BIOLOGICAL NITROGEN FIXATION

BNF BULLETIN

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Extension Training Workshop

Above: Course participants examine nodulation on root systems. Upper right: Participants practice different methods of inoculation in the field. Lower right: A buried urn provides inexpensive cool storage for inoculants.

A training course for extension specialists in the applied technology of biological nitrogen fixation (BNF) was offered March 28-April 5, 1990, Khon Kaen, Thailand.

This interactive course consisted of hands-on exercises and demonstrations, discussions, self-evaluation, and review. This process was organized by NifTAL and BNFRC, and greatly facilitated by extensive on-farm trials set up by the Thailand Department of Agriculture (DOA) and the Agricultural Research and Development Center (Khon Kaen).

Funds for development of this course and an extension training manual were provided by the Secondary Food Corps Development project (SFCDP) supported by the Government of Indonesia and USAID/Indonesia.

Fifteen extension specialists and BNF researchers from Indonesia participated. Course instructors were Drs. Saroso Sindhoesarojo, Mintarsih Adimihardja, and Brian Hilton (Indonesia); Dr. Nantakorn Boonkerd, Mr. Chirasuk Arunsri, and Mr. Precha Wadisirisuk (Thailand) and; Drs. Paul Singleton, Padma Somasegaran, and Ms. Princess Ferguson (NifTAL Project, Hawaii). Drs. E. Edwards McKinnon and Brian Hilton (Academy for Educational Development CTTA Project, USAID S&T) contributed to the development of the course and the manual.

The extension manual developed for this course, "Applied BNF Technology: A Practical Guide for Extension Specialists," is a modular package. Each module contains adequate technical information, instruction for set-up of demonstrations, and prototypes for hand-outs and case-studies for self-evaluation and problem-solving. Modules are also accompanied by slide sets and other teaching aids. A more recent training course in Uganda used the same manual to train PVOs (see p. 5 for details).

POINT OF VIEW

Where Have All the Experts Gone!

The current crisis in the Middle East once again highlights the vulnerability of our fossil-fuel dependent agricultural and food production systems. As the price of oil increases, so does the cost of agricultural inputs, notably of N-fertilizers. In most developing countries N-fertilizers are neither readily available nor affordable. In addition, government subsidies for N-fertilizers are being phased out in many countries.

Biological nitrogen fixation (BNF) by legume crops and trees, *Azolla* and non-legume trees like *Casuarina* offers the most practical, low-cost and non-polluting alternative to industrial fertilizers.

Extensive BNF knowledge and technology is available. Use of rhizobial inoculants for legume crops and trees in many developing countries, however, is limited by technical and cultural obstacles that can only be removed by comprehensive educational programs involving scientists, extension workers, private voluntary organizations, development agencies and private enterprise. The task of training these segments of the in-country resources to deliver BNF information and material has been made difficult by the critical shortage of specialists with knowledge and interest in practical and applied aspects of the technology. The appeal of molecular biology and genetics has attracted most of the newcomers, as well as many of the "old-timers," away from involvement in BNF outreach activities. The Joe Burtons, Jim Vincents, Lloyd Fredericks, Dean Webbers, *et al.* of yesteryears are not being replaced. Even active scientists, previously involved in applied BNF, have been lured away by molecular BNF because of funding pressure and/or professional reasons. Institutions that were once centers of applied BNF have either closed down or completely shifted gears. The current worldwide emphasis on solving problems in malnutrition, sustainable agriculture, deforestation, soil fertility and environmental degradation are also constrained by a shortage of BNF experts who can address these problems, especially in the tropics. Where will these future experts come from and how are we preparing them for this enormous challenge?

NifTAL and the BNFRC in Bangkok are among a few institutions left that have BNF outreach and training activities for developing countries as their mandates. Since 1976, these institutions have trained several hundred researchers, members of private voluntary organizations and extension agents in rhizobial technology. Neither, however, is large enough to address present and future needs at the global level.

Donor funding agencies should do more to educate and train developing country scientists who can integrate BNF technologies into soil, cropping, farming, and national agricultural systems. BNF is an essential component of the foundation of sustainable agriculture. The world needs a supply of experts in BNF technology for a sustainable future.

B. Ben Bohlool, NifTAL, University of Hawaii.

Charles Sloger, S&T, USAID, Washington, DC.

