

9310613-③

9310613001701

Attachment 1. Report of Review Team on Nitrogen Fixation Symbiotic
Project 931-0613; University of Hawaii Contract AID/ta-C-1207

PO-AA6-348-C1

Summary Findings

The review team strongly recommends that the project be continued. Detailed findings are summarized below:

I. Project Administration

- A. The project is to be commended for the quantity and quality of the staff and their morale.
- B. The integration of NifTAL with University of Hawaii programs should be improved.
- C. AID missions should make better use of NifTAL professionals.
- D. The University of California, Davis subcontract should be better integrated into the overall project.
- E. The establishment of an External Advisory Board for BNF activities at the University of Hawaii is recommended.

II. Research

- A. The emphasis on inoculum production techniques and the initiation of the INLIT program are notable achievements.
- B. A viable data analysis system for INLIT should be developed prior to submission of a project renewal request.
- C. Staffing requirements need to be reassessed before expanding the INLIT program.
- D. An expansion of NifTAL research on tropical forage legumes is recommended.

III. Training and Information Dissemination

- A. NifTAL should be commended for its worldwide leadership in Rhizobium technology training.
- B. The encouragement of other donors to provide training support funds and reimbursement for information services is recommended.

IV. Outreach and Technical Assistance

- A.** AID management should take more initiative in assisting NifTAL's work in LDC's through improved information dissemination to field missions and other donors.

- B.** The inclusion of a funding component for outreach in the developing countries in the project renewal request is recommended.

Report of Review Team on Biological Nitrogen Fixation Project (NifTAL)

University of Hawaii contract AID/ta-c-1207

July 7-10, 1980

The project "Maximizing Symbiotic Fixation by Grain and Forage Legumes in the Tropics" has completed the fifth year of a six year contract. The review team made site visits to the University of Hawaii and to the University of California (Davis) which has a research sub-contract. The purpose of the review was to assess project performance, to date, and provide guidance on project direction and continuation.

The review team, unanimously, thinks the project is of high quality, and is making a substantial contribution to the dissemination of knowledge and materials to enhance the application of techniques for manipulating symbiotic nitrogen fixation in tropical crops. The team strongly recommends that the project be continued.

Several features of the project which are particularly noteworthy and exciting are:

- 1) Development of small scale low capital inoculum production systems and the proposed consulting and advisory role of NifTAL on establishing inoculant production facilities in LDC's.
- 2) The scientific competence and enthusiasm of the NifTAL staff.
- 3) The outstanding Rhizobium culture collection and availability of this collection to BNF scientists worldwide.
- 4) The initial positive steps to develop and implement the International Network of Legume Inoculation trials.

Overview

The basic NifTAL program headquarters are on the island of Maui in building leased from Maui county. This program, with a staff of thirty, is under the jurisdiction of the Soils and Agronomy Department of the College of Tropical Agriculture of the University of Hawaii. The program also has a subcontract with the University of California (Davis) on soil stress tolerance of genotypes of legume hosts and Rhizobium.

Although somewhat isolated from the main campus of the University of Hawaii, the Maui site is ideal for training activities and research on tropical legumes and Rhizobium. Some land is available for experimentation at the site and in several nearby areas.

The team was impressed with the international leadership role of NifTAL in scientific and technical training of LDC personnel and a number of its research activities. Indeed, NifTAL is, without doubt, a preeminent organization in training activities on the practical aspects of the use of tropical legumes.

Administration

The team noted the dynamic leadership of Jake Halliday, who in a little more than one year, has strengthened the project with decisive, resourceful and objective management.

The personnel at Maui are enthusiastic about the program and exhibited good morale. The project appears to be making good progress and certainly is playing a leadership role in the training of young scientists and technicians in the implementation of nitrogen fixation technology.

The team recognized a need for better integration of NifTAL with programs at the University of Hawaii, although some recent progress has been made. Two large AID supported programs, NifTAL and Benchmark Soils, are both located in

the Department of Soils and Agronomy, placing a substantial burden on one department. The University administration is considering the establishment of an interdisciplinary program for Biological Nitrogen Fixation within the College. If so, NIFTAL might fit easily into such a framework and be benefited by it.

