRDC) in Shanhua, Taiwan. Dr. Stearn will conduct microbiology research programs in Asia.

Soybeans in the Tropics

Many facets of soybean culture were discussed at the First International Symposium on Soybeans in Tropical and Subtropical Cropping Systems held at Tsukuba, Japan, earlier this year.

Some of the aspects discussed are reported below by Dr. Joe C. Burton.

Expanding Use of Soybeans in the Tropics

Interest in soybean culture in the tropics is continuing to grow not only because of the greater recognition of the quality of this legume as a substitute for meat, but because it fits into the multiple cropping system so well. In some areas, it is possible to produce three soybean crops annually. However, in most countries the soybean is used as a pre-crop or follow-up crop to supplement income from the main crop of rice or maize, intercropping of soybeans with cassava or with rubber or palm trees is also popular in some countries.

In contrast to the large producing areas, cultivars of soybean which mature in 80 to 90 days are preferred over the higher producing longer maturing genotypes grown in the U.S. or Brazil, which require 110 to 130 days to mature. Yields of one to one and one-half tons per hectare are quite satisfactory in the tropics, but these would not be acceptable in the U.S. or in Brazil.

There was considerable discussion on the growing need for soybeans and some of the prospects of filling this need. Soybean culture is increasing in the tropics but the area used to grow soybeans in the tropical countries is so small in comparison with that of the U.S. or Brazil that these increases will not affect world supplies to any significant degree. It is estimated that the world's need for soybeans will double by the year 2,000. The possibilities of increasing soybean acreage in the U.S. are not very great. Brazil, with its vast reserve of undeveloped land in the more tropical regions, offers the most promise. Brazilian representatives suggested that development of these areas will be economical and that it can be done with present technology.

Nitrogen Fertilization of Soybeans

In temperate climates where soybeans are grown, the application of nitrogen fertilizer is considered a wasteful practice. Soybean yields are not usually increased; the fertilizer nitrogen merely reduces the nitrogen fixed in the soybean nodules. However, this is not true in many of the tropical countries and even in some of the more temperate regions. In Japan, top dressing with 120 kg N/ha increased grain and protein yield by 6.7 and 1.3% respectively. Increases varied with cultivar. Application after initiation of flowering appeared to be the optimum time. Yield response of soybeans to combined N remained relatively constant up to 200 kg N/ha. Nodule contribution decreased when fixed N exceeded 200 kg N/ha. It appears that the fast-maturing cultivars of soybeans are more likely to respond to N fertilizer than the slower-maturing varieties grown in the temperate climates.

Cost of Planting Soybeans

Most of the soybeans in the rice paddies are planted by hand. Mr. Singh from Thailand demonstrated a new planter designed to give more uniform planting both in seeds per hill and in depth. Ordinarily it requires 45 man-days to plant one hectare of soybeans. At the low wage of $2.00 U.S. per day, it would cost $90.00 U.S. to seed one hectare of soybeans. With the new planter, the cost could be reduced to $45.00 per hectare.

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BIOLOGICAL NITROGEN FIXATION

BULLETIN

Volume V, Number 1

Low Cost Commercial Scale

New Course on Legume Inoculant Production

Production of high quality legume inoculants at a local level in developing countries is the goal for NifTAL's 3 - 21 December course.

This practical course is for producers of legume inoculants for farmer use. It covers simplified fermentor design and operation, as well as, carrier processing and packaging. Equipment and process options for various levels of investment will be discussed. Content areas for the course will include carrier preparation, broth culture preparation, inoculant preparation and production, quality control, and inoculant use.

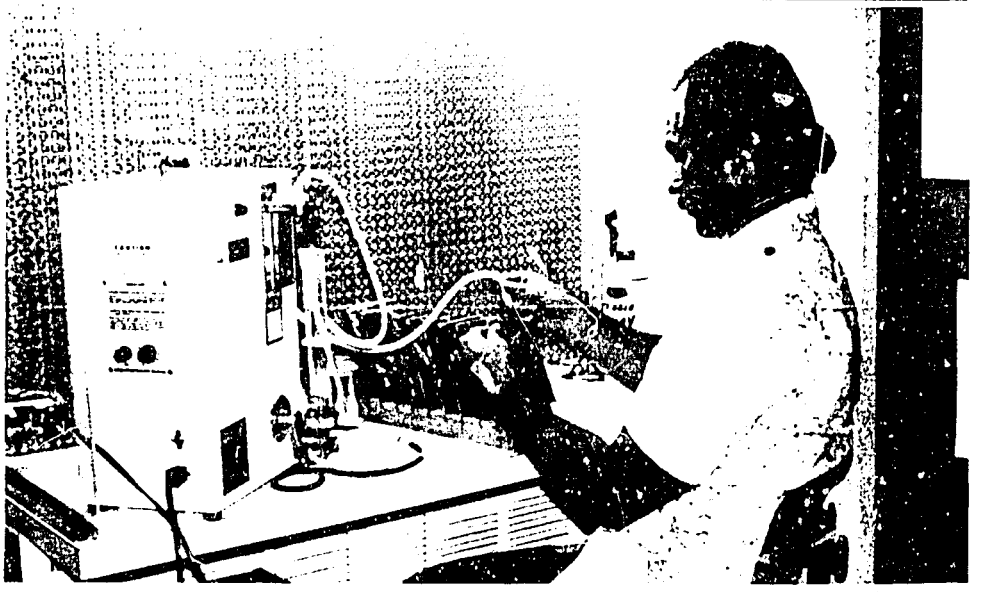
Drs. J. C. Burton and R. J. Roughley, internationally recognized authorities on commercial-scale inoculant production, will head a team of respected instructors at the NifTAL Haleakala Inoculant Production Plant.

Prospective participants should have training in microbiology; have involvement (current or anticipated) in inoculant production; have had previous *Rhizobium* training; be proficient in the English language; and be financially sponsored.

Interested persons should apply by 15 July to Legume Inoculant Production Course, NifTAL Project-MIRCEN, P.O. Box 0, Paia, Maui, HI 96779 USA. Ten candidates can be accepted. NifTAL waives tuition fees for selected candidates. NifTAL does not offer financial assistance for participant's travel or other costs. Information on housing costs, etc., is available on request.

USAID has initiated priority efforts calling for increased resources devoted to research in agriculture and biotechnology. And, at the same time, USAID is focusing on training, especially with non-governmental institutions.

As a major science and technology project, NifTAL is participating in these efforts by sponsoring a legume inoculant production course for commercial scale operators. If USAID mission people know of institutions or candidates who meet NifTAL's primary screening requirements listed above, please have them contact NifTAL as soon as possible to apply for this very specialized course which will emphasize indigenous materials and production.



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Low Cost Trellis

After harvesting for forage, cut *Leucaena leucocephala* trunks can serve as a trellising system. This approach can provide support for even heavy climbing crops like winged bean.

An essential element for using this technique is effectively killing the Leucaena. One treatment offering 100% kill rates and no regrowth after 12 weeks is diesel fuel. The tree is cut at 1½ meters above the ground and diesel fuel is sprayed on the trunk.

The diesel fuel degrades quickly and leaves no evidence of harmful residue in the top soil. Only two weeks following the treatment, crops (such as winged bean) can be planted near the base of the trunks. Climbing shoots will naturally twine onto these Leucaena trellises.

Spacing the Leucaena trees to be used as trellises should be an important consideration when climbing plants are to be sown around the base of the Leucaena. One half meter spacing should be adequate for most climbing varieties.

After as long as eight months, winged bean vines are known to thrive on the Leucaena trellis. Leucaena regrowth appears to be negligible or nonexistent on trellises such as those pictured below which were in use at a NifTAL field plot.

Liquid Inoculation Application

Hand sown seed can be inoculated with liquid inoculant (peat mixed with water) very efficiently and effectively. ICRISAT (International Crops Research Institute for the Semi-Arid Tropics) recommends this technique for inoculating groundnut (*Arachis hypogaea* L.).

Liquid inoculant should be applied at 3-4ml per seed in furrow below the seed. The inoculant can be applied with a plastic jerry can, or similar container, fitted with a small tube. Less than one man day and 400 litres of water containing 210 grams of peat (containing 10^9 to 10^{10} *Rhizobium* cells per gram of peat) are required to inoculate one hectare by hand.

Salinity Effects on Soybean Nodules

The effect of salinity on nodule formation by soybean has been reported by P. W. Singleton and B. B. Bohlool.

A split-root growth system was employed to evaluate the effect of NaCl on nodule formation by soybean (*Glycine max* L. Merr. cv Davis). By applying the salinity stress and rhizobial inoculum to only one-half the root system, the effects of salinity on shoot growth were eliminated in the nodulation process. *Rhizobium* colonization of inoculated root surfaces was not affected by the salt treatments (0.0, 26.6, 53.2, and 79.9 millimolar NaCl).

While shoot dry weight remained unaffected by the treatments, total shoot N declined from 1.26 grams N per pot at 0.0 millimolar NaCl to 0.44 grams N per pot at 79.9 millimolar NaCl. The concentration of N in the shoot decreased from 3.75% N (0.0 millimolar NaCl) to 1.26% N at 79.9 millimolar NaCl. The decrease in shoot N was attributed to a sharp reduction in nodule number and dry weight. Nodule number and weight were reduced by approximately 50% at 26.6 millimolar NaCl, and by more than 90% at 53.2 and 79.9 millimolar NaCl. Nodule development, as evidenced by the average weight of a nodule, was not as greatly affected by salt as was nodule number. Total nitrogenase activity (C_2H_2 reduction) decreased proportionally in relation to nodule number and dry weight.

Specific nitrogenase activity, however, was less affected by salinity and was not depressed significantly until 79.9 millimolar NaCl. In a second experiment, isolates of *Rhizobium japonicum* from nodules formed at 79.9 millimolar NaCl did not increase nodulation of roots under salt stress compared to nodule isolates from normal media (0.0 millimolar NaCl). Salt was applied (53.2 millimolar NaCl) to half root systems at 0, 4, 12, and 96 hours from inoculation in a third experiment. By delaying the application of salt for 12 hours, an increase in nodule number, nodule weight, and shoot N was observed. Nodule formation in the 12- and 96-hour treatments was, however, lower than the control.

The early steps in nodule initiation are, therefore, extremely sensitive to even low concentrations of NaCl. The sensitivity is not related to rhizobial survival and is probably due to the salt sensitivity of root infection sites.

Reprints may be requested from NifTAL.

FAO: Multiple Cropping Systems

Cooperators in an FAO (Food and Agriculture Organization of the UN) / IAEA (International Atomic Energy Association) research study presented results of their 1983 experiments at a March meeting in Indonesia. The Research Coordination Meeting on Multiple Cropping Systems was held at the Centre for Application of Isotopes and Radiation, Jakarta, Indonesia.

The emphasis of the field trials was to determine, through the use of isotopic labelled N and P fertilizers, the optimum efficiency of those fertilizers. The second objective was to study the residual effect of the previous crops, i.e., legumes and corn, on the subsequent crop.

From completed experiments, results show that, compared with a non leguminous crop such as corn, legumes had a more beneficial effect on yield of the subsequent crop. Final results will be reported when all cooperators have been able to complete the 2-part experiment.

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For Information on the NifTAL Project contact Dr. Jake Halliday, NifTAL Project, P. O. Box O, Paia, Hawaii 96779. Submissions to the BNF BULLETIN may be sent: Attention: Communication Section, NifTAL Project.

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.

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Azolla: Assessing the Potential

Several workshops on Azolla have been held recently. Tom Lumpkin, Azolla authority with the Department of Agronomy and Soils, Washington State University, reports on Azolla's potential use in the humid tropics.

This aquatic fern has potential as a green manure because of its high relative growth rate and symbiotic relationship with *Anabaena azollae*. Its symbiotic relationship gives Azolla a competitive advantage over other floating hydrophytes in environments such as rice fields which are relatively low in nitrogen.

Azolla has the potential of supplying the entire nitrogen requirement for a high yielding rice crop since it can accumulate more than 10 kg of nitrogen/ha/day (25 tons/ha x 6% dry weight x 4% N x RGR 0.17 ton/ton/day).

Under proper management and conditions, this rate can be sustained because the growth of Azolla more closely resembles the growth of single-cell organisms than terrestrial plants Azolla can also be used to suppress paddy weeds and is an excellent food for pigs, ducks, and fish.

At present, Azolla is regularly cultivated on a large scale only in southeastern China and northern Vietnam. In these areas, Azolla is primarily used as a green manure for rice and is viewed as a crop of rather low economic value. Only short periods, before or with the spring rice crop, are allocated for its cultivation.

Azolla can make use of short periods in the cropping sequence because some varieties have both the ability to sustain a relatively high growth rate under cool temperatures (10-20 degrees C) and a potential for doubling their biomass in as little as two days under optimal conditions.

Cool weather tolerance is the key to successful cultivation in Vietnam and China. A high growth rate in cool seasons makes Azolla a good economic competitor against alternative crops grown for food and a good biological competitor against other hydrophytes and algae. In addition, cultivation during cool seasons allows Azolla to avoid devastation by its thermophyllic insect pests.

Viewing an azolla/rice intercrop are workshop participants from the 23-30 October 1983 University of Hawaii and WARDA/ADRAO Azolla Workshop held in Senegal.

The cool season (winter-spring) cultivation of *Azolla pinata* var. *imbricata* in Vietnam's Red River Delta and irrigation system reached an area exceeding 500,000 hectares during the late 1960's and has continued to be an important crop because of insufficient nitrogen fertilizer. In China, cool season cultivation of *A. pinnata* var. *imbricata* and *Azolla filiculoides* peaked in the late 1970's at over 1,000,000 hectares and has since declined in the face of improved supplies of nitrogen fertilizer and increasing pressure for food through population growth and rising expectations.

An upsurge of interest in Azolla which began in the mid-1970's helped to stimulate substantial research in developing countries that produce rice. There are, however, a number of constraints and a lack of progress in applying Azolla technology. A workshop to assess the potential use of Azolla was convened in Bangkhen, Thailand, from 22 - 28 February 1984. The workshop, attended by 34 Azolla researchers from 12 countries, was supported by the NifTAL Project, the Thai Ministry of Agriculture, and the International Rice Research Institute. Participants discussed the constraints and outlined the areas of research that might yield breakthroughs. The discussion of constraints and important research areas are summarized in the table below.

Continued on page 5

FUNDAMENTAL

- Induction of sporogenesis and germination of spores for applied use, breeding material, and for pest and stress avoidance.
- Plant resistance and inexpensive non-polluting methods to control insects, disease, and competitors.
- Importance of available phosphorus in soil and water, and ways to improve uptake of applied phosphorus.
- Implements for incorporation into soil under different rice planting systems and methods for improving the availability and uptake of nitrogen by rice.
- Greenhouse and growth chamber methods to characterize agronomic traits.
- Management procedures to allow water transportation of planting material, avoid flushing of Azolla during typhoons and rain storms, and avoid draining of water for incorporation of Azolla.
- Characterization of rice producing areas for potential use.

ORGANIZATIONAL

- International coordination of research programs with defined objectives and priorities.
- Distribution of mini-grants (U.S. $5,000 – 10,000) to support coordinated research.
- Education of administrators on potential and limitations of use.
- On-site technical advice and assistance for regional researchers.
- Newsletter of aquatic nitrogen fixation containing annotated references and communication announcements.
- Standardization of research procedures.

SOCIAL, CULTURAL, POLITICAL

- Fertilizer uses and policies, especially influence of subsidized nitrogen on use of Azolla.
- Attitude of farmers, bureaucrats, industrial organizations, and politicians to Azolla promotion and use.
- Government extension programs which often fail because of excessive propaganda, untrained personnel, and inconsistent support.
- Detailed economic analysis and description of national Azolla programs in China and Vietnam and relevance of their structure and methods to programs in other countries.
- Year-round production of Azolla as a fodder and forage for pigs, ducks, and fish combined with its sale to rice growers.

MEETING NOTES

BNF Extension Course in Bangladesh

A BNF extension course was held during 11 - 19 March in Bangladesh and was sponsored by NifTAL and BARC (Bangladesh Agricultural Research Council).

Course objectives for the 35 research and extension participants were to 1) create awareness and understanding of the potentials and limitations of BNF workers at the research extension level; 2) upgrade the capabilities of these personnel in BNF technology; and 3) create a permanent working linkage between researchers and extension personnel.

This course was the prototype of future courses to be organized by NifTAL. The next such course will be conducted at the South and Southeast Asian BNF Resource Center in Bangkok. The purpose of the course is not only to inform personnel with extension responsibilities about BNF, but also to provide participants with a format to use in conducting similar courses in their countries.

Pakistani Symposium

Twenty visiting international and nearly seventy Pakistani scientists of various disciplines attended the Nitrogen and the Environment Symposium/Workshop held in mid-January at Lahore, Pakistan. The meeting was sponsored by the National Science Foundation of the USA and the Pakistan Atomic Energy Commission.

BNF was a main focus of this workshop which addressed a wide range of nitrogen management topics. A one-day visit to the Nuclear Institute for Agriculture and Biology (NIAB), Faisalabad, a leading agricultural research institute in the country was made in connection with the symposium. Dr. Kauser Malik, NIAB, Faisalabad, was the chief organizer of this program.

Vincent Points to Research Needs

Over 100 participants attended the Seventh Australian Legume Nodulation Conference held during February in Sydney, Australia. Dr. J. M. Vincent opened the conference with a review of past, present, and future N-fixation programs. One major conclusion of his talk was that more attention needs to be paid to the host in the legume-*Rhizobium* symbiosis.

Meeting topics included measurement of N-fixation, fixation by native Australian plants, rhizobial ecology, physiology and biochemistry, genetics, non-legume symbiosis, inoculant production and quality control, and soil factors affecting the symbiosis.

IARI Rhizobium Technology Course

Twenty-one persons from all parts of India participated in a 3-week *Rhizobium* Technology Course held during January at the Indian Agricultural Research Institute in New Delhi. Dr. N. S. Subba Rao, head of the Division of Microbiology, directed the course.

Participants were from private industry, agricultural research institutes, and agricultural universities. Group discussions, lectures, and practicals on isolation of *Rhizobium*, plant testing, quality control, mass production technology, and serology were included.

NEW PUBLICATIONS

Who says catalogues are dull? The first ten strains listed in NifTAL's new *Rhizobium* catalogue were collected from N-fixing trees in Nicaragua in January 1984.

Under NifTAL's program, a comprehensive *Rhizobium* collection has been assembled from which inoculant strains for legume crops are selected. The collection includes strains for legumes used at high or low elevations in the tropics for grain, forage, fodder, green manure, firewood, erosion control, shade, ground cover and other development purposes. 1800 strains isolated from 285 legume species and collected in 56 countries are included.

A microcomputer-based data management system serves for day-to-day collection data storage and retrieval, for generating a periodic user's catalogue, and for responding to information requests from users of the *Rhizobium* Germplasm Resource at NifTAL. Thirty-two fields make up the record for each strain. Tailored programs allow records to be output in a convenient 8" x 5" index card format. Programs were also written to output a catalogue directly from the data base.

The catalogue gives full information for key strains, abbreviated information for secondary strains, and a minimum data set for all strains. Strains are catalogued numerically, and an alphabetical host plant index to strains is generated directly from the data base.

The collection was established with USAID support and is being preserved as a commitment with UNEP and Unesco (under the MIRCEN concept). The *Rhizobium* Germplasm Resource is a member of the World Federation of Culture Collections.

This catalogue is now available free to USAID-recipient country researchers and for US $10 per copy to all others. Request from NifTAL Director J. Halliday and Curator P. Somasegaran, NifTAL Project, P.O. Box O, Paia, HI 96779 USA.

FAO has released a new volume called *Technical Handbook on Symbiotic Nitrogen Fixation: Legume/Rhizobium*.

A collaborative output between FAO and Groupe de Recherche et d'echanges Technologiques, the handbook presents sections on the biology of symbiotic N fixation, symbiotic fixation in farming systems, *Rhizobium* bacteroids, inoculant production, legume inoculation, and guidelines for experimentation.

FAO's handbook is designed to increase awareness of the role of symbiotic fixation of atmospheric nitrogen in crop production and to serve as a source of reference for the application of legume-*Rhizobium* technology.

Contact your local UN bookdealer or the Distribution and Sales Section, FAO, Via delle Terme de Caracalla, 00100, Rome, Italy.

97

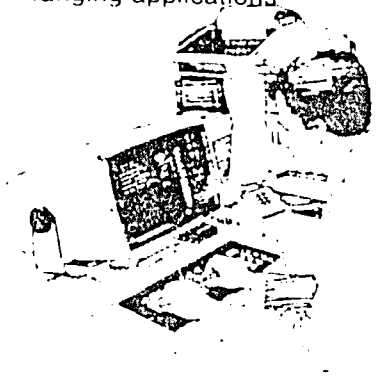
DIRECTIONS IN COMMUNICATION

Thud. The impact of the computer is here.

While it is a wonderfully logical communication tool, the computer conforms to a number of Murphy's laws — yet to be written. But, it is here and it is a communication tool BNF researchers can use.

Communications means to share information. The way we generate information is through our research and its publication, and by having others read, apply, and test our ideas.

The same goes for the computer. You have to use the computer to develop *literacy* on it. Computer literacy means learning about the computer through utilization. BNF researchers are now starting to employ the computer in wide ranging applications –



management of germplasm collections, design of training projects, proposal development, agronomic forecasting, statistical manipulation and computer graphics, budgeting, and a host of routine functions.

Skills in making the computer work grow with daily use. And as people understand what the computer can offer as a tool – a long term memory, the power of manipulation, and a communication device – they begin to sense the ability for change. New ways of doing both old and new tasks emerge, dreaming the dreams that could not be.

One challenging opportunity to realize these dreams and to implement new found computer skills will be involvement in the upcoming BNF Computer Conference. This "meeting" offers researchers and other interested persons a forum of explore BNF issues, a chance to apply computer technology, and an opportunity to experience the potential benefits and problems of computer conferencing in BNF.

Take time to read the last page of the *BNF Bulletin* for a fuller explanation of the Computer Conference. This will be a special occasion to share knowledge and skills and to open a new communication channel and a new level of interaction. It will only work if people share, if *you* share – communicate.

Talk to you on line. THUD.

– James N. King

BNF Work in the Virgin Islands

The Virgin Islands Agricultural Experiment Station in St. Croix is presently involved in investigations of pasture and cropland improvement utilizing *Teramnus labialis*. Inoculation trials and interplant/cover crop evaluations are scheduled for 1984. Preliminary observations show that the vigorous growth, rapid regrowth after mowing and non-invasive characteristics of this legume make it a promising candidate for further evaluation.

This is reported by Robert R. Webb a Research Plant Pathologist at the Station. Another aspect of BNF being investigated is the contribution, establishment, and population dynamics of leaf surface N-fixing bacteria.

For more information on the Station's work, contact Webb, College of the Virgin Islands, P.O. Box 920, Kingshill, St. Croix, U.S. Virgin Islands 00850.

Moroccan BNF Research

Legume researcher A. Jamal reports work being done in the area of N-fixation in the Microbiology Laboratory, Biology Department, Faculty of Science at Rabat.

Other researchers in the laboratory are B. El Bekkay who is interested in *Cicer arietinum* and B. Fatiha who is working with *Vicia faba*. Jamal is working with *Phaseolus vulgaris*. The three are working under the direction of H. Abdel Ali of the Institute of Agronomy and Veterinary Hassan II and S. Albert, professor of the Faculty of Science, who is detached from Unesco headquarters in Paris, France.

These researchers are interested in exchanging information with others. Direct your correspondence to them at Laboratoire de Microbiologie, Department de Biologie, Faculte des Sciences, Hassan II University, B.P. 1014, Rabat – Morocco.

Peruvian Studies N-Fixing Trees at NifTAL

Tomas Tello Reyes a forage crop specialist from the Agricultural Promotion and Research Center at Chiclayo, Peru, has joined NifTAL as a research intern.

Tello is assessing the effects of rhizobial and mycorrhizal inoculation on the growth of 3 N-fixing trees — *Prosopis pallida*, *Leucaena leucocephala*, and *Gliricidia sepium*. Another aspect of his work is comparing forage legumes under different P levels.

Continued from page 3

Despite its cultivation and use in China and northern Vietnam, Azolla has not been successful in the humid tropics, including southern Vietnam, because of problems with insects and disease, availability of water and phosphorus, and an intensive labor requirement.

If cultivation in the tropics is ever to be successful on a large scale, a number of scientific breakthroughs are necessary, and these will only be accomplished by a well focused and well financed internationally coordinated research program.

Contact Dr. Lumpkin at the University of Washington, Pullman, Washington, U.S.A. 99164-6420, for further information.

INLIT Strengthened

In order to facilitate coordination between the 3 INLIT (International Network of Legume Inoculation Trials) geographical divisions, NifTAL has appointed Mr. Rudy Holthius to the position of Network Coordinator. He is a graduate of UC-Davis with a degree in agricultural science and management.

Holthius will be coordinating trials in association with Drs. Robert J. Davis, (Asian Network), Joann Roskoski (Latin American Network), and Paul Singleton (African Network).

ANNOUNCEMENTS

FAO/IAEA Program

Guidelines to be used in breeding grain legumes with better capability to support symbiotic N-fixation were developed during a 1983 meeting sponsored by FAO/IAEA.

Increasing the yield as well as the N-fixing capacity in grain legumes will require breeding for improvement of the host-*Rhizobium* symbiosis in addition to the improvement of agronomic characteristics and of resistance to pests and diseases. The complex relationships between these factors suggest that the problems will best be tackled by research teams, to include a plant breeder, a microbiologist, and a plant physiologist, with experts in agronomy and plant protection.

It is also recommended that N-fixation breeding programs be built within established plant breeding programs, where the expertise in dealing with inter-related breeding objectives exists. To verify the improved N-fixation capacity of new lines, ^{15}N techniques to quantify amounts of fixed nitrogen should be appropriately applied.

The possibility of initiating a coordinated research program is now being considered at the joint FAO/IAEA Division. Anyone interested in applying for participation in such a research program is invited to write to Dr. G. Hardarson, FAO/IAEA Agricultural Biotechnology Laboratory, A-2444 Seisbersdorf, Austria.

World Soybean Research Conference III

Preregistration is open for the World Soybean Research Conference-III. According to meeting planners, scientists from throughout the world will present papers on research accomplishment since the 1979 meeting, current activities, and research prospects for the future. The comprehensive program of invited and contributed papers will cover all aspects of soybean research. In addition, the program has been arranged to provide ample opportunity for persons to exchange information informally.

Iowa State University will be venue for the meeting scheduled for 12-17 August. For information write to: World Soybean Research Conference-III, Office of Continuing Education, 102 Scheman, Iowa State University, Ames, Iowa 50011 USA.

Farming Systems Papers Needed

Until 15 June, abstract submissions will be received for the 1984 Farming Systems Research and Extension Symposium. Farming Systems Research and Extension: Implementation and Monitoring will be held at Kansas State University from 7 - 10 October.

The symposium will look at projects which have attempted to implement on-farm research that will identify technological innovations that impact the entire farming system. Being sought are papers dealing with case studies and analyses of problems and success in the institutionalization of farming systems research and extension in national programs.

Submit abstracts to Cornelia Butler Flora, International Agricultural Programs, Kansas State University, Manhattan, Kansas, 66506, USA.

African BNFers to Meet

Aimed at bringing into contact scientists in Africa working on all aspects of BNF, this conference will allow these BNF workers to share information, experiences, and give them an opportunity to evaluate present and future BNF work. It will be held from 23 - 27 July 1984 in Nairobi, Kenya.

Main session topics are: 1) culture collection/preservation, 2) inoculation production/usage, 3) factors affecting BNF/BNF estimation, 4) BNF in grain legumes, 5) BNF in pasture/tree/other legumes, 6) non-symbiotic BNF systems, 7) field applications of BNF technology, and 8) coordination/dissemination of BNF technology.

Conference and poster papers will be accepted. The deadline for papers is 30 May. For information and registration contact AABNF Secretariat, Department of Soil Science, University of Nairobi, P.O. Box 30197, Nairobi, Kenya.

BOSTID Research Grants

As of January, thirty-one new research grants were approved by BOSTID (Board on Science and Technology for International Development). These new grants bring the total number of research awards to fifty-five. The breakdown of research areas includes ten in BNF and fourteen in fast-growing, N-fixing trees.

The next deadline for submitting proposals is 31 May 1984, for an October decision.

For further information, contact Dr. Michael P. Greene, Executive Secretary, Committee on Research Grants, BOSTID, National Research Council, 2101 Constitution Avenue, Washington, D.C. 20418.

• • •

BOSTID research grant BNF projects include studies of legume-rhizobia symbiosis and of associative fixation in grasses. Recent revisions in the guidelines encourage use of 15N and serological techniques for study of the plant-microbe interaction, with appropriate training and assistance to be provided. A coordinating meeting of grantees will be held in mid-1984.

• • •

Two publications have been prepared for use by grantees. The International Council for Research in Agroforestry (ICRAF) is preparing a comprehensive manual to guide research on multipurpose trees. A subcommittee of grantees, chaired by Dr. Fred Owino of the University of Nairobi, has produced a draft protocol and manual for grantees and other researchers on techniques for field surveys, nursery studies, and field trials for N-fixation.

Plant Biologists to Meet

Now being organized for 27 October - 2 November 1985 is the 1st International Congress of Plant Molecular Biology. BNF workers will be interested in several meeting topics, especially that exploring the molecular biology of nitrogen fixation and other symbioses.

Venue for the meeting is Savannah, Georgia. For information contact the Congress Secretary, 1st ICPMB, The Georgia Center, Athens, GA 30602, USA.

N-FIXING TREE NOTES

"Technical factors influencing establishment and productivity of tree plantings in semi-arid regions," is the subject of an international symposium being planned for early 1985. Drs. Henri LeHouerou and Peter Felker are organizing the meeting which will be sponsored by Caesar Kleberg Wildlife Research Institute (CKWRI).

Conceived in response to the need for good germplasm and technical linkages, this meeting will facilitate personal contacts between researchers in countries that have similar climatic regions (Argentina, Brazil, Chile, Venezuela, the Caribbean, West Africa, India, Pakistan, and Australia) and similar genera (*Acacia*, *Leucaena* and *Prosopis*).

Discussion will focus on several issues: 1) historical background of semi-arid trees with regional emphasis, 2) situations (climatic, soils, economic) where trees are being successfully used and situations where they appear to have good potential for economic development, 3) specific problems that need to be resolved such as fencing, weed control, insects, diseases, and lack of seeds or cuttings, 4) identifying germplasm that is available for exchange or that is being sought, and 5) pinpointing basic research questions to be pursued.

For information about his meeting, contact Peter Felker, Associate Research Scientist, CKWRI, College of Agriculture, Texas A&I University, Campus Box 218, Kingsville, Texas 78363.

AGRINTER, a computer data bank on tropical forestry for Latin America and the Caribbean, has information on a variety of topics of interest. Subject areas are agricultural sciences, soils, meterology, ecology, forest production, forest management, forest use, aquatic systems, natural resources, and pollution. For more information contact CIDIA, Apartado 10281, San Jose, Costa Rica.

Dr. C. Cross is beginning a research program on colonizing strategy and seedling establishment parameters of *Leucaena* in new environments. Cross can be reached at the Graduate School, Department of Botany, Howard University, Washington, D.C. 20059.

A germplasm collection of *Gliricidia sepium*, founded in Costa Rica, is available for use by scientists searching for improved tree types. *G. sepium* is recognized as a useful multi-purpose tree – providing firewood, lumber, living fence posts, fodder, shade and mulch for soil improvement – which is suited to the agroforestry production systems currently being developed for use in the tropics. The collection was partially funded by IDRC of Canada and is accessible at Centro Agronomico Tropical de Investigacion y Ensenanze (CATIE), Turrialba, Costa Rica.

SHORT TAKES

Dr. Thomas J. Wacek, formerly of North American Plant Breeders is now Director of Research of the seed inoculation division of Kalo Agricultural Chemicals, Inc., in Columbus, Ohio

• • •

Dr. G. W. O'Hara has moved to Murdoch University in Australia. His current project is concerned with ammonia movements in *Rhizobium leguminosarum*. He expects to be working with **Professor Mike Dilworth** on the mineral nutrition of *Rhizobium*.

• • •

Dr. N. S. Subba Rao, Head of the Division of Microbiology, Indian Agricultural Research Institute, New Delhi, has been awarded the Norman Borlaug Award for outstanding contributions to the development of BNF and biofertilizer technologies.

In January 1984, **Dr. Ashok K. Alva** began postdoctoral research at the University of Queensland with **Drs. Edwards, Asher,** and **Date**. He plans to evaluate the influence of varying quantities and proportions of monomeric and polymeric aluminum species on nodulation and N-fixation of tropical pasture legumes.

• • •

Dr Eduardo Schroder reports that the University of Puerto Rico (UPR) USAID funded BNF Project has been extended to December 31, 1984.

• • •

Mr. Yovanny A. Valazquez from the Secretaria de Agricultural of the Dominican Republic was accepted by the UPR and is working towards his M.S. degree at the Department of Agronomy and Soils. He plans to work on the inoculation of *Phaseolus vulgaris*.

Accepting a job as research assistant at the UPR BNF project is **Mr. Robert Kluson**. He recently received his M.S. from the University of Maryland

• • •

Dr. I. L. Pepper of the University of Arizona has a research assistantship in soil microbiology available for fall, 1984. This is for a M.S. or Ph.D. student. Contact him at the Department of Soils, Water and Engineering, College of Agriculture, 429 Agricultural Sciences Building #38, Tucson, Arizona 85721

• • •

Kalo Agricultural Chemicals, Inc., has acquired the lab and manufacturing facilities of Agricultural Labs, Columbus, Ohio. Kalo has also purchased the inoculant and seed treatment division of North American Plant Breeders of Mission, Kansas.

Microcomputer Communication

Widespread availability of relatively inexpensive microcomputers is facilitating exchange of technical information and comment among scientists who are widely dispersed geographically. Computer conferencing is increasingly lauded as ideally suited for continuing information exchange on a global scale. And computer communications have been advocated for active management of international networks of agriculturalists.

NifTAL became equipped, and gained experience, in microcomputer communications because of its isolated location on the Island of Maui and the immediate, local need for a link with facilities and individuals at the University of Hawaii's main campus in Honolulu. More recently we have become interested in the potential of microcomputer communications and computer conferencing to further NifTAL's international development goals.

NifTAL seeks to provide farmers in less developed countries with an inexpensive alternative to purchased nitrogen fertilizer. Thus we offer comprehensive development support in the form of research, technical and material services, and multi-tier training in all aspects of agrotechnologies based on biological sources of nitrogen.

The quality of legume inoculants available to farmers in developing countries is of concern to NifTAL. Our strategies to ensure inoculant quality have included research into improved production processes, and training the producers how to manufacture high quality products. Now we are adding a new approach, which we call the Inoculant Quality Incentive Program (IQIP). This involves formation of a Board on Standards, definition of uniform standards for inoculant products, award of "seals of approval" to be carried only by products of companies subscribing to the Board's standards, and creation of an awareness among users and retailers that the seal is a sign of quality they can trust.

During 1984 NifTAL proposes to determine whether microcomputer communications are accessible to LDC scientists who have a role to play in design and implementation of the IQIP. Thus we will be organizing a computer conference on the theme of legume inoculant production and quality control. The conference will begin 1 September and culminate in an interactive question and answer session during 1 - 20 December. This latter session is possible due to the presence at NifTAL, Maui at that time of some of the world's leading authorities on commercial scale inoculant production. They will be serving as instructors in our hands-on training course on inoculant production.

We intend to use the period from now to September to actively arrange for participation of key LDC scientists.

We invite the participation of any agency which might wish to use this NifTAL initiative as a test case for appraising the utility of microcomputer communications for the maintenance of international agricultural research networks that involve scientists in Third World countries.

Contact: Dr. Jake Halliday, Univ. of Hawaii NifTAL Project and MIRCEN, P.O. Box 0, Paia, Hawaii 96779, U.S.A.

For USAID agriculturalists in missions across the world, computer conferencing offers challenges—first, to make the conference work, and second, to get host country agronomists and policy makers involved. NifTAL is eager to explore the possibilities of computer conferencing with developing countries and the Missions' desires and roles. We look forward to comments from you on Dr. Halliday's article.

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Bangkok, Thailand 10900

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BIOLOGICAL NITROGEN FIXATION BULLETIN

First NFT Workshop

Volume V, Number 2

Training Tree Researchers

How do you get seven diverse groups to cooperate? By having them co sponsor a training workshop on the production and management of Fast Growing Trees (FGT).

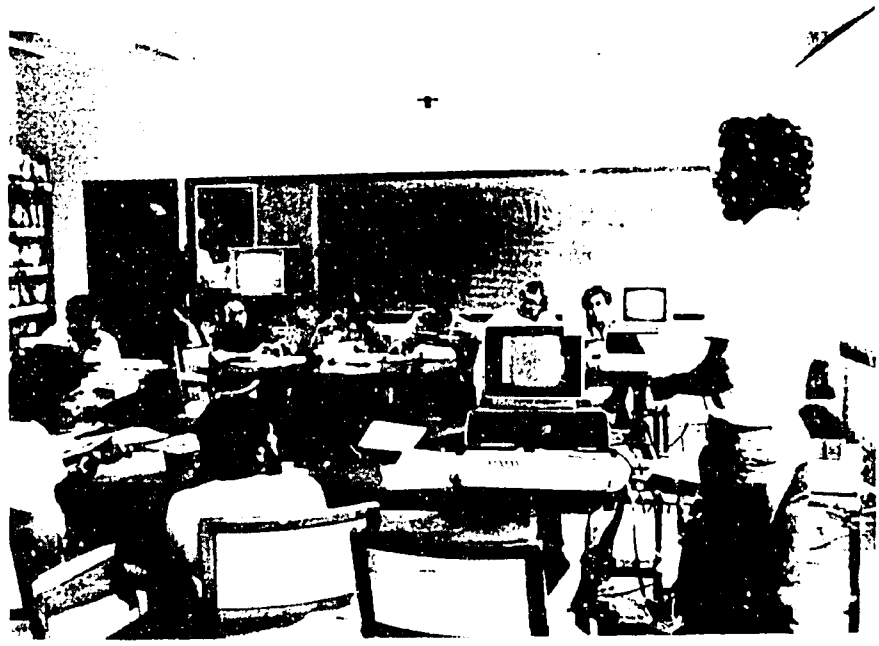
Such an event took place from 5 19 August at the University of Hawaii campus with eleven participants coming from the Pacific Islands, the Philippines, and Mexico.

The Nitrogen Fixing Tree Association took the lead in organizing the workshop with assistance from NifTAL, The Agency for International Development, South Pacific Regional Development Office; FAO Regional Office for Asia and the Pacific; UH s College of Tropical Agriculture and Human Resources; the Environment and Policy Institute East West Center; and the Bio Energy Development Corporation The National Academy of Sciences sponsored one individual.

A tremendous amount of content was covered during the workshop with materials focusing on FGT plantation establishment, management, and uses, research design, data collection and analysis, yield assessment and prediction, statistical analysis, and research project development. Other activities included field trips taken to FGT research and production sites and a variety of participant exercises in the field.

Participants were P. Joseph, A. Manarangi, M. Purea, and N. Tuakana (Cook Islands); B. Raynor (Federated States of Micronesia), J. L. Delgado, (Mexico); D. Inapero and V. Kesavan, (Papua New Guinea); D. Parreno and V. Ramos, (Philippines); B. Paeniu, (Tuvalu); and D. Mac Lauren (observer from Canada).

For further information contact K. Mac Dicken, NFTA, P. O. Box 680, Waimanalo, HI 96795, USA.



The course featured laboratory and field instruction, including a special section on computer assisted data analysis.

Rhizobium Strain Selection

Strain selection is performed to ensure that a legume seed inoculant contains a strain, or strains, of effective *Rhizobium*. This means the *Rhizobium* is capable of forming N_2-fixing nodules on the legume species for which it is recommended and under the conditions of soil and climate in which the legume crop is grown.

Some characteristics of strains of *Rhizobium* to be used as legume inoculants can be regarded as "essential," whereas others are "desirable" depending on the specific selection objective.

One essential characteristic is the ability to nodulate the legume crop of interest in the field conditions under which it is grown. Such strains are referred to as infective. Strains of *Rhizobium* which are infective in the field will usually have exhibited competitive ability if they displaced nodulation by native strains present at the site. They will also have been stress tolerant if they successfully nodulated legumes in soils with excesses or deficiencies in their physical and chemical composition.

A second essential characteristic is that the strain be able to fix sufficient N_2 to sustain a level of legume production close to, or surpassing, the production possible if the legume were supplied with nitrogenous fertilizers. Such strains are referred to as effective. Strains which are fully effective are usually carbon efficient and hydrogen efficient as well. The "efficiency" of a *Rhizobium* is seldom measured during strain selection, and use of the term should be avoided. Effectiveness is usually what is meant.

ESSENTIAL CHARACTERISTICS

- CAN INFECT
- IS EFFECTIVE
- CAN BE PROCESSED
- CAN SURVIVE

A third essential character of an ideotype *Rhizobium* strain is that it should perform satisfactorily when subjected to the component processes of commercial-scale inoculant-production systems. Inoculant strains must multiply well in bulk culture and be able to mature to high populations in the carrier material, which is usually peat.

A fourth essential character is ability to survive well during distribution to, and use by, farmers. Strains should be tolerant to the anticipated maximum temperatuire that they will encounter. They must also survive well during the seed and soil inoculation procedures used by farmers. Additionally, they must survive on seed in soil from the time of their application until the emerging legume radicle is susceptible to infection (usually at least 7 days).

Characteristics which are in the "desirable" category are long term persistence and fungicide and insecticide tolerance.

Long term persistence is expected of strains of *Rhizobium* used to inoculate perennial forages. Implicit in the concept of persistence is saprophytic competence, a summary term for all those traits that permit a *Rhizobium* strain to live as a stable member of the soil microflora, even in the absence of the legume host. Persistence of strains for annual crop legumes from season to season may be considered a desirable trait in some circumstances as it obviates the need for inoculation in subsequent years. But there may be cropping systems in which carry-over strains from a previous crop may nodulate a follwing crop relatively ineffectively and even out-compete effective introduced strains. This can occur in rotations of soybean with legumes such as peanut and cowpea that nodulate with the cowpea miscellany of rhizobia.

Fungicide or insecticide resistance may be a desirable trait when the normal practice is to sow legume seeds pretreated with these substances, some of which are toxic to most strains of *Rhizobium*.

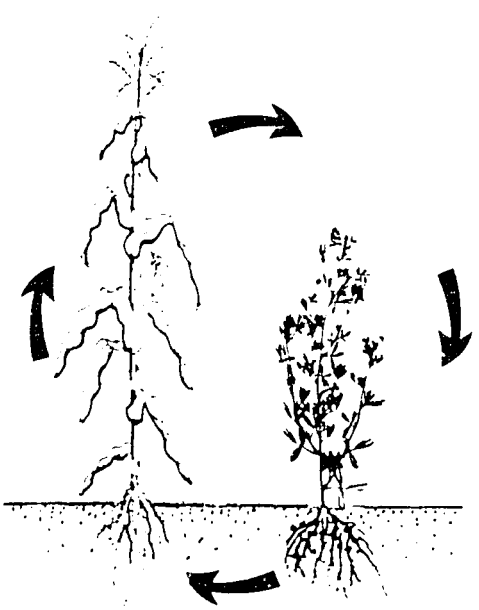
From Principles of *Rhizobium* Strain Selection by J. Halliday. Copies available on request from NifTAL.

N Response in Alfalfa/Corn Rotations

Availability of a new alfalfa (*Medicago sativa L.*) germplasm with increased storage of total reduced N in roots and crowns provided an opportunity to determine whether its use in a cropping sequence would improve yield of a subsequent non-legume crop.

There were 2 objectives of the study conducted by O. B. Hesterman, C. C. Sheaffer, D. K. Barnes, W. E. Leuchen, and J. H. Ford of the Dept. of Agronomy and Plant Genetics, and USDA-ARS, University of Minnesota, St. Paul, MN. These objectives were: 1) to compare effects of two harvest systems on forage yield and quality, and N incorporated from an experimental ('MN ROOT N') and a standard ('Saranac AR') alfalfa and 2) to evaluate effects of previous cropping (alfalfa, corn [*Zea mays L.*]), or soybean (*Glycine max L.* [Merr.]) and fallow treatments on grain yield and N response of a subsequent corn crop.

Field studies were conducted for 2 consecutive years at four locations each having a different soil type. First-phase rotation



components included alfalfa (grown for the seeding year only), corn, soybean, or fallow, and the second phase component was corn. Alfalfas were subjected to two

Continued on page 7

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Volume V, Number 2
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For Information on the NifTAL Project Contact Dr. Jake Halliday, NifTAL Project, P. O. Box O, Paia, Hawaii 96779. Submissions to the BNF BULLETIN may be sent: Attention: Communication Section, NifTAL Project.
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.