BNF: Investments and Expectations

According to E.T. Craswell, (in a paper presented at the 14th International Congress of Soil Science, Kyoto, Japan, 1990), developed countries are undergoing changes in macroeconomic and trade policies to reduce overproduction and associated profligate use of nitrogen fertilizers. An increased demand by consumers for "organically" produced foods may swing the pendulum in North America and Europe back towards increased use of legumes in farming systems. "Research funding agencies are monitoring these trends and are increasingly taking into account the economic and farming systems perspective of technology options developed through research," he states.

"The Peanut Vendor" c. 1890 H. Buchman
Courtesy of Arizona Hist. Soc./Tucson

Craswell concludes that, "research on nitrogen fixation should be attractive because it would seem to be especially appropriate for subsistence farmers who cannot afford, or have limited access to, nitrogen fertilizers." He agrees with D.H. Hubbell (*Nitrogen Fixation by legumes in Mediterranean Agriculture*), that "most nitrogen fixation technology transfer is directed to large-scale farmers who may need it least, and the dilemma arises from the fact that transfer of nitrogen fixation technology to poor upland farmers requires a great deal of education and effort by extension agencies, often inhibited by poor infrastructures."

Craswell refers to R.J. Roughley, (*Biotechnology of Nitrogen Fixation in the Tropics; Proceedings of UNESCO regional Symposium and Workshop*) who found the failure to effectively transfer the *Rhizobium* technology in many countries to be disturbing because legume inoculation has been "the most important practical contribution from research on biological nitrogen fixation." Craswell's recommendation in dealing with this dilemna is to encourage governments and private firms not only to produce and distribute inoculants but to institute effective quality control programs.

NEWSWORTHY

News From Friends

Dear Editor,

On April 1, 1990, I took a Faculty Development leave from my position as professor of soil microbiology (Dept. of Soil Science) at the University of Florida for a grant position in Ecuador. I am working with Dr. Peter Graham on his Bean-Cowpea Collaborative Research Support Program (CRSP), a collaborative effort between Soil Science Dept. at the University of Minnesota and INIAP, Quito, Ecuador.

The objective of the project is to improve bean yield in Ecuador. The primary approach is through selection of improved bean varieties, accompanied by isolation of strains of rhizobia which are highly compatible, symbiotically, with the selected bean genotypes. My primary responsibilities are; (1) location and identification of local peat sources which are acceptable in quality for eventual use as carriers for production of rhizobial inoculants in Ecuador, and (2) isolation and testing of strains of bean rhizobia from the three principal bean-growing regions.

It is interesting (in a negative sense) to note that legume inoculation, one of the oldest and most beneficial of agronomic practices, remains virtually unknown to the vast majority of farmers here, as it is in many parts of the world.

Dr. Bob Henson completed an assignment with the Bean-Cowpea CRSP Project of Dr. Fred Bliss in Brazil and has recently joined Dr. Graham's CRSP Project here as agronomist-physiologist. He is off on a strong start and I believe this project will be highly successful. Life and work here are most agreeable.

Greetings to all N-fixers from Latitude 0^{o}!

David Hubbell, Ph.D.

NifTAL-IRRI Collaborative Research

NifTAL has entered into a joint venture with the International Rice Research Institute (IRRI), Los Banos, Philippines, to study the potential contribution of N_2-fixing legumes to rice production. NifTAL has placed one of its scientists, Dr. Thomas George, at IRRI for the design and conduct of legume BNF/soil N dynamics research in the context of rice-based cropping systems in cooperation with IRRI scientists: Dr. Jagdish K. Ladha, Dr. Dennis P. Garrity and Dr. Roland J. Buresh (from IFDC). The major focus of this ambitious program is sustaining productivity of rice-based cropping systems through conservation and recycling of soil and atmospheric N through the use of legumes.

To quantify the dynamics of soil N and legume BNF, they have established microplots of suitable ^{15}N isotope enrichments. Monitoring the fate of ^{15}N in incorporated residues produced *in situ* will enable them to determine the magnitude of recycling of N in these systems.

