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Industry Council for Development

FINAL REPORT TO USAID:

Adapting the Agribusiness Methodology
for the Demands of Sustainable Agriculture

Cooperative Agreement No. DAN-4200-A-00-1076-00
{10/1/91 - 9/30/92}

Submitted by the Industry Council for Development

March 1993

300 EAST 44th ST. ▪ NEW YORK, NY 10017 ▪ (212) 867-5017 ▪ CABLE: INDUCODEV ▪ TELEX: 23 89 76 ▪ FAX: (212) 573-6028

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SECTION I: Introduction

A. Background

Under its cooperative agreement with the United States Agency for International Development (USAID), the Industry Council for Development (ICD) has worked to expand the use (especially private sector applications) of new technologies for sustainable agricultural development. ICD efforts focused particularly on two fields of technology that USAID projects have helped to develop:

- Computer software systems that greatly facilitate decision making in agriculture, agribusiness and other natural resource management fields;

- Expansion of the production of biological nitrogen fixation (BNF) inoculants and their use in developing countries.

Senior Associate Dr. Alexander Grobman directed ICD activities under the cooperative agreement in close coordination with the Council's Executive Director Walter Simons and Program Manager Will Kennedy. Dr. Grobman is a leading agronomist, plant breeder and agribusiness executive. He has held senior posts with the Peruvian government and educational institutions, as well as international companies and agricultural research centers.

1. Computer Technology to Facilitate Decision Making in Agriculture and Natural Resource Management

Working through the International Benchmark Sites Network for Agrotechnology Transfer (IBSNAT), a global network of universities and research institutions, the U.S. Agency for International Development (USAID) has invested $10 million over the last ten years to develop a computerized systems simulation technology capable of generating information for addressing a wide range of agricultural, environmental and economic problems.

The resulting Decision Support System for Agrotechnology Transfer (DSSAT) software enables decision makers, ranging from farmers and farm advisors to business executives and government policy makers, to assess the comparative advantages of alternative strategies for the sustainable management of agricultural and other natural resources.

Over 100 scientists from 25 countries belonging to the IBSNAT project have contributed time and resources to design and develop DSSAT. In the past five years, the project has trained 275 scientists and administrators to use DSSAT and has distributed the software to over 500 user groups in 45 countries. This growing user group has generated a momentum for change which coincides with the groundswell of public concern over food safety and food security stemming from increased evidence of environmental degradation and natural resource depletion.

ICD/IBSNAT Cooperation (80% of effort)

With the basic DSS technology developed and well received, USAID requested ICD to:

- Explore opportunities for wider use of the DSSAT software as a problem solving tool, particularly by private sector agribusiness and other firms.

- Propose a practical, self-sustaining approach to facilitate development, wider transfer, and more effective utilization of DSS products by a cross-section of users.

2. Commercialiazation of BNF (biological nitrogen fixation) Technologies

Over the past decade, technologies based on BNF have been developed at the University of Hawaii, through USAID's NifTAL (Nitrogen Fixation by Tropical Agricultural Legumes) project.

BNF uses rhizobia inocculants to help plants which do not have natural rhizobia to fix nitrogen from the air in the soil. This is a cost-effective, energy efficient and non-polluting technology that could be a major source of technological support for future yield increases which is increasingly being used as a complement or option to chemical fertilizers. If made available on a widespread basis, the relatively inexpensive inocculant could be a valuable input particularly for poor smallholder farmers.

ICD/NifTAL Cooperation (20% of effort)

USAID requested ICD to work with the NifTAL project to:

- explore opportunities and constraints to achieving greater commercialization of BNF technologies in developing countries.

- assist NifTAL shape a market development strategy which optimizes its contribution to BNF enterprise development.

SECTION II: Preliminary Planning

A. Strategic Planning in Collaboration with USAID, IBSNAT,NifTAL & Oceanic Institute

1. Reconnaissance Mission {Annex I}

ICD Senior Associate Dr. Alex Grobman established a dialogue between ICD and staff of USAID supported institutions and projects indicated above. Through these initial meetings ICD obtained information, ideas, and insights on specific project activities needed to complete the cooperative agreement workplan and establish effective institutional linkages.

The reconnaissance mission and Dr. Grobman's trip report helped to establish the basis of an ICD partnership with IBSNAT and NIFTAL to assist USAID to effectively promote the wider use of DSSAT and BNF inoculants through private sector delivery systems. Due to limited funds it was decided that ICD cooperation with the Oceanic Institute could not be funded under the cooperative agreement.

2. Approval of Proposed Workplan and Budget {Annex II}

ICD staff submitted to USAID a comprehensive workplan and budget to complete the proposed schedule of activities under the cooperative agreement. Because the anticipated workplan expenses exceeded the USAID funds available under the agreement it was agreed, in principle, that IBSNAT and/or NifTAL would provide project funds to support activities that exceeded the cooperative agreement budget. USAID agreed, in principle, to support the schedule of activities and budget as proposed.

SECTION III: ICD/IBSNAT Cooperation

A. Activities & Outputs

1. ICD Mission to the University of Florida; IFDC {Annex III}

ICD representatives Walter Simons (Executive Director), Alex Grobman (Senior Associate) and Will Kennedy (Program Manager) held meetings with IBSNAT Network members Dr. James Jones, Dr. Walter Bowen and several of their colleagues at the University of Florida/Gainesville on 16-17 January. Demonstrations of DSSAT and GIS (Geographic Information Systems) and their applications were presented and discussed at some length during the course of these visits.

The meetings served to strengthen the basis of ICD/IBSNAT partnership and provided an opportunity to:

- Gain further knowledge of the DSSAT models, including DSSAT's comparative advantages and potential to serve a range of potential public and private sector end-users;

- Reach consensus on immediate programmatic matters as agreed to in the ICD/IBSNAT workplan, including plans for DSSAT demonstrations to companies and other institutions in Europe and the United States.

- Enhance ICD's effectiveness in marketing DSSAT demonstrations to potential commercial end-users.

Following the visit to the University of Florida Dr. Grobman met for 2 days with several representatives of IFDC who are active in developing the DSSAT model for fertilizer and briefed them on ICD/IBSNAT objectives under the cooperative agreement. IFDC expressed its support for the activity and recommended fertilizer companies to target for demonstrations.

2. Conducted Research of Potential DSSAT Demonstration Target Groups in the U.S. {Annex IV}

ICD researched and identified U.S. Agribusiness Companies, Trade Associations, Commodity Brokers, Farm Cooperatives, Software, Seed and Fertilizer firms (based in 10 states) likely to have an operational interest in DSSAT crop models and applications. A comprehensive list of priority target companies and institutions was compiled and submitted to IBSNAT Network and USAID representatives for comment and further refinement.

3. Prepared DSSAT Synopsis/Brief and Cover Letter for Distribution to Companies {Annex V}

ICD prepared a 4 page background brief on DSSAT which describes its current and future capabilities applications of specific interest to the private sector. ICD also drafted a tailored cover letter directed to potential commercial users which described the cooperative agreement objectives, provided specific examples of how a given company or institution might utilize the DSSAT tool in their work and inquired whether a given firm was interested in having a demonstration conducted at their headquarters.

ICD and IBSNAT reached agreement on priority DSSAT demonstration target groups in 5 states and the District of Columbia, and an itinerary was prepared.

4. PAM Workshop

Dr. Grobman attended the PAM (Policy Analysis and Management) workshop (19-21 Feb.) in Washington, D.C. to further explore the potential for linking DSSAT with PAM. Dr. Grobman and

Mr. Simons met with USAID and IBSNAT representatives to brief them on cooperative agreement progress and reach agreement on the next priorities.

5. Customized DSSAT Demonstrations

Dr. Grobman returned to the University of Gainesville (24-28 Feb.) to assist IBSNAT group members Drs. Jones, Uehara, Ritchie and Bowen to (1) develop customized DSSAT demonstrations for targeted end-users identifed above; and (2) discuss possibilities for an integrated approach to DSSAT market development which encompasses public, private and mixed markets and further refines existing products, develops new products and fosters wider use. Such an approach would involve a market (versus research) driven process linking core research activities to product development and marketing.

6. Participation in CODATA Conference

Dr. Grobman joined IBSNAT representative Dr. Joe Ritchie (Michigan State University) in leading a DSSAT presentation and discussion at the International Workshop on "Integration, Dissemination, and Use of Environmental Data for Research on Crop Modeling," sponsored by the Committee on Scientific and Technical Data (CODATA) of the U.S. National Research Council.

The objective of the workshop was to "focus on integration, dissemination and use of environmental data for research, monitoring, prediction and decision making in developing countries" and "to identify new or improved methodologies for multidisciplinary data integration in crop modeling." Conference participants addressed issues related to data quality, data accessibility, data management and presentation of information.

7. Assessment of Market Potential for DSSAT Technology {Annex VI}

ICD conducted a DSSAT market assessment, involving demonstrations to a cross-section of agribusinesses and related companies as well as development institutions located in 14 U.S. and European cities. The ICD survey demonstrated the current DSSAT product, assessed opportunities and methods for adapting it to specific commercial applications, and considered opportunities for further product and market development. The organizations covered by the survey included:

Agribusiness and other companies: Nestlé, Unilever, IBM, Shell, Quaker Oats, Land O' Lakes, Cargill, International Minerals and Chemicals Corp. (IMC), Ralston-Purina;

Seed companies: Northrup King, ICI Seeds (UK and USA), Pioneer

Hi-Bred International Inc., Delta and Pine Land Company, Garrison and Townsend Seed Company;

Commodity brokers: Chicago Board of Trade, Merrill Lynch;

Trade organizations: National Corn Growers Association (USA), American Soybean Association;

National and international development organizations: World Bank, UNDP, U.S. Department of Agriculture (USDA), NOAA/USDA Joint Agricultural Weather Facility, Commonwealth Development Corporation (CDC/UK);

Development consulting groups: American Society of Agricultural Consultants, Rural Investment Overseas (RIO/UK), Earth Satellite Corporation;

Other ICD Member Companies: Dr. Grobman demonstrated DSSAT at the 41st Session of the ICD Board held in Zurich in March which included representatives of Britannia Brands PTE Ltd., Bühler Ltd., Daimler-Benz Holding AG, EDESA Management AG, F. Hoffmann-La Roche Ltd., Nestlé SA, Philips, Polservice Foreign Trade Enterprise, Rabobank Nederland, Sagantec Europe BV, Shell International Petroleum Company Ltd., and Tetra Pak International SA.

Meetings with user groups (ranging from one to 20 individuals), were organized by ICD Executive Director Walter Simons and Program Manager Will Kennedy and conducted primarily by ICD Senior Associate Dr. Alex Grobman. Dr. Grobman was assisted in the U.S. presentations by scientists representing IBSNAT, including Drs. Goro Uehara of the University of Hawaii, Jim Jones and Walter Bowen of the University of Florida/Gainesville, Joe Ritchie of Michigan State University, and Tony Hunt of the University of Guelph and in Europe by Barry Dent of the University of Edinburgh.

From a large database of firms representing a cross-section of the various subsectors mentioned above, a limited number of firms were selected on the basis of being representative of each subsector and available to the ICD/IBSNAT team during the tight April trip schedule. Some firms dropped out after visits began, and a few were opportunistically added. Overall, some 90% of the originally planned visits were successfully carried out. (See annex 7 for the itineraries for the DSSAT market surveys conducted in the United States and Europe).

Meetings with user groups began with a standard demonstration of DSSAT, its possibilities and the validation of its predictive abilities with various examples. Depending on the audience, DSSAT applications were also presented that address issues relating to agricultural research, prediction of varietal performance, promotion of sustainable agricultural practices, fertilizer management/application, environmental management

concerns, use of geographical information systems to assess new cropping practices, and the possibility of yield prediction on large geographical areas.

The demonstration was followed by a discussion in which the audience raised questions, offered views on the relevance of DSSAT to their operations and provided feedback on future interactions between their organization and a possible DSSAT marketing/research operation.

Results of the survey indicate strong interest in a greater range of crop modeling products and services which would be available on a commercial basis.

7a. Summary of Market Assessment Conclusions

Dr. Grobman and Dr. Jones summarized the findings of the market assessment at a meeting on 22 April at USAID with Dr. Pat Peterson, Dr. Tej Gill and Mr. Walter Simons, as follows:

i. DSSAT as a product offers most of the companies visited opportunities for application either as is or, more likely, as a family of products and services.

ii. DSSAT products require further development to become more user friendly, with direct down-to-earth interfaces with the users; in some cases products need to have specific application orientations.

iii. There is a need for new crop models, especially in the cash, vegetable and plantation crop areas. Users are also particularly interested in potential DSSAT applications for crop performance prediction, and in disease and pest monitoring.

iv. A family of generic DSSAT products should evolve in the next generation of research and development, and they should be user driven in their succeeding evolutionary steps. Some of the generic products should be geared to specific market segments, such as seed companies, commodity traders, consultants, economic analysts, agricultural support services, etc. Specific proprietary products for individual firms could evolve from them.

v. There is interest in participating in some type of user association or consortium that would invest in and help guide future DSSAT research and development. Such a product research, development and marketing system, with appropriate financing and structure, needs to be established.

vi. There is a definite need to package DSSAT products with ancillary services, such as on-line and off-line database

information facilitation on soils, weather, crop research data, economic resources, prices of commodities, transportation, land use categories, and water resources. These services should include aggregated spatial data in GIS formats, and collateral services such as AEGIS.

Remotely sensed data should be interpreted and used in defining image and linear data for cartographic, mapping and imaging applications in interaction with DSSAT products and available on-line and off-line. Selected weather data should be made available on-line to specific users. Historical weather data, soils data, and other basic information could be made available on CD-ROM disks as optional products.

vii. Training for the use of DSSAT products should be developed by the IBSNAT consortium, and also be made available through third parties. DSSAT training should be reduced to a session of no more than 8 hours for the category of corporate users who will need straightforward applications.

viii. A permanent phone support service, periodic software updates, seminars and the formation of user groups will be an absolute requirement. Without these support services, the market will not be receptive to DSSAT but rather to less time consuming products.

At the debriefing meeting, a preliminary proposal was discussed for marketing future DSSAT licenses within a price range that insures the level of return necessary for future research and development to become financially self-sustaining. USAID officials appeared to concur with these views, and expanded on them.

7b. Report of DSSAT Market Survey

ICD finalized its report to USAID providing a preliminary assessment of the commercial potential for DSSAT based on the demonstrations and meetings in Europe and the U.S. Brief summaries of each of the demonstration/discussion meetings held with companies and other organizations in the U.S. and Europe are included in the assessment along with conclusions. Copies of the full report were sent to USAID and IBSNAT representatives. An executive summary of the report was distributed to a cross-section of 27 companies, trade associations and international aid agencies.

8. Preparation of DSS Consortium Concept Paper {Annex 7}

Based on the positive reactions gained from the market

assessment, IBSNAT and ICD agreed to jointly develop a concept paper, proposing a partnership between a new commercial organization and IBSNAT in the research, development and marketing of current and future DSSAT products on a self-sustaining basis.

With guidance from USAID, ICD and IBSNAT finalized the concept paper which provides a "pre-feasibility" rationale for establishing an integrated product development and marketing system. This proposed system's purpose is to facilitate widespread transfer and utilization of full service Decision Support System (DSS) products to promote sustainable development objectives.

ICD distributed the concept paper for review by private and public sector representatives who participated in the earlier DSSAT market surveys and others who are likely to have an applied interest in DSS products {annex 7}. In addition to the covering letter and proposal itself ICD attached a short questionnaire requesting as much information as possible about possible corporate interest in supporting DSS system development.

ICD had initially planned to further revise the concept paper based on reactions from the above key informants but received only a few replies to its mailing by the end of the project period. All correspondence was forwarded to the USAID project officer and to IBSNAT representatives.

9. Plans to Conduct DSS Consortium Feasibility Study {Annex 8}

This assessment will be essential to attract public and private sector funding committments. Although not covered under the cooperative agreement, plans are underway for ICD to cooperate with the research network (formerly IBSNAT) in conducting a full feasibility study of the proposed DSS System in early 1993. Dr. Alex Grobman is presently preparing the feasibility study proposal and corresponding budget.

Several of the universities involved in the IBSNAT Network may be willing to provide funding for such a study. Other possible sources of funding are presently being identified.

Terms of reference: The purpose of the feasibility study would be to assess the proposed DSS Consortium's commercial viability, including the specific applied DSS product and service needs, their competitiveness and costs to potential clients.

Regarding the DSS Corporation, the feasibility analysis would:

a) evaluate existing and potential markets and identify

special client categories;

b) identify resource requirements: finance, human, institutional, and technical;

c) propose a business plan with detailed financial calculations for the first three to five years;

d) propose ownership, governance, financing and legal aspects including by-laws and articles of association;

e) propose the structure and activities of an advisory committee which would coordinate Corporation and Research Network planning, operations and external affairs of mutual interest;

f) assess and recommend options for policies regarding pricing, intellectual property considerations, linkages with other software systems, etc.

The feasibility study should cover all technical, legal, and financial matters required for decision by equity investors. It should also have provisions for grant and endowment financing.

The feasibility of the Corporation would be tested within the context of DSS Consortium operations. It will require a thorough examination of legal, financial and operational links between Consortium partners and their significance for the sustainability of such an integrated operation.

10. Workplan Modifications

It was agreed by USAID, IBSNAT and ICD that the DSSAT demonstrations and concept paper (described above) served the same purpose as the DSSAT strategic planning and national workshops proposed in the initial cooperative agreement workplan. Therefore, to optimize the financial resources available and avoid duplication of effort, plans to conduct public/private sector workshops were dropped.

SECTION IV: ICD/NifTAL Cooperation

A. Activities & Outputs

Responding to USAID request, ICD:

1. Researched and collected information on BNF production and distribution.

2. Developed a "summary profile" list of the leading companies producing and marketing inoculants in the United States. The list was sent to both USAID and NifTAL. Another list of inoculant producers, distributors and researchers worldwide has also been compiled. {Annex 9}

3. Prepared a "brief" which provides the logical framework for ICD cooperation with NifTAL, including the objectives,

activities, outputs and rationale for the proposed BNF industry workshop. {Annex 10}

4a. Drafted a cover letter directed to executives of leading inoculant companies in the U.S. which (1) briefly described the objectives of ICD/USAID/NifTAL cooperation; and (2) requested their views on opportunities and barriers to increasing the production, marketing and application of BNF inoculants in developing countries through commercial channels. The cover letter and background material was sent out to a cross-section of inoculant industry executives. {Annex 11}

4b. Conducted telephone interviews with BNF industry leaders in the U.S. to get their guidance in identifying and obtaining information concerning:

- case studies involving the economics and profitability of inoculant production and marketing.

- known quality control standards and enforcement experience.

- the "bottlenecks" (technical, economic, marketing) to expanding the inoculant industry and lessons learned from successful and unsuccessful commercial applications.

- specific technical constraints to exporting inoculants that may be addressed in future research work.

A informal draft record of the interviews was prepared by ICD graduate research assistant Mr. Steven McCann. {Annex 12}

5. NifTAL's director Mr. Paul Singleton suggested that due to funding and timing considerations the proposed ICD/NifTAL workshop on BNF enterprise development and commercialization be cancelled.

6. In lieu of this and given the very limited funds remaining through the cooperative agreement, ICD proposed to consolidate the research it has conducted and draft a final report which would:

- identify the "bottlenecks" and possible solutions to increasing the production, marketing and application of BNF inoculants in developing countries through commercial channels.

- assist NifTAL in its efforts to develop an integrated approach to BNF market development through private sector delivery systems.

At NifTAL's request, Dr. Alexander Grobman travelled to Hawaii in late September (en route to China on a World Bank mission) where he held a series of meetings with representatives of NifTAL to more clearly define and agree on future strategies to promote private sector development of BNF inoculant production and marketing.

Dr. Grobman prepared ICD's final paper which assesses NifTAL's present strategy to promote BNF enterprise development and recommend additional ways to achieve this objective in the future {Annex 13}.

TERMS OF REFERENCE

ICD Reconnaissance Mission:
Dr. Alex Grobman
Senior Associate

Meetings with NIFTAL, IBSNAT, Oceanic Institute
Hawaii/November 4-9, 1991

Background

ICD has entered into a new cooperative project agreement (No. DAN-4200-A-00-1076-00) with the United States Agency for International Development (USAID) that will initially focus on greater private sector involvement in the technological and managerial achievements of one or more USAID funded technologies developed in collaboration with NIFTAL, IBSNAT and the Oceanic Institute. These activities will, in turn, assist ICD in adapting its agribusiness methodology to the increasing demands that commercial projects satisfy the criteria of sustainable agriculture.

Objective

The purpose of this reconnaissance mission is to establish a dialogue between ICD and staff of USAID supported institutions and projects indicated above. Through key informant interviews and discussions Dr. Grobman will obtain information, ideas, and insights on specific project activities needed to complete the cooperative agreement workplan and establish effective institutional linkages.

Terms of Reference

I. NIFTAL - Biological Nitrogen Fixation Technologies for International Development

The meetings at NIFTAL should develop an understanding of how USAID and other donors, directly or through intermediaries, can most effectively promote and support commercialization and wider use of BNF technologies in LDC's.

To this end ICD will develop a global agribusiness system profile of the inoculant industry and its interrelation with seeds and other input industries; analyze BNF as a subsector agribusiness activity; identify potential markets and propose commercialization guidelines for follow-up programs in selected countries where BNF would be most attractive both economically and ecologically.

1. Overall

The reconnaissance mission will identify practical opportunities for ICD to work in close liaison with NIFTAL in order to define and implement the project work plan. Specifically, Dr. Grobman will:

- Obtain NIFTAL staff views on how the liaison with ICD and USAID on this project can be most effectively organized.

- Assess research and other information available at NIFTAL and its potential use by ICD.

- Assess whether NIFTAL or the project should assign an expert to facilitate communication and information exchange between NIFTAL, ICD and USAID.

- Brief NIFTAL staff on ICD - its work generally and specific role in this project.

- Identify NIFTAL staff members who might participate in the public/private sector workshop on BNF.

2. Key Informant Meetings with NIFTAL Staff

Dr. Grobman will obtain NIFTAL staff views on:

- Project history, current work and future directions is they relate to the cooperative agreement objectives.

- Opportunities and constraints to commercializing BNF technologies through increased private sector investment and market development.

- NIFTAL's role, including strengths and limitations, in the process of promoting commercialization.

- Lessons learned from successful and unsuccessful commercial applications/activities in developed and developing countries.

3. Assessment of Information Resources

Dr. Grobman will assess NIFTAL project information resources relevant to ICD's project needs, including:

- Status of information collection and research that has or could be carried out at NIFTAL vis á vis commercial applications of BNF.

- Information on commercial applications of BNF in developed and developing countries.

- Statistics on products sold for which crops, profitability, and business alliances between BNF companies and other agribusinesses.

- Profiles of the inoculant industry including lists of companies, type and extent of product development and differentiation.

- Assessments of market potential and economic benefits from inoculation including practical issues which limit the expansion and benefit of legume inoculant applications by the private sector.

- Potential for linking developing country and U.S. inoculant producers with the aim of developing joint ventures in production, marketing, and research and development in legume inoculant use.

- Successful approaches and barriers to increasing the supply and quality of inoculant available to small holder farmers through private sector delivery systems as part of or apart from a comprehensive input package.

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Annex I

Industry Council for Development

ICD RECONNAISSANCE MISSION

Dr. Alex Grobman
Senior Associate

Meetings with NIFTAL, IBSNAT, Oceanic Institute
Hawaii/November 4-9, 1991

ICD has entered into a new cooperative project agreement (No. DAN-4200-A-00-1076-00) with the United States Agency for International Development (USAID) that will initially focus on greater private sector involvement in the technological and managerial achievements of one or more USAID funded technologies developed in collaboration with NIFTAL, IBSNAT and the Oceanic Institute.

These activities will, in turn, assist ICD in adapting its agribusiness methodology to the increasing demands that commercial projects satisfy the criteria of sustainable agriculture. This methodology was developed under a USAID core grant in the early 1980's, and has been used by ICD in a number of developing countries to help restructure agroindustrial subsectors and promote private enterprise.

The purpose of this reconnaissance mission is to establish a dialogue between ICD and staff of the USAID supported institutions and projects indicated above. Through key informant interviews and discussions ICD Senior Associate Dr. Alex Grobman will obtain information, ideas and insights on specific project activities needed to complete the cooperative agreement workplan and establish effective institutional linkages.

Dr. Grobman (Peru) is a leading agronomist, plant breeder and agribusiness executive. He has held senior posts with Peruvian government and educational institutions, as well as CIAT and international companies. As an ICD Senior Associate, Dr. Grobman helped design and implement the Council's agribusiness development methodology in various developing countries.

ICD is a private, non-profit development organization whose members are major corporations worldwide. The Council was established in 1979 to assist economic and social development by making available the managerial, technological, scientific and other expertise of industry as a contribution to the development process. This is done in cooperation with major multilateral and bilateral development organizations such as United Nations Development Programme (UNDP), USAID and the World Bank and various private sector non-governmental organizations.

ICD's philosophy is based on the belief that industry has an opportunity — perhaps an obligation — to share its knowledge and management expertise with public authorities toward the long-term mutual goal of self-sustaining economic growth and social equity in developing countries. In this context, ICD's activities range from advising governments and development institutions to the design and execution, on its own initiative, of clearly

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defined projects. The theme underlying most ICD activities is self-sustaining development through effective public/private sector partnerships.

At their request, the Council advises governments on establishing an "enabling environment" to promote partnership, as well as restructuring of public/private sector cooperation in priority sectors. In subsequent investment promotion and enterprise development work, ICD utilizes an integrated business system approach encompassing policy, technological, managerial, marketing and investment factors.

The Council itself is financed through membership fees, grants and contracts, and is managed by a Board of Directors chosen by the corporate members. ICD maintains a small staff at its headquarters in New York.

10/30/91

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Industry Council for Development

UNEDITED DRAFT

REPORT ON VISIT TO USAID SUPPORTED PROJECTS IN HAWAII

Prepared by

Dr. Alexander Grobman

ICD Senior Associate

November 1991

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D R A F T

REPORT ON VISIT TO USAID SUPPORTED PROJECTS IN HAWAII

1. General Information

At the request of Mr. Walter Simons, Executive Director of ICD, a visit was made to three USAID supported projects in Hawaii and other related projects by Dr. Alexander Grobman, Senior Associate of ICD. The objective of these visits was to evaluate the status of advance and possibilities of marketing or adapting to the markets the various products and services that have been developed at the following research and development centers:

International Benchmark Sites Network for Agrotechnology Transfer (University of Hawaii, Honolulu)
Oceanic Institute, Center for Applied Aquaculture, Makapuu Point, Oahu
Niftal Project, Biological Nitrogen Fixation for International Development, Paia, Maui
Nitrogen Fixing Tree Association, Waimanalo, Oahu
Office of Technology Transfer and Economic Development, University of Hawaii, Manoa, Honolulu
Dean, College of Agriculture, University of Hawaii
James Brewbaker, Professor, University of Hawaii, and former President of the Nitrogen Fixing Tree Association and presently member of its Board, and researcher.

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ICD COOPERATIVE AGREEMENT WITH USAID/WORKPLAN BUDGET (PROPOSED) 12/91
(NO. DAN-4200-A-00-1076-00)

WORKPLAN BUDGET SUMMARY:

ACTIVITY	FUNDING SOURCE			
	USAID	ICD	IBSNAT	NIFTAL
I. PRELIMINARY RESEARCH	15,617	--	--	--
II. DIALOGUE WITH KEY INFORMANTS	29,195	--	25,075	--
III. DRAFT SHORT SUBSECTOR WORKING PAPERS	4,065	4,000	--	--
IV. PLAN AND CONDUCT SUBSECTOR WORKSHOPS	10,298	12,000	18,560	12,860
V. PREPARATION OF FINAL REPORT	5,866	4,000	--	--
SUBTOTAL:	65,041	20,000	43,635	12,860
OVERHEAD RATE (23 percent):	14,959	--	--	--
TOTAL:	80,000	20,000	43,635	12,860

ANNUAL WORKPLAN/Schedule of Activities

SPECIFIC IMPLEMENTATION ACTIVITIES	TIME PERIOD Begin	TIME PERIOD End	TOTAL EFFORT (in person days)
5. PREPARATION OF FINAL REPORT			
. Draft final ICD report for review by USAID, IBSNAT, NIFTAL and select public/private sector representatives	8/92	9/92	11
Revise final report for USAID approval	9/92	9/92	2
			=======
		Subtotal:	13 days

ANNUAL WORKPLAN/Schedule of Activities

SPECIFIC IMPLEMENTATION ACTIVITIES	TIME PERIOD Begin	End	TOTAL EFFORT (in person days)
3. DRAFT SHORT SUBSECTOR WORKING PAPERS			
. Draft short working papers on each subsector (computer modeling, BNF) for use in guiding workshop discussions.	4/92	4/92	10
. Distribute working papers to workshop invitees and other key audiences.			1
		Subtotal:	11 days
4. PLAN AND CONDUCT SUBSECTOR WORKSHOPS			
. Jointly plan and conduct 2 day BNF workshop with NIFTAL in Hawaii, May '92	3/92	5/92	10
. Jointly plan and conduct 2 day computer modeling (DSSAT) planning workshop with IBSNAT in Hawaii immediately following BNF workshop (above), May '92	3/92	5/92	10
. Jointly plan and conduct 2 day computer modeling (DSSAT) workshop, in collaboration with IBSNAT, July '92	5/92	7/92	10
. Write short reports documenting the findings of subsector workshops (above) and recommendations for follow-up strategy.	5/92	7/92	5
		Subtotal:	35 days

ANNUAL WORKPLAN/Schedule of Activities

SPECIFIC IMPLEMENTATION ACTIVITIES	TIME PERIOD Begin	TIME PERIOD End	TOTAL EFFORT (in person days)
2. DIALOGUE WITH KEY INFORMANTS			
. Phone calls and mailings to 150 - 200 companies, associations, etc. regarding ICD's work with IBSNAT and USAID to promote DSSAT computer modeling program.	12/91	3/92	17
. Review and expand familiarity with DSSAT computer models in cooperation with IBSNAT	1/92	2/92	4
. Plan DSSAT computer modeling demonstrations conducted by ICD and IBSNAT to 20-25 target audiences at 8 to 10 locations in the U.S.	12/91	2/92	12
. Spend one week at the University of Florida in Gainesville preparing to conduct computer modeling (DSSAT) demonstrations	2/92	2/92	7
. Attend CODATA Conference in France (optional)	3/2/92	3/5/92	4
. Conduct computer modeling (DSSAT) demonstrations with IBSNAT to 20-25 target audiences at 8 to 10 locations -- in the US submit written report of findings and recommendations.	2/92	3/92	21
. Develop profile of BNF inoculant industry	10/91	4/92	12
. Extensive ongoing communications: key informant interviews/dialogue with public and private subsector (computer modeling, BNF) experts	10/91	9/92	10
. Conduct survey of DSSAT user network	12/91	2/91	3
		Subtotal:	90 days

USAID/ICD COOPERATIVE AGREEMENT: 12/91

ANNUAL WORKPLAN/Schedule of Activities (PROPOSED)

SPECIFIC IMPLEMENTATION ACTIVITIES	TIME PERIOD Begin	TIME PERIOD End	TOTAL EFFORT (in person days)
1. PRELIMINARY RESEARCH			
. Strategic planning in collaboration with USAID, NIFTAL and IBSNAT.	10/91	11/91	6
. Conduct Reconnaissance Mission: Meet with key informants at NIFTAL, IBSNAT, and the Oceanic Institute in Hawaii to assess subsector activities (BNF, computer modeling, aquatics). Submit report to ICD and USAID with recommendations for workplan.	11/2/91	11/10/91	9
. Conduct information search utilizing computer data base services (e.g. Dialog)	10/91	5/92	5
. Identify and research firms with sub-sector business interests (BNF, computer modeling)	10/91	2/92	11
. Assess BNF inoculant financial analysis program (PROBE) in cooperation with NIFTAL.	12/91	12/91	2
. Preparation of 200 sets of standard information packets on IBSNAT and ICD for distribution to companies, trade associations, etc.	12/91	12/91	2
. Preparation of 150 sets of standard information packets on ICD's activities with NIFTAL (BNF)	12/91	12/91	2
		Subtotal:	37 days

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MAJOR ACTIVITIES	RATIONALE (relation to outputs)
5. PREPARATION OF FINAL REPORT	
ICD will submit a final report that summarizes project findings and recommendations for implementing key aspects of the subsector agribusiness system strategies.	a. Recommend how ICD's agribusiness system methodology can be used most effectively, through partnerships, to further develop subsector products and processes that support sustainable development, and where possible to provide new opportunities for small and medium scale enterprise in developing countries. b. Identify policy options and other legal and administrative mechanisms that will further facilitate development of each subsector and contribution to commodity system implementation, including those which optimize intersectoral coordination and cooperation. c. Recommend communications and marketing strategies that would expand project operations and leverage core funds for maximum developmental impact. d. Present options for creating and implementing new strategic agribusiness models relative to each subsector through public/private partnerships. e. Propose new developing country enterprises that transfer and adapt subsector technologies, processes, and services that facilitate both viable agribusiness development and natural resource management on a sustainable basis.

ICD COOPERATIVE AGREEMENT WITH USAID:
[NO. DAN-4200-A-00-1076-00]

12/91

ANNUAL WORKPLAN/Schedule of Activities (PROPOSED)

MAJOR ACTIVITIES	RATIONALE (relation to outputs)
1. PRELIMINARY RESEARCH: ICD will gather information and conduct preliminary research in targeted subsectors (computer modeling, biological nitrogen fixation), identifying companies that might have an interest in commercial applications of DSSAT software (IBSNAT) or BNF inoculants (NIFTAL).	a. Define the scope, structure, and dynamic relationships of each subsector b. Identify existing subsector projects and programs, particularly private sector initiatives. c. Develop profiles of private sector companies and groups. (ongoing)
2. DIALOGUE WITH KEY INFORMANTS In order to establish a dialogue ICD will conduct series of key informant interviews with a select group of subsector staff from international development institutions and private sector experts. ICD will obtain the needed information, ideas, and insights on potential for markets and commercial applications of subsector products.	a. Establish public/private sector dialogue on priority subsector commercialization issues. b. Assess potential for commercial applications of subsector projects and programs. c. Evaluate how international development institutions and private organizations might more effectively utilize the outputs of each subsector in business development.

25

MAJOR ACTIVITIES	RATIONALE (relation to outputs)
3. DRAFT SHORT SUBSECTOR WORKING PAPERS	
ICD will abstract the information and analysis generated from meetings and ongoing dialogue with private & public sectors and draft brief working papers on each subsector (computer modeling, BNF). The working papers will identify development methodologies for promoting wider commercial applications of these specific agribusiness subsector technologies.	a. Highlight "talking points" for workshops and guide discussion of focus groups. b. Build public/private sector consensus around opportunities and constraints to greater private sector application of subsector products, especially considerations for production and marketing in developing countries.
4. WORKSHOPS	
ICD will conduct at least one workshop on each subsector (computer modeling, BNF) Public/private sector participants will be carefully targetted for attendence.	a. Foster dialogue and create consensus on strategic model approaches for further development of each subsector both technically and commercially. b. Identify potential markets and commercialization strategies as well as opportunities for product improvement and/or new product development. c. Identify potential innovative partnerships and clearly define the opportunities and constraints posed by each strategic model approach.

I. DECISION SUPPORT SYSTEMS FOR AGROTECHNOLOGY TRANSFER

1. Product Description

Under a support grant from the US Agency for International Development, the University of Hawaii at Manoa organized the International Sites Network for Agrotechnology Transfer, (IBSNAT) as a project which was initiated in 1982. The AID - U. of Hawaii contract stipulated that the project would strive to bring together knowledge on crop and farming systems, would identify major components and processes incident on crop production, and would bind them together in a problem solving instrument, which using the capabilities of information science would be aimed at helping potential users to obtain predictions on crop performance, given variations in constraining factors. Such constraining factors were related to soils, water, weather, crop type and management. The instrument was called Decision Support System for Agrotechnology Transfer (DSSAT).

The IBSNAT Project - as it is called - has plans for developing models for 12 food crops (maize, rice, sorghum, millet, barley, wheat, soybean, peanut, *Phaseolus* beans, cassava, taro, and potato). Other scientists working in cooperation with U. of Hawaii scientists, have expanded the basic models to other crops, including cotton and coffee.

Users of DSSAT were described by the scientists who developed the systems as "individuals or teams of scientists from Agronomy, Soil Science, Engineering and Economics involved in field research on crops, soils and weather, in efforts to evaluate alternate agrotechnologies for specific sites." Users are expected to apply DSSAT to predict crop responses based on management, soil, crop and weather parameters, or else to validate predictive responses with actual crop data.

A network of collaborators, including scientists from the University of Florida, Michigan State Univeristy, IRRI, International Fertilizer Development Center, International Rice Research Institute, University of Guelph, Edinburgh School of Agriculture, are active in extending the original capabilities of DSSAT. These include strategies involving farm systems beyond the original crop modelling, the use of economic factors, in addition to physical factors, the evaluation of risk-efficient strategies, thus increasing the power of this analytical instrument in decision-making. A genetic factoring component is yet another variable that needs to receive full recognition and implementation. These scientists, in addition to expanding the DSSAT capabilities, cooperate in benchmark experiments validating the predictions reached with the use of DSSAT crop models. There have been 45 benchmark experimental sites in developed countries and there are additionally 16 developing countries participating in the network.

DSSAT is en evolving product, with new variables and attributes being constantly added. It would be absolutely impossible to develop a model which would be at the same time practical and yet include all the possible factors which affect crop production. At the farm level the complications of the model would be higher in predictive ability than in the estimation of means for a given wider area or region. The models have not yet evolved the economic analysis to the level where their predictive abilities are providers of no more than general indicators. Further input by scientists competent in econometrics in required for depth and refinement of the various possible variations of the product.

The reliability of the models as developed today has been tested, and found to be high and consistent. DSSAT crop models are available today for wheat, maize, soybean, peanut, cotton, and coffee. The others aimed at are in process of development. There are Beta- versions of rice, sorghum, and bean models installed and currently in validation exercises. With moderate effort and participation of IBSNAT scientists, teams of scientists interested in other models, could develop cooperatively in a short time additional models for other crops. Their requirement is to have availability of a minimum supply of daily data inputs. Some limitations of the models are that they do not have considerations for effects of pests and diseases, for genetic effects, and for effects of mineral nutrients other than nitrogen.

The use of DSSAT has been concentrated in scientific research institutes. The only agency outside University and Agricultural Experiment Station research groups effectively utilizing DSSAT is the U.S. Environmental Protection Agency. EPA has adapted variations in carbon dioxide atmospheric levels and changes in temperature to the crop models.

The distribution of DSSAT has been basically directed to institutions requesting its. Other than contacts between peers at the scientific level no attempts have been seriously made to either adapt DSSAT for commercial end users or to approach commercial users for their interest in either using or reselling - after modifications - the DSSAT models. The price charged for a package ($199.00) is simply based on direct cost recovery for small volumes of production (200+). IBSNAT has conducted seminars and training courses, but again restricted to its scientific peers.

2. <u>Future of DSSAT</u>

DSSAT, because of its simplicity, user friendliness, common structure for all its models, its ability to extract data from common databases, and its application to microcomputers has excellent conditions for widespread utilization. Its output in tables and graphical displays is well thought out. DSSAT has a shall written in the C language which allows it to gain access to any of the DSSAT programs regardless of language in which it is

written, thus allowing expandability and adaptation. The programs are designed to be globally oriented. Thus they are independent of location and could be applied on a world-wide basis.

One of the main variable that needs to be accounted for in crop modelling is weather. Weather data is available for many locations around the world for a number of years and is accessible for weather stations, weather organizations, and private database suppliers of weather data. A private company has approached IBSNAT with a proposal to team up in the future with the supply of weather database information. Presumably such data might be made available in CD-ROM disks for any given region - where available - to users for a purchase price or subscription fee.