Several suggestions may be considered by the contractor which would establish NIFTAL more firmly within the university framework, and overcome some of the inherent disadvantages due to its relative geographical isolation. The Department or College should be more actively involved in the recruitment and evaluation of professionals for NIFTAL. Subsequently, tenure and promotion of these faculty members could be facilitated. Procedures should be established so that current faculty members in the Department could more readily be used on a short-term basis in NIFTAL projects, particularly the Network activities. This would also contribute to the depth of experience within the Department. Greater use might be made of Strengthening Grant and Section 406 funds to further facilitate integration. Special attention must also be paid to the matter of departmental integration of outposted staff of NIFTAL. The Department should also be involved in the recruitment and evaluation of graduate students. The above actions also would improve the linkage between basic research and field application.

We believe that the NIFTAL program has attracted a number of first class professionals. Somehow, these workers should be better known and made more available to AID missions throughout the tropics through an improved communication system with AID. This action would improve AID's return on its investment by extending the benefits of NIFTAL talent and expertise to field missions, many of which have programs in this area. AID mechanisms would also be useful in participant recruitment through advertising and scheduling.

The team recommends the research subcontract with the University of California (Davis) be better integrated into the Hawaii program. Although the research performance at Davis is impressive, both programs would gain substantially through

better communication. In the future the NIFTAL program could benefit by similar subcontracts at other institutions for some of the more basic research components.

Budget and Financial: The quality of project budget and financial management was judged satisfactory by the team. However, some suggestions might be considered to even further increase returns from expenditures.

Although the present system is adequate, planning and budgeting by objective would make it easier to define the true costs of some activities. This is especially true for training programs. We believe that other sources of support for training activities could be explored (i.e., AID Missions, FAO; other national, bilateral and multilateral agencies) once real costs for training are properly evaluated.

The team favorably endorses the use of "The Research Corporation of the University of Hawaii" as a disbursing vehicle for funds. This mechanism has certainly avoided some of the financial difficulties that frequently are encountered through traditional university channels.

Earlier we recommended that NIFTAL make greater use of University of Hawaii faculty in short-term assignments. This would benefit both the University and NIFTAL. To facilitate this activity the University of Hawaii should more clearly define its policy to departments on the methods for transferring funds or line items for salaries. In most universities this can be accomplished in one of two ways.

1. When a faculty member is working on a short-term contract assignment, he remains on his university line and the department is reimbursed for his salary from contract funds. These monies can then be used by the department for alleviating losses to the program from these temporary absences.
2. A faculty member on a short-term assignment is transferred to a contract line during his absence from the regular department activities. The vacant state line can then be used for another appointment to make up for the temporary loss.

External Advisory Board: The team strongly recommends that an External Advisory Board for BNF activities at the University of Hawaii be established by the University of Hawaii. This Board could be composed of national and foreign scientists, as well as representatives of other user groups. The Board would provide policy guidance to the University of Hawaii, improve the coordination with other groups working on nitrogen fixation and enhance the opportunities for other institutions and PVO's to become involved in the Network activities. This would be very important as NifTAL moves into more country programs where much could be gained by working through institutions (including AID-University contracts) now in place.

Evaluation of Research Efforts at NifTAL

The evaluation of research progress to date can best be seen in light of the stated original and continuing project objectives as described below. Of the five, only No. 4 may not be judged a major research item.

- 1) The development of a collection of Rhizobium strains, including strains which have been varified and tested on targeted legumes for distribution to researchers world-wide.
- 2) Development of an improved inoculum delivery technique to ensure effective dependable field inoculation.
- 3) Development of improved techniques and cultural systems to exploit more fully the nitrogen contribution of legumes in tropical cropping systems.
- 4) Development of training programs on applied research and technology of Rhizobium bacteriology for technicians and scientists in tropical countries, and
- 5) Develop a formal Network of cooperators in the tropics for field testing of Rhizobium inoculants.