NifTAL Expands Into Genetic Technologies

From a joint effort by NifTAL and the Biotech Program, University of Hawaii at Manoa, a USAID funded amendment was added to NifTAL's existing agenda in research, training, and outreach in BNF technologies. The purpose of the amendment is to use modern genetic methodologies for studying, and in the process improving, ecologically important attributes of tropical rhizobia. The University of Hawaii provided funds for facilities and equipment at NifTAL and Dr. Dulal Borthakur is filling an added faculty position on the main campus of the university. USAID provided support for a molecular biologist, Dr. Douglas Rice, to be stationed at NifTAL, and operational support for these two scientists to collaborate on related aspects of rhizobial genetics. This new biotech thrust at NifTAL presents opportunities in research and training for scientists and students interested in the molecular genetics of tropical rhizobia.

Rhizobium-Induced Nodules on Cereals

Earlier, E. C. Cocking and his coworkers in the U.K. had reported formation of nodular structures on both rice and wheat roots, if the roots of seedlings were treated with a cell wall degrading enzyme mixture (1% cellulase, 0.1% pectolyase, in 8% mannitol) and inoculated with rhizobia in the presence of polyethylene glycol (J. Exp. Bot. 40,743, 1989; Int'l. J. Genet. Manipul. in Plants 5, 1, 1989).

At the 8th International Congress of Nitrogen Fixation, May 20-26, 1990, in Knoxville, Tennessee, there were three reports of nodulation of non-legumes. Cocking described how their enzyme treatment was effective in nodulation of a non-legume, oilseed rape. B. Rolfe and coworkers from Australia reported that an engineered rhizobial strain formed nodule-like structures on rice plants with very low frequency (about 0.25% of inoculated plants.)

By far the most striking example of the reports (and photographs) was the work of Y. Jing *et al.* from the Peoples Republic of China. These workers reported nodules on rice formed by mutagenized rhizobia from *Sesbania cannabina*. Nodule morphology and fine structure, they reported, resembled legume nodules. They reported that a small amount of nitrogenase activity and a significant amount of leghemoglobin was detected in the nodules.

These exciting new developments underscore the message in the "Point-of-View" section in this issue of the BNF Bulletin, "Where Have All the Experts Gone!?" If in the not-too-distant future growers throughout the world were to inoculate rice and other cereals, where are the technical resources and expertise to respond to this enormous demand?

MEETING NOTES

Upcoming Meetings

13th NARC, N.A. Rhizobium Conference

The 13th North American Symbiotic Nitrogen Fixation Conference (Better known as N.A. Rhizobium Conference, NARC), will be held in Banff, Canada, August 25-30, 1991.

The conference will emphasize the genetic, physiological, microbiological, and agronomic aspects of the Rhizobium-host plant symbiosis.

The conference will consist of plenary lectures, discussion sessions, and poster presentations

For additional information contact 13th NASNFC, P.O. Box 478, Sub. 6, Saskatoon, Sask., Canada S7N OWO.

Nitrogen-fixing Trees in Small-Scale Farming

NFTA, NifTAL, and the University of Hawaii are offering a joint short course on the production, inoculation and use of nitrogen-fixing trees in small-scale farming. Contact NFTA, P.O. Box 680, Waimanalo, HI 96795, USA, for more information.

Rhizobium Training

A training course, Modern Methods for the Study of Rhizobium, will be offered June 3-30, 1991 in Bangkok, Thailand. The purpose of the course is to provide training in Rhizobium culture, strain identification, genetics of Rhizobium, inoculant production, and field application. For more information, contact Training Coordinator, NifTAL Project, 1000 Holomua Avenue, Paia, HI 96779, USA.

Indonesian Soybean Seed Training Course

R.M.H. Manurung will be using NifTAL's BNF manual for Extension Specialists as a part of a workshop in Sumatra, June 11-22, 1991, in Medan, N. Sumatra. The National Soybean Seed Technology Training course will be sponsored by Seed Production Improvement Project, funded by FAO DANIDA Project (Danish Government).

UNESCO's Global Network

An international seminar on the importance of microbial biotechnology and its allied disciplines for community and economic development will be organized within the framework of UNESCO's global network of Microbiological Resources Centres (MIRCEN). The seminar will be held in Montreal, Canada, from September 23-26, 1991. For additional information, contact Dr. Jean-Claude Panisset, Director of Medecine du Travail et Hygiene du Milieu, Faculte de medecine, University de Montreal, C.P. 6128, Succ. A, Montreal, Quebec, Canada, H3C 3J7. FAX number: 514-343-2200.