Potential end users of DSSAT in its future versions or "flavors" could well be:

- Local Project, Regional and National Planners
- Irrigation District Managers
- Policy Decision Makers at various Public and Private institutions
- Agri-Business enterprises, especially Seed Industry
- Commodity Exchange, Export and Import organizations
- Agricultural Research, Extension and Promotion organizations
- Consulting firms
- Environmental control agencies
- Pest control agencies

The further development of DSSAT would require specific adaptations for these users. In addition to economic analysis, the inclusion of farming system components, the pest, disease and weed constraints, the micro-nutrient and other major nutrient constraints, the limiting soil-factor constraints (aluminum, acidity, alkalinity, salinity), the genetic coefficients, it would be interesting to create specific adaptations or versions of the packages for the various users. Another possibility would be a multi-crop alternative for selecting possible crop mixes in relative use in a certain limited area under given constraints. An intercropping variant has been tested already for cases in which small farmers normally work in a sustainable agricultural system in some less-developed countries. The anti-narcotics agencies of several countries might feel themselves attracted to the possibilities of predicting various scenarios of crop area mixes in which present narcotics-producing crops would be phased out, their place being taken up by various other crop alternatives. The same situation might apply to crops producing economic losses at the present time which might be substituted over a short period of time reducing actual field testing with predictions based on crop modelling.

It is envisioned that organizations that might be interested in developing and marketing the various DSSAT products in their

various new flavors, and who might wish to engage in market studies of their applicability, cost, and penetration of markets [....illegible....]

- Specialized Software houses (type Computer Associates, IBM, DEC, Value Added Resellers with vertical markets for computer hardware and software)
- Consulting firms (type Arthur D. Little, Arthur Andersen)
- Brokerage firms
- Private technical assistance firms

The staff at IBSNAT agrees with this analysis. It further agrees with a proposal that a set of demonstrations be prepared for the different markets and potential private sector developers and marketers. These portable demonstrations would be ready by early January 1992 and would then be used in demonstration meetings with groups of users and/or developers for further evaluation and response from each of them. It was also agreed that the demonstrations would best be carried by a joint IBSNAT/ICD team.

University of Hawaii authorities agree that there is a need for a new approach on the part of the University in establishing direct links with the business community in responding to their potential needs by bridging the gap between scientific research and market application of products. Both the business community and the University stand to benefit from the new products of research. It is expected that ICD might help with its resources to establish models of cooperation between the University and the future co-developers and marketers of the products of their research, so that these products become widely used.

The development of a users and co-developers and marketers workshop is seen as a potential third step, after the demonstrations take place. Its timing could be June 1992. There is an agreement on this as a possibility and it is left up to ICD to define at a later stage whether such a meeting ought to be convened or whether the demonstrations and direct previous contacts with potential co-developers/marketers may bruing about the necessary bridging process to the achievement of our goals.

It has been clearly expressed and well understood that ICD, USAID and the University of Hawaii are joined in a new endeavor, gaining experience, and out of which the development of a standard model for University and private sector agreements will spring out and on which similar future activities and prjects will be based. Therefore, it is important that we be in constant communication with IBSNAT and other projects to jointly study and develop a strategy that should bring us to the achievement of our immediate goal. This is defined as establishing the conditions for the negotiations of agreements between the USAID sponsored projects in Hawaii and private contractors, and the development of such contracts.

The Oceanic Institute, created in 1960, is located at Makapuu Point on the Windward Coast of Oahu, Hawaii, a short distance away from the town of Waimanalo. Its facilities cover 56 acres. It is in the midst of a process of expansion of its facilities with new laboratories and offices, a fish feed mill and laboratory, and new fish rearing tanks.

The OI is a private organization not linked to the University of Hawaii. It is supported by State and Federal funds. Its objectives are the applied research necessary for the support of commercial aquaculture and specialized commercial fisheries, and the supply of technical services in these areas.

The Research interest of the OI are focused on:

- Applied Biological Oceanography
- Finfish Aquaculture
- Shrimp and Shellfish Aquaculture
- Aquaculture Research Services

In addition the OI provides consulting services to commercial aquaculture and fisheries and any other services that might be required by industrial, environmental, and public agencies. For example it participates in studies on the culture of mahimahi (a local fish species), oysters, and marine shrimp; it conducts environmental monitoring; it conducts assessments in connection with the development of Ocean Thermal Energy Conversion project; it gives bioassay services.

The Agency for International Development has supported the OI in various programs.

A visit was conducted to the facilities of the OI, its shrimp program, the feed laboratory and the finfish program. Discussions were carried out with the technical and scientific staff and with the Director, over lunch and in a single afternoon.

2. <u>The Shrimp Program</u>

The Shrimp Program at the OI is conducted in coordination with the Gulf Coast Research Laboratory Consortium. It has the support of the USDA. Marine Laboratories from the states of Mississippi, Hawaii, South Carolina, Texas, Arizona and Massachusetts cooperate in the program. Its objectives are the development of facilities and methods for the adequate supply of high quality shrimp seed to the U.S. shrimp industry, the implementation of disease control methods, the transfer of shrimp management at high technology levels to shrimp farms, the training and preparation of manuals, the development of a database for financial and technical management of shrimp farms, the development and release of information on shrimp harvesting [....illegible....]

The shrimp program has had success in establishing a broodstock population of IHHN virus free Pacific white shrimp Penaeus vannamei in Hawaii. The IHHN virus is presently devastating shrimp famrs in Asia with upwards to 100% mortality. In the Western Hemishpere its effect is felt in reduced growth and production. This specific Pathogen Free (SPF) shrimp population is the only one anywhere, at this time. It could, after release from the Konaa, Hawaii, Quarantine Station, help stock shrimp farms in 1992 in the U.S. and elsewhere.

The pattern of distribution of SPF shrimp seed which has been already started with distribution to the Harlingen Shrimp Farm in Texas and Amrient Aquafarm, Inc., in hawaii, might be expanded and could follow the system and commercial methods, with appropriate variants, developed for agricultural crop seeds. Central SPF Quarantined broodstock populations in the Big Island of Hawaii could be sent for multiplication in a number of commercial seedstock farms, which would have technical support from the OI in increasing SPF seed, and would sell them to commercial farms in the U.S., and eventually elsewhere.

At the present time Indonesia, Philippines, Thailand produce manadan shrimp which account for 50% of world shrimp farming. Another 20% of shrimp farming is conducted in Asia with chinensis shrimp stock, while the vannamei stock is basically grown only in the western hemisphere. This is the only species grown in the western hemisphere, and the only one supported by USDA funding.

ICD's role could be that of supporting the shrimp project with economic/marketing/technical advice, which the OI scientific personnel lack, for the establishment of a commercial system of SPF shrimp seed production and marketing hatcheries with the similarities it may have to the seed industry. This could be organized in 1992 in the shrimp farms of the states of Texas, Louisiana and Mississippi.

Other interesting activities of the OI shrimp program have centered in developing round ponds for shrimp growout yielding upwards of 40,000 lb shrimp/acre-year. It also provides technical cooperation to shrimp farms.

This brings about another possibility which would be the marketing of consulting services and turnkey shrimp production farms, with the participation of commercial consulting and development firms extending the reach of the OI.

3. Feed for Aquaculture

The OI has a small feed laboratory where feed components for finfish and shrimp are processed and analyzed. The demand for high feed quality and characteristics inimic to feed that has to be consumed underwater in an accessible physical form to both fish and shrimp creates special research needs. A new laboratory which is completely funded with Federal funds will be erected shortly after the present ground work is finished.

The feed mill will be the first of its kind built with pharmaceutical type components (stainless steel and easy cleaning). It will have a pellet mill for shrimp but floating feed will be produced for other species. It should be considered that Aquaculture feed is the strictest of feed technologies, it is in its inception, the technology is new and that there is a potential export market, especially in Asia for turnkey aquaculture feed plants.

The Mill Lab was designed by a team from Kansas State University. This is a new experience as it will be the first mill designed with aquaculture feed processing in mind, which is different in requirements than terrestria feed. It is expected that researchers and commercial feed millers will be attracted by this Lab for their further participation in aquaculture feed development.

4. Finfish Program

USAID supports the OI Finfish Program. It has selected two species for a long-term study of reproduction, spawning, and larval rearing in captivity. These are milkfish (*Chanos chanos*) and mullet (*Mugil cephalus*). One of the successes of this project has been the development of a method of hormone implantation that allows the fish to spawn in captivity, overcoming this limitation that existed before. Mullet and milkfish can now additionally spawn out of their regular spawning period.

In addition to work at Hawaii extension work has been conducted in other countries with these species under USAID sponsorship. There is a cooperative program with the Tungkank Marine Lab in Taiwan for improving aquaculture in developing countries with culture and management courses to be developed over the next three years.

OI has been working in cooperation with Indonesian private fisheries in that country in a cooperative project supported by USAID. With the reduction of shrimp yield, some Indonesian shrimp farms are converting to milkfish fry production, as hatcheries.

Another project for technology transfer is the establishment of a prototype finfish hatchery in Alexandria, Egypt. This project is in cooperation with the Egyptian government and is based on striped mullet. The first fertilized mullet spawned in captivity in Egypt was recently obtained.

The University of Guam and the Guam Department of Commerce are also receiving technology transfer from OI on mullet aquaculture. Hawaiian fishponds will also be the recipients of the finfish program technology transfer.

The products of this program are essentially technology and management and could be transferred in cooperation with OI as packages to technology via consulting services and the promotion of investment of aquaculture in developing countries. In addition to spawning and larval rearing technology for hatcheries there is a complete technological package that might be transferred via training and consulting services. The OI consulting branch is located in Washington, DC, and could be the medium through which technology transfer contacts could be negotiated with interested parties.

The OI technology is mature and ready for diffusion. The search for clients could be initiated. It might be possible to identify interested companies that might wish to investigate the possibilities of developing commercial fish hatcheries in the developing countries, and to bring them to a workshop concentrated on this potential activity. This workshop could organized in parallel with a similar workshop to be organized on shrimp hatcheries and shrimp farming. Some of the feed companies and feed millers might also be tapped for their interest in aquatic feeds.

III. NIFTAL PROJECT. BIOLOGICAL NITROGEN FIXATION

1. Status of Development

Various species of bacteria related to the Rhizobium genus have been known to be infective on the roots of plants of the family Leguminosae which comprise around 20,000 species united in over 650 different genera. The infection produces nodules in the roots in which the bacteria thrive in symbiosis with the plants, supplying the latter with nitrogen that they fix from the atmosphere, and receiving in turn carbohydrates for their energy needs transported to the roots from the tops of the plants where they have been produced through photosynthesis. Nitrogen fixed could be as little as 40-70 kilos N/hectare/year for the common bean to as much as 890 kilos/hectare/year for tick clover (Desmodium intortum). Alfalfa could fix under good conditions 250 kilos/, while soybeans could fix about 60-170 kilos/hectare/year depending on other soil and management conditions. It is clear that the diffusion of technology of inoculating with effective nitrogen fixing bacteria, could go a long way in reducing fertilizer consumption, decreasing crop production costs, and consolidating sustainable agricultural systems.

The NifTAL Project (Nitrogen Fixation in Tropical Agriculture) is being conducted at the University of Hawaii, Manui, under Cooperative Agreement with USAID. After a number of years of activity and expected termination in October 1991, it has been extended to September 30, 1992. Its Project No. is 936-4177. Its objectives are to develop appropriate technology for the production of inoculants - developing and conducting [....illegible....]

regional training programs, and supporting in-country research activities in developing countries with the expertise of the NifTAL project. Its area of operations is worldwide.

NifTAL has cooperated with a number of country national research programs, with International Agriultural Research Centers such as CIAT and ICRISAT and private companies. It has helped establish inoculant production capabilities in Thailand, Zambia, Haiti and Uganda; to train extension agents in several countries in inoculant use; and to assist inoculant producers in several countries (Bangladesh, Burma, Egypt, Indonesia, Morocco, Pakistan, Philippines, and Sri Lanka). The crops on which they have conducted work are grain, forage and tree legumes.

While some initial responses to NifTAL technology are apparent, the diffusion of inoculum supply industry has not taken off with the strength and amplitude that it could probably muster. It appears that a large proportion of the efforts have been focalized in developing countries into government agencies either in production or in distribution of inoculants. Price paid for inoculants is insignificant when compared to the savings in chemical fertilizers it produces. Charges to farmers vary from country to country and depend on the price structure in each country but are so low that the rate of return on investment is also very low, and the number of doses required to be sold to break even is very high.

The effectiveness of the inoculants is also different in different crops; it is highly conditioned by the fertility of the soil, the fiertilization program, the species and variety, the presence and permanence of rhizobium remnants in the soil from previous legume crops, and weather and soil factors. With one inoculation, the persistence of sufficient rhizobium bacterial numbers may be assured when a legume rotation is maintained, thus eliminating the need for inoculation every crop of legumes. The native bacteria may also ge highly competitive with the ones carried in the commercial inoculant in terms of root infectivity, reducing their possible higher nitrogen fixing efficiency. There is also - very likely - a high proportion of commercial inoculant doses which carry no live bacteria due to poor preparation of the media, poor preservation of the commercial packages, or exceeded shelf life. All these causes may have been incidental in diminishing expected responses and reducing interest on the part of the users.

Thus, when coupling low expected responses in terms of introgen fixation from the use of commercial inoculants with the low income potential of the industry as conceived today, the conditions for industry failure are given.

Several problems are additionally confronted by the inoculant industry. One of the very serious ones is quality control. NifTAL personnel are engaged in devising systems for quality control. They include infection techniques, growth of test plants for infection assessment by rhizobia, strain identification and

maintenance, development of methods for identification and numbering of populations of rhizobia in inoculants on non-sterile carriers and in soils. Simple quality control techniques must be adapted by inoculant producers. Furthermore, many developing countries have no quality regulations on inoculants in their legislation, and no means of enforcing them in the marketplace.

The development of systems and equipment for the production of inoculants has been a subject of special attention by NifTAL which has been able to provide technical assistance to inoculant manufacturwers in the acquisition of reactors and other equipment designed by NifTAL. Two alternative systems are available: (a) one based on using non-sterile peat medium with undiluted bacterial media, and (b) sterilized peat (usually obtained by irratiating with a 5 megaRAM radiation dose) with diluted medium. The second option may substantially reduce the investment in large fermenters, and using higher dilutions of rhizobia produced in small fermenters at lower cost. In this way labor (cheap) would be traded for capital requirements (expensive). A number of countries especially in Latin America are acquiring expensive public commercial irradiation service facilities and have large peat resources (Argentina, Brazil, Chile and Peru). These could target production for their areas of inoculants at low cost and high efficiencies. Some countries in Asia could be singled out for these available facilities as well, which would help in the reduction of fixed capital expenses in inoculant production facilities by the public sector.

NifTAL has worked with a regional approach in developing a center in Bangkok. It also has representatives in India and Guatemala. These regional Resource Centers are used for backstopping national and private agencies (PVOs, inoculant manufacturers, etc.) in inoculant programs, providing training, workshop support, testing fermentation equipment, providing cultures, antisera, and technical services.

At this stage it seems safe to identify valid technologies available at NifTAL and which could be used in the expansion of the inoculant industry. NifTAL admits that it has not been as effective as it should have in the diffusion of technologies to the private sector. There seems to be a potential interest in the private sector in the possibility of producing inoculants and marketing them. The conditions must be provided, however, for the private sector to be able to extract a profit out of this industry.

Further economic analysis is needed to establish the feasibility of the industry. A financial analysis program called PROBE, based on the CARE small business development program, has been developed at NifTAL and is being used to define the opportunities of return to investment based on alternative cost, price, and output variables. This program is being examined for refinement of its assumptions at my office. It seems to be an efficient program, although we have identified some economic assumptions that are not correct in its make-up. Some simulations

might be in order comparing farmers' returns to investment in inoculants as compared to nitrogen fertilizers, in order to define appropriate pricing for inoculant doses.

With this information ready, it would be possible to organize a formal workshop in which potentially interested companies might participate to define a strategy for action in this field of industry development. NifTAL would do the preliminary preparation of data with the participation of ICD.

It would be important to consider the future of NifTAL until agreements are set up for technology transfer to private sector companies. The establishment of a financial safety net during an intervening period of two-three years might be necessary to see the technology transfer process catch up, in case interested parties can be located and interested in further development in cooperation with NifTAL.

IV. NITROGEN FIXING TREE ASSOCIATION

A visit was paid to the NFTA project located at the Agricultural Experiment Station at Waimanalo of the University of Hawaii. Since about 50% of the activities of the NifTAL appear to be directed to N-fixing trees, this visit was considered pertinent. The President of the Association and the Executive Director were present at the time of my visit.

NFTA works on about 120 species of the more than 1,400 N-fixing trees in existence. It is repository of seed of these trees for its distribution. They are supplying the demand for research purposes with 10-20 gr. samples of seed. Large demands have to be transferred to commercial growers. Unfortunately, the large agroforestry demand that exists worldwide for these species cannot be met, as there are not enough seed orchards producing sufficient seed to cover the demand. NFTA has established personnel in Guatemala and cooperates with the Z-Baire Foundation in India in the establishment of tree orchards for seed production. With the potential provided by tree hybrids this field should effectively be of interest to commercial seed producers, who should be alerted to the opportunities of entering this field. Not only seed orchards planted specifically for seed production but the collection of seed in the wild may be a possibility in the near future.

ICD could offer assistance in helping diffuse the information on need for seed of legume trees for agroforestry projects. Among them as an important special project could be mentioned the work on Leucaena leucocephala and other species of the genus. Leucaena (pronounced "leuwcena") is being used as windbreak, in strip cropping for feeding animals, and for fuel. Many of these species could be of interest for controlling soil erosion in slopes (Haiti is a case in point), and for providing fuel, beans for animal feed, as might be the case for goats, and honey. Seed

companies have some general idea of this potential but it is admitted that no real diffusion has been made to the commercial sector.

7. SYSTEMS APPROACH BETWEEN ICD, USAID AND PROJECTS

A meeting was held with the Dean of the College of Agriculture and his staff, another with the Chairman of the Agronomy Department, and the last day still another with the Director of the Office for Technology Transfer and Economic Development of the University of Hawaii. The common ground that had already been established with the leaders of the projects was expanded at these meetings, so that it included the administrators views in a general consensus.

The University realizes, in the view of all these persons, that it has to establish links with the private sector, and produce products that may be utilitarian and transferable to the private sector out of its research. The private sector shall further develop and then market them. They have not had these views in the past. The University would expect to derive income through royalties, the selling of services and other types of contracts, as I suggested they might, following the lead of other universities. In turn these funds would contribute to support their research. The University is ready and willing to cooperate with ICD and find ways and means to carry out the proposed activities in order to achieve our goals.

Our goals would be, as described to them, planned in phases. A first phase would terminate with the selection of candidates who might be interested in the products of the University, and the signing of contracts with them. ICD's role would terminate there. At that time the contractual relation between the companies and the University would be established, and from there on it would be a straightforward business relationship. It was expressed at various times that ICD's role of continuing its support after this phase might be sought by the University. I indicated that this option was certainly open, but this was not necessarily our goal, as we understand our activities as of catalysts, and we would be ready to move on to other areas of action, but still it would be a matter to consider in due time.

The strategies are open at this time. The University officials and project leaders accept that they have to prepare specific brochures and "prospectuses" for specialized buyers of their technology. At the same time they admit that some of their products need to be refined and better packaged for the commercial market. The requests for information contained in the terms of reference for this mission have been understood by the project leaders, and they expect to prepare and deliver the information we have requested. Ideas were suggested for demonstrations to specific commercial groups, and the workshops have been agreed to.

II. IBSNAT - International Benchmark Sites Network for Agrotechnology Transfer

The meetings at IBSNAT should develop an understanding of how ICD might assist USAID to effectively promote and support the wider use of DSSAT (Decision Support System for Agrotechnology Transfer) through private sector delivery systems. ICD is considering initial activities to:

(a) Identify and contact companies to determine their interest in either using DSSAT and/or collaborating with members of the IBSNAT network in developing new models.

(b) Determine existing company applications of computer modeling of production, postharvest, or marketing which may be of interest over the next 10 years to an expanded IBSNAT network.

(c) Identify and employ a computer systems marketing expert who can quickly master DSSAT, facilitate company contacts and conduct effective DSSAT demonstrations and discussions with select personnel at company sites.

1. Overall

Dr. Grobman will:

- Obtain IBSNAT staff views on how the liaison between ICD and IBSNAT can be most effectively organized.
- Assess research and other information available at IBSNAT and its potential use by ICD.
- Brief IBSNAT staff on ICD - its work generally and specific role in this project.
- Identify IBSNAT staff members who might participate in the public/private sector workshop on DSSAT.

2. Key Informant Meetings with IBSNAT Staff

Dr. Grobman will obtain IBSNAT staff views on:

- DSSAT project history, current work and future directions as they relate to cooperative agreement objectives.
- Opportunities and constraints to greater commercial applications of DSSAT through increased private sector investment, market and product development.
- Strategies, opportunities and limitations to effectively marketing current and new DSSAT products in terms of developing country needs.
- DSSAT pricing strategies as part of marketing effort.
- IBSNAT's role, including strengths and limitations, in the process of promoting greater use of current DSSAT products by the private sector and decision-makers at national and farm levels. Also ideas for new DSSAT products.

- Lessons learned from successful or unsucessful marketing of DSSAT in developed and developing countries.

- Technological limitations of DSSAT in predicting crop responses for different crop types and under varying conditions.

3. Assessment of Information Resources

- Status of information on and profiles of existing DSSAT users and their applications.

- Existing research and lists of private sector companies that utilize similar computer modeling technology in production, postharvest, or marketing and have expressed an interest in DSSAT;

- Assessments of DSSAT's market potential and economic benefits.

III. OCEANIC INSTITUTE

The meetings at the Oceanic Institute should expand ICD's understanding of those products and processes (eg. maturing, spawning and hatchery rearing of marine species) developed with USAID assistance that have strong potential for wider use in developing countries through public/private sector cooperation.

1. Overview

Dr. Grobman will:

- Assess research and other information available at the Institute and its potential use by ICD.

- Brief Institute staff on ICD - its work generally and specific role in this project.

- Identify Institute staff members who might participate in a possible public/private sector workshop.

2. Key Informant Meetings with Institute Staff

Dr. Grobman will obtain staff views on:

- Those products and processes which the Institute has developed with expected potential for wider commercial application.

- Opportunities and constraints to greater commercial use of Institute developed products.

- The Institute's role, including strengths and limitations, in the process of promoting greater use of current products by the private sector in developing countries.

- Lessons learned from successful or unsuccessful promotions of indicated products in developed or developing countries, including the role of research and other public sector institutions.

III. Assessment of Information Resources

Dr. Grobman will review:

- Existing research on and lists of private sector companies using or interested in the Institute's products or processes.

- Institute or external evaluations of product market potential and economic benefits in developing countries.

10/29/91

wk13/grobman

ICD COOPERATIVE AGREEMENT WITH USAID/WORKPLAN BUDGET (PROPOSED) 12/91
[NO. DAN-4200-A-00-1076-00]

ACTIVITY	FUNDING SOURCE			
	USAID	ICD	IBSNAT	NIFTAL
I. PRELIMINARY RESEARCH				
SALARIES AND FRINGE:				
Executive Director (7 days @ $375)	2,625			
Program Manager (6 days @ $202)	1,212			
CONSULTANT FEES:				
Senior Associate (Grobman) (17 days @ $300)	5,100			
Graduate Research Associate (McCann) (10 days @ $112)	1,120			
TRAVEL:				
(air transportation)				
1 Peru - Hawaii (RT)	2,500			
2 New York - Wash. DC (RT)	600			
PER DIEM:				
9 days @ $140	1,260			
COMMUNICATION: (telephone, fax, courier, etc)	500			
COMPUTER SERVICES:	200			
OTHER DIRECT COSTS: (printing, production, etc.)	500			
SUBTOTAL:	15,617	--	--	--

ICD COOPERATIVE AGREEMENT WITH USAID/WORKPLAN BUDGET (PROPOSED) 12/91
[NO. DAN-4200-A-00-1076-00]

ACTIVITY	FUNDING SOURCE			
	USAID	ICD	IBSHAT	NIFTAL
I. PRELIMINARY RESEARCH				
SALARIES AND FRINGE:				
Executive Director (7 days @ $375)	2,625			
Program Manager (6 days @ $202)	1,212			
CONSULTANT FEES:				
Senior Associate (Grobman) (17 days @ $300)	5,100			
Graduate Research Associate (McCann) (10 days @ $112)	1,120			
TRAVEL: (air transportation)				
1 Peru - Hawaii (RT)	2,500			
2 New York - Wash. DC (RT)	600			
PER DIEM: 9 days @ $140	1,260			
COMMUNICATION: (telephone, fax, courier, etc)	500			
COMPUTER SERVICES:	200			
OTHER DIRECT COSTS: (printing, production, etc.)	500			
SUBTOTAL:	15,617	--	--	--

ICD COOPERATIVE AGREEMENT WITH USAID/WORKPLAN BUDGET
[NO. DAN-4200-A-00-1076-00]

ACTIVITY	FUNDING SOURCE			
	USAID	ICD	IBSNAT	NIFTAL
II. DIALOGUE WITH KEY INFORMANTS (cont...)				
PER DIEM:				
ICD Senior Associate (Grobman) [30 days @ $125/day]			3,750	
IBSNAT Representative [25 days @ $125/day]			3,125	
COMMUNICATION: (telephone, fax, courier, etc)	3,265			
COMPUTER SERVICES:	500			
OTHER DIRECT COSTS: (printing, production, etc.)	500			
SUBTOTAL:	29,195		25,075	

ICD COOPERATIVE AGREEMENT WITH USAID/WORKPLAN BUDGET
[NO. DAN-4200-A-00-1076-00]

ACTIVITY	FUNDING SOURCE			
	USAID	ICD	IBSNAT	NIFTAL
III. DRAFT SHORT SUBSECTOR WORKING PAPERS				
SALARIES AND FRINGE:				
Executive Director (3 days @ $375)	1,125			
Program Manager (2 days @ $202)	404			
CONSULTANT FEES:				
Senior Associate (Grobman) (5 days @ $300)	1,500			
Senior Industry Advisers (4 days @ $1,000/contributed)		4,000		
Graduate Research Associate (McCann) (3 days @ $112)	336			
COMMUNICATION: (telephone, fax, courier, etc)	400			
OTHER DIRECT COSTS: (printing, production, etc.)	300			
SUBTOTAL:	4,065	4,000		

ICD COOPERATIVE AGREEMENT WITH USAID/WORKPLAN BUDGET
[NO. DAN-4200-A-00-1076-00]

ACTIVITY	FUNDING SOURCE			
	USAID	ICD	IBSNAT	NIFTAL
IV. PLAN AND CONDUCT SUBSECTOR WORKSHOPS				
SALARIES AND FRINGE:				
Executive Director (10 days @ $375)	3,750			
Program Manager (6 days @ $202)	1,212			
CONSULTANT FEES:				
ICD Senior Associate (Grobman) (10 days @ $300)	3,000			
Industry Advisers (12 days @ $1,000/contributed)		12,000		
Graduate Research Associate (McCann) (3 days @ $112)	336			
TRAVEL:				
ICD Senior Associates/Staff (3)				
1 Lima - Hawaii (RT)			2,500	
2 New York - Hawaii (RT)			3,200	
Industry Advisers to IBSNAT (5 persons)				
5 U.S. Mainland - Hawaii (RT) (5 persons @ $ 1,500)			7,500	

ICD COOPERATIVE AGREEMENT WITH USAID/WORKPLAN BUDGET
[NO. DAN-4200-A-00-1076-00]

ACTIVITY	FUNDING SOURCE			
	USAID	ICD	IBSNAT	NIFTAL
IV. PLAN AND CONDUCT SUBSECTOR WORKSHOPS (cont...)				
Industry Advisors to NIFTAL (5 Persons)				
5 US Mainland - Hawaii (RT) (5 persons @ $ 1,500)				7,500
PER DIEM (Hawaii):				
ICD Senior Associates and Staff (3): (3 persons for 6 days @ $140/day)			1,260	1,260
Industry Advisors to IBSNAT (5): (5 persons for 3 days @ $140)			2,100	
Industry Advisers to NIFTAL (5): (5 persons for 3 days at @ $140)				2,100
COMMUNICATION: (telephone, fax, courier, etc)	1,500			
OTHER DIRECT COSTS: (printing, production, workshop facilities, receptions, etc)	500		2,000	2,000
SUBTOTAL:	10,298	12,000	18,560	12,860

ICD COOPERATIVE AGREEMENT WITH USAID/WORKPLAN BUDGET
[NO. DAN-4200-A-00-1076-00]

ACTIVITY	FUNDING SOURCE			
	USAID	ICD	IBSNAT	NIFTAL
V. PREPARATION OF FINAL REPORT				
SALARIES AND FRINGE:				
Executive Director (4 days @ $375)	1,500			
Program Manager (3 days @ $202)	606			
CONSULTANT FEES:				
ICD Senior Associate (Grobman) (5 days @ $300)	1,500			
Industry Advisers (4 days @ $1,000/contributed)		4,000		
TRAVEL: (air transportation)				
2 New York - Washington D.C. (RT) (2 person @ $300)	600			
COMMUNICATION: (telephone, fax, courier, etc)	1,000			
OTHER DIRECT COSTS: (printing, production, etc.)	660			
SUBTOTAL:	5,866	4,000		

Annex IV

DRAFT LIST OF POTENTIAL TARGET GROUPS FOR DSSAT DEMONSTRATIONS IN THE U.S.

{For Review & Revision by IBSNAT, USAID & ICD}

Prepared by ICD

February 1992

STATE: MINNESOTA (CONT.)

COMPANY/ORGANIZATION	ADDRESS/PHONE/FAX	CONTACT(S)	BUSINESS INTEREST
Land O'Lakes, Inc.	P.O. Box 116 St. Paul, Minnesota 55440 TEL: 612/481-2222 FAX: 612/	Ms. Martha Cashman Director International Development Operations	(Agricultural Products, soybean seed, etc.)
Northrup King Co.	7500 Olson Memorial Hwy. Golden Valley, Minnesota 55427 TEL: 612/593-7121 FAX: 612/593-7141	Robert G. Richardson	
University of Minnesota	1994 Buford Avenue St. Paul MN 55108 TEL: 612/625-5778	Dr. Dale Dahl, Professor Agricultural & Applied Sciences Dr. Vernon Eidman, Professor R. Kent Crookston Sustainable Agriculture Program Vernon W. Ruttan	
Internatl Alliance for Sustainable Agriculture	Newman Cntr 1701 University Ave SE Minneapolis MN 55414	Terry Gips, Executive Director	
Faribault Foods Inc.	Faribault, MN		Beans (consumer, inst'l, private label, bulk)

STATE: MINNESOTA

COMPANY/ORGANIZATION	ADDRESS/PHONE/FAX	CONTACT(S)	BUSINESS INTEREST
Harvest States Cooperatives (M)	P. O. Box 64594 St. Paul, Minnesota 55164 TEL: 612/646-9433 FAX: 612/641-6857	Allen D. Hanson President and CEO	
Minnesota Assn. of Cooperatives	480 Cedar Street, Suite 380 St. Paul, Minnesota 55101 TEL: 612/228-0213	Allen Gerber Executive Director	
The Pillsbury Company	200 S. 6th Street MS 21A9 Pillsbury Center Minneapolis, Minnesota 55402 TEL: 612/330-5133 FAX: 612/330-8961		
General Mills	P.O. Box 1113 One General Mills Blvd. Minneapolis, MN. 55440 TEL: 612-540-2311	Gortons Stephen H. Warhover President	
Cargill Incorporated	Box 9300 - Lake Office Minneapolis, MN 55440 TEL: 612/475-7575	Dr. Daniel R. Pearson Public Affairs Analyst	
Curtin University	Two Appletree Office, Suite 144 8011 34th Avenue South Minneapolis, MN 55425 TEL: 800/245-2575 FAX: 215/251-7580	Dr. Ian Fairnie North American Director	
Doane Agricultural Services Co.	Minneapolis Software Division 8800 Queen Avenue South Bloomington, MN 55431 TEL: 612/921-6342 FAX: 612/921-6869		(ag. software prdts)

STATE: IOWA (CONT.)

COMPANY/ORGANIZATION	ADDRESS/PHONE/FAX	CONTACT(S)	BUSINESS INTEREST
Leopold Center for Sustainable Agriculture Iowa State University	126 Soil Tilth Bldg. Iowa State University Ames, IA 50011 TEL: 515/294-3711 FAX: 515/294-9696	Dennis R. Keeney	

STATE: IOWA

COMPANY/ORGANIZATION	ADDRESS/PHONE/FAX	CONTACT(S)	BUSINESS INTEREST
Iowa Institute of Cooperation (State Ag. Coop. Council)	2515 Elwood Drive, Suite 104 Ames, IA 50010 TEL: 515/292-2667	Larry Kallem Executive Director	
Pioneer Hi-Bred International	6800 Pioneer Parkway P. O. Box 316 Johnston, IA 50131 TEL: 515/270-3103 FAX: 515/270-3156	John T. Watson	
Pioneer Hi-Bred International Business Information Services	11153 Aurora Avenue Des Moines, IA 50322 TEL: 515/253-5700 FAX: 515/253-5793	John James President	(ag software for financial, crop, and livestock management)
Iowa State University	Center for Agribusiness Mngemnt Ames, IA 50011 TEL: 515/294-3657 FAX: 515/294-6060	Dr. Max Wortman Director	
Agri-Education, Inc.	P.O. Box 497 801 Shakespeare Stratford, IA 50249 TEL: 515/838-2785 FAX: 515/838-2788	Keith R. Carlson President	(ag. software developer)
Global Technologies Inc.	P. O. Box 3886 7200 Hickman Road, Ste. 202 Des Moines IA 50322 TEL: 515/276-6642 FAX: 515/278-8054	Suri Sehgal	
ICI Seeds Inc.	P. O. Box 300 Coon Rapids, IA 50058 TEL: 712/684-2211 FAX: 712/684-3349	R. A. Woods	

STATE: ILLINOIS (CONT.)

COMPANY/ORGANIZATION	ADDRESS/PHONE/FAX	CONTACT(S)	BUSINESS INTEREST
University of Illinois Agricultural Economics	1301 W. Gregory, 305 Mumford Urbana IL 61801 TEL: 201/333-1817	Dr. Michael Mazzocco Assistant Professor Dr. Anthony Soskin Professor	
Assn of Agricultural Computer Companies	P. O. Box 122 Claytonville IL 60926	John F. Bruns Executive Director	
American Farm Bureau Research Foundation	225 Touhy Avenue Park Ridge IL 60068 TEL: 312/399-5700	Dean R. Kleckner, President	

STATE: ILLINOIS (CONT.)

COMPANY/ORGANIZATION	ADDRESS/PHONE/FAX	CONTACT(S)	BUSINESS INTEREST
Illinois Farm Bureau Computer	1701 Towanda Avenue Bloomington, IL 61701 TEL: FAX:	John White, Jr. President	(ag software developer)
Agriculture Experiment Station	1301 W. Gregory Dr., 211 Mumford Urbana, IL 61801 TEL: 217/333-0240 FAX: 217/333-1952	Dr. Donald Holt Director	(ag decision aid software development)
United Agri Seeds Inc.	P.O. Box 4011 Champaign, IL 61820 TEL: 217/373-5300 FAX: 217/356-5300		
Beef Industry Council Natl Livestock and Meat Board	444-G N. Michigan Ave. Chicago, IL 60611 TEL: 312/467-5520		(beef industry)
DeKalb Plant Genetics	3100 Sycamore Road DeKalb, IL 60115 TEL: 815/756-7333 FAX: 815/758-3711	David L. Curtis	
Illinois Foundation Seeds Inc.	P. O. Box 722 Champaign, IL 61824-0722 TEL: 217/485-6260 FAX: 217/485-3687	Dale E. Cochran	
Kraft	2211 Sauders Road Northbrook, IL 60062	Mrs. Marcia Glenn, Director Econ. Research Opera. & Technology	
Chicago Mercantile Exchange	30 South Wacker Chicago, IL 60606	Mr. Mike Gorham VP Marketing & Research	
Chicago Board of Trade	141 W. Jackson Blvd. Ste 3110 Chicago IL 60604 TEL: 312/435-3794	Dr. Eugene Kunda, Agricultural Economist, Economic Analysis & Planning	

STATE: ILLINOIS

COMPANY/ORGANIZATION	ADDRESS/PHONE/FAX	CONTACT(S)	BUSINESS INTEREST
Sara Lee Corporation	3 National Plaza Bldg 70 W. Madison Street Chicago, IL 60602 TEL: 312/726-2600	Paul Fulton President	
Archer Daniels Midland Co.	P.O. Box 1470 Decatur, IL 62525 TEL: 217/424-5200 FAX: 217/424-5581	John G. Reed, Jr. Vice-President, International	
The Quaker Oats Co.	Quaker Tower P.O. Box 9001 Chicago, IL 60604-9001 TEL: 312/222-7111		
Beatrice Company	Two North LaSalle Street Chicago, IL 60602 TEL: 312/782-3820		
Farm Foundation	1211 W. 22nd Street, Suite 216 Oak Brook, IL 60521 TEL: 708/571-9393 FAX: 708/571-9680	R.J. Hildreth Managing Director Dr. Walter Armbruster Associate Managing Director	
IMC Fertilizer	501 East Lange Street Mundelein IL 60060 TEL: 708/272-9200	Dr. Peter Heffernan Manager Market Research Mr. Billie B. Turner CEO	(world's largest producer of phosphate rock & potash)
Agri Business Computer Review	1401 E. Washington Street Pittsfield, IL 62363 TEL: 217/285-2482	Paul Ransom Editor	(media)
IlliNet Software University of Illinois	1301 W. Gregory, 330 Mumford Urbana, IL 61801	Dan Cotton Coordinator	(part of university cooperative extension service)

STATE: GEORGIA (CONT.)

COMPANY/ORGANIZATION	ADDRESS/PHONE/FAX	CONTACT(S)	BUSINESS INTEREST
UNIVERSITY OF GEORGIA	DEPARTMENT OF AG ENGINEERING GEORGIA STATION GRIFFIN, GEORGIA 30223-1797 TEL: 404/228-7216 FAX: 404/228-7270	DR. GERRIT HOOGENBOOM (IBSNAT NETWORK REPRESENTATIVE) DR. STANLEY FLETCHER ASSOCIATE PROFESSOR	EDUCATION/RESEARCH
UNIVERSITY OF GEORGIA AG ECONOMICS	CONNER HALL ATHENS, GA 30602 TEL: 404/542-2481	DR. ROBERT SHULSTAD CHAIRMAN & DEPT HEAD	

STATE: GEORGIA

COMPANY/ORGANIZATION	ADDRESS/PHONE/FAX	CONTACT(S)	BUSINESS INTEREST
GOLD KIST INC.	P.O. BOX 2210 244 PERIMETER CTR. PKWY. N.E. ATLANTA, GA. 30301 TEL: 404/548-2855 FAX: 404/393-5421	DON SANDS, CEO RICHARD L. WEAVER FERTILIZER DIVISION DR. GLEN GLOVER, DIRECTOR STRATEGIC PLANNING & ECONOMIC RESEARCH	FARMER COOPERATIVE: PEANUTS, SOYBEANS, POULTRY, ETC. FERTILIZER
POTASH & PHOSPHATE INSTITUTE	ATLANTA, GA. TEL: 404/634-4275		
GEORGIA COOPERATIVE COUNCIL, INC	635 FOREST ROAD ATHENS, GA. 30605 TEL: 404/548-2855		STATE COUNCIL OF FARMER COOPERATIVES
GOLDEN PEANUT COMPANY	1100 JOHNSON FERRY ROAD ATLANTA, GA 30342 TEL: 404/843-7810	MICHAEL A. STEMPERT EXECUTIVE V.P./CHAIRMAN	PEANUT GROWER/PROCESSOR
BROOKS & EVANS INC.	8285 DUNWOODY PLACE ATLANTA, GA. 30338 TEL: 404/843-7810		PROCESSORS & EXPORTERS OF PEANUT COTTONSEED,AND SUNFLOWER
PEANUT ADVISORY BOARD	1950 N. PARK PLACE, SUITE 525 ATLANTA, GA 30339 TEL: 404/763-3511		
EVERETT SEED INC.	480 CENTRAL AVE. BOX 90992 EAST POINT, GA. 30364 TEL: 404/998-3900		HYBRID CORN SEEDS, ETC.
AGRATECH SEEDS	P.O. BOX 2210 ATLANTA, GA 30301 TEL: 404/393-5410 FAX: 404/393-5339	DARREL GRABOW	

ustour2
usaid/ca-wk

STATE: FLORIDA

COMPANY/ORGANIZATION	ADDRESS/PHONE/FAX	CONTACT(S)	BUSINESS INTEREST
Helm Fertilizer Corporation	9950 Princess Palm Ave. Suite 312 Tampa, FL 33619 TEL: 813/621-8846 FAX: 813/621-0763	Arthur J. Roth	(fertilizer producer/supplier)
NITRAM, INC	P.O. Box 2968 Tampa, FL 33601 TEL: 813/626-2181 FAX: 813/623-6080	John F. Harris	(Fertilizer producer/supplier)
Northern Star Minerals, Inc.	3710 Corporex Park Drive Suite 210 Tampa, FL 33616 TEL: 813/623-6005 FAX: 813/628-4324	Don Sarginson	(fertilizer producer/supplier)
Transammonia, Inc.	3109 W. Martin L. King Blvd. Suite 745 Tampa, FL 33607 TEL: 813/878-2005 FAX: 813/878-0147	Edward L. Gleason	(fertilizer producer/supplier)

STATE: CALIFORNIA (CONT.)