Maximum emphasis and success has been achieved for objectives 1, 4, and 5. Lesser activity and, therefore, less success has been associated with objectives 2, and even less activity and development with objective 3. These differences are recognized by the NifTAL staff and represent a decision on research priorities based on budgetary and manpower constraints (see NifTAL Annual Report, 1978-79). Research priorities supported all other training or outreach program and by necessity have a practical orientation.

Research progress relative to objectives are further defined:

- 1) The development of a collection of Rhizobium strains.

The collection of Rhizobium isolates (currently 1,493 from 83 different legumes species) provides a most valuable resource for BNF research and LDC use. Use by LDC researchers of this collection is appreciable and will undoubtedly increase markedly in the future. This activity was necessary to supply the best possible strains for the International Network of Legume Inoculation Trails (INLIT) which are now just beginning. INLIT should provide a useful vehicle to evaluate some of the more promising strains identified in the collection under a variety of conditions. It is also the place where the research on selection of Rhizobium strains tolerant to soil stress factors (sub-contract University of California at Davis) will receive field verification.

A delay in providing long-term storage of cultures by lyophilization has occurred. Likewise, other research demands and a shortage of technical help will limit the most desirable further evaluation and characterization of strains for numerous other properties and attributes. This is a common constraint with all culture collections, not only the one at NifTAL.

- 2) Development of an improved inoculum delivery technique.

NifTAL staff is to be commended for their consideration of and partial verification and development of low capital, low technology, small-scale systems for inoculant production in LDCs. The planning for pilot studies

in selected LDCs is an excellent step. Associated studies of Rhizobium survival at high temperatures during inoculum shipment and storage is informative and useful.

Furthermore, the possible development of an outreach for providing a technical consultant service to LDCs on inoculant production technology seems particularly exciting and useful.

These positive comments should be tempered by the fact that the proposed small-scale technology for inoculant production has been developed only with pre-sterilized peat inoculants. Suitable peat deposits may not be available in many LDCs. It would appear that a priority should be given to developing research on alternate carriers, which must proceed simultaneously with those of small-scale production facilities. Perhaps the use of outside research grants modeled after the University of California at Davis approach would be helpful in overcoming this limitation. Additionally, the development of inoculation techniques suitable and attractive for small-holder farmers must also be developed and thought given to how this information and technology can best be disseminated.

3) Development of improved techniques and cultural systems to exploit legumes.

This objective, thus far, has not been a high priority. Research has been conducted on starter nitrogen effects and phosphorus nutrition effects on legumes and the legume symbiosis. The initial studies to find legumes and Rhizobium strains less affected by the presence of soil or fertilizer nitrogen may be a useful approach. Logical studies on intercropping have been deemphasized because the International Centers with commodity orientation have a strong research effort in this area. The review team learned that a current graduate student's research dissertation will focus on intercropping systems with legumes.

A definitive interest and research effort in agro-forestry systems seems

to be emerging. Initial studies with Leucaena spp. are already in progress. It is commendable that outside research funds are being sought to supplement NIFTAL Project funds for supporting these and other studies. It seems appropriate that NIFTAL continue to expand their involvement with other kinds of useful legumes whenever appropriate.

4) Development of training programs in applied research and technology.

Research effort is largely supportive, and this topic is described in the training section of this report.

5) International Network of Legume Inoculation Trials (INLIT)

Appreciable progress has been made in the implementation phase of INLIT since the January, 1979 planning workshop. The research data to be obtained raises the potential for great benefits to the world-wide community of BNF researchers and the LDCs. INLIT implementation appears well planned and managed, and holds a very promising future.

However, the review team was somewhat surprised that the details for analyzing and summarizing the large volume of data that are to be generated have not been worked out. Planning details on the procedures for regular and rapid dissemination of this data in the scientific community after analysis and summarization also needs to be addressed. These items can be costly both in terms of human resource and financial requirements. It is important that these issues be resolved prior to the submittal of a project renewal request.