Meetings of Recent Past

Nigeria

A wide diversity of papers were presented at the meeting of the Fourth African Association of Biological Nitrogen Fixation (AABNF) which was held from September 25-29, 1990, at the International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria. Paper topics ranged from economics and agroforestry systems to molecular biology of rhizobia and measuring BNF in crop systems. The meeting was organized by Dr. Kalemani Mulongoy of IITA.

Kenya

The National Conference on Plant and Animal Biotechnology, sponsored by the Kenya Agricultural Research Institute, was held February 25-March 3, 1990, in Nairobi, Kenya. BNF Technology: Potential for Maximizing Agricultural Production, was presented by Dr. B. Ben Bohlool, NifTAL Project, in the series of lectures on technology for improvement of production.

Knoxville, Tennessee

The 8th International Congress of Nitrogen Fixation, May 20-26, 1990, was organized by Drs. Peter Gresshoff and Gary Stacey of the University of Tennessee.

Guatemala

A reunion was held in November, 1990, in Guatemala for 15 years of rhizobial study in LatinAmerica(XV Reunion Latinoamericana de Rhizobiologia).

Uganda

Twenty-four NGO, PVO and extension specialists participated in a BNF Technology Workshop, November 26-30, 1990, in Uganda and focused on the applied aspects of BNF technology using NifTAL's manual for training extension specialists.

Course sponsors were the Uganda Cooperative Alliance and Agricultural Cooperative Development International, and the workshop was coordinated by Makerere University Faculty of Agriculture and Uganda Cooperative Central Union.

The workshop was part of the activities of the consortium of PVOs and NifTAL on the AID-sponsored "BNF Legume Management Outreach Pilot Project." Course instructors included Mr. C. Nkwine (Makerere Univ.), Dr. G. Gumisiriza (Ministry of Ag.), Dr. H. Keyser (NifTAL), Ms. M. von Schaik (Save the Children), and Mr. K. Rweenda (CARE-Uganda).

Uganda course participants practice seed coating methods.

News from BNFRC

The Regional BNF Resource Center for South and Southeast Asia, located in Bangkok, Thailand, is alive and doing well under the direction of Dr. Nantakorn Boonkerd. BNFRC, a joint effort of Thailand Department of Agriculture and NifTAL, was created to provide information, material and research support in BNF on a regional basis. Dr. Boonkerd is the P.I. of a recent three year grant from USAID's PSTC Program entitled, "Ecologically Based Models for Prediction of Legume Inoculation Requirements." He and his colleagues at the Soil Microbiology Research Group in Thailand plan to field-test and validate inoculation response models developed by NifTAL under the WREN (Worldwide Rhizobial Ecology Network) Project.

COMMERCIAL CORNER

ICARDA/FAO/NifTAL Host Course in Morocco

Scientists from five North African countries participated in a training course entitled "Techniques in Rhizobiology of Pasture and Forage Legumes," held at the University of Mouley Ismail, Meknes, Morocco, April 22-May 5, 1990. The course, organized by FAO, the hosting university, ICARDA, and NifTAL, was sponsored by ICARDA and FAO. Dr. Luis Materon, ICARDA, oganized the course. Assisting in instruction were: Dr. Mohammad Ismaeli (host university) and Heinz Hoben, (NifTAL). Ms. Monika Zaklouta, ICARDA, provided technical support. In addition to methods of isolation, enumeration, and mass culturing of rhizobia in fermentors, participants learned inoculant preparation, seed coatings, screening rhizobia, field experimentation, and methods for measuring nitrogen fixation. Participants gained valuable hands on experience in operating a NifTAL commercial scale steel fermentor.

Medicom

In the last issue of the BNF Bulletin an article described the establishment of legume inoculant production capability in Haiti with the private firm, Medicom. In addition to providing inoculum for the agroforestry projects in Haiti, Medicom is now filling custom orders for inoculants (grain, pasture, and tree legumes) for interested parties. The inoculant carrier is sterile peat.

Inquiries should be sent to Ms. Muriel Bouchereau, P.O. Box 2270, Port-au-Prince, Haiti (Phone: 509-1-73350).