COMPANY/ORGANIZATION	ADDRESS/PHONE/FAX	CONTACT(S)	BUSINESS INTEREST
Royal Sluis, Inc.	1293 Harkins Road Salinas, CA 93901 TEL: 408/757-4191 FAX: 408/757-1512	Pieter van Kesteren	
World Vision Relief & Development Inc.	919 W. Huntington Drive Monrovia CA 91016 TEL: 818/357-7979 FAX: 818/358-2896	Julian Pitchford	
Del Monte	1 Market Plaza P. O. Box 3575 San Francisco, CA 94119 TEL: 415/442-4000		Canned fruits, vegetables, food specialties, dried fruits, frozen, fresh produce

STATE: CALIFORNIA

COMPANY/ORGANIZATION	ADDRESS/PHONE/FAX	CONTACT(S)	BUSINESS INTEREST
Pacific Coast Producers	P.O. Box 1600 Lodi, CA 95241-1600 TEL: 209/734-1710 FAX: 209/339-8815	Larry Clay President & CEO	
Rice Growers Assn. of CA	P.O. Box 958 Sacramento, CA 95804 TEL: 916/371-6941 FAX: 916/372-[illegible]58	David R. Long Chief Executive Officer	
Tri-Valley Growers	P.O. Box 7114 San Francisco, CA 94120-7114 TEL: 415/445-1600 FAX: 415/445-1628	James Saras Chief Executive Officer	
Agricultural Council of CA	P.O. Box 1712 Sacramento, CA 95808 TEL: 916/443-4887 FAX: 916/443-0601	Mr. Leland H. Ruth President	
Farmers' Rice Cooperative	P.O. Box 15223 Sacramento, CA 95851-0223 TEL: 916/923-5100 FAX: 916/920-4295	Ralph S. Newman, Jr. President & CEO	(chairman, govt/public affairs ctte, Rice Millers Assn)
AutoDesk	Sausalito, CA TEL: 415/332-2344	Mr. Alvar James Green CEO	(leader in software for desktop computer aided design)
McArthur Overseas Corporation	P.O. Box 35836 Los Angeles, CA 90035 TEL: 213/939-5353 FAX: 213/939-3053		(farm management/crops)
Pacific Seed & Feed Company	1981 N. Broadway, Suite 370 Walnut Creek, CA 94596 TEL: 415/256-7400 FAX: 415/256-9149		(sorghum seed, fertilizer, etc.)

Industry Council for Development

Annex III

REPORT ON ICD DISCUSSIONS WITH IBSNAT NETWORK REPRESENTATIVES AT THE UNIVERSITY OF FLORIDA & IFDC
16-21 January 1992

1. ICD Executive Director Walter Simons, Senior Associate Alex Grobman and Program Manager Will Kennedy held meetings with Jim Jones, Walter Bowen and colleagues at Gainesville on 16-17 January. In addition, Alex Grobman held meetings with IFDC representatives, 20-21 January.

   Demonstrations of DSSAT and GIS and their applications were presented and discussed at some length during the course of these visits.

2. The meetings served as an important opportunity to:

- Further ICD's knowledge and understanding of DSSAT and to a lesser extent AEGIS.

- Strengthen the basis of ICD/IBSNAT partnership particularly in terms of:

  . DSSAT's comparative advantages and potential to serve a range of potential public and private sector end-users;

  . formulating a logical strategy for serving such markets;

  . reaching consensus on immediate programmatic matters as agreed to in the ICD/IBSNAT workplan;

- Explore the logic and attractiveness of linking DSSAT, AEGIS and PAM.

Meetings at the University of Florida/Gainesville

3. It was agreed, that the initial DSSAT product has been developed and well received. There is now a need to conduct further market research — to assess the potential markets for DSSAT products outside of the academic research sector by conducting demonstrations to a cross-section of potential public and private sector end-users. The feedback from these demonstrations will help to determine the level of interest and potential for market expansion of current and future DSSAT models. The process should also help to identify a nucleus of private sector experts to assist ICD and IBSNAT in formulating a strategy for long-range DSSAT product development and marketing to both public and private markets.

4. Discussions prioritized user groups to be targeted for DSSAT demonstrations (e.g. seed companies, farmer cooperatives (including fertilizer), policy makers, commodity brokers, food processing companies, consultants, etc), identified several DSSAT

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applications that might be of interest to each group and reviewed the structure, format and possible locations of the presentations. It was agreed that Grobman would be joined by an IBSNAT representative while conducting the demonstrations during the last 2-3 week period in March.

IBSNAT will need to decide who should assist Grobman during the exercise. If feasible, it may be advantageous to have IBSNAT network representatives with specific model expertise to conduct demonstrations to commercial end-users with an interest in the same commodity (e.g. Jones/soybean producers and processors; Thornton/fertilizer manufacturers, etc.)

5. Jones briefed ICD on the results of the IBSNAT Technical Assistance Committee (TAC) meeting in Thailand and outlined the market development strategy proposed by McWilliam which focused on securing alternate sources of funding for the core activity, preferably from multilateral donors, particularly the CGIAR system, UNDP and the World Bank. The strategy would strengthen the research, training and extension linkages particularly with CGIAR Centers and NARS groups.

6. ICD outlined (see attached diagram) an integrated approach to DSSAT market development which encompasses public, private, and mixed (e.g. education) markets and further refines existing products, develops new products and fosters wider use. This would involve a market (versus research) driven process linking core research activities to product development and marketing, with private sector support through ICD.

7. The approach designed in Thailand focused on public sector markets and foresees "a core group of permanent systems scientists representing the core disciplines that form the basis of the technical advice and the input to the system." The core group would be responsible for the management and directions taken by the system. Around this core group (the outer core or what ICD refers to as the coordinating body) would be a number of experts who could be brought in as advisors to the system as required. It was agreed that ICD could participate as a member of the outer core group to act as an advisor and marketing intermediary service with private and mixed markets.

8. Demonstrations to commercial end-users should include AEGIS as well as DSSAT, if possible, and convey the potential as well as existing applications of the models.

9. A DSSAT demonstration and discussion with an interdisciplinary group of researchers and administrators at the University generated a productive exchange of ideas. Dr. Uma Lele, formerly with the World Bank, was very familiar with crop and farm system models and had a number of constructive suggestions for enhancing DSSAT's use by developing country policy makers, extension agents, farmers and private sector agents which Jones and Bowen will pursue further. The assistant director of the International Affairs Office expressed the University's strong interest in linking research activities to revenue generating operations.

<u>Meetings at IFDC</u>

10. Grobman met with Thornton, Stangel and others (e.g. Drs. Baanante, Parish and Livingston) at IFDC who are active in developing the DSSAT model for fertilizer and briefed them on ICD/IBSNAT objectives under the cooperative agreement. IFDC expressed its support for the activity and recommended fertilizer companies to target for demonstrations.

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11. Thornton agreed to help develop the DSSAT demo for presentation to fertilizer manufacturers. Thornton confirmed that the model still needed considerable work before it would be ready for extensive private sector application. He has since been in contact with Jones and Bowen to coordinate activities.

12. Grobman urged Thornton, who is an economist, to attend the PAM workshop in Washington.

13. Unfortunately, Singh will be leaving IFDC for IRRI within the next month and will not be in a position to assist this effort.

14. Operational Priorities and Timetable

(1) 24-31 Jan. / ICD will draft the DSSAT synopsis/brief and cover letter intended for industry, propose target groups for the demonstrations and an itinerary for review and revision by IBSNAT and USAID. Jones and Bowen will develop a one-page summary sheet of IBSNAT Network member expertise as it relates to specific DSSAT models.

(2) 19-21 Feb. / Grobman, Jones, possibly Bowen and Thornton and/or a U of F/Gainesville economist will attend the PAM workshop in Washington D.C. to further explore potential linkages with DSSAT. The program for the 21st will be developed in consultation with Dean Alter.

(3) 24-28 Feb. / Grobman will travel to Gainesville to work with Jones, Bowen, Uehara (1 day) and Ritchie (1 day) to develop customized DSSAT demonstrations for targeted end-users identified above and to discuss overall project management alternatives that incorporate public funded research and development as well as the private sector.

(4) 2-5 March / Grobman will attend CODATA conference with Ritchie in France.

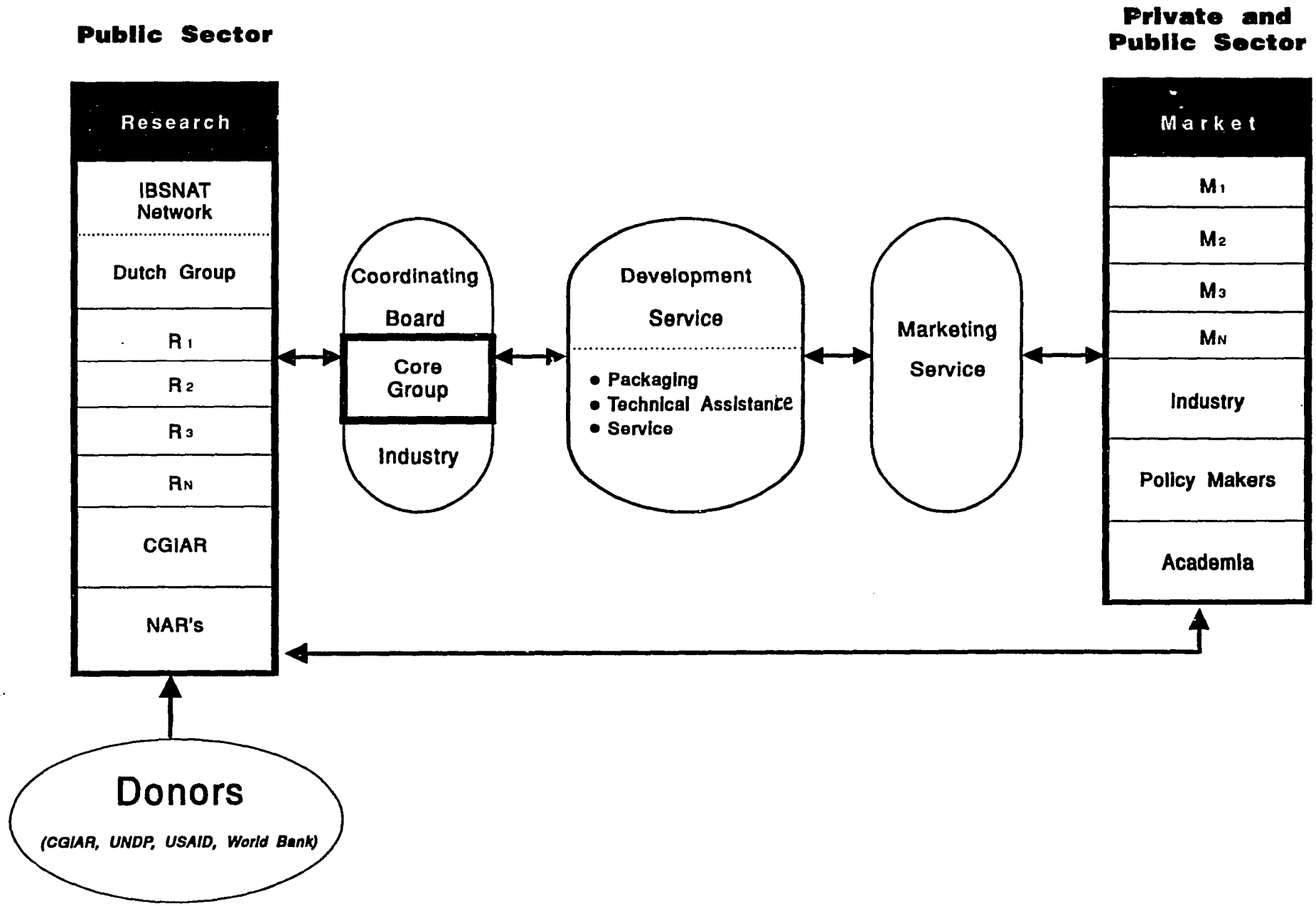
(5) 6 March / Grobman will present status report on USAID/ICD cooperative agreement including potential DSSAT market development program to ICD Board of Directors meeting in Zurich.

(6) 9-10 March / Grobman will discuss DSSAT applications with ICD members in London (e.g. , Unilever, Shell, BAT, ICI, Tate & Lyle, etc.)

(7) Last 2-3 weeks of March / DSSAT demonstrations will be conducted to (primarily) private sector representatives in several major U.S. agribusiness centers as well as multilateral development agencies (e.g. UNDP, World Bank etc.)

1/24/92

Core DSSAT Product



Attachment

STATE: MISSOURI

COMPANY/ORGANIZATION	ADDRESS/PHONE/FAX	CONTACT(S)	BUSINESS INTEREST
Monsanto Agricultural Company	Mail Code B2SF	John Scott Information Systems Specialist	
Monsanto Agricultural Company	800 N. Lindbergh Blvd. C2NA St. Louis, MO 63167 TEL: 314/694-2118	Robert Shapiro President	
Ralston Purina Company	Checkerboard Square-2CBC St. Louis, MO 63164 TEL: 314/982-2669	James Allwood, Director Commodity, Economic & Regulatory Services	
American Soybean Association	540 Maryville Center Drive Suite 400 P.O. Box 27300 St. Louis, MO 63141 Tel: 314/576-1770	Michael Phillips Staff Vice President Research & Promotion Division	
National Corn Growers Assn.	St. Louis TEL: 314/275-9915 FAX: 314/275-7061		
University of Missouri-Columbia	College of Agriculture, Food & Natural Resources 2-69 Agricultural Bldg. Columbia, MO 65211 TEL: 314/882-3846	Dr. Roger Mitchell Dean	
Busch Agricultural Resources Inc	One Busch Place St. Louis, MO 63118 Tel: 314/577-3314 Fax: 314/577-2900		grain processing
PET, Inc.	400 South Fourth St. P.O. Box 392 St. Louis, MO. 63166 Tel: 314/621-5400 Fax: 314/621-		specialty foods including dry beans

STATE: NEW YORK/NEW JERSEY

COMPANY/ORGANIZATION	ADDRESS/PHONE/FAX	CONTACT(S)	BUSINESS INTEREST
Cornell University	Department of Agric'l Economics	Dr. Deborah A. Streeten	(interested in information systems which support decision making for commodity futures and options markets).
Merrill Lynch & Company, Inc.			
IncoTrade, Inc.	55 East 59th Street, 18th Fl. New York, NY 10022 TEL: 212/752-2400 FAX: 212/752-2553/7		(commodity exporters/traders: rice, etc.)
Continental Grain Company	277 Park Avenue New York, NY 10172 TEL: 212/207-5495 FAX: 212/		
Kraft General Foods	250 North Street White Plains, NY 10625 TEL: (914)-335-2500 FAX:		
CPC International	International Plaza Englewood Cliffs, NJ 07632 TEL: 201/894-2113 FAX: 201/894-2186	Mr. John W. Scott Vice-President	
Borden, Inc.	277 Park Avenue New York, NY 10172 TEL: 212/573-4000 FAX:		
Nabisco Brands, Inc	100 Deforest Avenue East Hanover, NJ 07936 TEL: 201/682-5000		(cookies, crackers, nuts, margarines, hot cereals)

STATE: NEW YORK/NEW JERSEY (CONT.)

COMPANY/ORGANIZATION	ADDRESS/PHONE/FAX	CONTACT(S)	BUSINESS INTEREST
Rabobank Nederland	245 Park Avenue New York, NY 10167 TEL: 212/916-7830 FAX: 212/818-0233	Mr. Sanford A. Belden Senior Vice President	
Computer Association Int'l.	Garden City, NY TEL: 516/227-3300	Mr. Charles B. Wang CEO	(nation's largest software only company)
IBM Corporation	Armonk, NY 10504 TEL: 914/765-1900	John F. Ackers CEO	
H.J. Baker & Bro., Inc.	100 E. 42nd Street New York, NY 10017 TEL: 212/867-0200 FAX: 212/370/1639	Aaron L. Mathis	(fertilizer producer/supplier)
UNDP	1 United Nations Plaza New York, NY 10017	Tim Rothermel Luis Gomez Echeverri Nyle Brady Friedrich von Mallinckrodt	
Cornell University Dept of Agriculture Economics	301 Warren Hall Ithaca, NY 14853 TEL: 607/255-1611	Dr. Deborah Streeter Professor	
CARE	660 First Avenue New York NY 10016 TEL: 212/686-3110 FAX: 212/696-4005	Remko Vonk Peter Hazelwood	
American Breeders Service		Priscilla Myerson	bull semen, livestock feed

STATE: NEW YORK/NEW JERSEY (CONT.)

COMPANY/ORGANIZATION	ADDRESS/PHONE/FAX	CONTACT(S)	BUSINESS INTEREST
Campbell Soup Company	Campbell Place Camden, NJ 08103-1799 Tel: 609/342-4800 Fax: 609/342-3878		

STATE: TEXAS

COMPANY/ORGANIZATION	ADDRESS/PHONE/FAX	CONTACT(S)	BUSINESS INTEREST
Viterra International Ltd.	P. O. Box 19435 Houston TX 77224-9435 TEL: 713/589-6477 FAX: 713/589-1585	Robert W. Temple	
American Rice, Inc.	P.O. Box 2587 Houston, TX 77252 TEL: 713/873-8800 FAX: 713/873-9439	John M. Howland President & CEO	
Comet Rice, Inc.	P.O. Box 1953 Houston, TX 77251-1953 TEL: 713/872-6638 FAX: 713/872-2031	John S. Poole President & CEO	
Gulf Rice Milling, Inc.	950 Echo Lane, Suite 330 Houston, TX 77024 TEL: 713/464-0606 FAX: 713/467-0325	Fred Brenckmann President	
Uncle Ben's Inc.	P.O. Box 1752 Houston, TX 77251-1752 TEL: 713/674-9484 FAX: 713/670-2111	C. Ronald Caffey Director, Commodities	
Creed Rice Co. Inc.	800 Wilcrest, Suite 200 Houston, TX 77042 TEL: 713/782-3260		(rice broker)
Coastal Rice and Futures, Inc.	P.O. 821267 Houston, Texas 77282-1267 TEL: 713/558-4333 FAX: 713/497-6770		(rice broker)

STATE: TEXAS (CONT.)

COMPANY/ORGANIZATION	ADDRESS/PHONE/FAX	CONTACT(S)	BUSINESS INTEREST
BMC Software	Sugar Land, TX TEL: 713/240-8800	Max P. Watson Jr. CEO	(spends 25% on R&D, -likes new prdts.)
Compaq Computer Corporation	20555 State Hwy 149 Houston, TX 77070 TEL: 713/370-0670	Joseph R. Canion CEO	(# 3 in personal computers)

STATE: WASHINGTON, DC & VICINITY

COMPANY/ORGANIZATION	ADDRESS/PHONE/FAX	CONTACT(S)	BUSINESS INTEREST
American Seed Trade Association	Executive Building, Suite 964 1030 15th Street NW Washington, DC 20005 T:202/223-4080 F:202/293-2617	Mark S. Condon International Marketing Director	
Institute for Alternative Agriculture	9200 Edmonston Road, Suite 117 Greenbelt, MD 20770 TEL: 301/441-8777		
The Fertilizer Institute	501 Second Ave, NW Washington DC 20002 TEL: 202/675-8250 FAX:	P. Whitney Yelverton Vice-President	
National Association of Wheat Growers			
Citizens Network for Foreign Affairs			
National Peanut Council	1500 King Street Alexandria, VA 22314 TEL: 703/838-9500 FAX: 703/838-9508	J. Anderson Director, International Marketing	
National Council of Farmer Cooperatives	50 F Street NW Washington, DC 20001 TEL: 202/626-8700	Dr. Wayne Boutwell President	
U.S. Department of Agriculture	Economic Research Service 1301 New York Avenue N.W. Rm 1226 Washington, D.C. 20005-4788 TEL: FAX:	Dr. John Lee Administrator	

STATE: WASHINGTON, DC & VICINITY (CONT.)

COMPANY/ORGANIZATION	ADDRESS/PHONE/FAX	CONTACT(S)	BUSINESS INTEREST
RONCO Consultant Corporation	2301 M Street N.W. Washington DC 20037 TEL: 202/785-2791	Mr. Mubarik Ali Consultant Mr. Leon Hesser Agricultural Economist	
O'Connor-Abell Inc.	1121 Arlington Blvd., 1014 N. Arlington, VA 22209 TEL: 703/524-3953 FAX: 703/527-3498	Dr. James O'Connor President	
U.S. Dept of Agriculture and Development	Office of Internatl Cooperation 2121 K Street N.W. Room 205 Washington, D.C. 20250-5776 TEL: 202/245-5776	Dr. Dwayne Acker Administrator	
U.S. Dept of Agriculture CSRS/NRF & SS	901-D Street S.W. Washington DC 20250-2200 TEL: 202/401-5971	Dr. Roland R. Robinson Principal Agric'l Economist	
U.S. Dept of Agriculture Economic Research Service	1301 New York Ave. Room 1226 Washington DC 20005 TEL: 202/219-0300 FAX: 202/219-0146	Dr. John Lee Administrator Ken Gray Ed Garr	
U.S. Dept. of Agriculture CSRS/SPPS	14th & Independence SW, #342 Washington DC 20250-2200 TEL: 202/401-4860	Dr. Paul O'Connell Deputy Administrator	
Checchi and Co. Consulting Inc.	1730 Rhode Island Ave, N.W. #910 Washington, D.C. 20036-3193 TEL: 202/452-9700 FAX: 202/466-9070		
Agricultural Cooperative Development International (ACDI)	50 F Street N.W., Suite 900 Washington, D.C. 20001 TEL: 202/638-4661 FAX: 202/626-8718		

STATE: WASHINGTON, DC & VICINITY (CONT.)

COMPANY/ORGANIZATION	ADDRESS/PHONE/FAX	CONTACT(S)	BUSINESS INTEREST
National Cooperative Business Assn.	1401 New York Ave.,N.W. Suite 1100 Washington, D.C. 20005 Tel: 202/638-6222 Fax:	Ms. Peggy Sheehan Senior Vice-President	
Abt Associates Inc.	4800 Montgomery Ln. Ste. 600 Bethesda, MD 20814 TEL: 916/753-6313	Dr. Mark Newman, Director Agribusiness Research & Consulting	
U.S. Congress	Office of Technology Assessment Washington DC 20510 TEL: 202/228-6510	Dr. Michael Phillips Senior Associate	
BIFADEC	320 21st Street NW Rm 5314NS Washington DC 20523 TEL:	Dr. Stewart Collison Deputy Executive Director	
OICD/USDA	Room 3838-S Washington DC 20250-4300 TEL: 202/245-5737	Mr. Frank Fender, Acting Director Food Industries Division	
InterAction	1815 H Street, NW 11th Floor Washington DC 20006 TEL: 202/822-8429 FAX: 202/659-2661		
Winrock International	1611 North Kent Street Arlington VA 22209 TEL: 703/525-9430 FAX: 703/525-1744	Ned Raun	
World Resources Institute	1709 New York Avenue NW Washington DC 20006 TEL: 202/638-6300 FAX: 202/638-0036	Robert Repetto	

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STATE: WASHINGTON, DC & VICINITY (CONT.)

COMPANY/ORGANIZATION	ADDRESS/PHONE/FAX	CONTACT(S)	BUSINESS INTEREST
WorldWatch Institute	1776 Massachusetts Ave NW Washington DC 20036 TEL: 202/452-1999 FAX: 202/296-7365	Peter Weber	
John Mellor Associates Inc.	801 Pennsylvania Avenue NW #810 Washington DC 20006 TEL: 202/347-8802 FAX: 202/347-8806	John Mellor	
MARS, Inc.	6885 Elm Street McLean, VA 22101 Tel: 703/821-4900 Fax: 703/448-9678	Ed Eng systems modeler	Candy, pet food, rice, snack food Major subsidiaries: Kal Kan Foods, Inc. Uncle Ben's Inc.
National Food Processors Assn.	1401 New York Ave. Washington, DC 20024 Tel: 202/639-5900	Roy Martin Vice-President Science & Technology	
Protein Grain Products Int'l	6707 Old Dominion Drive Suite 240 McLean, VA. 22101 Tel: 703/821-3025	Betsy Faga President	
National Academy of Sciences	Board on Agriculture 2101 Constitution Avenue Washington DC 20418 TEL: 202/334-3078 FAX: 202/334-1978	John Pino	
IM&D Group	1729 King Street, Suite 200 Alexandria VA 22314 TEL: 703/684-8400 FAX: 703/684-9489	David Shear	
U.S. Congress	Office of Technology Assessment Washington DC 20510-8025 TEL: 202/228-6533 FAX: 202/228-6098	Phyllis Windle	

STATE: WASHINGTON, DC & VICINITY (CONT.)

COMPANY/ORGANIZATION	ADDRESS/PHONE/FAX	CONTACT(S)	BUSINESS INTEREST
Conservation Foundation	1250 24th Street, NW Washington DC 20037 TEL: 202/778-9638 FAX: 202/293-9211	Montague Yudelman Senior Fellow	
U.S. Wheat Associates	1620 Eye Street, N.W., Suite 801 Washington, D.C. 20006 Tel: 202/857-0999	Nelson Denlinger Executive Vice-President	
University of Maryland			
IFPRI			
WORLD BANK			

ustour2
usaid/ca-wk

OTHER CONTACTS:

Neil Havermale
Farmer's Software Association
P.O. Box 660
Fort Collins, CO. 80522
Tel: 1-800-237-4182

Dr. David Norman
Kansas State University
Manhattan, KS
(913) 532-6702

New Computer Technology Speeds Decision Making in Agriculture, Agribusiness

Once used primarily for research, computer simulation models are becoming valuable aids for evaluating options for sustainable agricultural production. A simple, cost-effective computer system is now available to help farmers and agribusiness executives simulate in minutes crop production scenarios that would take years through field research. This technology, the Decision Support System for Agrotechnology Transfer (DSSAT), has been developed over the past ten years by a global network of research scientists at major agricultural universities and funded largely by the U. S. Agency for International Development (USAID).

With the basic technology now proven, USAID, the participating universities and the Industry Council for Development (ICD) are exploring opportunities for wider use of DSSAT as a problem solving instrument for planners, policy decision makers, and agribusinesses.

DSSAT has had only limited diffusion so far — to some 400 users, mostly with research institutions and a handful of public sector organizations.

Results of a Decade of Scientific Effort

DSSAT was developed by the International Benchmark Sites Network for Agrotechnology Transfer (IBSNAT) project financed by USAID. The project is headquartered at the University of Hawaii, and supported by a network of scientists at some universities in the U. S., Europe and research and development institutes in Asia, Latin America, and Australia.

DSSAT has a software system which integrates the various crop models with databases, allowing users to test and implement the crop models to variable circumstances at specific sites, conduct sensitivity analyses, and predict outcomes. A standard set of inputs — including soil, crop and variety, weather, irrigation water, crop management and economic functions — determines crop growth, yield and other outputs. Crop modeling systems can be extended to include the functions most important to individual users.

In addition to yield variability, DSSAT can estimate price and market risk associated with changing farm management strategies or the introduction of new technologies. By testing the performance of new cultivars or management practices under specific conditions, a user can evaluate the economic risks of various crop strategies for a desired number of years. The user can then integrate new crops, products and practices with existing farming systems to optimize their stability and sustainability of production.

Validated Crop Models Available

Crop growth models are the core of DSSAT. Validated models exist for seven food crops (wheat, maize, rice, soybean, dry bean, peanut and sorghum). Others for millet, barley, aroid, and potato are at various stages of development. The models are process oriented and designed to have global applications; each simulates crop growth, development, and yield under different soil, weather, and management conditions.

DSSAT crop models feature a series of database programs on soil types, weather, management and experimental data and genetic coefficients. Additional programs may be added later. Each program retrieves data and creates input data files for the crop models. Other programs analyze and present outputs according to the specifications of the user.

DSSAT can focus on a particular crop, a specific soil type, designated weather patterns and other factors relevant to production agriculture. Different possible agro-technology packages for specific sites may be evaluated prior to field experimentation. The result: charts and graphs showing the effect that planting dates, fertilizer application, irrigation, crop varieties and other farming practices have on yields, profits, and sustainability.

Proven Reliability

Simulation results obtained from crop models have been field tested at many locations, and are highly reliable as compared to trial and error on-site testing. DSSAT is capable of generating whole probability distributions for outcome quantities such as yield or profit. Agribusiness managers can compare distributions and their probabilities, and assign values as a function of risk rather than relying on the uncertainties of comparing averages.

An Evolving Product

Work is proceeding on new DSSAT applications which will deal with the effects of pests and diseases; for genetic coefficients required as model inputs that vary from crop to crop and describe growth phases; and for the effects of fertilizer components other than nitrogen. New intercropping models, multiple cropping models, and economic input/output functions will add power and value in the analysis of options in agricultural production.

Because it was developed through a publicly funded program, DSSAT is freely available at nominal cost, without restrictions on further adaptation by individual companies.

Flexible and User Friendly

Computer implementation of the DSSAT models is done through a menu system which allows access to data entry, retrieval, summarization or utilities from the database system; crop growth models; a weather generator in case no complete weather data are available; and a DSSAT utility to tailor the system to user needs and computer resources. Installation is simple; it allows the installation of only the components desired by the user. Users will find DSSAT flexible in terms of application of any of the crop models with any site and weather data sets contained in the database management system. Training in the use of DSSAT is available through members of the IBSNAT network, and will be expanded in the future.

The programs to perform the DSSAT functions are written in various computer languages. Crop models have been developed in FORTRAN, the data entry programs in dBASE III, and the graphics programs in Quick BASIC and PASCAL. A shell program in the "C" language provides users access to any DSSAT programs without having to worry about which language is being used and how to execute

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that particular program. The DSSAT shell uses pop-up menus to guide users to these functions.

A Tool for Farmers, Agribusiness Executives

DSSAT was designed primarily for agricultural sector users. However, its structure allows extensions that other users have exploited to adapt the modeling system to their own needs. For example, the U.S. Environmental Protection Agency (EPA) uses DSSAT in global climatic assessments, especially regarding effects of increasing carbon dioxide concentrations in the atmosphere.

DSSAT is a tool that farmers, agribusiness managers and policy planners can use to explore options for:

Strategic Decisions

- crop and seed yield prediction throughout the growing season (national, regional, and local level yield or production projections worldwide can be constructed by DSSAT)
- optimum crop and land use
- potential adaptation of new cultivars to a wide range of environments
- credit/loan requirements related to crop management
- market potential for improved seeds, fertilizer, crop protection supplies, alternative crops, machinery storage or processing equipment, etc.
- crop mix and management in regional development projects
- crop mix and management in irrigation projects for optimization of use of water resources

Tactical Crop Management Decisions

- irrigation management (i.e., determination of crop water requirements)
- fertilizer management/application
- variety screening, selection and testing to match crop requirements with land and environmental characteristics
- planting date
- pest/crop interaction
- whole-farm system models
- plant breeding decisions
- seed production site selection

Decisions on Maintaining a Sustainable Environment

- nitrogen leaching as related to fertilizer management
- optimum crop rotations and intercropping
- best management practices to reduce potential pollution
- the impact of global climate change on agricultural production
- selection of cropping patterns that will reduce soil run-off and factor in the value of soil in estimating return
- long-term environmental consequences of land use decisions

In these and other ways DSSAT can help managers allocate resources more effectively in terms of economic and environmental outcomes.

The Future of DSSAT

Future versions of DSSAT will expand the range of crop models and databases to include more commodities from vegetables to perennial fruit trees. Models for pest and disease factors will also be available. The intercropping model is being refined to allow applications of DSSAT to whole farm modeling and sustainable agriculture issues.

In August 1992, the IBSNAT project will issue an updated version of the DSSAT software which will be even more powerful and versatile than the current version. This software will enable decision makers to address more problems quickly and reliably and to assess the comparative advantage of alternative agricultural strategies specified by the user.

Like its predecessor the new version of the DSSAT software can be linked to a geographic information system (GIS) called AEGIS which allows decision makers to evaluate different crop production strategies in a regional context and interactively develop a regional plan to suit their objectives. AEGIS can perform tasks such as:

- Estimating production and resource requirements for different agricultural strategies (e.g., combining crop, variety, planting date, irrigation and fertilizer treatment);
- Assessing potential environmental impact, generating tables and thematic maps (e.g., maps of simulated yield, biomass accumulation, runoff, etc.);
- Creating and modifying a production plan indicating the crop and management practices of a selected region.

With DSSAT linked to AEGIS, yield and production projections appear to be possible at national and world levels. They may also be more reliable than those constructed from satellite imagery and infra-red photography of crop growing conditions.

Market Research Program Initiated

Now that the core DSSAT product has been developed and well received, a market research program has been launched by ICD and DSSAT representatives including demonstrations to farmers, agribusiness executives and other possible users in the U. S. and Europe. These demonstrations will introduce the current DSSAT product, assess opportunities and methods for adapting DSSAT for specific commercial applications, and discuss priorities for further product and market development. The results will be reviewed in workshops sponsored by USAID to agree upon a new marketing and product development strategy linking both public and private sector markets with the university research base.

The DSSAT demonstrations will be conducted by ICD Senior Associate Dr. Alex Grobman and a research scientist from the IBSNAT Network. Dr. Grobman is a leading agronomist, plant breeder and agribusiness executive. He has held senior posts with the Peruvian government and educational institutions, as well as international companies and agricultural research centers. A summary of Dr. Grobman's professional and academic background is attached.

Industry Council for Development

Dr. Alexander Grobman
ICD Senior Associate

Dr. Alexander Grobman is a leading agronomist, plant breeder and agribusiness executive. He is currently President of Grobman Genotecnica S.A. (Peru) and Chief Executive Officer of Penta Genetics International, S.A. (Panama). He is also a member of the Board of Directors and former President of Computer Clubs of Peru, S.A.

As a Senior Associate of the Industry Council for Development (ICD), Dr. Grobman has helped develop a model for public/private sector partnership which ICD has used to help developing country governments and aid agencies restructure and expand seeds and other agroindustries.

Dr. Grobman's assignments with ICD, in cooperation with USAID and the World Bank, have included agribusiness development projects in Turkey, Thailand, Haiti, Pakistan, Sudan, Uganda, Nigeria, Egypt and the English speaking Caribbean countries.

Dr. Grobman served as Deputy Director of the International Center for Tropical Agriculture (CIAT), Colombia, from 1977 to 1981. His service with the Peruvian government has included assignments as a founder and Director of the Instituto Nacional de Investigacion y Promocion Agropecuaria (INIPA), and Advisor to the Ministry of Agriculture. As Director of Research and Development for Latin America for Northrup, King and Company, from 1966 to 1976, he was active in the large scale introduction of sorghum hybrids in Latin America.

Dr. Grobman was awarded the 1990 "World Seed Prize" by the Federation Internationale du Commerce des Semences (FIS), in Seville, Spain, "in recognition of his important work in the implementation of [improved seeds] in many parts of the world and especially in Latin America."

Dr. Grobman received a B.Sc. in Agriculture from Ohio State University, and a Ph.D. in Agriculture from Harvard University. He was awarded fellowships by the Rockefeller Foundation for research in corn hybrids, and for graduate studies at Harvard University. He is a Professor Emeritus at the Universidad Nacional Agraria La Molina, Lima.

10/30/91

agl/pb14

300 EAST 44th ST. ▪ NEW YORK, NY 10017 ▪ (212) 867-5017 ▪ CABLE: INDUCODEV ▪ TELEX. 23 89 76 ▪ FAX. (212) 573-6028

Annex VI

Industry Council for Development

ICD ASSESSMENT OF MARKET POTENTIAL FOR DSSAT TECHNOLOGY

Submitted to USAID and IBSNAT

By

The Industry Council for Development

15 July 1992

300 EAST 44th ST. ▪ NEW YORK, NY 10017 ▪ (212) 867-5017 ▪ CABLE: INDUCODEV ▪ TELEX: 23 89 76 ▪ FAX: (212) 573-6028

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ICD ASSESSMENT OF MARKET POTENTIAL FOR DSSAT TECHNOLOGY

Introduction and Summary

Under its cooperative agreement with the United States Agency for International Development (USAID), ICD is assessing the potential for expanding the use of a computer software system that greatly facilitates decision making in agriculture and agribusiness.

This technology, the Decision Support System for Agrotechnology transfer — DSSAT — is a problem solving software which provides a tool to predict crop growth and yield under specified conditions including soil type, crop variety, weather and crop management data. DSSAT was developed over the last ten years by a global network of research scientists working through the International Benchmark Sites Network for Agrotechnology Transfer (IBSNAT), funded largely by USAID. A background summary of DSSAT prepared by ICD is attached as Annex 1.

With the basic DSSAT technology developed and well received, USAID requested ICD to explore opportunities for wider use of the software, particularly by private sector agribusinesses and other firms.

Responding to USAID's request, ICD conducted a DSSAT market assessment, involving demonstrations to a cross-section of agribusinesses and related companies as well as development institutions located in 14 U.S. and European cities. The ICD survey demonstrated the current DSSAT product, assessed opportunities and methods for adapting it to specific commercial applications, and considered opportunities for further product and market development. The organizations covered by the survey included:

Agribusiness and other companies: Nestlé, Unilever, IBM, Shell, Quaker Oats, Land O' Lakes, Cargill, International Minerals and Chemicals Corp. (IMC), Ralston-Purina;

Seed companies: Northrup King, ICI Seeds (UK and USA), Pioneer Hi-Bred International Inc., Delta and Pine Land Company, Garrison and Townsend Seed Company;

Commodity brokers: Chicago Board of Trade, Merrill Lynch;

Trade organizations: National Corn Growers Association (USA), American Soybean Association;

National and international development organizations: World Bank, UNDP, U.S. Department of Agriculture (USDA), NOAA/USDA Joint Agricultural Weather Facility, Commonwealth Development Corporation (CDC/UK);

Development consulting groups: American Society of Agricultural Consultants, Rural Investment Overseas (RIO/UK), Earth Satellite Corporation;

Other ICD Member Companies: Dr. Grobman demonstrated DSSAT at the 41st Session of the ICD Board in March which included representatives of Britannia

Brands PTE Ltd., Bühler Ltd., Daimler-Benz Holding AG, EDESA Management AG, F. Hoffmann-La Roche Ltd., Nestlé SA, Philips, Polservice Foreign Trade Enterprise, Rabobank Nederland, Sagantec Europe BV, Shell International Petroleum Company Ltd., and Tetra Pak International SA.