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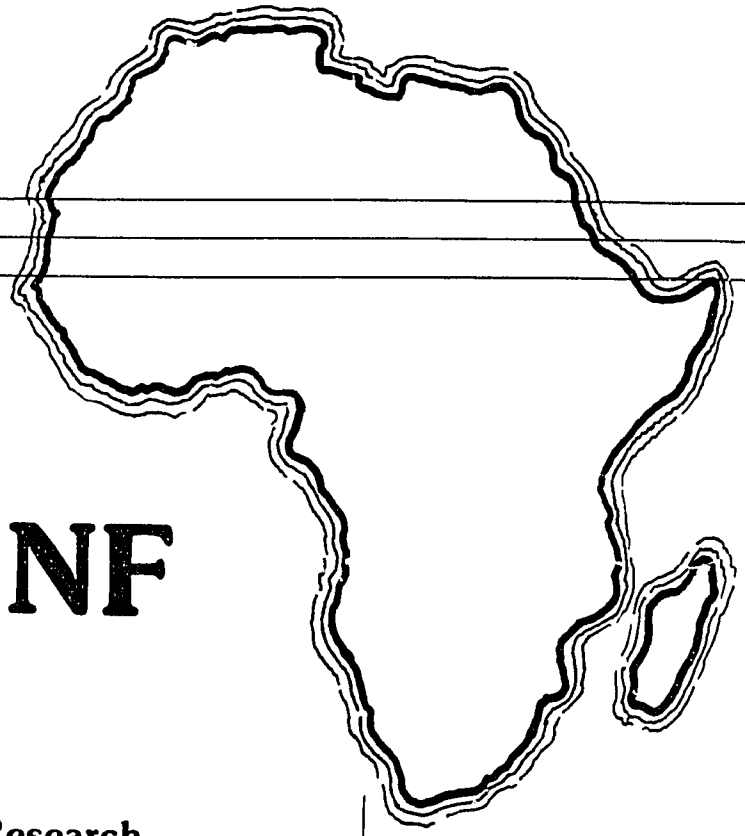
AFRICA and BNF



Zambia Inoculant Production

Joe Rourke, NifTAL researcher, left Maui in August for the Zamare Project at Mount Makulu, Zambia. A committment by NifTAL's Biological Nitrogen Fixation Resource Center for Africa led to Rourke's consultancy on inoculant production. He will be working closely with Zambian scientists to set up a Rhizobium inoculant production system.

Realizing the value of legume inoculation versus costly nitrogen fertilizers, Zambian government agricultural officials put a high priority on national inoculant production. This priority led to NifTAL's offer of assistance.

Zambian Soybean Association Growing

The Soyabean Newsletter, printed by the Zambian Department of Agriculture, reports that a large number of membership applications have been received for the Zambian Soyabean Association. This response points toward a successful future for the group.

Organizers have suggested these tentative objectives: 1) to promote profitable production and improved marketing and processing methods; 2) to promote the utilization of soybean and soybean products both at an industrial and village level; 3) to promote research and extension in all areas affecting soybean development; 4) to promote the export of soybean and soybean products after national self-sufficiency has been achieved; 5) to serve as a means for dissemination of information and experiences relevant to the development of an integrated soybean industry in Zambia; and 6) to promote professionalism among soybean scientists.

For information contact, Soyabean Newsletter, Mount Makulu Research Station, Private Bag 7, Chilanga, Zambia.

NFT Research in Sierra Leone

Research on Nitrogen fixing Trees (NFTs) has been undertaken by an interdisciplinary team at Njala University College, University of Sierra Leone. Specialists in the Departments of Agronomy, Animal Science, and Agricultural Economics and Extension are working under team leader Dr. D. S. Amara. Amara, a soil microbiologist, received his Ph.D. from Ohio State and also studied at NifTAL.

This project's general objective is "to collect, propogate, and evaluate indigenous fast-growing NFTs and shrubs for comparison with exotic species, to identify species that can be incorporated into bush-fallow and other agroforestry systems in Sierra Leone." The rhizobia and mycorrhiza symbioses of the trees/shrubs will also be studied with the objective of selecting species with the highest capacity to recycle nitrogen and phosphorus under field conditions.

Funding for the project, scheduled to continue through January 1986, is through a grant from the International Development Research Centre of Canada.

Cooperation is solicited with respect to the exchange of seed materials, *Rhizobium* strains, and relevant information; participation at workshops, conferences or symposia; and other activities related to the project's research theme. Address correspondence to D. S. Amara, Dept. of Agronomy, Njala University, PMB. Freetown, Sierra Leone, West Africa.

1ST African BNF Meeting – A Success

Nearly 90 scientists representing 19 African countries and 12 countries outside Africa met in Nairobi from 19-29 July. Many short papers were presented by researchers from throughout Africa. Main topic talks included N-fixation for Developing countries with specific reference to Africa and BNF state-of-art in Africa. Meeting sessions covered all phases of BNF work.

This was the first conference of the African Association for BNF. For more information on this group, contact AABNF Secretariat, Department of Soil Science, University of Nairobi, P. O. Box 30197, Nairobi, Kenya.

IFS Grant Goes to Ethiopian

BNF research will soon become possible at the Nazeret Agricultural Research Station in Ethiopia. IFS (International Foundation for Science) awarded a $10,000 grant for the purchase of necessary equipment and lab supplies.

Amare Abebe, a 1982 NifTAL trainee, happily reports receipt of this grant in response to his proposal submission. He also has a proposal currently under review by FAO. Abebe is enthusiastic about conducting research that will meet his country's need for BNF as an alternative source of N for soil enrichment.

99

Desirable Inoculant Qualities

Legume inoculants may consist of one strain selected for a particular legume host or they may comprise two or more strains effective on that particular host. The latter is often advantageous particularly in areas where several varieties or cultivars of the legume are grown or where the soils vary widely in characteristics. However, it is important to have compatible strains and the strains should be grown separately before combining to make the inoculant.

Multiple host inocula are often desirable and they are feasible. Certain genera and species of legumes tend to give a similar response to particular strains of rhizobia. For multiple host inoculants, wide-spectrum strains are preferable. No strain should be included in a multiple host inoculant which could produce ineffective nodules on any of the leguminous hosts for which it is intended.

Inoculants with only two or three strains are preferred over inoculants with many strains. Strain selection and maintenance is a very important aspect of legume inoculant production. Certain desirable qualities of legume inoculants are listed in the table below.

DESIRABLE QUALITIES

- Ability to form N-fixing nodules on the species and cultivars of legumes for which the rhizobia are recommended.
- Competitiveness in nodule formation and survival in the presence of other infective rhizobia in the soil.
- Prompt nodulation and good N_2-fixation over a wide range of soil temperatures.
- Good growth ability in the carrier and in the soil.
- Persistence in the soil.
- Effectiveness on a wide range of host genotypes or cultivars.
- Tolerance to stress factors: acidity, alkalinity, salinity, high concentration of aluminum and manganese.

INDO/USA Cooperation

One of the first Indian scientists to travel to the USA in the Indo U.S. scientific cooperation program, Dr. K. S. Jauhri of IARI (Indian Agricultural Research Institute), spent three weeks at the NifTAL project. He met with members of NifTAL's research staff to exchange ideas, learn about current experiments and research, and plan for collaborative research.

Jauhri heads the inoculant production wing of IARI and is currently studying improvement of carriers, inoculation techniques, and serology. IARI currently produces single strain inoculants for over a dozen legumes.

Alfalfa Cropping Rotation Under Study

As part of the UNDP FAO project on Development of Improved Irrigated Farming Systems and Stregthening of Extension, the People's Democratic Republic of Yemen (PDRY) has a considerable area under alfalfa production. This is part of a rotation program aiming at establishing the best cropping pattern for PDRY's subtropical region.

The basic problem being examined is that alfalfa does not nodulate in that location. PDRY is working with assistance from ICARDA on soil sample analyses. At the trial stage, the cropping pattern includes legume fodder as intercrops with banana.

For further information contact: A. R. Yawson, National Project Director, UNDP/FAO Development of Improved Irrigated Farming Systems & Strengthening of Extension, PDY 81 001, P. O. Box No. 1188, Aden, People's Democratic Republic of Yemen.

New Publications

The **BNF REGIONAL NEWS** published by the BNF Resource Center for Asia, released its first issue in July. The newsletter will be printed quarterly and will be distributed on a limited basis to regional scientists, instructors, and administrators working in the field of BNF. The main purposes of the newsletter are to provide a forum for information exchange between regional scientists and to highlight regional BNF activities.

Newly released is **Chemistry and World Food Supplies: The New Frontiers/Perspectives and Recommendations**, the second publication of the CHEMRAWN II Conference which was held in Manila in December 1982. This document includes the report of the CHEMRAWN II Future Actions Committee plus general plenary lectures of the Conference.

Obtain copies from IRRI, P. O. Box 933, Manila, Philippines, or the American Chemical Society, 1155 Sixteenth St., N.W., Washington, D.C. 20036, USA.

State of the art in BNF work is presented in **Fixacao Biologica do Nitrogenio Pela Simbiose Entre Rhizobium E Leguminosas.** This Portugese language publication is available from Instituto de Pesquisas Agronomicas, Departamento de Pesquisa, Secretaria Da Agricultura, Porto Alegre, RS-Brasil.

Have you pre-registered yet? The 10th NARC is still accepting the $25 pre-registration fee, payable by June 30, 1985.

Space is limited for the conference and early registration is recommended. Details for submitting papers and posters will be available in the near future.

Meetings will be at the Maui Intercontinental Wailea Hotel. Special room rates have been negotiated for participants and families. These rates also apply before and after the conference.

Send your registration fee to: 10th NARC, c/o NifTAL Project, P. O. Box O, Paia, Hawaii 96779, USA.

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DIRECTIONS IN COMMUNICATION

Microcomputer . . . the buzz word of the 1980's. But still many of us are just becoming familiar with micros and this column will give an overview to microcomputers and their use in BNF.

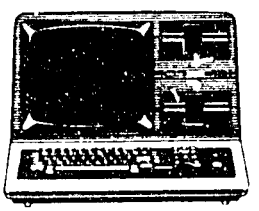
Uses: With a microcomputer, you can type letters and reports, do financial and other calculations, perform statistical analysis and other research data processing, prepare charts and graphs, sort, retrieve, and store information, organize mailing lists, plan project activities, do training, and play games. Detailed uses can be expanded upon by the users. As each person becomes more familiar with the computer, she becomes better able to do a wider variety of tasks.

Equipment: What type of equipment is needed? First is the computer processor, which contains the typewriter-like keyboard and the body which houses the guts of the computer. The most important component is the memory cell, the RAM – Random Access Memory – which comes in various sizes. For most work, 64K – 64,000 bytes of memory – is necessary. A byte of memory is roughly equal to a single typed number or letter. For example, one line of information in this column takes approximately 21 computer bytes of memory. You can also buy "add-on cards" which fit into the computer. They can be used to increase the memory and plug in peripheral equipment.

Other necessary equipment are disk drives, TV screen (Cathode-Ray Tubes), electrical power accessories, and printers.

We have found that it is best to buy top-of-the-line printers as they are the most durable for heavy use, provide the best quality, and have faster speeds.

Programs: It is usually best to buy packaged programs and learn how to use them for various applications. The capabilities, flexibility, and ease of use of the packaged programs are



amazing. At NifTAL, we use only a few of the thousands of programs available: Wordstar for word processing; Supercalc for financial calculations, dBase II for information storage and sorting, and MSTAT for research data processing.

Deciding What to Buy: First, talk to other microcomputer users, especially those in similar fields who can show you applications that might be relevant to your particular office or project. Try to determine which dealers are reliable and offer an appropriate range of equipment, programs, and reliable maintenance and training. Also, look at the microcomputer magazines. Compare all the information to make your decision. The two prime consideration are: (1) What is already being used with the ministry or institute; and (2) dealer support.

For an extremely helpful and free document, write to the Publications Editor, UNDP/DTCP, P.O. Box 2-147, Bangkok 10200, Thailand, and ask for document MRS #106, Microcomputer Primer. This column was taken from that paper and written on a microcomputer.

– James W. King

Chinese Scientist Visits Cornell and NifTAL

After spending one year in Cornell working with Martin Alexander, Hu Zheng Jia stopped in Hawaii to discuss serology with NifTAL staff. Hu's studies in the United States were sponsored by the Chinese Academy of Science. At Cornell, he studied microorganism interaction in the rhizosphere.

Hu is a soil microbiology teacher at the Central China Agricultural College in Wuhan, China.

Australian Inoculant Production

Gary K. Bullard is the new owner of Root Nodule Pty, Ltd, an Australian-based legume inoculant manufacturing company. The company's major production of inoculants is for lupines and soybeans.

Bullard took over Root Nodule in February, 1983, after an accidental death claimed former owner Ron Daniels. Bullard's address is 84 Rawson Road, P.O. Box 367, Woy Woy, N.S.W. 2256, Australia.

Inoculant Production in Burma

U Hla Than, a researcher with the Agricultural Research Institute in Yezin, Pyinmana, Burma, submitted this report on inoculant production in his country.

Current plans are to produce – using NifTAL strains – sufficient inoculant for one million acres of crops. The acreage will be planted in such crops as peanut, lima bean, chick pea, and black gram. Inoculant for .2 million acres of peanut has already been produced.

During his internship at NifTAL, Hla Than studied inoculant production; and he has used fermentors and other equipment from NifTAL's Haleakala Production Plant as a model for modernizing the present plant at Yezin.

Another production center is slated to be opened at Maymyo. In addition to research and production of inoculants for upper Burma, this center will be combined with a peat mining, drying, and grinding facility.

Hla Than in the plant soon to be modernized using pressure vessel fermentors.

101

ANNOUNCEMENTS

GIAM VII Scheduled

The Seventh International Conference on The Global Impacts of Applied Microbiology is scheduled to take place in Helsinki, Finland, 12-16 August 1985.

GIAM VII will be organized by the University of Helsinki, with support from the Finnish Ministry of Education and the Finnish National Commission for Unesco. Unesco, UNEP, in cooperation with the Panel on Applied Microbiology and Biotechnology of the ICRO.

The conference will focus on the contributions that applied microbiology and biotechnology can bring to the economy and welfare of the developed and developing countries. The conference will, therefore, help to strengthen efforts to combat world hunger and to promote the conservation, distribution, and environmentally sound management of available natural resources in relation to overall human and social development.

Registration information is available from Professor H. G. Gyllenberg, Chairman, GIAM VII Organizing Committee, Dept. of Microbiology, University of Helsinki, SF 00710 Helsinki 71 Finland.

Microbiol Ecology

The invitation is out to attend the 4th International Symposium on Microbial Ecology (ISME-4) to be held 24-29 August 1986, in Ljubljana, Yugoslavia. The aim of the scientific program will be to provide coverage on a wide range of topics of interest; these include bacteria, applied microbiology, and nutrient cycling.

For information contact Cankarjev Dom, Congress and Cultural Centre, TRG Revolucije 2, 61000 Ljubljana, Yugoslavia.

MEETING NOTES

Associated N-Fixation in Rice

A group of nearly 30 international experts attended the United Nations University (UNU) of Tokyo, Japan, and International Rice Research Institute (IRRI) sponsored workshop on Associated Nitrogen Fixation in the Rhizosphere of Rice, held at IRRI, Los Banos, Philippines. The following is excerpted from the Recommendations to the UNU following the workshop.

To have alternatives to intensive use of N fertilizers in the cultivation of rice, it is necessary to explore the potential of BNF in rice fields. Among the known systems, rhizospheric N-fixation as well as the use of stem nodulated legumes and actinorhizal plants in rice fields has been relatively underexplored.

Participants felt that fundamental research is needed and agreed to recommend the establishment of a network of research in this area under the UNU program. Following discussion of research proposals, the following aspects were identified in which in-depth studies are essential to have a clear picture of plant-bacteria associations: 1) survey of diverse rhizosphere ecosystems of rice for isolating and identifying the components of active N_2-fixing associations; 2) accurate and reproducible assessment of N_2-fixation and colonization potentials of different isolates of microorganisms; and 3) accurate and reproducible assessment of the ability of rice cultivars to benefit from biological N-fixation.

In order to arrive at a meaningful comparison of the results from different laboratories, the meeting stressed adopting uniform methodologies in the following areas: 1) isolation of strains of microorganisms; 2) assessment of strain potential; and 3) assessment of rice cultivar potential.

Participants also recognized the necessity to enhance, through periods of study in recognized centers, the training of scientists to include application of molecular biological techniques to rhizosphere BNF.

Establishing a computer network for communication among participants and – provided links are effective – holding another meeting not earlier than 1986 were also recommended. A consultive group comprised of Drs. J. Banandreau, Y. Hirota, and I. Watanabe was proposed to provide expert advise to the network.

Further information on this meeting is available from Robert Kokke, Sr. Programme Officer, Development Studies Division, UNU, Toho Seimei Building, 15-1, Shibuya 2-chome, Shibuya-ku, Tokyo 150, Japan.

ASIA: Soybean Use Workshop

Soybean Foods Research Centre in Gannoruwa, Peradeniya, Sri Lanka, will be venue for the Soybean Utilization Workshop For Asia. Workshop foci will be organizing a soybean development project and using soybeans in foods and food products that appeal to the eating habits of Asian consumers.

Sri Lanka Soybean Project and INTSOY, in collaboration with FAO, UNDP, USAID, and UNICEF are organizing the workshop scheduled from 14-26 January 1985.

The course is intended for food scientists and processors, nutritionists, home economists, policy makers, and individuals responsible for the management or coordination of projects designed to establish soybean production and expand the use of soybeans for human food.

Enrollment for the course is limited to 25 participants. Interested persons should write to INTSOY for fee and registration information. Address inquiries to: INTSOY, College of Agriculture, University of Illinois at Urbana-Champaign, 113 Mumford Hall, 1301 West Gregory Drive, Urbana, IL 61801, USA.

Symposium: Biology of the Leguminosae

Advance notice has been received for Biology of the Leguminosae – An International Symposium. The meeting is scheduled for 23-27 June 1986 and will be held at Missouri Botanical Garden, St. Louis.

For symposium information contact Dr. James L. Zarrucchi, Legume Conference Coordinator, Missouri Botanical Garden, P.O. Box 299, St. Louis, MO 63166 USA. Meeting sponsors are Missouri Botanical Garden and Royal Botanic Gardens, Kew, United Kingdom.

Cairo-MIRCEN Needs Information

The Cairo-MIRCEN is planning to publish a new personnel catalogue for all microbiologists working in the region. The catalog is slated to contain: names, addresses, curriculum vita, professions, and fields of interest. The publication should be of value for possible research cooperation and should promote exchange of scientific information and experience.

Send your information to Editor, C/o Dr. M. A. El-Nawawy, Cairo MIRCEN, Faculty of Agriculture, Ain-Shams University, Food Science Department, Shobra-Khaima, Cairo, Egypt.

Continued from page 2

Alfalfa/Corn

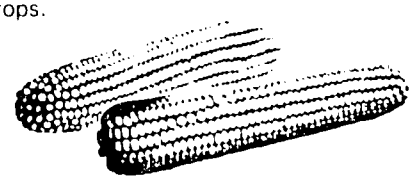
harvest systems that resulted in different amounts of herbage removal and phytomass incorporation.

The harvest systems used were: 1) three cuts removed; two at 1/10 bloom and fall harvest; crowns and roots incorporated, and 2) one cut removed at 1/10 bloom; herbage regrowth, crowns, and roots incorporated. Four or five rates of N fertilizer were applied to corn across all first-phase treatments.

The two alfalfas did not differ in total forage production, but Saranac AR tended to have higher CP and IVDDM concentrations than MN ROOT N. MN ROOT N had greater root dry matter yield and N concentration than Saranac AR. With fewer harvests, greater plant N was available for soil incorporation. The difference between harvest systems for N incorporation was greater than the difference between alfalfas within a harvest system.

Differences in second-phase corn yields were not associated with differences in first-phase alfalfa N incorporation at three of four locations. On the Webster clay loam (a Typic Haplaquolls soil type), second-phase corn grain yield with no N applied was greater following MN ROOT N after Saranac AR. With no N applied, second-phase corn grain yields were greater after all first-phase alfalfa treatments than after first-phase corn. Second-phase corn yields were greater following soybean than following corn at two locations. Corn yields were not different following either nodulated or non-nodulated soybean at any level of applied N.

The response of second phase corn to increasing levels of applied N was not consistent over locations. At three locations corn N response was similar following all alfalfa treatments. Differences in N incorporation between alfalfas were small, and it is unlikely that alfalfa selection alone, without consideration of harvest management, will result in increased yields of subsequent crops.



It Ain't Hay!

Five tons of alfalfa hay contain 1,800 pounds of protein, the same amount of protein found in 356 bushels of corn or 74 bushels of soybeans.

Five tons of alfalfa hay contain 7,000 pounds of total digestible nutrients, the same amount found in 158 bushels of corn or in more than 5 dry matter tons of corn silage.

MEXICO: FGT Work

The National Academy of Science FGT project in Mexico is headed by E. Prado Tejeda and J. L. Delgado M. of the Programa Jardin Botanico, Instituto Nacional de Investigaciones Sobre Recursos Bioticos, Veracruz, Mexico.

Their project seeks to promote forest conservation through the utilization of seven FGT species. For lowland agriculture, tree forage production is being studied while questions revolving around soil enrichment and fuelwood production are being tackled in the highlands.

For further information, contact them at Apdo. Postal 63, Xalapa, Veracruz, 91000, Mexico.

Associative N Fixation in Pakistan

Dr. K. Malik is a grantee in the National Academy of Science's Research Grant Program in BNF.

His research will examine the processes of N fixation associated with roots of grasses growing in saline soils. This information will help in returning salt affected waste lands in developing countries (approximately 14.4 million hectares in Pakistan) to economic use.

The broad research objectives are: 1) to examine associative nitrogen fixation in roots of grasses growing in saline soils with special emphasis on Kallar grass *(Diplachne fusca)*; and 2) to devise methodology for quantitative estimation of biologically fixed nitrogen and its contribution to the nitrogen requirements of the plant under study.

Malik is at the Soil Microbiology Division, Nuclear Institute for Agriculture and Biology, Jhang Road, P. O. Box 128, Faisalabad, Pakistan.

SHORT TAKES

The Department of Agronomy, The University of Georgia College of Agriculture, has been successful in their proposal for a CSRS Limiting Factors Grant to do nitrogen fixation work in Nepal. The Project's inoculation experiments will be conducted in conjunction with NifTAL's International Network of Legume Inoculation Trials (INLIT).

• • •

Luis Materon has been appointed microbiologist of the Forage and Pastures program at ICARDA, Aleppo, Syria.

• • •

C. T. Lee, a horticulturist at the University of Guam, currently is conducting research on winged bean *(Psophocarpus tetragonolobus)* together with the NifTAL Project. He visited NifTAL earlier this summer to assess progress and to discuss future directions of winged bean research in the Pacific Basin area. In the collaborative effort, 2 "A" experiments (based on the INLIT experimental design) have been completed—one each in Guam and Maui.

• • •

Moving to the Department of Plant Pathology, University of Missouri, is **Steven Pueppke.** He formerly was with the Institute of Food and Agricultural Sciences, University of Florida.

Now firmed up are dates for the symposium: **Establishment and Productivity of Tree Plantings in Semi-Arid Regions.** Participants will assemble at Caesar Kleberg Wildlife Research Institute, Kingsville, Texas, from 29 April to 3 May 1985.

• • •

Ken Cassman recently assumed duties as Assistant Professor of Cropping Systems at the Department of Agriculture and Range Science, University of California, Davis. This newly defined position in the Department reflects recognition of cropping systems as an important area of research, especially in BNF methodologies.

• • •

Shiva Chaudhary completed his Ph.D. work at the University of Hawaii earlier this summer. Chaudhary, a NifTAL-sponsored graduate student from Nepal, studied cropping systems under A. S. Whitney.

• • •

David McNeil is the new Agronomy Research Leader at Ord River Irrigation Area. He would like to increase contact with institutes interested in the lowland tropics and seeks to exchange progress reports with other institutes. His address is Western Australia Department of Agriculture, P. O. Box 19, Kununurra, W.A. 6743, Australia.

BNF Outlook for Africa

Grain legumes are widely grown in Africa. The cowpea, common bean, pigeon pea, chick pea, faba bean, and lentil provide most of the food protein for human consumption. While peanuts are grown extensively, soybeans continue to grow in popularity as a high protein oil crop because of their wide range of adaptability to different soils and climates. There is an ever-increasing need for larger supplies of food legumes in Africa but yields remain shockingly low.

Inadequate N is a serious limiting factor in legume production despite the fact that legumes have the ability to work with rhizobia and utilize the vast reservoir of gaseous nitrogen N_2, in the atmosphere. Yet the practice of inoculating legume seeds in Africa is almost nonexistent for two reasons: 1) effective rhizobial inoculants are not widely available and 2) farmers are not aware of the benefits of inoculation even if the inoculants were available.

There is little question regarding the benefits and great need of inoculants for introduced legumes such as soybeans. Nonetheless, the response to inoculation of soybeans has been variable because of the low quality of inoculants available (Hamdi, *et al,* 1982). Cowpeas (*Vigna unguiculata*), have been grown in Africa for centuries and the nodule bacteria are widespread (Ahmed, *et al,* 1981). Recent experiments involving 400 different cultivars revealed a positive response to fertilizer N in many cases even when the roots were well nodulated. Studies of the rhizobia indicated a high percentage of poor or ineffective strains. In contrast, some of the strains proved highly effective and were good prospects for use in making legume inoculants. Further, some of these strains were very tolerant of high temperatures, 40 degrees C and higher. These highly effective strains could be used to great advantage to improve crop production.

Preliminary results with peanuts in Cameroon (personal communication, 1984) are very exciting. In tests involving seven strains of rhizobia and three cultivars of peanut, one association, Cv20-206, in combination with *Rhizobium* Strain NC-92 from South America, resulted in a 26% increase in yield despite the presence of numerous peanut rhizobia in the soil. In contrast, field tests with groundnuts in the Sudan (Hadad, *et al,* 1982) failed to show any increase in yield attributed to inoculation of the seed. The native groundnuts were effective and the soil contained 1 X 10^4 cowpea rhizobia/g soil in the Wad Medani area.

The evidence is quite clear. Africa can benefit greatly with inoculation of their leguminous crops with highly effective rhizobia. This applies both for introduced legumes and those which have been grown for a long time. It will require careful screening of rhizobia to find the most effective and the most competitive strains which tolerate the harsh soil conditions. It will require preparation of dependable effective legume inoculants and it will require good extension work to make farmers aware of the potential benefits. This is the program which should be pursued. It could help greatly in solving the world hunger problem.

The above is an excerpt from a paper presented by Dr. J. C. Burton at the First African Conference on Biological Nitrogen Fixation.

African interest in BNF and legume inoculation is on the upswing – see associated stories on page 3.

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104

BIOLOGICAL NITROGEN FIXATION

BULLETIN

Volume V, Number 3

At NifTAL— Inoculant Production Course

NifTAL's first Legume Inoculant Production Course is now history. International participants worked at NifTAL's headquarters from 3-21 December 1984 studying inoculant production and actually producing the finished product.

Practical exercises included 1) testing *Rhizobium* strains selected for use in inoculant production; 2) media preparation and characterizing growth of rhizobia using different media; 3) starter cultures and broth transfer systems; 4) producing broth cultures in glass fermentors; 5) producing broth cultures in stainless steel fermentors; 6) quantifying the growth of *Rhizobium;* 7) processing carrier materials for inoculant production; 8) preparation and evaluation of inoculants using non-sterile carriers; 9) preparing inoculants with pre-sterilized peat by incorporating undiluted or diluted broth cultures of *Rhizobium;* 10) inoculation of legume seeds; and 11) inoculating the soil.

Lectures supporting these exercises were given by Drs. J. C. Burton, R. J. Roughley, P. Somasegaran, and Mr. H. Hoben. Drs. D. Hubbell and P. Singleton also presented short reports on their work.

Participants included Dr. Mongi Zouaghi—Tunisia; Dr. A. E. El Shafie—Sudan; Dr. A. Glatzle—Morocco; Mr. A. Cardenas Espinoza—Mexico; Mr. C. G. Suarez—Dominican Republic; Mr. W. Yongmanitchai—Thailand; Mrs. C. C. Pan—Brazil; Mr. J. Million—St. Croix, and Mr. M. Sarwani—Indonesia. Also participating was Dr. Walt Graves from San Diego, California, who is working with Dr. Zouaghi.

Halliday Accepts New Position

Former NifTAL Project Director Jake Halliday left in November to assume the directorship of the Battelle-C.F. Kettering Research Laboratory at Yellow Springs, Ohio. Halliday ably served as NifTAL director from April 1979.

The Kettering Laboratory conducts agricultural-related research aimed at developing improved crops, chemicals, and fertilizers. With its tradition of conducting basic research on the plant and microbial processes affecting crop production, the Laboratory is well known for its work on BNF.

The University of Hawaii is presently in the process of selecting a replacement for Halliday as the NifTAL Project Director position. Joann P. Roskoski has been named Acting Project Director.

105

FAO FIELD ACTIVITIES

FAO recognizes that BNF is an important component of their "Integrated Plant Nutrition Systems" approach. BNF is being promoted through the Fertilizer and Plant Nutrition Service (AGLF) within the framework of its Fertilizer Programme. An area of contact is their Field Activities program.

One of the most important considerations in BNF activity is to narrow the gap between research results and farmer use. Depending on their capabilities, national institutions for applied research work have been contracted to carry out field experiments in order to obtain more field information on the beneficial effects of inoculation with Rhizobia strains on grain and fodder legumes and primarily to determine the essential limiting factors of fixation.

A large number of trials have been conducted and are being continued in farmers' fields, especially in African countries. Results are under compilation, but the following preliminary observations were made:

—Soybean greatly benefit from inoculation, since most soils in West Africa are deprived of specific and efficient Rhizobia strains able to establish adequate symbiotic relationships with this crop. Yield increases from 800 kg/ha (control plot) to nearly 2000 kg/ha (inoculated plots) have been recorded in Senegal.

—*Leucaena leucocephala,* an important fodder shrub of the Sahelian zone, also seems to be quite specific as far as inoculation requirements are concerned. Experiments have shown that inoculation with efficient *Rhizobium* strains permits the plant to take full advantage of its very high N-fixing capacity, which may be as high as 900 kg/ha/year.

—Concerning a variety of other legumes, it is quite possible to increase the yields in the Sahelian zone by at least 10-20% through inoculation.

—No effect from inoculation observed on *Stylosanthes* spp. and groundnuts in Upper Volta and the Ivory Coast is attributed to poor inoculation techniques, competitiveness from native *Rhizobium* strains versus imported ones, adverse soils conditions such as strong acidity, excess of exchangeable aluminum, incidence of nematodes.

—Efficiency of different inoculants of good bacteriological quality differed under some situations when tried on existing selected legume varieties. This calls for screening of specific, efficient strains for a particular variety for its wider adoption.

—In any legume selection program, the whole system of the legume/*Rhizobium* couple should be taken into consideration and not each of its components separately.

—Survival and competitiveness of imported strains of *Rhizobium* in acid soils with low organic matter content and high temperature are still major limiting factors in tropical and sub-tropical areas.

—When some very efficient strains of *Rhizobium,* selected in temperate conditions are tested in warm areas, results are often discouraging.

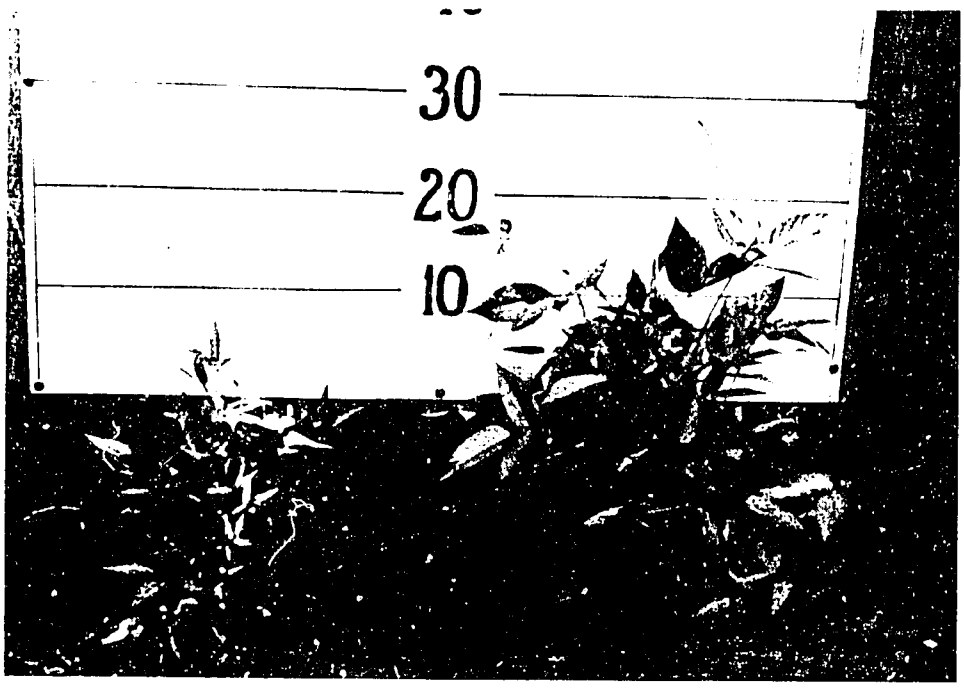
—Cultivars of legume species, selected in soils with a high level of nitrogen, are poor fixers of atmospheric nitrogen, while cultivars selected in soils with low levels of nitrogen respond much better to inoculation.

—To facilitate early growth and consequent efficient N-fixation, a starter dose of 20 kg N/ha was found beneficial. However, contradictory results have been observed in Tanzania emphasizing the need for further follow-up trials. Also, beneficial effects of adequate levels of other nutrients, especially P were found.

—Significant differences in growth of lupine *(L. albus)* is noticed when inoculated *(R. lupini)* plots are compared with non-inoculated plots, even though efficient native strains of *Rhizobium* are present in the soil.

(Continued on page 4)

Inoculation Response in *Centrosema*



Pictured above is a trial showing a marked response to *Rhizobium* inoculation in association with two different cultivars of *Centrosema macrocarpum.* Inoculant was specifed for *C. pubescens* and supplied by NifTAL. Don Schmidt and Asep Saefuddin reported the work done at the River Basin Agricultural Development Project in Citanduy, Indonesia.

Centrosema brasilianum showed a modest response and *C. pubescens* had no response. Plants of the latter from non-inoculated seed were apparently nodulated by native soil rhizobia.

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For Information on the NifTAL Project Contact NifTAL Project Director, NifTAL Project, P. O. Box O, Paia, Hawaii 96779. Submissions to the BNF BULLETIN may be sent: Attention: Communication Section, NifTAL Project.
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.

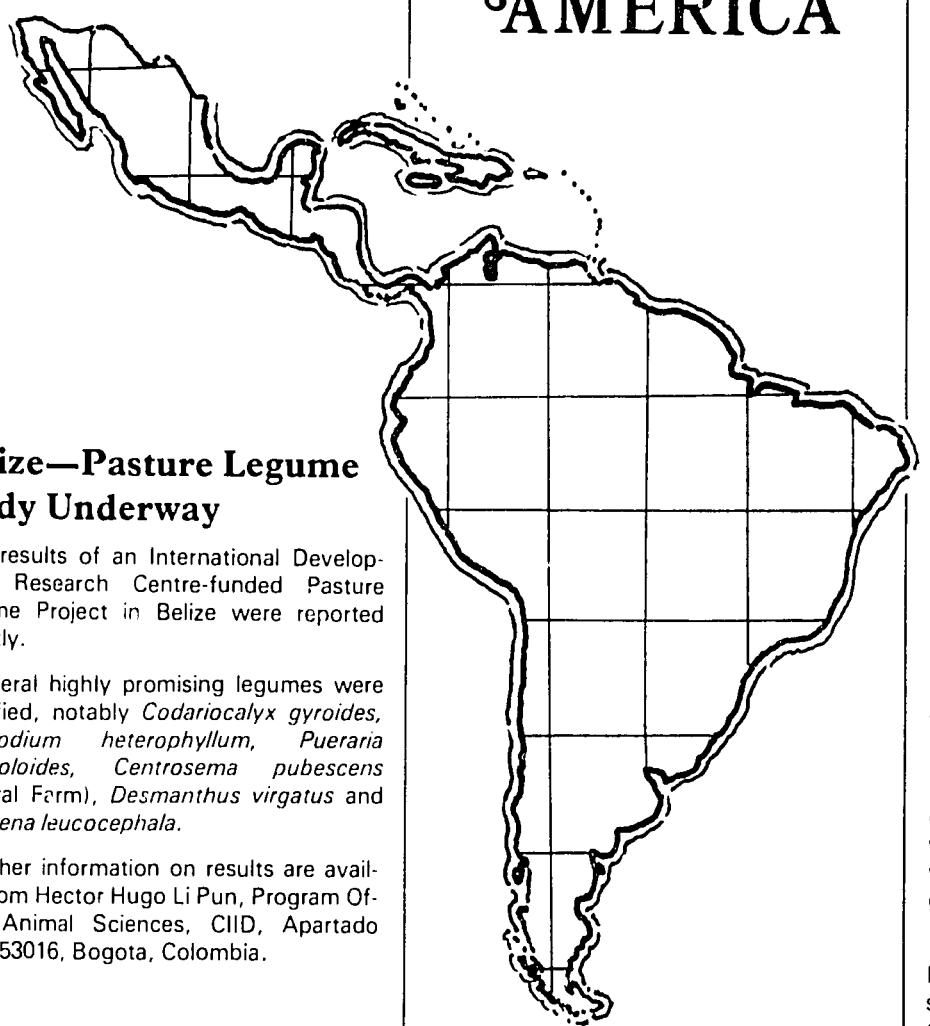
Editors: Dr. James King
Princess Ferguson

Graphics: Keith Avery

BNF IN LATIN AMERICA

Mexico: 3rd BNF Conference

The Facultad de Quimica, UNAM, Post Graduate College, Chapingo, Mexico, the Universidad Autonoma, and Fertimex, announce that the Third BNF Conference will be held 13-15 March, 1985, in University City, Mexico City, D.F. It is sponsored by the National BNF Committee of Mexico. For information, contact M. C. Rosa Maria Ramirez Gama, Faculty de Quimica, Lab de Microb Exp, UNAM 04510, Mexico, D.F.



Belize—Pasture Legume Study Underway

Early results of an International Development Research Centre-funded Pasture Legume Project in Belize were reported recently.

Several highly promising legumes were identified, notably *Codariocalyx gyroides, Desmodium heterophyllum, Pueraria phaseoloides, Centrosema pubescens* (Central Farm), *Desmanthus virgatus* and *Leucaena leucocephala.*

Further information on results are available from Hector Hugo Li Pun, Program Officer, Animal Sciences, CIID, Apartado Aereo 53016, Bogota, Colombia.

XII RELAR

The XII RELAR was attended by over 150 Latin American scientists and was exceptionally well planned and organized.

Scientific sections included presented papers, posters, and debates on the following topics: production and use of inoculants, methodology, soil factors, strain selection, specificity, ecology, management, physiology, biochemistry, and genetics, and BNF/VAM interactions. The focus of the presentations was applied science and the scientific quality of the work was excellent.

The XIII RELAR will be held in Panama in 1986. B. Hernandez was chosen as president of the organizing committee.

1st Caribbean Symposium on BNF

From 4-10 August 1984 the First Regional Caribbean Symposium on BNF was held. It was sponsored by the Secretary of Agriculture of the Dominican Republic, FAO, the bean/cowpea CRSP, and the University of Puerto Rico.

Representatives of the Dominican Republic, Haiti, and Barbados presented brief outlines of BNF activities in their countries. One of the presenters, N. Bretons, described three BNF projects in Haiti funded by FAO, FIS, and NAS. The latter focuses on the inoculation response of pigeon pea.

Inoculant Production Training in Uruguay

A one week course in inoculant production, organized by C. La Bandara, was held in Uruguay in August, 1984.

The course involved a mixture of formal theory lectures and practical lab exercises which primarily focused on inoculant quality control, excursions to inoculant manufacturing facilities in Uruguay, and discussion groups.

The 26 participants from 10 Latin American countries were divided into four geographically-related groups and asked to develop a strategy for introducing or amplifying the use of inoculants in these regions. This exercise proved most worthwhile since it gave participants a chance to become familiar with factors that constrained the manufacture and use of inoculants in other Latin American countries.

Argentina Workshop

At a UNDP-sponsored meeting in Argentina in March 1983 BNF was identified as one priority area for a proposed network of biotechnology centers in Latin America. J. Jardim-Freire was charged with holding a workshop to formulate a multi-national BNF project for the biotechnology program. This workshop was held 18-20 October 1984 in Campinas, Brazil.

The outcome of the workshop was a project proposal composed of a general description of BNF activities in Latin America. This description contained a detailed outline, by country, of training needs; a list of countries able to provide training; the individual country projects; and an appendix with summaries of the national BNF programs.

Professors C. LaBandara and Jardim-Freire are combining the information and sending it to the UNDP Biotechnology Center Program.

Following the symposium, discussions were held by a group of participants which included R. Bradley, R. Graham, M. Habit, D. Hubbell, E. Martinez, R. Martinez, E. Pimentel, H. Reynosa, J. Roskoski, E. Schroder, C. Suarez, and N. Tilforth. It was proposed that a Caribbean *Rhizobium* Group be formed. Discussion centered around the need to contact other BNF workers in the area who were not in attendance to assess their interest in joining the organization.

E. Schroder, who was elected provisional chairperson, will present the proposal before the executive committee of the Latin American Rhizobia Association for formal recognition. E. Pimental was elected vice-chairperson.

107

NEW PUBLICATIONS

Available from the Tropical Agriculturure Research Center (TARC), Ministry of Agriculture, Forestry and Fisheries, Yatabe, Tsukuba, Ibaraki, 305 Japan, is the proceedings from the **International Symposium on Soybean in the Tropics and Subtropics.** Held in late 1983, the symposium was jointly sponsored by the TARC and the Asian Vegetable Research and Development Center.
Order from the above address as Tropical Agriculture Research Series No 17.

Practical Application of Azolla for Rice Production, Proceedings of an International Workshop held at Mayaguez, Puerto Rico, has been published by Martinus Nijhoff. The book was edited by W. S. Silver and E. C. Schroder. Information on ordering (ISBN 90-247-3068-6) is available from Kluwer Academic Publishers Group, Distribution Center, P.O. Box 322, 3300 AH Dordrecht, The Netherlands.

An interesting report has been released by Thomas E. Loynachan. Entitled Groundnut Inoculation in Sudan, the report is based on results from a USAID-funded grant. Request from Thomas E. Loynachan, Department of Agronomy, Iowa State University of Science and Technology, Ames, Iowa 50011.

The Rhizobium Catalogue, 2nd Edition, is available from Dr. V. B. D. Sherman, Department of Microbiology-WDC, University of Queensland, Sta Lucia, Brisbane 4067, Australia.

The program and abstracts of the First Conference of the African Association for Biological Nitrogen Fixation (AABNF) held during July at Nairobi, Kenya, is available. For information, write conference Chairman Professor S. K. Imbamba, Department of Botany, University of Nairobi, P.O. Box 30197, Nairobi, Kenya or Prof. S. O. Keya, Rhizobium MIRCEN, University of Nairobi, P.O. Box 30197, Nairobi, Kenya.

First published in October 1984, the ACIAR Food Legume Newsletter is from the Australian Centre for International Agricultural Research Food Legume Program.

Twice yearly, the newsletter will report on research aimed at identifying agricultural problems in developing countries and finding solutions to such problems.

Editing the newsletter is E. S. Wallis, ACIAR Research Program Co-ordinator. His address: Department of Agriculture, University of Queensland, St. Lucia, Qld. 4067, Australia.

FAO (Continued from page 2)

—New forage legumes (e.g., alfalfa) can only be effectively introduced in a region (e.g., Mbeya, Tanzania) through the use of proper inoculation.

—Even if the bacteriological quality of an inoculant is good at the production unit, the transporation of this perishable product in warm areas can cause serious damage.

Several follow-up trials are underway. Depending on respective countries' stages of development in BNF, similar field activities in the Asia region are underway. A number of trials have been conducted in Indonesia and a research contract on alley cropping in Thailand is in progress.

Under research contract, a study on N-fixation by *Casuarina* (a non-legume, N fixing tree) with Frankia inoculation in Egypt is in progress.

In collaboration with ORSTOM (Dakar, Senegal), studies on inoculation of *Sesbania rostrata* in Nepal, Sri Lanka, Gambia, and Costa Rica are underway.

Relatively intensive country projects on BNF in Sudan, Tanzania, and Senegal under UNEP funding were operational from mid-1984.

This information is contained in a report, AGLF Activities on BNF, by R. N. Roy and S. Verniau, FAO, Rome.