Nitragin Company Ownership Changes

While still under the same management and at the same address, Nitragin is now LiphaTech, Inc. The parent company is Lipha S.A., Lyon, France. Their inoculants will still be under the brand name of Nitragin.

Pop-Nunas: High Protein Snack

Nunas are colorful beans that, like popcorn, burst and expand when rapidly heated. They puff up slightly and split in half, yielding a tasty, high protein snack that has a nutlike flavor and high fiber content. The beans are native to high elevations in the Andes Mountains of Peru, Bolivia, and Ecuador. The beans will not pop when grown at lower elevations so further work needs to be done to breed varieties that will perform appropriately under different growing conditions.

The USDA magazine, Agricultural Research (August 1989) reported work done with this legume by USDA/ARS researchers Stephen C. Spaeth and Matt J. Silbernagel along with CIAT (Centro Internacional de Agricultura Tropical) scientists. The goals of research are to introduce this crop outside its native area as a commercial crop.

WHOS WHO and WHERE

Recent NifTAL Grad Students

Maria Luz Caces

A USAID/NifTAL supported Ph.D. student from the Philippines, completed her degree in fall, 1990, under the direction of Dr. Francoise Robert, Dept. of Microbiology, University of Hawaii. Her dissertation research was concerned with the relationship between competitiveness of strains of *Rhizobium leguminosarum* bv. *phaseoli* and their ability to suppress nodulation across split-roots of beans. Dr. Caces is currently conducting postdoctoral research with Dr. Dulal Borthakur, Biotechnology Program, University of Hawaii. We look forward to important future contributions from this dynamic duo to the genetics of tropical rhizobia.

Thomas George

An Indo/US STI and USAID/NifTAL sponsored Ph.D. candidate, from southern India, completed his degree in December of 1988. The chairman of his committee was Dr. Duane Bartholomew, Dept. of Agronomy and Soil Science, Univ. of Hawaii. His thesis was entitled "Growth and Yield Responses of *Glycine max.* and *Phaseolus vulgaris* to Mode of Nitrogen Nutrition and Temperature Changes with Elevation." He is currently employed by NifTAL working at IRRI on a collaborative project (see story on page 3).

ANNOUNCEMENT: Drs. Maria Luz Caces and Thomas George (who met at the University of Hawaii while grad students) have announced their plans to be married in January, 1991. We wish them a happy life together.

Paul L. Woomer

Completed his Ph.D. degree in the spring of 1990 with a thesis entitled "Predicting the Abundance of Indigenous and the Persistence of Introduced Rhizobia in Tropical Soil." His work was supported by USAID/NifTAL and by a grant from NSF/Ecology. He developed mathematical models that use environmental data to predict how long an introduced rhizobial species will persist in the soil. He was also the main contributor to the computer software program, MPNES, for enumerating rhizobia. Dr. Woomer is currently employed by the Tropical Soil Biology and Fertility (TSBF) Project, and is stationed at the UNESCO Regional Office for Africa, in Nairobi, Kenya.

Janice E. Thies

A Ph.D. student supported by USAID/NifTAL and by a grant from NSF/Ecology, she completed her degree in the summer of 1990. Her dissertation title was "Modeling Ecological Determinants of the Symbiotic Performance of Introduced Rhizobia in Tropical Soils." Her work, accepted for publication in the January issue of *Applied and Environmental Microbiology*, builds the foundation for development of ways to predict legume response to rhizobial inoculation by using indices of indigenous rhizobial populations and the nitrogen status of the soil. Dr. Thies is currently working as a postdoctoral fellow with Dr. David Myrold at Dept. of Crop and Soil Science, Oregon State University, Corvalis. Dr. Thies' postdoctoral project is supported by a USDA/CSRS grant to Dr. Myrold entitled "Fate and Cycling of ^{15}N labeled dairy manure." We wish her all the success in this transition from ecology to fecology!

Grad Students

Dan Turk

An M.Sc. student working on rhizobial specificity of several tree legume species, plans to complete his masters thesis in spring of 1991. Dan lived in Africa most of his life and was involved in agroforestry projects in Zaire before coming to NifTAL.