Meetings with user groups (ranging from one to 20 individuals), were organized by ICD Executive Director Walter Simons and Program Manager Will Kennedy and conducted primarily by ICD Senior Associate Dr. Alex Grobman. Dr. Grobman was assisted in the U.S. presentations by scientists representing IBSNAT, including Drs. Goro Uehara of the University of Hawaii, Jim Jones and Walter Bowen of the University of Florida/Gainesville, Joe Ritchie of Michigan State University, and Tony Hunt of the University of Guelph and in Europe by Barry Dent of the University of Edinburgh.

From a large database of firms representing a cross-section of the various subsectors mentioned above, a limited number of firms were selected on the basis of being representative of each subsector and available to the ICD/IBSNAT team during the tight April trip schedule. Some firms dropped out after visits began, and a few were opportunistically added. Overall, some 90% of the originally planned visits were successfully carried out.

Meetings with user groups began with a standard demonstration of DSSAT, its possibilities and the validation of its predictive abilities with various examples. Depending on the audience, DSSAT applications were also presented that address issues relating to agricultural research, prediction of varietal performance, promotion of sustainable agricultural practices, fertilizer management/application, environmental management concerns, use of geographical information systems to assess new cropping practices, and the possibility of yield prediction on large geographical areas.

The demonstration was followed by a discussion in which the audience raised questions, offered views on the relevance of DSSAT to their operations and provided feedback on future interactions between their organization and a possible DSSAT marketing/research operation.

Results of the survey indicate strong interest in a greater range of crop modeling products and services which would be available on a commercial basis.

This report summarizes the findings of the DSSAT demonstrations in Europe and the U.S. The general findings include:

1. Most organizations saw possible applications of DSSAT technology for their operations.

2. However, to use this technology most organizations would require new or customized products and/or a variety of data, training and other supporting services. The current trend toward downsizing companies increases their potential need for a full "package" of DSSAT products and services.

3. The organizations indicated a willingness to purchase such products and services on a commercial basis consistent with the eventual income requirements of a self-sustaining DSSAT operation.

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4. Some of the organizations contacted would also consider supporting a DSSAT organization as shareholders and/or subscribers.

5. There is also a large potential market for DSSAT technology through government services, development organizations and other public sector users. Again, these markets will require product adaptation, ancillary services and other support functions.

ICD DSSAT Demonstrations in Europe

1. ICD Board Meeting

A demonstration highlighting DSSAT capabilities and potential applications was made at the Industry Council for Development (ICD) Board meeting in Zurich, Switzerland, March 5-6, 1992. This included several actual DSSAT simulations.

Members present, representing Britannia, Bühler Ltd, Daimler-Benz, EDESA, ENBI, Nestlé, Hoffmann-La Roche, Philips, Polservice, Rabobank, Sagantec, Shell International and Tetra Pak International, expressed interest in DSSAT and agreed that ICD should continue to support the further development of DSSAT in cooperation with the IBSNAT network and USAID.

2. Nestlé

A DSSAT demonstration was conducted at the Nestlé S.A. headquarters in Vevey, Switzerland, on March 9. Nestlé operates in 150 countries and has plants in 90 locations. While Nestlé initially focused on producing dairy products it has since diversified to include many areas of the food processing industry.

Nestec S.A., a subsidiary of Nestlé S.A., was selected for the demonstration. Some of its activities deal with research, and others with technical assistance in the Nestlé group. The demonstration was performed for Mr. Patrick Leheup, of the agricultural services section, who deals with technical assistance. The director of the agricultural services section was away at the time.

Mr. Leheup thought DSSAT could be a valuable tool for technical assistance to farmers in the company's extension activities, as well as for sourcing of raw materials in several countries. He did not elaborate further on this except to indicate that it would be of interest to demonstrate DSSAT to people in the raw materials sourcing section of the Nestlé group. He also thought DSSAT might be useful in the public sector and in public relations with governments.

Mr. Brian Suter, Head of Research at Nestlé, suggested that ICD visit other Nestlé operations overseas, all of which work independently. There are four Nestlé research centers, and the one at Cumbaya, near Quito, Ecuador was recommended for a demonstration. The contact persons at Latin RECO are Messrs. Christian Wahli, Director, and Samuel von Rutte, agronomist.

Both Mr. Leheup and Mr. Suter expressed their interest in the development of a tomato model.

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3. IBM Europe

At IBM's Paris office (Tour Pascal, La Défense) Dr. Grobman met with Mr. Fouad Elamrani, software consultant for open systems and Mr. Serge Caby, in charge of the Social Responsibility Department.

After the demonstration both IBM officers agreed that DSSAT could evolve into a family of derived crop modeling products. In their view, many companies have developed their own modeling systems, some of which are ready for marketing. In order to compete with present and future professional/commercial products, DSSAT would have to stand on its merits and adapt to the market. They indicated the willingness of IBM to help develop DSSAT by suggesting software companies that might participate in future development work. They also supported the idea of involving a large number of companies in a consortium that would guide the future development of DSSAT.

In addition to maintaining its present PC compatible platform, Dr. Grobman discussed the possibility for future DSSAT versions to be ported to platforms of RISC-based computers and minicomputers such as the AS-400 (especially as complex geographic information systems are worked into the DSSAT model). Such is already the case with use of AEGIS on Sun based platforms.

4. Commonwealth Development Corporation (CDC)

At the CDC headquarters in London a demonstration of DSSAT was carried out by projecting computer slides and conducting several simulations. Potential applications of DSSAT were discussed. CDC senior agriculturalist Michael D. Taylor led the meeting. Also present were Robin Haggarty and Harry Percy of the Natural Resources Dept.; Robert L.O. Ely, Senior Associate of ICD, Dr. John Meadley, Managing Director of Rural Investment Overseas Ltd. (EDESA Group), David L. Jackson of Natural Resources Institute, Dr. Barry Dent of Edinburgh University, a member of the IBSNAT network, and Walter Simons, Executive Director of ICD.

CDC was particularly interested in the spatial aggregation capabilities of DSSAT as a tool for developing regional crop performance predictions. More site specific research information is needed in many developing countries, and especially in Africa.

A lack of decision support systems products for modeling cash crops and plantation crops was the most serious need. Future horticultural crop models of special interest included tomatoes, bananas, citrus, other fruit crops, cotton and sugar cane. The most important application of such crop models would be the simulation of crop alternatives in CDC investment studies.

CDC has a special need for modeling crop strategies for the use of water. In this area the representative of the National Resources Institute emphasized their need to model water harvesting strategies. They are presently interested in modeling applications together with the University of Newcastle in Tanzania's semi-arid areas.

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Other applications of interest to CDC concern assessing opportunities for germination and crop establishment in semi-arid areas, and modeling crop behavior in hard-drying soils. Some interest in modeling work at Reading University was mentioned.

The fact that some universities, including Reading, are conducting their own independent modeling brought about a discussion in which Dr. Dent advocated the uniform use of a standard modeling system such as DSSAT, thus avoiding the independent development of incompatible modeling systems.

Dr. Meadley of Rural Investment Overseas (RIO) stated his interest in the DSSAT tool, particularly potential horticultural, plantation, and cash crop models.

The consortium approach was viewed with interest among the group as a means of facilitating further product development.

5. Shell Chemicals

At Shell Centre in London, Mr. Luiz E. Fortes of the Chemicals Regional Western Hemisphere and Africa Department met with Dr. Grobman accompanied by Dr. Dent, Mr. Simons and Mr. Meadley.

Mr. Fortez thought that opportunities for DSSAT applications within his groups might cover such concerns as: (a) local relationships with Shell customers in areas such as crop protection and extension, and (b) to a limited extent in Shell's relationships with governments in creating good will. He felt that the usefulness of DSSAT largely depends on the databases that would be attached to it. He thought that Shell as an organization would not be a data gatherer but rather a data user.

The pest related applications of DSSAT would be of great interest to Shell. One application mentioned was the modeling of pests erupting at any given time.

Shell has divested itself of its former seed business and the company is no longer a major actor in the fertilizer business.

Mr. Fortez confirmed Shell's interest in cash crop applications, particularly citrus, cotton, tobacco and bananas. Among the vegetables, tomatoes were singled out again as a priority.

6. PBI Cambridge Limited (Unilever)

PBI Cambridge Ltd is dedicated to research in plant breeding and genetic engineering, and in basic seed production. It has taken over the operations of the former Plant Breeding Institute at Cambridge and the National Seed Development Organization, which produced and sold basic seeds from public varieties.

Participating in the demonstration were Mr. Julian Stanning, Director, Business Development; Mr. Ian Ferguson, Chairman, Business Development; Mr. Des Dempsey, Commercial Director; Mr. Del Colbert, Commercial Manager; Mr. Russell Clarke, Manager, Computers, Commercial; Ms. Sally-Ann Forsyth, Assistant Management Accountant; Mr. Keith Day, International Manager; Dr. Jeremy Davis,

International Development Manager, and Mr. Michael Handy, Agricultural Services Manager. The demonstration was held on March 12 at PBI headquarters in Maris Lane, Trumpington, near Cambridge, using an overhead projector system.

The discussion centered on potential applications of DSSAT in Unilever's extensive territory. In addition to their seed business applications, they showed interest in plantation crops, and specific vegetable crops for the development of future models. Tomato and sunflower were of special interest among the annual crops. Among the plantation crops PBI expressed particular interest in tea and African oil palm.

In addition to research applications, sourcing applications for raw materials, especially oil crops such as soybeans, are of interest. Forecasting yields of vegetable crops, and crop quality assessment, including the permanence of pesticide residues, were mentioned as needed applications. Possible applications of DSSAT for agricultural extension work in Eastern Europe and the tropics were also discussed. Finally, the establishment of activities related to public relations with governments was mentioned.

The PBI group was interested in participating in a consortium type association for generating future DSSAT models, and would be quite comfortable with the development of generic type crop models that they and other participants could use.

PBI representatives requested a copy of DSSAT so they could further familiarize themselves with the product and its applications, while the new version 3.0 is being developed.

7. <u>ICI Seeds</u>

On March 13 a meeting was held at ICI Seeds headquarters in the Jealott's Hill Research Station in Bracknell, Berkshire, England. Dr. Derek J. Pike, Consultant Statistician and Manager, Seeds Computing and Statistics group helped to convene the meeting. Most of the attendees were from the Computing and Statistics Seed group, namely Joanne Thomas, Bob Smith, Richard Allen, and Belinda Neil; also Simon Young, from Statistics, Ag. Chemistry. From other groups, Pauline Stewart from Irdits (Information dissemination function) and John Coutts, Senior Technical Services Manager of Agricultural Chemicals, and an assistant from Farnham. DSSAT was demonstrated on several monitors operating simultaneously with a splitter device, which worked quite well. This arrangement allowed for closer group arrangement around the monitors and more interest in viewing simulations.

After viewing the demonstration and simulations the immediate comments and responses were as follows.

The Information Technology representative stated that she did not see any applications of DSSAT that would be of use in her work. The Agricultural Chemicals manager expressed interest in modeling for use in pest and disease monitoring, but emphasized the need for confidence in the accuracy of the predictions obtained with the model. The group as a whole found few immediate uses of DSSAT and the crop models that they could apply to their operations.

They thought the models could be useful for specific situations such as predicting wheat performance in England, but were uncertain of the validity of predictions in other places. It was observed that some of the simulations carried out with wheat based on the Rothamsted set of experiments, while very detailed, deviated from the predictions to a large degree, thus reducing confidence in the validity of the models.

Because of the predominant statistical and programming background of the ICI contingent present much discussion centered on the model structure, the way in which data sets were obtained, and development of the models for predictive purposes. Questions centered on the genetic coefficients and how they were obtained. Such questions require closer scrutiny and the assistance of an experienced crop modeler. Accordingly, a meeting with Dr. Barry Dent was suggested for follow-up. In fact, other companies and institutions were also advised to hold follow-up meetings with Dr. Dent who had generously volunteered to meet with such groups and act as a local contact for the IBSNAT network and ICD.

A special use was seen for the models in applications on seeds research. It was suggested that a demonstration be conducted at the ICI seed research station in Slater, Iowa, where the maize research group would benefit. Because of their immediate interest in the development of applications for ICI maize hybrids, and use of genetic coefficients, they would prefer that a crop modeler with experience in this subject be present at these meetings.

The Farnham group was particularly interested in the applications of models for monitoring pests and diseases.

Wheat was designated their most important crop in England.

An application regarding global warming and its effects in modifying present crop distribution patterns would be of interest to the group. Such crop modeling could be used to target new areas for specific crops, after predictions of weather changes are obtained. An example could be changes in the spatial distribution of maize and sorghum areas.

The prediction of performance of USA varieties in Europe was mentioned as another possible application.

Some interest was also expressed in economic and financial analysis applications although the group did not have the composition to fully enter into a discussion in this area.

There was no decision to acquire a copy of DSSAT at this time, although ICI would like to be kept informed of decisions concerning future applications.

ICD DSSAT Market Survey in the U.S.

Market research in the U.S. in April was a continuation of the assessment conducted in March 1992 in Europe. The U.S. private agribusiness sector was divided into sub-groups which were thought to have possible interest in DSSAT product applications. These were agribusiness firms, agricultural cooperatives,

seed companies, fertilizer companies, farm commodity trading companies, agricultural consulting firms and independent consultants, agricultural banking and insurance companies.

Additionally, and because of their specific importance in fostering utilization of DSSAT and derivatives, opportunities and methods for adapting and diffusing DSSAT were reviewed with officials at USDA, UNDP and the World Bank.

The visits were organized by William Kennedy and Walter Simons at ICD headquarters and conducted by Dr. Alexander Grobman, ICD Senior Associate for Agribusiness. He was accompanied during the various parts of the circuit by IBSNAT scientists, including Drs. Goro Uehara of the University of Hawaii, James Jones and Walter Bowen of the University of Florida, Joe Ritchie of Michigan State University, and Tony Hunt of the University of Guelph. The technical assistance and support of IBSNAT representatives during the demonstrations and discussions is acknowledged and highly appreciated.

Dr. Tejpal Gill of USAID AGR/R&D and Mr. Walter Simons of ICD were present at various demonstrations in Washington and New York. The demonstrations and their contents were previously organized at work sessions involving Jim Jones, Walter Bowen and Alex Grobman at the University of Florida.

Following is a report on specific company/institutional responses to the demonstrations.

1. International Minerals and Chemicals Corp. (IMC), Mundelein, IL. Contact person Dr. Peter Heffernan (April 6)

Dr. Heffernan and his colleagues of the Potash Institute envisaged many applications for DSSAT and its derivatives in the fertilizer industry. The downsizing of their staff precludes them from any in-house developments and management of data. For DSSAT to be useful to a firm like IMC a full service package would have to be available.

A subscription kind of approach might be their preference, especially if it included database access and an 800 phone number for support. At present, they subscribe to NERAC and NASA, which provide them with some 100 databases. Their typical information requests are related to preparation of sales proposals, for which they may have very little lead time, but must provide answers quickly.

They requested phosphorus and potash models, and eventually microelement additions to the various crop models. At present only nitrogen is available.

2. Chicago Board of Trade, Chicago, IL. Contact person Dr. Eugene Kunda, Staff Economist, Economic Analysis and Planning (April 7)

Dr. Kunda felt that a DSSAT product derivative for the prediction of yields for specific geographical areas would be a useful tool to many of the more than 1,200 commodity brokers affiliated with the Chicago Board of Trade. While dealing directly with individual brokers might be a feasible marketing approach, a service including database information supplied through a contract with the Chicago Board of Trade should also be considered.

Dr. Kunda and his four associates who participated in the demonstration expressed the need for database and on-line weather information and training to be added to the basic product to enhance its utilility to end-users. Some of the participants requested interface simplicity, and a DSSAT version that would address the specific commodity yield prediction needs of their users. They also requested that transportation and storage database functions be added to the DSSAT generic version for commodity traders.

3. Comdex Show, McCormick Place, Chicago, IL (April 8)

Dr. Grobman visited the Comdex Show for Computer Products manufacturers and distributors which was being held in Chicago at the time. He also contacted software houses that were exhibiting there and might be interested in subcontracting phases of DSSAT product development. At the Indian software pavillion, two firms with USA offices indicated they had expertise with GIS and would be willing to discuss participation in specific development activities. These were a subsidiary of the TATA group and Thapar Indian Software House. Further contact was made with Thapar in Washington, DC.

4. Quaker Oats, Chicago, IL Contact person Mr. Phil Sisson, Manager of Commodity Analysis and Crop Development (April 8)

Mr. Sisson and five Quaker Oats associates were present at the demonstration. Their main interest in DSSAT was its possible application to the purchasing of commodities. Quaker Oats is not very active in promoting production or supporting farmers with technical assistance. They expressed interest in possible development of a DSSAT oat crop model. They also work with other crops which are already modeled in DSSAT.

Due to reductions in senior as well as support staff at Quaker Oats, DSSAT would have to be available with the related data as tailored and user-ready as possible. They no longer have in-house staff capabilities to assemble the kind of data used to drive DSSAT applications. They would certainly be interested in joining a DSSAT user group.

5. Ralston Purina, Saint Louis, MO Contact person Mr. James Allwood, Director, Commodity, Economic and Regulatory Services (April 9)

Ralston Purina produces animal feed, human food and other consumer goods. A good deal of the business is farm oriented, through the supply of Purina products for the livestock industry. They source wheat, corn, soybeans and other farm commodities for feed. The Protein Technology Division would be the part of the company that would use DSSAT. Their major orientation is to U.S. farm commodity production, prices, and government policies. DSSAT could be of help to them. At present Ralston is buying CROPCAST forecasting services from EarthSat in Rockville, Maryland, for crop prediction through remote sensing and imaging.

Their view is that trading houses do predictive work on crops through simple systems using meteorologists who supply them with information on a commercial basis. DSSAT products might be the future way to go. They have no manpower

to compile and use data in-house, as the company has reduced staff from 25 economists to one economist half-time. Information must be obtained from outside firms. To be useful to Ralston, DSSAT products must offer an information support service.

6. National Corn Growers Association, Saint Louis, MO Contact person was Mr. Larry Rus, Executive Director (April 10)

This organization represents the interests of U.S. corn growers, and works actively in promoting the production, sale and use of corn in such products as ethanol, sweeteners and biodegradable plastics. The NCGA has 22 state offices. They are members of the Feed Grains Council. A staff of five lobbyists works in Washington.

The organization also promotes research on subjects related to their interests (e.g., they are funding database research on corn at Kansas State University). NCGA would be interested in making DSSAT products and services available to users either directly or through intermediaries such as the Gromark service — a computer information service available to farmers, which works with Farmland and Pioneer Seeds in bringing database information to farmers, as "broadcast partners." The use of DSSAT, they suggested, would be enhanced if conversions were made in farmers' versions to commonly used measures such as bushels, cwts, lbs and acres. The use of DSSAT in advisory services to farmers is the main application that they foresee. At their next national convention to be held in San Antonio, TX, they would be willing to host presentations of DSSAT applications to members.

7. American Soybean Association, Saint Louis, MO Contact person Dr. Keith Smith, Director of Research (April 10)

Other persons present were Dick Burdorff, Management Information Systems; Stewart Reeve, Manager; Grant Mangold, Consulting Editor; Ron Reuwee, Producer of Communications; James Thompson, Manager. The ASA is familiar with DSSAT; they funded research that led to improvements in SOYGRO, the DSSAT soybean crop model. Dr. Smith sees DSSAT as being useful to soybean farmers in (1) assessing management, soil and crop variables in order to predict yields under various conditions, and (2) in assessing soil, weather and land use information at the farm level for optimizing whole farm utilization in cropping. In ASA's opinion, DSSAT must be customized for specific uses. A subscription system for users would be appropriate. They expressed an interest in supporting a DSSAT product development and marketing consortium. Dr. Smith suggested linking DSSAT to GPS for yield predictions at the field level. Soybean Digest would be willing to offer space for articles on DSSAT use.

8. Pioneer Hi-Bred International, Inc., Johnston, IA Contact person Mr. Don Sapienza, Director International Silage Programs (April 13)

Some 15 staff members from research, production and marketing were present at the presentation, which was assisted by Dr. Tony Hunt. Pioneer is the largest seed company in general seed sales. Corn seed sales account for nearly 80% of their business worldwide. They also sell soybean, small cereal, forage seed and microbial products. DSSAT would be acceptable to their company for applications

in research, dealer and general marketing support, seed production, and general commodity yield prediction over large geographical areas. A generic product would be useful to them, as would also a product with proprietary changes. Pioneer would require databases for soil, weather and other information supplied as a service, together with training, and an information support service bureau with an 800 phone number.

Discussion centered on the applicability of models especially to their proprietary hybrids, and how the information on genetic coefficients could be used for marketing purposes.

There was also discussion on forage quality. Mr. Sapienza was concerned about the future availability of several forage crop models. Pioneer would be interested in becoming a user of DSSAT products. Future demonstrations for the research group might be in order as only one of the attendants was from the Plant Breeding Department.

9. ICI Seeds, Inc., Slater, IA Contact person Ms. Aileen Jensen (April 13)

Some 15 staff members from ICI Seeds attended the demonstration/discussion. They represented sections in Agronomy, Statistics, Sales, Entomology, Plant Breeding. Dr. Tony Hunt also participated. We were prepared to review isssues similar to those discussed at the ICI Jealott's Hill research station in England, particularly the genetic coefficients component of the crop models. Their chief contention was that determination of the genetic coefficients within a given environment, encompasses a genetic x environment interaction incorporated with the specific values attached to each environment. This concept, which to them was crucial, invalidated the use of genetic coefficients as constants.

The DSSAT crop models, on the other hand, define the genetic coefficients as constants and are not subject to environmental variation. Dr. Hunt, who is very knowledgeable about genetic coefficients and programs to evaluate them, discussed the conceptual approach and the relative stability of the different coefficients. Growth-related genetic coefficients may not be as stable as juvenile related coefficients, Dr. Hunt admitted. Still it was important to dispel the concept of the genotype as a black box, by examining and defining the components, as is done in crop modeling.

The genotype x variety interaction estimation in plant breeding analysis has been a standard approach, although admittedly a crude one. The differing views of plant breeding professionals and crop modelers create antagonism, which surfaced at the ICI England and U.S. meetings, and which needs careful screening and explanation. Tests should be devised to prove stability of the model's genetic coefficients. Ranking of hybrids by genetic coefficients might then be possible.

Views were also presented by the ICI Entomology staff about the need to incorporate disease and pest components to make the models relate better to actual conditions. The discussion of DSSAT technology at both U.S. and U.K. meetings with ICI staff is covered in detail in a separate memo (W. Simons to Dr. T. Gill, July 15, 1992).

10. Cenex-Land O'Lakes, Minneapolis Contact person Dr. John Ahlrichs, Manager of Agrisource, Agronomy Services of Cenex-Land O'Lakes. Also present at the meeting were Ms. Lucia Lazar, Analyst/Agronomist and Mr. Glen Christiansen, Forage Marketing and Dr. Tony Hunt, IBSNAT/U. of Guelph (April 14)

Five years ago two large farm cooperatives, Land O'Lakes (LOL) and Cenex, joined forces to form an agronomy service and a joint distribution organization for agricultural production inputs. Some 1600 cooperatives are included in the present system, out of which some 600 are active participants. LOL also produces dairy products, and distributes forage and corn seed, feed additives and related materials.

Cenex is the seventh largest petroleum products cooperative in the U.S. The joint Cenex-LOL organization distributes fertilizers, agrochemicals, and sells farm advisory services. Cenex-LOL started with $2 million seed money to form the farm advisory services. Today it bills $9 million in this line of activity. It has paid off its debt and AgriSource is a money making proposition. Their major geographical area of activities is Wisconsin, Minnesota, northern Iowa, the Dakotas, Montana and Washington.

AgriSource collects information from 25 centers for its on-line databases, which are accessed by 400 subscribers. These are generally large cooperatives, with a few large farmers also being subscribers. Information supplied on-line is used in farm management, and includes technical information, legal information, and updates on pesticide labels. No commodity price information is supplied.

Users pay $290 per month for these services. Cenex-LOL has also developed a testing service to support their technical advisory system. Every year their farm advisors conduct farm tests of various inputs at over 400 locations.

In order to support the management of the farm cooperatives Cenex-LOL employs 140 farm advisers at the B.S. in Agriculture level, who are assigned to various cooperatives on a permanent basis, and for whose services Cenex-LOL is paid a fee. The advisers also promote the agricultural input products sold by Cenex-LOL. Another service offered by this organization is a series of training courses in technical subjects ranging from applied plant physiology to pest control, and agronomic management practices. These courses are held in a numerous locations, last for two days, and cost about $200 per course. About 1600 persons are trained annually. These courses qualify for academic credits at some universities.

AgriSource uses a network of personal computers (about 24), and a battery of modems that are linked with individual PCs and modems at each cooperative or farm.

DSSAT and its crop modeling applications would blend naturally into the overall advisory services provided by AgriSource to its clients. A simulation was conducted for an actual situation in southern Minnesota and northern Iowa last year. When farmers were obliged to plant late, the DSSAT crop responses with several corn hybrids showed that if DSSAT had been available, it would have assisted in selecting corn hybrids. Dr. Ahlrichs was very interested in the possibility of using DSSAT under a general license agreement, and being able to

have it fully operational within two years of receiving the license and the necessary training and support services. He was keen on following up after a strategy decision was made to continue IBSNAT project activities.

11. Cargill, Inc., Minneapolis, MN Contact person Mr. William Pearce, Vice-President (April 14)

The demonstration at Cargill Corporate center was attended by six persons representing sourcing of commodities, information resources, marketing and research. Dr. T. Hunt participated for IBSNAT.

Cargill already uses information and prediction systems to establish and estimate future yield levels for the various commodities in which they trade. Some of the models are regression based and admittedly crude. For example, last year's projections of soybean crops missed the real figures by an appreciable margin. DSSAT derived products linked with GIS applications might have real value for Cargill's operations. Unfortunately, no plant breeders from their seeds organization were present, so reactions to these specific applications were not available.

Cargill's staff found DSSAT interesting and worth following up in the future. Mr. P. J. Harroun, Project Leader, Research was interested in obtaining additional information on DSSAT.

12. Merrill Lynch and Co., New York Contact person Mr. Tony Wolfskill, Agricultural Products Manager (April 15)

Two Vice-Presidents of Merrill Lynch in the Securities Research and capital markets group attended the meeting along with a futures meteorologist. Mr. Will Kennedy of ICD was also present.

Considerable interest was expressed about the efficacy of DSSAT applications in predicting yields in various geographical areas of the U.S. and foreign countries for grain and oil seed crops. At Merrill Lynch, as in other companies, reduction of personnel has led to the need for full-service contracts. If DSSAT applications to farm commodity trading, via wide-area yield predictions, were to be contracted at Merrill Lynch, they would have to be tailored so the VPs could sit at their computer terminals or monitors, and obtain direct information in a minimum of time and with as few complications as possible. Collection of data would have to come with the service. The applications would need a simple interface, and training that would require a minimum of time. The present service of Earth Satellite Corp. which they are buying for their yield prognosis activities appears to them to be less useful than a future DSSAT system. It provides, however, database information and on-line weather data, integrated into the service.

13. Delta and Pine Land Co., New York Contact person Dr. Roger Malkin, President; Mr. Murray Robinson, Director of Operations (April 16)

Delta and Pine Land Company specializes in cotton seed. They operate mostly in the Southeastern cotton areas of the U.S., and partially in the Southwest and Latin America. Mr. Robinson came to New York specifically for a demonstration and discussion. The possibilities of using DSSAT for their soybean business were evident.

However, they are especially interested in the possibilities of a DSSAT cotton model. Cotton farmers usually operate on a larger scale than grain farmers, are highly capitalized, and their decision making processes are critical in terms of investment in production inputs. Pest control decisions are especially important, as farmers spend far more money on chemicals for cotton than for grain crops. Large farmers would be candidates for direct crop model utilization in cotton, while grain farmers would be more likely to operate through advisory and extension systems. Dr. Jim Jones indicated that a cotton model existed, but it was a private development and not directly available as such within DSSAT. It might be interesting to negotiate a contract for marketing the cotton model or to develop a new one.

14. United Nations Development Programme (UNDP), New York Contact person Mr. F. M. von Mallinckrodt (April 16)

The meeting was organized within the Seminar Series of UNDP. In attendance were Dr. Al A. App, DGIP; Mr. Herbert Behrstock, RBAP; Mr. Ben Brown, RBAP; Ms. Hertha Krestovsky, RBA West; Ms. Kees Wijnen, RBAS-Europe; Mr. Bajracharya, UNICEF; Mr. Alexander Davidson, BPPE; Mr. Chakib Behassan, RBAS/DRP and Mr. Valenzuela, Latin America. Dr. Jim Jones, U. of Florida and Mr. Walter Simons of ICD also participated.

Following the standard presentation of DSSAT, several areas of interest to UNDP were discussed, chiefly farm management systems for sustainable agriculture; quantification of ecological problems and their control; technification of agriculture and transferability of technologies and know-how through computer simulations; credit and risk propositions in agriculture in developing countries; drought assessment and yield prediction leading to estimates of food requirements in humanitarian project assistance; utilization of DSSAT in agricultural research; opportunities for agricultural planning exercises at all levels, including that of UNDP.

UNDP could, through its field offices, be instrumental in using and introducing DSSAT and knowledge of crop modeling to recipients of UNDP assistance through various executing agencies. UNDP staff were very receptive to the possibility of using DSSAT in their future projects, and would welcome further contacts.

No commitments were made regarding UNDP financing for future DSSAT product research and development activities, although it was indicated that funds were presently committed to specific projects that might use DSSAT technology. It would be easier to introduce DSSAT activities at the project level than at the global level. Any global level actions would have to be planned within the framework of a large project. At the field level there could be immediate possibilites, such as DSSAT training for the Latin American region. UNDP was interested in becoming directly familiar with DSSAT in order to plan and implement future action.

15. American Society of Agricultural Consultants, Tysons Corner, VA (April 20)

A meeting was held with Dr. Kelly M. Harrison, the Executive Vice-President of ASAC. Mr. John W. Murdock, Chairman of International Systems Development Corp. Dr. Goro Uehara of U. of Hawaii/IBSNAT also participated.

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ASAC has over 400 members, one-third of whom are active in 60 foreign countries. There is some skepticism among members as to the benefits of crop modeling. An educational approach on the applications of DSSAT to their membership will be needed. This could start at their annual meeting which usually brings together some 100 members or at their various regional meetings. A few members might be candidates for immediate use of DSSAT. The future possibilities, once information and training are conducted, are good for the utilization of DSSAT. A number of ASAC members are involved in economic analysis, and versions of DSSAT handling economic functions or linkages with other budgeting or economic analysis programs would be helpful to them. Time is a limiting factor to consultants, as that is the commodity they sell, so DSSAT applications must be easy to handle.

16. U.S. Department of Agriculture, Economic Research Service, Washington, DC Contact person Ms. Aqapi Somwaru on behalf of Dr. John Lee, Administrator (April 20)

Only six staff officers attended the DSSAT demonstration because of last minute rescheduling problems. Unfortunately, commodity modeling people were not at the meeting. Discussions centered on DSSAT applications, especially its use in developing a system of crop yield predictions in an aggregated area. Although the participants were not directly involved in this area they did offer interesting suggestions concerning potential applications and linkages to other programs in their area.

After the meeting, Dr. Grobman met with Mr. Kenneth Gray, Chief of the Centrally Planned Economies Branch of ERS, and Dr. Jorge Fernandez-Cornejo, Ag. Economist of the Agricultural Inputs & Production Systems Branch, Resources and Technology Division of the ERS. Mr. Gray, in particular, is involved with the CIS crop forecasting and analysis activities, and was quite interested in DSSAT, but had not been able to attend the demonstration. Dr. Fernandez-Cornejo was working at the time on a project involving GIS in which DSSAT might have been of use.

17. Northrup King and Co., Minneapolis, MN Contact person Dr. Robert Romig (April 21)

Dr. Robert Romig, VP for Research, flew to Washington expressly for a meeting and demonstration on DSSAT. Both Dr. Jim Jones and Dr. Goro Uehara participated. The immediate application that Dr. Romig found for DSSAT at Northrup King, one of the largest international seed companies, was in plant breeding research, and especially in the variety testing area. With over 250,000 test plots in the corn breeding program alone, DSSAT simulations might be instrumental in reducing expenses and streamlining efforts to identify superior genotypes. Other areas of interest would be in seed production, and in marketing support.

When asked about his interest in subscribing to a full service, he indicated that this firm would go along. He found the suggested subscription rate of $3,000 per year reasonable. NK is one of the Sandoz group companies; they are also involved in pharmaceuticals and pesticides.

18. The World Bank, Washington, DC Contact person Ms. Susan Gnaegy (April 21)

More than 20 people attended the meeting, including:

Dr. J.A.N. Wallis, Division Chief
Agriculture and Rural Development
Economic Development Institute of the World Bank

Dr. Jock Anderson, Principal Economist
World Bank

Dr. Jitendra Srivastava, Senior Agriculturist Agriculture Dept., World Bank

and 3 staff members of International Food Policy Research Institute (IFPRI); Dr. Tejpal Gill, in charge of the IBSNAT project; and Drs. Jim Jones and Goro Uehara.

Immediately after the DSSAT presentation, one participant made strong objections to the use of crop modeling and to models in general, as opposed to actual data. Dr. Srivastava disagreed in the same strong terms by referring to the many possibilities offered by DSSAT in technology transfer, in research, advisory services, and planning.

IFPRI personnel found DSSAT potentially useful for their activities. Dr. Wallis also agreed that crop modeling would be useful to the economic analysis efforts conducted at the EDI; he added that the Commonwealth Secretariat in London was interested in expert systems for their development projects. He mentioned that ACCT (France) might fund projects involving crop modeling.

Dr. Anderson doubted that DSSAT could be used by Bank staff in project preparations. Neither he nor Dr. Wallis felt that the Bank would be in a position to fund the DSSAT project in the future, as they indicated the Bank was not a donor but a lending agency.

Dr. Gill gave an overview of the history of the IBSNAT project, explaining the initial objective in funding it as a way of reducing the cost of technology transfer to less developed countries, reducing the need for expensive site-specific research.

While the discussion touched upon a number of potential applications, it became apparent that for the Bank staff to become users of DSSAT applications, modeling specialists would have to be available to assist Bank economists with in-house training and support. A majority of Bank staff work in project preparation and supervision activities. Modeling, including GIS applications, is currently being used by Bank officers. They have used CROPCAST Services from EarthSat Corporation. A commercial approach would have to be made to the Bank from a different base such as the IBSNAT/DSS Corporation idea.

Dr. Wallis confirmed this the next day indicating that, in addition to developing software, the Bank licensed it commercially to some companies for further development and marketing. An example was a Project Development (Bank Style) software, which might eventually be linked to DSSAT. Dr. Wallis indicated that

the Bank would be much more receptive to the purchase of a packaged product, involving training and database information services.

The persons in attendance did not have the authority required to advise on IBSNAT project funding, and no specific proposal was discussed.

19. NOAA/USDA Joint Agricultural Weather Facility, Washington DC (April 22)

A meeting was held with Dr. Douglas Le Comte, Chief, Agr. Weather Section of the National Weather Service at NOAA/USDA JAWF in USDA, and with Mr. Robert J. Stefanski, Agr. Meteorologist, World Agricultural Outlook Board of JAWF, USDA. After a DSSAT demonstration and discussions of its relevance to the work that JAWF is conducting they were of the opinion that DSSAT was a powerful tool, which they knew about but had not formally utilized, and that could have significant importance to their work. They were interested in further information and training. Their GIS applications could benefit directly from DSSAT and AEGIS.

20. Earth Satellite Corp., Rockville, MD (April 22)

Dr. Grobman had a conflict with another meeting at USAID for the only time available, so Dr. Jim Jones visited EarthSat alone. After Dr. Jones's meeting, telephone contact was made by A. Grobman again, concerning the possibility of cross licensing of the respective products and services, and a possible future strategic alliance with this group.

21. Garrison and Townsend Seed Co., Hereford, TX

A meeting was held with Mr. Bill Townsend, Manager of T&S a small seed company specializing in sorghum and grass seed, and Mr. Shirley Garrison, a partner who operates a large (70,000 head of cattle) feed lot operation. DSSAT would be of use to the group in their sorghum CERES applications in research, and they would be interested in becoming DSSAT users when the sorghum model is validated.

Summary of Market Assessment Conclusions

Dr. Grobman and Dr. Jones summarized the findings of the market assessment at a meeting on 22 April at USAID with P. Peterson, T. Gill and W. Simons, as follows:

1. DSSAT as a product offers most of the companies visited opportunities for application either as is or, more likely, as a family of products.

2. DSSAT products require further development to become more user friendly, with direct down-to-earth interfaces with the users; in some cases products need to have specific application orientations.

3. There is a need for new crop models, especially in the cash, vegetable and plantation crop areas. Users are also particularly interested in potential DSSAT applications for crop performance prediction, and in disease and pest monitoring.

4. A family of generic DSSAT products should evolve in the next generation of research and development, and they should be user driven in their succeeding evolutionary steps. Some of the generic products should be geared to specific market segments, such as seed companies, commodity traders, consultants, economic analysts, agricultural support services, etc. Specific proprietary products for individual firms could evolve from them.

5. There is interest in participating in some type of user association or consortium that would invest in and help guide future DSSAT research and development. Such a product research, development and marketing system, with appropriate financing and structure, needs to be established.

6. There is a definite need to package DSSAT products with ancillary services, such as on-line and off-line database information facilitation on soils, weather, crop research data, economic resources, prices of commodities, transportation, land use categories, and water resources. These services should include aggregated spatial data in GIS formats, and collateral services such as AEGIS.

   Remotely sensed data should be interpreted and used in defining image and linear data for cartographic, mapping and imaging applications in interaction with DSSAT products and available on-line and off-line. Selected weather data should be made available on-line to specific users.

   Historical weather data, soils data, and other basic information could be made available on CD-ROM disks as optional products.

7. Training for the use of DSSAT products should be developed by the IBSNAT consortium, and also be made available through third parties. DSSAT training should be reduced to a session of no more than 8 hours for the category of corporate users who will need straightforward applications.

8. A permanent phone support service, periodic software updates, seminars and the formation of user groups will be an absolute requirement. Without these support services, the market will not be receptive to DSSAT but rather to less time consuming products.

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At the debriefing meeting, a preliminary proposal was discussed for marketing future DSSAT licenses within a price range that insures the level of return necessary for future research and development to become financially self-sustaining. USAID officials appeared to concur with these views, and expanded on them.

IBSNAT and ICD representatives agreed to jointly develop a concept paper for USAID, proposing a partnership between a new commercial organization and IBSNAT in the research, development and marketing of current and future DSSAT products on a self-sustaining basis. USAID would consider financial support for the proposed partnership during its transitional period, including authorization for commercial marketing of the DSSAT family of products.

As a follow-up to the Washington debriefing meeting, Dr. Grobman met with Walter Simons and Will Kennedy in New York, and then with Dr. Jones and other IBSNAT scientists from IFDC, the Universities of Michigan State, Hawaii, and Georgia, at the University of Florida in Gainesville, to further refine views and begin preparing the concept paper.

The paper will present the rationale for a new DSS Corporation to help develop and market DSSAT and related products, plus information and services, in coordination with IBSNAT or its successor, which will also carry out contract research for the DSS Corporation.

dssat/pb18

New Computer Technology Speeds Decision Making in Agriculture, Agribusiness

Once used primarily for research, computer simulation models are becoming valuable aids for evaluating options for sustainable agricultural production. A simple, cost-effective computer system is now available to help farmers and agribusiness executives simulate in minutes crop production scenarios that would take years through field research. This technology, the Decision Support System for Agrotechnology Transfer (DSSAT), has been developed over the past ten years by a global network of research scientists at major agricultural universities and funded largely by the U. S. Agency for International Development (USAID).