INDO-US Initiative

The latter part of 1984 saw visits exchanged between Indian and NifTAL research scientists. Visiting from India were N. S. Subba Rao, Director, Indian Agricultural Research Institute (IARI), and S. Hegde, Microbiologist at the University of Agricultural Science at Bangalore.

Subba Rao, the Indian Program Coordinator, briefly visited to share information and concerns. One suggested area of cooperation is a joint effort studying salinity and symbiotic N-fixation by chickpea. Hegde, a former participant in NifTAL's Legume/*Rhizobium* Technology training, spent two weeks during the month of December consulting on possible project designs.

NifTAL researchers Jake Halliday, Robert Davis, and Paul Singleton travelled to India in September. They presented seminars and explored cooperative research opportunities. One project concerns NifTAL's cooperation with IARI in developing, maintaining, and computerizing an Indian national *Rhizobium* germplasm bank.

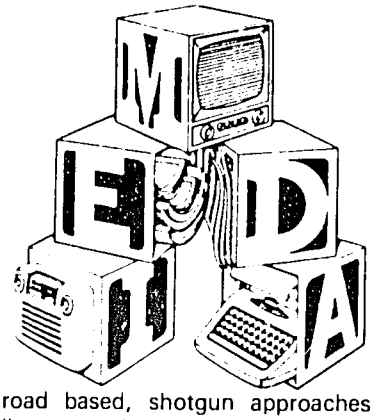
Despite Indira Ghandi's regretable and untimely death, cooperation between NifTAL and Indian scientists continues in the INDO-US Science and Technology Initiative.

DIRECTIONS IN COMMUNICATION

The term "public relations" often conjurs negative images in the BNF community. The image seems to be that of some individual or organization manipulating an event, issue, person, or organization for a less than wholesome end. And, because many of us think along these lines, we don't use the positive aspects of public relations.

From an organizational perspective, public relations is a conscious, ongoing communication effort to motivate or influence people to think well of an organization, to respect it, to support it and to stick with it through trial and trouble. Public relations is not a cure-all for an agency's problems, rather it is a communication process to provide new information or bring new meaning to old information.

How can people and organizations involved in BNF research use public relations to their benefit: First, public relations must be thought of as long-range and long-term programming. Like research projects, public relations needs to identify goals and objectives of the effort and to specify a variety of target audiences.



Broad based, shotgun approaches to public communication efforts do not usually have a dynamic impact when compared to smaller, well developed public relations programs. Thus, long term planning based on defined goals and objectives for specific audiences is the foundation for successful public relations efforts. While there are no formulas for foolproof public relations, the following are several ways to improve our current efforts. Try to think like a newspaper editor and be aware of the trends and subject areas that certain publications favor with repeated coverage. Your organization and people often can provide other angles on a topic and can expand or provide background on certain stories. Be aware of your own experts in the organization. Not only can they write, but they can find speaking opportunities at professional meetings, schools, and business and government-sponsored seminars.—Get to know the editors of the publications with which you deal. An open house with a special emphasis on informally introducing your organization to the media is one suggestion.—Don't force a story on a publication. Forcing stories on publications hurts your relationship with them. Try to build a positive relationship.—Develop good newsworthy stories. A good guage for newsworthiness is that a story involves a lot of people (i.e., hiring new people), a lot of money (i.e., just received a grant), a prominent person (i.e., important visitor), something unique (i.e., new research), or something universal.

A thing to be useful must be used. Controlled and managed public relations is an opportunity for meaningful communication for BNF organizations.

Sorwli Studies Bambara Groundnut

Dr. Frank Sorwli, lecturer in the Crop Science Department, Faculty of Agriculture, University of Ghana, Accra, is a visiting scientist at NifTAL. During his stay from August 26 to mid-January 1985, he has been working on the bambara groundnut *(Voandzeia subterranea)* which is an underexploited legume and a very important grain legume in Africa.

Along with Dr. Padma Somasegaran, NifTAL microbiologist, Sorwli investigated the variation in the effectiveness of native rhizobia isolated from the nodules of *Voandzeia* plants grown in Kenya and Hawaii. The *Rhizobium* affinities of *Voandzeia* were also studied using rhizobia isolated from other legume species.

Sorwli also studied host-strain interactions in the *Leucaena-Rhizobium* symbiosis using three Leucaena species *(L. lanceolata, L. diversifolia,* and *L. pulverulenta).* A multi-strain Rhizobium inoculant was used to inoculate the three Leucaena species and strain competitions were studied.

2nd AABNF Meeting

The second meeting of the African Association of Biological Nitrogen Fixation (AABNF) will be held at the University of Cairo in Egypt in 1986. The newly formed association has agreed to meet every two years and plans to periodically publish an AABNF bulletin.

World Soybean Conference

The World Soybean Research Conference held in Ames, Iowa, during August 1984 was attended by over 1,200 participants from 50 countries.

Many papers relating to BNF were presented. Currently, there appears to be a tremendous interest in expanding soybean production in the tropics and developing countries. An increased emphasis on plant controlled aspects of the symbiosis rather than work with *Rhizobium* was expressed. *Rhizobium* genetics and research with fast-growing *R. japonicum* from China are notable exceptions.

Heat Tolerant Soybean

Development of a more stress-tolerant soybean variety has been reported by J. Specht and J. Williams of the University of Nebraska at Lincoln.

Researchers there are working on the practical aspects of developing a soybean with increased pubescence (plant hairiness). Increased pubescence allows soybeans to reflect more light and use less water. Thus, hairy soybeans could be more tolerant under the stress of hot, arid growing conditions.

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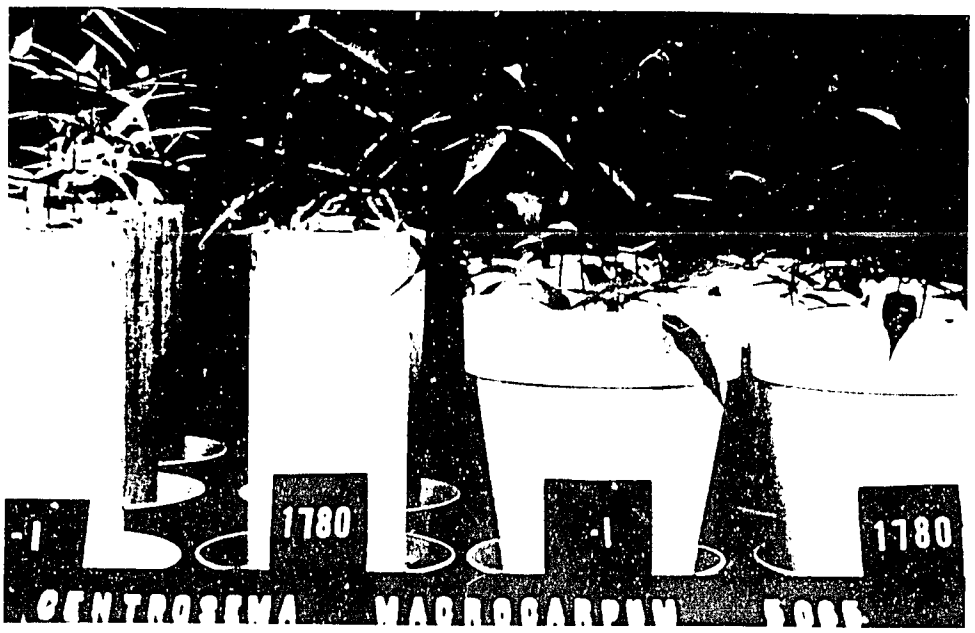

Pictured above the comparison is shown between plants grown in undisturbed soil cores and potted soil. Strains were pre-selected in undisturbed soil cores which were found to give much better results than soil in pots due to high rates of N mineralization stimulated by disturbance of the soil.

ACIAR Programs

ACIAR's (Australian Centre for International Agircultural Research Food Legume Program) focus is on semi-arid areas in the tropics and sub-tropics of Australia's near neighbors in Southeast Asia. Two factors leading to the establishment of ACIAR were the realization by the Australian Government of the high returns possible from investments in agricultural research and the potentially applicable expertise within the Australian scientific community to benefit developing country agriculture.

Two projects in the plant nutrition program dealing specifically with BNF are 1) Ecological Studies of Root Nodule Bacteria and the Use of Legume Inoculants and 2) Micronutrient Requirements for BNF and Growth of Legumes.

The former project is based at the Horticultural Research Station of the New South Wales Department of Agriculture. It will look at the problem of introducing suitable *Rhizobium* by seed inoculation. The project's aim is maximizing the chances of *Rhizobium* nodule formation on peanut and cover crop legumes in Malaysia and northeast Thailand. Also under investigation will be the effectiveness of native Rhizobium in northern Thailand in association with soybean strains of U.S. and Asian origin.

The latter project will explore how nutrient deficiencies limit N-fixation and legume production. The goal is to develop techniques and standards for six of the most important nutrients. These techniques will be used in the soils of northern and central Thailand.

Mr. E. S. Wallis is the ACIAR Project Coordinator, Professor J. R. McWilliam the Project Director. Listed below are names and addresses of Legume Program Research Groups.

ACIAR Headquarters Prof. J. R. McWilliam ACIAR Director	P.O. Box 1571 Canberra, A.C.T. 2601 Australia
Pigeonpea Project Dr. D. E. Byth and Development of Legumes For Farming Systems of NE Thailand Dr. L. R. Humphreys	Department of Agriculture University of Queensland St. Lucia, Qld. 4067 Australia
Plant Virus Identification Dr. A. J. Gibbs and Water Use Efficiency in Tropical Legumes Dr. G. D. Farquhar	Research School of Biological Sciences P.O. Box 475 Australian National University Canberra City, A.C.T. 2601 Australia

Rhizobia for Tropical Pasture Legumes

Marked responses to inoculation of *Centrosema macrocarpum, Desmodium heterophyllum,* and *Pueraria phaseoloides* in the field at Carimagua have been observed by microbiologists of the Tropical Pastures Program, CIAT, Colombia. Strains were pre-selected in undisturbed soil cores which were found to give much better results than soil in pots due to high rates of N mineralization stimulated by disturbance of the soil.

Strains for inoculation of other promising forage legumes (e.g., *Stylosanthes capitata* and *Arachis pintoi*) are being selected. A catalogue summarizing results of all strains-screening on tropical forage legumes carried out at CIAT to date is available from Dr. Rosemary Bradley, CIAT, Apartado Aereo 6713, Cali, Colombia.

Having shown marked responses in the field to inoculation of some tropical forage legumes it becomes necessary to ask the question "Can farmers in such isolated regions obtain and use peat-based inoculants?"

The answer in Colombia, says Bradley, is unfortunately "no", at least until a local firm can be persuaded to produce inoculants. A government-run plant which produces veterinary vaccines in Bogata (VECOL) has shown interest in this. And, in collaboration with CIAT, a recently published method for producing lyophilized, oil-based, inoculants is being tested. Rhizobia can be applied to seeds at much higher rates and survive on inoculated seeds much longer than with traditional peat-based inoculants. So far results have been very encouraging.

If this method proves to be as successful as the preliminary results indicate, it may go a long way toward increasing BNF by tropical legumes.

Cooperation: NifTAL-ACIAR

A cooperative agreement was signed between NifTAL's BNF Resource Center for South and Southeast Asia and ACIAR in August of this year. The agreement recognizes mutual interests in the area of BNF.

ACIAR has developed projects on various aspects of BNF as part of its Farming Systems, Plant Improvement, Plant Protection, and Plant Nutrition Programs. These projects cover many different aspects of legume production including viral diseases, improvement of the role of legumes in farming systems, legume bacteriology, micronutrient requirement of grain legumes, and the measurement of BNF.

In part, ACIAR and NifTAL will coordinate training and research to gain maximum effect in raising the research capabilities of developing country scientists.

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N-FIXING TREE NOTES

Frans Geilfus of IICA (Inter-American Institute for Cooperation on Agriculture) is currently beginning an experimental program with *Calliandra calothyrsus* for erosion control and agroforestry in hilly areas of the Dominican Republic. He desires to collect information and would like to contact all people connected with *Calliandra* research. Anyone who would like to exchange information should write to Geilfus, c/o IICA, A.P. 711, Santo Domingo, Dominican Republic, W.I.

Prosopis species is the focus of a project presently underway to evaluate a range of leguminous trees as sources of fuel and fodder for smallholder village farmers in Southeast Asia. R. C. Gutteridge, Research Fellow, in the Department of Agriculture, University of Queensland, St. Lucia Queensland, 4067, Australia, is involved in the project.

FAO's Committee on Forestry proposes that 1985 be proclaimed International Year of the Forest. This proposal addresses the need to alert the world to the importance of protecting forest resources worldwide.

Colin E. Hughes at the Commonwealth Forest Institute, South Parks Road, Oxford OX1 3RB, U.K., is looking for information on *Gliricidia* and nodulation. He is also interested in inoculum for *Gliricidia*.

N-Fixing Tree Trial Results

Jeng-Chuan Yang, visiting scientist from Taiwan, reports on work he did while at Boyce Thompson Institute, Cornell University, Ithaca, New York. Results from a cross-inoculation experiment showed that (1) *Rhizobium* strains 94A3 and Leu 166 (both isolates from *Leucaena esculenta*) are able to re-nodulate effectively the host *L. esculenta*, strain 94A2 (also isolated from *L. esculenta*) did not re-nodulate; (2) Strains Leu 120 and Leu 121 (both isolates from *L. pulverulenta*) can nodulate *L. esculenta* seedlings; and (3) Strains 94A2, Leu 166, Leu 166' (isolates from *L. esculenta*), Leu 2 (isolated from *L. leucocephala*), Leu 108, Leu 120, Leu 121 (isolates from *L. pulverulenta*) effectively nodulate cowpea seedlings.

Yang also reports on work done in Taiwan. *Acacia mangium* and *A. auriculiformis* have been planted extensively under the CSIRO-sponsored "International Provenance Test Program." In a pot experiment, it was found that seedlings of both species were well nodulated by using the surface soil collected from forests of native *A. confusa*.

Presently, Yang is at the Maria Moors Cabot Foundation for Botanical Research, Harvard University, Harvard Forest, Petersham, Massachusetts 01366. He will be returning to Taiwan in May, 1985.

Inoculation Response—Saudi-Arabia

In a field trial at Gassim, Saudi Arabia, several soybean varieties to N P K fertilization and rhizobia inoculation. Y. Al-Saheal, N. A. Hegazi, H. Saleh, and A. I. Fathi, of the College of Agriculture at King Saud University carried out the experiment.

Results showed that 2 of the 3 soybean varieties (S5 and S16) tested grew satisfactorily under typical farming conditions in Gassim. The varieties provided yields of 1-2.6 tons/ha with the application of 100 kg N/ha in soils void of specific nodulating rhizobia.

Inoculation with a powdered peat inoculum of *R. japonicum* was very successful. Both S5 and S16 were heavily nodulated (> 35 nodules per plant). These plants developed as vigorously as those fertilized with N and yielded 1.3-2.8 tons/ha. Phosphorus application had a positive effect on nodulation and plant growth.

Contact the authors at King Saud University, Gassim, Buraydah, P.O. Box 1482, Saudi Arabia, for more information.

BURMA—Legume Crops

A recent report shows that the chief legume food crops grown in Burma are groundnut (1.5 million acres in 1983), lima, chickpea, cowpea, pigeon pea, soybean, mung, and black gram. Very good inoculation response has been obtained on lima, chickpea, mung, blackgram, groundnut, and soybean.

Soybean is now grown in upland situations (mostly by hill tribes and used as a fermented food). Native soybean cultivars are used in these situations because of their preferred flavor and their longer storage capability.

SHORT TAKES

J. Nolt has replaced **P. Graham** at CIAT. Her research program will focus on evaluating the nitrogen fixation of superior bean lines from the CIAT breeding program. These legumes will be inoculated with rhizobia previously isolated using 15N tracer.

• • •

Good news. **Dr. Carlos Batthyany**, permanent president of ALAR, is recovering favorably after his recent illness.

• • •

From Indonesia, **Omar O. Hidayat** reports that inoculation experiments are being conducted in the transmigration settlements in Kalimantan and Sulawesi this rainy season with soybean, mung bean, and peanut.

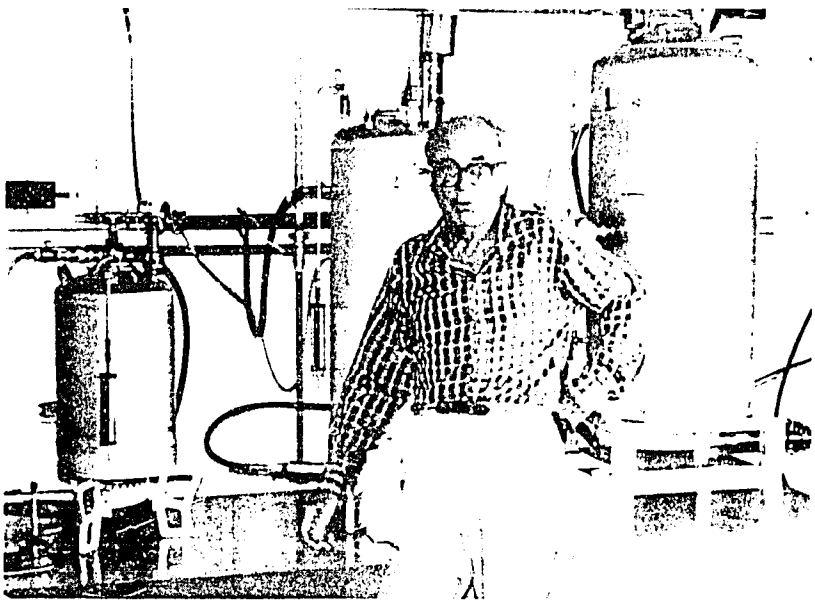
• • •

Dr. Donald L. Keister has left the C. F. Kettering Research Laboratory in Yellow Springs, Ohio. He is now at the Plant Physiology Institute, USDA, Beltsville, Maryland.

• • •

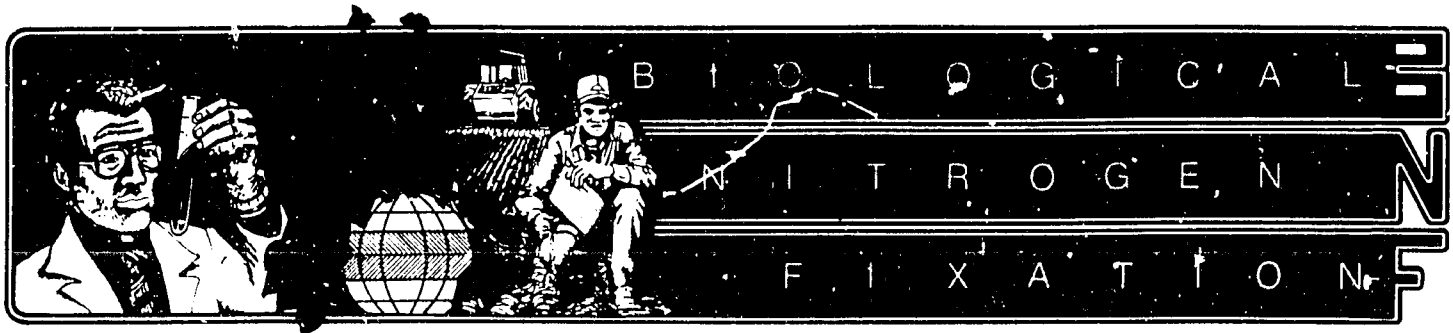
Returning to Korea after completing his Ph.D. degree from the University of Queensland is **Moo-Key Kim**. He will be working in the Department of Agricultural Chemistry, College of Agriculture, Jeonbug National University, Jeonju, Korea.

111



Producing quality inoculants requires mastering a variety of specialized techniques.

112



BULLETIN

Volume VI, Number 1

NifTAL: 10 Years Young

It has been ten years since NifTAL began its work at the University of Hawaii under contract to USAID. Our goal was, and still is, to reduce dependence of small farmers on costly nitrogen fertilizers for production of high quality food. This is accomplished by doing research and providing assistance to *Rhizobium* and legume programs throughout the tropics to more effectively exploit the *Rhizobium*-legume symbiosis.

These have been productive years and, like a well balanced wheel, momentum has carried us forward and kept us moving ahead. Whether by offering innovative training courses or technical expertise in setting up inoculant production facilities or by providing services from a regional center, NifTAL is working toward meeting its goal.

TECHNOLOGY TRANSFER

The present worldwide emphasis on biotechnology development is well met in NifTAL's adaptation and promotion of the naturally occurring phenomenon of BNF. Dr. N. C. Brady, Senior Assistant Administrator for Science and Technology, USAID, has stated in a recent article on tranferring technology for small scale farming, ". . . technology worthy of adoption cannot be transferred [to farmers with limited resources] unless existing technology is modified, or new technology directly related to the developing countries is developed, or both." This is what NifTAL has done, is doing, and will continue to do.

INTEGRATED APPROACH

To achieve its overall project goal, NifTAL has used an integrated approach involving research, outreach, and training activities. Through research, a comprehensive collection of *Rhizobium* germplasm was developed containing effective strains adapted to tropical conditions which are distributed to researchers and inoculant producers in the tropics. Also developed have been improved techniques and systems for ensuring dependable effective nodulation and maximum utilization of legume-fixed nitrogen in cropping systems.

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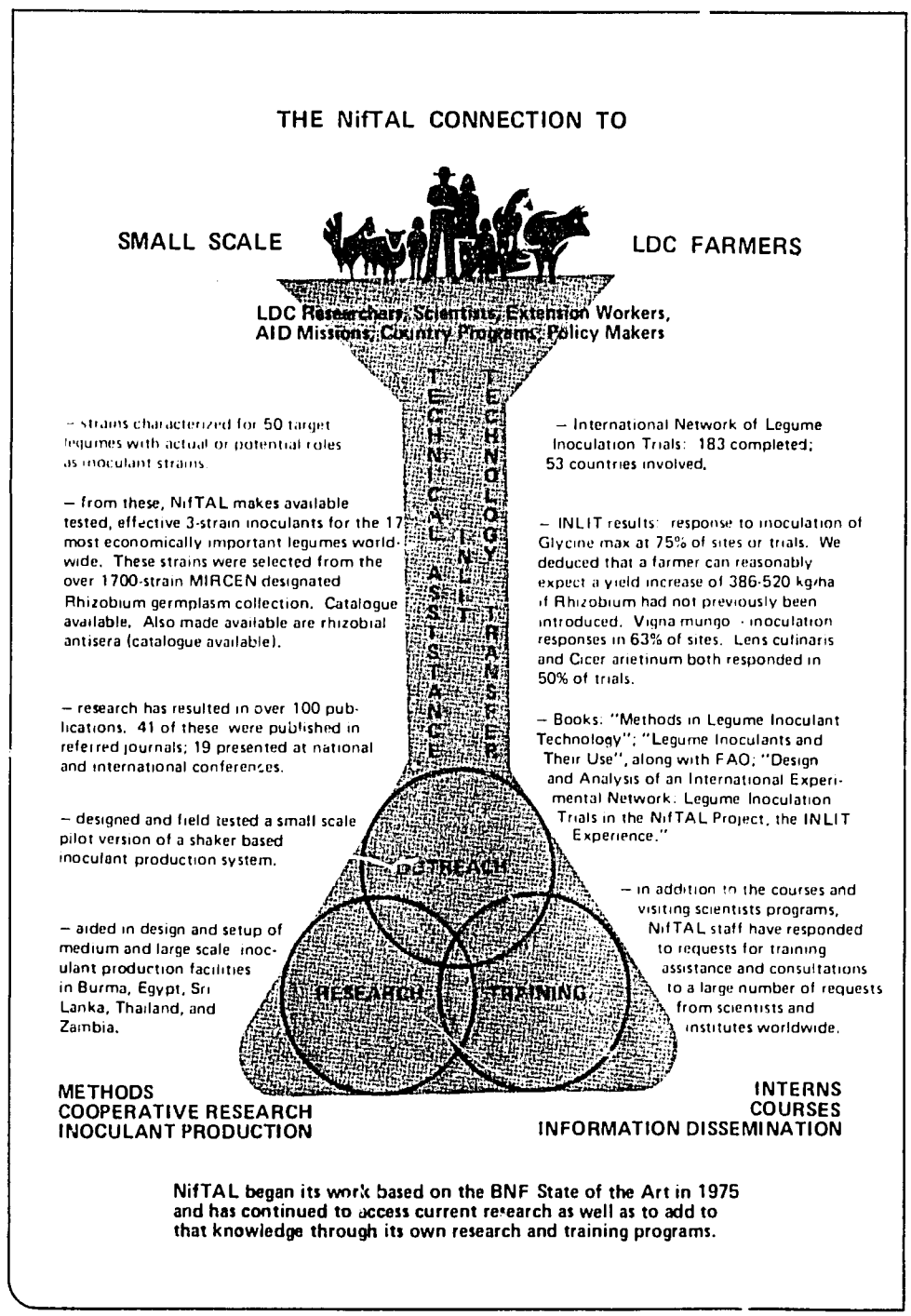

113

Soybean Research at Zamare

It is imperative that researchers understand the nature of the interaction between native populations of rhizobia and introduced legumes. Work is being done in this vein on the soybean varieties being developed by the ZAMARE Project (USAID/U of Illinois/NifTAL) at Mount Makulu, Zambia. If repeated cultivation of these varieties enriches rhizobial populations sufficiently to sustain maximum yield, there are great implications for the future of the inoculum industry in Zambia.

Two recently completed field experiments examined the response to rhizobial inoculation of Zambian soybean varieties. These varieties have been selected to nodulate effectively with native soil rhizobia that do not nodulate traditional soybean cultivars from the USA. Strains of *Rhizobium japonicum* selected on USA soybeans do, however, effectively nodulate the Zambian varieties.

Responses to inoculation have not been obtained on Zambian varieties when yields were moderate (1,100–2,000 kg ha^{-1}). Inoculation by variety trials indicated that when yield potential is substantially increased by management practices (3,700 kg ha^{-1}), all varieties and cultivars significantly respond to inoculation by rhizobial strains from Zambian soils and traditional inoculant strains of *Rhizobium japonicum* from the USA. Inoculation increased the yields of Zambian and USA soybean varieties by more than 1,000 kg ha^{-1}. When Zambian and USA cultivars were inoculated, the USA cultivars tended to yield more. However, when the two types were left uninoculated, the Zambian cultivars yielded more than the USA varieties. The soil populations of rhizobia were sufficient only to support moderate yields of Zambian cultivars.

Results indicate that Zambian varieties should definitely be employed where inoculation is not possible and when yield potential is low. The benefits of inoculation to both Zambian and USA cultivars in conditions of high yield potential are enormous and should be encouraged at all costs.

Legume Inoculants In Zimbabwe

This history of the Legume Inoculant Factory at Grasslands Research Station, Marondera, Zimbabwe, was submitted by factory manager, Mrs. Jean Grant.

The factory was started in 1962 by Dr. H. D. L. Corby and Microbiologist W. P. L. Sandmann. Corby and Sandmann collected samples of most of the legumes in Zimbabwe and catalogued them.

Sandmann then isolated *Rhizobium* from the root nodules and tested them for effectiveness. This was the basis for the *Rhizobium* strain collection held at Grasslands Research Station. With a few additional strains imported from outside the country, the collection was built up to about 700 strains.

In 1962, the *Rhizobium* strains grown on a factory scale were sold to commercial farmers for groundnut, lucerne and soybean. Research officers were provided other rhizobia strains for trials.

Initially, different inocula were produced on agar medium in flat glass bottles. Since 1981 however, sieved sugar cane waste (bagasse) amended with nutrients, is being used as carrier material. This inoculum is distributed in 50 g quantities packaged in high density plastic bags.

The amount of seed that one bag of inoculum will inoculate depends on seed size. Packages are labelled with the quantity of seed per unit, the quantity of sugar water to mix it with, and the batch and *Rhizobium* strain number. The bag of inoculum guarantees a minimum of 1,000 bacteria per seed. By carefully following instructions, farmers have reported very good results with a big savings on N fertilizer. Packaging in plastic bags has been well received and is much easier to handle. Publicity on the benefits of *Rhizobium* inoculation has been directed at communal farmers and, says Grant, it remains to be seen how quickly this good news spreads.

The annual sales of inoculant vary from 50,000 to 90,000 units. The factory has been expanded in anticipation of an expected upsurge in inoculant use by communal farmers.

For information on obtaining inoculants contact The Manager, Horticulture Branch, Farmers' Co-op Ltd., P.O. Box 510, Harare, Zimbabwe. Telephone: 728551, Cable: MAIZE, Telex:2371 ZW.

Pictured above are peat deposits located in Kataba Valley, Zambia. This peat has shown tests conducted by NifTAL in cooperation promise for use as an inoculant carrier in with the University of Illinois' ZAMARE Project.

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For Information on the NifTAL Project Contact NifTAL Project Director, NifTAL Project, P. O. Box O, Paia, Hawaii 96779. Submissions to the BNF BULLETIN may be sent: Attention: Communication Section, NifTAL Project.

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.

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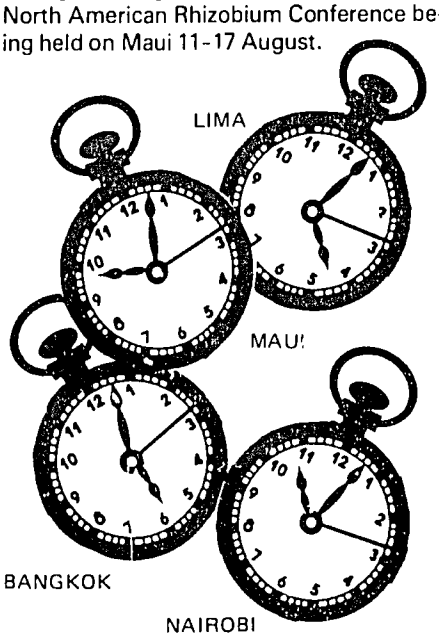
Editorial Asst: Judith Dozier
Graphics: Keith Avery

114

NifTAL Computer Bulletin Board: OPEN

"Welcome to the NifTAL Electronic Mail and Bulletin Board." That's the message you'll get if you call the newly operating communication program on NifTAL's main computer. For the price of a phone call you can leave a message for any staff member at the Maui NifTAL headquarters. Considering the length of time mail can take, and the difference in time zones around the world, this system can be a real advantage in contacting NifTAL.

Ask a question, start a discussion, or simply leave a message. These are some of the exciting features of NifTAL's communications program. One of the first practical uses for the Electronic Mail and Bulletin Board will be it's availability to reach participants—either through messages or questions—at the 10th North American Rhizobium Conference being held on Maui 11-17 August.



How does one get in touch with NifTAL's Bulletin Board? First you need a computer, modem, communications program and some expertise in using them. Then, just dial our computer telephone connection at 808-579-9140. The computer will ask for a name and password. Type in NEW for name and NIFTAL for password. You should then see the program menu. Under M for message section identify yourself with your full name and organization. Address your message to the system operator, Rudy Holthuis. After this initial contact the system operator will place you on the member list and will assign you a user number and password for further communications.

The system is currently operating on Hawaiian time from 5 p.m. to 7 a.m. daily and on weekends and in the near future, it is expected to operate on a 24-hour basis.

For further information about NifTAL's communications program, contact: Rudy Holthuis, NifTAL Project, P.O. Box O, Paia, HI 96779. Hope to hear from you on the computer...

Leucaena Seed Production Information Requested

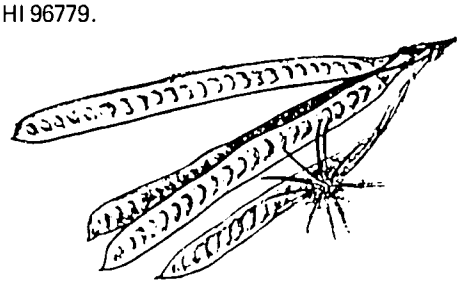
Consistant with NifTAL's overall mandate to examine all tropical legumes with a potential in development, NifTAL undertook a three-year research grant entitled "Development of *Leucaena leucocephala* Seed Production Systems Appropriate for Third World Countries." This grant was funded by the Donner Foundation and administered by the National Academy of Sciences (NAS).

Some aspects of this grant have been to: 1) compare growth and seed production of different Leucaena species at various NifTAL Maui field sites with varying agro-climatic conditions; 2) recruit cooperators in developing nations and assist them in establishing Leucaena seed orchards; 3) send Leucaena seed and information to those who have made requests; and, 4) use research results in producing a "how-to" Leucaena seed production manual.

A recent activity of this grant was the development of a questionnaire that was sent to over 70 Leucaena seed producers worldwide. The purpose of this questionnaire is to assemble information on various aspects of Leucaena seed production. Some of the information requested was orchard location, climatic conditions, production techniques (i.e.,irrigation, inoculation procedures, pests, etc.), and orchard yield (i.e.,seed production, fuelwood, charcoal etc.).

Returned questionnaires will enable NifTAL researchers to identify trends in Leucaena seed production and to make recommendations for future directions of Leucaena research.

Anyone wishing to fill out a questionnaire who has not yet received one is encouraged to do so. To receive a questionnaire or further information about Leucaena seed production systems, contact Dr. Joann Roskoski, NifTAL Project, P.O. Box O, Paia, HI 96779.

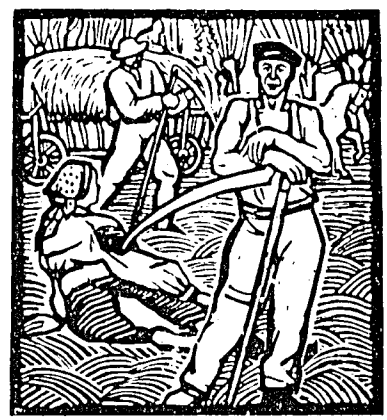


Inoculation Response

Sarah Workman, nursery coordinator with a reforestation project in Dedougou, Burkina Faso, West Africa, reports on Leucaena response to inoculation. Nursery trials there showed that *L. leucocephala* did not nodulate in local soils due to the absence of *Rhizobium*. In one comparison, 80% of the *Leucaena* seedlings inoculated with *Rhizobium* were found to have nodules. In another comparison, *Cajanus* had 50% nodulation.

Alternatives to Destruction

New crops and plant management techniques that would induce peasants of the lowland tropical humid forest to permanently settle a plot of land are being studied at the Forest Garden Project located in the Barro Colorado Nature Monument, Balboa, Republic of Panama. Dr. Gilberto Ocana reports progress on the Project.



Soils of the experimental area are acid red clays of poor fertility, with very low phosphorus and high aluminum content. Small, unburned forest clearings have been planted with a number of non-traditional crops among which, mung bean *(Phaseolus aureus)*, Mexican yam bean *(Pachyrhizus erosus)*, winged bean *(Psophocarpus tetragonolobus)*, Jack bean *(Canavalia ensiformis)*, Sagu *(Canna* sp.) and one variety of eggplant (Dumagut long purple) have been the most outstanding performers.

The main advantages of these crops, in this unfavorable agricultural environment, are vigorous growth, absence of significant disease or insect pests, and good yield. Data from replicated plots will be available during 1985.

With one exception, all species demand full daylight conditions—only the Sagu is shade tolerant. Other introduced plant species that show highly promising features for purposes other than food production are:

- For restoration and maintenance of soil fertility: *Mucuna pruriens, Pueraria phaseoloides, Codariocalix gyroides, Centrosema macrocarpum.*
- For timber and/or firewood production and enhancement of soil fertility (fast-growing legume trees): *Acacia magnium, A. auriculiformis, A. polystachya, A. aulacocarpa, A. crassicarpa, Albizia falcataria.*
- As forage legumes, highly attractive to valuable components of the wild fauna: *Stylosanthes guianensis* and *S. capitata.*

For further information contact Dr. Ocana at Smithsonian Tropical Research Institute, Box 2072, Balboa, Republic of Panama.

115

Saudi Arabia: BNF Group Report

Tne College of Agriculture, King Saud University, Gassim, Saudi Arabia, has initiated a research program on BNF. An interdisciplinary team composed of Dr. Y. Al-Saheal (Geneticist), Dr. N. A. Hegazi (microbiologist) and Dr. H. Saleh (soil scientist) have been in action since early 1984.

The project's objective is to: 1) introduce soybean to Saudi agriculture to be included in a crop rotation with Saudi's main crop, wheat, 2) survey native rhizobia in soil and in root nodules of indigenous leguminous plants, 3) assess rhizobial symbioses with local trees and shrubs (mainly *Acacia* sp. and *Sesbania* sp.) and compare these local species with exotic species in order to select the most effective for windbreaks, and 4) study the feasibility of producing legume inoculants.

Concluded as of January 1985 were three (INLIT) field trials on soybean nodulation and a cooperative effort with Nitragin Company comparing granular with seed coating inoculum. Research results were reported at the 2nd International Conference on Biological Agriculture in Kent, England, and at the 8th Symposium on Biological Aspects of Saudi Arabia, held in March 1985.

These researchers would like to increase contacts and exchange progress reports with institutes interested in BNF in soils and crops of arid regions. The address is Department of Soil and Water, College of Agriculture, King Saud University, Gassim, Buraydah P. O. Box 1482, Saudi Arabia.

SUPER SOYBEANS

Work at the Australian National University has produced super nodulating lines of soybean—more details will be forthcoming in the next issue.

Indo-US Science Initiative Update

Scientists from Indian and U.S. research institutions met at a workshop at the Indian Agricultural Research Institute (IARI), Delhi, in late March. The purpose of the meeting was to plan and coordinate the direction of collaborative research projects under the Ghandi—Reagan Indo/US Science and Technolgy Initiative.

Indian institutions represented at this workshop were: Indian Agricultural Research Institute (New Delhi); Universities of Bangalore, Coimbatore, Punjab, Madurai and New Delhi; Bhaba Atomic Research Center (Bombay); and Central Rice Research Institute (New Delhi).

U.S. institutions represented were: Battelle-Kettering Research Laboratory (Ohio); Massachusetts General Hospital (Boston); NifTAL Project (Hawaii); University of California (Davis), University of Florida (Gainesville), Louisiana State University (Baton Rouge), University of Nebraska (Lincoln), and Cornell University (New York); USDA/ARS and USDA/FRS. Scientists from USAID were also present and participated in the scientific and technical exchange.

Plans were made for a number of Indian scientist to attend the 10th North American Rhizobium Conference in Hawaii in August, 1985. At least one of them will remain at NifTAL and conduct a series of short experiments.

NifTAL: 10 Years Young

(continued from page 1)

APPROPRIATE TECHNOLOGIES

NifTAL has developed appropriate and usable technologies for preparing much needed inoculants. Flask-sized to small scale, practical, low or moderate cost production systems have been improved or designed. NifTAL staff have aided in the implementation of inoculant production facilities in Bangladesh, Burma, Egypt, Sri Lanka, Thailand, and Zambia. We have drawn from the expertise of *Rhizobium* inoculant specialists—both in the U.S. and other countries. This expertise combined with the innovative efforts of NifTAL scientists has had excellent results.

COLLABORATIVE NETWORKING

NifTAL researchers realize the benefits of collaborative efforts and have used international contacts to make best use of networking through NifTAL's International Network of Legume Inoculation Trials (INLIT). More than 200 LDC scientists from 53 nations have participated in the INLIT program.

TRAINING METHODS

Over 200 linkages have been formed through NifTAL's Legume/*Rhizobium* Technology training courses. Nine 6-week training courses have been held. The first four were held in Hawaii followed by five in Africa, Asia, and Latin America.

Forty-five interns from 25 countries have spent from several weeks to six months at NifTAL acquiring skills while working in collaboration with NifTAL researchers. Additionally, NifTAL has either totally or partially supported 25 graduate students working toward advanced degrees.

Two new training courses were instituted in 1984: BNF for LDC extension leaders (in conjunction with North Carolina State University and Bangladesh Agricultural Research Council) and an intensive Inoculant Production Course for LDC researchers and inoculant producers. NifTAL has also cooperatively sponsored several Azolla Technology Courses. Available in August 1985 will be the revised training manual **"Methods in Legume-Rhizobium Technology,"** the well tested result of NifTAL's training program.

This book will be on sale at the 10th North American Rhizobium Conference in August.

TRAINING RESULTS

This training has borne fruit as follow-up on ex-trainees has revealed that 60 are active in BNF research and outreach, 3 head BNF programs at National institutions, 13 are working toward advanced degrees, 10 are university professors, 2 are in policy-making positions, 18 have obtained outside funding to carry on BNF research, and 3 have offered their own BNF technology courses in cooperation with NifTAL.

The above presents just a few highlights of the many services that NifTAL offers. It has taken this integrated approach to keep abreast of changing needs and emphases in the development and promotion of BNF.

As NifTAL's tenth year passes, we can look back on many successes. We have learned, and through experience have adjusted our approaches, just as we have adapted to changing needs. Our momentum is up and a critical mass has been achieved. We are viable and fully ready to meet the challenge of our mission, to improve the lot of developing country farmers.

Editors Note: For a look at NifTAL's future plan, see page 8.

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116

DIRECTIONS IN COMMUNICATION

How we use language shapes the way we describe and thus perceive the world. The manner in which we use words also influences how we view our jobs, our organizations, and our goals and objectives.

By questioning and changing the generally accepted language we use to describe our activities, we can reconceptualize old jobs and continuing objectives for the purpose of developing better fitting BNF programs in LCDs.

At NifTAL we have reconceptualized our project from an agricultural endeavor to that of an international development effort.

How does this use of language affect what we do? As an international development effort, we communicate directly with other USAID projects outside the science and technology agricultural sector—such as rural development, nutrition, and media programs.

Expanded contact with the Unesco/UNEP/ICRO MIRCEN network has taken place, along with growing linkages to the World Bank, the International Centers, and private foundations. Substantial scientific exchange and a broader funding base targeted to assist tropical LDCs are the results of our "international development effort" reconceptualization.

The focus of NifTAL's science is aimed at solving baseline agricultural development problems. This new view expands a researcher's vision of what "could be"—a BNF system encompassing a larger scientific community—in a LDC and allows him freedom to problem solve without predetermined, disciplinary answers.

Reconceptualizaiton of a project's goals, objectives, and activities is an important aspect of development. Use of language does influence what we can conceptualize as possible and it helps us to dream what seems to be the impossible.

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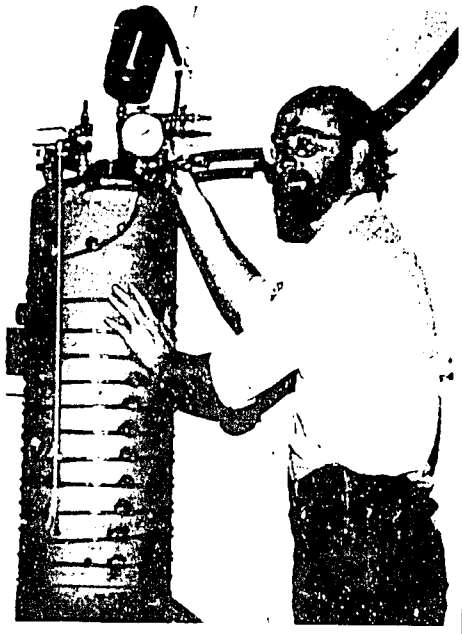
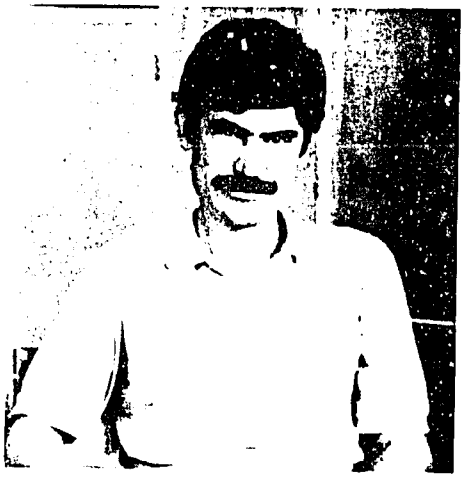
Dr. James W. King, former head of the Training and Communication Section at NifTAL and editor of the BNF Bulletin, has accepted a position as Associate Professor and Communications Specialist with the University of Nebraska. While there, King expects to continue in the development field.



He can be reached at the Department of Agricultural Communication, University of Nebraska, Lincoln, NE 68583-0918.

At NifTAL: Visiting Scientists



Dr. Velittin Gurgun, Associate Professor, Department of Agricultural Products, University of Ankara, Turkey, spent five months at NifTAL as a visiting scientist. Dr. Gurgun was sponsored by the U.S. Department of Agriculture.

During his stay, Dr. Gurgun collaborated with Dr. Padma Somasegaran and Heinz Hoben as he worked on the N-fixation of chickpea *(Cicer arietinum)*—an important legume in Turkey. He studied host-*Rhizobium* interaction in the Kabuli and Desi cultivars of chickpea using ten *Rhizobium* strains.

Competition for nodulation on these cultivars was also studied and the fluorescent antibody technique was employed in analyzing the nodules for strain occupancy.