Some concern was expressed by the review team that the implementation and continuation of the Network may be so time consuming to the regional coordinators that other research goals may be diluted. Additional staffing may be needed to prevent this detrimental impact. Alternately, specific research topics could be sub-contracted to other scientists.

Consideration is being given by the NIFTAL staff to the idea of outposting staff members in geographical regions of the tropics to assist in the development of BNF programs and meet NIFTAL goals more effectively. It seems appropriate that this be done if administrative details can be worked out, and this approach should provide a valuable service and resource to LDC programs in BNF. Initial locations under consideration are in Africa (Kenya) or Asia (Thailand). Outposting should have a desirable impact in enhancing research of problems specific to a region and expedite the transfer of BNF technology.

The Review Team also encourages greater cooperation of NIFTAL and faculty in the College of Tropical Agriculture through the development of a joint research effort on tropical forage legumes. Tropical forage legumes should be an important resource for Hawaiian agriculture.

Sub-contract with the University of California at Davis (UC, Davis): A sub-contract with UC, Davis (Dr. Don Munns) has been in effect during the entire contract period. Dr. Munns' research focused on the selection of soil stress tolerant genotypes of various legume hosts as well as Rhizobium. To date the research has been successful in finding effective acid tolerant, Mn and Al tolerant strains of Rhizobium some of which have been included in the Network trials. Current studies are centering on P nutrition of, and salinity influences on, Rhizobium and the methodology and initial results are unique and exciting.

The question was raised during the review concerning continuation of this linkage with the University of California, Davis, during the next contract extension. The Review Committee felt that the research by Dr. Munns' laboratory should continue to provide a valuable input to the goals and objectives of NIFTAL and therefore it is recommended that this linkage continue in the contract extension. Logically any continued research on acid tolerant Rhizobium should

be coordinated carefully because of the expertise in this area of Dr. J. Halliday.

The future strength of this linkage could be improved by tying the graduate studies of University of California, Davis, students of Dr. Munns' more closely to NIFTAL. Experience and training of these students at NIFTAL would enhance their education and provide them a greater appreciation of the significance of their research work and tie their research more closely to NIFTAL's goals and objectives.

Training and Information Dissemination

The team extensively reviewed the training and information activities.

Training. The training component includes short courses (mostly in other countries), an intern program for scientists and technicians and a graduate program. There is an increasing demand for the training in the LDC's and non-USAID donors are beginning to participate in these programs. The review team feels that training costs should be carefully analyzed and a schedule of costs published to encourage participation by all user agencies.. Alternate vehicles for recruitment of trainees such as USDA/OICD should be explored.

Dissemination of Information. The scope of NIFTAL's information dissemination activities was broadened in FY 1979/90. An Information Section was formed and staffed by an information specialist, a bibliographer, part-time artist, and editorial, circulation and clerical assistants. A list of publications is contained in Attachments A through L.

An extensive but highly specialized document collection, along with a core of basic reference books, serve the staff and trainees as a library for special research purposes. These resources are also available to eligible clients aboard. So far, 900 addressees in 88 countries have been involved in information exchange. The review team recommends that the possibility of cost reimbursement from international agencies, country programs and AID missions for these services should be explored.

Outreach and Technical Assistance

NIFTAL management is proceeding in developing linkages with the LDC's and International Centers through its programs of bilateral and regional training workshops and seminars, training programs for LDC personnel at NIFTAL facilities at the University of Hawaii as well as through the development of the International Network of Legume Inoculation Trials. The information materials developed at NIFTAL related to the above activities are well presented and detailed. Distribution of these documents is made available to a wide range of international and national organizations and individuals associated with or involved in BNF activities.

Streamlining information flow and the procedures involved in developing these NIFTAL outreach activities remains a continual task. While some satisfactory linkages of the project are being forged in several LDC countries (Thailand, Zambia), NIFTAL management is hampered by some time-consuming operational methods. AID should take more of an initiative in helping to find additional and more efficient mechanisms.