With the basic technology now proven, USAID, the participating universities and the Industry Council for Development (ICD) are exploring opportunities for wider use of DSSAT as a problem solving instrument for planners, policy decision makers, and agribusinesses.

DSSAT has had only limited diffusion so far — to some 400 users, mostly with research institutions and a handful of public sector organizations.

Results of a Decade of Scientific Effort

DSSAT was developed by the International Benchmark Sites Network for Agrotechnology Transfer (IBSNAT) project financed by USAID. The project is headquartered at the University of Hawaii, and supported by a network of scientists at some universities in the U. S., Europe and research and development institutes in Asia, Latin America, and Australia.

DSSAT has a software system which integrates the various crop models with databases, allowing users to test and implement the crop models to variable circumstances at specific sites, conduct sensitivity analyses, and predict outcomes. A standard set of inputs — including soil, crop and variety, weather, irrigation water, crop management and economic functions — determines crop growth, yield and other outputs. Crop modeling systems can be extended to include the functions most important to individual users.

In addition to yield variability, DSSAT can estimate price and market risk associated with changing farm management strategies or the introduction of new technologies. By testing the performance of new cultivars or management practices under specific conditions, a user can evaluate the economic risks of various crop strategies for a desired number of years. The user can then integrate new crops, products and practices with existing farming systems to optimize their stability and sustainability of production.

Validated Crop Models Available

Crop growth models are the core of DSSAT. Validated models exist for seven food crops (wheat, maize, rice, soybean, dry bean, peanut and sorghum). Others for millet, barley, aroid, and potato are at various stages of development. The models are process oriented and designed to have global applications; each simulates crop growth, development, and yield under different soil, weather, and management conditions.

DSSAT crop models feature a series of database programs on soil types, weather, management and experimental data and genetic coefficients. Additional programs may be added later. Each program retrieves data and creates input data files for the crop models. Other programs analyze and present outputs according to the specifications of the user.

DSSAT can focus on a particular crop, a specific soil type, designated weather patterns and other factors relevant to production agriculture. Different possible agro-technology packages for specific sites may be evaluated prior to field experimentation. The result: charts and graphs showing the effect that planting dates, fertilizer application, irrigation, crop varieties and other farming practices have on yields, profits, and sustainability.

Proven Reliability

Simulation results obtained from crop models have been field tested at many locations, and are highly reliable as compared to trial and error on-site testing. DSSAT is capable of generating whole probability distributions for outcome quantities such as yield or profit. Agribusiness managers can compare distributions and their probabilities, and assign values as a function of risk rather than relying on the uncertainties of comparing averages.

An Evolving Product

Work is proceeding on new DSSAT applications which will deal with the effects of pests and diseases; for genetic coefficients required as model inputs that vary from crop to crop and describe growth phases; and for the effects of fertilizer components other than nitrogen. New intercropping models, multiple cropping models, and economic input/output functions will add power and value in the analysis of options in agricultural production.

Because it was developed through a publicly funded program, DSSAT is freely available at nominal cost, without restrictions on further adaptation by individual companies.

Flexible and User Friendly

Computer implementation of the DSSAT models is done through a menu system which allows access to data entry, retrieval, summarization or utilities from the database system; crop growth models; a weather generator in case no complete weather data are available; and a DSSAT utility to tailor the system to user needs and computer resources. Installation is simple; it allows the installation of only the components desired by the user. Users will find DSSAT flexible in terms of application of any of the crop models with any site and weather data sets contained in the database management system. Training in the use of DSSAT is available through members of the IBSNAT network, and will be expanded in the future.

The programs to perform the DSSAT functions are written in various computer languages. Crop models have been developed in FORTRAN, the data entry programs in dBASE III, and the graphics programs in Quick BASIC and PASCAL. A shell program in the "C" language provides users access to any DSSAT programs without having to worry about which language is being used and how to execute

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that particular program. The DSSAT shell uses pop-up menus to guide users to these functions.

A Tool for Farmers, Agribusiness Executives

DSSAT was designed primarily for agricultural sector users. However, its structure allows extensions that other users have exploited to adapt the modeling system to their own needs. For example, the U.S. Environmental Protection Agency (EPA) uses DSSAT in global climatic assessments, especially regarding effects of increasing carbon dioxide concentrations in the atmosphere.

DSSAT is a tool that farmers, agribusiness managers and policy planners can use to explore options for:

Strategic Decisions

- crop and seed yield prediction throughout the growing season (national, regional, and local level yield or production projections worldwide can be constructed by DSSAT)
- optimum crop and land use
- potential adaptation of new cultivars to a wide range of environments
- credit/loan requirements related to crop management
- market potential for improved seeds, fertilizer, crop protection supplies, alternative crops, machinery storage or processing equipment, etc.
- crop mix and management in regional development projects
- crop mix and management in irrigation projects for optimization of use of water resources

Tactical Crop Management Decisions

- irrigation management (i.e., determination of crop water requirements)
- fertilizer management/application
- variety screening, selection and testing to match crop requirements with land and environmental characteristics
- planting date
- pest/crop interaction
- whole-farm system models
- plant breeding decisions
- seed production site selection

Decisions on Maintaining a Sustainable Environment

- nitrogen leaching as related to fertilizer management
- optimum crop rotations and intercropping
- best management practices to reduce potential pollution
- the impact of global climate change on agricultural production
- selection of cropping patterns that will reduce soil run-off and factor in the value of soil in estimating return
- long-term environmental consequences of land use decisions

In these and other ways DSSAT can help managers allocate resources more effectively in terms of economic and environmental outcomes.

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The Future of DSSAT

Future versions of DSSAT will expand the range of crop models and databases to include more commodities from vegetables to perennial fruit trees. Models for pest and disease factors will also be available. The intercropping model is being refined to allow applications of DSSAT to whole farm modeling and sustainable agriculture issues.

In August 1992, the IBSNAT project will issue an updated version of the DSSAT software which will be even more powerful and versatile than the current version. This software will enable decision makers to address more problems quickly and reliably and to assess the comparative advantage of alternative agricultural strategies specified by the user.

Like its predecessor the new version of the DSSAT software can be linked to a geographic information system (GIS) called AEGIS which allows decision makers to evaluate different crop production strategies in a regional context and interactively develop a regional plan to suit their objectives. AEGIS can perform tasks such as:

- Estimating production and resource requirements for different agricultural strategies (e.g., combining crop, variety, planting date, irrigation and fertilizer treatment);
- Assessing potential environmental impact, generating tables and thematic maps (e.g., maps of simulated yield, biomass accumulation, runoff, etc.);
- Creating and modifying a production plan indicating the crop and management practices of a selected region.

With DSSAT linked to AEGIS, yield and production projections appear to be possible at national and world levels. They may also be more reliable than those constructed from satellite imagery and infra-red photography of crop growing conditions.

Market Research Program Initiated

Now that the core DSSAT product has been developed and well received, a market research program has been launched by ICD and DSSAT representatives including demonstrations to farmers, agribusiness executives and other possible users in the U. S. and Europe. These demonstrations will introduce the current DSSAT product, assess opportunities and methods for adapting DSSAT for specific commercial applications, and discuss priorities for further product and market development. The results will be reviewed in workshops sponsored by USAID to agree upon a new marketing and product development strategy linking both public and private sector markets with the university research base.

The DSSAT demonstrations will be conducted by ICD Senior Associate Dr. Alex Grobman and a research scientist from the IBSNAT Network. Dr. Grobman is a leading agronomist, plant breeder and agribusiness executive. He has held senior posts with the Peruvian government and educational institutions, as well as international companies and agricultural research centers. A summary of Dr. Grobman's professional and academic background is attached.

Industry Council for Development

CONCEPT PAPER

THE DSS CONSORTIUM

An Integrated Marketing/Research System to Put DSS Technology on a Self-Sustaining Basis

Prepared by

The Industry Council for Development

and

The International Benchmark Sites Network for Agrotechnology Transfer Group

August 1992

300 EAST 44th ST. ▪ NEW YORK, NY 10017 ▪ (212) 867-5017 ▪ CABLE: INDUCODEV ▪ TELEX: 23 89 76 ▪ FAX: (212) 573-6028

CONCEPT PAPER

The DSS Consortium - An Integrated Marketing/Research System to Put DSS Technology on a Self-Sustaining Basis

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CONCEPT PAPER

The DSS Consortium - An Integrated Marketing/Research System to Put DSS Technology on a Self-Sustaining Basis

1. INTRODUCTION AND RATIONALE

The Challenge

Decisions on the use of our planet's natural resources made within this decade will have a profound impact on the quality of life for billions of people well into the next century. With a global population that may double in less than two decades, the intensity of pressure on natural resources may result in even greater land degradation, environmental pollution, malnutrition, hunger and poverty.

This realization, heightened by the results of the recent U.N. Conference on Environment and Development (UNCED), has made sustainability an essential criterion for virtually all development activities involving natural resources. Here is how the UNCED report, The Global Partnership, describes the challenge:

"Hunger and malnutrition are endemic among developing countries. By the year 2025 about 84% of the expected global population of 8.5 billion will be living in developing countries. The fundamental challenge facing agriculture in developing countries today is to increase food production in a sustainable way and feed expanding populations. Such an increase has to come primarily through intensification of current agricultural production, as the potential for bringing new land under cultivation in many countries is very limited. If hunger is to be eventually eradicated in these countries, this intensification must be both ecologically and socio-economically sustainable.

"Major adjustments are needed in national and international policies to create conditions for sustainable agriculture and rural development. A major objective is to increase food production in a sustainable way and enhance household food security. This involves education initiatives, utilization of economic incentives and the development of appropriate and new technologies, thus ensuring stable supplies of adequate food by vulnerable groups and production for markets, employment and rural income generation as well as efficient natural resources management and environmental protection.

"Priority must be given to maintaining and improving the capacity of higher potential agricultural lands to support an expanding population. At the same time conserving and rehabilitating lower potential land is essential. Emphasis should also be given to reforming agricultural policies relating to price, subsidies, trade, land tenure, and appropriate farm practices and technologies."

The Response - New Tools for Decision Makers

In response to the challenge, management systems must be developed that can utilize modern information technology to assess alternative uses of natural resources and predict their biophysical and socioeconomic effects. Such new approaches must be client-oriented and demand-driven. They can succeed only if

they are interdisciplinary and systems-based, incorporating generic, portable, integrative decision support tools which can be used by decision makers at all levels, worldwide.

Working through the International Benchmark Sites Network for Agrotechnology Transfer (IBSNAT), a global network of universities and research institutions, the U. S. Agency for International Development (USAID) has invested $10 million over the last ten years to develop a computerized simulation technology capable of generating information for addressing a wide range of agricultural, environmental, and economic problems. The resulting Decision Support System for Agrotechnology Transfer (DSSAT) software enables decision makers, ranging from farmers and farm advisors to business executives and government policy makers, to assess the comparative advantages of alternative strategies for the sustainable management of agricultural and other natural resources (Annex 1).

Over 100 scientists from 25 countries belonging to the IBSNAT project have contributed time and resources to design and develop DSSAT. In the past five years, the project has trained 275 scientists and administrators to use DSSAT and has distributed the software to over 500 user groups in 45 countries. This growing user group has generated a momentum for change which coincides with the groundswell of public concern over food safety and food security stemming from increasing evidence of environmental degradation and natural resource depletion.

With the basic Decision Support System (DSS) methodology and technology now proven, USAID, the participating universities and the Industry Council for Development (ICD) are exploring opportunities for wider use of DSS software as a problem solving tool by public and private sector decision makers.

Providing decision makers with the tools necessary to assess the agronomic, environmental, and socioeconomic consequences of farming and other natural resource management practices, will also help change the way people view decision making and the way complex problems are studied and solved.

This concept paper proposes a practical approach to facilitate the continuous development, transfer and more effective utilization of DSS technology. It provides a "pre-feasibility" rationale for establishing an integrated research, product development and marketing system that links public and private sector markets with the university research base and puts decision support system technology on a self-sustaining basis.

A full feasibility study is recommended to test the assumption that this system, combining a new commercial marketing organization and a research group built around the IBSNAT model, can develop self-sustaining operations in a reasonable time period and without major continuing aid grants.

2. PRELIMINARY MARKET SURVEY

DSS crop modeling products are presently being used for a limited set of applications to assess the comparative advantage of alternative strategies for

improving agricultural production and natural resource management. DSS models require further refinement to enhance the utility of the software, and increase user confidence in its predictive accuracy. Easily accessible databases, various other support services and training must be an integral part of future DSS products.

Expanding the use of DSS products beyond the public research sector is essential if the enormous potential of this technology is to be realized. The challenge is to ascertain what clients need and are willing to pay, and to develop products that can generate site and situation specific information for each decision maker.

At USAID request, ICD has conducted a preliminary market research survey including DSSAT demonstrations to a cross-section of agribusinesses and related companies such as farmer cooperatives, agricultural consultants, food processing companies, commodity brokers and marketing agents. Survey results indicate strong interest in a greater range of crop modeling products and services which would be available on a commercial basis.

On behalf of the IBSNAT network and paralleling the ICD effort, Dr. Jim McWilliam, former Director of the Australian Centre for International Agricultural Research (ACIAR), has met with directors of several research centers belonging to the Consultative Group on International Agricultural Research (CGIAR) to assess their interest in forming a new collaborative effort to tailor DSSAT for distribution to national agricultural research system (NARS) organizations. Six CGIAR centers are now using DSSAT, while the others are still searching for a research methodology to deal with the new mandate to promote ecologically sustainable development.

3. AN INTEGRATED RESEARCH, PRODUCT DEVELOPMENT AND MARKETING CONSORTIUM

Based on these market assessments, ICD and IBSNAT propose establishment of an integrated research, product development and marketing Consortium composed of two primary units — (1) a development/marketing DSS Corporation; and (2) a university-based Research Network — fully capable of continuing the research, development and distribution of DSS products on a self-sustaining basis (Figure 1).

The DSS Consortium partners will cooperate to:

1. Develop an array of DSS products and services based initially on DSSAT but not restricted to it, exploring other related modeling niches and a wide variety of applications;

2. Improve and expand the capabilities of DSS products to meet the needs of diverse public and private sector markets worldwide.

3. Facilitate widespread transfer and utilization of full service DSS technology products by linking the research base to private and public sector markets; including government, industry, farming, research, trading, consulting, environmental regulatory agencies, etc.

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DSS CONSORTIUM

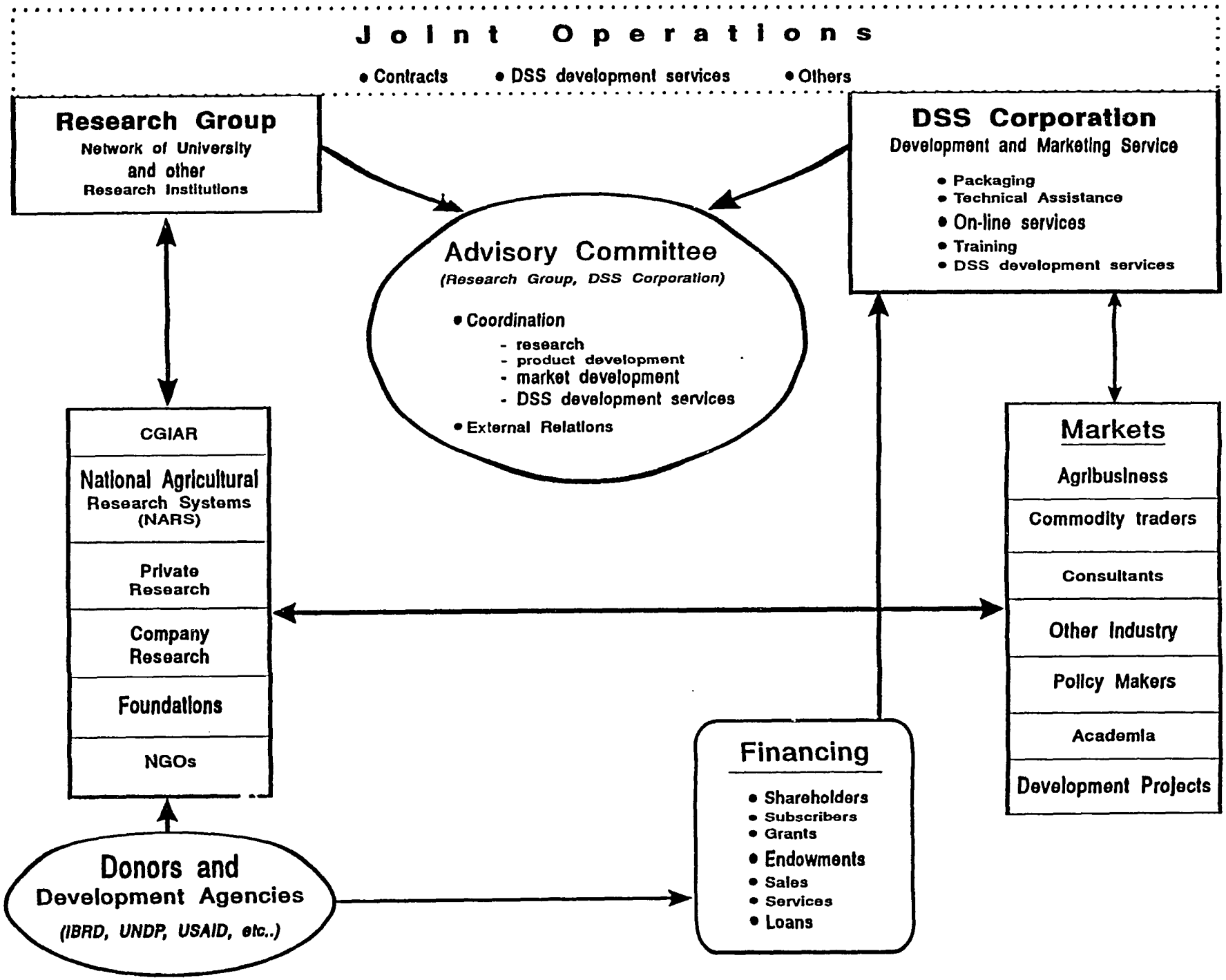

Figure 1

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4. Coordinate DSS product research, development, marketing and support service activities to optimize efficiency and impact.

5. Provide an additional, permanent source of financing to the Research Network through DSS product research contracts.

6. Initially, at least, provide advisory and project execution services to government agencies as well as multilateral, bilateral and private aid organizations. This will help "prime the pump" and speed the transfer of DSS technology while also providing income for the Consortium in its start up phase.

The DSS Corporation

ICD's preliminary assessment (Annex II) indicates sufficient market demand for DSS products and services to warrant establishing commercial operations. This assumption will be tested in a full feasibility study.

The DSS Corporation would develop and market high quality products and related services based on clearly identified demand from public and private sector users. The DSS Corporation would also stimulate demand for new and improved products which would be designed and created in partnership with the research group. Products would be customized to meet specific user group demands. The DSS Corporation would be the sole marketing and sales organization for all clients, with exclusive marketing rights to the products obtained through the operation of the DSS Consortium.

ICD has identified market potential for DSS products that serve industries such as the seeds industry, fertilizer, irrigation, pest control and other input companies, consultants, crop insurance, agricultural banking and commodity traders, natural resource planning and monitoring, etc. Other DSS products might also serve functions in public and private organizations such as agricultural extension; crop, soil and weather research; agricultural economics research and practice; project design and management; environmental policy analysis and economic decision-making (Figure 2). The DSS Corporation would also provide database and on-line information services and training to meet specific client needs.

As a commercial operation, the Corporation will be expected to achieve financially self-sustaining operations in a reasonable period. Its commercial feasibility will depend on the capacity to offer competitive products that enable decision makers (clients) to assess agricultural and other natural resource management problems quickly and reliably in terms of economic and environmental outcomes.

Within the context of an integrated marketing/research system, the Corporation will:

a) Identify and develop products and services demanded by targeted user markets, including:

   - DSS models for horticultural, fiber, pasture, and tree crops including legume tropical trees and both temperate and tropical fruit trees,

Figure 2

Potential Clients of DSS Corporation

* CGIAR Centers
* NARS (Nat'l. Ag. Research Ctrs)
* Agroindustry
* NGOs
* Environment Control Agencies
* Consultants
* Government Agencies
* Farm Groups
* Environmental and Natural Resource Management Agencies
* Food Security Agencies
* Analysis and Marketing of Commodities
* Weather, Earth and Atmosphere Agencies
* Multilateral & Bilateral Technical Assistance

tomatoes, sugar cane, banana, pineapple, etc;

- DSS models for environmental monitoring, irrigation, forestry, natural resources conservation and development, transportation;
- Linkage products for policy analysis and decision making;
- Soil and weather data;
- On-line and off-line economic, commodity, banking and other business information;
- Seminars, workshops and other training services.

b) Deliver products and services to subscribers and buyers on a commercial basis;

c) Help design and create new and improved DSS products through contracts with the Research Network and, when necessary, contracts with other specialized institutions and firms (e.g., on-line database information);

d) Establish a marketing system to obtain and evaluate feedback from users; and review results with the research group for potential product modifications and innovations;

e) Collaborate with the Research Network in the assessment of market potential for crop model and geographical information system (GIS) linkages, and other technological innovations;

f) Identify, prepare, and execute advisory and operational projects under contract with governments and development agencies.

The DSS Corporation will contract services to be resold in packaged form with DSS derived products.

The Research Network

DSS products will be designed and created largely through a closely coordinated group of universities and research institutions patterned after IBSNAT. Scientists would continue research in their fields of specialization, and participate in crop modeling research projects, either individually or as a group, as determined by the Network. (The Research Approach is presented in Annex III.)

The DSS Corporation and the Research Network will be interdependent and closely linked through an Advisory Committee composed of senior officials of both organizations. In effect, the Corporation will be the primary development and marketing arm of the Research Network; the Research Network will be the primary research and product design arm of the Corporation.

The Research Network will receive research contracts and share in the profits of the DSS Consortium through royalties.

In partnership with the DSS Corporation, the Research Network will:

a) Provide users with existing DSS, including the new DSSAT version 3.0, AEGIS, and the various models, databases and analysis programs within these systems.

b) Develop new components for decision support systems as defined by client needs, and financed by the corporation.

c) Provide expertise for defining minimum databases for soils, crops, weather, pests and other components, as well as standards (as needed) for organizing such databases for international applications.

d) Provide services for training and educational programs; for the development of special applications of DSS products; and for developing new components.

e) Provide generic DSS products for field, farm and regional levels that can be adapted for various user applications.

The interdependence of the Corporation and the Research Network will require close coordination of market research, sales, product design and research activities. A DSS Consortium advisory committee, including senior officials of both organizations, will provide this coordination. The committee will also identify areas for joint operations, develop relations with new cooperating organizations and in other ways promote the sustainable growth of the consortium as a whole.

4. PRODUCT DEVELOPMENT AND MARKETING

Existing DSS models will be improved further to assess the agronomic, environmental, and economic consequences of agricultural management practices. The same tools can then be used to develop alternative strategies for sustainable production and improved natural resource management in temperate and tropical regions. Future models will also be linked to GIS systems to evaluate different crop production strategies, including resource requirements and potential environmental impacts, in a regional context.

Another immediate task is to further develop efficient crop and soil models oriented to the needs of specific user groups. The ongoing development of such products requires continual investment.

Product support services will include on-line weather data (historical weather conditions from locations worldwide); an improved soils database; databases of other information elements required by users, such as trade, economic, natural resource and environment, land use, etc.

Some products will be developed by the DSS Corporation, while others will be subcontracted to software houses, and specialized technical companies. New strategic alliances will naturally emerge with other companies whose services complement those of the Corporation.

The ICD survey of companies in Europe and the U.S. showed that users expect a full-package product, including data and service support, which performs simply and consistently and is cost-efficient. The Corporation will draw on the experience and information resources of the Research Network to gather database and other information. Wherever possible, the marketing effort will sell integrated software, on-line database, support and training packages.

DSS Corporation will market a family of DSS products with information database and support services, including:

- on-line information retrieval by subscription,
- upgrades of future versions of DSS products,
- add-on software and linkages,
- training and other services such as newsletters and seminars.

Products and services will be organized generically or customized for specific sets of users or individuals.

The initial core product will be DSSAT version 3.0. Further advanced versions of DSS products will follow. If necessary, an agreement will be negotiated with USAID to allow the Corporation to market DSS products. New crop models may be added to DSS, and would be purchased independently.

The DSS products would be sold with linked programs as demanded by clients. Among these would be geographical information system linkages (such as the AEGIS system) and linkages to other applications software, e.g., statistical analysis and experimental design, project management, economic and environmental policy analysis.

Other databases including soils, historical weather, economic, and ecological factors may soon become available on CD-ROM disks, and could be accessed on-line. Software and database updates will be available at least annually through CD-ROM disks.

Services will be provided by subscription and will cover direct customer access on-line to:

- weather data,
- on-line economic and market data,
- technical, product, environment and resource databases,
- agricultural production input prices and recommended uses,
- transportation cost/availability matrices,
- land use planning and soils data,
- pest and pesticide data,
- crops statistics,
- commodity prices and futures markets,
- international crop policies matrices,
- updates on import/export national regulations,
- tariffs on commodity and other product imports/exports.

After the market demand for products and services are further specified, the DSS Consortium will prioritize its research, development and marketing efforts in those areas where demand is high and where initial efforts are likely to be most cost effective. This should not detract from investing in forward looking research which may not bring an immediate financial return.

The DSS Consortium should be prepared to not only improve on basic models and applications, but to contract the design and development of an entirely new set of models and inter-model linkages for decision making processes associated with population, food resource conservation and development, health education, the environment, etc.

DSS Development Services

In order to "prime the pump" for expanding the use of DSS products and services, the DSS Consortium, through the Corporation, will provide advisory, technology, management and related operational services under contract to governments and development agencies. These DSS Development Services will also help generate revenues for the Consortium during its critical start-up period.

DSS Development Services will be managed to avoid conflict with major clients or creating dependency relations with developing country governments and institutes that would contradict the purpose and principles of the DSS Consortium, which are to create and transfer DSS technologies and services to end-users who are primary actors in the decision making process for sustainable development.

Within this context, particular attention will be given to helping build national capacity for the use of DSS technology by both public and private sector users in the developing countries.

Another immediate market for DSS Development Services will be preparing databases on local agronomic, weather, and other factors essential for DSS programs in developing countries.

5. THE CONSORTIUM PARTNERS: ORGANIZATION AND MANAGEMENT

DSS Corporation

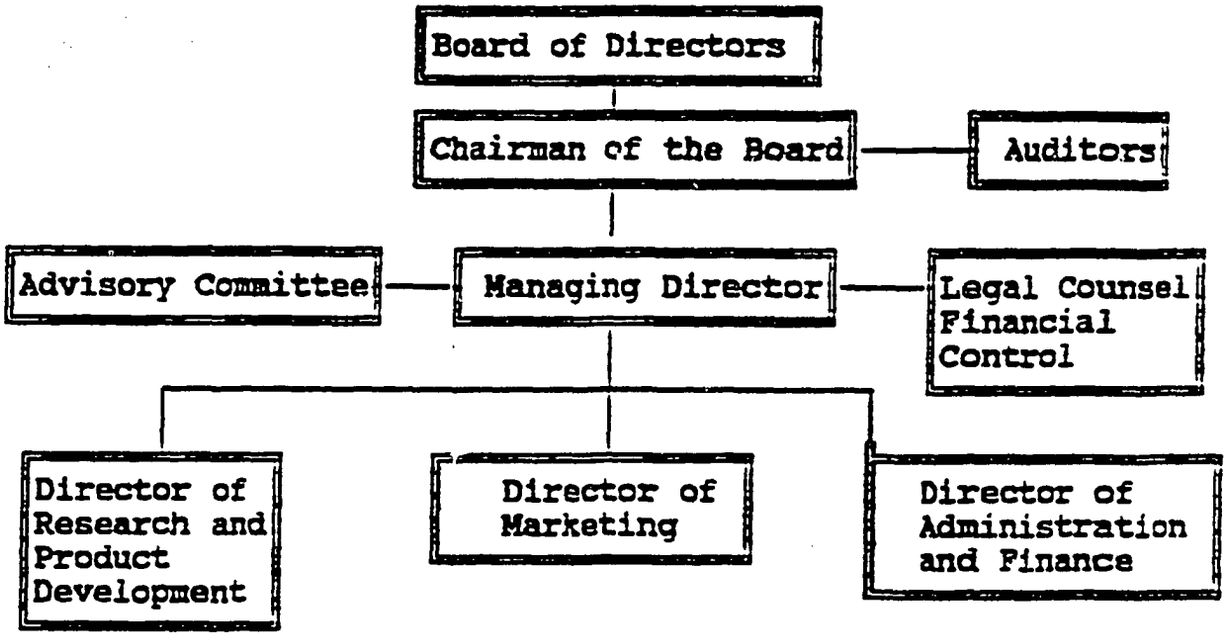
The Corporation will be owned by partners or shareholders. ICD will identify founding owners in consultation with the Research Network and USAID, and invite them to invest in the DSS Corporation. Corporations, international and bilateral technical assistance agencies, development finance organizations, and NGOs may be interested in ownership.

The DSS corporate structure will be further defined in the feasibility study (Figure 3). It will probably include:

a) A Shareholders Council which would meet at least once a year to elect officers and directors and conduct other required business functions.

Figure 3

DSS Corporation Structure



b) A Board of Directors that would determine general policy and supervise the conduct of business.

c) The management: a Managing Director who will be responsible for the strategic conduct of business and for supervising financing, contracts, operations, coordinating research, development, and marketing; and Division Managers (or VPs) responsible for (1) research and product development; (2) administration and finance; (3) marketing.

The support staff will maintain computer databases, communication systems, marketing and development support activities. Most development and production work will be contracted out.

To facilitate operations, the management of DSS Corporation may be contracted to ICD or an ICD affiliate.

DSS Corporation operations will be defined in the feasibility analysis and business plan. It will begin business on a limited basis but will provide basic marketing services.

It will be necessary to establish an infrastructure for communications and the sale of support services and training. It will also be important to obtain on-line weather, economic, and resource information to sell as services to subscribers. The collection and production of recorded data on crops, economics, soils, weather and other databases will be a priority at the onset of operations.

Product marketing will begin with DSSAT version 3.0 (due in Fall 1992), and will continue with the sale of support services, training, historical weather sets, and soil classification sets. Once the communications system is installed, the sale of subscriptions integrating DSSAT, GIS, other software packages, and on-line data will proceed. There will be various market targets and products with different price ranges. The business plan will define timing for each of the activities indicated above.

Financing for the Corporation may include (Figure 4):

a) Shareholder equity to cover the initial capital costs.

b) Grants, endowments or reimbursable loans from individuals or institutions.

c) Commercial loans to acquire equipment, materials and the financing of development contract obligations.

d) Subscriptions for DSS Corporation services.

A 5-year business plan will be proposed in the feasibility analysis.

Access to DSS products will be user friendly, whether on-line or with packaged data in CD-ROM disks. The subscription price will include direct telephone support and basic training. Additional services will be in the form of updates, newsletters, seminars, etc.

Figure 4

Funding Routes for DSS System

```
Subscriptions
Service Fees
Risk Capital
Endowments   = = = = = >  DSS Corporation
Grants                          |
Loans                           |
                            R & D Contracts
                                |
Grants                          |
Endowments   = = = = = >  DSS Research Network
```

The Research Network

The DSS Research Network will evolve from the IBSNAT network, a consortium of universities and institutions (Annex IV) that have worked together on the DSSAT project over the past decade. The University of Hawaii will continue to be the facilitating organization in the research group. The University would work with a small core group of other research institutions to provide coordination and administrative services for the group as a whole.

As a member of the DSS Consortium, the Research Network will:

- Contract research from DSS Corporation related to specific user needs;
- Provide consulting and training services for specific client projects;
- Provide advisory, technical and managerial services for DSS Development Services projects with governments and development agencies;
- Participate in the DSS Consortium advisory committee.

The Research Network will interface with other major research organizations at both international and national levels, including the CGIAR system, national agricultural research systems (NARS), private, corporate, and foundation research organizations, and NGOs. Such organizations may be both clients and collaborators with the DSS Consortium.

The DSS Consortium will thus have unique access to the world research and scientific community based on common interests in developing methodologies for decision making in sustainable development.

The relationship may also help the research group to attract funding directly from donors and agencies to develop new products and services for the research community; or to help improve communications between research organizations and stimulate innovative thinking on the decision making process.

Representatives of the IBSNAT group believe that the DSS Consortium concept is an historic move which will bring major changes in the way information is made available to decision makers.

It will also bring an unprecedented change in the way research costs are shared by public and private sectors alike. It will allow development agencies such as USAID to use scarce resources to establish self-sustaining partnerships between public institutions and businesses. It will also help establish guidelines for universities and research institutions to collaborate with private sector users in generating income to conduct research.

Advisory Committee

The DSS Consortium is an innovative attempt to put the results of a decade of aid-funded scientific work on a financially self-sustaining basis. The viability of the Consortium will depend on close cooperation between the partners in maintaining a competitive line of DSS products and services that are attractive to a wide range of public and private sector clients.

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An advisory committee including senior officials from both partner organizations will ensure the close coordination of research, product development and marketing operations. The committee will also provide guidance for DSS Development Services, particularly in terms of potential new public sector markets.

Another function of the committee will be to monitor and evaluate DSS Consortium operations, providing recommendations to the governing bodies of the partner organizations.

The advisory committee will, in addition, serve the common external affairs interests of the partners and help maintain a long term market perspective for DSS products and services. Within this context, the committee may occasionally host workshops or seminars which bring together DSS Consortium clients and collaborators to explore common interests which are also primary factors for future market development. DSS Consortium publications and public relations materials will document case histories of DSS products in client operations, particularly those related to sustainable agriculture.

6. CONSORTIUM FEASIBILITY STUDY

A full feasibility study and business plan for the DSS Consortium will be necessary to attract public and private sector investors and subscribers.

Regarding the DSS Corporation, the feasibility analysis would:

a) evaluate existing and potential markets and identify special client categories;
b) identify resource requirements: finance, human, institutional and technical;
c) propose a business plan with detailed financial calculations for the first three to five years;
d) propose ownership, governance, financing and legal aspects including by-laws and articles of incorporation;
e) propose the structure and activities of an advisory committee which would coordinate Corporation and Research Network planning, operations and external affairs of mutual interest.
f) assess pricing policy, intellectual property considerations, linkages with other software systems, etc.

The feasibility study should cover all technical, legal, and financial matters required for decision by equity investors. It should also have provisions for grant and endowment financing.

The feasibility of the Corporation would be tested within the context of DSS Consortium operations. It will require a thorough examination of legal, financial and operational links between Consortium partners and their significance for the sustainability of such an integrated operation.

The business plan should include financial projections (general expenses and revenues) and market targets, and should present a proposed marketing plan for evaluation at the first meeting of the Board of Directors.

ICD will conduct the feasibility analysis in cooperation with the universities and other institutions likely to compose the Research Network.

Upon completion and acceptance the feasibility study and business plan would be presented to the proposed business partners, which could include:

- ICD members and other Corporations,
- various universities and research institutions which participated in the creation of DSSAT,
- USAID and other international development organizations,
- other institutions and individuals.

An initial commitment in equity and loans to implement the corporation would most likely come from the institutions who share its proposed technological and service purposes.

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Annex I

DSSAT - A DECISION MAKING TOOL

DSSAT was developed by the International Benchmark Sites Network for Agrotechnology Transfer (IBSNAT) project financed by USAID. The project is headquartered at the University of Hawaii, and supported by a network of scientists at some universities in the U.S., Europe and research and development institutes in Asia, Latin America, and Australia.

DSSAT has a software system which integrates various crop models with databases, allowing users to test and implement the crop models to variable circumstances at specific sites, conduct sensitivity analyses, and predict outcomes. A standard set of inputs — including soil, crop and variety, weather, irrigation water, crop management and economic functions — determines crop growth, yield and other outputs. Crop modeling systems can be extended to include the functions most important to individual users.

In addition to yield variability, DSSAT can estimate price and market risk associated with changing farm management strategies or the introduction of new technologies. By testing the performance of new cultivars or management practices under specific conditions, a user can evaluate the economic risks of various crop strategies for a desired number of years. The user can then integrate new crops, products and practices with existing farming systems to optimize their stability and sustainability of production.

Validated Crop Models Available

Crop growth models are the core of DSSAT. Validated models exist for seven food crops (wheat, maize, rice, soybean, dry bean, peanut and sorghum). Others for millet, barley, aroid, and potato are at various stages of development. The models are process oriented and designed to have global applications; each simulates crop growth, development, and yield under different soil, weather and management conditions.

DSSAT crop models feature a series of database programs on soil types, weather, management and experimental data and genetic coefficients. Additional programs may be added later. Each program retrieves data and creates input data files for the crop models. Other programs analyze and present outputs according to the specifications of the user.

DSSAT can focus on a particular crop, a specific soil type, designated weather patterns and other factors relevant to production agriculture. Different possible agro-technology packages for specific sites may be evaluated prior to field experimentation. The result: charts and graphs showing the effect that planting dates, fertilizer application, irrigation, crop varieties and other farming practices have on yields, profits and sustainability.

Proven Reliability

Simulation results obtained from crop models have been field tested at many

locations, and are highly reliable as compared to trial and error on-site testing. DSSAT is capable of generating whole probability distributions for outcome quantities such as yield or profit. Agribusiness managers can compare distributions and their probabilites, and assign values as a function of risk rather than relying on the uncertainties of comparing averages.

An Evolving Product

Work is proceeding on new DSSAT applications which will deal with the effects of pests and diseases; for genetic coefficients required as model inputs that vary from crop to crop and describe growth phases; and for the effects of fertilizer components other than nitrogen. New intercropping models, multiple cropping models, and economic input/output functions will add power and value in the analysis of options in agricultural production.

Because it was developed through a publicly funded program, DSSAT is freely available at nominal cost, without restrictions on further adaptation by individual companies.

Flexible and User Friendly

Computer implementation of the DSSAT models is done through a menu system which allows access to data entry, retrieval, summarization or utilities from the database system; crop growth models; a weather generator in case no complete weather data are available; and a DSSAT utility to tailor the system to user needs and computer resources. Installation is simple. It allows the installation of only the components desired by the user.

Users will find DSSAT flexible in terms of application of any of the crop models with any site and weather data sets contained in the database management system. Training in the use of DSSAT is available through members of the IBSNAT network, and will be expanded in the future.

The programs to perform the DSSAT functions are written in various computer languages. Crop models have been developed in FORTRAN, the data entry programs in dBASE III, and the graphics programs in Quick BASIC and PASCAL. A shell program in the "C" language provides users access to any DSSAT program without having to worry about which language is being used and how to execute that particular program. The DSSAT shell uses pop-up menus to guide users to these functions.

A Tool for Decision Makers

DSSAT was originally designed primarily for agricultural sector users. However, its structure allows extensions that other users have exploited to adapt the modeling system to their own needs. For example, the U.S. Environmental Protection Agency (EPA) uses DSSAT in global climatic assessments, especially regarding effects of increasing carbon dioxide concentrations in the atmosphere.

DSSAT is a tool that farmers, business managers and policy planners can use to explore options for:

Strategic Decisions

- crop and seed yield prediction throughout the growing season (national, regional, and local level yield or production projections worldwide can be constructed by DSSAT)
- optimum crop and land use
- potential adaptation of new cultivars to a wide range of environments
- credit/loan requirements related to crop management
- market potential for improved seeds, fertilizer, crop protection supplies, alternative crops, machinery storage or processing equipment, etc.
- crop mix and management in regional development projects
- crop mix and management in irrigation projects for optimization of use of water resources

Tactical Management Decisions

- irrigation management (i.e., determination of crop water requirements)
- fertilizer management/application
- variety screening, selection and testing to match crop requirements with land and environmental characteristics
- planting date
- pest/crop interaction
- whole-farm system models
- plant breeding decisions
- seed production site selection

Decisions on Maintaining a Sustainable Environment

- nitrogen leaching as related to fertilizer management
- optimum crop rotations and intercropping
- best management practices to reduce potential pollution
- the impact of global climate change on agricultural production
- selection of cropping patterns that will reduce soil run-off and factor in the value of soil in estimating return
- long-term environmental consequences of land use decisions
- design of soil and water conservation and water quality projects

In these and other ways DSSAT can help managers allocate resources more effectively in terms of economic and environmental outcomes.