In another experiment, the influence of five *Rhizobium* inoculation rates was studied using the two chickpea cultivars and two soils. Three antigenically distinct strains of *Rhizobium* represented in equal numbers was used in a peat-based inoculum and competition for nodulation was also studied in this experiment.

Another visiting scientist working at NifTAL this year was Muhrizal Sarwani. He is a researcher at Banjarmasin Research Institute for Food Crops (BARIF), Kalimantan Selatan, Indonesia.

At BARIF, Sarwani carries out field experiments, especially for field crops like rice, mung bean, and soybean in tidal swamp areas. He was sponsored in part by AID/Jakarta.

Sarwani began his internship by attending the NifTAL's Inoculant Production Course in December 1984. During his internship he worked on four research projects. In collaboration with Heinz Hoben and Dr. Padma Somasegaran, he conducted two experiments in the greenhouse. One was to evalute the competitive ability between *Rhizobium phaseoli* strains on cultivars of *Phaseolus vulgaris*. The other assessed host-strain interaction between cultivars of *P. vulgaris* and *R. phaseoli*.

Two more experiments were carried out in collaboration with Dr. Paul Singleton. One looked at the symbiotic interaction between fast- and slow-growing soybean *Rhizobium* and cultivars of soybean in a greenhouse trial. Fir[illegible], he assessed the effects of lime, zinc and molybdenum on N_2-fixation by soybean. In this trial the soil used was of low pH and low P and had high levels of iron oxide.

117

NEW NifTAL PUBLICATIONS

Antisera Catalog

Early in 1985, the NifTAL Antisera Resource Catalogue became available. This useful catalogue contains lists of antisera which have been developed for those strains which are recommended for the NifTAL INLIT trials.

However, NifTAL's antiserum bank is not solely meant for INLIT collaborators. This catalogue will provide all potential users access to the antisera held at NifTAL. It also contains useful information about antisera and handling and ordering information.

The catalogue is available free of charge to developing country researchers involved in serological work.

Methods in Legume-Rhizobium Technology

After extensive field testing at NifTAL training courses, review by experts in BNF, and extensive revision, Methods in Legume--*Rhizobium* Technology is in press. Copies will be available in mid-August.

This book will be useful to both those who are new to Rhizobium work and for those with extensive experience. It is a practical and useful teaching tool. The cost is $22 postage included; $10 (postage included) to requesters from developing countries.

Order either publication from the Communication Section, NifTAL Project, P. O. Box O, Paia, HI 96779 USA.

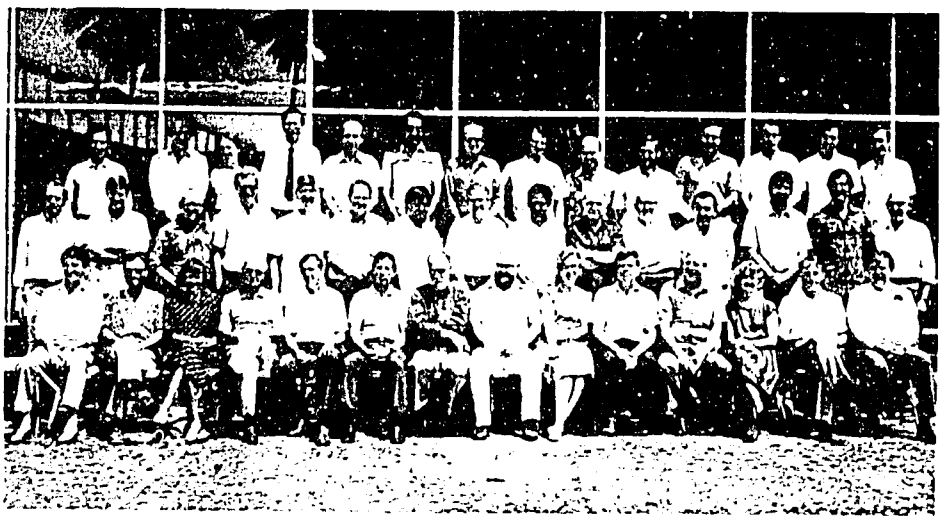
International Azolla Workshop Held

The first internationally organized Workshop on Azolla Use was held 31 March to 5 April at the Fujian Academy of Agricultural Sciences (FAAS), Fuzhou, China. The Workshop was held at the invitation of FAAS to coincide with the inauguration of the FAAS National Azolla Research Center.

Thirty-two participants from ten countries joined with 44 Chinese scientists to discuss the use of Azolla. Participants met at three workshops to summarize information presented and to represent new avenues of research in the following areas: 1) the use of Azolla as a green manure, its ability to fix nitrogen, and insects and diseases that attack the fern, 2) new uses of Azolla as a feed for animals and fish, and 3) the classification of Azolla and ways to collect and maintain specimens of this valuable aquatic plant from all parts of the world.

Key remarks were made by two persons. Huang Changzi, Vice Governor of the People's Government of Fujian Province said that his government, in the spirit of international cooperation and sharing of scientific knowledge among all peoples, considered the National Azolla Research Center a world resource. And, that the Center would welcome scientists from other countries to work and study there. Liu Chung-chu, Vice President of FAAS, called for a new recognition and evaluation of the role of Azolla.

AID Mission Oficers Meet



In April USAID Agricultural and Rural Development Officers from the Asian region met at IRRI, Los Banos, The Philippines. The purpose of their meeting was to exchange information, discuss changing opportunities and problems, and keep up-to-date on technical matters related to agricultural development in Asia.

Topics of interest on the agenda were "Approaches to Upland Resource Management", "Agricultural Research and the Private Sector", "Current Issues in Irrigation Management", "Food Security Policy Formulation and Management", and "Biotechnologies for Agricultural Development."

Biological nitrogen fixation (BNF) and plant tissue culture were highlighted as two biotechnologies that are current and available for utilization in agricultural development projects.

Honduras Workshop

The Pan American Agricultural School, University of Wisconsin, Bean-Cowpea CRSP, USAID/Honduras, and NifTAL are sponsoring the Nitrogen Fixation Seminar for Central America which will be held June 24-28 in El Zamorano, Honduras. The Workshop is organized by Drs. Jorge Chang and Juan Carlos Rosas. BNF scientists and legume breeders from Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua, Mexico, Panama, and the U.S. will attend.

Program objectives are: 1) to heighten awareness of the legume/*Rhizobium* symbiosis with particular emphasis on crops most important for Central America; 2) to assess the state of BNF activities in the region and discuss factors that limit BNF work, with a goal toward assembling an information bank that can be used to formulate future BNF programs in Central America; and 3) to establish an interchange of information, plants, and superior *Rhizobium* strains between regional scientists and between them and outside institutions participating in the workshop.

10TH NORTH AMERICAN RHIZOBIUM CONFERENCE

August is just around the corner and preparations are underway for the 10th North American Rhizobium Conference (NARC) being held on Maui, 11-17 August at the exclusive Wailea-Intercontinental Hotel.

Picture warm, balmy weather, scenic tropical isles, gentle ocean waves, romantic sunsets, first class accommodations and you have the beginning of a perfect holiday, excuse me, conference setting. Arrangements are being made to ensure that the 10th NARC is not only memorable as a scientific conference of international importance, but also one noted for its warmth and spirit of "aloha". Perhaps, these are some of the reasons three other groups have organized their meetings around the NARC conference.

One of the groups meeting for two days before NARC will be recipients of Cooperative Research Grants (BOSTID) in N_2-fixation from the National Academy of Sciences (NAS). Organizers of this meeting are Drs. Maurice Fried and Judith Bale.

The Limiting Factors Workshop, under the leadership of Drs. Gerald Elkan and Joann Roskoski, will be held after the 10th North American Rhizobium Conference. Attending this workshop will be 40 recipients of AID/USDA/CSRS limiting factors grants.

A three-day meeting for US/Japan scientists interested in factors limiting N_2-fixation by soybeans will be held after the NARC. This workshop is being organized by Dr. John Streeter and Prof. Masuro Yamaguchi.

118

N-FIXING TREE NOTES

Tree experts enthusiastically received information about leguminous trees and *Rhizobium* at the Symposium on Establishment and Productivity of Tree Plantings in Semi-Arid Regions, organized by Dr. Peter Felker. From 29 April-May 2 these experts—foresters, botanists, and agro-foresters, gathered at Caesar Kleberg Wildlife Research Institute, Texas A & I University, Kingsville, Texas.

The wide variety of papers presented at the symposium addressed regional issues; soil, water, and plant nutrition; physical and chemical properties of trees for arid areas; nursery and field cultural practices, and genetics and tree improvement. For many it was their first exposure to the BNF story.

Ken McDicken has been appointed program associate for the Nitrogen Fixing Tree Association. His interest is in expanding NFT training and development programs. Contact McDicken at 15319 Roosevelt Road, Snohomish, Washington, DC 98290.

The *Acacia senegal* (L.) Willd system of agroforestry has evolved in the Subsaharan countries as an improvement over the slash and burn system of agriculture. Zakaria Saad from Sudan who is a doctoral candidate at Old Dominion University, Norfolk, Virginia, reports on this useful tree.

A. senegal plays three major roles in the agricultural areas of sandy soil and low rainfall in the Sudan.

- As a legume species, the tree harbors N-fixing bacteria in the root system, providing an invaluable nutrient which would otherwise be limited because of economic constraints.
- The trees are rich in crude protein in the leaves, pods, and seeds. Thus, they are attractive to animals whose contribution to soil organic matter is invaluable. Additional organic material is provided seasonally to the soil as the trees shed their leaves at the beginning of the dry season.
- Also contributed by *A. senegal* is gum arabic, a commercial product which provides the farmer with additional income and helps balance foreign currency with other countries.

The research that has been conducted in Sudan on *A. senegal* is varied and of long-term character. Three main areas of research have been: 1) factors affecting gum yield and methods of yield improvement, including genetic improvement, environmental, social, and economic factors; 2) silviculture of the species including tree spacing, weeding, seed collection and handling, seedling production, and nursery techniques; and 3) N-fixing capability of the tree.

The 2nd meeting of IUFRO Agroforestry Working Group will be held in Turrialba from 24-28 June 1985. The meeting will be run by Drs. G. Budowski and Dr. Bjorn Lundgren (ICRAF Nairobi) and is open to any scientist studying agroforestry. Contact Ricardo Russo, 2a Reunion del Grupo de Trabajo IUFRO S1-07-07, DRNR-CATIE 7170, Turrialba, Costa Rica.

SHORT TAKES

Moving to the Department of Botany at Tribhuvan University, Kirtipur, Kathmandu, Nepal, is Dr. Vimal N. Prasad Gupta. He was formerly at the University of Gorapkhpur, in India.

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After receiving his Ph.D. at the University of Queensland, Australia, Dr. Moo-Key Kim has returned to his duties in the Department of Agricultural Chemistry, College of Agriculture, Jeonbug National University, Korea. He plans to teach a course in BNF, among the other classes he teaches in plant nutrition and soil fertility.

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Dr. Jeng-Chuan Yang and Wei-Er Cheng of the Taiwan Forestry Research Institute each stopped for a short visit at NifTAL Headquarters. Dr. Yang was enroute to Taiwan after completing a program at the Maria Moors Cabot Foundation for Botanical Research at Harvard University.

MIRCEN Director Professor M. N. I. Magdoub, reports that a successful training course in Endomycorrhizae was held at the Cairo MIRCEN from 15-20 January.

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Dr. Frank Sorwli of IITA in Nigeria recently began a cooperative effort with Dr. Paul Singleton. He will be looking at the response to inoculation of IITA freely nodulating soybean varieties and North American varieties of soybean at different levels of P. The testing is to see if these freely nodulating lines respond to inoculation and whether yield potential is increased through the application of P.

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C. S. Saraf and S. K. Kothari, researchers in the Division of Agronomy, Indian Agricultural Research Institute, New Delhi-110012, India, are studying the effects of inoculating summer mungbean *Vigna radiata* (L.) Wilezek grown under different phosphorus levels with *Rhizobium* and *Azospirillum* or *Azotobacter*.

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Stephen F. Dowdle, a NifTAL graduate assistant, has recently completed his doctoral degree at the University of Hawaii, under the direction of Dr. B. Ben Bohlool. Dr. Dowdle's dissertation research on "The Ecology of *Rhizobium japonicum* in Soybean/Rice Cropping Systems in Central China", was in part carried out during an 18 month stay at the Central China Agricultural College in Wuhan, People's Republic of China. While in China, Dowdle was supervised by the noted *Rhizobium* scientist, Professor Chen Huakui and was supported with a fellowship from the "Committee on Scholarly Communication with the People's Republic of China", U.S. National Academy of Sciences.

Dr. Dowdle has recently accepted a position with the Phosphate and Potash Institute and will be stationed in Hong Kong.

The Future is Now

Where do we go from here?

The external review this past February gave us a chance to not only look at where we've been and where we are but also plan where we should be heading in the future.

We see the past ten years as a time of learning followed by attainment of unique capabilities to foster the transfer of BNF technolgy to developing nations. We need to further capitalize on our expertise in this area by widening our impact and refining our delivery systems.

NifTAL will certainly continue distributing *Rhizobium* cultures, antisera, research quality inoculants, and literature to researchers from developing nations working in tropical agriculture. As the increasing number of requests for these materials verifies, the interest in BNF by developing countries is growing steadily.

We will also continue characterizing the NifTAL culture collection, which has a large number of strains for legumes that are becoming increasingly important in development projects, i.e., tree and forage species. Rhizobia for these species need to be well characterized so they can be properly utilized.

The INLIT program has established a worldwide network of over 200 collaborators in 53 nations. This large, viable network is not only the heart of the INLIT program but has also facilitated other types of scientific exchange and, in particular, identified individuals/groups with specific training needs.

It is now time to extract the maximum from the scientific data collected during the INLIT trials. We envision a collaborative effort by some network participants to formulate a predictive model of inoculation response using a minimum data set approach. To accomplish this goal additional data will be needed to fill in some gaps but the net result will be well worth the effort. A model that would predict how an inoculant will perform in a farmer's field would not only decrease his production costs but provide proof that appropriate agrotechnologies can help solve his agricultural problems.

NifTAL is particularly proud of the success of it's BNF Resource Center and the excellent reception it is receiving from the host institution, the Department of Agriculture, Government of Thailand. We believe that similar centers should be established in Africa and Latin America. These centers should not only focus on BNF, but also should function as transfer points/training sites for other agrotechnologies. We are encouraged that individuals in these regions have expressed interest in the regional resource center concept.

NSF Review

In February, a National Science Foundation review team was contracted by AID to review the NifTAL Project. In this photo, review team members, NifTAL and University of Hawaii staff inspect an INLIT trial of *Vicia faba* at NifTAL's high elevation Haleakala Site. From left, Drs. Bob Miller (review team), B. Ben Bohlool (NifTAL Director), Ada Demb (Assitant Director HITAHR, University of Hawaii), Patrick Flannigan and Irvin Pikus (review team), and Mr. Rudy Holthius and Dr. Chris van Kessel (NifTAL).

The demand continues for NifTAL's *Rhizobium* technology training course, one of the few "hands on" courses of this type and also for other more specialized courses. We have developed not only courses that are in demand but a training methodology resource with much broader applications. We have learned how to train people not merely teach material. The next step in the transfer of this training technology is modularization and packaging of these courses so they will be available at any time to any group seeking training in this area.

NifTAL intends to launch a major effort in agricultural biotechnology, taking advantage of the recent advances in cellular biology and molecular genetics. Three major areas that are relevant to BNF are: genetic engineering for improvement of ecological traits of *Rhizobium*, plant tissue culture selection of superior symbionts, and monoclonal antibodies for differentiation of *Rhizobium* and pathogens of nitrogen-fixing legumes. NifTAL plans to initiate research and training activities in one or more of these biotechnologies in the next phase of its operation.

As recent events around the world demonstrate, the need for the development and transfer of appropriate agrotechnologies has never been greater. NifTAL sees itself as participating in the world development effort by addressing agricultural problems of today and tomorrow through research, networking and training.

NifTAL's New Director

Dr. B. Ben Bohlool, formerly a Professor of Microbiology at the University of Hawaii, has been appointed as Director and Principal Investigator of the NifTAL Project effective January, 1985. Bohlool is a microbial ecologist and brings to NifTAL 20 years of experience working with the ecology of nitrogen-fixing bacteria and the *Rhizobium*/legume symbiosis. With the arrival of Bohlool, NifTAL looks forward to expansion into the area of biotechnology.

He is no newcomer to the Project, having been involved with NifTAL from its early inception, first as Associate Director and later as Senior Advisor. He has a keen understanding of and a sincere committment to the mission of NifTAL.

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120

BIOLOGICAL NITROGEN FIXATION BULLETIN

Volume VI, Number 2
Fall 1985

BNF EMPHASIS AT FOUR GATHERINGS

10TH NARC

Focus of the North American Rhizobium Conference (NARC) expanded during the 10th NARC as many international *Rhizobium* and BNF workers joined North American scientists for this important meeting.

Most of the International Agricultural Research Centers (IARCs) were represented. Scientists were in attendance from CIAT (Colombia), ICRISAT (India), ICARDA (Syria), IITA (Nigeria), and IRRI (Philippines); CATIE (Costa Rica) and FAO were also represented.

The IARC participation was especially useful for two reasons. First, it gave IARC representatives a chance to preview new areas of scientific investigation that might be relevant to their programs, and, second, it afforded them the chance to meet with scientists from the regions that their organizations service.

"Developing and developed country scientists were brought together in a working and learning experience."

Dr. Joann Roskoski, Conference Chairperson, heard many general comments on how much scientists from both developed and developing countries enjoyed the meetings. Many said they "appreciated the format of the meeting which allowed time for informal discussions." A break scheduled in the middle of the day facilitated scientific interactions and exchange on an informal basis.

The meeting, "provided a forum for special interest groups to meet." Scientists from Africa met several times as did groups from Asia and Latin America. This allowed participants to plan future BNF

Continued on page 4

BOSTID BNF Grantees Meet

Also meeting in conjunction with the 10th NARC was the BOSTID (Board on Science and Technology for International Development) BNF Research Grants Program. Grantees, BOSTID Staff members Drs. Judith Bale and Maurice Fried, and guest participants met to review research projects and the BNF Program.

"BOSTID.....supports research in developing country institutions on scientific questions of wide applicability..."

The Committee on Research Grants, BOSTID, National Academy of Sciences, supports research in developing country institutions on selected scientific questions of wide applicability—especially for developing countries. Funded are a limited number of research grants on BNF. Projects deal with questions related to N-fixation by legume-rhizobial symbiosis, interaction of mycorrhizal fungi with crops, or use of azolla.

Projects reviewed were the following. N-Fixation by Plant-Bacteria Association in Tropical Grasses and Cereals, Dr. Johanna Dobereiner (Brazil); Competitive Relationships Between Indigenous and Inoculant Rhizobia Nodulating Broadbeans and Lentils, Dr. Hassan Moawad Abdel Al (Egypt); Production and Testing for Effective Strains of *R. phaseoli,* Roberto de Leon (Guatemala); Field Assessment of Need to Inoculate Pigeon Pea and Other Legumes, Dr. Jean Fenel Felix (Haiti); Improved Grain Legume Production by Enhanced N-Fixation, Dr. Taslim (Indonesia); Effects of Environmental Factors on N-Fixation, Dr. S. O. Keya (Kenya); Genetic Manipulation of *R. phaseoli*

Continued on page 8

LIMITING FACTORS WORKSHOP

The United States Department of Agriculture/Collaborative State Research Service Limiting Factors Program brought together cooperating scientists to present the results of their research and to review the accomplishments of the program.

One significant result of the workshop was the realization that the model used in this program has proven highly successful. The particular collaborative approach adopted by the Limiting Factors Program insures success by linking a developing country scientist with a developed country scientist.

"The particular collaborative approach adopted . . . insures success . . ."

In this linkage the U.S. scientist contributes not only scientific and grant preparation expertise that the developing country scientist may lack but also strong motivations for completing an experiment and publishing the results.

What the developed country scientist lacks is an appreciation for the real problems in developing countries and workable solutions to them. That is where the developing country scientist provides a definition of the problem and an awareness of what will work and what won't. Combining real world aspects with strong basic scientific training helps the collaborators form an attack plan in which continuous feedback leads to successful projects.

Using this combination, work has been done in: factors limiting the use of inoculant technology and soil and plant factors limiting

Continued on page 8

Supernodulating Soybeans

Research by three scientists at the Australia National University (ANU)—Bernard Carroll, Peter Gresshoff, David McNeil—has resulted in a mutant of soybean (*Glycine max* (L.) Merr. cv. Bragg) that forms exceptionally large numbers of nodules even under high levels of nitrate. This finding may have major agronomic and ecological implications.

These workers used EMS mutagenesis and isolated 15 independent soybean mutants that continued to form nodules in the presence of nitrate which they labeled as "nitrate tolerant symbiosis, nts." Some of these mutant lines (e.g., nts382) formed significantly more nodules than the parent cultivar Bragg in the presence and absence of several combined nitrogen sources (KNO_3, NH_4Cl, NH_4NO_3, and urea).

Mutants were generally smaller than wild type plants. But, in the presence of KNO_3 and urea, nitrogenase activity is considerably higher in the mutant. Studies on the genetic and physiological mechanisms of the supernodulating phenomenon are continuing at ANU and elsewhere. This work was published in Plant Physiology (78: 34-40, 1985) and 1985 Proceedings of National Academy of Science USA (82 (12): 416-20, 1985).

For more information on this work contact the authors at Department of Botany, Australian National University, Canberra, ACT 2600, Australia.

Photo Courtesy of P. Gresshoff

An example of supernodulation.

Call For INLIT Test Results

As NifTAL enters the final year of its 5-year extension, INLIT data are in the final analysis stage. All cooperators should submit their outstanding data to the INLIT Coordinator at NifTAL immediately.

INLIT materials will still be sent out on request and support given to INLIT cooperators. However, statistical analyses will be done on an individual case basis and not included in the composite analysis.

Ureides in Xylem Sap: A Measure of N-Fixation Dependency

Besides the more well known methods for measuring N_2-fixation activity—such as acetylene reduction, 15-N dilution, and N-balance—the concentration of ureides in the xylem sap, in some legumes such as soybeans, also can provide an estimate for N_2-fixation activity. When N_2 becomes fixed in the nodule, most of it will be transported out of the nodule into the xylem. The form in which it is transported through the xylem vessels will be either as amides or ureides. Very small amounts of ureides may be formed in the root itself. Concentration of ureides in the xylem sap, therefore, can give an indication of the N_2-fixation activity.

The ureide method for measuring N_2 fixation has been used most often for annual legumes such as soybeans and beans. Dr. David Herridge of Australia, who has extensive experience with the ureide method, gave a three-day workshop at NifTAL. He explained how the method is used and showed the possibility for using it for measuring N_2-fixation by leguminous trees.

Measuring N_2-fixation by adult trees has been difficult and cumbersome. In field studies where the occurrence of nodules may be difficult to locate, this method is a very useful tool for quantifying N_2-fixation by trees.

Ureides can be used to measure N_2-fixation in trees by cutting branches and attaching the end of the branch to a length of surgical tubing. The tube passes into a syringe whose needle penetrates through a rubber stopper into a vial. A second syringe also penetrates through the rubber stopper and is attached at its base to another length of tubing and finally to a vacuum pump. When pump suction is applied, air in the vial is evacuated causing the xylem sap to be pulled into the vial. Then, the captured xylem sap can be analyzed for amides, ureides and nitrate.

For further information on this technique, contact Herridge at the New South Wales Department of Agriculture, Agriculture Research Center, RMB 944, Tamworth NSW 2340, Australia.

Photo by H. Hoben

David Herridge clips a plant's leaves to force xylem lower into the stem. Participants in the workshop are (from left) Ben Bohlool, Herridge, Janice Pinchin, Eduardo Schroder, and Padma Somasegaran.

NSF Identifies Ecology Research Needs

A new National Science Foundation research emphasis may interest BNF researchers. This is the decision by NSF's Division of Biotic Systems and Resources (BSR) that there has been, and currently is, insufficient research on the ecology of microorganisms.

The NSF Bulletin notes that deficiencies in our knowledge of microbial ecology constitute ever-increasing impediments to understanding the dynamics of ecological processes in major systems, especially in the tropics. Also noted is that the lack of basic information is now a serious problem for regulation of genetically engineered microorganisms and their introduction to agricultural and natural systems.

The BSR Division, through its Ecology program, has identified microbial ecology as a priority subject for development over the next five years. Research needs are perceived at three levels: 1) microbial function diversity and gradients in time (i.e., succession) and space (i.e., rhizosphere); 2) intermicrobial interaction and relationships with other organisms (e.g., competition or symbiosis with roots and predation by invertebrates) and how these processes influence energy flux and mineral cycling; and 3) the consequences of introducing alien microorganisms into the natural microbial milieu (e.g., survival, persistence, and spread of altered organisms).

For further information, contact Dr. Patrick Flanagan, Ecology Program, National Science Foundation, Washington, D.C. 20550.

BNF BULLETIN

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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.

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NOTES FROM THE FIELD

The Pakistan Agricultural Research Council (PARC) has been upgrading their BNF Program. While at the National Agricultural Research Center (NARC) in Islamabad, Davis worked with Drs. Anwar Khan, Director General, NARC, and G. R. Sandhu, Member (Natural Resources), PARC, in planning, fabricating, and initiating installation of a pilot legume inoculation production plant at NARC.

Also at NARC, Davis served as consultant on *Rhizobium* in the Soil Microbiology Laboratory which is under the supervision of Dr. Muzaffar Khan. PARC BNF Coordinator Dr. Kauser Malik of the Nuclear Institute for Agriculture and Biology was advised on the legume inoculation field trials segment of the PARC BNF Program. Expediting implementation of PARC's BNF Program was another of the principal activities of Davis's consultancy.

AVRDC: New Germplasm Storage

Seed germplasm availability from the Asian Vegetable Research & Development Center in Taiwan has been enhanced by completion of a new cold storage facility. Available storage space has been tripled. Germplasm of many crops including mungbean and soybean are available from AVRDC.

The goals of AVRDC's Genetic Resources and Seed Unit include building a base collection of vegetable species popular in the tropics and promoting use of good quality seed in the tropics, and ensuring that incoming and outgoing seed samples are free of pest and diseases.

For more information, contact AVRDC, P.O. Box 42, Shanhua, Tainan 741, Taiwan, ROC.

14 Years of BNF Work in China

Dr. You Chongbiao, Director General of the Institute for Application of Atomic Energy, Chinese Academy of Agricultural Sciences, Beijing, China, reports on BNF work at his laboratory. Workers there have been studying N_2-fixation for fourteen years. They have done work in the area of biochemistry of nitrogenase, associative N_2-fixation in paddy soil, and N_2-fixation and nitrogen cycling of Azolla. They have also been studying the N_2-fixation role of *Rhizobium* using the N-15 technique.

For further information, Dr. You can be contacted at P.O. Box 5109, Beijing, People's Republic of China.

Comparing Inoculant Carriers

The goal of any *Rhizobium* inoculant is to provide proper specific strains of rhizobia in large numbers. An important secondary goal is to produce an inoculant which coats the seed well or which can be introduced into the soil in a precise manner via methods which are convenient and efficient for the farmer.

Dr. Tom Wacek writes (Kalo Research Report 8-84) that different carriers work best with different types of seed, soil, or planting equipment. Clay based carriers for areas where pre-inoculation is important for small seeded legumes, humus based carriers with sticker systems for convenient planter box applications, humus granular carriers for hot dry soils, oil based for air planters, and oil combination products for the farmers who need fungicides and/or molybdenum. By choosing carefully, the farmer is able to select the best product for the appropriate soil, seed, and handling requirements.

CARRIER SYSTEM COMPARISONS

Carrier System	Advantages	Disadvantages
Humus	Good bacterial survival	High level of background contamination. Moderate adhesion to seed without use of a sticker.
Clay	Good bacterial survival for some rhizobial species. Good adhesion to seed. Low level of background contamination. Easily obtainable raw materials.	Moderate bacterial survival for some rhizobial species.
Oil	Little or no background contamination. Ability to combine rhizobia with some fungicides and molybdenum. Excellent seed coverage.	Short expiration dates. Expensive raw materials.

Extension Agents Trained in BNF

Following up a successful 1984 course, the Graduate Training Institute (under the direction of Dr. Abdul Halim) of Bangladesh Agricultural University, Mymensingh, Bangladesh, presented BNF training to 24 extension workers. Course coordinators were Dr. Jobed Ali Mirza and Mr. M. Tazul Islam.

The 1984 Course was organized by NifTAL and the Bangladesh Agricultural Research Center. NifTAL Project was represented at this course by Dr. Bob Davis who along with other NifTAL staff had participated in the 1984 course. Davis was on hand throughout the course as a lecturer and advisor. Another instructor, Dr. Shamsul Hoque, is a former participant in NifTAL training.

Participants and instructors in the BNF Extension Training Course, March 1#7, 1985.

DIRECTIONS IN COMMUNICATION

During the four meetings held on Maui this past summer, many talks were given on research in BNF. One of the most difficult tasks for scientists is to stand in front of a large crowd of their contemporaries and speak about their work.

Indeed, professionally trained men and women must expect to give talks or speeches occasionally, especially research scientists who wish to share the results of their experiments at international meetings. Often, even those scientific meetings held in countries that are non-English speaking use English as the course's official language.

To a non-native English speaker, giving a speech in English may seem a difficult assignment, but there is much more to public speaking than language. Many compensatory, nonlinguistic skills are important in presenting a talk. Among these are good organization, a mature objective tone of voice, and a special style of body language. However, the single most important ingredient in giving a good presentation is practice.

Although practicing your talk alone is effective, it is far more beneficial to give your talk before a colleague who understands English. This is also useful in timing your talk. Since most presenters are given 10 or 15 minutes to speak and another 5 minutes for a question and answer session, you must prepare and practice carefully to confidently remain within the time limit.

Confidence can also be exhibited by the way a talk is delivered. A good speaker slowly looks from face to face around the room as he/she speaks. This helps not only to let the audience feel that the speaker is speaking to them, but to help the speaker know how the talk is going. If people are smiling or nodding in agreement, the talk is going well; however, if they are frowning or looking bored, the speaker should adjust.

Speaking should be done at a normal rate or slower if the normal rate of speech is quite fast. To be better understood, non-native English speakers should be careful to pronounce consonants at the ends of words. It is useful to ask if you are being heard at the beginning of the talk, especially if you think that your voice may be too loud or too soft.

The use of visuals (i.e., slides, overhead transparencies, flip charts, etc.) requires care. Carefully prepared graphics enhance a scientific talk immeasurably. Simplicity is the key to the very best visuals. Try to use simple tables that the audience can grasp within the short time they will be on the screen. Even while a slide or overhead is projected on the screen try to look at the audience.

A thoughtfully prepared and thoroughly rehearsed talk will result in confidence for the speaker whether or not he/she is experienced. Relaxing while presenting, being natural, and knowing what you have to say are the keys to presenting a good talk—no matter what the language skills of the speaker.

A very useful book for improving communicating skills for that special group of scientists addressed above is "Communication Skills for the Foreign-Born Professional" by Gregory A. Barnes, 1982, ISI Press, Philadelphia, PA USA.

—P.F.

Continued from page 1

programs, workshops, and meetings for their particular regions. Another advantage of these impromptu sessions during the 10th NARC was that it provided the opportunity for groups to invite interested developed country scientists and possible donor organizations to participate in planning activities. This interaction worked both ways since it gave developed country scientists a chance to talk personally to and establish linkages with scientists from developing countries.

NifTAL was able, through this meeting, to bring BNF scientists from developed and developing countries into a working and learning experience; one of the goals of the NifTAL Project.

Many aspects of *Rhizobium* work were covered in several round table, paper, and poster sessions. Paper sessions included: 1) *Rhizobium* genetics and physiology, 2) Symbiotic interactions, 3) Ecology, 4)Inoculation response, agronomy, and cropping systems, and 5) Strain selection and inoculant production. Poster sessions held on these same topics reported on a wide range of interesting related work.

Dr. Robert J. Burris, Professor Emeritus, University of Wisconsin, set the tone of the conference with his keynote address. He began by outlining the history of the field of BNF and the developments in elucidation of the structure and function of the nitrogenase complex. He concluded his remarks by stressing that a holistic approach involving the rhizobia, the legume, and the environment should be applied in the future.

The Round Table discussions presented an exciting forum for exposition of timely topics. Often, lively question and answer periods followed these Round Tables leading to "Point/Counterpoint-like" discussions.

Round Table I was titled "Towards a satisfactory taxonomic system for *Rhizobium*." Peter Graham (U of Minnesota, USA) opened this session by giving a synopsis of the techniques based on biochemistry, physiology, and serology that have been used to classify *Rhizobium*. Gerald Elkan (N. Carolina State U, USA) then gave a talk on DNA/DNA hybridization for assessing relatedness among, within, and between species of *Rhizobium*. Brion Jarvis (Massey U, New Zealand) concluded the session with some new approaches to classification using DNA/RNA hybridization techniques that may lend support for the new classification of the type genus *Rhizobium* into *Rhizobium* and *Bradyrhizobium* species.

The consensus of the discussion following the presentations was that more studies on characterization of *Rhizobium* are essential, and some attendees suggested that for the present a moratorium should be called on creating new species names.

The first two talks in Round Table II "Host-*Rhizobium* Compatibility" were presented by Perry Cregan and Harold Keyser (both from USDA/Beltsville, USA). Their talks focused on the host and bacterial factors that are involved in nodulation of soybeans by *R. japonicum* serogroup USDA 123. Their efforts are centered on breeding for soybean varieties that restrict nodulation of less effective strains of *R. japonicum*.

Alan Gibson (CSIRO/Canberra, Australia) concluded the session by focusing on the inhibitory effects of nitrate on early stages of nodulation. The main value of this line of research is developing soybean lines that will nodulate even in soils which have high nitrate levels.

In Round Table III "Interstrain Competition in *Rhizobium:* Is modern genetics the answer?", B. Ben Bohlool (NifTAL, USA) set the tone by emphasizing the complexity of interstrain competition, which includes attributes of the bacteria, genotype of the host, and their interaction with and within the environment.

Clive Pankhurst (DSIR/Palmerston North, New Zealand) gave interesting evidence that in one strain of *R. loti* the loss of a cryptic plasmid led to enhancement of its competition for nodulation in *Lotus pedunculatus*. Les Barran (Agriculture Canada) showed that rifampicin resistance in a strain of *R. meliloti* influences nodulating competition. Alan Paau (AGROCE-

Continued on page 8

124

Personnel Changes

Sheldon Whitney

Dr. A. Sheldon Whitney, Senior Consultant in Agronomy, took an early retirement for medical reasons in June, 1985. He was the founder and the first Director of the NifTAL Project.

Before serving as NifTAL Project Director from 1975 to 1979, he was a Professor of Agronomy at the University of Hawaii from which he received his Ph.D. in Soil Management.

Whitney plans to remain in Hawaii with his wife Mildred and two teen aged children. He has made a great impact on the study of BNF with more than 50 journal articles, paper presentations at professional meetings, and popular articles.

Doug Beck

Doug Beck, Executive Director of NifTAL's BNF Resource Center for South and Southeast Asia in Bangkok, Thailand, has resigned his position there. Beck had been working closely with Nantakorn Boonkerd of the Thailand Department of Agriculture. Boonkerd will assume some of Beck's duties and will also be assisted by NifTAL staff member Rudolph Holthuis who was outposted to Bangkok in September.

R. O. Torres Completes Program

Rolando O. Torres, a researcher at International Rice Research Institute, Philippines, has completed a 5-month internship at NifTAL. His research emphasis at his home institute is rice-based cropping systems under the Multiple Cropping Department.

Torres received systematic training beginning with collecting nodules, isolating the rhizobia, observing culture growth reactions, and authenticating the isolates. Training was also offered in preparation of inoculants and quality control methods.

Two pot experiments were undertaken by Torres in participation with Padma Somasegaran and Heinz Hoben. The first was a study on competition and survival of *R. japonicum* in soil inoculated with a 3-strain mixed inoculant and six inoculation methods.

The second experiment looked at host-*Rhizobium* interactions on four *Phaseolus lunatus* cultivars. Three strains were applied as a single-strain inoculum, a double-strain inoculum, and a triple-strain inoculum to study strain competition.

Torres familiarized himself with the application of the fluorescent antibody technique for studying competition, the plant infection method of enumerating rhizobia, the acetylene reduction assay, and other techniques which were integrated in his research projects.

Photo by H. Hoben

Torres expects that the training he has received at NifTAL will supplement his soils and agronomy background with knowledge of the methodology and principles of *Rhizobium* and N-fixation. This will enable him to carry out more intensive research on N-fixation in his department's component technology studies in multiple cropping.

Mirza Begins Graduate Studies

Photo by R.J. Davis

N. Mirza in his home laboratory.

Mr. Naseer A. Mirza has been selected as a NifTAL graduate student. Mirza was a winner of the competitive graduate assistantship awarded by NifTAL through the BNF Resource Center for South and Southeast Asia. He arrived in Hawaii during August in time to participate in the 10th North American Rhizobium Conference. His studies commenced in Fall 1985.

A Senior Scientific Officer with the BNF Group in the Soil Microbiology Laboratory at the National Agricultural Research Center in Islamabad, Pakistan, Mirza is on a leave of absence from his job. He holds a Master's degree from Quaid-I-Azam University in Islamabad.

Tragic Accident Claims Sanogho

NifTAL staff member, Seydou T. Sanogho, was killed in a tragic automobile accident in Zambia on September 9. Since 1983, he had been outposted at the Zamare Project at Mount Makulu, Zambia, where he worked with NifTAL, the University of Illinois, and the Ministry of Agriculture of Zambia to improve inoculant quality and increase inoculant production and use in Zambia.

A native of Mali, Sanogho received his Doctor of Specialty, Microbiology, from the Centre Pedagogique Superieur Bamako. Before joining NifTAL, he worked as a biochemist at the Pasteur Institute, Paris, France; was a senior research fellow at IITA, Ibadan, Nigeria; and a visiting scientist at USDA/ARS Beltsville, Maryland's Nitrogen Fixation Laboratory.

This is a sad loss to the world of nitrogen fixation research. Our sincere condolences to his family and friends.

MEETING NOTES

Biotechnology of N-Fixation

The first announcment has gone out for the Regional Symposium & Workshop on "Biotechnology of Nitrogen Fixation in the Tropics" (BIOnifT). The meeting is being organized by University Pertanian Malaysia, Malaysian Society for Microbiology, and Malaysian Society of Soil Science. Venue for the 25-29 August 1986 meeting is the University Pertanian Malaysia, Serdang, Selangor.

Objectives of the symposium and workshop are 1) to bring together researchers, academicians, and extension officers interested in the science of BNF of legumes, blue-green algae and associative or free-living bacteria; 2) to assess recent technological developments in the field of BNF; 3) to provide practical knowledge of some aspects of handling samples for bioassay, and in the operation and maintenance of basic equipment associated with N-fixation studies; and 4) to form a regional co-operative group within Southeast Asia through which further technological advances or cooperation can be channelled to member countries.

For information on the symposium, contact Dr. Wan Mohamad b. Wan Othman, Secretary Organizing Committee, BIOnifT, Dept. of Agronomy and Horticulture, Faculty of Agriculture, Universiti Pertanian Malaysia, Serdang, Selangor, Malaysia. The registration deadline is 31 January 1986.

Food Legume Research

The International Food Legume Research Conference on pea, lentil, fababean, and chickpea will be held 6-11 July 1986 in Spokane, Washington. Chairman of the meeting is Dr. R. H. Lockerman, Plant and Soil Science Department, Montana State University, Bozeman, Montana 59717 USA.

Selected meeting topics include: germplasm, breeding, biotechnology, N_2-fixation, nitrogen and carbon economy, physiology, environmental stress, etc. Complementary workshops and open discussion sessions will address topics such as N_2-fixation research methods, rhizosphere ecology, seed quality, inoculant production technology, etc.

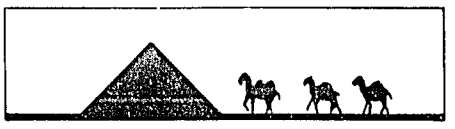
ISME-4 Call for Papers

The call for papers is out for the Fourth International Symposium on Microbial Ecology ISME-4 to be held from 24-29 August 1986 in Ljubljana, Yugoslavia. For information on submitting papers, contact ISME-4 Secretariat, Cankarjev dom, Congress and Cultural Centre, Kidricev park 1, 61000 Ljubljana, Yugoslavia, Telex: 32111 cd kkc yu.

2ND AABNF Conference

The first announcement and call for papers is out for the Second Conference of the African Association for Biological Nitrogen Fixation. Venue for the 15-19 December 1986 meeting is Cairo, Egypt. Program coordinator is Prof. Dr. M. N. Alaa El-Din, Soils and Water Research Institute, Agricultural Research Centre, Cairo University Street, Giza, Egypt, telex: Cairo 20332FCRI UN.

"The Current State of the Art of BNF Technology Transfer and Diffusion" is the general theme of the meeting. Papers are invited on these topics: A) rhizobia-legume associations (N-fixation under grain & forage legumes; nodulation problems and response to inoculation; legume inoculants, their preparation, quality control, storage and distribution); B) blue-green algae (characteristics and N-fixation, propagation and application); C) azolla associations (characteristics and N-fixation, propagation and utilization in rice fields); and D) associative N-fixation (azotobacter, their contribution to the soil nitrogen, azospirillum/grasses association, its role and prospectives, inoculation with azotobacter and azospirillum preparations).



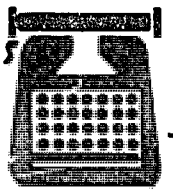
INTERCIENCIA Biotechnology Symposium

The National Council for Scientific and Technological Research (CONICIT), San Jose, Costa Rica, and the INTERCIENCIA Association organized a symposium held in mid-July. Entitled "Biotechnology in the Americas II. Applications to Tropical Agriculture," this symposium attracted over thirty researchers from South America.

The program covered a variety of biotechnological topics including nitrogen fixation. Other topics covered were the following: creation of novel genotypes for tropical agriculture; clonal propagation; genetic improvement; and genetic engineering. The meetings final session, a panel discussion, explored the exciting future of biotechnology in agriculture.

The meeting was co-chaired by Dr. Rodrigo Zeledon. For further information on the results of this symposium contact Srta Silvia Hernandez, CONICIT, Apartado Postal 10318-1000, San Jose, Costa Rica.

NEW PUBLICATIONS



Released earlier this year was the NifTAL-FAO publication **"Legume Inoculants and Their Use"** by Dr. Joe C. Burton. This sturdily plastic bound handbook is ready for use by agricultural extension personnel, progressive farmers, and agencies engaged in encouraging legume grain and fodder production.

Copies are available from NifTAL (P.O. Box O, Paia, HI 96779 USA) or FAO, Via delle Terme di Caracalla, 00100 Rome, Italy, for US$8.

A timely release is **"Biological Nitrogen Fixation in Africa"** edited by H. Ssali and S. O. Keya. This is the Proceedings of the first Conference of the African Association for Biological Nitrogen Fixation held from 23-27 July 1984 in Nairobi, Kenya. The 540-page book includes 52 papers on a wide range of topics about BNF in Africa. The book may be ordered from the Nairobi Rhizobium MIRCEN, Dept. of Soil Science, P.O. Box 30197, Nairobi, Kenya. The cost of US$30 includes postage.

A supply of **"World Catalogue of Rhizobium Collections"** Edited by V. B. D. Skerman is available from NifTAL. Cost of this very useful book is $10 per copy, surface mail. Order from NifTAL's Communication Section.

Also available from NifTAL is the **Conference Book** from the **10th North American Rhizobium Conference.** The book contains abstracts of the work presented at the meeting. Cost of the Book is $5 which includes postage.

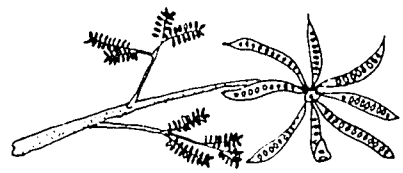
46

N-FIXING TREE NOTES

ACIAR's (Australian Centre for International Agricultural Research) Forestry Program aims to develop guidelines for rational and effective use of trees indigenous to Australia in developing countries. This program addresses the need for fuelwood sources in many developing areas.

Program Coordinator Dr. John Turnbull, CSIRO Division of Forestry Research, Canberra, Australia, will be responsible for the operations of the ACIAR Forestry Research and Information Network which is now in its formation stages.

Aims of the Forestry Program are to: collect representative seed samples of potentially useful tree species from Australia's extensive and unique genetic resources; evaluate and characterize these species under a range of conditions in developing countries; assess in detail the potential ecological adaptability of selected species specifically for high stress environments such as semi-arid, saline, and calcareous conditions; document the characteristics of selected species with special reference to propagation and to treatment and management in cultivation; and encourage adoption of this technology by collaborating in forestry research projects with developing countries.