As pointed out in the May 2, 1977, evaluation (Deane Weber, etc.) a recommendation was made for AID to "play a far more active role in forging links between the NIFTAL Project and operational agricultural development projects, and between NIFTAL and the LDC's". Essentially this recommendation is still appropriate and can be further defined to include:

- 1) Fuller use should be made of the AID information delivery system (cables and letters) to missions that describe NIFTAL services and outline potentials of NIFTAL activities to local agricultural development strategies.
- 2) The AID Project Manager should help educate regional Bureaus in Washington and explore areas of cooperation whereby NIFTAL is better understood within the agency.

3) The AID Project Manager should expand and maintain contacts with other organizations and agencies (such as Peace Corps, private voluntary agencies, and National Science Foundation) and encourage participation with their resources in the NIFTAL program.

To further NIFTAL outreach needed in satisfying the rapidly expanding technical assistance requests in the field of BNF by LDC's, the team recommends the project extension include a funding component for these purposes. This should be separate from the core research fund and designed to provide expertise on a case-by-case basis for special research and outreach issues in the developing countries. This service should be then made known to AID missions and respective host country personnel. Procedures for engaging these services can be similar to other DSB centrally funded activities. An example of NIFTAL's attempt to broaden its resource base can be seen in Table I. These attempts should be encouraged.

TABLE I

Broadening NIFTAL's support base - Summary of Progress. July, 1980

Project	Source of Funds	P.I.	Status	Amount
Better inoculants for acid in fertile soils of tropics	USDA SEA/CR (USAID)	Halliday	Funded	90,000 (3yrs)
Legume Rhizobium Genoplasm for Tropical Soil Conditions	UH Section 406	Halliday/ Stockinger	on hold*	195,000 (3yrs)
An allelopathic interaction between a grass and a legume	USDA Competitive Grants	Tang/Bartholomen Whitney/Halliday	Funded	25,000 (3yrs)
Nitrogen fixing trees for agro-forestry systems	ICRAF (International Council for Research in Agroforestry)	Halliday/Nair	Funding probable	200,000 (3yrs)
International Workshop on BNF Technology	CIAT 20,000 ICRISAT 25,000 USDA SEA/CR 57,000 UNESCO 8,000	Halliday	Funding obligated	110,000 (one-time)
Participant training sponsorship	UNESCO	Halliday	Funding assessible	10,000 (per year)
Bean/Cowpea CRSP	USAID	Halliday	UH excluded by planners	200,000 (3yrs)
Appropriate inoculation technology for propagation of leguminous trees	USDA SEA/CR	Halliday	Preproposal approved - full proposal pending	90,000 (3yrs)
Soil management CRSP	USAID	Halliday	under review	undefined share of integrated departmental project
Promiscuity as a tool for selecting chickpea rhizobia for India conditions	USDA SEA/CR	McNeil/Sandhu	not approved	90,000 (3yrs)

In addition to the above, NIFTAL is included as a technical contributor in two major socio-economic evaluations of the impacts of BNF technology - one with the East-West Centre (under NSF) and the other with University of Minnesota (under USAID). Direct support to NIFTAL is written into the project papers. Funding level is under negotiation.

NIFTAL's international travel is supplemented by awards to Halliday from non-NIFTAL sources. Since March 1979, Halliday has visited Kenya (twice), Egypt (twice), Italy (twice), France, Sweden, England, Ireland, U.S. mainland (twice), Puerto Rico, Mexico (twice), Colombia, Peru, Brazil, Australia, Indonesia, Thailand, India. (dollar value \$20,000)

*This proposal can now be resubmitted following recent clarification that Halliday, as contract faculty and an RCUII employer, can act as Principal Investigator on a grant to the University of Hawaii.