The Future of DSSAT

Future versions of DSSAT will expand the range of crop models and databases to include more commodities from vegetables to perennial fruit trees. Models for pest and disease factors will also be available. The intercropping model is being refined to allow applications of DSSAT to whole farm modeling and sustainable agriculture issues.

In late 1992, the IBSNAT project will issue an updated version of the DSSAT software which will be even more powerful and versatile than the current version. This software will enable decision makers to address more problems quickly and reliably and to assess the comparative advantage of alternative agricultural strategies specified by the user.

Like its predecessor, the new version of the DSSAT software can be linked to a geographic information system (GIS) called AEGIS which allows decision makers to evaluate different crop production strategies in a regional context and interactively develop a regional plan to suit their objectives. AEGIS can perform tasks such as:

- Estimating production and resource requirements for different agricultural strategies (e.g., combining crop, variety, planting date, irrigation and fertilizer treatment);

- Assessing potential environmental impact, generating tables and thematic maps (e.g., maps of simulated yield, biomass accumulation, runoff);

- Creating and modifying a production plan indicating the crop and management practices of a selected region.

With DSSAT linked to AEGIS, yield and production projections appear to be possible at national and world levels. They may also be more reliable than those constructed from satellite imagery and infrared photography of crop growing conditions.

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SUMMARY CONCLUSIONS

ICD ASSESSMENT OF MARKET POTENTIAL FOR DSSAT TECHNOLOGY

Introduction and Summary

Under its cooperative agreement with the United States Agency for International Development (USAID), ICD is assessing the potential for expanding the use of a computer software system that greatly facilitates decision making in agriculture and agribusiness.

This technology, the Decision Support System for Agrotechnology Transfer — DSSAT — is a problem solving software which provides a tool to predict crop growth and yield under specified conditions including soil type, crop variety, weather and crop management data. DSSAT was developed over the last ten years by a global network of research scientists working through the International Benchmark Sites Network for Agrotechnology Transfer (IBSNAT), funded largely by USAID.

With the basic DSSAT technology developed and well received, USAID requested ICD to explore opportunities for wider use of the software, particularly by private sector agribusinesses and other firms.

Responding to USAID's request, ICD conducted a DSSAT market assessment, involving demonstrations to a cross-section of agribusinesses and related companies as well as development institutions located in 14 U.S. and European cities. The ICD survey demonstrated the current DSSAT product, assessed opportunities and methods for adapting it to specific commercial applications, and considered opportunities for further product and market development. The organizations covered by the survey included:

Agribusiness and other companies: Nestlé, Unilever, IBM, Shell, Quaker Oats, Land O' Lakes, Cargill, International Minerals and Chemicals Corp. (IMC), Ralston-Purina;

Seed companies: Northrup King, ICI Seeds (UK and USA), Pioneer Hi-Bred International Inc., Delta and Pine Land Company, Garrison and Townsend Seed Company;

Commodity brokers: Chicago Board of Trade, Merrill Lynch;

Trade organizations: National Corn Growers Association (USA), American Soybean Association;

National and international development organizations: World Bank, UNDP, U.S. Department of Agriculture (USDA), NOAA/USDA Joint Agricultural Weather Facility, Commonwealth Development Corporation (CDC/UK);

Development consulting groups: American Society of Agricultural Consultants, Rural Investment Overseas (RIO/UK), Earth Satellite Corporation;

Other ICD Member Companies: Dr. Grobman demonstrated DSSAT at the 41st Session of the ICD Board in March which included representatives of Britannia

Brands PTE Ltd., Bühler Ltd., Daimler-Benz Holding AG, EDESA Management AG, F. Hoffmann-La Roche Ltd., Nestlé SA, Philips, Polservice Foreign Trade Enterprise, Rabobank Nederland, Sagantec Europe BV, Shell International Petroleum Company Ltd., and Tetra Pak International SA.

Meetings with user groups (ranging from one to 20 individuals), were organized by ICD Executive Director Walter Simons and Program Manager Will Kennedy and conducted primarily by ICD Senior Associate Dr. Alex Grobman. Dr. Grobman was assisted in the U.S. presentations by scientists representing IBSNAT, including Drs. Goro Uehara of the University of Hawaii, Jim Jones and Walter Bowen of the University of Florida/Gainesville, Joe Ritchie of Michigan State University, and Tony Hunt of the University of Guelph and in Europe by Barry Dent of the University of Edinburgh.

From a large database of firms representing a cross-section of the various subsectors mentioned above, a limited number of firms were selected on the basis of being representative of each subsector and available to the ICD/IBSNAT team during the tight April trip schedule. Some firms dropped out after visits began, and a few were opportunistically added. Overall, some 90% of the originally planned visits were successfully carried out.

Meetings with user groups began with a standard demonstration of DSSAT, its possibilities and the validation of its predictive abilities with various examples. Depending on the audience, DSSAT applications were also presented that address issues relating to agricultural research, prediction of varietal performance, promotion of sustainable agricultural practices, fertilizer management/application, environmental management concerns, use of geographical information systems to assess new cropping practices, and the possibility of yield prediction on large geographical areas.

The demonstration was followed by a discussion in which the audience raised questions, offered views on the relevance of DSSAT to their operations and provided feedback on future interactions between their organization and a possible DSSAT marketing/research operation.

Results of the survey indicate strong interest in a greater range of crop modeling products and services which would be available on a commercial basis.

Summary of Market Assessment Conclusions

Dr. Grobman and Dr. Jones summarized the findings of the market assessment at a meeting on 22 April at USAID with P. Peterson, T. Gill and W. Simons, as follows:

1. DSSAT as a product offers most of the companies visited opportunities for application either as is or, more likely, as a family of products.

2. DSSAT products require further development to become more user friendly, with direct down-to-earth interfaces with the users; in some cases products need to have specific application orientations.

3. There is a need for new crop models, especially in the cash, vegetable and plantation crop areas. Users are also particularly interested in potential

DSSAT applications for crop performance prediction, and in disease and pest monitoring.

4. A family of generic DSSAT products should evolve in the next generation of research and development, and they should be user driven in their succeeding evolutionary steps. Some of the generic products should be geared to specific market segments, such as seed companies, commodity traders, consultants, economic analysts, agricultural support services, etc. Specific proprietary products for individual firms could evolve from them.

5. There is interest in participating in some type of user association or consortium that would invest in and help guide future DSSAT research and development. Such a product research, development and marketing system, with appropriate financing and structure, needs to be established.

6. There is a definite need to package DSSAT products with ancillary services, such as on-line and off-line database information facilitation on soils, weather, crop research data, economic resources, prices of commodities, transportation, land use categories, and water resources. These services should include aggregated spatial data in GIS formats, and collateral services such as AEGIS.

   Remotely sensed data should be interpreted and used in defining image and linear data for cartographic, mapping and imaging applications in interaction with DSSAT products and available on-line and off-line. Selected weather data should be made available on-line to specific users.

   Historical weather data, soils data, and other basic information could be made available on CD-ROM disks as optional products.

7. Training for the use of DSSAT products should be developed by the IBSNAT consortium, and also be made available through third parties. DSSAT training should be reduced to a session of no more than 8 hours for the category of corporate users who will need straightforward applications.

8. A permanent phone support service, periodic software updates, seminars and the formation of user groups will be an absolute requirement. Without these support services, the market will not be receptive to DSSAT but rather to less time consuming products.

At the debriefing meeting, a preliminary proposal was discussed for marketing future DSSAT licenses within a price range that insures the level of return necessary for future research and development to become financially self-sustaining. USAID officials appeared to concur with these views, and expanded on them.

IBSNAT and ICD representatives agreed to jointly develop a concept paper for USAID, proposing a partnership between a new commercial organization and IBSNAT in the research, development and marketing of current and future DSSAT products on a self-sustaining basis. USAID would consider financial support for the proposed partnership during its transitional period, including authorization for commercial marketing of the DSSAT family of products.

The paper will present the rationale for a new DSS Corporation to help develop

and market DSSAT and related products, plus information and services, in coordination with IBSNAT or its successor, which will also carry out contract research for the DSS Corporation.

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Annex III

THE DSS RESEARCH APPROACH

The Information Crisis

There is a large, unmet demand for agricultural information which is increasing at a faster rate than that which traditional sources can supply. This need for more information arises from concerns for ecological collapse caused by current human interaction with the environment and also the prospect of rendering the planet unsuitable for human habitation.

To fill this information void, agriculturalists in general, and agricultural researchers in particular, must be prepared to make "cultural" changes that will enable users to obtain reliable information in a timely and cost-effective manner. To do so, agriculturalists must first identify and remove bottlenecks that prevent them from generating the information users need and, second, form communication channels to link information demand to supply.

The Bottleneck

In the information age, data is fuel, knowledge the inference engine, and information the power to bring about change.

The failure of universities and research centers to meet the demand for information stems from a system that rewards scientists primarily for publishing their discoveries in disciplinary journals. The reward system results in an over-supply of disciplinary knowledge and a concomitant under-supply of interdisciplinary knowledge. Just as an engine part cannot produce power in isolation, it is not possible for disciplinary knowledge to produce information about the behavior and performance of whole systems.

Systems scientists have always believed that the bottleneck is caused not so much by a shortage of knowledge, but the failure to integrate existing knowledge into information-generating decision support systems.

The problem domain related to the DSS Consortium has particular characteristics. First, it is of an infinite nature. Second, it is in a continuous state of flux; the problems are always with us, but their nature changes over time — either gradually or abruptly. Third, the interactions between man and the environment are complex. These characteristics have implications on two fronts: 1) the extent of the problem domain that can realistically be addressed; and 2) the methods that must be applied to address it.

For the first, the problem domain of this project is defined in terms of the management of natural resources as they affect agriculture and the environment, particularly with respect to soil, water, weather and pests.

For the second, the methodology used has to enable the research and development process to quickly and efficiently produce decision aids that permit an appropriate response to problems. It also has to be able to deal with the inherent complexity of the systems of interest. Much traditional research has proceeded in a way that

can be visualized as a sprawling tree: the overall direction is upwards, but many of the lateral branches and sub-branches do not contribute to the overall height. This predominantly trial-and-error approach has the advantage of generating an enormous store of knowledge (not all of it is of obvious use). This store of knowledge has been of great benefit, particularly in the early developmental stages of a branch of science, but is not an efficient method for goal-driven research. Moreover, trivial problems are solved before complex problems, because studying complex aggregations of components is difficult, owing to the lack of suitable methodology or because of a dearth of integrative research.

Many of the problems that face humankind today, including the global issue of food safety and food security, are systems problems—not disciplinary problems. Because a trial-and-error approach is too slow, inefficient and costly to countenance, the use of systems methodology and modern information technology becomes necessary.

An operational guiding principle of systems synthesis and analysis, as an approach to carrying out science, is this: improvements to one component of a system cannot be assumed to lead to an improvement in the performance of the whole system without an understanding of how system components interact. Given the nature of the problem domain, a systems approach, with its ability to integrate disciplines and synthesize knowledge, is the only appropriate approach.

The building blocks of the tools proposed are simulation models of component biophysical processes and mininmum data sets of these processes. Substantial development work on such models has already been accomplished. Such models derive their value by allowing the objective extrapolation of results across time and space. By assembling and testing tools composed of particular groupings of these models, information can be provided which directly concerns alternative uses of natural resources in agriculture, and suggest their biophysical and socioeconomic effects. The high-level policy maker and planner and the resource-poor farmer both share an urgent need to assist in a) assessing the current and future impact of management practices on sustainability; b) preparing and implementing legislation concerning acceptable practices and land-use patterns; and c) providing producers and consultants with technical packages that are appropriate and adoptable for diverse conditions.

In addition to providing information for decision making, a systems approach to natural resource use and sustainability serves other purposes including the following:

- In assembling the framework of a decision support system, critical gaps in the knowledge base can be identified, allowing the prioritization of component research activity, and providing the framework whereby such research results can be rapidly assimilated and applied in problem solving.

- A problem-solving methodology is produced that can be applied in other situations and to other decision making domains.

- A methodology is produced that allows the extension of results from other research projects for implementation at the regional or farm level.

The Minimum Data Set Concept

Adoption of an international standard for a minimum agroecological data set by all parties in the private and public sector is a critical part of the DSS concept. The design and collection of minimum data sets (MDS), consisting of key descriptors that are common to all sites and situations are collected routinely to form input data for the decision support tools. Crop model minimum data sets already exist, and these will be expanded as appropriate as well as supplemented by MDS for key natural resource and socioeconomic system descriptors. Several small businesses have expressed keen interest in compiling data in computer compatible form for site- and situation-specific application.

Spatial data bases consisting of soil, climate, topographical, farming system, and socioeconomic information that can be accessed by impact assessment tools for spatial levels of aggregation. Small businesses are ready to supply customers with hardware and spatial data bases as soon as the decision support tools are coupled to GIS software.

A single standard implies that users will need to have in hand one standard set of data to generate information for a wide variety of uses. If this minimum data set is also employed to guide researchers in their efforts to develop decision support tools, major improvements in research efficiences can be gained. A common minimum data set for decision making is the key link that connects client needs to the capabilities of researchers.

Simulation Models

Crops

The development of new crop models, the refinement of existing models of growth, development and yield, and an increase in the sensitivity of these models to factors not currently treated, such as pests and diseases and various soil constraints, are needed. Also needed is the development of generic intercropping simulation models. The private sector is especially interested in simulation models of high value crops and several firms have expressed a willingness to pay for model development.

Pests

The addition of modules to enable simulation of outcomes of key pests and diseases, and their effects on the photosynthetic, respiratory and reproductive capacity of crops and their final expression as yield loss. The ability to simulate residual pest effects on subsequent crops will also be incorporated. Agrichemical firms should become major partners in this effort.

Soil and Water

Refine existing models of soil and water processes; addition of sensitivity to phosphorus, potassium and sulfur dynamics in plant and soil; modeling of biological nitrogen fixation processes, the use of organic fertilizer materials, soil erosion, and nutrient loss pathways. These models will be modified as needed to simulate long-term changes in soils, and will be evaluated using long-term experiments. Fertilizer companies are already supporting research to develop models for integrated nutrient management. Their aim is to use fertilizer in the

right place at the proper time to maximize crop yields and minimize atmospheric and ground water contamination.

Socioeconomics

The development of models capable of evaluating resource constraints of competing enterprises, farmers' objectives and attitudes, and other socioeconomic circumstances as these affect farm-level decision making. Banks providing agricultural loans will be interested in assessing risk and crop productivity with models that can simulate probable outcomes of crop productivity.

Measuring Sustainability

Sustainability has to be expressed in terms of measurable properties because efforts to improve performance almost always involve tradeoffs among properties of agricultural systems that affect sustainability. The project will develop indices and procedures for measuring productivity, stability, resiliency, biodiversity, and equitability of agricultural systems. Quantification is needed to assess trade-offs between any of the above properties. For example, the introduction of high yielding varieties may increase productivity, but lower stability, resiliency and equitability. Irrigated agriculture can increase productivity and stability, but may result in loss of resiliency through salinity and waterlogging. Likewise, attempts to increase resiliency through organic farming may lower equitability by increasing commodity prices, thereby enabling only the wealthy to enjoy the benefits of ecologically sound farming. And finally, the genetic diversity which is so critical to ecological balance and sustainable farming can only be protected from the ravages of human encroachment into natural ecosystems by increasing productivity on existing farm lands.

The realization that the actions of an individual operating at the field or farm level can affect processes at the global level is one of the underlying reasons for reassessing the way agriculture is practiced. Processes operate at different rates at different levels. For example, fluctuations in methane concentration directly over a rice field can be detected in time increments of hours, but years are needed to detect significant changes in methane concentration in the earth's atmosphere. In this way, a field represents one level in a hierarchy of nested organizations, and the world is composed of ecoregions such as the humid tropics or semi-arid tropics. Ecoregions are in turn composed of watersheds, farms and fields.

The DSS research group will develop procedures for the measurement and analysis of the impact of alternative systems as these affect biophysical and socioeconomic variables. Existing decision support tools already enable users to examine many scenarios by ex ante means. The DSS procedure is timely, cost-effective, and especially effective in dynamic situations.

annx3/pb21

Annex IV

INSTITUTIONS COLLABORATING WITH IBSNAT IN SOFTWARE GENERATION

Centro Internacional de Agricultura Tropical	Colombia
Cornell University	U.S.A.
Dept. of Agriculture, Thailand	Thailand
Edinburgh School of Agriculture	U.K.
International Fertilizer Development Center	U.S.A.
International Crops Research Institute for the Semi-Arid Tropics	India
Institut National de la Recherche Agronomique	France
International Rice Research Institute	Philippines
Michigan State University	U.S.A.
University of Florida (Gainesville)	U.S.A.
University of Georgia (Griffen)	U.S.A.
University of South Pacific	Fiji
University of Queensland	Australia
University of Guelph	Canada
U. S. Department of Agriculture, Agricultural Research Service	U.S.A.

annx4/pb21

DSS CONSORTIUM SURVEY*

To complete the DSS Consortium pre-feasibility assessment please comment on the following:

1. Based on your experience, does this "pre-feasibility" assessment provide a practical approach (logically, technically, structurally) to facilitating the continuous development and transfer of DSS products on a commercially self-sustaining basis? What issues/factors, short of a full feasibility study and business plan, need to be further elaborated?

   How could the assessment be strengthened to better reflect the interests of your company/institution?

2. Without making any commitments, do you think your company/ institution would be interested in supporting the DSS Corporation financially? If so, under what conditions?

3. What types of existing or new DSS models, inter-model linkages, on-line databases, and other support services would your company require if it were to subscribe to the services of the proposed DSS Corporation?

4. Do you have suggestions for alternative ways to organize and manage the proposed Consortium?

5. How do you evaluate DSS technology (current and potential) within the range of competitive software packages and related services that are available to you?

6. Your further comments on issues not covered by the above questions are most welcome.

* Please complete the survey on a separate page and return to:

Mr. Walter W. Simons
Executive Director
Industry Council for Development (ICD)
300 East 44th Street, Suite 1601
New York, NY 10017
(Fax: 212-573-6028)

sur/wk25

USAID Chron

Industry Council for Development

17 August 1992

Dr. Peter Heffernan
Manager Market Research
IMC Fertilizer
501 East Lange Street
Mundelein IL 60060

Dear Dr. Heffernan:

Attached is the summary of our report to the U.S. Agency for International Development (USAID) assessing the commercial potential for the Decision Support System for Agrotechnology Transfer (DSSAT). The findings are based on demonstrations and meetings conducted by ICD senior associate, Dr. Alexander Grobman, at a wide range of private and public organizations including IMC Fertilizer.

Based on the positive reactions to this assessment, we (ICD and the IBSNAT scientists) are now working to determine the feasibility of establishing a corporation linked to a consortium of universities to develop DSSAT technology on a commercial basis, for both public and private sector markets.

Our next step is to prepare a concept paper on the corporation/consortium idea prior to carrying out a full feasibility study. This paper is now being finalized and will be sent shortly for your review.

Once again, many thanks for hosting the DSSAT meeting and demonstration.

Sincerely,

William H. Kennedy
Program Manager

WK:wk23/mktsur
Enclosure

300 EAST 44th ST. ■ NEW YORK, NY 10017 ■ (212) 867-5017 ■ CABLE: INDUCODEV ■ TELEX: 23 89 76 ■ FAX: (212) 573-6028

The attached letter mailed 18 August to the following:

Dr. Peter Heffernan
Manager Market Research
IMC Fertilizer
501 East Lange Street
Mundelein IL 60060

Dr. Eugene Kunda
Agricultural Economist
Economic Analysis & Commodity Broker
Chicago Board of Trade
141 W. Jackson Blvd. Ste 3110
Chicago IL 60604

Mr. Phil Sisson
Manager of Commodity Analysis
and Crop Development
The Quaker Oats Company
321 N. Clark St., Suite 13-8
Chicago, IL 60610

Mr. James Allwood
Director of Commodity, Economic & Regulatory
Services
Ralston Purina Company
Checkerboard Square-2CBC
St. Louis, MO 63164

Mr. Larry Rus
Executive Director
National Corn Growers Association
1000 Executive Parkway, Ste. 105
St. Louis, MO 63141

Dr. Keith Smith
Director of Research
American Soybean Association
540 Maryville Center Drive
Suite 400
P.O. Box 27300
St. Louis, MO 63141

Mr. Don Sapienza
Director, International Silage Programs
Pioneer Hi-Bred International
6800 Pioneer Parkway
P. O. Box 316
Johnston, IA 50131

Ms. Aliene Jensen
Project Leader
ICI Seeds Inc.
2369 330th St.
P. O. Box 500
Slater, IA 50244

Dr. John Ahlrichs
Manager, Agrisource and Agronomy Services
Cenex Land O'Lakes, Inc.
4001 Lexington Ave N, Box 116
Arden Hills, MN 55126-2998

Mr. William Pearce
Vice President
Cargill Incorporated
P.O. Box 9300
15407 McGinty Rd
Minnetonka, MN 55440-9300

Dr. Roger Malkin
Chief Executive Officer
Delta and Pine Land Company
60 East 42nd Street, Ste. 3410
New York, NY 10165

Dr. Bob Romig
Vice-President, Research
Northrup King Company
7500 Olsen Memorial Highway
Golden Valley, MN 55427

Dr. Kelly M. Harrison
Executive Director
American Society of Agricultural
Consultants (ASAC)
8301 Greensboro Drive
Suite 260
McLean, VA 22102

Dr. John Lee
Administrator
U.S. Department of Agriculture
Economic Research Service
1301 New York Avenue N.W. Room 1008
Washington, D.C. 20005-4788

Dr. Jock Anderson
Principal Economist
The World Bank
1818 H Street N.W.
Room N-8019
Washington, DC 20433

Mr. Kevin Marcus
Director, CROPCAST Services
EarthSat
6011 Executive Blvd, Suite 400
Rockville, MD 20852

Mr. Michael D. Taylor
Commonwealth Development Corporation
One Bessborough Gardens
London SW1V 2JQ, England

Mr. John Meadley
Rural Investment Overseas Ltd.
Westbourne House
Station Road
Stroud, Glos., GL5 3AP, England

Dr. Derek Pike
ICI Seeds
Jeallot's Hill Research Station
Brecknell
Berkshire RG12 6E4, England

USAID Chron

Industry Council for Development

23 September 1992

Mr. James O'Connor
President
O'Connor-Abell, Inc.
1121 Arlington Blvd.
Arlington, VA 22209

Dear Jim:

Under its cooperative agreement with the U.S. Agency for International Development (USAID), ICD is assessing the potential for expanding the use of a computer software system -- the Decision Support System for Agrotechnology Transfer (DSSAT) -- that greatly facilitates decision making in agriculture and agribusiness.

As a fellow member of the International Agribusiness Management Association (IAMA) I would like to have your views on how the DSSAT technology could be further developed to promote sustainable development objectives and serve the interests of your company/institution.

As you know, decision makers at all levels worldwide are under increasing pressure to expand agriculture production while also sustaining the resource base. A major obstacle to developing sustainable production plans and policies is the lack of integrated information systems to assess the viability of alternative management strategies.

Responding to this challenge, an international team of scientists have worked with USAID over the last ten years developing a prototype computer simulation technology capable of generating information for addressing a wide range of agricultural, environmental and economic problems. The result, DSSAT, is a problem solving software designed to help decision makers assess the comparative advantages associated with complex alternative management strategies in agriculture and other natural resource based disciplines.

The present DSSAT model can quickly predict crop growth under specified conditions, allowing users to assess various cultivar and management combinations without devoting excess time to

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expensive field trials. When linked to a geographic information system, DSSAT enables decision makers to evaluate different crop production strategies and yield projections within a national or regional context.

DSSAT models are available for wheat, maize, rice, soybean, dry bean, and peanut crops. Models for sorghum, millet, barley, aroid and potato crops are at various stages of development.

The DSSAT system is inexpensive, flexible, relatively user-friendly, and allows for evaluation of the probability of crop failure and success in any location. The enclosed paper by Dr. Jim Jones of the University of Florida provides a current technical assessment of DSSAT technology and its potential, including DSSAT V3.0.

At the request of USAID, ICD recently conducted a preliminary DSSAT market survey, involving demonstrations to a cross-section of agribusinesses and related companies as well as development institutions in the U.S. and Europe. The encouraging responses from executives led us to consider how the DSS technology might be made more widely available on a commercially self-sustaining basis.

Continuing its work with USAID, ICD and the IBSNAT Network have subsequently prepared the attached concept paper which outlines an integrated research, product development and marketing system which would:

- Improve and expand the capabilities of DSS technology products to meet the needs of diverse private and public sector markets worldwide;

- Coordinate DSS research, product development, marketing and support service activities for long-term commercially viable operations;

To help us complete the "pre-feasibility" assessment of the proposed DSS System, we would greatly appreciate having your views on the concept paper, including the points put forward in the attached short questionnaire. This information will help us plan a full feasibility study of the DSS System later this year.

ICD is a private, non-profit development organization supported by corporations worldwide, particularly major food companies. The enclosed documentation explains the ICD mission, which is basically to assist developing countries achieve their economic and social goals by utilizing the managerial and technological skills expertise of international industry. ICD draws on 25 years of experience in practical projects in some 30 developing

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countries, generally in partnership with one or more development agencies such as UNDP, USAID or the World Bank. In fact, USAID funded our agribusiness development program in the early 1980's.

Thank you for considering this matter. Your views will be important in helping the promise of DSS technology to become a reality.

Sincerely,

Walter W. Simons
Executive Director

WWS:pb
usaidca

Attachments

DSS Concept paper, etc. sent to these IAMA members 24 Sept.:

Dr. Charles E. French
President
Charles E. French & Associates
P. O. Box 726
Nellysford, VA 22958

Mr. Peter Mostyn
Consultant
Strategic Directions, Inc.
Rock House Pond Square
London N6 6BA, England

Dr. Roland R. Robinson
Principal Agricultural Economist
CSRS/NRF & SS
U.S. Department of Agriculture
901 D Street S.W.
Washington DC 20250-2200

Dr. Max Wortman
Pioneer Hi-Bred International Professor
College of Business Administration
Iowa State University
Ames, IA 50011

Mr. William Griffith
Vice President & General Manager
American Cyanamid Company
Crop Protection Chemicals
One Cyanamid Plaza
Wayne, NJ 07470

Mr. Kenneth Jochum
Assistant Vice President
Continental Grain Company
Management Training & Development
10 South Riverside Plaza
Chicago, IL 60606

Mr. Robert Shapiro
President
Monsanto Agricultural Company
800 N. Lindbergh Blvd. C2NA
St. Louis MO 63167

Mr. F. Curt Beatty
Vice President & Director International
Sales
John Morrell & Co.
250 East Fifth Street
Cincinnati, OH 45202

Mr. John W. Power
President
Rhone-Poulenc
Seed Technology Business Unit
2 T.W. Alexander Dr.
Research Triangle Park, NC 27709

Mr. Norman Blanchard
President
Smithkline Beechum
Animal Health
1600 Paoli Pike
West Chester PA 19380

Dr. Emerson Babb
Professor
Food and Resource Economics
University of Florida
1130 McCarty Hall
Gainesville, FL 32611

Mr. Charles Bauman
Senior Vice President Executive
Dole Food Company
10900 Wilshire Boulevard, Ste. 1500
Los Angeles, CA 90024

Mr. Michael Bear
Consultant
Mars & Company
124 Maron Street
Greenwich CT 06830

Mr. Max Downham
Vice President
Mission & Strategy
The NutraSweet Company
1751 Lake Cook Road
Deerfield, IL 60015

Mr. Peter Hamilton
Director
Biotechnology Business Development
DuPont
P.O. Box 80038
Wilmington DE 19805

Mr. James O'Connor
President
O'Connor-Abell, Inc.
1121 Arlington Blvd.
Arlington, VA 22209

Mr. Elmo Beyer
Director of Discovery Research
DuPont
P. O. Box 30
Newark, DE 19714

Dr. Estaban Brenes
Academic Director
Agribusiness Program
Central American Institute of Business
Administration
P.O. Box 960-4040
Alajeula, Costa Rica

Dr. Wayne Broehl
Professor of Business
Dartmouth College
Hanover, NH 03755

Dr. Bernardo de Carvalho
Tropical Agriculture Department
University of Tecnica De Lisboa
Tapada da Ajuda 1300
Lisboa 1300, Portugal

Dr. Y. C. Chiang
Professor
Department of Agriculture Economics
National Taiwan University
Taipei, 10764 Taiwan

Mrs. Marcia Glenn
Director
Economic Research Operations and Technology
Kraft
2211 Sauders Road
Northbrook, IL 60062

Dr. Glen Glover
Director
Strategic Planning & Economic Research
Gold Kist, Inc.
244 Perimeter Center Parkway NE
Atlanta, GA 30346

Dr. Jorge Gonzalez
Assistant Professor
Department of Agriculture Economics
University of Puerto Rico
Box 5000
Mayagez 00709, Puerto Rico

Dr. Scott Pearson
Professor of Economics
Food Research Institute
Standford University
Stanford CA 94305

Mr. Richard Perry
Trustee
M.G. Johnnye D. Perry Foundation
P.O. Box 1228
Robstown TX 78380

Mr. Emanuel Shemin
Director
Division of Wayerhaueser Co.
Shemin Nurseries, Inc.
268 Round Hill Road
Greenwich CT 06831

Dr. Rolf Soiron
Group Vice President
Agribusiness
Sandoz Corporation
608 Fifth Avenue
New York, NY 10020

Mr. Siauw Liang Tan
C.E.O. Sinar Mas Plantation I
Wisam BII, 10th Floor
JL.M.J. Thamrin KAV. 22
Jakarta, Indonesia

Mr. Tony Webster
President
Agribusiness Association of
Australia and New Zealand
25 The Ridge
Canterbury 3126
Australia

Dr. Robert Weill
Chairman of the Board
Venezuelan Tropical Fruit Company
Torre KLM, Penthouse
Avenue Romulo Gallegos
Caracas, Venezuela

Ms. Lynn Austin
Agricultural Futurist
Agriculture 3.2
CIBA-GEIGY
R-1039.206
4052 Basel, Switzerland

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Mr. Mike Gorham
Vice President
Marketing and Research
Chicago Mercantile Exchange
30 South Wacker
Chicago IL 60606

Mr. Emmanuel Gras
General Secretary
Et Grandes Cultures
G.I.E. Agro-Industries
3 rue Casimir Perier
Paris 75007, France

Mr. Charles Harper
Chairman
ConAgra Inc.
1 ConAgra Drive
Omaha, NE 68102-5001

Mr. Jacques Kozub
Technical Advisor
International Fund for Agriculture Development
6401 Kenhouse Drive
Bethesda, MD 20817-5445

Mr. Minoru Kunita
Senior Managing Director
Suntory Limited
2-1-40 Dojimahama, Kita-Ku
Osaka 530, Japan

Mr. Luc Maene
Secretary General IFA
International Fertilizer Industry Association
28 rue Mardguf
75008 Paris, France

Mr. William Mott III
President
Agland Investment Services
900 Larkspur Landing Circle
Larkspur, CA 94939

Dr. Deborah Streeter
Professor
Department of Agriculture Economics
Cornell University
301 Warren Hall
Ithaca, NY 14853

Mr. James Tobin
Manager
Market Department - Animal Nutrition & Health
Monsanto Agricultural Company
800 North Lindberg Blvd.
St. Louis, MO 63167

Dr. M. Ann Tutwiler
Associate Director
International Policy Council on
Agriculture & Trade
1616 P Street N.W. Suite 406
Washington DC 20036

Industry Council for Development

BY TELEFAX

24 November 1992

To: Goro Uehara {808/956-3421}
Tej Gill {703/875-4384}
Joe Ritchie {517/353-5174}
Jim Jones {904/392-4092}
Jim McWilliam {61 62 573051}

From: Will Kennedy WK

RE: Draft Feasibility Study Proposal:
ASSESSING DSS CONSORTIUM VIABILITY

Attached is the draft proposal for a feasibility study to assess the viability of the DSS Consortium as described in the earlier IBSNAT/ICD concept paper. Your review and comments, including recommendations for further revision, would be most helpful.

Please forward, via fax, a written assessment of the proposal to us within the next 10 days. We will compile your comments and suggestions, forward them to Alex Grobman for review, and revise the draft accordingly.

We are eager to get this initiative underway as soon as possible but will first need to secure adequate funding.

Let us know if we can be of further assistance.

Regards.

Note: Cost estimates for tasks 8 & 11 presented in table 1 have yet to be determined but will be kept to a minimum.

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{Draft for Review/Revision, 11/24/92}

ASSESSING DSS CONSORTIUM VIABILITY:
Draft Feasibility Study Proposal

1. Background

Over the last year the Industry Council for Development (ICD) has been working with USAID and IBSNAT to assess the potential for expanding the use of a computer software system -- the Decision Support System for Agrotechnology Transfer (DSSAT) -- that greatly facilitates decision making in agriculture and natural resource management.

As part of this effort, ICD and IBSNAT conducted preliminary DSSAT market surveys in the last year involving demonstrations to a cross-section of companies and development institutions based in the U.S. and Europe. The encouraging responses to the demonstrations led to further consideration of how the DSS technology might be made more widely available on a commercially self-sustaining basis.

Continuing its work with USAID, ICD and the IBSNAT Network subsequently prepared a concept paper which outlines an integrated research, product development and marketing system that would:

- Improve and expand the capabilities of DSS technology products to meet the needs of diverse private and public sector markets worldwide;

- Coordinate DSS research, product development, marketing and support service activities for long-term commercially viable operations.

Plans are underway for ICD to continue its cooperation with the former IBSNAT Network by conducting a full feasibility study of the DSS Marketing/Research System, as proposed in the concept paper, in early 1993.

Such an assessment will be essential not only to determine DSS Consortium financial and operational viability but also to attract public and private sector funding committments.

2. Objectives of feasiblity study

A feasibility study is necessary to assess the operational and financial feasibility of the proposed DSS Consortium as a self-sustaining organization, capable of:

- Providing new DSSAT-related products and services that are competitive and cost efficient in meeting potential user needs;

- Advancing DSS research -- supporting the research activities in crop modeling of the institutions grouped in the former IBSNAT network;

- Commercial viability -- generating sufficient income through the sale of products and services to achieve commercial viability within a reasonable time period (3-5 years); eventually generating a profit which could be reinvested and used to build financial reserves.

The feasibility of the Corporation would be tested within the context of DSS Consortium operations. It will require a thorough examination of legal, financial and operational links between Consortium partners and their significance for the sustainability of such an integrated operation.

3. Implementation: operational plan

A preliminary draft of the CPM (critical path management) Project Schedule and Tabulated Task and Time Sheet is attached. It divides the feasibility study activities, following preliminary preparation, into 11 distinct tasks. The sequence of tasks (and subtasks) presented is not definitive and improvements and reassignments will be made to this preliminary draft plan.

The various tasks summarized below describe the discrete activities that compose the feasibility assessment.

Task 1 **Analysis of base DSSAT market and development needs** -- further defines the market potential of the base DSSAT v 3.0 product, and decide on the investment (e.g. technical, financial, time) needed to prepare it for commercial distribution.

Task 2 **Analysis of DSSAT services** -- assesses the types of services required to supplement DSSAT, including linkages with other software products and information services, and how to develop them.

Task 3 **Analysis of physical resource requirements** -- determines physical resource needs including equipment, personnel, building, office space, communications for presenting the range of products and services.

Task 4 **Analysis of costs and investments** -- provides a detailed estimate of all operating costs, capital costs and investment requirements. Earning calculations will be shown on a gross and net basis.

Task 5 **Assessment of markets for DSS products and services** -- defines and segments the expected market and income from specific DSS products and services.

Task 6 **Pricing and intellectual property** -- assess and recommend options for policies regarding product and service pricing, intellectual property considerations, etc.

Task 7 **Economic and financial feasibility** -- aggregate information collected in previous tasks to analyze the economic viability of the project under various scenarios; define the financial parameters of the project presenting alternative approaches to its financing. The sensitivity of the economics of the DSS Corp. to changes in key variables will be presented and financial and economic evaluations undertaken to meet the requirements of potential public and private sector investors.

Task 8 **DSS Corp. management, ownership and governance** -- assess options and propose frameworks for DSS Corp. management, ownership and governance.

Task 9 **Organization and coordination of DSS Corp and Research Group** -- will study the optimum organizational structure to facilitate coordination between the DSS Corporation and the Research Group; including the proposed structure and activities of an advisory committee which would coordinate Corporation and Research Group planning, operations and external affairs of mutual interest.

Task 10 **Legal Matters** -- define and advise on the various legal matters related to the corporation and to the products to be marketed, as well as to its relationship with the Research Group.

Task 11 **Develop a business plan** -- based on findings of tasks 1 - 10 propose a business plan for the initial 3 to 5 years of operation.

Task 12 **Preparation of project document** -- finalize and consolidate the task reports into the final feasibility proposal. It should have a preliminary draft and a final draft, with a peer review between them.

4. Time frame

Based on the Critical Path proposed herein the project will be completed in slightly over 60 working days. The project should be fully completed, including report preparation, within a three month time period.

5. Resource requirements

A total of 100 consultant person/days are anticipated to conduct the proposed feasibility study. These would result in a base number of 62 days of work after the team is organized.

Cost estimates for the study are broken down into consultant fees, communications, travel and overhead. The figures are detailed by task in Table 1 -- up to $30,450 would be spent on consultant fees, $3,000 in communications (fax/phone/mail), $13,300 in travel and $5,600 in overhead (which would include office support, materials and space), making a total of $52,350. A 5% margin for contingency expenses should also be included, bringing the total projected budget to about $55,000.

This cost could be lowered if some of the consultant services could be carried out on a contributed basis by representatives of universities and institutions participating in the DSS Research Group (formerly IBSNAT).

6. Consultant qualifications and experience

The project will require appropriate consultant services under the guidance and leadership of a project manager. These may include both independent consultants and representatives of universities and other institutions participating in the new Research Grcup ICASA, which is presently being established.

The consultants recruited to work on the feasibility study (many of which will hired on a short-term, task specific basis) should have:

- expertise in developing and marketing high technology software products and services for agriculture, agribusiness and natural resource management.
- experience in the preparation of commercial feasibility studies
- legal expertise (e.g. formation of company, patent questions), business planning experience, etc.

The lead consultant or project manager would organize and manage the consultant inputs , including those inputs from the research group itself. As such, he would work closely with ICASA representatives and the project team members to plan and implement the feasibility study.

Table 1. Preliminary Budget Estimate for DSS Corp. Feasibility Study (US$)

Description	Consulting Time No. days	Per day	Total	Phone FAX	Travel	Overhead	TOTAL
PROJECT PREPARATION							
Consultants	5	350	1,750	300	3,000		5,050
TASK 1 Analysis of Base DSSAT Market and Development Needs							
Consultants	9	350	3,150	500	1,000		4,650
TASK 2 Analysis of DSSAT Services							
Consultants	20	350	7,000	400	2,800		10,200
TASK 3 Analysis of Physical Resource Requirements							
Consultants	9	350	3,150	500	1,000		4,650
TASK 4 Analysis of Costs and Investments							
Consultants	3	350	1,050	200			1,250
TASK 5 Assessment of Markets for DSS Products and Services							
Consultants	19	350	6,650	600	3,500		10,750
TASK 6 Pricing and Intellectual Property							
Consultants	3	350	1,050	200	500		1,750
TASK 7 Economic and Financial Feasibility							
Consultants	5	350	1,750	100			1,850
TASK 8 DSS Corp. management, ownership and Governance							
Consultants							
TASK 9 Organization and Coordination of DSS Corp. & Research Group							
Consultants	2	350	700				700
TASK 10 Legal Matters							
Consultants	2	350	700	100			800
TASK 11 Develop a Business Plan							
Consultants							
TASK 12 Preparation of Project Document							
Consultants	10	350	3,500	100	1,500		5,100
548 TOTAL			30,450	3,000	13,300		46,750
TOTAL:						5,600	52,350

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ICD/AgAccess Survey:

LEGUME INOCULUM SOURCES

Note: A listing of persons contacted to provide information about inoculum producers/distributors are presented and coded in Section I. The list of inoculum producers/distributors and research instutions recommended by these contact persons is presented in Section II and coded to identify the origin of the referral. This list partially overlaps with the list of inoculum companies (mostly U.S. based) compiled earlier this year by ICD.