Fuelwood is in critically short supply in many developing countries. Direct problems resulting from this shortage result in a depressed living standard. Adverse agricultural effects are soil erosion problems through denudation of the landscape by fuelwood gatherers, decreased food production when animal dung is burned as a fuel instead of being returned to the soil as fertilizer, and problems in water catchment.

Dr. Rick Van Den Beldt, formerly with the Nitrogen Fixing Tree Association, University of Hawaii, has begun work at ICRISAT, Hyderabad, India, on a new project. He will be working for the next two years with the support of a grant from the Ford Foundation. Van Den Beldt plans to evaluate, along with an economist, the role of agroforestry in the semi-arid tropics and plan future research needs. His working definition of agroforestry to be used in this project is a mix of trees and annuals as related to all land use practices and systems where woody perennials and annuals can be grown either as relay crops or intercropped.

Porto Alegre MIRCEN: Site of BNF Course

This course, sponsored by UNDP, has been organized by CIAT, the Porto Alegre, Brazil, MIRCEN, and NifTAL. Also contributing to the course is FAO. This course "Methods for evaluating the contribution of *Rhizobium* inoculants to productivity of tropical legumes" will be offered to invited participants during November and December 1985 in Porto Alegre. The languages of instruction are Spanish and English.

Although the course will be completed in four weeks, it is only the first of three phases in this training program. The second phase will be carried out by participants at their home institutions to evaluate the need for inoculation. And, finally, after follow-up experiments have been completed, an evaluation workshop will be held at CIAT.

The aim of the program is to provide national BNF programs with appropriate methodology and the capacity for evaluation of *Rhizobium* inoculants and inoculation technology for legumes which have been shown to be adapted to local conditions. The program will also include methods necessary for the identification of nutritional constraints to legume productivity and inoculation response.

Participants are being selected in pairs consisting of an agronomist and a microbiologist. These two scientists will cooperate in carrying out these experiments. It is expected that the pair's expertise will provide a well balanced and successful program.

Central America: BNF Workers Unite

An impromptu problem solving session proved to be a highlight of the First Central American Workshop on BNF. The session responded to disparities held in the numbers of well trained researchers and the amount of funding available to BNF programs in the region. While some nations have well developed BNF programs, others are just beginning activities in this area and thus lack financial support, governmental interest, and trained personnel.

The session was chaired by B. Hernandez of Panama. In the course of discussions on how to rectify the situation, the further advanced nations volunteered information and help. Among these offers of assistance were help in revising and preparing grant proposals and offers of training at home institutions of some of the scientists present.

A key result of this session was an agreement by all members that greater regional interaction would be beneficial. An informal network of workshop participants was established. The group is seeking funding for this network which will initially concentrate on information exchange, short term exchange visits, and periodic workshop/seminars.

The formal presentations of this workshop included theoretical lectures on BNF as well as summaries on the state of BNF work in each country. Attending the workshop were two representatives of each country, a microbiologist working in BNF and a legume breeder.

Photo by J. Chang

Workshop sponsors were NifTAL, the University of Wisconsin, Escuela Agricola Panamericana, and University of Puerto Rico-Bean/Cowpea CRSP. For information on this Central American Group, contact B. Hernandez, Dept. of Microbiology, University of Panama, Republic of Panama; Carlos Ramirez, Faculty of Agronomy, University of Costa Rica, Apartado 505, Heredia, Costa Rica; or M. Valdes, Dept. of Microbiology, Apdo 4-870, Mexico-4, D.F., Mexico.

SCENES FROM THE 10th NARC

Photos by H. Hoben

LFW Continued from page 1
the expression of BNF.

Joann P. Roskoski (NifTAL) and Gerald Elkan (North Carolina State University) coordinated the workshop. Although the workshop began on the free day of the North American Rhizobium Conference, it was a pleasant surprise that of the 60 workshop participants, 40 participants were program members and the other 20 were casual observers from the NARC. Representatives of CIAT, IITA, CATIE, and other international centers were in attendance.

During workshop discussions, developing country scientists acknowledged that promotion is the single most difficult problem to overcome in implementing inoculation and they agreed that developing country scientists should take the lead in promotion. One factor that has kept this from being done in the past is that only recently has proof that inoculation works been available. U.S. farmers have been using inoculation successfully for more than 50 years, but only in recent years has the value of inoculation been demonstrated for some crops in a few developing countries.

Another interesting fact surfaced during discussion. Even though Limiting Factor experiments focus on basic scientific questions, developing country scientists related that practical spin offs of this basic science program have occurred in inoculant production and *Rhizobium* strain development.

Photo by J. Dozier

Pictured above are members of the group inspecting a soybean trial during a field trip.

U.S.-Japan Soybean Symposium

U.S./Japan Seminar on Factors Limiting Nitrogen Fixation by Soybeans was the title of the fourth meeting held in conjunction with the 10th NARC. The meeting was organized by Dr. John Streeter (Ohio State U, USA) and Professor Masuro Yamaguchi (University of Osaka, Japan).

BOSTID Continued from page 1
for Increased Bean Production, Dr. Rafael Palacios (Mexico); Improved Soil Fertility by Inoculation of Cover Legumes with *Rhizobium* and Mycorrhizae, Dr. E. Pushparajah (Malaysia); Factors Limiting Biomass Production and BNF of *L. leucocephala* in Acid Soils, Dr. Blanca C. de Hernandez (Panama); Associative N-Fixation in Grasses Growing in Saline Environments, Dr. Kauser A. Malik (Pakistan); Improving the Yield and BNF of Bambara Groundnut, Dr. Mamadou Gueye (Senegal); Interactions in Legume-Nonlegume Intercropping Systems, Benjavan Rerkasem (Thailand); and Culture, Maintenance, and Propagation of Azolla Under Tropical Conditions, Dr. Nantakorn Boonkerd (Thailand).

NARC Continued form page 4
TUS, USA) talked about a mutant of *Rhizobium* that forms unusually high numbers of nodules, albeit ineffective. A lively discussion session followed this presentation. Emphasized was the role that the plant host may play in interstrain competition.

Round Table IV "Inoculant Production" emphasized the need for product quality assurance by either government or private producers. Tom Wacek (Kalo, Inc, USA) gave a review of inoculant production in terms of types of inoculant, methods of application, and quality control. Stewart Smith (Nitragin, Inc, USA) outlined large scale industrial production as done in a U.S. commercial operation. Dave Martin (Mintech, New Zealand) discussed the commercial aspects and potential for small scale production plants in developing countries.

126

BIOLOGICAL NITROGEN FIXATION

BULLETIN

Volume VII, Number 1
Spring 1986

Biotechnology in the Service of Agriculture

Microbes are clever chemists. Their noble achievements are as yet unsurpassed by man himself. They are not only able to synthesize a variety of useful products from simple feedstock, but are also capable of degrading such complex insoluble substances as wood and wax, rendering them soluble. The dawn of biotechnology was when man learned to use the power of microbes for his own benefit—when he began to produce alcoholic beverages, fermented dairy products, and pickled vegetables. Biotechnology in its broadest meaning, therefore, has been an established enterprise since the early days of civilized history. Of relatively more recent vintage are biotechnologies based on biological nitrogen fixation, namely the practice of *Rhizobium* inoculation on leguminous crops. The inoculum industry has been a viable and profitable enterprise in many developed countries.

Recent advances in molecular biology known as genetic engineering have inaugurated a new era in human history that promises to improve the very quality of our daily lives. They provide the potential for tailoring beneficial traits into animals, plants, and microorganisms. Of particular significance to agriculture are two advancing fronts in genetic engineering that utilize either recombinant DNA methodologies or somatic cell hybridizations.

In forthcoming issues of the BNF Bulletin, from time to time, we will highlight some of the new forntiers in agricultural biotechnologies. As a prelude, we are presenting below some exciting developments that utilize the more conventional approaches such as plant breeding and plant tissue culture.

Plant Breeding to Alter Competitive Patterns of Rhizobium on Soybeans

P. B. Cregan and H. H. Keyser

The establishment of a new *Rhizobium* strain in a large proportion of the nodules of field grown soybeans is extremely difficult in soils in which indigenous strains are present. Evidence suggests that in most soils of the northern U.S., indigenous strains of *Bradyrhizobium japonicum* serogroup USDA 123 will occupy from 50% to 100% of soybean nodules even with the application of high amounts of inoculum. Herein lies one of the most critical obstacles to the enhancement of N_2 fixation in soybean: strains of *Rhizobium* offering superior N_2 fixation which are already available, and those which may be

Continued on page 6

Soybean Plants from Somatic Cells to be Field Tested

The power of biotechnology is apparent when as little as a flask of soybean cells can be regenerated into plants that would be equivalent to 250 acres of soybeans. This year soybean plants produced from somatic cell cultures will be field tested by United AgriSeeds Inc., Champaign, Illinois.

The process, known as somatic embryogenesis, allows for consistent regeneration of viable, seed-bearing plants, according to a company spokesman.

Field tests of the regenerated plants will begin during the 1986 growing season and distribution of improved soybean varieties could follow as soon as 1989. Early products could include new varieties of soybeans with resistance to various stress factors that would be difficult to select for in the whole plant system; for example, herbicide resistance.

Continued on page 2

Tissue Culture for Crops

This USAID program, established at Colorado State University, seeks to accelerate the development of food crop varieties with high yields under conditions of environmental stress. The project consists of four components—research, networking, training, and technical assistance.

The research objectives are to develop methodologies for improved stress-tolerant mutant selection and plant regeneration, provide plant breeders with stress tolerant germplasm and methods for rapidly cloning useful plants, and verify stress-tolerance selection techniques through greenhouse and field testing of whole plants.

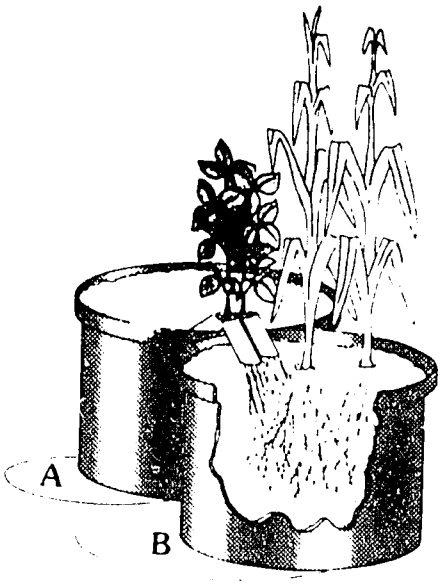
Specific tasks are to obtain high-frequency, long-term plant regeneration of selected species—among the plants under study are soybean, cowpea and common bean—and to develop techniques for 1) selecting a) tissue cultures tolerant to heat, salt, drought, and/or aluminum, and b) tissue

Continued on page 2

129

Enhanced N-Transfer

Research conducted by C. van Kessel, P. W. Singleton, and H. J. Hoben (NifTAL reseachers) indicated that N-transfer from a soybean to maize was enhanced by Vesicular Arbuscular Mycorrhizal (VAM) fungi. (Plant Physiology, 79, 562-563, 1985.)



Using a split root technique, roots of soybean plants were divided between two pots. In one of the two pots, two maize plants were grown. Fifty percent of the pots with maize were inoculated with the vesicular arbuscular mycorrhizal (VAM) fungus, *Glomus fasciculatus*. Fifty-two days after planting, ^{15}N-labeled ammonium sulfate was applied to the pots which contained only soybean roots. Two days after application, significantly higher values for atom percent ^{15}N excess were found in roots and leaves of VAM-infected maize plants as compared with the non-VAM-infected maize plants. Results indicated that VAM fungi did enhance N transfer from one plant to another. However, additional studies are needed to establish the agronomic significance of VAM-mediated N-transfer for each specific legume/non-legume association.

Continued from page 1 (TCCP)
cultures more efficient at utilizing nitrate and phosphate; 2) obtaining high-frequency plant regeneration from selected cereal and legume protoplasts; and 3) cloning nitrate reductase and introducing cloned nitrate reductase into protoplasts.

The training program titled "Tissue Culture Technologies and Laboratory Practices" was established at the TCCP facilities to train scientists/technicians from developing countries who have an interest in starting or expanding a tissue culture laboratory.

The course teaches basic tissue culture techniques and offers attendees an opportunity to develop a portfolio on crops of interest to their particular countries. Trainees are expected to transfer knowledge gained
Continued on page 7

NifTAL Begins Study: Microbial Ecology in Tropical Soils

A major grant has been awarded to the University of Hawaii from the National Science Foundation. The NifTAL Project will coordinate research on this grant which was awarded to study the effect of tropical soil conditions on the fate of introduced organisms. The project will expand upon NifTAL's International Network of Legume Inoculation Trials' experimental design by adding environmental factors to develop a predictive model for inoculation response.

Another aspect of the research is related to the current scientific concern regarding the fate of exotic organisms introduced into the environment. *Rhizobium* is an ideal experimental model for this purpose because it is proven not to be harmful when introduced into the environment.

The proposed research is based on the general hypothesis that measurable ecological parameters determine, and can be used to predict, the behavior of the native rhizobial populations in tropical soils. And further, that these ecological factors will also control the fate of rhizobia introduced into soil and their interaction with the host legumes.

Research objectives are based on the following four hypotheses relating to:

1. Abiotic Factors: Soil chemistry and climate influence the establishment, spread, and persistence of introduced strains of *Rhizobium*.
2. Importance of Being Indigenous: Indigenous species of *Rhizobium*, due to selective pressures over time and adaptation to the prevailing stresses, will out-compete inoculum strains derived from culture collections and from non-stress environments.
3. Law-of-the-Minimum: When other factors, such as phosphorus, micronutrients, or environmental stresses, are limiting plant growth, *Rhizobium* inoculation and/or nitrogen application will have little or no effect in increasing productivity; and management practices that ameliorate limitations to legume growth (other than nitrogen) alter the balance between legume nitrogen demand and *Rhizobium* requirement, therefore, the *Rhizobium* requirement by the legume will be a function of management practices.
4. Persistence: While establishment of new rhizobia may be initially accomplished by inoculation with high numbers or manipulation of the environment, the newcomers will not persist due to lack of adapation to the prevailing environmental conditions.

Continued from page 1 (Soybean)
This information excerpted from a recent article in GENETIC ENGINEERING NEWS also notes that plant breeders select for desirable traits of use to farmers by working with plants in the field. But at the cellular level, thousands of cells can be screened for some of those traits in a shorter time. This is one of the main areas in which biotechnology has the potential to increase the flow and speed of improved products to the farmer.

Asian Legume Research Planned

According to an article in AT ICRISAT, 46 agricultural scientists from Bangladesh, India, Indonesia, Nepal, Pakistan, the Philippines, and Thailand met to assess the progress made in supporting and strengthening research programs on groundnut, chickpea, and pigeonpea since their first meeting held in 1983.

Of interest to BNF researchers are several recommendations from the group that make provision for linking together the activities of relevant national, regional, and international research organizations within the region to ensure the efficient use of resources for the improvement of these crops; identifying ways of utilizing "new" legume crops in local cropping patterns; planning multilocation trials to identify the adaptation of specific varieties; setting up joint projects for the basic research needed to support crop improvement; and identifying training needs.

Participants' recommendations and summaries of the contributed papers will be presented in a report on the meeting which is scheduled for release this year from ICRISAT, Patancheru P.O., Andhra Pradesh 502 324 India.

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For Information on the NifTAL Project Contact NifTAL Project Director, NifTAL Project, P. O. Box O, Paia, Hawaii 96779. Submissions to the BNF BULLETIN may be sent: Attention: Communication Section, NifTAL Project.
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.

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150

Training at Porto Alegre, Brazil

A training course in *Rhizobium* technology entitled "Methods for Evaluating the Contribution of *Rhizobium* Inoculants to the Productivity of Tropical Legumes" was held from 16 November to 14 December 1985. The Department of Soil Science, Faculty of Agronomy, UFRGS, Porto Alegre, Brazil, was the location for this course.

Organized by CIAT, the Porto Alegre MIRCEN, and NifTAL, the course was sponsored by the United Nations Development Program (UNDP) with an additional contribution by the Food and Agricultural Organization of the United Nations (FAO).

Dr. Jardim-Freire and Mr. Pedro Selbach were the local organizers. Drs. R. Bradley, D. Harris, and J. Kipe-Nolt were the CIAT instructors and organizers. H. J. Hoben represented NifTAL as instructor and coordinator of the laboratory exercises. An additional 15 scientists participated as lecturers.

The course, given in both Spanish and English, emphasized "hands-on" experience in general *Rhizobium* microbiology, inoculation technology, and field and greenhouse experimentation. Theoretical knowledge in support of the practical exercises and additional information was given in 30 hours of lectures. Also included in the course was an 11-hour mini-workshop on team research.

Attendance was by invitation and, whenever possible, candidates were selected as teams of agronomists and microbiologists. The seventeen participants came from Latin American countries with the exception of one person from Zambia.

Following is a list of course participants and their countries: Renato Valenzuela Bedregal—Boliva; Stela Dalva Vieira Midlej Silva and Reinaldo Bertola Cantarutti—Brazil; Joaquin Garcia Pena and Justo Alejandro Barros—Colombia; German Hernandes Cordoba and Lidieth Uribe Lorio—Costa Rica; Marcial E. Guzman Alburez and Maria Ines Castellanos Arrechea—Guatemala; Juan F. Aguirre Medina and Anselmo Cigarroa de Aquino—Mexico; Esteban Arosemena Jaen and Margarita X. Cornejo Montenegro—Panama; Silos Gonzalez del Aguila and Caesar Augusto Reyes Atac—Peru; Mirta Lopez Gutierrez—Cuba; and Martin N. Mbewe—Zambia.

Photos by H. Hoben

Collecting nodules for isolating rhizobia

Observing growth reactions of rhizobia

Planting seeds in growth pouches

Opportunities

Biotechnology Career Fellowships

The Rockefeller Foundation offers a program of career development fellowships that will give biotechnology scientists from developing countries an opportunity to conduct investigations requiring periodic residence at a premier research institution.

This program, Biotechnology Career Fellowships, has a primary objective of assisting developing country scientists to assume leadership in the development and application of the new biotechnologies. Among the areas of biotechnology that are presently being emphasized by the divisions of the Foundation participating in the program are agricultural sciences, i.e., application of advances in molecular and cellular biology to improved crop and livestock production.

Applicants to this program should have at least Ph.D.-level training in a relevant field, excellent scientific qualifications, and a proven record of productivity. They should be citizens of developing countries holding a permanent position at a research or teaching institution in that country. Their participation in the program must be formally endorsed by the home institution, which must consider them to be on official assignment during the period of the fellowship. The host laboratory must be in the forefront of research in its field. In selecting fellows and their host laboratories, the Foundation will consider the relevance of the research proposed to the needs of the applicant's country, as well as that country's commitment to biotechnology as a development tool.

For information on financial arrangements and application procedures, write Biotechnology Career Fellowships, Fellowship Office, Rockefeller Foundation, 1133 Avenue of the Americas, New York, New York 10036 USA. The Foundation plans to award 50 fellowships between August, 1984, and April, 1987. If the program proves successful, it will be continued for a longer period and renewals will be considered.

International Foundation for Science

The Foundation, founded in 1972, is a non-governmental organization with a membership of 77 scientific academies and research councils in 67 countries, of which two-thirds are in developing countries and one-third in industrial countries. The Foundation is governed by an international Board of Trustees with its secretariat being located in Stockholm, Sweden.

Young scientists and technologists of outstanding merit from developing countries are provided by the Foundation with financial and other support in their work. Between 1974 and January 1986, the IFS has awarded grants to some 900 researchers in 86 countries in Asia, Africa, Oceania, and Latin America. More than half these scientists have received one or more renewal grants.

BNF workers may be interested in applying for grants in the scientific area of Applied Microbiology. Criteria for a grant are the scientific quality and potential of the proposed research project and its relevance to the needs of the country.

Other essential information on grants follows: 1) grantees must be native to, and carry out the research in, a developing country; 2) grants enable researchers to purchase equipment, expendable supplies, literature, etc.; and 3) communication and sharing of scientific information between the grantees themselves and between grantees and senior advisors is encouraged and promoted by regional meetings and visits to projects.

For further information and grant applications, write IFS, Grev Turegatan 19, S-114 38 Stockholm, Sweden.

131

DIRECTIONS IN COMMUNICATION

Slides: Simple is Best

Communication today is not simply conversation or letter writing as more and more researchers and instructors are moving into producing their own communications by computer. Letters, lectures, manuscripts, and even graphs and charts are produced by the writer. A seemingly natural progression is the creation of graphics which can be converted to visuals for seminars and other types of presentations. Therefore, it is essential to have a basic knowledge of what makes a good slide.

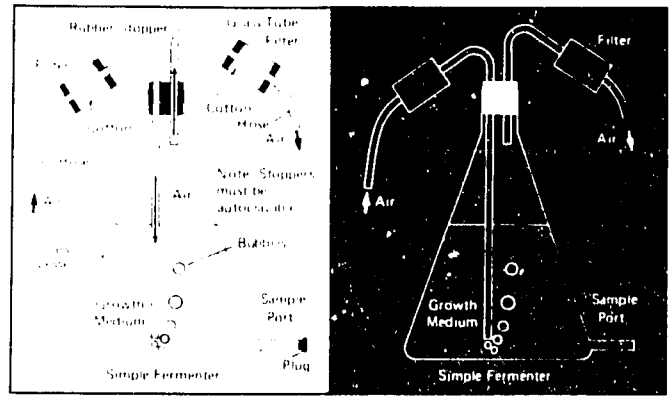
The single most important element to producing good slides is simplicity. There seems to be a tendency for presenters to give in to the temptation of filling that big screen with facts – too many facts. Everyone who has attended a lecture, meeting, or seminar remembers the table flashed on the screen with 5 columns, 10 variables, and calculations carried out to the thousandths place. Those slides rate low on the legibility scale.

Keep in mind that just because the space is big that doesn't mean you should fill it with tiny words. The basic principle that applies to legibility is: Keep your slides clear and simple, with the words and graphics as large as possible.

The fact that you can read the original at a normal reading distance does not mean the final slide will be legible. Easy reading depends on three keys to legible slides: type size and style, contrast, and simplicity.

A rule of thumb for judging the size of lettering or artwork is to design the size of lettering to be no smaller than 1/25 the height of the screen. For example, on a typical 2 meter high screen, lettering should project to at least 8 cm high. Artwork should also conform to this basic rule in that lettering used in the artwork should follow the same 1/25 rule.

Type styles give an opportunity to add distinction to visuals. There are several forms of lettering that work well on original copy for slides; examples are press type lettering, mechanical lettering, and typeset material. Regular



typewritten copy can also be used, but projection shows its ragged edges. Typewritten lettering should be considered the least preferred method.

Contrast between lettering and background is also very important. Choose colors that are contrast widely, i.e., black and white or yellow. Yellow is known to be the most legible color for the farthest distance. However, it should be used only on a dark background because yellow on a white background goes against the high contrast rule. A very effective combination is using white lines on black since the eye is attracted to the light spaces on the screen.

Finally, back to simplicity. Eliminate everything that isn't essential to the message. Shorten headings, use simple diagrams rather than intricate drawings (note the example shown), and use an overall view followed by close-ups of each section.

Whether you do the graphic yourself or are assisted by others, it will enhance your visual presentations if you keep in mind these basics of good slides. This final reminder: a perfectly effective slide can be an inexpensive black and white typewritten table if you remember that simplicity is the key.

NOTE: Much of the information in this article was excerpted from Audiovisual Notes from Kodak, publication number V9-2-2-5, available from Eastman Kodak Company, Dept 412-L, Rochester, NY 14650 USA.

NEW PUBLICATIONS

AZOLLA NEWSLETTER

I. Watanabe, Soil Microbiologist at IRRI (International Rice Research Institute), announces a new semi-annual publication, the AZOLLA NEWSLETTER. This periodical fulfills a recommendation made at the International Workshop on Azolla Use held in early 1985 in Fuzhou, China, and is intended to help workers share information, keep abreast of developments in the field, and maintain current information on Azolla specimen collections throughout the world.

Subscriptions to the newsletter are free. To subscribe, write to the editor, Dr. Iwao Watanabe, Soil Microbiology Department, IRRI, P. O. Box 933, Manila, Philippines. Regional editors are Liu Chung-chu (Asia), T. A. Lumpkin (North and South America), Elizabeth G. Cutter (Europe), B. W. Norton (Australia), and H. F. Diara (Africa).

Newsletter: AGROTECHNOLOGY TRANSFER

Agrotechnology Transfer is a newsletter that combines IBSNAT (International Benchmark Sites Network for Agrotechnology Transfer) Project's Benchmark Sites News and the SMSS (Soil Management Support Service) Soil Taxonomy News. The newsletter will be preserving the information content of these two earlier newsletters and, in addition, demonstrate how the quality and content of a single publication can be made larger than the sum of its former parts. The newsletter will focus on the integration of interdisciplinary research through systems analysis and simulation for agrotechnology transfer.

Subscriptions are free. Send letters and contributions to Managing Editor, University of Hawaii, SMSS/IBSNAT Projects, 2500 Dole Street, Krauss Hall 22, Honolulu, HI 96822, USA.

LIMITING FACTORS WORKSHOP PROCEEDINGS

Proceedings of the Limiting Factors Workshop held in Maui, Hawaii, during August, 1985, are now available. Interested researchers may request free copies from the NifTAL Communication Section, P. O. Box O, Paia, Maui, HI 96779 USA.

Also still available are a limited a number of the 10th North American Conference Abstract books at $5 per copy. Request from the above address.

132

MEETING NOTES

Khon Kaen Venue

Legumes will be the topic for a training course and workshop to be held later in 1986 at Thailand's Khon Kaen University.

• Cowpea & Soybean Course

International Institute of Tropical Agriculture and United Nations Development Program are planning to conduct a six-week training course on cowpea and soybean from 1 August-15 September. Twenty participants from 10 Asian counties will attend.

For information on this course contact R.K. Pandey, IITA Grain Legume Improvement Program, P. O. Box 933, Manila, Philippines.

• ACIAR Food Legume Workshop

ACIAR (Australian Centre for International Agricultural Research) is sponsoring the workshop titled "Food Legume Improvement for Asian Farming Systems" to be held from 1-5 September. This workshop will cover all aspects of the role of food legumes in the tropics and subtropics. Of particular interest to BNF researchers is the topic addressing limits imposed by edaphic factors, specifically nitrogen fixation.

For information on this workshop contact The Meeting Secretariat, Food Legume Improvement for Asian Farming Systems, ACIAR, GPO Box 1571, Canberra, Act 2601 Australia.

8th Australian N-Fixation Conference

When it is convened in Adelaide, Australia, from 1-5 December, 1986, the emphasis of this conference will be expanded beyond legume noduation into such topics as actinorhizzal associations and free-living bacteria.

Details on the conference are available from the Chairman of the Organizing Committee, Dr. W. Wallace, Department of Agricultural Biochemistry, Waite Agricultural Research Institute, Glen Osmond, Adelaide, 5064, South Australia.

100 years of N-Fixation Research

The Royal Society, London, England, will be venue for the discussion meeting titled "A century of Nitrogen Fixation Research: Present Status and Future Prospects" which will be held on 22-23 October, 1986. Many eminent international BNF scientists will be on hand to discuss basic properties for natural N-fixing systems; genetics and regulation of nif and related genes; and objectives for future research and application.

For information on this meeting contact C. A. Johnson, Discussion Meetings Organizer, The Royal Society, 6 Carlton House Terrace, London, SWIY 5AG, UK.

Advances in N-Cycling in Agricultural Systems

Information is now available for this 11-15 May 1987 symposium which will be held in Brisbane, Australia. The meeting addresses the major problem of nitrogen deficiency in agricultural systems and aims to draw together worldwide experts to review existing knowledge of the nitrogen cycle and to identify future research needs.

Write for information to Mr. Keith Weier, Symposium Secretary, Division of Tropical Crops and Pastures, CSIRO, Cunningham Laboratory, St. Lucia, Brisbane, Queensland, Australia, 4067.

XIII RELAR

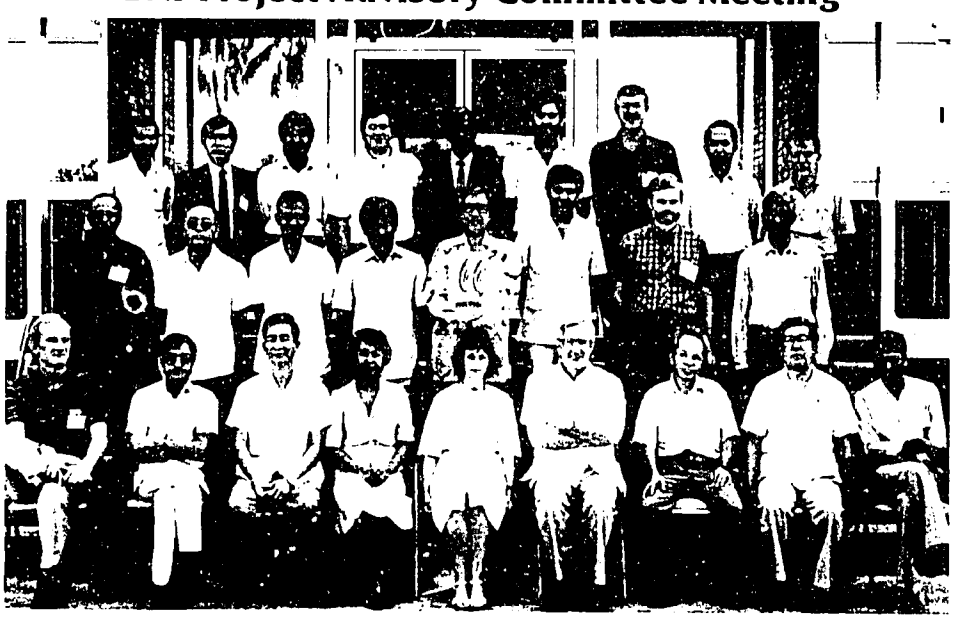
The thirteenth Latin American Rhizobium Meeting will be held in Panama City, Panama, 19-25 October, 1986. This will be the first RELAR held in Central America. For information about this meeting, contact Dr. Blanca Hernandez, RELAR 86, Universidad de Panama, Panama, Republica de Panama.

Rhizobium Technology

A short course on techniques for *Rhizobium* identification for inoculant production and quality control will be held at Porto Alegre, Brazil, from October 5-18, 1986. Staff members of the Instituto de Pesquisas Agronomicas, Department of Soils, Universidade Federal do Rio Grande do Sul and NifTAL will collaborate in the program as well as some specially invited scientists from other institutes in Brazil.

Furtner information on this course should be requested from Prof. Pedro A. Selbach, Training Coordinator, IPAGRO/UFRGS MIRCEN, Caixa Postal 776, 91500 Porto Alegre, RS, Brasil. Deadline for the reception of applications is 30 August 1986.

BNF Project Advisory Committee Meeting



An international advisory committee was convened in late 1985 at the International Rice Research Institute (IRRI), Los Banos, Philippines, to review and evaluate the accomplishments of a UNDP-sponsored Project being conducted at IRRI. Pictured here are the members of this committee.

133

POINT OF VIEW

Dear BNF BULLETIN:

In regard to transferring technology for small scale farming, the BNF BULLETIN, Volume VI, Number 1, 1985, quoted Dr. Nyle C. Brady, Senior Assistant Administrator for USAID, as stating that ". . . technology worthy of adoption cannot be transferred [to farmers with limited resources] unless existing technology is modified, or new technology directly related to the developing countries is developed, or both." I couldn't agree more!

For the past several years I have been increasingly involved with transfer of legume inoculation technology to subsistence farmers in Latin America and the Caribbean Basin. Much of my work has been funded by AID USDA grants. I recently attended a BNF Limiting Factors Grant Program Workshop in Hawaii where I presented a critique paper on the past, present, and future of the program. One of the two main points that I tried to make was precisely what was stated in the above quote. We continue to make excellent progress in identifying limiting factors for BNF in subsistence farming, but the process seems to stop there. Knowing what the limiting factors are is only the first step in transferring technology which will increase the productivity of subsistence farmers. The technology pertaining to legume inoculation is highly developed -- but it was developed for high input, mechanized farming on large acreage of fertile lands. As a result, it is largely inappropriate for direct transfer to subsistence farming systems. However, the existing technology is certainly valid in principle and very amenable to modification and adaptation to the local/regional needs of subsistence farmers.

I offer the opinion that we need sustained, long-term programs, carried out on-site, which are aimed at simplifying/modifying/adapting high input legume inoculation technology into low input technology which can be effectively used by subsistence farmers according to local/regional needs and capabilities. These efforts depend on a long-term commitment. Dr. Borlaug has recently pointed out that the "Green Revolution" required seventeen years! I don't believe a short-term solution ("quick-fix") is a realistic expectation.

The second point that I tried to make in my Workshop presentation emphasized the need for extension. In my experience, an agricultural extension service is often inadequate or entirely lacking in developing countries. The reasons for this are many and complex and they vary from country to country. In my experience field workers in these countries are well aware of the extension need but cannot deal with the problem due to deficiencies in government infrastructure.

The problem of low productivity subsistence farming has evolved over a long period of time and at great expense. The solution will also require time and great expense. If we do not initiate expenditure on the solution we will continue to invest in development of the problem.

- D. H. Hubbell
University of Florida

SHORT TAKES

Frank Kumaga (formerly Frank Sorwli), a former NifTAL Intern, is at IRRI on a six month United Nations University fellowship. He will be working with Dr. I. Watanabe.

Hussein Kamel, an Egyptian who is also a former NifTAL Intern, has received a peace fellowship granted by USAID and is working with Harold Keyser at Beltsville, Maryland.

Casuarina N-fixation is the focus of a Joint FAO/IAEA Division Research project headed by **Glynn D. Bowen**. The work is mainly being carried out in Adelaide, Australia.

Continued from page 1

developed through genetic engineering or other approaches, will be of no effect if they cannot occupy a substantial proportion of soybean nodules in the face of competition from indigenous strains. While most studies of competition among soybean rhizobia have focused on soil-rhizosphere ecology, the selection of more competitive strains, or massive inoculation trials, comparatively little research has been directed toward the utilization of host plant genetic systems to improve the nodulation success of inoculum strains. It is this latter approach that is being studied in the Nitrogen Fixation and Soybean Genetics Laboratory, Agricultural Research Service, USDA, Beltsville, Maryland, USA.

Thirteen soybean genotypes have been identified at Beltsville which are sparsely nodulated by the USDA 123 serotype strain. In a competition study, when these plants were inoculated simultaneously with both USDA 123 and a more desirable strain such as USDA 110, 122, and 138, less than 10% of their nodules were occupied with USDA 123 as compared to approximately 80% of the nodules of a standard soybean cultivar. The USDA 123 restricting soybean genotype formed very effective symbioses with USDA 110, 122, and 138. Two of the USDA 123 restricting genotypes, PI 371607 and PI 377578 (PI = Plant Introduction #) were used in further experiments to examine nodulation response with serogroup 123 isolates obtained from soil in the U.S. and the People's Republic of China. About 25% of these isolates produced very sparse nodulation on the PI's in a manner similar to USDA 123, whereas others produced varying amounts of nodulation with some isolates producing nodule mass similar to USDA 110, 122, and 138. It was therefore apparent that in order to restrict nodulation by the entire range of USDA 123 isolates the soybean germplasm would have to be examined for additional host genetic factors which eliminate nodulation by those isolates which nodulated the PI's. One USDA 123 serogroup isolate from Minnesota (MN1-1c) nodulated the PI's particularly well and it was used as the inoculum in an examination of 875 additional soybean germplasm accessions. Three accessions nodulated very poorly with the MN1-1c. In contrast, these same genotypes nodulated well with the USDA 123 serotype strain. Research will soon be initiated to examine the proportion of the USDA 123 isolates which show restricted nodulation with these newly identified soybean accessions. In addition, genetic crosses between the various soybean genotypes is being undertaken to determine if the genetic factors conditioning restricted nodulation of the USDA 123 serotype strain and isolate MN1-1c can be combined in a single soybean genotype. Such a genotype would hopefully restrict nodulation by a broad range of USDA 123 isolates.

A second approach using host genetic factors to restrict nodulation by strains of serogroup USDA 123 employs a *Glycine soja* (wild soybean) genotype recently identified at Beltsville which nodulates but fixes little N_2 with several *Bradyrhizobium japonicum* strains. Fixation by this genotype is exceptionally poor with USDA 123, but in contrast, highly effective symbioses are formed with fast-growing *(Rhizobium fredii)* soybean rhizobia. When seed of the wild soybean (PI 468397) was grown in the same sterile soil with a standard soybean cultivar and inoculated with both USDA 123 *(B. japonicum)* and USDA 193 *(R. fredii)*, 85% of the nodules of PI 468397 contained USDA 193. In contrast, only 2% of the nodules of the standard cultivar were occupied by USDA 193. Thus, PI 468397 appears to preferentially nodulate with *R. fredii* rather than USDA 123. This characteristic may provide a vehicle whereby strains of serogroup USDA 123 and other *B. japonicum* can be excluded from nodulation in favor of highly effective fast-growing soybean rhizobia. Research is now underway to investigate the inheritance of this characteristic in PI 468397 and to determine if the trait can be successfully transferred to the cultivated soybean.

Keyser, H. H., Weber, D. F., & Uratsu, S. L. (1984). *Rhizobium japonicum* Serogroup and Hydrogenase Phenotype Distribution in 12 States. Appl. Environ. Microbiol. 47, 613-615.

Keyser, H. H. and Cregan, P. B. (1984). Interaction of Selected *Glycine soja* Sieb. & Zucc. Genotypes with Fast- and Slow-growing Soybean Rhizobia. Crop Sci. 24, 1059-1062.

131

N-FIXING TREE NOTES

What's in a Name (or Acroname!)

Occasionally, people will confuse NifTAL and NFTA (Nitrogen Fixing Tree Association) perhaps because both organizations are associated with the University of Hawaii and are interested in N-fixing trees; however, there the close similarity ends. NFTA, a private, non-profit corporation, concentrates solely on trees. Its purpose is to encourage international research and development, communication, and utilization of nitrogen-fixing trees to provide fuel, fertilizer, forage, food, fiber, forests, and other products for human benefit.

A major thrust of NFTA's development focus is assembling existing information on production and utilization technologies, disseminating this information to development workers and farmer organizations, and seeking means of effectively getting trees planted. A small grants program designed to encourage private voluntary organizations to help farmers plant trees was initiated in 1985. Small grants for innovative community-based NFT projects are currently targeted for organizations in Bangladesh and the Philippines.

Continuing NFTA publications are Leucaena Research Reports (LRR), Nitrogen Fixing Tree Research Reports (NFTRR), and NFT Highlights. NFTA has produced several useful publications on N-Fixing trees, of especial note to tree researchers are WOOD PRODUCTION AND USE and its companion, LEUCAENA FORAGE PRODUCTION AND USE.

NFTA continues to provide quality consulting services upon request to both government and non-government organizations. Training workshops and other in-country training programs are being planned.

Collaborators—from university researchers to missionaries—are invited to participate in NFTA's multi-level trials. All participants receive the book GUIDE TO THE ESTABLISHMENT OF RESEARCH AND DEMONSTRATION PLANTINGS OF N-FIXING TREES.

The most informal level of the trials has a demonstration focus. In this trial seeds of 5 to 10 tree species are provided along with instructions. The second level is a site adaptability trial which includes provision of a few more species and in which a planting regime is followed. The final, and most formal level, is a scientific and statistical trial in which an experimental design is used and strict records are kept.

Anyone interested in participating in these trials or in receiving any other information should contact NFTA at: P. O. Box 680, Waimanalo, HI 96795 USA. Annual dues are $10 for members from developed and $5 developing countries.

Forestry/Fuelwood Research

Recently approved by USAID and being implemented by the Science and Technology and Asia-Near East Bureaus is a project to enhance forestry/fuelwood research capabilities and knowledge in developing countries. The project's goal is to meet basic needs of these countries for fuelwood and other tree products; for improved land, water, and human resource management; and for increased employment and income.

Research will be conducted to 1) improve formulation, planning, and management of forestry/fuelwood research and develop agriculture/forestry linkages; 2) support and develop networks of scientists and institutions in developing countries focused on the assessment, improvement, and management of fuelwood/multipurpose tree species; and 3) enable researchers to address their own critical forestry/fuelwood needs through better use of on-farm forestry techniques and agriculture related research information.

Winrock International has been awarded the prime contract for this project within which the University of Hawaii has been subcontracted to provide data-base management services. A data base will be built by developing, collecting, analyzing, and synthesizing research information from all regions which will encourage and support activities in selected reseach support areas, such as multipurpose/fuelwood tree selection and improvement, biotechnology, environmental models, methods and tools. Another key element of the subcontract is consulting with researchers to create an experimental design that will facilitate accumulation of accurate, useable data. This database management system will be located on the Hamakuapoko Campus on the Island of Maui where the NifTAL Project is located.

Tree Project in the Philippines

Jerry Bisson, a USAID Agricultural Development Officer stationed in the Philippines, reports on the Rainfed Resources Development Project he manages there. The objective of this project is to develop innovative approaches for implementation of technology to address problems of upland rainfed and coastal areas.

The project which began in 1980 is using an approach of research, policy dialogue, and pilot field activities. Research is primarily carried out in support of the project. Project activities began with an agroforestry pilot project coordinated through a University, Municipal Manager's Office, District Forester, and the Provincial Governor's office.

The strategy used was to start with a simple soil conservation intervention by contouring a hillside and installing canals for irrigating *Gliricidia sepium* and *Leucaena leucocephala*. Interested, innovative farmers worked together in groups of ten to fifteen persons. These pilot projects became "hot sites" with an appeal that motivated other curious farmers to visit the sites. This provided training opportunities not only for the participating group, but also to the visiting farmers.

Bisson has found that the project provides not only a method to approach and identify local leaders, but also a technique to motivate farmers and teach them a simple technology.

Mr. Bisson, who is also a cooperator with the Nitrogen Fixing Tree Association, can be contacted through the U. S. Embassy, 1201 Roxas Building, 395 Buendia Avenue, Manila, Philippines.

Continued from page 2 (TCCP)
from the course to their own institutions in their home countries.

Technical assistance is expected to strengthen the capabilities of developing countries to produce stress-tolerant plants, expand the plant biotechnology knowledge base, and increase the rate of plant biotechnology transfer. To carry out these goals, the TCCP will provide limited financial assistance, in the form of sub-agreements, to scientists in developing countries who conduct research compatible with the TCCP objectives. The research should involve the food crops important to the country for which the research is intended.

Networking will be carried out through the International Plant Biotechnolgy Network (IPBNet) which was formed to encourage and facilitate information exchange among scientists in developing countries through a newsletter, an annual Network conference, annual visits by TCCP personnel and the technical assistance and training mentioned above. For more information on the project, contact Dr. Murray W. Nabors, Director, Tissue Culture for Crops Project, Department of Botany, Colorado State University, Fort Collins, CO 80523 USA.

135

DOA-BNFRC Course: Rhizobium Inoculant Production

A training course in *Rhizobium* Inoculant Production Technology was jointly organized by the Thailand Department of Agriculture (DOA) and NifTAL's Biological Nitrogen Fixation Resource Center (BNFRC). The course was held from 3-28 March 1986 at the Rhizobium Building of the DOA. Ms. Yenchai Vasuvat (DOA) and Dr. Nantakorn Boonkerd (BNFRC) were instrumental in the organization and hosting of the course.

Participants selected for this course were Usha Kiran (India), Sebastian Wangaruro (Kenya), Fuzoyah Bte Ibrahim (Malaysia), Kayo Devi Yami (Nepal), R.G.A.S. Rajapakse (Sri Lanka), Binsar P.A. Radjagukguk (Indonesia), and Ronnie Nyemba (Zambia). The sponsoring agencies for the participants were ICRISAT, FAO, BOSTID, UNESCO, IIE (New York), University of Illinois Zamare Project, and Eurindo Combined P.T. (a private company from Indonesia).

Photos by P. Somasegaran

Sealing packages of peat inoculant

Course instructors were Drs. R. J. Roughley (Principal Research Scientist, Dept. of Agriculture, N.S.W., Australia), Nantakorn Boonkerd (BNFRC Director), and Padma Somasegaran (Microbiologist, NifTAL Project).

The four week intensive course covered exercises on *Rhizobium* isolation: strain selection; genetic compatibility and cross-inoculation groups; media preparation and growth of *Rhizobium;* methods of enumeration of rhizobia; mass culture of *Rhizobium* in fermenters; carrier processing; inoculant preparation; inoculant quality control methods; seed inoculation; and antisera development.

Several techniques that may be used to back up inoculant production research were also taught. These were the fluorscent antibody technique; membrane filter immunofluorescence (MFIF); enzyme-linked

"Hands on" experience with fermenters

immunosorbent assay (ELISA); the acetylene reduction assay; and the ureide method for determining N-fixation. These aspects of inoculant production were comprehensively covered in 21 lectures and 18 practical exercises. In addition to the normal microbiological techniques learned in the course, the participants gained valuable "hands on" experience operating stainless steel fermenters built in Thailand based on the prototype design developed at the NifTAL Project in Hawaii.