ATTACHMENT A

Published Publications and Documents Sponsored by NIFTAL

1. Berger, J. A., S. N. May, L. R. Berger, and B. B. Bohlool. 1979. Colorimetric enzyme-link immunosorbent assay for the identification of strains of Rhizobium in cultures and in the nodules of lentils. *Appl. Environ. Microbiol.* 37(3):642-646.
2. Bose, J. II. 1979. The legume/Rhizobium symbiosis in tropical agriculture: A selective bibliography with annotations. Univ. Hawaii. 193 p.
3. Bose, J. II. 1980. The legume/Rhizobium symbiosis in tropical agriculture: A bibliographic update. Univ. Hawaii. 167 p.
4. Cassman, K. G. 1979. The phosphorus nutrition of two grain legumes as affected by mode of nitrogen nutrition. Ph.D. Dissertation. Univ. Hawaii. 95 p.
5. Cassman, K. G., A. S. Whitney, and K. R. Stockinger. 1980. Root growth and dry matter distribution as affected by phosphorus stress, nodulation and N source. *Crop Science* 20(3):239-244.
6. Cassman, K. G., A. S. Whitney, and R. L. Fox. 1980. Symbiotic nitrogen fixation by legumes requires extra phosphorus. Illustrated concepts in Tropical Agriculture. Univ. Hawaii, Dep. Agron. Soil Sci. No. 17.
7. Guevarra, A. B., Y. Kitanura, A. S. Whitney, and K. G. Cassman. 1980. A low cost system for circulating nutrient solutions in pot studies. *Crop Science* 20(1):110-112.
8. Harris, S. C. 1979. Planning an international network of legume inoculation trials. Univ. Hawaii. 241 p.
9. Keyser, H. H., and D. N. Munns. 1979. Effects of calcium, manganese, and aluminum on growth of rhizobia in acid media. *Soil Sci. Soc. of Am. J.* 71(2):256-260.
10. May, S. N. 1979. Ecological studies on lentil rhizobia: Competition and persistence in some tropical soils. M.S. Thesis. Univ. Hawaii. 54 p.
11. Munns, D. N., et al. 1979. Tolerance of soil acidity in symbiosis of mung bean with rhizobia. *Agron. J.* 71(2):256-260.
12. Reyes, V. G., P. Somasegaran, and D. N. Munns. 1978. Catalog of selected strains from the NIFTAL Rhizobium collection. Univ. Hawaii. 16 p.
13. Samasegaran, P., H. Hoben, and J. Halliday. 1979. Practical exercises in Rhizobium technology: A training manual. Univ. Hawaii.
14. _____. 1979. International network of legume inoculation trails: Experiment A. Univ. Hawaii. 19 p.

15. Singleton, P. W. 1979. Effect of inoculation with Rhizobium bacteria on Arachis hypogaea. M.S. Thesis. Univ. Hawaii. 70 p.
16. Vincent, J. M., A. S. Whitney, and J. Bose II. (Editors). 1977. Exploiting the legume. Rhizobium symbioses in tropical agriculture. Univ. Hawaii Coll. Trop. Agr. Misc. Pub. K/5. 467 p.
17. Woomer, P. L. 1979. Root tuberization and nitrogen fixation by Pachyrhizus erosus (sic). M.S. Thesis. Univ. Hawaii. 96 p.
18. Annual Report NifTAL Project. Univ. Hawaii. 1975-76.
19. Annual Report NifTAL Project. Univ. Hawaii. 1976-77.
20. Annual Report NifTAL Project. Univ. Hawaii. 1977-78.
21. Annual Report NifTAL Project. Univ. Hawaii. 1978-79.