SECTION I -- Resource Persons Contacted

(a)
Mr. Brian Holl
University of British Columbia
Department of Plant Science
Suite 248, 2357 Main Mall
Vancouver, B.C., Canada V6T 1Z4

(b)
Mr. Avilio Antonia Franco
Chefe do CNPBS
Empresa Brasileirs de Pesquies Agropecarua (EMBRAPA)
Centro Naciolan de Pesquisa de Biologia do Solo (CNPBS)
Seropedica
23851 Rio de Janiero, RJ Brazil
Telephone: 21-6821250; 6821086; 6821500
Telex: 32723 (Answerback: EPBA)
FAX: 21-6821230

(c)
Mr. Jose Roberto R. Peres
Head of CPAC
Empresa Brasileira De Pesquisa Agrop
Br 020 Km 18 Rod. Bras/Fortaleza
Caixa Postal 70023
73300 Planal DF, Brazil
Telephone: 55-61-3891171
FAX: 55-61-3892953

(d)
Mr. R. B. Brinsmead
Principal Agronomist
Queensland Department of Primary Industries
Hermitage Research Station
Via Warwick Qld 4370
Telephone: 76-61-2944
FAX: 76-61-5257

(e)
BNFNET -- electronic mailing group

(f)
Dr. Nantakorn Boonkerd (NifTAL)
Biological Nitrogen Fixation Resource Center
for South and Southeast Asia
Department of Agriculture
Soil Science Division
Rhizobium Building
Banghken, Bangkok 10900, Thailand
Telephone: 662-5797522-3; 5760065
FAX: 662-5614763
Telex: 84478 (Answerback: INTERAG TH)

(g)
Mrs. H.M.J. Schiermann, M.Sc.
Keuring Registratieonderzoek Zaadanalyse
General Netherlands Inspection Service
for Vegetable and Flower Seeds
Sotaweg 22, Postbus 27
2370 AA Roelofarendsveen, The Netherlands
Telephone: 1713-19102
FAX: 1713-16256

(h)
Mr. Michel Besson
Federation internationale du commerce des semences (FIS)
International Seed Trade Federation
Internationaler Saathandelsverband
Ch. du Reposoir 5-7
CH-1260 Nyon, Switzerland
Telephone: 41-22-619977; 619914
Telex: 419974 (Answerback: seed ch)
FAX: 41-22-619219

(i)
Mr. Ricardo Pineda M.
Centro De Investigaction Y Promocion Del Campesinado (CIPCA)
Apartado 305
Piura, Peru
Telephone: 328634

(j)
Mr. Bernward Geier
International Federation of
Organic Agriculture Movements (IFOAM)
Okozentrum Imsbach
D-6695 Tholey-Theley, Germany

(k)
Ms. Judy Kipe-Nolt
CIAT
Cali, Colombia
FAX: 5723-647243

(l)
Mr. Joe Rourke
NIFTAL Project-Hawaii
University of Hawaii
1000 Holuma Avenue
Paia, Maui, Hawaii 96779
Telephone: 808/579-9568
FAX: 808/579-8516

(m)
Mr. Luis Carreras
Centro De Protection A La Naturaleza
4 De Enero 1753
Santa Fe, Argentina

(n)
Mr. Ricardo Pineda M.
Centro De Investigacion Y Promocion Del Campesinado (CIPCA)
Apartado 305
Piura, Peru
Telephone: 328634

(o)
Mr. J. A. Daughton
Queensland Department of Primary Industries (QDPI)
Roma Research Station
P.O. Box 308
Roma Q 4455, Australia
Telephone: 76-22-1511
FAX: 76-22-3235

SECTION II -- Inoculum Sources, including Producers/Distributors

The following information has not been further verified.

ARGENTINA:

(m)
Ing. Oscar Alloatti
AGROPROYECTOS
Rivadavia y Obispo Gelabert 3000
Santa Fe, Argentina

(k)
Dr. Gabriel Favelukes
Centro de Investigacion y Desarrollo de
Fermentaciones Industriales (CINDEFI)
Calles 47 y 115 (1900)
La Plata, Argentina
Telephone: 21-33794

(k)
Ing. Agr. Rosa Dieguez
INTA
Departamento de Microbiologia
C.C. 25-1712
Castelar, Argentina

(k)
Dr. Antonia Pedro Balatti
Fac. de Ciencias Exactas y Naturales
Avda. Uruguay No. 151
6300 Santa Rosa, La Pampa, Argentina

(k)
Dra. Haydee Lackner
Crawford, Keen y Cia. S.A.
Florida 681, 3er. Piso
CEP 1375 Buenos Aires, Argentina

VENEZUELA:

(k)
Ms. Margarita Sicardi de Mallorca
Instituto Venezolano de Investigaciones Cientificas (IVIC)
Apartado 21827
Caracas 1020 A, Venezuela
URAGUAY:

(k)
Dr. Carlos Labandera
Laboratorio de Microbiologla de Suelos y
Control de Inoculantes del Plan Agropecuario
Bulevar Artigas 3802
Montevideo, Uruguay

(k)
Mr. Miguel Castiglioni
ENZUR, S.A.
Azara 3787, Montevideo, Uruguay

COLOMBIA:

(k)
Dr. Fernando Munevar
Microagro Ltda.
Transversal 22 No. 161-17
Bogota, Colombia
Telephone and FAX: 2351817

MEXICO:

(k)
Biol. Alvaro Nathal Sanchez
Empresa Nitragin S.A.
Rio Tizapan 1716, Colonia Atlas
Guadalajara, Jalisco, Mexico

CHILE:

(j)
Mr. Erik van Baer
Campex
Casilla 87
Temuco, Chile

(k)
Ms. Martha Granger
PROBICAL LTDA.
Alcalde Pedro Alarcon 754
Santiago, Chile
Telephone: 5556016

CUBA:

(k)
Ing. German HernaneMinisterio de Agricultura
Estacion Experimental La Renee Quivican
La Habana, Cuba

162

COSTA RICA:

(k)
Ing. Oscar Acusa
Universidad de Costa Rica
Centro de investigaciones Agron micas
San Pedro, Montes de Oca
San Jose, Costa Rica

INDONESIA:

(1)
Mr. N. Pesik
Rhizogin Indonesia
Ventura Building
Suite 303
Jl. Jagorawi-Cilandak
Jakarta Selatan 12430, Indonesia

(1)
Dr. Ratna Siri Hadioetomo
Bogor Agricultural University
Bogor Baru Nlok D 11/3
P.O. Box 306
Bogor 16144, Indonesia

NEW ZEALAND:

(1)
Mintech (NZ) Ltd.
Agricultural Division
P.O. Box 440
Nelson, New Zealand

(1)
Rhizocoat
Coated Seed Ltd.
P.O. Box 11-007
Christchurch, New Zealand

ZAMBIA:

(1)
Mr. Gilbert Tembo
Mt. Makulu Central Research Station
Soil Microbiology/Inoculum Production
Private Bag No. 7
Chilanga, Zambia

ZIMBABWE:
(1)
Ms. Mary Ryder
Grasslands Research Institute
Soil Productivity Laboratory
Private Bag No. 3757, Marondera, Zimbabwe

162

UGANDA:

(1)
Dr. M. A. Bekunda
Mr. Charles Nkwine
Makerere University
Inoculum Production Unit
Soil Science Department
P.O. Box 7062
Kampala, Uganda

(1)
Mr. Rick Pierce
USAID CASS Project
ACDU/Ronco
P.O. Box 7007
Kampala, Uganda (proposed facility)

ETHIOPIA:

(1)
Dr. I. Hague
International Livestock Center for Africa (ILCA)
P.O. Box 5687
Addis Ababa, Ethiopia

CANADA:

(1)
Canadian Seed Coaters, Ltd.
P.O. Box 219
Brampton, Ontario L6V 2L2, Canada

(1)
Titre Inc.
Box 220
Beachville, Ontario N0J 1AO, Canada

(a)
First Line Seeds Ltd.
R.R. #2
Guelph, Ontario N1H 6H8, Canada

(a)
Esso Ag Biologicals
402-15 Innovation Boulevard
Saskatoon, Saskatchewan S7N 2X8, Canada
FAX: 306/975-3750

(a)
McIver Scientific, Inc.
343A Elgin Street
Cambridge, Ontario N1R 7H9, Canada

(a)
Institut Rosell, Inc.
8480 Boulevard St. Laurent
Montreal, Quebec H2P 2M6, Canada

(a)
Philom Bios, Inc.
Mall 2, #104-110 Research Drive
Innovation Place
Saskatoon, Saskatchewan S7N 3R3, Canada
FAX: 306/975-1215

(a)
Lamorna Enterprises Ltd.
2896 West 38th Avenue
Vancouver, B.C. V6N 2X1, Canada
Telephone: 604/266-5742

(a)
Microbio Rhizogen Corporation
Bay 5, 116-103rd Street
Saskatoon, Saskatchewan S7N 1Y7, Canada
FAX: 306/374-8510

USA:

(1)
Microlife Technics
Box 3917/1833
57th Street
Sarasota, Florida 33578

(a)
Mr. R. Stewart Smith
Lipha Tech, Inc.
3101 West Custer Avenue
Milwaukee, Wisconsin 53209
Telephone: 414/462-7600

(a)
Titre, Inc.
P.O. Box 150
Rothiemay Road
Ryegate, Montana 59074

(a)
Mr. Tom Wacek
Urbana Laboratories
Box 1393
3105 Third Street
St. Joseph, Missouri 64502

165

(a)
Trace Chemicals
839 Brenkman Drive
Pekin, Illinois 61554
Telephone: 309/347-2184

(a)
Agracetus
8520 University Green
Middletown, Wisconsin 53562
Telephone: 608/836-7300
(a)
NIFTAL Project
1000 Holomua Avenue
Paia, Maui, Hawaii

ENGLAND:

(a)
MicroBio Division
Church Street, Thriplow
Royston, Hetrs. SG8 7RE, England
Telephone: 44-763-208198
FAX: 44-763-208881

(l)
Agricultural Genetics Co. Ltd.
154 Science Park
Milton Road
Cambridge, Cambs CB4 4G6, England
Telephone: 44-223-420882
FAX: 44-223-420801

BOLIVIA:

(k)
Ing. Renato Valenzuela
Centro de Investigacion Agricola Tropical (CIAT)
Av. Ejercito Nacional No. 131
Casilla 247, Santa Cruz de la Sierra, Bolivia

BRAZIL:

(k)
Dra. Mariangela Hungria
Empresa Brasileira de Pesquisa Agropecuaria (EMBRAPA)
Rodovia Carlos Joao Strass, Acesso Orlando Amaral
Caixa Postal 1061
86001 Londrima, Parana, Brazil
Telephone: 432-204166
FAX: 432-204186

160

(k)
Dr. Jardim Freire
Centro de Recursos Microbiologicos en Rhizobium
MIRCEN
Fac. de Agronomia, UFRGS
Av. Bento Gonzalves 7712
91500 Porto Alegre, R.G.S. Brazil

(k)
Dra. Alaides Puppin Ruschel
Centro de Energia Nuclear en Agricultura (CENA)
Av. Martins Francisco 119
Caixa Postal 96
CEP 13400 Piracicaba, Sao Paulo, Brazil

(b)
Mr. R. Carlos Alberto Beninca 294
1 - Agro-quimica Planalto Ltda
P. Fundo-RS, CEP 99100, Brazil
Telephone: 54-3122947

(b)
FECOTRIGO
Central-Sul-Cruz alta, Brazil

(b)
Industria BIO-SOJA de Inoculantes Ltda
Via Anhaguera Km 383 Marginal Esquerda, No. 1.000
Caixa Postal No. 87
CEP 14600 Sao Joaquim da Barra, Brazil

(b)
Mr. R. Benjamin Constant
Leivas Leite S/A-Industrias Quimicas E Biologicas
1637 Pelotas RS, Brazil
Telephone: 532-253666
Telex: 236 (Answerback: LLSA)

(b)
Nitral S.A. Industria E Comercio De
Inoculantes E Produtos
Agropecuarios
Rua Luiza Verone Picolli, 594 Bacacheri
Caixa Postal 4162
8000 Curitiba PR, Brazil

(b)
Nitroar Industria E Comercio De
Produtos Agricolas Ltda
Km 19 da Br 20 Brasilia Fortaleza
Caixa Postal 70008
CEP 73300 Planaltina DF, Brazil

167

(b)
TURFAL
Caixa Postal 7410
CEP 80000 Curitiba PR, Brazil
Telephone: 41-263414
Telex: 2220 (Answerback: TIQA)

(c)
Mr. Rubens Buschmann
TURFAL - Ind. Com. Prod. Quim. Ltda
Rodovia BR 116, km 79
Quatro Barras, PR 83420 Brazil

(c)
Mr. Paulo Leite
Leivas Leite S/A
Rua Benjamin Constant 1637
Pelotas RS 96010, Brazil
Telephone: 532-25366

(c)
Ms. Sonia Donadelo
Nitral Ltda
rua Rio Piquiri, 650
Pinhais, Piraquara PR 83340, Brazil
Telephone: 41-2675352

(c)
Mr. Samuel Rumor
Nitroar, Ind. Com. Prod. Agric.
Caiza Oostal 70008
Planaltina DF 73300, Brazil

(c)
Mr. Carlos Alberto Mantovani
Bio-Soja Ltda
Caixa Postal 87
Rua Sao Joaquim de Barra, SP 14600 Brazil
Telephone: 16-7285500

(c)
IRFA
Av. hulio de Castilhos, 342-15q Andar
Porto Alegre, RS 900300 Brazil
Telephone: 512-591203

(c)
Mr. Solon C. Arujo
Solo-Fix
Av. Candido Abreu, 526, Conj 407-A
Centro Civico
Curitiba, PR 80530 Brazil

AUSTRALIA:

(o)
Inoculant Services
Tenagi
Bethanga 3691
Victoria, Australia
Telephone: 60-264437

(d)
Queensland Inoculants
P.O. Box 1052
Toowoomba OLD 4350, Australia

(d)
Root Nodule Pty Ltd.
84 Rawson Road
Woy Woy NSW 2256, Australia
Telephone: 43-422533

(l)
Mr. Gary Bullard
Bio-Care Technologies, Pty Ltd.
P.O. Box 367
84 Rawson Road
Woy Woy, NSW 2256, Australia

(l)
Bio-Care Technologies, Pty Ltd.
95-99 Carlingsford Road
Sefton, New South Wales
P.O. Box 8
Regents Park 2143, Australia

BURMA:

(l)
Dr. Hla Than
Agricultural Research Institute
Plant Pathology Division
Yezin, Burma

FINLAND:

(e)
Mr. Petri Leinonen
Elomestari Ltd.
Partala
51900 Juva, Finland
Telephone: 358-55-52490
FAX: 358-55-52492

161

THAILAND:

(f)
Bangkok Seeds Industry Company
36 Soi Yenchit, Chan Road
Yannava, Bangkok 10120, Thailand
Telephone: 662-211-1561
FAX: 662-212-4265

THE NETHERLANDS:

(g)
Mr. J. S. Paternotte
PTG
Postbus 8
2670 AA Naaldwijk, The Netherlands
Telephone: 31-1740-26541

(g)
Mrs. C. E. Winterswijk
IPO
Postbus 9060
6700 GW Wageningen, The Netherlands
Telephone: 31-8370-6700

PERU:

(k)
Dra. Gloria Cornejo de Zvietcovich
Universidad Nacional de San Augustin de Arequipa
Departamento de Microbiologia
Av. Alcides Carrion s/n, La Pampilla
Arequipa, Peru

(k)
Biol. Freddy Mackie Martinez
Universidad de San Cristobal de Muamanga
Laboratorio de Rhizobiologia
Portal Independencia 57
Ayacucho, Peru
Telephone: 912510
Telex: 64753

(k)
Ing. Oscar Amoros
Universidad Nacional de Cajamarca
Ciudad Universitaria
Cajamarca, Peru
FAX: 44-922796

170

FRANCE:

(h)
LIPHA
34 rue St. Romain
B.P. 8481
F-69539 Lyon Cedex 08, France
Telephone: 33-78-754424
Telex: 340495
FAX: 33-78-753905

(h)
BIOPROX
6, rue Barbes
B.P. 177
F-92305 Levallois-Perret Cedex, France
Telephone: 33-1-47577400
FAX: 33-1-47576928

(j)
Jean Gondrau
INRA
F-86600 Lusignan, France

(j)
Ms. Muriel Lasneau
GEP
P.O. Box 63
F-41004 Bloiz Cedex, France

THE PHILIPPINES:

(l)
Dr. Erlinda Paterno
University of the Philippines, Los Banos
Department of Soil Science
College Laguna
The Philippines

wk20/sources

COMMERCIALIZATION OF BNF TECHNOLOGIES:

Framework for ICD Cooperation with USAID and NifTAL

Long Term Goal

To increase the production, marketing and application of BNF inoculants in developing countries through commercial channels.

Immediate Objective

To assist NifTAL in developing an integrated approach to BNF market development using private sector delivery systems to further refine existing products, develop new products and foster wider use of both.

Process/Activities

1. Research & Dialogue

ICD will collect information on BNF commercial activities in developed and developing countries. In order to develop a global profile of the inoculant industry, we will:

(a) Identify and profile the principal domestic and international companies that are producing and marketing inoculant.

(b) Analyze the markets, costs, profitability, etc. of the industry. Production information for several developing countries will be included in the study.

(c) Quality control standards and enforcement issues are also important. Canada has quality standards and they enforce them on inoculants.

(d) Assess NifTAL's current strategy for promoting BNF enterprise development.

To collect and analyze the above information ICD will contact a large cross-section of private (emphasis) and public actors in the BNF business system, describe the objectives of its work with NifTAL and USAID, and assess their interest and willingness to assist our project. Dialogue, particularly with private enterprise, will serve to build a network of key informants to promote utilization of current inoculant technologies. A selection of these key informants could be invited to participate in the NifTAL/ICD workshop.

2. Draft BNF Subsector Papers

Based on the foregoing research ICD will draft two short subsector briefing papers which will form the basis of the workshop discussion:

The first paper will:

(a) Assess the inoculant industry as an integrated business system from market

back to research based on several case histories that illustrate system dynamics;

(b) Identify the "bottlenecks" (economic, marketing, etc.) to expanding the inoculant industry in developing countries.

(c) Present lessons learned from successful and unsuccessful commercial applications in developed and developing countries.

(d) Identify information gaps and priorities for further research.

Attachments to this paper would include the list of businesses with summary descriptions of their activities, statistics on BNF trade, figures showing trends, and country specific information or case studies to the extent possible.

The second workshop discussion paper will:

(a) Recommend a strategic approach for increasing BNF commercialization in developing countries.

(b) Recommend a market development strategy for NifTAL.

3. BNF Industry Workshop

ICD and NifTAL will convene a 2-3 day workshop in Hawaii in late August or early September 1992 which will address the major issues covered in the discussion papers. Participants will represent a cross-section of public and private sector actors in the business system. They will be from developed and developing countries, possibly including 5 or more lead BNF company representatives, NifTAL, select PVO's, key USAID officials, and government officials.

The workshop will seek consensus on an action plan covering:

- The opportunities and constraints to commercializing BNF technologies in developing countries through increased private sector investment and market development;

- Potential markets and commercialization strategies for expanding the inoculant industry;

- A market development strategy for NifTAL which optimizes its contribution to BNF enterprise development in developing countries;

- A business model and guidelines for establishing viable inoculant enterprise based on an integrated business systems approach in selected developing countries.

ICD will integrate the workshop action plan in its final report which will include follow-up recommendations for NifTAL and USAID.

wk15/bnfplan

Attached letter with slight changes sent 3/17/92 to:

Mr. Jack Croucher
Program Development Director, Asia
Appropriate Technology International
1331 H Street N.W.
Washington, D.C. 20005

Kenneth A. Barton, Ph.D.
Project Coordinator
Agracetus
8520 University Green
Middleton, WI 53562

Peter Innes, Ph.D.
Director of Technology Transfer Division
Rhizogen Corporation
Bay 5, 116
103rd Street East
Saskatoon, Saskatchewan S7N 1Y7
Canada

Mr. Gary K. Bullard
Director
Bio-Care Technology Pty Ltd.
P.O. Box 367, 84 Rawson Road
Woy Woy, New South Wales 2256
Australia

Mr. Roger Salquist
Chief Executive Officer
Calgene
1920 Fifth Street
Davis, CA 95616

Mr. John Howard
Department of Biotechnology Research
Pioneer Hi-Bred International Inc.
P.O. Box 38
7300 Northwest 62nd Avenue
Johnston, Iowa 50131

Mr. Karl Herman Wessel
Director
Yellowstone International
200 Securities Building
First Avenue North
Billings, MT 59101

Thomas J. Wacek, Ph.D.
Research Microbiologist
Urbana Laboratories
P.O. Box 1393
St. Joseph, MO 64502

James R. Sims, Ph.D.
Cropping System Agronomist
Montana State University
Bozeman, MT 59717

R. Stuart Smith, Ph.D.
Director of Agriculture Research
Liphatech
3101 West Custer Avenue
Milwaukee, WI 53209

Mr. James C. Delouche
Seed Technology Laboratory
Mississippi State University
P.O. Box 5267
Mississippi State, MS 39762

Dennis Parish, Ph.D.
Director of Resource Management
International Fertilizer Development Center (IFDC)
P.O. Box 2040
Muscle Shoals, AL 35662

Yoram Kapulnik, Ph.D.
Rutgers University
436 Mansfield Street
Highland Park, NJ 08904

Industry Council for Development

16 March 1992

R. Stuart Smith, Ph.D.
Director of Agriculture Research
Liphatech
3101 West Custer Avenue
Milwaukee, WI 53209

Dear Dr. Smith:

As you know, ICD is working with USAID and NifTAL to explore opportunities and constraints to achieving greater commercialization and transfer of biological nitrogen fixation (BNF) technologies to developing countries. (See attached summary of ICD/NifTAL Strategy.)

ICD is continuing its efforts to collect information on BNF commercial activities in developed and developing countries to further understand the opportunities and constraints to expanding production, marketing and application of inoculant technologies through private sector delivery systems. In this context, we greatly appreciated receiving information on Liphatech's inoculant products. We were also pleased to learn from Paul Singleton of your willingess to contribute to the success of this initiative.

Given your familiarity with NifTAL and extensive knowledge of these issues we would certainly appreciate your continued guidance in identifying and obtaining information (reports/studies) concerning:

- case studies involving the economics and profitability of inoculant production and marketing.

- known quality control standards (state, national, international) and enforcement experience.

- the "bottlenecks" (technical, economic, marketing) to expanding the inoculant industry and lessons learned from successful and unsuccessful commercial applications.

- specific technical constraints to exporting inoculants that may be addressed in future research work.

300 EAST 44th ST. ■ NEW YORK, NY 10017 ■ (212) 867-5017 ■ CABLE: INDUCODEV ■ TELEX: 23 89 76 ■ FAX: (212) 573-6028

The information collected by ICD will be presented in two working papers which will be shared with companies and/or individuals that demonstrate interest in our assessment efforts. These working papers will be prepared by ICD Senior Associate for agriculture Dr. Alexander Grobman, and will serve as documentation for a workshop at NifTAL in early September. The workshop will involve a representative group of public and private sector participants active in the research, production and marketing of BNF inoculant.

ICD program assistant Steven McCann will be contacting you or Dr. Arthur Nethery in the next couple of weeks to follow up. We appreciate your cooperation in this matter which we trust will lead to results of mutual value.

Please let us know if we can be of further assistance.

Sincerely,

WW Simons

Walter W. Simons
Executive Director

bnfltr/sml

Enclosure

bcc: T. Gill
P. Singleton

Industry Council for Development

16 March 1992

Mr. James C. Delouche
Seed Technology Laboratory
Mississippi State University
P.O. Box 5267
Mississippi State, MS 39762

Dear Mr. Delouche:

The Industry Council for Development (ICD) is working with the United States Agency for International Development (USAID) and the Nitrogen Fixation by Tropical Agricultural Legumes Research Center (NifTAL) to explore opportunities and constraints to achieving greater commercialization and transfer of biological nitrogen fixation (BNF) technologies to developing countries. (See attached summary of ICD/NifTAL Strategy.)

Over the past decade technologies based on BNF have been developed at the University of Hawaii, through USAID's NifTAL project. As you know, BNF offers a cost-effective, energy efficient and non-polluting technology that could be a major source of technological support for future yield increases. If made available on a widespread basis, the relatively inexpensive BNF inoculant could be valuable input for developing country farmers.

ICD is presently collecting information on BNF commercial activities in developed and developing countries to further understand the opportunities and constraints to expanding production, marketing and application of inoculant technologies through private sector delivery systems.

Paul Singleton has suggested that we contact the MSU Seed Technology Laboratory. Given your familiarity with NifTAL and knowledge and experience working on inoculant enterprise development issues, ICD would greatly appreciate your help in identifying and obtaining information (reports/studies) concerning:

- case studies involving the economics and profitability of inoculant production and marketing.

- known quality control standards (state, national, international) and enforcement experience.

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- the "bottlenecks" (technical, economic, marketing) to expanding the inoculant industry and lessons learned from successful and unsuccessful commercial applications.

The information collected by ICD will be presented in two working papers which will be shared with companies and/or individuals that demonstrate interest in our assessment efforts. These working papers will be prepared by ICD Senior Associate for agriculture Dr. Alexander Grobman, and will serve as documentation for a workshop at NifTAL in early September. The workshop will involve a representative group of public and private sector participants active in the research, production and marketing of BNF inoculant.

ICD program assistant Steven McCann will be contacting you in the next couple of weeks to follow up. We appreciate your cooperation in this matter which we trust will lead to results of mutual value.

Please let us know if we can be of further assistance.

Sincerely,

Walter W. Simons
Executive Director

bnfltr/sml

Enclosure

Annex XII

BNF Interviews

Working Draft

22 May 1992

Steven McCann

UPDATED CONTACT LIST

Individuals Interviewed

Mr. Jack Croucher
Program Development Director, Asia
Appropriate Technology International
1331 H Street N.W.
Washington, D.C. 20005
Ph# (202) 879-2900
Fax (202) 628-4622

Dr. Steve Stephens
Research Microbiologist
Rhizogen Corporation
Bay 5, 116
103rd Street East
Saskatoon, Saskatchewan S7N 1Y7
Canada
Ph# (306) 373-3060

Mr. Gary K. Bullard
Director
Bio-Care Technology Pty Ltd.
P.O. Box 367, 84 Rawson Road
Woy Woy, New South Wales 2256
Australia
Ph# 011-61-43-42-2533
Fax 011-61-43-43-2083

Dick Davidson
Latin American Sales Manager
Yellowstone International (subsidiary of
United Agri-Products)
200 Securities Building
First Avenue North
Billings, MT 59101
Ph# (406) 252-6628
Fax (406) 252-0008

Thomas j. Wacek, Ph.D.
Research Microbiologist
Urbana Laboratories
P.O. Box 1393
St. Joseph, MO 64502
Ph# (800) 892-2013
Fax (816) 233-8295

James R. Sims, Ph.D.
Cropping System Agronomist
Montana State University
Bozeman, MT 59717
Ph# (406) 994-5073

R. Stuart Smith, Ph.D.
Director of Agriculture Research
Lipha Tech
3101 West Custer Avenue
Milwaukee, WI 53209
Ph# (414) 462-7609
Fax (414) 462-7186

Mr. James C. Delouche
Seed Technology Laboratory
Mississippi State University
P.O. Box 5267
Mississippi State, MS 39762
Ph# (601) 325-2391
Fax (601) 325-8827

Dennis Parish, Ph.D. (Debra Hellums,
Research Associate)
Director of Resource Management
International Fertilizer Development Center
(IFDC)
P.O. Box 2040
Muscle Shoals, AL 35662
Ph# (205) 381-6600
Fax (205) 381-7400

Yoram Kapulnik, Ph.D.
Rutgers University
436 Mansfield Street
Highland Park, NJ 08904
Ph# (908) 932-1048

John Walsh
Celpril Industries
251 Oak Street
Manteca, CA
Ph# (209) 823-1738
Fax (209) 823-8855

131

Individuals yet to be contacted

Bruce Hamilton ✓
Director of Process Development
Agracetus
8520 University Green
Middleton, WI 53562
Ph# (410) 531-4561

Tom Bockhaus
Export Sales Manager
Pioneer Hi-Bred International Inc.
P.O. Box 38
7300 Northwest 62nd Avenue
Johnston, Iowa 50131
Ph# (515) 270-3123

182

4 April 1992

Interview with Jim Simms, Ph.D. (Montana State University)

Australia:

-Dr. Simms talked about how NifTAL's efforts reflect lessons learned from previous ley-farming methodologies in Australia where cottage industries were responsible for the production and distribution of BNF inoculants. Cottage industries refer to small endeavors housed in shops or barns and where the production takes place in 55 gallon barrels.

-Dr. Simms emphasized the idea that the technology should not be sophisticated. The maintainance of the production facilities is key and that must be simple and not require specialized parts if the endeavor is going to be sustainable and successful in LCDs.

1. Opportunities:

-Two examples were given concerning the opportunities available to BNF expansion, changing methodologies in the US and identification of established and proven legume production areas overseas. (EXAMPLE IS INDIA TO IN MT)

a) Dr. Simms believes that a lot of opportunity will present itself in the western states, west of the 100 meridian (Great Plains States). He believes the opportunity will grow from changes in crop production methodologies (cropping systems). As cereal grain/legume rotations become more widely accepted, the demand for BNF inoculants will grow.

b) As for opportunities overseas, Dr. Simms believes that the identification of established and proven legume production areas will allow efforts to improve or generate an inoculant market (with appropriate attention focused on the ~~to~~ removing stress that exist; water stress, nutrient stress). Again, Dr. Simms pointed out the need for simple, low maintainance production technologies that have few parts.

He also pointed out that distribution systems were very important to the success. He cited his experience in Egypt as an example. Cairo was the main (only) source of BNF inoculant available to Egyptian farmers. And to acquire the inoculant a farmer would have to travel to the capital and pick it up. Recognizing that for BNF inoculants to be effective, the rhizobia quality must be maintained and which results from quality production, packaging and distribution. In Egypt the producers were in charge of quality control (responsible for criticizing their own product) which was not successful. Also, the packaging process did not insure product integrity but individuals responsible for reviewing and changing the packaging process had a vested interest in the present method of packaging (they were benefiting from the use of a specific peat and

from the packaging service). The distribution of BNF inoculant must involve cold storage, which can be a real constraint in LDCs.

2. Steps to realize Opportunities

a) Steps to realize the opportunities in the west will occur through more flexible US farm programs and trade agreements. When legumes can be grown on soil required to be left fallow, then demand for BNF inoculants will increase. Already, the farm program does allow certain legumes to be used as green manure crops (I think), and when alternative cropping systems become more widespread among dry-land producers legume inoculants use will increase.

As far as the US farmer's aptitude to utilize BNF inoculants, Dr. Simms believes they are strong. US farmers, seed distributors and extension agents are all familiar with the benefits of inoculants.

As a specific case, Dr. Simms gave the example of a business enterprise in Montana. Timeless Seeds of Conrad is passing through the final stages of incorporation. David Oien is the manager of the company and Dr. Simms is the technical advisor. The business will provide legume seeds to farmers in Montana and possibly other western states. Timeless Seeds will provide green manure cover crop seeds (clovers and alfalfa are examples), cash crop legume seeds (black medic (?), snow peas are examples), and specialty crops such as flax. Timeless seeds will not sell barley or wheat seed but will focus on the soil building crop seed market. In is worthwhile to note that this is a unique business in Montana. It is the first seed company to serve alternative agriculturalists. It may prove to be very profitable because under current legislation and cropping systems methodologies, 1/2 of all dry-land cropland lays idle and with more flexibility written into the US farm bill, green manure cover crops could well cover those idle acres in the future. (Green manure cover crops replenish nutrients while lowering maintainance costs and allowing an equal level of moisture retension.) Timeless Seeds could be serving a growing market niche.

Timeless Seeds is a distributor of Titre inoculants and a dealer of Urbana and Liphatech inoculants. (Distributors supply dealers so the link with Titre [ConAgra, United Agri-Products] is much stronger. Seeds sold by the company will include inoculant in the price. Timeless Seeds plans to market extension efforts to area producers also. This would include information concerning the demonstration plots and recommendations for starting up green manure systems within their own systems. Timeless Seeds puts out brouchers and conducts field-day trips to demonstration plots.

Usually, BNF inoculants are/have been sold through alfalfa seed companies. This is the first enterprise to sell the BNF from a different angle (in Montana). Incidently, to finish the incorporation process, Timeless seeds is selling stock at

$100/share. The company plans to raise $50,000 to $60,000.

4). Constraints to BNF:
In response to the question of what are the biggest constraints facing BNF proliferation, Dr. Simms identified three issues; user friendliness, understanding and resistance to new cropping systems.

a) The US production and distribution system is not applicable to LDCs. Unlike farmers in Montana, LCD legume producers cannot hop into their pickup (truck) and drive 30 miles to obtain a quality, refrigerated quantity of BNF inoculant. Attention must be focused upon creating a distribution systems that puts a quality product into the hands of producers within an appropriate time period (2 weeks).

b) LDC farmers are just as "agriculturally" intelligent as US farmers. While they may not understand the process of fixing atmospheric nitrogen to nodules on the roots of legumes, they do understand the importance of legumes to their production process. Similarly, farmers in LCDs (like farmers in the US) must be demonstrated the benefits of BNF use. Farmers are hesistant to change a system that works, especially LDC farmers who depend upon their production for survival.

c) Resistance to new cropping systems is proving a large constraint to the proliferation of BNF technology. To a large degree, land grant universities and international agri-product companies are structured around high-input agricultural technologies and low input technlogies return a smaller profit margin and consequently are a less desireable product. Dr. Simms believes that farmers will pressure the service industry into providing low input technologies but that this will only occur as a result of extensive demonstration efforts. Currently he is involved in extension efforts to several parts of the state (Bozeman, Conrad, Fort Benton, and Circle) where he has been asked by agricultural leaders to advise them concerning green manure rotations and the use of legumes within their cropping systems. Another company that is employing a similar tactic is Intermountain Canola which is a joint effort between Du-Pont and DNA Technology Corporation that is located in Idaho Falls. Intermountain Canola is using the concept of shared risk to convince farmers to grow contracted crops of canola. The company offers $50/dry-land acre and $100/irrigated acre UPFRONT to grow canola. The strategy seems to be working for the business.

9. As to the question about successful/unsuccessful efforts to initiate BNF production and distribution in LDCs, Dr. Simms gave three examples of unsuccessful attempts with which he was personally familiar.

a) The government initiated and maintained program in Egypt was a failure because of the quality of the inoculant and the method of distribution.

b) Liphatech was interested in the idea of setting up a joint effort between itself and the Egyptian government but the initiative fell through because of the vested interest of government officials in the government BNF inoculant production and distribution program. The peat that was used as the transporting medium was a lower qualilty, coarse type that inhibited the performance of the bacteria but because the proceeds from the use of the peat were accrued by government officials, the peat remained as the transport medium. Dr. Simms mentioned that government officials were paid very little in Egypt and that often they relied upon agreements such as this peat example for their livelihood. Also the packaging process was identified as one of the principle constraints to the successful application of BNF but again, since the packaging process economically benefited Egyptian officials, it was not changed.

Additional constraints were the failure of the Egyptian government to utilize the suggestions of the USAID assessment team and the fact that the production and quality control were housed in the same entity causing a conflict of interest (there was very little incentive to critize its own program).

c) The third example involved the possibility of Liphatech building a inoculant production facility in Colombia. Colombian officials wanted Liphatech to finish the facility and then turn it over to the Colombian government (a turn-key operation). Dr. Simms did not know why the endeavor never got off the ground. He thought it might have had something to do with the political atmosphere at the time, or possibly the goverment did not want to cover the costs. Dr. Simms went to Cali Colombia twice during the early 1980s and remarked that indeed the atmosphere was uncomfortable for US citizens.

11. In response to the question on quality control and its role in the transfer of BNF technology, Dr. Simms readdressed many of the points that had risen previously.

First, production technologies produce good quality batches of bacteria but the quality deteriorates because of the logistics of LDCs. In much of Africa and South America, cold storage is unavailable for transport or storage of BNF inoculants. Many times the production center is not convenient to the application spot and a feasible method of transporting the inoculant does not exist.

Second, LDC farmers have more to loose from a crop failure so consequently they are less likely to try new, untried technologies. While the application procedure for BNF inoculants is not complicated it does require a degree of competance to insure maximum return. The ability to capitalize from BNF inoculants is part of a learning process.

The final question focused on the population of rhizobia in the soil, their propensity for self sustainability and an example of BNF use.

Many times indigenous strains of bacteria are in the soil and they survive quite well providing the conditions remain constant. Fire, drought, or extensive chemical use can cause a bacteria population to decline. Usually, Dr. Simms suggest farmers to inoculate each time they plant legumes, especially if they are doing a rotation.

An average scenario in Montana that describes the application of BNF inoculant is:

Apply $3-4 worth of BNF inoculant to 100lbs of alfalfa seed.

Plant 5-10lbs of alfalfal seed per acre.

The yield is different in each case but this application will usually result in an additional ton of alfalfa hay/acre and/or 2-3% rise in protein content and in the case of beans, an additional 500lbs of beans per acre.

9 April 1992

Interview with Mr. James C. Delouch at the Seed Technology Laboratory at the Mississippi State University.

Mr. Delouch has worked for the Seed Technology Laboratory for over thirty years. The Seed Technology Laboratory is funded by USAID and is the oldest of AID cooperative organization (similar to NifTAL). Seed Technology Laboratory has worked in 40-50 countries (some more extensively than others) and is involved in teaching, advising and research addressing the production, distribution and utilization of seed varieties. For the most part, Seed Technology Lab has cooperated in government to government exchanges of information and resources. It is only in the last 10 years has public institutions like AID considered using the commercial sector to forward development.

I started the conversation by reading to him the list of individuals that were sent the same packet of material. I also set the stage by saying the ICD was involved in the effort to pass the low-input technology from the public sector to the private sector.

Mr. Delouch declared that he was old enough to be skeptical about any new wonder product. He thought that the BNF inoculant may have some positive attributes but that he had seen to many years to be swept off his feet. He gave several examples that he considered pertinent to our effort. The first was his personal experience in Thailand. Seed Technology Lab was involved in a project with Thailand's government around 15 years ago. Seed Tech Lab was involved in an outreach program concerning seeds and originally the project did not have a BNF component. After heavy lobbying by the Thai government, a BNF component was added to the project which Delouche indicated was not well received by the Seed Tech crew. Delouche felt the BNF component was added on hap-hazardly. He thought the component was not really implemented or monitored very carefully and really made no great impression upon him or Seed Tech work. He remembered that originally the inoculant was created for soybeans but that in fact the BNF inoculant had a greater effect on peanut crops. He said that during this time period there were a lot of "old wives tales" about conditions under which rhizobia flourish and under what conditions rhizobia populations decline. One such tale was to the effect that rice and soybeans could not be grown in a rotation because the water used for the rice would kill the rhizobia. This was not true he explained, but represented the degree to which the project lacked a coherent scientific structure. (Documentation of this project could be obtained from the Thai Ministry of Agriculture).