Fairest Bean of All?

Apparently inspired by the winged bean soup served during a dinner following a BNF symposium, Dr. Buckminster Fuller, the well known engineer, inventor, humanist, and poet and also a conference participant composed the following poem on the winged bean:

No politicking hog wash
No vote seeking hokus pokus
Real nitrogen enfixing
Genus Psophocarpus
tetragonolobus

Soup and French cut
Formally served
Not only did not bloat us
But also pleased our palates
Long podded Psophocarpus
tetragonolobus

Purple, yellow, brown and green
Sometimes spotted
Sometimes clean
Grotesquely knotted
Roots unseen
Why do they call you
Winged Bean?

Nodulated tuber
Pole bean tall
Flowers, seed pods
Edible all
Who's the fairest
Bean of all
Soy or Psophocarpus
tetragonolobus?

Richard Buckminster Fuller
January 1978

S&T/AGR Soil and Water Projects to Work Together

Renewable Natural Resources (RNR) Division, Science and Technology Branch, in the U.S. Agency for International Development's Office of Agriculture has initiated an effort to create a new alliance of eight projects dedicated to improving the use of scarce soil and water resources in the developing nations. The projects are:

Soil Management Support Services (SMSS)

International Benchmark Sites Network for Agrotechnology Transfer (IBSNAT)

Technology of Soil Moisture Management (TSMM)

Soil Management Collaborative Research Support Program (TropSoils)

International Fertilizer Development Center (IFDC)

Nitrogen Fixation in Tropical Agricultural Legumes (NifTAL)

Water Management Synthesis (WSM)

Tissue Culture for Crop Production (TCCP)

The alliance was formed during a November, 1985, meeting in which AID called together representatives from each of its eight soil and water projects and advised them that the limits of time and budgets made it imperative that the projects assert a new commitment to teamwork and coordination. Representatives were advised that their projects should not operate independently of one another, but must meet their individual objectives as one program, united. The projects were asked to propose a plan that would unite them in concept and function.

A coordinating committee consisting of representatives of each project met again in January, 1986, and agreed on a more structured effort having the primary objectives of: 1) consolidating the cluster of RNR's soil and water related projects into an integrated program; 2) advising and assisting AID in matters of agricultural research; and 3) promoting the utilization of new agrotechnologies in the developing countries through the dissemination of innovative concepts and techniques.

The committee is seeking comments and suggestions. Responses may be addressed to Dr. F. H. Beinroth, Chairman, Soil and Water Program Coordinating Committee, Department of Agronomy and Soils, University of Puerto Rico, Mayaguez, PR 00708.

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136

BIOLOGICAL NITROGEN FIXATION BULLETIN

VOLUME VII, Number 2
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Molecular Genetics & BNF

In recent years, molecular genetic studies focused on biological nitrogen fixation (BNF) have provided insight into the genes involved in nodulation (*nod* genes) and nitrogen fixation (*nif* genes). Studies of *Klebsiella pneumoniae* have identified 17 genes involved in the synthesis and regulation of the nitrogenase system. At the same time, studies of some *Rhizobium* species have identified some of the genes involved in nodulation.

In the fast growing *Rhizobium* species (*R. trifolii, R. leguminosarum, R. phaseoli, R. meliloti, and R. fredii*), *nod* and *nif* genes are located on plasmids, whereas in the slow-growing species (*Bradyrhizobium* spp.) these genes are on the chromosome. In this article, we would like to comment on some recent advances in this field.

Reiteration of the *nif* genes. In our laboratory, it has been shown that several naturally-occurring strains of *R. phaseoli* have three regions containing the nitrogenase structural genes. Two of the regions have copies of each of the three genes, *nif* H, D, and K; whereas the third region harbors only the *nif* H gene. Reiteration of *nif* genes has also been shown in other rhizobial species, including *R. fredii* and the broad host range strain ANU 240. Whether gene reiteration allows for better symbiotic performance remains to be demonstrated.

Genomic rearrangements of the *nif* genes. Genomic rearrangements would result in the activation (or extinction) of existing pathways. R. Haselkorn's group has reported that in *Anabaena* the nitrogenase structural genes are comprised of different transcriptional units. During differentiation from vegetative to heterocyst, the *nif* genes undergo a rearrangement that joins them into a single transcriptional unit, activating their expression. On the other hand, in some isolates of *R. phaseoli*, G. Soberon and coworkers have found a high frequency of genome rearrangements that lead to the loss of *nif* genes. This could explain the high frequency of ineffective isolates found in nature.

***Nod* genes: their expression is controlled by plant metabolites.** Genetic studies have led to the identification of some of the *nod* genes. Interestingly, some genes (the *nod ABC* genes) are homologous between different rhizobial species, suggesting common principles and probably mechanisms, in the invasion of legume roots by *Rhizobium*. Other *nod* genes are specific for each system and though to be involved in the determination of host compatibility. Recent studies have indicated that the expression of *nod ABC* genes (or "common *nod*" genes) is controlled by metabolites present in root exudates. S. Long's group has found that a normal component of root exudates, the plant flavone, luteolin, is the main activator of the expression of these genes in *R. meliloti*. This is a significant breakthrough in our understanding of the chemical signals involved in the establishment of the *Rhizobium*-legume symbiosis.

Alternate system for nitrogen fixation. Recently, J. Bishop's group isolated *Azotobacter vinelandii* mutants which were affected in the nitrogenase structural genes. As expected, those mutants were unable to fix nitrogen. The unexpected finding, however, was that in the absence of molybdenum in the culture media those mutants regained the ability to fix nitrogen. This strongly suggested the presence of a second nitrogen fixing enzyme system in *A. vinelandii*. Recent biochemical evidence by J. Bishop and J. Postgate's groups indicates that the new system is not only inhibited by molybdenum, but requires vanadium for its functioning.

Important as they are, the findings summarized above raise new questions. What is the function of gene reiteration in *Rhizobium*? What is the role of genome rearrangements in the maintenance and variation of a symbiotic genome? What are the regulatory mechanisms that govern the expression of the "common nod" genes? Which are the genes and affectors that govern host specificity? What is the function, biochemical composition and distribution of the second nitrogenase system? How can molecular genetics help improve the competitive performance and nitrogen fixing efficiency of the *Rhizobium*/legume symbiosis? These are but a few of the critical questions that will demand attention in the years to come.

Submitted by: David Romero and
Rafael Palacios
Nitrogen Fixation Research Center
University of Mexico
Cuernavaca, Mexico

137

Opportunities

Science & Technology Cooperation

The Program in Science and Technology Cooperation (PSTC), is administered by the Office of the Science Advisor of the USAID. The Program seeks to stimulate new and innovative research on problems that confront developing countries and is implemented by a system of highly competitive research grants which undergo scientific peer review.

PSTC gives highest priority to submissions from scientists in those developing countries which receive USAID development assistance. Cooperation with U.S. scientists is encouraged but not required. Applicants may be affiliated with universities, non-profit or for-profit organizations, and/or government laboratories. Although PSTC does not support research in developed countries, competition for these grants is also open to U.S. investigators and scientists from middle income countries when the research is particularly relevant, unusually innovative, and where there is a strong linkage with developing countries.

Generally, PSTC seeks new research ideas in the natural sciences, such as biology and chemistry, and in engineering. Innovative findings that can be readily applied to serious developing country problems are accorded highest priority. Included in the six areas of investigation identified for special emphasis and priority funding are Biotechnology/Immunology and Plant Biotechnology.

Further information is available regarding what other topics can be considered; what areas PSTC excludes; how to write a preproposal; when and how to submit a preproposal; how proposals are evaluated; and why preproposals fail. To submit preproposals or request information, contact: Office of the Science Advisor, Agency for International Development, AID/SCI, 720 SA-18, Washington, D.C., USA 20523. The next deadline for receipt in Washington, D.C. of 2-3 page preproposals is 1 February 1987.

Promising Mid-altitude Soybeans

Soybean lines which are very promising for mid-altitude locations (1000-1500 m) in Africa have been developed and tested by International Institute of Tropical Agriculture (IITA) in Plateau State, Nigeria. These lines were developed in field trials over a three-year period as part of a collaborative project with the Evangelical Church of West Africa (ECWA) Rural Development, at an elevation of 1300 m.

Based on exploratory trials in 1983 and discussions with cooperators throughout Africa, IITA researchers discovered that soybean lines selected at low elevations often mature 10-30 days later when grown at elevations higher than 1000 m. These lines were consequently low yielding unless the rainy season was exceptionally long.

Three trials with early maturing lines were completed in 1984. Based on these results, eleven more trials were undertaken in 1985. Many 1986 trials are being done using the best seed from the 1985 trials. Results from preliminary yield trials were encouraging. Some of the promising lines will be further tested in advanced trials in Nigeria, Zimbabwe, Tanzania, and Kenya. The best of these lines will then be made available to national programs in 1987.

For further information on these soybean lines, contact IITA, PMB 5320, Oyo Road, Ibadan, Nigeria. The above was excerpt from a story in IITA RESEARCH BRIEFS

ACIAR Ecological Studies

Recently reported by Rodney Roughley in the ACIAR Food Legume Newsletter is an ecological program studying root nodule bacteria and the use of legume inoculants. This program is based on the fact that BNF is a major contributor of N for agricultural production. The level of input depends on the N-status of the soil, suitable conditions for legume growth, and highly effective strains of rhizobia to nodulate roots. The introduction of legumes into new areas is often delayed by lack of suitable rhizobia in the soil, but these can be introduced at seeding or planting.

Briefly, the following collaborative subprojects were approved by ACIAR's Board of Management:

Malaysia: 1) Malaysian Agriculture Research Development Institute (MARDI)-Determine the nodulation status of peanuts and leucaena; 2) Rubber Research Institute Malaysia (RRIM)-Determine the nodulation status of *Pueraria phaseoloides* and *Calopogonium caeruleum* (these plants are used as cover crops on rubber plantations). Also at RRIM, sample sources of peat for processing and testing as potential carriers for rhizobia.

Thailand: 1) Study population dynamics of introduced strains of rhizobia for some species of *Stylosanthes* and leucaena. 2) Soybean *Rhizobium* compatibility and need for inoculation.

The Philippines: 1) Ecology of *Rhizobium* nodulating tree legumes; 2) Ecology of *Rhizobium* nodulating grain legumes in the Philippines.

Jordan: Ecology of rhizobia in *Medicago* spp. as related to vegetation, soil, climate and management.

ACIAR provides technical backup, advice on inoculation problems encountered, as well as providing inoculants for their collaborators.

Mutual Cooperators

Several of the developing country collaborators who will be participating in the ACIAR study are former NifTAL trainees or visiting scientists. These are from Thailand, Dr. Banyong Toomsan of Khon Kaen University and Mrs. Ampan Bhromsiri of the University of Chiang Mai; and from The Philippines, Mrs. Angela Almendras of the Visayas State College of Agriculture and Dr. Erlinda Paterno of the University of the Philippines at Los Banos.

ACIAR Workshop

Over 300 participants from 15 countries and nine international organizations attended the ACIAR-sponsored Workshop on Food Legume Improvement for Asian Farming Systems in Khon Kaen, Thailand, from 1-5 September 1986. The theme of the Workshop was the limitations to productivity and adaption of food legumes in the farming systems of Asia.

The Workshop addressed the basic theme in a number of ways through invited papers covering the major limits to productivity and adaptation, a poster session encompassing the research, training and publication activities of various institutions in the region, a field tour to observe some regional limitation to legume crop improvement, contributed papers addressing the major limits and aspects of legumes in production systems, and concurrent forum sessions at which major issues and potential resolutions were raised in plenary sessions.

Food legumes are commonly seen in Asia as secondary to the major cereal crops and are therefore relegated to marginal land with little if any inputs.

136

Also, food legumes receive little government support and, in part because of this, are perceived by farmers as low yielding, high risk crops. These problems are compounded by the large number of legume crops grown in Asia and limited scientific knowledge of them. There was universal support of delegates for the development of a multidisciplinary team approach to the improvement of legume crops.

The question of the appropriate nature of the environments for selecton and testing was debated at length, and divergent views were expressed regarding the use of controlled test environments versus testing in the farmers' fields. The strong disciplinary focus in research organization and conduct was seen to be a fundamental constraint to crop improvement.

Proceedings will be published by Plant and Soil as a special volume. For information on availability of this proceedings, contact Mr. E. S. Wallis, Department of Agriculture, University of Queensland, St.Lucia, Qld., 4067, Australia.

3 Interns at Bangkok BNFRC

An internship program has been set up at the BNF Resource Center for South and Southeast Asia. This program is for scientists who have experience in rhizobial technology or who are now working in this area and require additional techniques or skills to improve their expertise.

Dr. Nantakorn Boonkerd, Acting Director, BNFRC, believes that internship training is more effective than other types of training courses. He reasons that a trainee can make personal decisions about the technique or subject of study undertaken and will, therefore, have a stronger sense of commitment to the program. Also, training time is used most effectively since no time is spent teaching topics that are already well known by the intern.

This year, the following three scientists have participated in the internship program:

- S.I. Khan, University of Dhaka, Bangladesh. Dr. Khan is an Assistant Professor in the Department of Soil Science. His program centered on the study of strain identification using agglutinations, gel immunodiffusion, and fluorescent antibody technique.
- Mirghani Abdel Rahman Wasfi, University of Khartoum, Sudan. Dr. Wasfi is a Lecturer in the Department of Botany, Faculty of Science. His training program was designed around his desire to have an overview of *Rhizobium* technology and inoculant production.
- Sirag Ali Ibrahim, University of Khartoum, Sudan. Dr. Ibrahim is a Lecturer in the Department of Botany. He opted for the general program in inoculum production and field evaluation of *Rhizobium*.

Anyone who is interested in information on future internships should contact Dr. Boonkerd, BNFRC, Rhizobium Building, Soil Science Department, Department of Agriculture, Bangkhen, Bangkok, 10900 Thailand.

Biotechnology of N-Fixation in the Tropics

Over 100 participants from 8 countries in South and Southeast Asia, Australia, France, and the United States, attended a regional symposium and workshop from 25-29 August at the Universiti Pertanian Malaysia. It was sponsored by Unesco, the Universiti Pertanian, and Malaysian Society of Soil Science. This Symposium and Workshop was a follow-up activity of a 1983 meeting that was held in Bangkok, Thailand, to formulate the establishment of a "BNF Resource Center (BNFRC) for South and Southeast Asia."

BIOnifT

The symposium was divided into sessions on the impact of fundamental applications of BNF in agriculture, physiological, environmental and nutritional factors affecting BNF, and methods for measuring BNF. In addition, a two-day workshop focused on the research problems related to application of BNF in field crops and wetland crops. A discussion of future directions in BNF research was also held. Representatives of South and Southeast Asian countries presented country reports in which ongoing research and the organizations involved in this research were highlighted. Finally, the workshop closed with a panel discussion and formulation of resolutions, one of which was to hold another BNF meeting in 3 years either in Thailand or in The Philippines.

The general consensus by participants was that the quality of research in the region is high and that the research activities are relevant to the needs of national programs. Participants stressed the need to communicate research results and the potential of BNF to policy makers in their countries. In addition, it was felt that the resources of most countries in the region were adequate for the type of research now being conducted, but that present resources would not facilitate moving into areas such as genetic engineering.

Research highlights were presented in diverse fields of BNF in seven session held over the three days. Topics included were: Session I: The impact of microbiology and biochemistry on BNF; Session II: Fundamental applications of BNF in agriculture; Session III: Methods of measuring BNF; Session IV: Commercial applications of BNF in agriculture; Session V: Physiological and environmental factors affecting N-fixation; Session VI: Effects of mineral nutrition on symbiotic systems; and Session VII: General aspects of BNF.

Participants suggested that the BNFRC in Thailand periodically publish a list of BNF researchers in the region, what they are doing, and by whom they are being funded.

Proceedings are expected to be published in the spring of 1987. For further information, contact The Secretary, BIOnifT, Dept of Agronomy and Horticulture, Universiti Pertanian Malaysia, 43400 UPM, Serdang, Selangor, Malaysia.

J. Roskoski

During the field trip, participants observe the use of legumes for ground cover at the Malasian Rubber Research Institute. In the foreground, Y. Vasuvat and Y. Dommergues check Prioria for nodules. Among the others shown are N. Boonkerd, E. Paterno, R. Tabor, and P. Wadisirisuk.

139

DIRECTIONS IN COMMUNICATION

Information dissemination has evolved into many forms in our modern world. There are slide programs and videotapes replacing photographs, computers which process words and data much more accurately and faster than hand written or calculated data, and televisions which spread news of current events farther and faster than printed newspapers. All these technologies are appropriate in certain circumstances. In the developing world, however, the most basic of all information disseminating devices—books and magazines—are virtually unavailable.

Through the BNF BULLETIN "Continuing Bibliography," NifTAL provides limited document copying services for developing country researchers, as well as noting the availability in the BULLETIN's "New Publications" section of free or low cost publications. Many other organizations also provide similar services, but there is still a long way to go in providing the variety and number of publications necessary for effective BNF research.

One possibility to help meet the need for keeping abreast of current research is to subscribe to one of the relatively low cost information services. For example, weekly issues of one such service (Current Contents) are prepared containing copies of the tables of contents of current journals. Additionally, there is a key work index, author index, and an author address list. By reviewing such publications, researchers can easily locate and request reprint copies.

Subscribing to a publication of this type can stretch limited library periodical budgets. This action will not solve the information crisis in the developing world, but it will go a long way in providing access to current research articles to BNF workers.

For further information on this topic, contact the NifTAL Communication Section.

-P. Ferguson

NEW PUBLICATIONS

Soil-Based Agrotechnology Transfer

This volume edited by Dr. James A. Silva and published by the Benchmark Soils Project, University of Hawaii, is the final report of the Crop Production and Land Capabilities of a Network of Tropical Soil Families Project. It contains an assessment of agrotechnology transfer made by the project and reports its studies. The book provides information accumulated by the Benchmark Soils Project about soils and soil management.

For information on obtaining copies of this book, contact the International Benchmark Sites Network for Agrotechnology Transfer (IBSNAT), Department of Agronomy and Soil Science, College of Tropical Agriculture and Human Resources, University of Hawaii, Honolulu, HI 96822 USA.

Newly Translated: Legume Inoculants and Their Use

This useful pocket manual jointly prepared by NifTAL and FAO, has been translated into 3 languages—Spanish, French, and Thai. For information on obtaining copies of the French or Spanish editions, contact FAO Publication Division, FAO, Via del Terme de Caracalla, 00100, Rome, Italy. The Thai edition should be requested from the BNFRC, Rhizobium Building, Department of Agriculture, Bangkhen, Bangkok, Thailand.

Crop Productivity

Crop Productivity Research Imperatives Revisited is the result of presentations and discussions at an International Conference held at Harbor Springs, Michigan, from 13-18 October 1985. Editors Martin Gibbs and Carla Carlson have put together an extremely useful volume. "This book...presents research needs in the contexts of newer demands on agriculture—and newer opportunities—and expands the discussion to science policy," states the foreword to this book.

Of interest to BNF workers are working group reports on genetic improvement, plant and cell physiology, rhizosphere dynamics, and biological constraints.

Free copies may be obtained by writing to meeting organizer Dr. Sylvan Wittwer, 108 Agricultural Hall, Agricultural Experiment Station, Michigan State University, East Lansing, MI 48824 USA.

Fixation of Atmospheric Nitrogen

Dr. C. Rodriguez-Barrueco has announced that the Spanish language book *"La Fijacion de Nitrogeno Atmosferico"* is now in print. To obtain this 69-page book which provides an overview of BNF, contact Coordinator Silvino Cuadrado Sanchez, C.S.I.C., Apartado 257, Salamanca, Spain.

Methods in Legume-Rhizobium Technology

Recently this book, authored by P. Somasegaran and H. Hoben of NifTAL, was reviewed in the American Society of Microbiology News by Dr. Peter P. Wong of Kansas State University. In part, the review referred to the book as "...a well-organized and comprehensive laboratory manual...the emphasis ...is on the microsymbiont...It is a descriptive or how-to type of publication intended as a manual for a 6-week training course...within this context the authors have succeeded admirably. Moreover, the book can serve as a guide for setting up a *Rhizobium* inoculum program, understanding the operation of such a program, and helping to evaluate or modify an ongoing program ...I would certainly recommend this book not only to scientists and technicians of developing countries, but to all scientists who are isolating, identifying, and evaluating rhizobia."

Feedback from users of this first edition has been extremely helpful to the authors in compiling a list of errata. This list will be distributed shortly to all those in possession of this edition. This book is available from the NifTAL Project Communication Section. Cost is $22, but copies are available for $10 to qualifing developing country BNF workers.

140

Biotech for Sustainable Farm Systems

The implications of biotechnology for sustainable farming systems were discussed at a scientific symposium held in Washington, D.C., during March, 1986, and sponsored by the Institute for Alternative Agriculture, Inc.

Some interesting information was presented at the meeting by leaders in the field. A synopsis of some of their ideas follows:

- Molecular genetics should be more effective than traditional plant breeding because specific desirable traits can be transferred;
- Better information is needed on genetically engineered plants and microbes before they are released into the environment. Some scientists believe that all genetic codes have been mixed together at some previous time and then lost because the combination was not adapted and useful;
- Alternative agriculture (reduced commercial input systems) has developed an awareness of the need for research. Nearly 1 out of 10 U.S. agricultural scientists is involved in alternative agriculture;
- There are several hundred biotechnology firms in the U.S. alone and at least 50 firms are active in plant biotechnology; Continued on page 6

Nyemba Receives M.S. Degree

R. Gabnelson

Ronnie Nyemba, one of NifTAL's graduate students at the University of Hawaii, completed his program in early September. Nyemba came from Mount Makulu, Zambia, and his program was financed by the University of Illinois Zamare Project. His M.S. seminar and examination were held at the NifTAL Headquarters on August 14. The seminar titled "Soybean Nodulation and Nitrogen Fixation as Affected by the Interaction of Phosphorus and Seed Inoculation Rate" presented work done by Nyemba at both the main University campus and field research at NifTAL's Maui Headquarters. He looked at the interaction between inoculation rate, P-fertility, and N-fixation by soybean.

Nyemba returned to Zambia in late September via the University of Illinois. He will be stationed at Mount Makulu and expects to produce inoculants for the many soybean farmers who have been using NifTAL/Zamare produced inoculants for the past two years.

A Tribute to J. M. Vincent

One of the leading scientists in *Rhizobium* work, Dr. James M. Vincent, was given a tribute when a two-day meeting was held in his honor at the University of Sydney, Australia. The meeting entitled "Microbiology in Action" featured presentations on all aspects of *Rhizobium* as well as general microbiology.

Dr. Vincent was a pioneer in *Rhizobium* microbiology work. During his career he conducted extensive research, wrote important literature, and taught or interacted with many of the researchers presently working with *Rhizobium*. One of his books, "A Manual for the Practical Study of Root-Nodule Bacteria" served as a standard text for many years. It is not unusual to hear *Rhizobium* workers refer to themselves proudly as a "Vincent Product."

Molecular Biology Meeting

Molecular biology of the *Rhizobium*-legume interaction will be the topic of a meeting designed to promote an exchange of ideas between a maximum of 60 scientists actively working with either or both partners in the *Rhizobium*-legume symbiosis. The meeting will be held in a hotel in Amalfi, Italy, from 7-11 April 1987. The workshop fee will cover transport from the airport or station, accommodation, and meals. A limited number of travel grants will be available.

People interested in receiving a circular and further information are invited to write to: Professor J. E. Beringer, Unit of Molecular Genetics, University of Bristol, Woodland Road, Bristol BS8 1UG, UK.

International Food Legume Research Conference

S. Frederick

Enjoying a lunch break during the intensive program of the 1986 Food Legume Research Conference are from left, Jake Halliday, Lloyd Frederick, David Herridge, and Ben Bohlool. The conference was held from July 6-11, 1986, in Spokane, Washington.

11th NARC Announced

The first announcement for the 11th North American Rhizobium Conference has been received. The meeting will be held at Laval University, Quebec City, Canada, from 9-15 August 1987. The second announcement will be mailed only to those responding to the first announcement.

The conference will be in plenary sessions and will include addresses by guest speakers, round tables, and contributed papers (oral and posters). All presentations will be in English and the scientific program is being developed around the topics of *Rhizobium* taxonomy, physiology, genetics, ecology, inoculation, and agronomy. The call for abstracts will be made in the second announcement.

To receive the first and second announcements, contact the Dr. Hani Antoun, 11th North American Rhizobium Conference, Department of Soils, Faculty of Agricultural and Sciences, Laval University, Quebec, Canada G1K 7P4. Pre-registration and receipt of abstracts deadline is April 30, 1987.

Romero Completes Program

R. Gabnelson

David Romero-Camarena from Cuernavaca, Mexico, spent 6 weeks at NifTAL Headquarters beginning in mid-September on a collaborative research program. Romero, who recently received his M.S. from the University of Mexico, is currently working on his doctorate degree at the Center of Nitrogen Fixation, University of Mexico.

His research program at NifTAL will give him an overview of different growth systems for assessing the nitrogen fixing abilities of different mutants of *Rhizobium phaseoli*. These mutants (developed in Dr. Rafael Palacios' laboratory in Mexico), derived from a strain that naturally contains three copies of the *nif*-structural genes, have one or more copies inactivated by transposon insertion. Romero is being sponsored by a BOSTID (Board on Science and Technology for International Development) grant from the U. S. National Academy of Sciences.

141

Biotech continued from page 5

- Results of a survey of biotechnology companies show that in plants the most common product is expected to be seeds, but beneficial microbes (rhizobia, mycorrhizae, *Bacillus thuriengensis*, etc.) and genes may be developed; and
- Emphasis was placed on using resources available on the farm to the greatest amount possible and to developing plants and animals better able to cope with pests and stresses. Time and research will be needed to develop the biotechnology products for agriculture, then they will need to be assessed for their practical and economical potential.

For information on obtaining copies of this symposium's proceedings contact the Institute for Alternative Agriculture, 9200 Edmonston Road, Suite 117, Greenbelt, MD 20770.

- L. R. Frederick

COMMERCIAL CORNER

This issue marks the first of a continuing section of our newsletter for useful information on *Rhizobium* and inoculation technology submitted by companies in the field. Below are excerpts from an information bulletin.

To Inoculate or Not To Inoculate...

The answer is not always "yes," but it is "yes" more times than many people think. Simply put, the farmer needs to inoculate when there are low numbers of *Rhizobium* in the soil. In the case of soybean, generally if a crop has not been grown previously there are no soil rhizobia present and inoculation is necessary. If a crop has been grown previously, the number of effective *Rhizobium* in the soil will depend on the following:

- Was the previous crop well nodulated?
- What is the pH of the soil? pH's below 6.0 can result in poor survival of rhizobia.
- What is the organic content of the soil? All bacteria, including rhizobia, survive best when there is greater than 1% organic content.
- What is the normal moisture and temperature status of the soil? Hot, dry soils generally do not support high populations of rhizobia.

The low cost of inoculants relative to the overall cost of soybean production makes inoculation a good insurance treatment.

-Tom Wacek, Kalo

POINT OF VIEW

Have You Thanked Your Curator Lately?

Taking care of a germplasm collection is an enormous responsibility, yet often a thankless job. The curator of the collection and his assistants are not only charged with collecting and cataloguing new germplasm, but also with the formidable task of assuring the purity and authenticity of cultures sent out.

The NifTAL Project manages a comprehensive collection of *Rhizobium* for tropical legumes. It contains nearly 2000 cultures from diverse sources, of which approximately 1700 are catalogued. A select group of nearly 50 strains are identified as superior and are recommended for 15-20 economically important grain, forage, and tree legumes. This group contains the rhizobia that are used in our International Network of Legume Inoculation Trials (INLIT) that have been conducted by more than 200 collaborating scientists in over 50 countries. These "INLIT" strains are characterized extensively and field-tested and most are antigenically distinct. NifTAL also provides antisera (and fluorescent antibodies) for those who wish to study the ecology of these rhizobia in the field.

The increasing number of requests for *Rhizobium* from the NifTAL collection is testimony to the increasing awareness of the potential benefits of BNF technologies in developing countries. It is rare, however, for our curator to receive a letter of encouragement, a note of appreciation, or technical feedback from recipients of cultures. Only when problems arise is he notified. What is especially discouraging is that very few recipients ever even acknowledge receipt of cultures.

At NifTAL, we follow a strict and rigorous protocol to ensure the purity of cultures we distribute. One microbiologist starts the process by preparing a batch of lyophilized cultures for the collection following extensive testing and purity confirmation of each stock culture. Another microbiologist then does a blind quality control test on a random selection of ampules from that batch before it is deposited in the collection for distribution. Periodically (1-2 times per year), random samples from the active collection are analyzed for purity and authenticated on the host plant. Each batch in the collection is coded and representative ampules are saved for future verification. Each order of cultures sent out from NifTAL also contains a one-page instruction sheet for proper opening of the freeze-dried ampules. We believe that if these instructions are followed closely the chances of contamination are minimized.

Despite all the above safeguards, of course, it is still possible to end up with a contaminated culture. It is difficult, however, to assess the source of contamination and determine where it occurs—either at the sending or the receiving end of culture distribution.

In addition to the standard microbiological precautions for handling bacterial cultures in general, there are certain guidelines that pertain to *Rhizobium* in particular. I would like to share with you some of the **dos** and **don'ts** for handling *Rhizobium:* 1) Authentication is the hallmark of careful work in *Rhizobium* research; so **do** check your cultures for proper nodulation on their appropriate hosts before embarking on a long and arduous research project; 2) When you receive a culture **do,** by all means, streak the culture out on appropriate media for purity and gram stain growth for microscopic verifications, but, **do not** select single colonies, unless for specialized purposes such as genetic or biochemical studies. Rhizobia are known to produce variants in culture and one is never certain which variant is being selected. Consequently, different investigators might end up working with different variants of the same culture; 3) If you must select single colonies or need to reisolate the culture from nodules, **do** make sure to authenticate the isolate as *Rhizobium,* and, **do not** rely on the good reputation of NifTAL or any other supplier; 4) If you suspect contamination, **do** write to the curator as soon as possible and request a replacement. Your notification will prompt an immediate purity check on the batch from which your cultures were taken; 5) Some rhizobial cultures, especially those from tropical locations, **do not** survive for long periods in culture, especially when refrigerated (some *Sesbania* rhizobia are particular sensitive), so, **do** transfer cultures frequently and keep back-up slants for referral; and 6) **do** keep records of the original designation cultures, and, **do not** yield to the temptation to rename cultures received from other sources.

The NifTAL collection represents a diverse genetic base for use in basic as well as applied work. It is compiled and maintained for your benefit. The curator works diligently to keep this germplasm resource current and useful. Your feedback to him in the characteristics and peculiarities of your cultures will provide a knowledge base that would benefit us all. Please keep us informed.

-B. Ben Bohlool

142

N-FIXING TREE NOTES

Ken McDicken, formerly of the Nitrogen Fixing Tree Association (NFTA), has been selected as species network specialist for the Forestry Fuelwood Research and Development (F/Fred) Project. He will be outposted in Bangkok, Thailand, where his duties will include coordinating establishment of multi-purpose tree information exchange and research networks. Research will focus on the assessment and improvement of multi-purpose trees to meet the needs of small farmers for tree products like fuelwood, fodder, etc. Activites will include meetings, workshops, training, publications, and research support.

Also with the F/FRED Project is a recent NifTAL visitor, Kirtland Barker, who is the Winrock International overall coordinator for the F/FRED project.

Dr. Peter Dart of the Australian National University in Canberra, NSW, is working with Mercedes Garcia at Los Banos, The Philippines, through an ACIAR collaborative agreement. They are looking at the suitability of approximately 12 species of fast growing N-fixing trees. The study, being done in several different areas of the Philippines, will assess the trees' response to inoculation and their rhizobia requirements.

The BOSTID Tropical Tree Programs will have a combined meeting at Harvard Forest, Petersham, Massachusetts, from November 9-14. Holding the meeting in a temperate locale is a significant departure from the locations of previous meetings—for example, Kenya, Thailand, and Mexico. Although this is not a tropical venue, participants will have a chance to see the activities that are going on at Harvard with actinorrhizal species, such as alder and casuarina.

Dr. Vibha Dhawan of the Tata Energy Research Institute in New Delhi, India, visited NifTAL during a research tour in the USA. Her recent work has centered on mass propagation of elite *Leucaena leucocephala* germplasm using meristem culture methodology. This research proceeds from basic to applied as the tree seedlings she produces are provided for outplanting in reforestation and bioenergy projects run by extension agencies.

The overall purpose of the program is to insure that high-yielding germplasm is utilized in tree programs. In addition, Dhawan is now working on the research and development of mass propagation systems for other species of fast-growing, N-fixing trees with high multi-use potential, such as *Albizia* species.

Three institutions engaged in research and development in the semi-arid lands of Kenya (Kenya Agriculture Research Institute, Machakos Integrated Development Program, and the National Dryland Farming Research Station) became research partners with the International Council for Research in Agroforestry. These groups conducted a series of field trials including a tree leaf manuring and intercropping systems trial. Among the data obtained from the 3rd year crop were rather promising results in increased maize yields when using *Cassia siamea* and *Leucaena leucocephala* for green manuring. This information was excerpted from a story in the ICRAF Newsletter.

USAID/Port-au-Prince has requested technical assistance from NifTAL to set up an inoculant production facility in Haiti to produce rhizobia inoculum for N-fixing trees. Based on experiences in Zambia and Turkey, NifTAL suggested two alternatives—either obtaining a government loan for starting a commercial inoculant production plant or developing a state inoculant plant. NifTAL was asked to play a major role in establishing the facility and in providing training, technical assistance, and back-up services. The alternatives are presently under consideration by USAID/Haiti.

S H O R T • T A K E S

Former NifTAL training participant, **Frank Kumaga,** has entered into a 6-month IRRI training program with Dr. I. Watanabe of the IRRI microbiology section. Kumaga will be conducting BNF research as well as conducting a collaborative experiment with NifTAL. This study will compare the inoculation response of promiscuous nodulating soybean lines developed in Zambia to North American cultivars. Background work for this experiment includes characterizing the native population of *Rhizobium* for both types of soybean.

While quantifiying N-fixation by acacias in Arid Australia, **Dr. J. Pate** found δN^{15} too low to use natural abundance so he is using acetylene reduction. Fixation was highest in youngest trees and decreased thereafter. But, same aged trees, if grown in greenhouses, fixed over longer periods of time—suggesting H_2O may limit fixation in the field.

1977 NifTAL Participant, **Mrs. Gayaga Ocampo,** of Manila, The Philippines, continues her research in soil microbiology specifically in the legume-*Rhizobium* symbiosis. Additionally, she serves as Quality Control Officer in the production of legume inoculants for the Bureau of Soils, Ministry of Agriculture.

Recent visitors at the NifTAL Project have been **Mrs. Yenchai Vasuvat** of the Department of Agriculture, Government of Thailand; **Dr. Loneragan,** Professor of Biology, School of Environmental and Life Sciences, Murdoch University, Australia; **Surjan Singh,** Program Specialist, Agriculture, Research & Institutional Development USAID-New Delhi, India; **Dr. S. C. Gupta,** Professor of Botany, University of Delhi, Delhi, India; and **Dr. David R. Mears,** Agricultural Research Advisor, USAID, New Delhi.

143

MIRCENS IN THE LIMELIGHT

Recently, the Microbiological Resource Centers have been in the news as U.S. funding to UNESCO has been drastically cut. Reactions from scientists have been swift and strong. For example, editorials and commentaries on the subject, appearing in SCIENCE and the ASM NEWS, have expressed concern with these funding cuts. We present here some comments on the subject.

The Microbiological Resource Centers (MIRCEN s) established in 1975 are carrying out highly cost-effective international programs. The MIRCEN s provide an infrastructure for a world network incorporating regional and interregional laboratories geared to the management, distribution and use of microbial gene pools. The MIRCEN network supports workshops, training courses, and research projects. The centers reinforce conservation of microorganisms, some emphasizing *Rhizobium* gene pools in developing countries with an agrarian base. The MIRCEN s have been active in fostering development of new technologies adapted to specific regions and have promoted the application of microbiology to strengthen world economies. They conduct programs throughout the world to investigate the economic usefulness of microorganisms to help meet both present and future agriculture, chemical, energy, food, health, and waste-management needs. But, despite a history of growing success, the U.S. support of MIRCENs previously provided through U.S. membership in UNESCO will be sharply reduced in the fiscal year 1987 budget.

Overall, the network provides a knowledge base in microbiology and biotechnology that is needed throughout the world in both developed and developing countries to support the new biotechnology industries. The MIRCEN s offer a working network beneficial to the United States by providing access to unusual and important genetic material of potential application in industrial processes and to developing countries in providing application of biotechnology appropriate to their needs, especially in enhancing their economy. The scope for the MIRCEN s includes soil fertility, rehabilitation of arid lands, bioconversion of waste, feed, fuel, and fodder, and production of microbial insecticides through biotechnology.

The amount of funding expected for the MIRCEN s from the U.S. fiscal year 1987 budget is only $20,000, to be awarded to the American Society for Microbiology for allocation to the MIRCEN s in accordance with an approved work plan. The funds available will assist with communication and research interaction among the centers. However, the allocation is small in comparison with the original budget submission of $175,000. Investment by the United States has already yielded significant return for this country by making available a source of genetic material for biotechnology applications. The MIRCEN s are a bargain: high productivity, low cost, and enormous potential. Here is where the United States may be penny-wise and pound-foolish in its foreign aid allocations. Excerpts from an editorial in SCIENCE by Rita R. Colwell, University of Maryland, College Park, MD USA.

From AMS NEWS:

An ASM forum by Stuart W. Glover, professor of genetics at the University of Newcastle, Newcastle upon Tyne, England, notes the important part that MIRCENs play in serving educational needs in microbiology in the developing world. He writes that if these needs can be fulfilled, the development of microbiology in these countries will be in good hands and microbiology's important role in contributing to health, agriculture, medicine, and industry will be assured.

The American Society of Microbiology has taken a strong stance urging Congress and the administation not to let international politics (i.e., disenchantment with the political character of UNESCO) interfere with valuable scientific programs such as the MIRCENs.

Rhizobium MIRCEN
Where they are:

NifTAL Project
P.O. Box O
Paia, Hawaii 96779 USA

Department of
Soil Sciences Botany
University of Nairobi
P.O. Box 30197
Nairobi, Kenya

Centre National de
Recherches
Agronomiques
D'Institut Senegalais de
Recherches Agricoles
BP 51
Bambey, Senegal

Nitrogen-Fixation and
Soybean Genetics
Laboratory
Building 011-A,
BARC-West
Beltsville, Maryland 20705
USA

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

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For information on the NifTAL Project and to request services, contact NifTAL Project Director, NifTAL Project, 1000 Holomua Rd., Paia, Hawaii 96779-6744. 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.

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Technical Editor: Chris van Kessel
Graphics: Richard Gabrielson

BIOLOGICAL NITROGEN FIXATION BULLETIN

Summer 1987 Volume VIII, Number 1

Re-Greening of Haiti: AID AOP's Attempt Through Tree Planting

Years of poor land use management, rising population, and increasing demand for agricultural and, in particular, wood products have resulted in serious environmental degradation in Haiti. In the forefront of efforts to reverse this trend is the USAID sponsored Agroforestry Outreach Project (AOP) whose initial phase ran from 1981 through 1986.

Recently refunded through 1990, AOP's goal is to reduce and ultimately reverse the ongoing degradation of Haiti's natural resources by motivating Haitian peasants to plant and maintain trees. In the course of accomplishing its primary goals, the project hopes to obtain reliable information on the technical, economic, and social variables of forestation in Haiti. AOP has adopted a unique strategy by supporting the idea of planting and harvesting trees as cash crops with near-term profitability. It thus appeals to the immediate self interest of cooperating small farmers. It also encourages tree planting by providing plant material, training, and support services to planters.

Harvesting one of the last few large Prosopis stands in the Northwest for charcoal.

Nitrogen-fixing leguminous trees, such as *Leucaena leucocephala, L. diversifolia, Samanea saman, Albizia lebbek, Gliricidia sepium, Calliandra calothyrsus,* and *Acacia auriculiformis* figure prominently in the AOP program. Because the tree seedlings experience severe environmental stresses upon outplanting—one of which is insufficient nitrogen in the poor soils of the outplanting sites—AOP Project nursery personnel routinely inoculate all susceptible seedlings with Rhizobium inoculant provided by NifTAL.

Reforesting hillsides dramatically reduces erosion and improves agricultural potential.

CARE, the Pan American Development Foundation, Operation Double Harvest, a coordination and technical support unit, and University of Maine and University of Florida research teams comprise the management and operational units of the Agroforestry Outreach Project. CARE and PADF work with small farmers in the Northwest and throughout the rest of the country, respectively. Operation Double Harvest works with large landowners helping them to improve the productivity of marginal lands through large scale tree plantings.

These organizations have established outreach programs designed to help the farmer manage all aspects of his own tree plantings, including making decisions on which species to plant, where and when to harvest, etc. Thus all benefits of trees planted accrue directly to the farmers. Although CARE operates its own seedling production and extension network, while PADF works primarily through local non-governmental organizations, both groups have established extensive regional nursery systems to service their outreach programs.

By any standards, AOP has been an unprecendented success. It developed, tested and proved that a tree planting extension methodology based on income-generation and self-interest can work. It has also stimulated over 200 local organizations to become involved in agroforestry activities in the course of which hundreds of persons have been trained in nursery installation, maintenance, extension, and in other areas related to tree planting and management.

Concrete accomplishments of the AOP include: the production and distribution of over 27 million fast-growing hardwood seedlings, the involvement of over 110,000 farmers in tree planting efforts demonstrating the economic potential of trees as a crop, the establishment of 39 regional nurseries with an annual production capacity approaching 15 million seedlings, the outplanting of 40% of project seedlings on hillsides where erosion control is desperately needed, and the establishment of over 60000 linear meters of Leucaena hedgerows set up in 500 small farmer-managed demonstration plots.

N-fixing Casuarina trees intercropped with vegetables yield wood products and enrich the soil via BNF.

If the project continues at its present pace several long term benefits are possible. Rural incomes and the incomes of those who transform wood products, e.g., charcoal makers, are likely to increase. Erosion may be reduced and environmental degradation reversed. If the physical and chemical properties of soils improve as a result of tree plantings, particularly on hillsides, overall agricultural production may rise. Lastly, if the present demand for AOP seedlings continues, wood from this one project will meet part of the domestic demand for wood products in Haiti.

- Joann P. Roskoski

145

Opportunities

Fellowships for African Researchers

The Project "African Agriculture: Crisis and Transformation," sponsored by the Joint Committee on African Studies of the American Council of Learned Societies and the Social Science Research Council, aims to establish a framework for interdisciplinary analysis of the agricultural crisis in Africa.

The project offers a program of fellowship activities which include analysis of biological processes which affect agricultural performance in Africa. The project has selected access, control, and use of resources as its focal theme during the fellowship program's first year, 1987-'88.

The typical fellowship award will provide up to $15,000 for support of activities during a period of 3-12 months. Fellowship support may be given for activities in three areas. The first area includes activities which will assist fellows in developing research project and proposals, including travel to libraries, literature searches, collection of bibliographic materials, visits to potential field sites, pilot studies, contacts with other researchers, and participation in workshops. The second area's activities, are those which will assist fellows in analyzing and writing up research results, including consultation with other researchers, participation in workshops to discuss preliminary findings, support for short periods of write-up, and participation in conferences to present and assess research results. Area three activities include those designed to provide specialized training needed to undertake particular kinds of research.

Individual African researchers and research teams comprised of African and non-African researchers in the following categories are eligible to apply: mid-career scholars based in universities or research institutes; individuals who have recently received graduate degrees; and professionals in government posts or other applied research settings. The second group of fellows will be selected in September 1987. For information about the program and application procedures, write to the Fellowship Program, Project on African Agriculture, Social Science Research Council, 605 Third Avenue, New York, NY 10158 USA.

International Training in Biotechnology

Developing country persons can be selected for training in biotechnology sponsored by Gesellschaft fur Biotechnologische Forschung mbH Braunschweig (GBF), Germany. GBF recognizes that the potential for applying biotechnology in developing countries was virtually limitless; but, that there is little activity in this area, partly because there is a profound shortage of individuals in these countries who possess the skills in advanced science and biotechnology needed to develop indigenous programs in industrial, medical, and agricultural biotechnology.

Participants are taught in courses lasting from one to two months which consist of providing both theoretical and "hands on" experience to the participants in order to enhance their ability to contribute directly toward the establishment of practical programs in biotechnology in their home countries and to provide local training for additional individuals.

Applicants may request an application form and additional information from any Embassy or Consulate of the Federal Republic of Germany or by writing directly to GBF at this address: Program Director, International Training Program in Biotechnology, Gesellschaft fur Biotechnologische Forschung, mbH (GBF) Mascheroder Weg 1, D-3300 Braunschweig, Federal Republic of Germany.