ATTACHMENT B

Publications and Documents Sponsored by NifTAL in Final Preparation

1. Cassman, K. G., A. S. Whitney, and R. L. Fox. 1980. Phosphorus requirements of soybean and cowpea as affected by mode of N nutrition. Submitted to Agron. J.
2. Eriksen, F. I. and A. S. Whitney. The effects of light intensity on the growth of some tropical forage species. I. Interaction of light intensity and nitrogen fertilization on six forage grasses. Submitted to Crop Science.
3. Eriksen, F. I. and A. S. Whitney. The effects of light intensity on the growth of some tropical forages species. II. Legumes. Revised manuscript to be submitted to Crop Science.
4. Eriksen, F. I. and A. S. Whitney. The effects of light intensity on acetylene reduction, dry matter accumulation and grain yield of soybean, cowpea and bushbean. Manuscript submitted to Departmental review and subsequently to Crop Science.
5. Guevarra, A. B., A. S. Whitney, and Y. Kitamura. Nitrogen relationships among some tropical legumes and their associated grasses. I. Maize-legume intercropping experiments. First draft manuscript for submission to Agron. J.
6. Guevarra, A. B., A. S. Whitney, and Y. Kitamura. Nitrogen relationships among some tropical legumes and their associated grasses. II. Nitrogen competition and release among container-grown plants. Manuscript in preparation for submission to Agron. J.
7. Kitamura, Y., A. S. Whitney, and A. B. Guevarra. 1980. Legume growth and nitrogen fixation as affected by plant competition for light and soil nitrogen. Submitted to Crop Science.
8. Kitamura, Y., A. S. Whitney, and A. B. Guevarra. Nitrogen fixation and nitrogen transfer in grass-legume mixtures as affected by the levels of starter nitrogen. Manuscript in preparation.
9. Singleton, P. W., W. G. Sanford, and K. R. Stockinger. Effort of varying proportions of effective and ineffective nodules on the growth and nitrogen fixation of soybean (Glycine max). In departmental review.
10. Annual Report NifTAL Project. Univ. Hawaii 1979-80.

ATTACHMENT C

Brochures, Newsletters, Bulletins and Announcements by NIFTAL

Brochures

Questions and Answers About NIFTAL. 1976.
What is NIFTAL. 1979.
Training Opportunities. 1979.
An International Network. 1980.
Training Opportunities. 1980.

Newsletters

Notes from NIFTAL (for trainees)
December, 1979.
May, 1980.

Bulletins

B(iological) N(itrogen) F(ixation) Bulletin. Univ. Hawaii (also
Consortium for BNF).
March, 1980.
July, 1980.

Announcements

Courses: Nairobi; Malaysia; Mexico (in preparation).
Conferences: CIAT; NIFTAL; ICRISAT

ATTACHMENT D

Papers Presented

1. Burton, J. 1980. Paper presented at Biological Nitrogen Fixation Workshop, FAO, Rome, Italy, June 16-20.
2. Cassman, K. G. 1978. Paper presented at Amer. Soc. Agron. Annual Meeting, Chicago, Ill., November.
3. Cassman, K. G. and D. N. Munns. 1980. Soil N availability and assessment of symbiotic N₂ fixation. Enhancing biological production of ammonia from atmospheric nitrogen and soil nitrate. National Science Foundation and Univ. Calif., Davis, June 29-July 2.
4. Davis, R. J. 1980. What is NifTAL? What is the International Network? All India Coordinated Pulse Workshop, Kanpur, India, April 7-10.
5. Davis, R. J., J. Halliday and P. Somasegaran. 1980. An international network of legume inoculation trials. Amer. Soc. Microbiol. Annual Meeting, Miami Beach, Fla., May 11-16.
6. Eriksen, F. I. and A. S. Whitney. 1977. Light intensity effects on yield and nitrogenase activity of three grain legumes. Amer. Soc. Agron. Annual Meetings, Los Angeles, Calif., Nov. 13-17.
7. Guevarra, A. B. 1977. N Contributions of legumes to cropping systems. In Fertilizer INPUTS: Research Methodology Assessments. East-West Center Resource Systems Institute, Chaing Mai, Thailand, May 18-27.
8. Guevarra, A. B., Y. Kitamura, A. S. Whitney, and J. R. Thompson. 1977. Yield of Leucaena leucocephala and its nitrogen contributions to intercropped maize. Amer. Soc. Agron. Annual Meetings, Los Angeles, Calif., Nov. 13-17.
9. Halliday, J. 1979a. Paper presented at Amer. Soc. Microbiol. meeting, Honolulu, Hawaii, May.
10. Halliday, J. 1979b. Paper presented at North Amer. Rhizobium meetings, College Station, Texas, June.
11. Halliday, J. 1980. Paper presented at Biological Nitrogen Fixation Workshop, FAO, Rome, Italy, June 16-20.
12. Keyer, H. H. and D. N. Munns. 1977. Characterization of rhizobia in an acid environment. Sixth Amer. Rhizobium Conf., Gainesville, Fla., Aug 29-Sept. 2.
13. May, S. N. and B. B. Bohlool. 1978. Application of immunofluorescence to the selection of highly competitive strains of lentil Rhizobium. Amer. Soc. Microbiol. Annual Meeting, Las Vegas, Nevada, May.
14. May, S. N. 1979. Paper presented at North Amer. Rhizobium meetings, College Station, Texas, June.