Ms. Moradeke A. Fadare

From Nigeria, Ms. Fadare is a new graduate student sponsored by a grant from IITA, Ibadan, Nigeria. She is currently attending classes at the main campus of the Univ. of Hawaii. Her research will be on rhizobial requirement of legumes used in the Alley Farming Network for Tropical Africa (AFNETA).

Staff

Ms. Princess Ferguson

NifTAL's Information Officer, Princess Ferguson, is on temporary leave from NifTAL and working in India with the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT). Ms. Ferguson will return to NifTAL in June, 1991, after filling a six month position with ICRISAT's information section.

NOTE TO BNF WORKERS

This Bulletin belongs to all people interested in various aspects of BNF. We are soliciting from our readers newsworthy items for inclusion in future issues. Human interest stories and photos, editorials and opinions, and notices of recent and upcoming books and events are especially welcome. It is editorial policy not to include extensive unpublished data in the BNF Bulletin.

N-FIXING TREE NOTES

Tree Rhizobia Strain Selection

Ongoing strain selection trials at NifTAL have identified superior effective rhizobial strains for the following tree legumes:

Acacia auriculiformis
Acacia mangium
Acacia mearnsii
Albizia lebbeck
Gliricidia sepium
Leucaena collinsii
L. diversifolia
L. esculenta
L. greggii
L. lanceolata
L. leucocephala
L. macrophylla
L. multicapitulata
L. pulverulenta
L. retusa
L. salvadorensis
L. shannonii
L. trichodes
Lysiloma latisliqua
Paraserianthes falcataria
Robinia pseudoacacia
Sesbania sesban
Sesbania grandiflora

These strains have been added to NifTAL's germplasm collection. To obtain cultures write: Curator of Culture Collection, NifTAL Project, 1000 Holomua Ave., Paia, HI 96779.

Bacteria	Comments
Fast-growing rhizobia (genus *Rhizobium*) 1. *Leucaena spp.* *Gliricidia sepium* *Calliandra calothyrsus*	Strains effective on each species were generally found to be effective on other species in the group.
2. *Sesbania sesban* *Sesbania grandiflora* 3. *Robinia pseudoacacia*	In general, species in groups 2 and 3 nodulate effectively only with strains isolated from their respective genera.
Slow-growing rhizobia (genus *Bradyrhizobium*) 1. *Acacia auriculiformis* *Albizia lebbeck* *Paraserianthes falcataria* *Tephrosia candida*	All species nodulated effectively with a wide range of slow-growing strains.
2. *Acacia mangium* 3. *Acacia mearnsii*	Only narrow subsets of slow-growing strains were found to be highly effective on *Acacia mangium* and *Acaciamearnsii.*

Implications: Rhizobia selected for effectiveness on a particular tree species are unlikely to be highly effective on tree species from other effectiveness groups.

FOR YOUR INFORMATION

- The BNF Bulletin is entering its 10th year of publication. For a fee of $15, we are offering a loosely bound volume of all past publications. To order a volume, contact Librarian, NifTAL Project, 1000 Holomua Ave., Paia, HI 96779.
- The NifTAL Library has broken sets of back issues of *Soil Science, Agronomy Journal, Crop Science, Ecology, Applied & Environmental Microbiology* and *Science*. Any institution in a developing country that would find one of these sets useful, contact Librarian, NifTAL Project, 1000 Holomua Ave., Paia, HI 96779.
- Legume Research is published semi-annually by the Center for Legume Research, University of Tennessee, Knoxville. The Center began in 1989 to increase the interdisciplinary interactions of faculty in different departments, and the Center is dedicated to basic research and the improvement of legumes as crop species. For additional information contact director Dr. Gary Stacey, M415 Walters Life Sciences Building, University of Tennessee, Knoxville, TN 37996-0845.