Being Compiled: Soybean and Mungbean Professional Directories

The AVRDC (Asian Vegetable Research and Development Center) is in the process of compiling data on professionals working on soybean and/or mungbean. The result of this compilation will be directories useful as a ready reference for communication and information exchange among researchers. Anyone interested in having his/her name appear in either directory can request a questionnare from Dr. S. Shanmugasundaram, The Asian Vegetable Research and Development Center, P. O. Box 42, Shanhua, 74199 Tainan, Taiwan, ROC.

Genetically Altered R. meliloti to be Field Tested

BioTechnical International's application to field test three strains of *Rhizobium meliloti* that have been genetically altered has been tentatively approved by the U. S. Environmental Protection Agency, reported Science in its 15 May issue. The organism, which the company has modified to improve its nitrogen fixing capability, would be tested on alfalfa at the company's research farm in Wisconsin if the final decision on the potential experiment is favorable.

A Novel "Leonard jar"

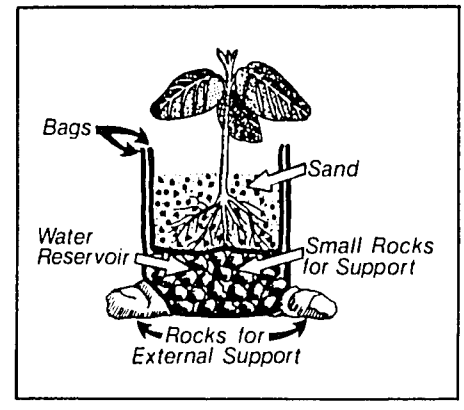
Dr. S.V. Hegde, Department of Agricultural Microbiology, University of Agricultural Sciences, Bangalore, India, has developed an intriguing variation of the standard Leonard jar.

The Leonard jar is used almost universally for testing *Rhizobium* strains under sterile conditions. It is a standard procedure, familiar to all *Rhizobium* workers, which was developed by Dr. Leonard, at the USDA Research Station at Beltsville, Maryland, in the early 1930s. It is generally constructed by cutting a bottle in half, and inserting the inverted top into the bottom. The top is filled with sterile growth media and the bottom serves as the reservoir for plant nutrient solution. A ready source of bottles is not always available, and anyone with experience cutting bottles knows that getting a good cut or break is an art not a science. Also, some glass tends to leave rough edges which can be a safety hazard.

Dr. Hegde's innovation consists of using plastic bags. The reservoir consists of a plastic bag filled with sterile rocks to give support. This simulates the bottom of the jar. The simulated top of the Leonard jar is a slightly smaller plastic bag filled with sterile sand to support the plant. To date, this has proven very satisfactory in service in Bangalore.

Dr. Hegde, was one of NifTAL's earliest trainees, having attended a training course in 1976. He has also visited NifTAL several times under the Indo-US Senior Scientific Panel for Joint Scientific cooperation. He is scheduled to return to NifTAL for several weeks in late 1987 as a visiting scientist.

- R. J. Davis



146

Ghanaian IAEA Fellow at NifTAL

Mr. Robert Abaidoo, a researcher and lecturer at the University of Science and Technology in Ghana, has been working as a visiting scientist at NifTAL since October 1986. His one year program has been sponsored by a fellowship from the International Atomic Energy Agency (IAEA) and funded by the National Academy of Sciences-National Research Council.

The main focus of Mr. Abaidoo's internship is the use of ^{15}N methods in quantifying nitrogen fixation in tropical legumes. In three greenhouse experiments with Dr. Chris van Kessel, he is evaluating the effect of phosphorus application on the atom % ^{15}N of reference crops not homologous to the fixing legume. And, in a field experiment with Drs. Paul Singleton and Ben Bohlool and NifTAL graduate student Thomas George, he is looking at the effect of nitrogen on nitrogen uptake, nodulation, and nitrogen fixation of soybean and bean.

In addition, Mr. Abaidoo is investigating with Dr. Padma Somasegaran the host-*Rhizobium* relationships and nitrogen fixation of bambarra groundnut *(Voandzeia subterranea)* an important pulse legume crop in Ghana. Mr. Abaidoo will present a poster on his work at the 11th North American Rhizobium Conference in Quebec this year.

Agreenhouse study on lima bean cultivars in potted soil with Dr. Somasegaran and Mr. Heinz Hoben will conclude his program in November 1987. This experiment will investigate the inoculation response of the lima bean *(Phaseolus lunatus)* in an Ultisol and competition of inoculant rhizobia in the presence of native populations.

Upon his return to Ghana, Mr. Abaidoo will continue his work as a University researcher and lecturer. He will also become one of the 19 collaborators in the Worldwide Rhizobial Ecology Network (WREN), a NifTAL-administered project partially funded by the National Science Foundation.

Correction

The Porto Alegre, Brazil, MIRCEN address was inadvertently omitted from the list of MIRCENs in the last issue of the BNF BULLETIN. The address is:

Centro de Recursos Microbiologicos en Rhizobium (MIRCEN)
Departamento de Solos
Faculdade de Agronomia da UFRGS
Caixa Postal 776
90.000 - Porto Alegre - RS - Brasil

MOPP —• BAPP

Late in 1986, U Mya Maung, former Director of the Maize and Oilseed Production Project (MOPP), Agriculture Corporation, Rangoon, Burma, visited NifTAL Headquarters. He reported on results of the MOPP project which is to be replaced by a similar project known as the Burma Agricultural Production Project (BAPP).

The Agriculture Corporation, Ministry of Agriculture and Forests, the Government of the Socialist Republic of the Union of Burma and USAID/Burma-funded Maize and Oilseed Production Project is soon to be completed. Goals of the project were 1) to increase the production of maize and oilseeds (peanut, sesame, and sunflower), 2) to reduce importation of cooking oil in order to save foreign exchange, 3) to transfer agricultural technologies to the farmers, and 4) to produce certified seeds by establishing four seed farms.

Before the beginning of the MOPP project, importation of cooking oils was more than 10,000 tons per year. At that time in-country oilseed production was quite low. For example, the maize yield per acre was only 20 baskets. This has now been increased in the project areas up to 55 baskets per acre. This increase in maize production is due mainly to inputs of fertilizer. Sesame production increased from an average national yield of 3 baskets per acre to 12 baskets. This increase was primarily due to irrigation and fertilization. Production doubled from 3 to 6 baskets using irrigation alone and from 6 to 12 baskets with the addition of fertilizers.

A new crop introduced to farmers during the project was sunflower. Project personnel were challenged with the task of introducing this new crop; however, farmers soon learned they could realize larger profits by growing sunflower than other crops since sunflower has no native insect pests and diseases. Sunflower areas are being increased as the MOPP project makes quality seeds available to more farmers each year.

The oilseed legume promoted by the project, peanut (groundnut), formerly yielded 25 baskets per acre. Now as much as 40 baskets per acre can be expected during the rainy season and for the dry season, winter crop, the average yield is about 45 baskets per acre. In the project area, as many as 65 baskets per acre have been harvested. This increase was due to application of *Rhizobium* inoculants and phosphate fertilizer. No urea fertizers were used in the project area.

For the non-legume crops, provision of nitrogen fertilizer was quite cost effective since low cost urea was available from government-subsidized production facilities. The abundance of

U Mya Maung, former director of MOPP.

natural gas makes nitrogen fertilizer production plants affordable.

To meet MOPP's outreach goal, farmers are taught the technologies of fertilizer applications, change of varieties, water management, pest management, row spacing, and *Rhizobium* inoculant applications. This outreach is done through extension workers trained and employed by the MOPP project. Training sessions which vary in length from a few days to more than a month are offered to both farmers and extension workers. These are practical courses which do not emphasize highly technical material.

Seed production has been begun by seed farms for four crops—these are divided into two foundation and two certified seed farms.

Key personnel on the project were U Khin Win (Managing Director); U Tin Hlaing (General Manager/Director of Extension and Education); U Sian Uk (Deputy Project Director); U Hla Than (Inoculant Producer); Dr. Charles A. Simkins (USAID/Agricultural Development Officer) and his staff; Dr. T.E. Bullard (Team Leader); Dr. Arlo Thompson (Sunflower Specialist); Mr. Ross Hagan (Water Management Specialist); and Dr. Frank Calhoun (Soil Scientist). U Sain Uk is implementing the transition from the MOPP to BAPP following the departure of U Mya Maung who has entered Ph.D. degree training at Ohio State University. And, Dr. Charles Simpkins has been replaced by Mr. Douglas R. Pickett.

"This project increases oilseeds so that we can produce more cooking oil and stop importation," says Maung. "The project has been successful since each year production has increased. For example, in fiscal year 1985-86, imports were reduced to 4,000 tons. It is possible that the project goal will be realized within the next two years. Since the project is going well, a second phase of the project would be appropriate."

147

Directions In Communication

Effective Posters

Official scientific communication at meetings and conferences is usually done using two methods—slide talks and posters. Although talks are often considered more prestigeous, posters are becoming the method of choice for many scientists. Posters promote in-depth one-on-one discussion between the author and interested persons, provide the ability to review material at leisure versus the limitations of a 10-minute talk, and allow for the use of a larger variety of materials and graphic techniques than slide talks.

As poster sessions continue to become more popular at scientific gatherings, potential poster presenters should familiarize themselves with some basics. Examples of questions a poster author should ask him/herself include: How large should the text and headings be and how large is the display space available for my poster? What information should I include? Are there specifics I should consider when creating graphs and tables? How can creative graphics enhance my poster?

Fortunately for persons presenting posters, meeting organizers usually include specific instructions on display space, allowable methods for attaching posters—i.e., tacks or tape, and other special instructions designed to standardize posters within a session. Some instructions also include allowable sizes for text and headings. A general rule for text lettering is that the poster should be readable from a distance of 1-2 meters. Thus, lettering should be at least 5 mm (¼ inch) high.

Generally speaking, the same information included in a paper or talk should be included in a poster, i.e., Summary, Introduction, Methods, Results, Discussion, and Conclusions. Posters should be clear and self-explanatory, but extensive details should be reserved for personal discussion. Text should be in short, concise, legible statements which can be easily read by the audience. A clear, simple message is the most effective for persons reading or studying your poster while you are away. If you have details that seem essential to be included, a presenter can prepare a short, detailed handout or leave a supply of business cards with the poster.

When showing results, the same rules for simplicity apply to tables and charts. The most useful and communicative table or chart does not have the largest possible amount of material, but points out especially interesting or relevant findings. Using color in charts is very effective; this also has the benefit of attracting attention.

Creative graphics are one of the most effective ways of making a poster more eye-catching and communicative. Arrows, photographs, headings, and a careful arrangement of materials will help the poster viewer follow the flow of information and better understand the work done on the particular experiment. Type styles are diverse and nearly any style can be used on a poster. When considering size of type, the 1-2 meter rule virtually eliminates the use of standard typewritten text. Machine made typeset text is the most professional looking, however, some large type typewriters, enlarged typewritten text, and computer plotters make attractive textural material.

The goal of either an attractive, informative poster or a talk is to communicate a scientist's research findings. As authors become more "poster-literate," they will become better able to meet the challenges of this innovative communication technique.

NEW PUBLICATIONS

NifTAL Final Report/Report 1986

The NifTAL Project, University of Hawaii, has recently entered into a new Cooperative Agreement (CA) with USAID. The final report for the first contract period (1975-1986) has been published in combination with annual report 1986. This publication is available to interested persons. Request a copy from the NifTAL Information Section.

Symbiotic N-Fixation Technology

A new release from Marcel Dekker, Inc., this book offers step-by-step guidance in the latest techniques. Edited by Gerald Elkan, chapters are written by highly reputed specialists in the field of N-fixation. For Information on obtaining copies, write Marcel Dekker, Inc., 270 Madison Avenue, New York, NY 10016 USA.

Mycorrhiza Book Available

Fifty copies are available of University of Hawaii Research Bulletin 194, **Research for Tropical Agriculture by Barbara Mosse.** This 1981 publication is a review, state-of-the-art report on Vesicular-Arbuscular Mycorrhiza from 1930-1978. Request a copy from the NifTAL Information Section.

"Pages of Contents"

CIAT's Communication and Information Support Unit is offering this monthly publication which gathers into six specialized packages the titles of recent articles published in major agricultural journals. Subject areas covered by the service are General Agriculture; Plant Physiology; Plant Protection; Soils and Plant Nutrition; Pastures, Animal Production and Nutrition, and Agricultural Economics and Rural Development. For the subscription price of this useful service, write to: CIAT, Communications and Information Support Unit, Library Services/Subscriptions, A.A. 6713, Cali, Colombia.

Enough Food

This book is published by Rodale Institute. It outlines the conceptual framework for the potential role regenerative—low input, sustainable—farming systems have in improving agricultural productivity and self-reliance in the Third World. Originally printed in English, printings in French and Spanish will be available by 1 September 1987. A short booklet will also be available at that time which focuses on six case studies of successful projects using regerative agriculture. The cost of Enough Food is $5 which includes surface postage; for airmail, add $1. The cost of the follow-up booklet has yet to be determined. Order from Rodale International, Attn: Robert Wagner, 222 Main Street, Emmaus, PA 18049.

shortakes

J.A. Scaglia, FAO, reports that he is working in Rwanda on the extension of inoculant use for legumes and Azolla in paddyfields. He was formerly in Bhutan where he set up a small-scale inoculant production lab. This lab is now under the direction of Mr. **Tsewang Dorji.**

The government of Karnataka State, India, has recently given the Microbiology Department, University of Agricultural Sciences, Bangalore, half a million rupees to develop an inoculant produc-

Continued on page 6

148

Meeting Notes

Rhizobium Discovery Centennial

The 7th International Congress on N_2-fixation will be held in Cologne from 13-20 March 1988. Besides covering all aspects of the legume-*Rhizobium* symbiosis, the meeting will begin with a review of the discovery, and history of *Rhizobium* during the past 100 years. Persons interested in attending the meeting should contact Professor H. Bothe, University of Koln, Botanisches Institut, Lehrstuhl, Gyrhofstrabe 15, D-5000 Koln 41 (Lindenthal), West Germany.

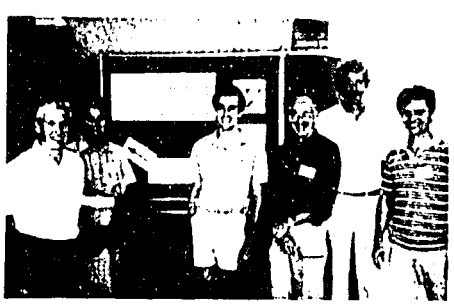
10th Trifolium Conference

This conference held biannually is the only national meeting where clovers are the focal point. Dates for the meeting are 24-25 March 1988. For information on this meeting contact Gerald W. Evers, Secretary-Treasurer, Tenth *Trifolium* Conference, Texas Agricultural Experiment Station, Texas A&M University, P.O. Box 728, Angleton, TX 77515 USA.

Australian Society for N-Fixation Met

One hundred and fourty registrants attended the 8th Australian Nitrogen Fixation Conference in Adelaide, Australia, at Waite Agricultural Research Institute from 1-5 December 1986. The meeting was organized to mark the retirement of Professor D.J.D. Nicholas, well known scientist in the area of Nitrogen metabolism. It was also the first meeting of the Australian Society for Nitrogen Fixation, which provided a broader forum than earlier Australian Legume Nodulation conferences.

Copies of the Proceedings may be obtained from the Australian Institute of Agricultural Science, 191 Royal Parade, Parkville, Victoria 3052, Australia ($15 Aust. post-free).



The conference organizing committee pictured here from left to right are Bill Wallace (organizer), Sally Smith (Secretary), Paul Reddell, Jim Silsbury, Peter Gibson, and Wojtek Michalski. Absent are Angus Alston (Treasurer) and Trish Rosbrook.

4th International Symposium on Molecular Genetics of Plant-Microbe Interactions

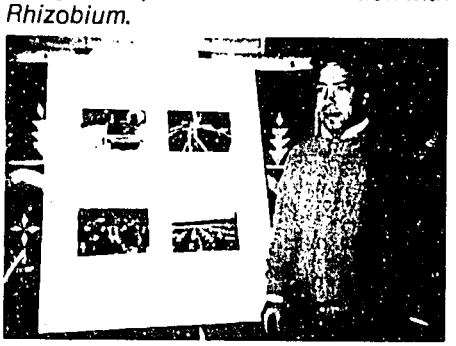
The first announcement is out for this Symposium which will be held in Acapulco, Mexico, from 15-20 May 1988. Previous meetings in this series have been held every two years since 1982 in Bielefeld, Ithaca, and Montreal. The main goals of the meeting will be to give a quick overview of the field, to review unpublished results, and to stimulate discussion on the new avenues that research can take in the future.

Most of the research work will be presented as posters. Oral sessions will include presentations by some invited speakers as well as by some poster authors that will be selected in situ by the corresponding chairpersons. Scientific organizer of the meeting is Rafael Palacios.

For more information on this meeting write to: Viajes Kuoni de Mexico, S.A. de C.V., Hamburgo No. 66 - 2nd Floor, Col. Juarez, 06600 Mexico, D.F. Mexico.

Soybean Technology Workshop

Dr. Ali Hilali, a BNF scientist at the Hassan II Institute in Rabat, Morocco, participated in the Soybean Technology Workshop at the Regional Farm Fair held in Agadir, Morocco, during November, 1986. He displayed a poster outlining the importance of inoculation with *Rhizobium*.



Dr. Hilali who received his Ph.D. in soil microbiology from the University of Minnesota spent several weeks in 1986 at NifTAL as a visiting scientist. While in residence, he conducted joint experiments with NifTAL scientists and learned advanced techniques for small and largescale inoculant production.

Mungbean Symposium Scheduled

The Second International Symposium on Mungbean will be held 16-21 November 1987 in Bangkok, Thailand. Sponsors are AVRDC, Thailand Department of Agriculture, Kasetsart University, and AVRDC-Thailand Regional Outreach Program. Objectives of the symposium are to review the latest advances in mungbean research, to understand the economics of mungbean production and to determine the production constraints and to identify potential areas of future research and cooperation. For information, contact S. Shanmugasundaram, Chairman, Program Committee, The Second International Mungbean Symposium, AVRDC, P.O. Box 42, Shanhua, Tainan 74199, Taiwan, ROC.

Rhizobium Topic of Italian Conference

Pictured here are many key international BNF workers who were among the participants at the Workshop held at Amalfi, Italy, from 7-11 April 1987. Molecular biology of the *Rhizobium*-legume symbiosis was the subject of the meeting. Specific discussion topics were genetics and physiology of free-living *Rhizobium*, host/*Rhizobium* recognition, structure and function of *nod A B C D*, and other *nod* and *nif* genes, bacteriods, nodulins, and host genetics. The meeting was organized by J. Beringer, R. Defez, M. Iaccarino, and M. Nuti.

4th International Symposium on N-Fixation with Non-Legumes

A variety of scientific and development organizations will sponsor this meeting to be held in Rio de Janiero, Brazil, 23-28 August, 1987. The symposium will focus on recent advances in the interaction of N-fixing microorganisms with non-leguminous plants. For this meeting, the organizing committee plans to give special emphasis to comparisons of the infection processes and mechanisms of various systems. The legume/*Rhizobium* symbiosis will be included as an example. For more information contact Dr. I. Fendrik, Institut fur Biophysik, Universitat Hannover, Herrenhauserstr. 2, D-3000 Hannover 21, Fed Rep. of Germany.

149

COMMERCIAL CORNER

Seed Treatments

Industry, universities, extension services and advisors must continue to inform farmers that *Rhizobium* inoculants provide the symbiotic nitrogen fixing bacteria which act as a biological nitrogen fertilizer with legumes. When we speak to growers about "seed treatments," we think about *Rhizobium* inoculants, but frequently they are referring to fungicides or other chemicals. A grower market research study concerning *Rhizobium* inoculants summarized the knowledge level of the average U.S. farmer as low. Misconceptions are common. Inoculants are often confused with fungicides or fertilizers. The word "Rhizobia" was even confused with "Rhizoctonia."

"Seed treatment" is too broad a phrase referring to many products used for very different reasons. "Inoculant" (a product which introduces a microorganism) is likewise too general. This term may suffice currently, but several microbial processes are being researched and developed, and may soon become agronomic practices. The following is a list of current or potential products which may be applied to seeds. Which one are you referring to when you speak of "seed treatment?"

A word to the wise: Don't ask a grower if he treated his seed. Be specific.

R. Stewart Smith
Nitragin Company

Fertilizers

Biotic:	Abiotic:	Combination:
Nitrogen fixing · Symbiotic Legume Inoculant · Rhizobium Inoculant Non-Legume · Associative · Mycorrhizal	Molybdenum	Pelleting – *Rhizobium* Inoculant + nutrients + Lime, etc.

Pesticides (Abiotic or Biotic)

· Fungicides	· Nematocides	· Insecticides
· Bactericides	· Herbicides	

(Shorts) Continued from page 4
tion facility. This is being directed by the Head of the Microbiology Department, Dr. **P.V. Rai.** The building to house this facility is now nearing completion on the grounds of the University adjacent to the Microbiology Department.

(Course) Continued from page 8
port of the practical exercises was given in 24 lectures. This course focused on commercial inoculant production. As in the previous course, the fermentors used were stainless steel units built in Thailand from a design developed at NifTAL's Maui Headquarters.

(Fermenter) Continued from page 8
down the temperature of the culture medium upon sterilization. Heat for sterilizing the culture medium is by bottom heating with a 980 BTU gas burner.

A modified version of the fermenter (built locally in Thailand) is based on the specifications of the prototype unit and was built at NifTAL's Biological Nitrogen Fixation Resource Center (BNFRC) at the Rhizobium Building, Department of Agriculture, Bangkhen, Thailand. This modified version is equipped with a coil which is not only used for cooling but which can also be used for steam heating during the sterilization cycle.

The simplicity of operation and acceptability of the fermenter design for small and medium scale inoculant production was clearly demonstrated during three training courses on *Rhizobium* inoculant production technology held at NifTAL Headquarters in Hawaii and BNFRC, Thailand.

More information on inoculant production fermenter units can be obtained by writing to Drs. Padma Somasegaran (NifTAL Project, 1000 Holomua Avenue, Paia, Maui, HI 96779 USA) and Nantakorn Boonkerd (BNFRC, Department of Microbiology, Rhizobium Building, Bangkhen, Bangkok 9, Thailand).

Legumes in the Kitchen

The ultimate application of BNF technology is using legumes as a food source for humans. Legumes provide a high source of protein for improving dietary nutrition while serving as a key ingredient in many low cost, delicious meals.

How better to provide an opportunity for discovering these culinary delights than offering you recipes with legumes as the main ingredient. All measurement conversions are approximate.

Middle Eastern Garbanzo Bean Dip

1 can (450 ml or 15-16 ounces) garbanzo beans or 115 grams (¼ pound) dry garbanzo beans, cooked
45 ml (3 tablespoons) fresh lemon juice
30 grams (2 tablespoons) finely chopped onion
2 large cloves garlic, finely chopped
⅛ litre (½ cup) olive oil
30 grams (2 tablespoons) dairy sour cream
Salt and freshly ground pepper (to taste)
30 ml (2 tablespoons) olive oil
30-40 grams (2 to 3 tablespoons) snipped fresh parsley

Puree beans, lemon juice, onion, and garlic in blender, food processer, or through food press. If using an electric blender or food processer, while machine is running, slowly pour in olive oil; process 10 seconds. If by hand, mix olive oil well into bean mixture. Stir in sour cream and season to taste with salt and pepper. Refrigerate covered 4 hours or overnight. To serve, pour bean mixture into a shallow serving bowl; make a well in center. Pour 30 ml (2 tablespoons) olive oil into well. Sprinkle with parsley. Serve at room temperature with warm pita bread or raw vegetables.

The BNF BULLETIN welcomes contributions of recipes from our readers. Bon apetit...

Dr. Jacob Schiffman In Memoriam

BNF Workers will be saddened to hear of the passing of Dr. Schiffman. In 1952, he founded the Division of Legume Inoculation at the Volcani Institute, Bet Dagan, Israel, which he headed until his retirement in 1973. He was the first scientist in Israel to isolate and select symbiotically effective rhizobial strains and, using local materials, develop the technology of inoculant production now used in Israel.

One of his significant contributions was the development of inoculant and an inoculation technique used by Israeli peanut farmers. This technology is the liquid injection inoculation method of spraying inoculant suspended in water into the planting furrows at the time of sowing. A special bacterial suspension applicator was developed for this purpose.

Dr. Schiffmann was regarded by his colleagues as having an encyclopedic knowledge and a rare courtesy. He is survived by his wife and three children. (Submitted by B. Kishnevsky, R. Lobel, and D. Gurfel)

150

N-FIXING TREE NOTES

Deeply rooted multi-use trees such as acacia, prosopis, carob, and others are promising as nitrogen sources for the soil because they are drought resistant and produce food, fodder, and fuel, as well as fixing nitrogen. Eventually, an integrated approach to dry land soil fertility maintenance may be developed using nitrogen fixing trees.

Research in the southern California, USA, desert near the Salton Sea by members of the Dry Lands Research Institute, San Diego State University, UCLA, and Washington University, St. Louis, has provided the first look at the deep soil interactions between rhizobia and prosopis.

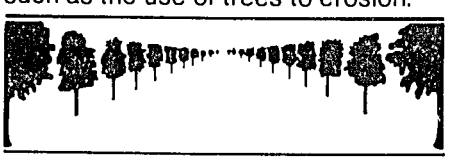
Although prosopis is capable of fixing nitrogen, excavation of the surface root system and soil chemical analysis showed that little or no nitrogen is fixed by the surface roots. Few nitrogen-fixing root nodules have been recovered from the surface soil; and none occur where the surface soil is high in salts and inorganic nitrogen. Yet, measurements of the nitrogen isotope abundance in plant tissue have shown that the rhizobial symbiosis provides about 70% of the annual uptake of nitrogen by prosopis.

Population density of prosopis-nodulating rhizobia was considerably higher at depths of 5-6 meters than in surface soils. The numbers of rhizobia at this depth were comparable to the numbers in surface agricultural soils supporting herbaceous legume crops.

This study showed that symbiotic organisms can function far below the surface and that more attention should be paid to the ecology of the deep soil. This is particularly important for the dry lands. This work was reported in Drylander, v1n1, 1987.

Sarah Workman, a U.S. Peace Corps volunteer, served for over 3 years in Ouagadedougou, and Po, Burkina Faso. She was placed there as a forestry volunteer in connection with the Village Forestry Program—a continuing program of the Ministry of Environment. An international team of funding agencies promoted the Program as a fight against desertification and promotion of the implementation and use of improved models of wood stoves and of more efficient wood use.

Ms. Workman's job was to manage a tree nursery of several different species, both exotic and local species—many of which were leguminous. Of the exotics, prosopis was well received, and four acacia species became more widely planted. Some fruit trees such as mangoes and cashews were well planted and taken care of by farmers because they had the potential of becoming cash crops. According to Workman, regional nursery problems such as transport of seedlings during the rainy season led to development of village nurseries which were in the charge of extension agents. Positive results of efforts she observed were visible regrowth in arid areas and improved soil techniques such as the use of trees to erosion.



Alley cropping using hedgerows of nitrogen fixing trees (NFT) can be beneficial in cycling nitrogen to companion food crops concludes K. Mulongoy in an article in IITA Research Briefs, December 1986. He reported on work being done to assess the benefit of organic matter decomposition and nutrient transfers from NFT green manures to crops.

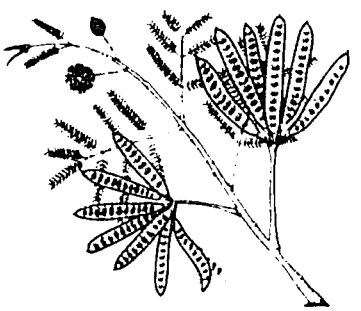
He noted that pruning is one of the most important management factors affecting BNF NFT symbiosis of NFTs. Pruning limits the supply of photosynthates to the nodules, particularly when hedgerows are pruned too low. N-fixation is affected and nodule decay and sloughing-off are induced, resulting in nutrient (essentially N) release from decomposing roots and nodules and shedding of rhizobia into the rhizosphere.

If NFTs are to be of maximum benefit in these systems, release and mineralization of their nutrients must be related to the requirements of the companion food crop. It is possible that experimental data will predict the best time for pruning and the minimum amount of pruning and the minimum number of hedgerow trees from which the necessary prunings for economic yield increases can be obtained.

More information is needed to determine the amount of N from prunings transferred to the food crop. Research must be done with reference to the following:

- the rate of decompositon and release of nutrients from prunings of alley shrubs
- the rate of mineralization of these nutrients and their profile in the soil
- the amount of nutrients tied up in the soil biomass and organic matter
- the proportion of N prone to leaching and volatilization in a given ecosystem
- the actual transfer of nutrients to the food crop and the benefits expressed in terms of N economy

Improved management methods can make better use of the decomposition process which is closely linked to mineralization and immobilization of nutrients. Further data on N cycling will undoubtedly contribute to improved management of alley cropping systems through optimizing N utilization and developing a system that will be economically superior to the prevailing methods of shifting cultivation.



The benefits of NFTs are spreading to all manner of development worker with even missionary groups describing Leucaena as a "miracle tree."

Dr. Foster B. Cady, Research and Development Director of the F/FRED Project is presently circulating a form designed to obtain information on multipurpose tree species (MPTS) specialists. This very specific form will gather information for F/FRED's Specialist Database which is expected to ensure efficient information exchange within the F/FRED research network. Persons wishing to be added to the Specialist Database should complete the questionnaire. Address inquiries to Dr. Foster B. Cady, Research and Development Director F/FRED Project University of Hawaii, P.O. Box 186, Paia, HI 96779 USA.

Rhizobium Technology Course

Ten *Rhizobium* scientists from nine ASEAN countries received training in Rhizobium technology in a course held during March 1987. The Course which emphasized inoculant production was conducted at the Rhizobium Building of the Thai Department of Agriculture (DOA) in Bangkhen, Bangkok, Thailand.

Organized and hosted by DOA and NifTAL's Biological Nitrogen Fixation Resource Center (BNFRC), the course was sponsored by the Food and Agricultural Organization (FAO) of the United Nations. Mrs. Yenchai Vasuvat and Dr. Nantakorn Boonkerd were the local organizers of the course. Instructors were BNFRC Director Dr. Boonkerd, and NifTAL Microbiologist Dr. Padma Somasegaran and Training Coordinator Heinz J. Hoben.

Scientists selected for participation in this course were: Mrs. Shahida Nasreen and Dr. Abdul Hamid (Pakistan); Mr. Jusuf Soepriaman (Indonesia); Mrs. P.R. Samaradeewa (Sri Lanka); Mrs. Fe S. Torres (Philippines); Mr. Li Xin (People's Republic of China); Dr. Kang Jun Cho (Korea); Mrs. Delowara Kanam (Bangladesh); Dr. V.N.P. Gupta (Nepal), and Mr. Nguyen Hai Nam (Viet Nam).

This four-week intensive course was similar in content to an inoculant production course taught a year earlier in Thailand. The course provided "hands on" experience in 18 exercises in general *Rhizobium* microbiology, strain identification techniques, field and greenhouse experiements, and inoculant production. Theoretical knowledge in sup-

Continued on page 6

Dissemination Update

Included with this issue of the BNF BULLETIN is a mailing list update. It includes a copy of your mailing label. Please make any necessary changes, complete the card, and mail to the NifTAL Communication Section. PERSONS NOT RETURNING THE UPDATE CARD WILL BE DELETED FROM THE BNF BULLETIN MAILING LIST. Please give us your correct mailing address and therefore allow us to serve you better.

NifTAL Fermenter Design is Adaptable

NifTAL-designed inoculant fermenter units are in operation at diverse locations. Currently, these fermenter units are being used for production in Thailand, Indonesia, Bangladesh, and Nigeria. NifTAL's original prototype fermenter was built because of the need to produce quality inoculants.

Inoculants for legumes are produced by blending broth cultures of *Rhizobium* with sterile carrier material such as peat. A major consideration in inoculant production is the mass culturing of *Rhizobium* which is an important factor determining the scale of inoculant production. Mass culturing requires suitable fermenters; these vessels must be simple enough to allow for easy sterilization, access to inoculation and sampling, aeration, and cleaning. To insure durability, strength, and resistance to chemical action, stainless steel is the optimal fabrication material.

Using commerically available portable stainless steel pressure vessels, scientists at NifTAL successfully designed and evaluated an autoclave-cum-fermenter for mass culture production of *Rhizobium*. This vessel serves a dual purpose: initially, it serves as an autoclave when the culture medium is sterilized in it; upon cooling and inoculation, it does double duty as a fermenter.

The capacity of NifTAL's fermenter is 140 litres. A built-in cooling coil for circulation of cool water is used to bring

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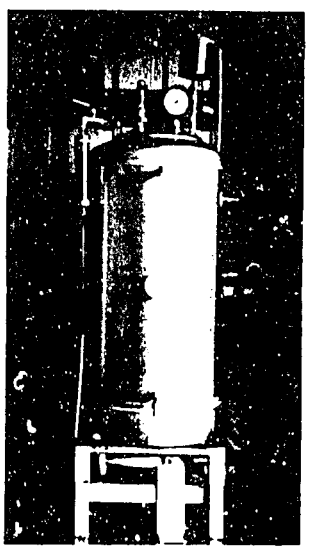

NifTAL PROVIDED SERVICES

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 1
Summer 1987

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For information on the NifTAL Project and to request services, contact NifTAL Project Director, NifTAL Project, 1000 Holomua Rd., Paia, Hawaii 96779-6744. 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.

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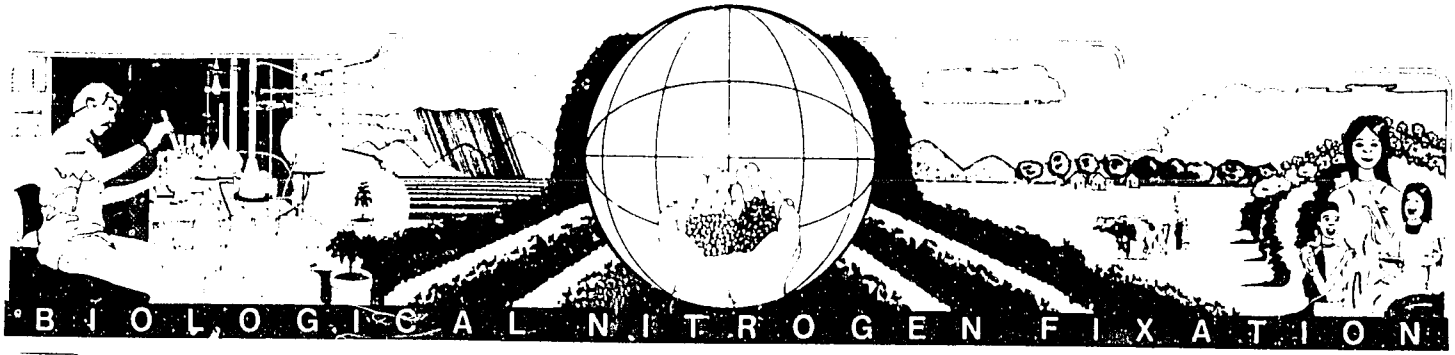
Technical Editor: Dr. B. Ben Bohlool
Graphics: Richard Gabrielson

152



BNF BULLETIN

Spring 1988

Volume VIII, Number 2

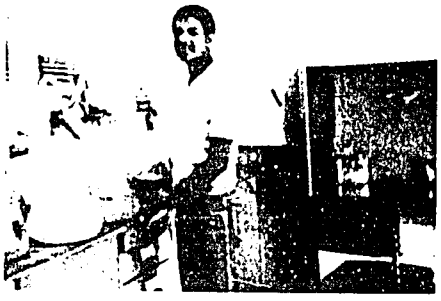
Demand for Inoculants Increasing in Zambia

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

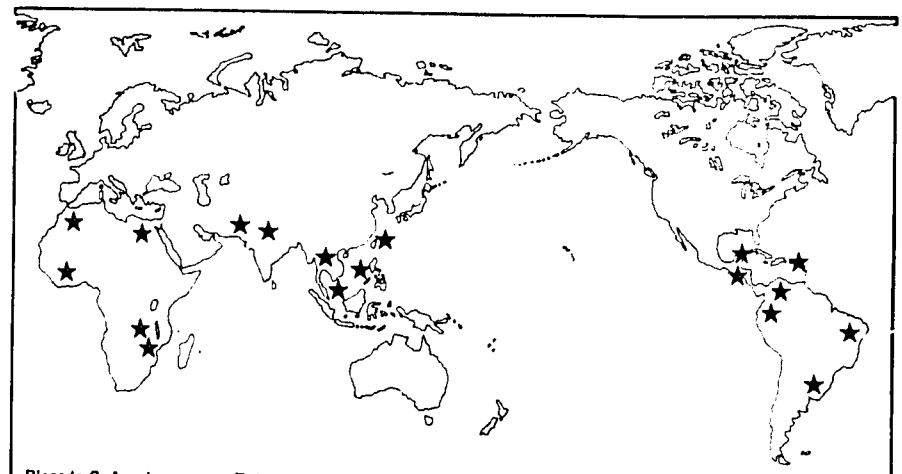
WREN: Worldwide Rhizobial Ecology Network

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.

B[illegible] researchers continued to ask w[illegible] any legume species show highly v[illegible]ble 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.



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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

154

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

155

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 (AA3NF) 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.

156

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

157

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.

158

N-FIXING TREE NOTES

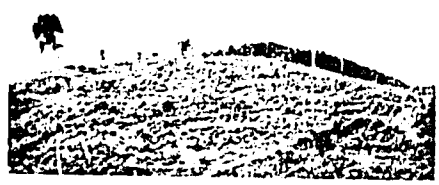
The Centro Agronomico Tropical de Investigacion y Ensenanza (CATIE) and the Nitrogen Fixing Tree Association (NFTA) cooperated on a workshop which was held at CATIE, Turrialba, Costa Rica, 21-27 June. Workshop objectives were to: encourage communication among researchers working with *Gliricidia sepium*; 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.

154

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.

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

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.

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 scientists 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

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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.

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160

BIOLOGICAL NITROGEN FIXATION

BNF BULLETIN

Spring/Summer 1989

Volume IX, Number 1

NifTAL, PVO, and Peace Corps Join Forces

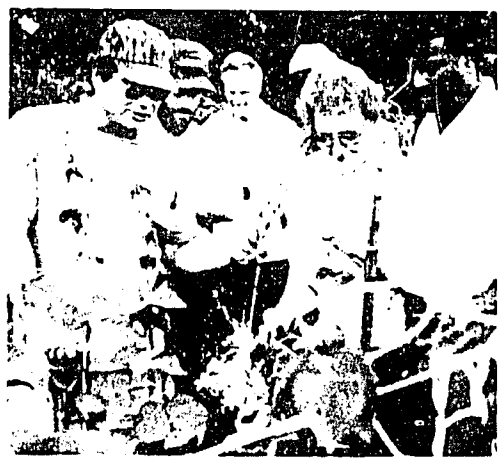
Forging the Missing Link in BNF Technology Delivery

NifTAL took another significant step by launching a training program for private voluntary organizations (PVO) and Peace Corps (PC) workers to give them the basic knowledge necessary to get BNF technology to developing country farmers.

Cooperating in the first planning workshop were USAID's Office of Agriculture, Bureau for Science and Technology and Office of Private and Voluntary Cooperation, Bureau for Food for Peace and Voluntary Assistance. The second workshop, a two week training course on BNF Technology Transfer, was held in late 1988 for fifteen participants who shared their unique expertise in this interactive workshop.

PVO and Peace Corps participation in BNF technology transfer will provide the missing link for NifTAL toward meeting its goal of helping small farmers in developing countries produce more protein rich food and fuelwood. Combining state-of-the-art research knowledge and grassroots technology transfer techniques will result in a dynamic outreach effort.

Designed especially for PVO and Peace Corps, this training workshop followed the BNF process from theoretical information through microbiological, laboratory, and field techniques to inoculant production and, finally, to potential application of the technology in the farmer's field. Participants gained knowledge through lectures, practicums, demonstrations, field trips, and discussion groups.



A field stop to examine healthy bean plants. From left, Paul Woomer (NifTAL), John Preissing, Lloyd Frederick (AID), Suzanne Rucker, and Ghandi Selvanathan.

Future Directions

By the end of the workshop a consensus was reached that some aspects of BNF technology are presently ready for use by the small holder farmer in developing countries. To effect use of the technology, the participants proposed that a consortium be formed between several PVO's and NifTAL.

The consortium's purpose would be to implement BNF assessment, training, and inoculant use in developing countries. NifTAL's strength in rhizobial germplasm, research, and technology development and transfer complements PVO strength in training, extension, and credit systems that exist at the farmer level in many countries.

This collaborative effort would take advantage of these strengths to enhance BNF in small farmer cropping systems. Such improvements have the potential of leading to greater farm income, crop yield, and protein content of legume crops.

Specific activities envisioned by the PVO-NifTAL consortium would supplement existing programs led by PVOs in targeted countries. Since the greatest benefits from BNF are a result of inoculating legumes that are introduced into a new area or where existing soil populations of rhizobia are low, projects with these characteristics would receive priority.

continued on page 2

Remko Vonk and Julia Morris discuss the growth pouch technique.

continued from page 1

Assessments would be made of potential benefits from improved BNF, training courses given to PVO trainers on inoculant use, BNF improvement techniques, and descriptive literature (i.e., manuals and guides) produced in local languages. Additionally, inoculant production capabilities would be assessed, followed by development of a suitable system.

An outline of the formal structure and funding of the consortium was ironed out at a follow-up meeting held in Washington, D.C., between eight PVO and Peace Corps persons and NifTAL representatives. The goal of this collaboration is to contribute to a better quality of life for small holder farmers in developing countries. A further goal is providing a model of how cooperation between research and assistance organizations can expedite the goals of international agricultural development.

"We're excited about this new experience," said Dr. Lloyd Frederick formerly of USAID Science and Technology's Office of Agriculture and NifTAL's Program Officer, "and the new opportunity to get the PVOs to take the technology that has been developed and improved and transfer it to their agriculture and agroforestry projects in the developing countries."

About the Participants

Joseph Wilmer Alix, Project Manager, Haiti, Save The Children

Omar Jadallah, Project Manager, Jordan, Catholic Relief Service

Scott Josiah, Nursery Specialist, Haiti, Pan American Development Foundation

John Michael Kramer, Director, Agriculture and Natural Resources, CARE

Julia Morris Associate Peace Corps Director, Mali, Peace Corps

Nathan Pagasura, Associate Regional Peace Corps Director, Region 8, Philippines, Peace Corps

John Preissing, Project Manager, Catholic Relief Services, Peru

Tanay Rema, Field Manager, World Vision Relief and Development Inc, Bangladesh

Suzanne Rucker, Director of Information, Agricultural Cooperative Development International

Gandhi Selvanathan, Agricultural Training Specialist, Opportunities Industrialization Center International, Inc.

Henry Taylor-Cline, Program Advisor, Togo, Opportunities Industrialization Centers International, Inc.

Hilberto Ugalde, Associate Peace Corps Director, Costa Rica, Peace Corps

Remko Vonk, Assistant Director, Agriculture and Natural Resources, CARE

Robert Wilson, Rural Development Specialist, Africare

James Worstell, Technical Advisor, Save the Children

Spreading the Word in the Philippines

Nathan Pagusara, Associate Peace Corps Director, Region VIII, has begun spreading the word on BNF to his fellow Peace Corps workers in the Philippines. In addition to writing and distributing a report about the BNF workshop he attended at NifTAL Headquarters, he designed a survey to gather information on legumes grown and on inoculant use in his area. He will use the accumulated data to determine the need for BNF training and rhizobial inoculant production.

Introducing BNF in Comoros

Remko Vonk, recently appointed Director of the Agriculture and Natural Resources unit for CARE, shared inoculum and training on nitrogen fixation with his extension staff and government counterparts in the Comoros Islands. He expects this training to increase the demand for the inoculum. Vonk was a participant in the BNF Course for PVO and Peace Corps.

Comorians learning BNF! Photo by R. Vonk

WREN Collaborators Meet

NifTAL staff presented a workshop on ecological models for predicting the fate and performance of introduced rhizobia in the environment. The workshop held on July 29, 1989, at the University of Iowa, Ames, was featured as a session of the National Academy of Sciences' BOSTID-PSTC BNF Networking meeting. This meeting preceeded the 12th Annual North American Symbiotic Nitrogen Fixation Conference held from July 30 to August 3.

Data to construct ecological models have been contributed by both NifTAL researchers on Maui and by collaborators participating in the Worldwide Rhizobial Ecology Network (WREN). These collaborators have been conducting standardized experiments at more than 30 tropical sites in 17 countries. Results from WREN are being used to model the ecological factors that determine the survival and symbiotic performance of rhizobia in tropical soils.