15. McNeil, D. L. 1980a. Nitrogen transport in soybeans. Hawaii Plant Physiology meeting, Honolulu, Hawaii, May.
16. McNeil, D. L. 1980b. Nitrogen transport in soybeans. Vienna, Austria, June.
17. Padmauabhan, S., R. W. Weaver, and L. W. Barnes. 1977. A simple shielding method for avoiding excessive root-zone temperature in contained-grown legumes in the glasshouse. Sixth Amer. Rhizobium Conf., Gainesville, Fla., Aug. 29-Sept. 2.
18. Reyes, V. G. and P. L. Nakao. 1977. Cross Infection in the Vigna and Arachis spp. by cowpea type rhizobia. Sixth Amer. Rhizobium Conf., Gainesville, Fla., Aug. 29-Sept. 2.
19. Singleton, P. W. 1978. Paper presented by Amer. Soc. Agron. Annual Meeting, Chicago, Ill., November.
20. Somasegaran, P. 1979. Paper presented at North Amer. Rhizobium meetings, College Station, Texas, June.
21. Whitney, A. S. 1975a. Symbiotic and nonsymbiotic nitrogen fixation as viewed by an agronomist, p. 51-75. In Proceedings of a Soil and Water Management Workshop, Washington, D. C.
22. Whitney, A. S. 1975b. Contribution of forage legumes to the nitrogen economy of mixed swards: A review of relevant Hawaiian research. Symposium on Biological Nitrogen Fixation in Farming Systems of the Tropics, Ibadan, Nigeria, October.
23. Whitney, A. S. 1976a. NifTAL inoculum production for legume-based research. In Fertilizer INPUTS. Proceedings East-West Center Resource Systems Institute, Honolulu, Hawaii, June 6-19.
24. Whitney, A. S. 1976b. NifTAL Rhizobium research program. VIII RELAR (Reunion Latinoamericana de Rhizobium), Cali, Colombia, Oct. 18-20.
25. Whitney, A. S. and B. B. Bohlool. 1977. NifTAL's role in increasing the exploitation of nitrogen fixation by tropical agricultural legumes. Sixth Amer. Rhizobium Conf., Gainesville, Fla., Aug. 29-Sept. 2.
26. Whitney, A. S. 1979. Paper presented at 12th Hawaii Fert. Conf., Kahului, Maui, Hawaii, April.
27. Whitney, A. S. 1979. Improving N Contribution of legumes in Hawaii. Amer. Soc. Microbiol. meetings, Honolulu, Hawaii, May.
28. Woome, P. L., A. B. Guevarra, and K. R. Stockinger. 1978. Winged bean investigations at the NifTAL project: Observational garden, Rhizobium strain testing and response across a liming gradient. Workshop/Seminar on the Development of the Potential of the Winged Bean, Los Banos, Philippines, January.
29. Woome, P. L. 1979. Paper presented at North Amer. Rhizobium meetings, College Station, Texas, June.