Important Notice: NifTAL BITNET number has been changed to NIFTAL@UHUNIX

An Electronic Network for BNF Workers: BNFNET-MIRCEN

This network was established in 1990 for professionals with interest in biological nitrogen fixation. It is a system commonly known as "Electronic Mail" (E-Mail), designed for information exchange among geographically dispersed BNF scientists. This is done with the help of an electronic mail distribution list called BNFNET-L. Its members have grouped themselves into six discussion groups for Legume-Rhizobium, Nitrogen Fixing Trees, Genetics/Biochemistry, free-living fixers, culture collections, and computer networking. BNFNET-L also serves as an electronic newsletter providing information on forthcoming conferences, publications, research activities, and development programs. News items from the BNF Bulletin, a newsletter published by NifTAL MIRCEN (Hawaii), are also reproduced. Newsworthy items of information for publication in BNF Bulletin and inclusion in the BNFNET should be sent via E-Mail directly to BNFNET (BITNET: < BNFNET-L @ FINHUT >) or to NifTAL (BITNET:NifTAL@UHUNIX; Or, CGNET:157:CG1056), or via regular mail to: Eng-Leong Foo (coordinator), MIRCEN Karolinska Inst., Stockholm, Sweden; Robert Harper, Center for Scientific Computing, ESPO, MIRCEN, Finland; or, Padma Somasegaran, NifTAL, University of Hawaii, 1000 Holomua Ave., Paia, Hawaii 96779, U.S.A.

Inoculant Carrier of Choice - Peat

Although other materials have been used as carriers for rhizobial inoculant, peat is generally preferred by inoculant producers. Favorable characteristics of peat as an inoculant carrier include: 1) high water holding capacity; 2) large surface area; 3) resistance to rapid microbial degradation; 4) pH buffering capacity (high cation and/or anion exchange capacity); 5) low cost; and 6) adherence to seed after simple processing. Of the three types of peat, fibrous and woody peats can be easily processed into suitable carriers for rhizobia. Pure sedimentary peat dries irreversibly and does not produce desirable structure. Most peats are actually often a mixture of types.

Peat by nature has a high organic matter (OM) content. When plant material dies and sinks into the water of marshes, bogs, or swamps, it begins to decompose in a relatively anaerobic environment preventing rapid oxidation of the OM. Decomposition in this environment favors the formation of humus, a colloidal OM of non-specific structure. Generally placed into three classes: 1)fulvic acid; 2) humic acid; and 3) humin, humus is relatively recalcitrant OM that is not readily degraded by microorganisms. It's a common misconception that high quality peat carrier materials are not found in the tropics. While the very large peat deposits are in temperate regions, there is ample evidence that acceptable quality peat carrier material is available in many tropical locations. The table shows organic Carbon(C) and Nitrogen(N) contents of some peat samples successfully used as an inoculant carrier in several countries. Note the wide range of organic C and N in the carriers. Generally the quality of the carrier material is enhanced with greater organic C content. The sample, from the Rubare Valley in Uganda (site 2), is equivalent in quality to the peat from the temperate region but differs considerably from another deposit in the same valley.

Organic Carbon and Nitrogen Content of Inoculant Carriers

SOURCE	CARBON	NITROGEN
	%	
Australia	43	1.84
Canada	36	0.93
Indonesia	14	0.70
Nepal 1	18	0.27
Nepal 2	36	0.93
Philippines 1	12	0.73
Philippines 2	12	0.75
Thailand	55	1.14
Uganda 1	25	1.51
Uganda 2	44	2.81
Uruguay	22	1.35
USA	39	1.62
Zambia	25	0.95

C and N analysis by LECO-600 analyzer. Data on an oven dry weight basis (110 C).

To increase the likelihood of finding a high quality peat deposit in the tropics, it is best to sample high elevation bogs and marshes that have plants growing in standing water. Avoid river valleys where significant flooding and rapid water flow can occur.These conditions increase the deposition of clay and silt with the organic material. Even in these cases peat can occur in layers and the soil profile must be examined to determine if there is suitable material available. Locating canals that farmers have made to drain the area can expose the profile. If drained areas are not available, use a soil probe to sample the various depths.

To make rough comparisons of OM contents in a field, take a sample and oven dry it. Weigh the sample, place it in a metal container or crucible and combust (in a muffle furnace or using a gas burner). Samples with high OM will burn. Weigh the cooled residue. The loss of material on ignition will give a rough idea of the amount of OM in the sample. Samples with much $CaCO_3$ will lose significant weight from oxidation of carbonate and yield artificially high OM values. This rough estimate of OM content can help in selecting places to mine additional material to return to the laboratory for proper analysis.

Reported by Paul Singleton, NifTAL.

SERVICES FROM NifTAL

OUTREACH

- Rhizobial germplasm
- Research quality inoculants
- Custom antisera
- 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

- Research & Information Networking
- 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

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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.

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