Ben Bohlool, Thomas George, and Paul Singleton, NifTAL staff scientists, addressed the rationale for WREN, the role of soil N in the model, and the potential application of the research. NifTAL graduate students Janice Thies and Paul Woomer presented models and demonstrated interactive computer programs which they have developed to predict rhizobial survival and symbiotic perfo mance. These models are expected to assist researchers and extension agents to anticipate where and to what extent inoculation of legumes will result in a positive yield response.

162

The 16 WREN international participants who attended the modelling workshop also gathered informally throughout the course of the Symbiotic N-Fixation Conference. Their meetings were distinguished by the generation of many innovative ideas for future collaborative research.

WREN collaborators in attendance were Robert Abaidoo (Ghana), Gustavo Bernal (Equador), Nantakorn Boonkerd (Thailand), Consuelo Estevez (Equador), S. V. Hegde (India), Ali Hilali (Morocco), Kauser Malik (Pakistan), Hassan Moawad (Egypt), Michael Nyika (Zimbabwe), Erlinda Paterno (Philippines), Carlos Ramirez (Costa Rica), Juan Carlos Rosas (Honduras), Eduardo Schroder (Puerto Rico), Mercedes Umali-Garcia (Philippines), Precha Wadisirisuk (Thailand), and Fauzia Yusuf (Pakistan).

POINT OF VIEW

NifTAL's USAID Project Officer Retires

Dr. Lloyd R. Frederick, NifTAL's Project Officer since 1978, retired at the end of April, 1989. He was an active participant in NifTAL activities. He now plans to spend more time farming and to "pitch-hit" in AID activities or universities where he might be needed. The following excerpt is from a letter he wrote to a long time colleague. It offers us food for thought.

"It seems to me that the pendulum of public favor has swung away from biological nitrogen fixation. The incongruous situation is that sustainable (or low input) agriculture is now being touted without the realization that the kingpin is biological nitrogen fixation. Perhaps it would be better to say that BNF is taken for granted.

If we plant legumes, we'll get BNF without any care or consideration!! The failures are excused as plants not adapted, and the terrible cost of failure is rarely mentioned. I mean the cost of precious seed, or nursery stock with all its costs, or the cost of expensive crops not performing at their best.

Oh well, the fight still needs to be fought and I plan to remain in the fight, but from more of a "ringside" seat. However, I believe and am thankful that we do have the tools to feed the people of the world and to provide rapid transportation [to transport food and technology]."

Joint Workshop of Indo-U.S. Science and Technology Initiative

The Third Joint Workshop of Indo-U.S. Science and Technology Initiative (STI), and the Senior Scientific Panel (SSP) Program in Agriculture was held in Bangalore, India in 1988.

The Joint Workshop highlighted 1) the initial objective and relevance of Indo-U.S. scientific cooperation; 2) its progress during the first three years; 3) rationale resulting in updating the Davis Workshop; 4) the progress since then; 5) appraisal of the future technical scope up to 1991; and 6) the topics jointly recommended at the High Level Panel Meetings.

The workshop included the agricultural topics of: 1) the efficient use of nitrogen fertilizers; 2) molecular biology of BNF; 3) Azolla and Blue-green Algae; and 4) Biological Nitrogen Fixation Rhizobia systems.

The workshop was attended by 30 American and 42 Indian scientists involved in the STI Program.

Submitted by S.V. Hegde, Bangalore, India.

Photo courtesy S. V. Hegde

BNF Scientists at the STI workshop. Seated (from left); Drs. J. K. Malcolm, R. K. Bhatnagar, and L. R. Frederick. Standing (from left); Drs. Y. D. Gaur, S. V. Hegde, D. L. Keister, A. W. Sen, K. S. Jauhri, B. B. Bohlool, and P. W. Singleton.

163

Application of BNF Technology in Rwanda

For many years, national institutions in Rwanda have been collaborating with the Food and Agriculture Organization (FAO) in the promotion of increased food crop production. In this land-locked country, where areas planted to legumes occupy nearly one-third of the agricultural land, the increase of yields due to enhanced biological nitrogen fixation (BNF) represents economically significant improvements.

After several years of research conducted at the Institut des Sciences Agronomiques du Rwanda (ISAR), the results were applied to extend the country's soybean production. With the assistance of FAO, a small pilot plant was set up in one of ISAR's research stations for the production of inoculants.

Production consists of multiplying rhizobia in small fermentors (50 litres), developed by the French Institut de Recherches Agronomiques Tropicales (IRAT). The culture is injected into steam-sterilized peat packed in autoclavable plastic bags. The quality of inoculants is continuously controlled for their rhizobia content, which should not be lower than 1 billion rhizobia per gram.

Inoculation is performed using the seed coating method. Yield increases of soybeans, obtained with inoculation, vary from 20 to 100 percent. However, techniques of inoculation are not known to most people involved in agricultural development, including the farmers. Apart from production, great efforts were made to ensure efficient use of the inoculants.

Several publications, for extension workers and farmers, were prepared jointly by ISAR and FAO. The slides are used for the training of users and potential users of the "black powder," as the inoculants are called by farmers. Within the framework of these information and training activities, the Fertilizer Program of FAO assists in conducting confirmation trials on farm and field demonstrations. These efforts have resulted in increased use of inoculants. In the six years since the start of production in 1982, the use of inoculants has grown to 18,000 bags of 40 grams each.

Crops other than soybeans can also benefit from inoculation. More recent work on peas, also grown in the highlands of Rwanda, has shown this plant to be responsive to inoculation when improved strains, provided by researchers from Denmark, were tested. Consequently, a program for developing the inoculation of this crop is under way. The program also includes Leucaena and alfalfa.

Unfortunately, these techniques cannot yet be applied with *Phaseolus vulgaris*, common beans, which are the major grain legume crop of Rwanda. Response to inoculation is very erratic and dependant on many factors. Researchers and extension workers, because of promising results at the experimental stage, are optimistic

NEW PUBLICATIONS

BNF Resource Persons

The *Directory of BNF Resource Persons in Developing Countries* is a general directory of contact people who have been trained at a NifTAL training course, who are collaborators in NifTAL research projects, or who have listed themselves on a recent survey as being involved in BNF work.

Refer to NifDoc #010289 in ordering this directory from: NifTAL Project, University of Hawaii, 1000 Holomua Avenue, Paia, Maui, HI 96779 USA.

Agricultural Tools Guide

Prepared by the Intermediate Technology Development Group (ITDG), the *Tools for Agriculture: a buyer's guide to appropriate equipment,* is intended to assist the prospective buyer in a rational choice of equipment. The guide presents a range of available equipment and manufacturers throughout the world.

The guide for tools covers a broad range of equipment from tools used in seed-bed preparation to wood gathering. First published in 1967, this third edition was published in 1985 by Intermediate Technology Publications Ltd., 9 King Street, London WC2 8HW, UK.

Forging the Missing Link: Applying Science & Technolgogy to Development

This 18-minute videotape was produced by NifTAL in conjunction with the NifTAL PVO/Peace Corps Training Course. It is of use to development workers who are interested in explaining the value of BNF in agricultural development. Private Voluntary Organization and Peace Corps workers are featured expressing their thoughts about and plans for applying BNF technology in their work.

VCR or Beta tape copies are available from the NifTAL Project for $10 per copy plus postage.

BNF Slide Set

Inoculate Legumes and Increase Yields is a slide set and printed explanation of the process of biological nitrogen fixation in legumes. Produced by the Food and Agriculture Organization (FAO) of the United Nations, the set is aimed at field technicians, extension agents, cooperative managers, and group organizers.

The slide set and printed commentary are available for $10.00 and may be ordered from: Distribution and Sales Section, Food and Agriculture Organization of the United Nations, Via delle Terme di Caracalla, 00100 Rome, Italy.

The 14th International Congress of Soil Science

The 14th International Congress of Soil Science is scheduled for August 12-18, 1990 in Kyoto, Japan. The motto of the International Conference is, "Improving Soil Management for Man and the Environment."

The conference organizing committee has planned 45 symposia, covering a variety of subjects closely connected to the motto. No oral presentations will be held, but interested participants are encouraged to submit a paper for consideration.

A variety of study tours are being offered both before and following the conference, including several tours throughout Japan and China, and a tour from Moscow to Siberia.

Correspondence should be addressed to: Secretariat of 14th ICSS, 6-26-10-202 Hongo, Bunkyo-Ku, Tokyo 113, Japan, Telephone: 03-815-6720 FAX: 03-815-6018.

for the possibility of providing farmers, in the future, with the benefit of higher yields of beans through the application of BNF. The combined use of fertilizers, improved varieties, and inoculation, might be required for success. This is a difficult task for research and application, but common beans are the staple food of the population and cover more than 260,000 ha.

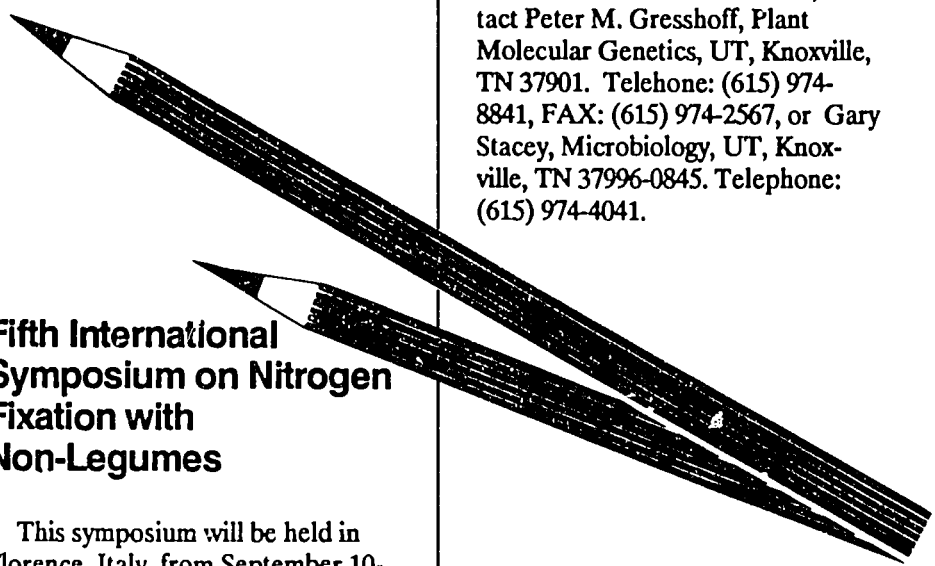
Submitted by: H. Braun, Chief, Fertilizer and Plant Nutrition Service, FAO, Rome, Italy.

The Fourth Conference of the AABNF

The fourth Conference of the African Association for Biological Nitrogen Fixation (AABNF) will be held September 25-29, 1990, at the International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria.

The conference, organized by IITA, is titled, "Biological Nitrogen Fixation and Sustainability of Tropical Agriculture."

For additional information, contact Dr. K. Mulongoy at; IITA, Oyo Road, PMB5320, Ibadan, Nigeria; or IITA, c/o L.W. Lamboum & Co., Carolyn House, 26 Dingwall Road, Croydon CR 9 3EE, England.



Fifth International Symposium on Nitrogen Fixation with Non-Legumes

This symposium will be held in Florence, Italy, from September 10-14, 1990. The meeting's primary focus will be to promote information exchange on the most recent advances in basic and applied aspects of BNF with non-legumes. The four main topics will be: free-livng diazotrophs, root-associated diazotrophs, nitrogen-fixing photosynthetic microorganisms, and diazotrophic actinomycetes.

The symposium will be organized as a series of plenary sessions, oral presentations, and a poster session. For registration information, contact the Organizing Secretariat; Studio EGA; Via dei Brunelleschi, 2; 50100 FIRENZE - Italy.

Eighth International Congress of Nitrogen Fixation 1990

An integrative conference, allowing cross-disciplinary sessions summarizing the developments in the area of nitrogen fixation over the last two years, will be held in Knoxville, Tennessee from May 20-26, 1990.

The conference, to be held at the University of Tennessee, will focus on the relevance and application of future research on nitrogen fixation.

For additional information, contact Peter M. Gresshoff, Plant Molecular Genetics, UT, Knoxville, TN 37901. Telehone: (615) 974-8841, FAX: (615) 974-2567, or Gary Stacey, Microbiology, UT, Knoxville, TN 37996-0845. Telephone: (615) 974-4041.

2nd International Food Legume Research Conference

The first announcement for this conference has been issued. The venue is Cairo, Egypt, and it is scheduled for April 28 to May 2, 1991. Interested persons may request information from Dr. A. E. Slinkard, IFLRC-II, Crop Development Centre, University of Saskatchewan, Sask. S7N 0W0, Canada; Phone (306) 966-4978; Fax (306) 343-1025.

Lessons from a Legume's Release

When it comes to agricultural development in the less developed world, the following principle is almost axiomatic: What may work in Norway and Nebraska may not in Niger. By assuming that technology transfer is just a matter of moving it from one place to another, many of the best-laid plans have gone awry, leaving abandoned agricultural machinery rusting, monuments to mistakes.

The existence of a superior technology does not guarantee its use. Often, better technology may be available; an improved cultivar, better seed, or a new method or machine, but the situation remains unchanged – the better cultivar is not planted, the new method does not replace the traditional method, and the machine, after a short usage, becomes a relic. Why?

There are several stages in the process of adopting new technology. In the case of a new cultivar, it may be necessary to nurture it beyond the release phase. Although the release process and the adoption process overlap, they are distinct. This truth was born out during the release of a pasture legume for the Colombian Llanos – the first legume ever for the region.

The main barrier to adoption was the lack of a tradition of growing legumes in pastures; this lack of experience constituted one of the obstacles to the release of the new cultivar (*Stylosanthes capitata*). The release process was accomplished in phases over several years, beginning with contacting commercial pasture-seed enterprises and offering them basic seed.

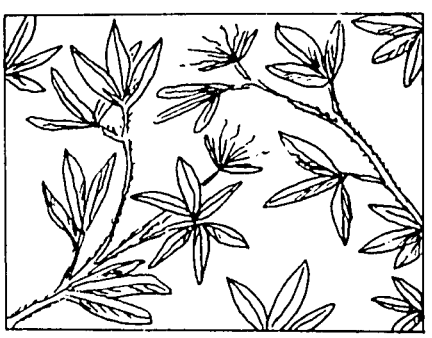
This was followed the next year with a second lot of seed and leaflets characterizing the legume. Later that same year, ranchers, seed companies, and the general public were invited to a field day drawing attention to the legumes qualities and potential.

However, scant harvests of commercial seed allowed only a small amount of seed to reach the market during the first three years. With a project so novel and without the benefit of technical and commercial promotion, the situation became a vicious circle: the lack of demand created a lack of seed supply which, in turn, reduced demand.

In the third to sixth year after initiation of the process, the trend toward use of the legume strengthened. More seed was made available, on-farm pasture demonstrations were expanded, and an aggressive campaign, built around field days, was set in motion.

Lessons learned which will benefit all persons interested in introducing beneficial legume crops are: 1) promotion in the form of field days and demonstrations are critically important; 2) make sufficient seed available from the very beginning of the release time and planting season and; 3) assure the availability of appropriate rhizobia for inoculation. Heeding the lessons from this example will help make the process of releasing new legumes a successful process like this one.

Ed. Note: This article is excerpt from CIAT International, December 1987, Vol. 6, No. 2).



Joe Burton - Memorial Notes

H. Braun, Chief, Fertilizer and Plant Nutrition Service, FAO, made the following comments about Joe Burton: "His participation in the joint FAO/UNEP advisory meeting held in Rome in 1980 allowed us to benefit from his complete knowledge of inoculant production and utilization. During his participation with FAO, while authoring *Legume Inoculants and Their Use*, we had the opportunity to very much appreciate his dedication to the dissemination of science and his wish to share his extensive experience with all those engaged in development assistance."

David Hubbell, Professor, Soil Science Department, University of Florida, wrote the following tribute: "I began my graduate studies in microbiology at North Carolina State University in 1960, under the supervision of Dr. Gerald Elkan. My thesis research was to be Rhizobia-related since Dr. Elkan had received grant funds to support his work on that problem.

My proposed comparative study on the physiology of Rhizobium strains required the use of several authenticated *Rhizobium* strains of documented nodulating ability. In response to my query regarding possible sources of the needed strains, Dr. Elkan replied 'Write Joe Burton.' When I indicated ignorance of the reason for his choice he was incredulous. How could anyone interested in *Rhizobium* not know of Joe Burton and his work?

I was very new to the game (obviously) and Dr. Elkan patiently told me the story on Joe. I was impressed with the depth and sincerity of his praise.

I wrote for the needed strains and received them soon therafter, complete with pedigrees and much useful comment and advice. Thus began a 27-year association during which I received a constant stream of assistance from Joe in the form of cultures, samples of standard and specialized inoculants for research, and much information, advice, etc.

I began to suspect that he had already forgotten more on the subject than I was likely to learn in a lifetime. I could write a large volume on happy recollections of my association with Joe, but so could anyone who knew him. I will relate one anecdote which has remained fresh in my mind for many years.

The occasion was a meeting of some 20 scientists and government officials in Washington, D.C. We had convened to 'brain-storm' the present and future status of research on biological nitrogen fixation. We were very heterogeneous in terms of background, position, etc., and this necessitated an initial round of self-introductions.

166

The introductions were becoming rather lengthy—until Joe's turn came. He rose to his feet somewhat reluctantly, cleared his throat slightly with embarrassment, and with no trace of pretension said, "I'm Joe Burton and I work with *Rhizobium*." Even that brief comment was not necessary. The reputation of Joe Burton, as a person and as a scientist, had long since preceeded him. Those who enjoyed the privilege of knowing Joe Burton can fill in the lines."

Editor's Note: The above were responses to a previous story announcing Joe Burton's death. We will continue to publish recollections of friends and colleagues of Dr. Burton as long as we receive them.

NifTAL Staff News

- **Harold Keyser**

Joining the NifTAL staff in late 1988 was Harold Keyser. Keyser, a well known scientist in rhizobial work, was formerly employed by the U.S. Department of Agriculture in Beltsville, Maryland.

His research at NifTAL will emphasize nitrogen fixation by fast-growing tree legumes. He will also be heavily involved in outreach activities for transfer of BNF technologies to developing countries.

Thomas George receives his award from Duane Bartholomew in Honolulu.

- **Thomas George**

Thomas George, NifTAL graduate student who received the Potash and Phosphate Institute's J. Fielding Reed Fellowship award for outstanding graduate research, completed his Ph.D. in agronomy and soil science in late 1988 from the University of Hawaii. He is presently working as a postdoctorate agronomist at the NifTAL Project.

SHORT TAKES

Malik Earns National Award

Kauser Malik, collaborator in WREN (Worldwide Rhizobial Ecology Network), received a National Award recently when the President of Pakistan presented the Award of Distinction to Malik in recognition of his research work in soil microbiology.

Malik has been with the Nuclear Institute for Agriculture and Biology in Faisalabad since 1971 and has published widely on the topic of reclaiming salt-affected soils. Besides his WREN connection, Malik has been a BOSTID grantee since 1983, initially working on "Associative Nitrogen Fixation in Grasses." His current project is "Biological Nitrogen Fixation in Plants Growing in a Saline Environment."

The Caribbean Rhizobium Group

Founded at the first Caribbean Conference on Biological Nitrogen Fixation (BNF) in 1984, the Caribbean *Rhizobium* Group (CRG) offers a network of information and resources to all BNF researchers.

Those interested in joining the CRG and receiving the newsletter free of charge may contact Dr. Eduardo C. Schroder, Coordinator, Dept. of Agronomy and Soils, College of Agricultural Sciences, University of Puerto Rico, Mayaguez Campus, Mayaguez, Puerto Rico 00709-5000.

Research Work in Giza, Egypt

Drs. Samir M. Abdel-Wahab and Mohamed E. Hassan report from Egypt that their work in BNF research, especially that related to *Rhizobium*-legume symbiosis, includes two large labs for research and production of rhizobial inoculants.

The produced inoculant will supply an area of 300,000 acres cultivated to different leguminous crops, and approximately 98% of the area cultivated to soybean is inoculated annually.

NifTAL Trainees Continue Work at Home

Ms. Chandini Mudannayake, microbiologist at the Central Agricultural Research Institute, near Kandy, Sri Lanka, looks on as Mr. R. G. A. S. Rajapakse, microbiologist at the Maha Illuppallama (MI) experiment Station, Sri Lanka, sets up a Leonard jar experiment designed to determine the cause of anomalous nodulation phenomenon noted in the MI area.

The two microbiologists, both NifTAL trainees, were engaged in discussions on strengthening coordination of the microbiological programs at the two Sri Lanka Department of Agriculture research units.

Ms. Mudannayake and her husband Ponnaampalan Thirukkurmaran, also a former NifTAL trainee, have since gone to the University of Alberta, Alberta, Canada, to pursue Ph. D. studies.

Soil Organic Matter Dynamics Experts Gather to Write a Book

In late 1988, NifTAL hosted a workshop which brought together a special group of scientists for an unusual purpose. The primary task of the event was to produce a book on soil organic matter (SOM) dynamics.

Meeting participants worked under the general agreement that organic matter can play an important function in alleviating nutrient and stress problems in soils. But, very little is known about the specific biological processes involved in transformation of soil organic matter (SOM) and organic matter inputs into ecosystems.

This is particularly true of tropical soils dominated by variable-charge clays and subjected to heavy rainfall over a long period of time. It is well known that highly leached tropical soils have high levels of acidity and toxic metals and low amounts of available nitrogen, phosphorus and the bases.

This landmark SOM book will be the result of a process that began with a questionnaire distributed in July of 1986 and ended in a workshop in October 1988. From responses we received to these questionnaires about tropical SOM sent to over 200 scientists, seven topics were selected as major themes for this workshop and the chapters of the book.

Teams of experts were commissioned to write a "position paper" on each of the seven themes. Authors were asked to be deliberately controversial and provocative. Each "position paper" was then submitted for evaluation to a separate panel of experts from such diverse fields as ecology, chemistry, physics, soil science and agriculture.

During the week-long workshop the authors and the reviewers gathered together to defend their positions, reconcile differences, and produce "consensus papers" that have become the book's seven chapters. The book also identifies gaps in knowledge, prescribes corrective measures, and formulates research priorities related to ecological interactions that regulate organic matter dynamics in tropical ecosystems. *Dynamics of SOM in Tropical Ecosystems* will be available from University of Hawaii Press in fall 1989 for $30.00.

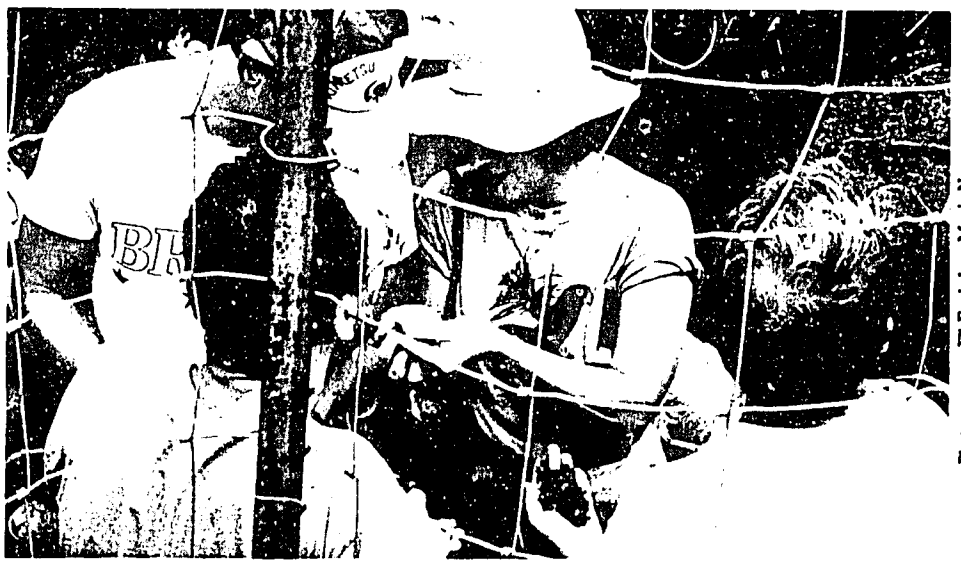


Photo courtesy Jill Engledow, Maui News

SOM Workshop participants inside a soil pit at a high elevation site on Maui.

NifTAL Course Set for November 1989

A new course entitled "Modern Methods for the Study of *Rhizobium*" is scheduled from November 1-28 at the BNF Resource Center in Bangkok, Thailand. The purpose of the course is to provide training in rhizobia culture, strain identification, genetics of rhizobia, and inoculant production and field application.

Course sponsors are: Biological Nitrogen Fixation Resource Center, for South and Southeast Asia, Thailand Department of Agriculture, NifTAL (Nitrogen Fixation by Tropical Agricultural Legumes) Project and Mircen, and the University of Hawaii's Biotechnology Program.

SERVICES FROM NifTAL

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 scientists 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

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., Pala, 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 inviduals acting on its behalf.

Editor: Princess Ferguson
Technical Editor: Dr. B. Ben Bohlool
Graphics: Anna Gillies

168

BIOLOGICAL NITROGEN FIXATION

BNF BULLETIN

Winter/Spring 1990 Volume IX, Number 2

Inoculant Production Capability in Haiti

Muriel Bouchareau and Harold Keyser.

Inoculant Specialist Joe Rourke prepares a shipment of essential materials to be sent to Haiti.

Muriel Bouchareau working in her commercial lab in Port-au-Prince.

In cooperation with the Agroforestry Outreach Project (AID-Haiti), the NifTAL Project is working with a private medical laboratory, Medicom, to establish the capability to produce rhizobial inoculum for tree legumes in Haiti. The inoculum will be purchased by CARE, PADF, and Operation Double Harvest nurseries in Haiti, whose production levels are approaching 10 million trees per year. There is also the potential to expand inoculum production to grain legumes, since a marked response to inoculum application has been demonstrated on peanuts.

In July, Harold Keyser of NifTAL visited Haiti to conduct the initial assessment of Medicom facilities and capability. From this intial assessment, planning was done for equipment procurement and training. In September, Ms. Muriel Bouchareau, the microbiologist owner of Medicom, spent two weeks getting a crash course in inoculant production.

The final step was to send Joe Rourke, a NifTAL inoculant production specialist, to Port-au-Prince for installation and assembly of specialized equipment and to provide on-site training. The first batches of inoculant were produced in late November and the future looks bright for in-country availability of rhizobial inoculant and their subsequent use in the reforestation of Haiti.

Indonesian BNF Assessment

Paul Singleton recently conducted an assessment of BNF technology in Indonesia for the Government of Indonesia, USAID, and the Secondary Food Crops Development/Communication for Technology Transfer in Agriculture Projects. The assessment developed a projection of the expected benefit to farmers from inoculating their crops. In this context, constraints to delivery of the technology were evaluated. It was found that the potential supply of high quality inoculant was in excess of demand and that institutional capability to conduct research is adequate.

The relatively small use of inoculant by farmers was associated with the lack of understanding of the use and economic benefits of this technology by extension personnel and farmers. To address this weak link to further implementation of BNF technology in Indonesia, NifTAL proposed conducting a BNF Technology Training Course for Indonesian extension workers who are active in farmer training. The course will be held in Thailand in conjunction with NifTAL's BNF Resource Center (Bangkok). This proposal is under consideration by the Communication for Technology, Transfer in Agriculture/Secondary Food Crops Development Products (AID- Indonesia and the Government of Indonesia).

Early Announcement of NifTAL Training Course

NifTAL is planning to hold a course, "Modern Methods for the Study of Rhizobium." The course is tentatively scheduled to be held in June, 1991, in Bangkok, Thailand.

For information, write:

Training Coordinator, NifTAL Project, 1000 Holomua Avenue, Paia, Maui, HI 96779 USA.

Moawad Awarded Prize for BNF Work

Dr. Hasan Moawad, a grantee of the BOSTID Research program, received the 1988 State of Egypt prize in agriculture and biology for his contribution in the field of BNF. This prize is given every year to seven scientists whose works have contributed to agricultural development in Egypt. Nominations and application to the prize are open to researchers of all disciplines of agriculture and biology from all universities and research institutions of Egypt.

Hassan Moawad has also been presented the Award of Distinction for the National Research Centre of Egypt in recognition of his research work in soil microbiology. Moawad was an IDRC research fellow in Dr. E. L. Schmidt's laboratory in the Soil Science Department, University of Minnesota, in 1979-80. In 1980-81, he was also a research fellow in Dr. Ben Bohlool's laboratory in the Department of Microbiology, University of Hawaii.

He has been with the National Research Center of Egypt in Cairo since 1967 and has published widely on nitrogen transformations. He translated into Arabic four books in biology, biochemistry, and microbiology. Moawad, a BOSTID grantee since 1984, has been working in competitive relationships between indigenous and inoculant rhizobia nodulating soybean and lentil.

Performing MPN by Computer

The design of most probable number (MPN) experiments is restricted by the availability and completeness of tables for a particular dilution ratio and replicate number combination.

A newly-written computer program, The Most Probable Number Enumeration System (MPNES), generates solutions for the population estimate of MPN data for inoculation of legume hosts by rhizobia.

Tables generated by MPNES agree with existing tables, yet MPNES is able to generate other tables and discrete solutions for design combinations that have not been published.

MPNES can also be used to generate population estimates from fractional base dilution ratios that increase the accuracy of MPN estimates by decreasing the base dilution ratio, by increasing the number of replicates per dilution, or by correcting for constantly inaccurate diluent volumes.

The MPNES program also adjusts for inoculation volume and initial dilution ratios. In this way, MPN experiments can be designed to better measure the organism of interest rather than have the design dictated by existing published tables.

This computer program was developed by NifTAL graduate student Paul Woomer to meet the continuing need to generate MPN data.

By way of background, the algorithm was initially written in IBM Basic and was compiled with Micro-soft Basic Compiler. The program will run on IBM-Compatible micro-computers with one floppy disk. Memory requirements are small (less than 256K RAM).

Other formats may be accommodated on a case-by-case basis. MPNES programs are available from NifTAL at U.S. $20.

For information on ordering, contact Information Section, NifTAL Project, 1000 Holomua Ave., Paia, HI 96779-9744.

DIRECTIONS IN COMMUNICATION

What's New in Today's Information Environment

Moving research findings from the laboratory and experimental plot to the farmer's field is part of a researcher's job. It's important that researchers take an active interest in communicating new findings as the old information environment rapidly changes.

People in both developed and developing countries are now faced with increasing volumes of data. This growth of information is not linear, but exponential. Farmers must sort out extraneous data to find the messages that are relevant to their own farming operation. Extension and research can select agricultural messages and reinterpret them for specific clients.

Today, these messages are being delivered by many more information sources than in the past. Industry, universities, technical schools, and other interests bombard farmers with competitive and contradictory messages that are not site specific. Researchers and extension personnel can translate general data into specific recommendations and options for local use.

Much information is from non-local sources. In the old days, most farm information came from sources known to the farmer. Today, farmers are exposed to a large number of non-local sources including federal government organizations and regional, state, county, and district groups. Natural resource interests, environmental groups, health interests, as well as consumer groups, all give advice and consultation to the farmer, as do international groups and trading partners.

Changes in the information environment are combining to involve agricultural researchers in the dissemiuation of information. In conjunction with extension agencies, researchers must take responsibility for selecting, designing and interpreting messages.

The generation of knowledge suggests it be shared. Sharing is a communication activity and through communication, researchers have the opportunity to extend their knowledge to farmers in manageable, credible, and timely ways.

James King
University of Nebraska

NEW PUBLICATIONS

Gliricida Topic of 2 Books

Released from NFTA is the **Gliricidia Production and Use Field Manual.** It is a practical manual for extension specialist and rural development workers in Third World countries throughout the tropics. Guidelines and experiences from around the world are presented on the uses and management of this species. The 44-page manual consists of nine chapters, selected readings, a list of researchers working with *gliricidia*, and seed sources. The nine chapters are well illustrated with pictures and drawings. The cost is $US 5 to NFTA associates and $6 to non-associates, add $4 for air mail service; there are also bulk order rates. Send orders to NFTA, P. O. Box 680, Waimanalo, HI 96795 USA.

Also available from NFTA is Gliricidia Sepium (Jacq.) Walp: Management and Improvement the Proceedings of a Workshop, June 21-27, 1987, Turrialba, Costa Rica. This 225-page report presented the most recent research on gliricidia with an extensive bibliography. Recommended research priorities brought forth during the workshop are included along with a summary on the state-of-the-art knowledge on this species. Copies are $US 8 for NFTA associates and $10 for non-associates, add $6 for air mail service.

Tropical SOM Book Released

Dynamics of Soil Organic Matter in Tropical Ecosystems, state-of- the-art on this topic, has been released by University of Hawaii Press. It is the result of a unique interactive process which brought together approximately fifty expert authors and reviewers. The project was funded by National Science Foundation Ecology Program with support from USAID and NifTAL and IBSNAT at the University of Hawaii, in collaboration with the University of Georgia, Institute of Ecology. Editors are David C. Coleman, J. Malcolm Oades, and Goro Uehara. Copies of the 300-page book are available for $30 plus $2 for shipping and handling from UH Press, Order Department, 2840 Kolowalu Street, Honolulu, HI 96822 USA. Developing country persons may be eligible for a significant discount of 50%. Persons who believe they are in this category should order directly from the NifTAL Information Section.

11th Trifolium Conference

This conference, held every two years, provides a forum for clover and special purpose legume researchers to exchange information and discuss common problems and goals. The venue is Silver Falls Conference Center, Sublimity, OR, July 9-11 1990. The program includes paper and poster sessions, a work session on seed production, tour of seed research and production in the Willamette Valley, and an overview of forage legume research in Oregon.

For information and to receive the second announcement contact Dr. Jeffery J. Steiner, USDA-ARS, National Forage Seed Production Center, Oregon State University, Corvallis, OR 97330 USA, telephone 503 757-4375.

2nd International Food Legume Research Conference

This meeting which will be held from April 28 to May 2, 1991, will focus on Pea, lentil, faba bean, chickpea, and grass pea. The latter was recently added to the list of species covered in the meeting. Objectives of the gathering are review and assess recent results from national and international research programs on cool season food legumes and to develop strategies for increasing production per unit area and increasing use of these cool season food legumes in various cropping systems. Both basic and applied research will be addressed and multidisciplinary research efforts emphasized.

To be included in the mailing list for the second announcement, send your name and title, address, phone and/or fax number, and mail to Dr. A. E. Slinkard, IFLRC-II, Crop Development Centre, University of Saskatchewan, Saskatoon, Saskatoon S7N OWO CANADA, telephone (306) 966-4978, telefax (306) 343-1025.

Nepal Biotechnology Association Hosts Meeting

The role of genetic engineering and biotechnology in agriculture and health will be the subject of the International Conference on Genetic Engineering and Biotechnology planned for September 9-13, 1990, in Kathmandu, Nepal. The first circular notes: "For a country like Nepal whose economy depends primarily upon agriculture and forest products, application of biotechnology is the only means for development." The meeting objective is to create awareness about genetic engineering and technology and provide Nepalese scientists the opportunity to interact with scientists working in various areas of technology.

Those interested in attending the meeting, being speakers, or presenting posters should contact the Secretary General, ICGEB Conference Organizing Committee, Nepal Biotechnology Association, P. O. Box 2128, Kathmandu, Nepal; telephone: 977-1-522-900, telex: 2492 MURARKA NP, cable: RLABB, Kathmandu.

Meeting Set for '91

Co-chairman Chris van Kessel announces that plans are set for the 13th North American Rhizobium Conference (now referred to as Symbiotic Nitrogen Fixation meeting). It will be held in Banff, Canada, from August 25-30, 1991. Expect further details and meeting announcements by mid-1990.

Biotechnology Course Offered

From 3 September to 17 October 1990 GBF (Gesellschaft fur Biotechnologische Forschung mbH Braunschweig) will hold its fourth course, "Introduction to Industrial Biotechnology." The course is designed for individuals from developing countries with a strong scientific background, especially in general microbiology and biochemistry, but who lack practical experience in biotechnological processes, such as fermentation technology. Emphasis will be given to selecting applicants from a wide geographic distribution. Fluency in English, including speaking, writing and understanding, is absolute necessary. There are no course fees, but applications are encouraged to seek funding for travel and subsistence costs. No candidate should be discouraged from applying on financial grounds. To receive an application, write to International Training Programme Office, GBF, Mascheroder Weg 1, D-3300 Braunschweig, Federal Republic of Germany; telephone: (0531) 61 81 - 172; telex: 9 526 67 gebio d; telefax (0513) 61 81 515.

In Memorium: Joe Burton

Yes: I knew Dr. Burton since July 1960 when I joined the Lab of Late Prof. D. N. Allen for my M.Sc. and Ph.D. studies which lasted five years. Now and then I had a meeting with Dr. Burton for discussion of my results and consultation for future work.

In 1970, I visited Dr. Burton in his laboratory in Nitragin Company when I was awarded the Andre Mayer FAO fellowship. I had the pleasure to meet Dr. Burton in different meetings in various parts of the world. In 1982-83, Dr. Burton, visited my country (Egypt) and wrote, in association with Dr. Lloyd Frederick, an analysis of the state of art of rhizobiology, a document which is very useful for me and my collegues. The last time we met was during the meeting on "Cool Season Legumes" in August 1986 in Spokane. Dr. Burton was a sincere friend and a colleague and I will always remember him. My deep condolences to Mrs. Burton and family, and may God bless them all.

This letter was received from Dr. Yousef Ali Hamdi.

Janez Hacin

A researcher from the University of Ljubljana, Ljubljana, Yugoslavia, Janez Hacin is spending a year working at NifTAL Headquarters as a visiting scientist. He is primarily working with Ben Bohlool and doing some interesting work on elucidation of possible mechanisms involved in host control of nodulation in soybeans.

Hacin is a research fellow supported by the OECD (Organization for Economic Co-operation and Development) in their Co-operative Research Project on Food Production and Preservation Program. It is expected that he will continue the BNF research along with teaching at the Department of Microbiology at his home university when he returns to Yugoslavia in late 1990.

Purifying antisera by dialysis.

Course participants inspecting interior of a steel fermentor.

Genetics New Topic

Continued from page 8

Bangkok. It was organized by NifTAL in collaboration with the Thai Department of Agriculture, The BNF Resource Center, and the University of Hawaii Biotechnology Program.

Course participants were: Drs. P. Lodha and Palaniappan from India; Dr. N. Inciong and Mr. C. Cali from the Philippines; Mr. 0. Cosenza from Honduras; Ms. K. Moors from Belgium; Ms. N.bt. Ab. Rahim from Malaysia; Ms. C. Ruraduma from Burundi; Mr. S. Setradi from Indonesia; Mr. S. Sivakumaran from Sri Lanka; Mr. X. Zang from China; and Dr. S. Suthipradit, Mrs. K. Tangcham and Mr. Worawich Rungrattankasin from Thailand. Instructors were: Dr. N. Boonkerd, local organizer and Director of NifTAL's BNF Resource Center; Dr. P. Somasegaran, course director and NifTAL microbiologist; and Mr. H. J. Hoben, international organizer and NifTAL training coordinator.

Most participants were fully supported through outside sources ranging from local USAID missions and home institutions to UNESCO funds. NifTAL and the University of Hawaii Biotechnology program subsidized tuition costs for some participants.

The course was judged by participants to be well worth the effort of working more than eight hours each day. The course contents were based on a well tested outline along with adjustments in content made to meet the particular needs and interests of participants. NifTAL expects to announce its next course in early 1990.

173

Priority Tree Legumes

With much international activity in the area of multipurpose tree planting, it is deemed necessary to re-evaluate NifTAL's list of priority species in order to reflect current emphasis. From reviewing current literature, and from discussions with staff of NFTA (Nitrogen Fixing Tree Association) and F/FRED (Forestry and Fuelwood Research and Development), the following priority list was established:

Acacia mangium

Acacia auriculiformis

Gliricidia sepium

Calliandra calothyrsus

Sesbania sesban

Sesbania grandiflora

Leucaena leucocephala

Leucaena diversifolia

Albizia lebbeck

Paraserianthus falcataria

Acacia mearnsii

Cajanus cajan (perennial habit types)

Dalbergia sissoo

Flemingia macrophylla

Faidherbia albida

Acacia nilotica

Prosopis cinceraria

Prosopis juliflora

Continued efforts in selecting rhizobia that are effective, competitive, saprophytically competent and compatible with several host species will be directed toward the species on this list.

Why Nitrogen Fixing Trees?

Nitrogen fixing plants are key constituents in many natural ecosystems. They are the major source of all nitrogen that enters the nitrogen cycle in these ecosystems. Many nitrogen fixing plants are woody perennials, or nitrogen fixing trees, most of these being found in the tropics. In temperate areas, the nitrogen fixers tend to be herbaceous.

NFTs have been removed or reduced in most man-made ecosystems, such as agricultural and forest lands and urban environments. These lands require expensive chemical fertilizer inputs in order to maintain their productivity. Man-made systems can be improved by learning and adopting from natural ecosystems. For example, the reintroduction of NFTs, with appropriate management, can increase and sustain productivity. Agroforestry land-use practices do this.

The above text introduces a release from NFTA which is in its series "NFT Highlights." Interested persons can request a copy of this short paper and a list of other available "Highlights" from NFTA, P. O. Box 680, Waimanalo, HI 96795 USA.

NifTAL & NFTA Teaming Up

NifTAL is supplying peat based legume inoculant for NFTA's Cooperative Planting Program. In this program, approximately 3100 seed packets per year are sent throughout the world for field trials. Having the appropriate rhizobia for the specific legume trees will insure adequate nitrogen nutrition during the early growth of the trees. Small packets (16 g) of peat inoculum are provided semi-annually. Currently, there are 50 legume species in the NFTA Cooperative Planting Program.

Short Takes

Two Thai scientists, Benjavan Rerkasem and Ampan Bhromsiro, a formar NifTAL trainee, of the Faculty of Agriculture, University of Chiang Mai, Thailand, are involved in a research project with ACIAR (Australian Centre for International Agricultural Research). Their project on food legumes is part of ACIAR's Project 8800 - Measurement of Nitrogen Fixation in Legume Production System.

Consortium

Continued from page 8

specific techniques as the means to reach the goals.

In its first year, the project focuses on five countries, Uganda, Haiti, Nepal, Senegal and Indonesia. PVOs and NGOs in those countries – in cooperation with the BNF/LM project staff – are at the moment assessing the resources and needs and designing an action plan. This plan can range from the development of extension materials to applied research or setting up collaboration between organizations.

In Haiti, for instance, NifTAL has helped a private enterprise set up a rhizobial inoculant production unit. The unit has a capacity great enough to be able to provide rhizobia to all Haiti's potential users. In March a conference on the principles and opportunities of BNF was held for all Haiti's potential users. This conference was offered to all interested agencies active in agriculture in Haiti. A future strategy for the project was determined during the conference.

A CONSORTIUM FOR BNF-EXTENSION

In November 1989 a unique step was taken to join technical expertise acquired over years of research with well-established local agricultural outreach systems. NifTAL, Agricultural Cooperatives Development International, Africare, CARE International, Pan American Development Foundation, Save the Children, Winrock International, World Vision International and Peace Corps united efforts and started the Biological Nitrogen Fixation and Legume Management (BNF/LM) Outreach Project.

The project aims at increasing and improving the knowledge and use of nitrogen fixing plants and their compatible inoculants by smallholders in tropical countries. BNF can provide small farmers with a cheap alternative for fertilizers and higher protein food. Currently, small farmers hardly use inoculation techniques. The project will use awareness building, training, organization and introduction of

Continued on page 7

Genetics New Topic at Course

NifTAL's most recent training course – held in Thailand during November – included exercises on genetics. This addition emphasizes NifTAL's continuing efforts to keep abreast of an increasingly promising area of rhizobiology. Other areas of emphasis were inoculant production and strain identification techniques. The trainees learned by doing with hands-on exercises used to maximize practical experience. Twenty-six lectures were presented to support the course exercises. Seminars highlighted the applications of techniques and encouraged discussions to enhance greater understanding of experimental approaches.

The course entitled "Modern Methods For the Study of Rhizobium" was held at the Rhizobium Building of the Thai Department of Agriculture in

Continued on page 6

PVO/Peace Corp/NifTAL Consortium: A Reality

From left: **Eugene Chiavaroli, Deputy Assistant Administrator for S&T, USAID; Ms. Phyllis** Dobyns (at podium), Senior Vice President for Save-The-Children; Noel P. Kefford, Dean, CTAHR, University of Hawaii; Sarah Ford, Peace Corp; Ambassador Mark Edelman, Acting Administrator, USAID, Senator Daniel Inouye, Hawaii.

A commemorative agreement was signed at the State Department in Washington, D.C., between key persons from the organizations which are members of the consortium to further BNF use in sustainable agriculture for developing country farmers. The consortium is a landmark cooperation between these diverse groups.

SERVICES FROM NifTAL

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 scientists 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

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For information on the NifTAL Project and to request services, contact NifTAL Project Director, NifTAL Project, 1000 Holomua Rd., Pala, 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 inviduals acting on its behalf.

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175