Another example he gave that he thought was pertinent to NifTAL's BNF project is a Brazilian lady's (Dr. Dobmeyer ??) revelation of a rhizobia strain that fixed nitrogen for grasses (which would include wheat and barley). This particular incident occurred around 20 years ago. The specifics of the

case involve a Brazilian lady showing up in the U.S. with a technology that she claimed fixed nitrogen for grasses. While the particular strain of rhizobia that she had identified did fix a little nitrogen under certain conditions, it was not the break-through that had been billed. The project had the acronym NON or some such.

Another example is the relatively recent work involving nitrogen fixation with algae and rice. The hype has not been equaled by the documented performance. Delouche was concerned with the credibility of BNF and the organizations which pushed the technology. He asked the question, "If the technology is good, why hasn't the private sector snapped it up?"

As far as impact of the technology, he thought the U.S. was a good example. Today, very few acres of soybeans are inoculated because the rhizobia population is self-perpetuating.

In answer to where he had seen the production and distribution of inoculants, he identified Australia, Indonesia, Thailand, Japan, and China. At this point and throughout the conversation, I got the feeling that Delouche was not an "expert" on BNF and quite frankly, had a professional interest in the technology but that he was skeptical about the past, present and future of the technology. He felt much more comfortable talking about seeds and their benefits.

Northrup

At this point I questioned Mr. Delouche concerning the utilization of seeds as a method of transporting and delivering the BNF inoculant. He thought the idea was good, if not new. He mentioned several names that might prove further sources of information concerning BNF and previous/on-going efforts to produce and distribute inoculants. Loyd Fredrickson, who use to work at the University of Iowa and with AID was mentioned as a resource on BNF. Mr. Delouche thought that Loyd had worked with NifTAL to some degree. Another individual he identified was Fred Porter who has previously worked with ~~North-Up~~ King. Fred is involved with the concept of pre-inoculating seeds (sell the seed and inoculant as one package such as Celpril is doing).

He continued this line of thought by saying that ICD should get in contact with the network of international research institutes. He named several;

CIMMYT (Centro Internacional de Mejorar Maize Y Traigo) located in Mexico.

IRRI (International Rice Research Institute) located in the Phillipines.

CIAT (Centro Internacional de la Agricultura Tropica) located in Cali, Colombia.

ICRISAT (International Center for Research in the Semi Arid Tropics) located in Hyderbad, India.

IITA (International Institute of Tropical Agriculture) located in Ibadan, Nigeria.

ICRDA (??) located in Allepo, Syria.

Each of the institutes has a different research mandate. CIAT ICRISAT, IITA, ICRDA and CIMMYT might have documents or informtion concerning the extent to which BNF is utilized in production technologies.

CIMMYT was the first institute to be established. This was done by the Rockefeller Foundation previous to WWII. The rest were established after WWII (IRRI was the second to be established) and were a joint philanthropic endeavor between the Rockefeller and Ford Foundation. These sources should be followed up.

Continuing the topic of seeds and their established distribution networks, I asked him if he thought large multi-national seed companies such as Pioneer would be a good method of distributing inoculant. Mr. Delouche thought there was a lot of potential in this area but he pointed out that many times the large multi-nationals do not reach the smaller markets in LDCs. As a rule, the large seed companies market hybrid seeds that have a profit margin. The self pollinating seeds such as wheat, barley and rice which are some of the most important crops in the world are not sold by the seed companies. The reason being is that the demand can be filled locally. Hybrid seeds which produce a sterile crop need to be replanted each year.

Another possibilty is the vegetable seed network. Delouche felt that pre-inoculated legume seeds may find their way to more LDC farmers through the established vegetable seed network. To an undertermined degree, the quality control and the distribution methodology could be of the level required to insure BNF inoculant integrity.

On the topic of distribution, Delouche made several additional points. Shelf-life and the fact that the profit margin for the product was small enough that it might discourage any company from seriously trying to enter markets. The second point which was very serious involved the fact that farmers in LDCs have serious cash flow problems which may inhibit the demand and use of the BNF inoculant. Delouche described a scenario which rings with truth. If for instances a BNF inoculant plant was set up, and an adequate demonstration program was instituted which lead to farmers demanding the inoculant then the product must deliver. Many times the BNF inoculant returns are over the long-run and as a result of changing methodologies. If the immediate return was not visible to the LDC farmer and their cash flow being tight, they may not be interested in continuing the use of BNF inoculants (<u>the strains of rhizobia must be good</u>). The bottom line Delouche came to was that a technology such as this may need to be subsidized. He thought it would be nice if the private sector could take over the production and distribution of the product but he thought it might be a bit unrealistic given BNF's profit margin and

delicate nature. He thought that BNF inoculant was more of an insurance treatment for seeds, much like treatments against pests.

The final topic was Seed Technologies relationship with NifTAL. Since Delouche has traveled to many countries under the auspices of teaching, extension and feasibility studies, he runs in the same circle as the NifTAL people. Periodically the two centers touch base because of mutual interests or programs. Currently, Seed Technology is involved in the Living Soils Project (Save the Children, WinRock Intrl) in the Gambia and Senegal. The first phase of the project involved WinRock, the Western Carolina University and Seed Technology. The second phase of the program is just starting and will involve soil fertility studies and extension efforts (composting, inoculm). He will send information concerning this project and pertinent seed network information.

9 April 1992

Interview with Dennis Parish, Ph.D. (International Fertilizer Development Center, IFDC).

The interview with Dr. Parish was conducted very efficiently by the interviewee. Once again I started the conversation by listing the people and organizations that were invovled in the assessment process.

Dr. Parish's response to the first question pretty much covered his position from start to finish. In response to what are some of the opportunities in conjunction with BNF inoculant, he replied, "none". IFDC's experience with BNF has not proved productive.

The only interest or window through which IFDC has been considering BNF is through inovative, alternative cropping methodologies. It has been involved with NifTAL through an effort to provide nutrients to crops raised in acidic conditions. The project included efforts to coat phosphorus and potasium fertilizers with BNF inoculants which was then made available to plants (cutting out the application of nitrogen). The effort proved unsuccessful, the phosphorus/potasium fertilizer did not prove a viable transport medium for the rhizobium, they died. While this attempt was unsuccessful, others may be considered. This type of effort (which utilizes some of the basic fertilizers) is of marginal interest to IFDC.

Dr. Parish indicated that IFDC was marginally interested in participating in this process and that they would be interested in the results of our efforts. He indicated that BNF could/should be put into trial/demonstration program so that a greater understanding of BNF potential is available. He stressed that IFCD's mandate required concentration on providing nutrients for plants. He said they were engineers not scientists.

He didn't think the fertilizer network would prove a viable distribution network.

The final point that Dr. Parish talked about was the proven record of BNF. He asked the question, "If BNF is a good product, why isn't it being successfully marketed by the private sector. Why is the effort needed to transfer the technology from a research institute to the private sector." His point was that through the years BNF has not proliferated. Twenty years ago the corn-belt in the US was using a large amount of BNF inoculant. This is no longer true. He also thought that the rhizobia had a difficult time surviving in tropical conditions.

The conversation finished with the recoginition that an effort to understand and describe the constraints to BNF use would be useful to the plant nutrition industry.

14 April 1992

Interview with Steve Stephens, Ph.D. Director, Rhizogen Corporation

At the beginning of the conversation, I received the sense that Dr. Stephens was prepared for the interview and he proved a receptive interviewee.

In answer to the question about opportunities presenting themselves to the BNF industry he answered there were 2 markets. The "developed" world market he felt was saturated with companies. The second market in the less developed countries was an untapped market.

Dr. Stephens has worked overseas, mostly in the Middle East. He was familiar with Pakistan, India, Thailand (existing govt. industry) and Africa which he felt offered the most potential. He spent five years in Syria, working at the International Center for Agriculture Research in Dry Areas (ICARD). He has also worked on occasion for USAID.

The difficulty of reaching the second market has much to do with the "user friendliness" of the present BNF technology, which has not been changed since in inception in 1898 (Milwaukee). He felt that using peat for the transfer medium was not feasible for "peasant" farmers. The peat BNF does not work well in situations where the farmer broadcasts seed by hand, which is the typical method by which the seed and fertilizer are spread.

I told him I thought that most BNF inoculants had sticker by which to adhere the inoculant to the seed. He answered that the technology that NifTAL was employing did not involve a sticker. The current method of using BNF works in mechanical seeding and broadcasting equipment and maybe, the in-road to less developed countries was through large, mechanized government farms or other capital intensive farmers in the LDCs.

Another constraint facing the peasant farmers is the fact that they have a hard time cash flowing and BNF is a product that doesn't fit into their budget.

I questioned him about the specific products and methodology behind his companies effort to market BNF. He told me Rhizogen is the only Canadian based company selling BNF in Canada. The company is small but it sounds healthy. He mentioned that all of Rhizogen equipment is plastic, 100%. This he felt was a solid attribute because plastic can be found in all parts of the world. Dr. Stephens talked a lot about a granular technology which his company has developed. The transport medium for the rhizobia is a completely dry clay, which I understood to

be somewhat unique. He said the granular BNF can be applied through convention seeding and fertilizing machinery, but also offered an alternative technology to peasant farmers. He feels that peat based technology is not feasible for LDCs and that new and different BNF technologies are needed, focusing on the needs and conditions of LDCs.

I questioned him about the idea of placing the inoculant apart from the seed and he responded by telling me Alberta Research Stations have tested the granular application technique and found that it returned a 40% greater yield than conventionally applied BNF inoculant (seed coating). He also mentioned that as a rule, correctly applied BNF inoculants result in a 20% increase in yields. So the granular application gives a 60% yield increase. He stressed that granular BNF was more "user friendly" which is a attribute in markets where simplicity is a key.

I questioned him on methods of reaching LDC markets and whether or not multi-nationals with established distribution networks were a possible answer. He said that his experience would lead him to believe otherwise. He gave the example of a Pakistani farmer. He said that to peasant farmers, the village is the life. Many farmers are nation proud and foreign products have a hard time entering these markets. He thought a better method would be to try and sell "wood shed" production technology to entrepreneurs in local areas. Possibly targeting certain areas to establish the technology. He mentioned that he had done his graduate work in Australia where "wood shed" production and distribution was the standard. (This is also the technology that NifTAL has available).

Finally, in response to a question about the small profit margin on BNF, he said there is money to be made. He said that one can easily charge 120% over costs, a "bloody good mark-up". Peat is the only real input and in most places that is cheap. Of course, a certain volume is needed, but money can be made. He said that Liphatech (Nitrogen when he entered the market) sells BNF inoculant for little or nothing and that by packaging his product and doing a bit of advertising, he sells his product for more and has a healthy share of the market.

Dr. Stephens said that he remembered some figures about what is feasible as an input for farmers. Farmers demand a 4:1 ratio of return. Farmers will purchase an item for $1 if they receive in return $4. By this model, BNF is a bargain.

16 April 1992

Interview with Thomas J. Wacek, Ph.D., Research Microbiologist (Urbana Laboratories)

Opportunities: Dr. Wacek identified opportunity for Urbana in 4 areas.

1. Urbana is trying to improve strains of bacteria by genetically engineering them. A larger market can be found if better, hardier, more aggressive strains of bacteria are engineered. Urbana has recently acquired several engineered strains of bacteria from BioTechnica in Cambridge Massachusetts but has done little to market them.

2. The use of peat as the transporting medium for the rhizobia is limiting. Urbana is considering several methods of transporting or applying the inoculant. The use of pre-inoculation offers market expansion opportunities. Urbana is working in this area with alfalfa and soybeans which are the money makers for Urbana.

3. In addition to pre-inoculation, Urbana is exploring the demand for, and feasibility of, a rhizobia liquid concentrate. The liquid concentrate can be introduced through irrigation systems, applied to directly to seeds, or sprayed on top of crops and washed into the earth with additional water. New Mexico State University is conducting tests with this product and the feed-back has been positive (Texas A&M also is using the technology with peanuts).

   Topical application raises an interesting point that has not been encountered previously. Specifically, topical application methods reach the lateral root system. Reaching more of the root system will increase the plants capacity to produce nitrogen. This technology also offers opportunity for numerous applications and Dr. Wacek pointed out that as long as producers get a return, the innovation is good for everyone.

4. Another method of transporting the rhizobia is freeze drying technology or biofilization (?). This technique allows the product to gain a longer shelf life. Through the freeze drying process the rhizobia become inactive and are packaged in tablets that resemble alka-seltzer tablets. Dr. Wacek explained the application as dropping the inactive tablets into water (plop, plop, fizz, fizz) and in a few minutes the rhizobia become active and ready for application. Efforts are addressing the packaging techniques that will allow the tablets to gain a longer shelf-life. (Freeze dried powder is also an alternative.)

It should be noted that Urbana has traditionally served the established, large-scale, capital intensive farming sector and will continue to concentrate on this market (as the R&D efforts attest).

Constraints:

Dr. Wacek said the largest constraint facing Urbana is existing rhizobia populations. The corn-belt and soybean production areas have a substantial and healthy rhizobia population which means they cannot sell their product in these areas. If Urbana could produce a genetically engineered strain of rhizobia that perform better than the indigenous bacteria, they could again, reenter these markets.

Company Affiliates or Methods of Reaching New Markets:

Dr. Wacek felt seed distributing networks offered more opportunity to inoculant companies that chemical company networks. Inoculant products are perishable. His experience leads him to believe chemical companies dealing herbicide or pesticide are not attentive and that seed companies are more cognizant of inoculant properties.

Urbana does not have any over-seas affiliates, only product distributors (he mentioned Italy and South America). He indicated that Urbana has been interested in established markets, basically, any place there is a demand, Urbana is willing to supply the inoculant. The size of the market is an important factor, Urbana only considers markets that are large enough to finance the logistical effort (the transportation, refrigeration and the distribution) needed to reach the markets .

Dr. Wacek was involved with the Argentinean market. During his tenure with this effort, Urbana was selling $1 million US dollars worth of inoculant to Argentinean distributors. The $1 million dollars would have retailed for @ $2 million in the US market, but do to the demand it was retailing for @ US $10 million in Argentina. This lead Dr. Wacek to an important point. To enter farmers production methodologies, the technology must have a value placed upon it. He used the example of the success of hi-bred corn seed. He said because hi-bred corn sells for more than the conventional corn seed, the farmers plant the seed in their best ground under the right conditions. Of course, this leads to better yields and enhances hi-bred corn seed's standing with farmers. Successful market entries by BNF inoculants should encourage similar respect and anticipation. A fair price will do more to spur market development than give away programs by the government.

To reach the Argentinean market, Urbana would truck the inoculant to Chicago, then to Baltimore where it would be loaded on ships and delivered to distributors in Argentina. The trip took 14 days and of course, required refrigerator for the duration. He said that the network of distributors was extensive and that many of the salesmen would travel by bicycle. Now that original network is more developed and it is moving a much larger volume and variety of goods. ($s are the best incentive for distributors.)

Urbana is cooperating with several research centers. Besides New Mexico State University,

- Bill Lindermann, a previous Urbana employee, ph#(505) 646-1907

Urbana is working with the University of Wisconsin,

- Eric Triplet, Agronomist, ph# (608) 262-9824.

Dr. Wacek thought for documentation or knowledge concerning the practical application of BNF inoculants two individuals would be worth contacting;

- Jim Dunithy (?) at North Carolina State's Crops Science Dept. (919) 737-2326. Jim has worked extensively with extension efforts involving BNF and will probably have info documenting returns. Incidentally, he is involved in computer modeling now, and might be interested in reviewing NifTAL's program.

- Ed Dunigan, Chairman of Louisiana State University's Agronomy Dept. (504) 388-2110. Ed has recorded results of farmers efforts in the south.

Link with NifTAL:

Good contact, Dr. Wacek was NifTAL's first microbiologist (1975).
Also knows Charlie Sloger well.

Quality Control:

Will send material regarding quality control or standards.

Australian and Canadian standards have historically formed the basis for US quality control (possibly European also). At the moment, the US inoculant industry is a mature industry and there are no standards for inoculants. US inoculant producers must register the product and meet qualitative criteria (that is the inoculate must produce nodules) but standards are lenient. Canadian standards are more restrictive, requiring a specific live population number per bag of inoculant.

If genetic engineered rhizobia hit the market with exaggerated claims then quality control or regulation may be re-instituted but there are no standards now.

16 April 1992

Interview with Dick Davidson, Latin American Sales Manager, (Yellowstone International)

Opportunities:

Mr. Davidson said that in most developed countries the market was established and limited. For example the rhizobia population is established and healthy in the soybean/corn belt of the US. Currently, only 5-6% of US soybeans are inoculated. He thought that in many countries that are developing, opportunities exist for market expansion. This would depend upon identifying and supplying the proper strains of rhizobia for each set of conditions (crop, soil, temperature, and moisture). Argentina was given as an example. Five or six years ago, 5% of the soybeans were inoculated, now the figure is around 30%. In virgin soil, a 2 to 3 dollar application of GRIP inoculant yields a 25 to 30 dollar return. I asked him why the market had developed, he answered that he thought the market developed as a result of the US grain embargo on the USSR. He said Japanese companies began to invest in ag-production during this period. He also mentioned Russia and Africa as holding potential.

One strength of Yellowstone International's is an established and extensive distribution network accessible through its parent company of United Agri Products (UAP). The network also is useful for identifying markets that can be developed.

As far as developing markets, Mr. Davidson said the process must be taken one step at a time. He said that the first step is to identify organizations/individuals that are capable of distributing the product to a specific area. Once the distributor is identified, a relationship is established, which leads to eventual market development. The process takes time and effort.

Mr. Davidson elaborated on his personal experience and work in South America where the combined acreage is equal to that of the US market. Several joint company efforts are under way; Argentina Cooperative Association, in Buenos Aires, Tomen (a Japanese ag-product firm), Hokko (a Japanese ag-chemical, ag-product company) in Brazil, and Enzor in Monte Video, Uruguay (servicing both Uruguay and Paraguay). Contracts give these companies exclusive distribution rights to the GRIP product. BNF inoculant is trucked to Houston, loaded on refrigerated ships and taken to the outlet points. Quality and packaging are UAP jobs. Eventually, UAP hopes to replace the domestic product with their "superior" product.

R&D and Demonstration Plots:

UAP is involved in ongoing R&D at Iowa State University and the University of Illinois. Mr. Davidson had just returned from a workshop involving BNF inoculant and no-till farming.

Also, test work is being done in South American university systems, particularly Brazil. Currently, at the University Rio Grand de Saul, near Port Alegre, Brazil, 8 research projects are being conducted. Research data from these projects will be compiled in the latter part of May. Mr. Davidson said he would make the data available to us.

Quality Control:

Dr. Ede McGeed (MSU professor) is in charge of quality control for the Grip product. Mr. Davidson claimed the UAP (which bought out Titre) has the most sophisticated approach to production. The technology behind the production originated in England and Canada where there were stringent standards.

The peat used as the transport medium is of very high quality. It is an fine peat from England. The peat has a balanced PH level which allows the rhizobia to live longer (longer shelf life). Granular BNF inoculant is available through UAP. BNF liquid concentrate has been tried in Canada but was not very successful.

UAP is involved in a joint venture with Du-Pont. The venture is examining "chitan" as a transport medium. I understand "chitan" is a by product of the fishing industry.

Finally, Mr. Davidson said that the President of UAP (Phil James) was receiving copies of all of our correspondence and that this will continue to happen.

22 April 1992

Interview with John Walsh, Celpril Industries

Mr. Walsh was receptive but not enthusiastic about answering the questions. He was interested in our endeavor and the information we had acquired. I read to him the list of individuals who had been contacted by ICD and he commented that the list was comprehensive and represented the BNF industry.

Opportunities:

Mr. Walsh said US companies are not producing a product for the low-input market. LDC producers are faced with the limitation of balancing inputs. Fertilizer, chemical, quality seed, and BNF all compete for the resources of a small producer. Many times, LDC producers must choose between several inputs as to which will give the largest return. BNF may be a lower priority than many of the other inputs (economic constraints).

Celpril Industries:

Celpril pre-inoculates seeds. BNF inoculant is a business emphasis but many other coatings are available for seeds. Celpril inoculates many different types of legume seeds; alfalfa, clovers, and forage legumes are a few.

I told him I was familiar with private seed coating systems employed by Montanan farmers and I asked him if they were exploring this method of market development (selling small private inoculating/coating systems). He said that Celpril's methods and equipment were capital intensive (expensive and specialized), which did not lend themselves well to private producers or grain elevators utilizing the technology.

Celpril's main method of market establishment is "word-of-mouth". He said that extension is a natural part of market development but to date Celpril has not been involved in and demonstration or extension efforts.

Quality Control/Shelf Life:

The marketing technique employed by Celpril reflects the Celpril pre-inoculation technology. To adequately supply a market, production facilities would have be set up at the market site. Seeds important to the local agriculturalists would be grown and pre-inoculated in the specific area. If pre-inoculated seeds are cared for properly, the rhizobia can survive 12 months.

Mr. Walsh didn't think trade regulation would be an important factor until the time genetically engineered seeds or inoculant became available.

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@24 April 1992

Interview with Jack Croucher (Appropriate Technologies International

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Jack Croucher began the interview by questioning the US private sector's ability to reach the small farmer in LDCs. He questioned whether the small farmers had the knowledge, interest, and money to utilize BNF technology. Mr. Croucher made clear that he was interested in finding ways of reaching "small" farmers with the technology. He feels that many times small farmers are overlooked/ignored and that past history illustrates the US private sectors inability to reach the small farmer.

Jack Croucher is a good friend of Paul Singleton. Mr. Croucher said that they have many long discussions on methods of reaching small farmers. Singleton argues that the private sector is the best method and Croucher believes the public sector has a greater capacity to reach the farmers that really need the technology. It sounds like they have a good dialectic discussion the continues every time they meet.

Opportunities:
Mr. Croucher believes opportunity exists in less developed countries for decentralized small scale commercial production. He mentioned two examples of this methodology that are successful endeavors. One in Thailand and the other in India (Barato Agro-Industry Foundation, BAIF) both of which have been successful in reaching the small farmers.

Mr. Croucher believes four things are necessary to ensure a successful transfer of an appropriate technology: 1. it must be good quality technology, 2. the benefits must be demonstrated to the target group of farmers, 3. extension agents or demonstration farm personnel must be trained in the use of the technology and, 4. small enterprises must be established to meet the local demand. Many times, technology transfers fail because they were not implemented correctly. BNF inoculants lend themselves well to this approach for because success depends upon identifying and producing a strain of rhizobia for specific soil, seed and weather conditions.

Constraints:
The **real market** is the small farmers who do not have access or the resources to acquire petroleum based fertilizers. One of the largest constraints to the proliferation of BNF inoculants is subsidized petroleum based fertilizers. The large ag-product companies usually sell fertilizers and it is in their interest that the market remain status quo. The low profit margin of BNF inoculants do not compare to the returns of petro based fertlizers. Subsidies for petroleum based fertilizers are a large constraint. Mr. Croucher gave the example of Sadam Hussain (? spelling). Sadam he said should receive the sustainable farmer of the year award because of his efforts to encourage low-input farming. The cost of petroleum is so high in Iraq that many inovative methodologies are being encouraged.

Extension:
Government agencies should not be responsible for extension. Mr. Croucher believes that the private sector should link with local NGOs in extension efforts. Demonstration plots are not adequate for extension. Many times the farmers are removed from the research farms and instead, extension should resemble actual production conditions and be instituted by producers. NGOS are much closer to the small farming sector and are much better equipped to provide this type of extension efforts than the government. The government's role could include research and development, training, educating, monitoring and standardization.

Quality control is very important to the success of a technology transfer. Many times an inferior product will find its way into the market and it can ruin the market for quality products.

Mr. Croucher said that US companies have not demonstrated a capacity to cooperate with public sector. Joint venture by companies in this particular area are hampered by the small profit margins of BNF inoculants and also the fact that companies do not repatriate the profits.

Technologies:
When pressed to identify an appropriate strategy for extending the use of BNF inoculants to LDCs Mr. Croucher said that the appropriate strategy would vary for each set of conditions. Peat as a carrier may be more feasible under certain conditions than coal dust or freeze dried carriers, but under other conditions the latter may be the most appropriate. Efforts must be designed and implemented to reflect the specific conditions/constraints/opportunities of each scenario.

Mr. Croucher had just returned from a inaugrual meeting/workshop of the Asia Network for Small Scale Biotechnologies in Catmandu. Mr. Singleton also attended this meeting. Mr. Croucher will send the proceedings of this meeting. He believes NifTAL is doing a spendid job providing technical assistance and training but he feels that their (Singleton's) business sense is "out to lunch". He feels small decentralized commercial efforts will be the most successful in the long run, but he also recoginizes that his voice is small compared to the number of individuals advising larger scale centralized production.

@27 April 1992

Interview with Stuart Smith, Ph.D. (Lipha Tech)

Opportunities:
Opportunity exist in some of the LDCs but poor farmers there are the hardest to reach with extension efforts than the more capital intensive farmers. Thailand, Indonesia, Argentina, and Chile are several countries that offer opportunity. Lipha Tech production of the brand name "Nitragen" BNF inoculants takes place at 3 facilities; Milwaukee, Buenos Aires, and Leon, France. Lipha Tech has established markets in Latin America and the Middle East countries. Dr. Smith considers the African continent and untapped market.

Constraints:
To successfully enter new markets, there must exist an infrastructure that will allow the distribution of the product. This includes the ability to educate farmers, store the product, and distribute it to farmers. Countries differ in readiness with which companies such as Lipha Tech can enter them. Argentina for example, needs a total market development plan. The Argentine market is accessible, it needs further extension and investment in the infrastructure. The United States on the other hand possesses a fine infrastructure and Lipha Tech need only concentrate on educating farmers on the new technologies. In the US 10 salesmen handle the education by attending conferences and meetings such as growers meetings where representatives from the farming community and the ag-distribution companies are present.

Dr. Smith has extensive experience in the BNF inoculant business and overseas development. He suggested that we contact **Harold Kauffman, who is director of INTSOY.**

113 Mumford Hall
1301 W. Gregory Drive
Urbana, IL 60801
phone number (217) 333-6422.

INTSOY is responsible for documenting efforts to improve the production of soybeans throughout the US and world. They may have documented successful/unsuccessful efforts to produce and distribute inoculants. Documents (analysis, assessments and/or appraisals) may be available concerning efforts in Puerto Rico, Sri Lanka, Peru and Egypt.

Dr. Smith feels that the most feasible method of transferring technology is through

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@27 April 1992

Interview with Yoram Kapulnik Ph.D. (Adjunct professor at Rutgers University.

Opportunities:
Dr. Kapulnik believes there are opportunities in the developing countries of S. America and Africa. The first step to identify countries of opportunity is to collect information about the use of legumes, the respective yields and estimate the return of BNF inoculants. FAO or AID may prove useful in the gathering of information. Companies and academics could be responsible for the obtaining the data but Dr. Kapulnik feels a government agency such as USAID should help fund the technology transfer.

Constraints:
Dr. Kapulnik believes that there are enough BNF inoculant experts throughout the world but that the technology is not being applied to the specific sociological conditions of different areas. The technology transfer must be put in the hands of people familiar with the country, its people, and the production environment. For instance, the individuals or agency that gathered the information in the first step should be responsible for establishing a distribution network. The effort must be coordinated. Dr. Kapulnik gave three examples: 1. Thailand has been very successful with a government program, 2. Argentina has been successful with private companies extending the technology, and 3. Israel has been successful with a combination of both approaches. In Israel, the government dept. of Agriculture carried out a production, extension and distribution program for 12 years. After which, private companies were contracted to fulfill the demand. The government still receives royalties (percentage of the profits) which it uses to continue its R&D and extension efforts.

Private sector may not be feasible in certain situations. Kapulnik gave the example of Ghana where the farmers (and country) is so poor they cannot afford to purchase the inoculants. Currently in Ghana, 95% of the farmers raising legumes do not use inoculants. The 5% willing to use the inoculants are stymied by the quality and uncertain supply of the inoculants. The conditions call for the application of the BNF inoculants but the technology transfer system is not adequate/does not reflect the conditions of the country.

As to the most feasible technology (peat, granular or liquid), Dr. Kapulnik said that would be determined by the specific conditions and level of mechanization in each country. Different technologies are pertinent to different areas.

Dr. Kapulnik is familiar with several efforts by Nitragen Company (now Liphatec) to set up joint ventures in the Middle East. Nitragen set up a production headquarters in Egypt as a result of Camp David but it is not operating currently. Nitragen also proposed a joint effort to the Israeli government but Israel never took the offer.

Annex XIII

ASSESSMENT AND RECOMMENDATIONS ON NIFTAL'S STRATEGY FOR THE PROMOTION OF BNF ENTERPRISE DEVELOPMENT

Industry Council for Development

March 1993

ASSESSMENT AND RECOMMENDATIONS ON NifTAL'S STRATEGY

FOR THE PROMOTION OF BNF ENTERPRISE DEVELOPMENT

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Quality Control:
Quality control plays a very important role in the successful transfer of technology. The technology is such that returns are present for a small dollar input. Critical to the success of the technology is that it be controlled and monitored. There must be a system that checks and tracking each batch that enters the market. The most feasible method of quality control would probably be housed in the government. University labs (paid by private companies) could be responsible for the standards and monitoring so that farmers obtain quality inoculants. Dr. Kapulnik believes this is a delicate point, the quality control must not be wholly in the hands of the government but still should be responsive to the profit makers.

Shelf life considerations have to reflect the logistics of the country or operation. For example, in Israel which is a small country, a 3 month shelf life is more than adequate to assure a quality product reaches the user. In larger and less advanced countries, a longer shelf life might be required.

Biotechnology trade regulation is not a constraint to the present situation. Genetic engineering is not so prevalent that this issue requires scrutiny. Instead, efforts should be focused on technologies that exist now that are beneficial and are not constrained by trade regulation. BNF is one of these technologies.

Dr. Kapulnik looked for documented cases of company and organization's efforts to establish production and distribution of BNF inoculants but he was unable to discover any. Nobody takes the time to document the failures or successes.

NifTAL:
Dr. Kapulnik was invited by NifTAL to spend his sabbatical with them. He has a high regard for the work they are doing. He feels that NifTAL is an established first link in the process of technology transfer. However, after individuals complete the workshops or graduate programs, there is very little support for them to implement the knowledge they have attained, the chain breaks down. When the graduates return to their home country, they do not find the where with all to establish demonstration plots or to implement an extension program which is important to the success. The graduate finds no place to start upon the return to the home country. Possibly, a program to conduct industry workshops in home countries may be the next feasible link in the chain after the training by NifTAL.

The final comment of Kupulnik's concerned strategy for production and distribution in LDCs. He feels the small, backyard production and distribution (decentralized), is not practical or efficient. The backyard method often results in more expensive, inferior products. Also, it is very hard to control or improve the quality of the product which is very important to the success of the process.

19 May 1992

Interview with Gary Bullard, (Director of Bio-Care Technology Pty Ltd.)

Bio-Care is company involved in the commercial development of Bio-Control technologies. Some of the products include micro-organisms that negate/destroy/eradicate other micro-organisms or insects that may be harmful to crops, fungal insecticides, and BNF inoculants.

Mr. Bullard grew up and was educated in the mid-west. He has worked with BNF inoculants for 15 years. The companies (2) that he directs are 40 years old. Bio-Care and one other Australian company share the major part of the domestic BNF market in Australia.

When I began to administer the questionnaire he immediately told me I should talk with **Rod Roughly, Ph.D. (Dept. of Agriculture) who works at the Australian Inoculant Research and Control Service (AIRCS), phone number 011-61-43-28-0347.** Bullard said that Roughly is one of the forefathers of the BNF inoculant industry in Australia. Roughly should have access to the type of information that we are interested in and would be well worth contacting.

Opportunities:
Mr. Bullard believes the opportunities available to the BNF inoculant industry hinge upon the production and distribution of a quality product. Vital to market expansion is the production and distribution quality products. He believes that the private sector should be responsible for the production and distribution, but he feels the public sector could and should handle the quality control and monitoring of BNF inoculants.

The Australians use a more sophisticated method of inoculant production. Bio-Care sterilize their peat-humus carrier before introducing the live rhizobia soup or cultures. A sterilized carrier is very important to the tropical environments. Bullard convinced me that the peat carrier they use is of outstanding quality and that they take particular care with the preparation of the carrier. Testimony to this idea is the fact that Bio-Care exports sterilized peat to many countries, and in particular, research institutes such as ICRSAT, CIAT and NifTAL. They are also in the process of finalizing an agreement with the Korean Dept. of Agriculture, in which they will supply inoculant and sterilized peat. Currently they are shipping sterilized peat to Japan. Other areas of the world which receive Bio-Care products are; the Middle East, North Africa, and Madagascar.

The shelf life of their peat carried BNF is @6 months, the same as most others.

Bio-Care does not produce a granular inoculant. The liquid inoculant that they do produce is not marketed vigorously.

As I mentioned, Bio-Care and one other company share the Australian market. They produce the majority of their produce (80%) in the fall period, between February and June. A second peak occurs during the summer. The largest legume crop in Australia is Lupine. Other crops for which inoculants are produced include; cowpeas, mungbeans, chickpeas, soybeans, etc.

Bullard believes that the strategy most likely to succeed in the creation of new markets would involve the production of BNF inoculants in established, large scale plants (which were subject to a high degree of quality control), and then the inoculant would be shipped overseas or to the markets by air mail. Bullard experience leads him to believe that quality control may play one of the largest roles in the future of the industry. He pointed to Australia as an example. 50 years ago, BNF inoculants were widely used in Australia, mainly because petroleum based fertilizers were so expensive. During that period of large demand, many companies entered the market. The quality was not controlled nor monitored and within a short time, the product was of poor quality that did not benefit farmers interested in using the technology. Many farmers quit the inoculants and would be hard to encourage the adoption of newer inoculants. He believes Australian inoculant producers would have a lot to share with individuals interested in expanding the use of BNF.

Bullard believes the public sector could enhance the process of market establishment by providing the monitoring and quality control of BNF inoculants. Research institutes such as NifTAL are well equipped to carry out this task. He pointed out that it is not in the best interest of the user to have the private companies responsible for the production, distribution and quality control. In addition, the public sector may be able to provide recommendations for particular strains in certain conditions.

One major constraint includes the inability to demonstrate to farmers clearly, that the use of BNF inoculants is beneficial. Research plots carefully laid out and cared for, many times do not show the benefits. Instead the benefits must be documented over a long period through monitoring of soil fertility, long term costs and benefits. Any extension program must use a sound and quality product and build upon a solid relationship with the farmers. For this reason, Bullard thinks that it is imperative to include the Dept. of Agriculture in any serious endeavor to create new markets. A trusted brokering agency must have the funds and expertise to extend knowledge to the farmers.

Joe Rourke (NifTAL) approached Bullard @8 months ago about the possibility of extension efforts in Australia. Bullard is very interested in the work of NifTAL and

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would very much like to receive a copy of Rourke and Bartolini's computer program. Bullard visited extensively with Rourke about the economic model upon which the computer program would be built.

Bullard ended the interview by stating the market expansion is a long and involved process. It is hard to enter new markets but he is very interested in contributing to the process.

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1. Introduction and Background

1.1 The Purposes and Objectives of the USAID/ICD Contracted Study on BNF Enterprise Development

NifTAL (Nitrogen Fixation by Tropical Agricultural Legumes) is an interdisciplinary unit developed at the University of Hawaii, College of Tropical Agriculture. Its physical headquarters is at a campus near Patia, Maui, HI.

NifTAL was created and initially implemented in June, 1975. Its development was financed through a series of three successive grants contracted by USAID with the University of Hawaii, the last of which has a duration of ten years starting in 1987.

The objectives of NifTAL were the application of technologies based on biological nitrogen fixation (BNF) to agricultural development, with primary focus on the less-developed countries. The background of the USAID decision to implement NifTAL can be seen in the energy crisis of the early and mid-1970's, and its significance in terms of fertilizer cost and availability to the agriculture of the less-developed countries.

From its inception NifTAL engaged in a series of applied research, extension, information, training and technical support activities intended to allow counterpart institutions in developing countries, especially those having legume crop (food, pasture and tree) production departments to benefit from the BNF technology and transfer it to farmers. NifTAL expanded its activities to the development of small-scale technologies for the commercial production of rhizobial inoculants. These technologies were to be simple, effective and inexpensive to adopt. It has in later years endeavored to have its inoculant production technologies adopted. Finally, NifTAL has become engaged in activities in two additional areas: (a) the promotion of initiatives for commercial production and marketing of rhizobial inoculants in developing countries, and (b) linking with private voluntary organizations (PVO) and Peace Corps workers in pilot projects of BNF technology transfer.

Early during the second decade of activities of NifTAL it was assessed that, as in many other agricultural development projects, there was a "blind spot" in the definition of its targets. While farmers, PVOs and research centers in developing countries were clearly targeted, there was almost no connection with the agribusiness world. By missing this link--the major agents for the production and marketing of inoculum--the analysis of the industry, the problems surrounding this activity, together with its opportunities, incentives and disincentives were not clear at all in their significance to the overall picture of farmers' utilization of rhizobial inoculants. It was, therefore, admitted that this area and its problems had to be immediately confronted in the NifTAL strategy.

NifTAL undertook a limited number of case studies, followed by seminars, aimed at defining the characteristics of commercial BNF enterprises in some key countries, and assessing their problems and performance.

To assist NifTAL in the development of an integrated approach to BNF product and services market development, USAID contracted with the Industry Council for Development (ICD) for the latter institution to liaise with NifTAL in a comprehensive project of defining the role, opportunities and potential, as well as constraints to the development of the BNF commercial production and delivery systems, particularly in the less developed countries.

ICD was asked to develop an agribusiness system profile of the inoculant industry, its interrelationship with the seed and other agro-industrial production input supply industries. It was to propose guidelines for commercialization of rhizobial inoculants with some countries used as models. It was planned, additionally, to analyze costs, markets, and profitability of the industry. The analysis of quality control standards and enforcement issues was also to be considered. Finally, it was also deemed very important that ICD, in collaboration with NifTAL's staff, should assess NifTAL's strengths and limitations as well as its current strategy for promoting the inoculant industry development.

The presentation of the analysis of the above mentioned issues was originally planned to follow an activity of data collection and referencing related primarily to the inoculant industry. The presentation itself was planned to be conducted in the course of a workshop with the participation of invited guests from industry, government, PVOs, and the direct project participants (NifTAL, USAID, ICD). The results of the workshop deliberations were to be condensed in a series of guidelines and recommendations to NifTAL, to USAID, to the industry, and to the governments of interested countries, and other interested parties (international aid organizations, PVOs, etc.).

While the collection of data proceeded to the extent possible, the funding limitation due to the allocation of most of the available funds to a sister project (IBSNAT) precluded any possibility of fulfilling all the initial objectives, including the development of the workshop. Therefore, it was decided that a Senior Associate of ICD, responsible for the management of the project, would travel to Hawaii and discuss directly with NifTAL management and staff the relevant findings. It was also agreed that after the exchange of views and an analysis of preliminary recommendations, and the reactions to it of NifTAL management and staff, a final position paper would be presented by ICD with NifTAL input, which would include the relevant guidelines and recommendations that would have possibly resulted from the workshop. The present document is the indicated position paper as well as a component of the final report of ICD to USAID on the accomplishments of the project.

1.2 The Concept and Activities of NifTAL

NifTAL as a concept was developed with the view that food production in a number of countries in Africa, Asia, Latin America and Oceania was undergoing a food and energy crisis, at the same time that their populations soared to levels where food was becoming scarce. Farmers in many of these countries are undercapitalized, operate in small holdings, and have no or very limited access to stable markets, to credit to buy inputs, and to technical assistance. Smallholding families are, furthermore, seeing their livelihood potential impaired with the passage of time as soil fertility and productivity decline. The decrease of natural soil fertility is due to continuous cropping with no restoration of nutrients in at least the amounts extracted. Soil degradation is also due to the impossibility of maintaining appropriate crop rotations, and building organic matter reserves. Finally, the processes of erosion and desertification are advancing and when accompanied by the depredation of forest resources by the increasing population pressure, the situation approaches a critical magnitude. The recent famine outbursts in several African countries, as exemplified by Somalia, are now becoming daily news.

There is a large reservoir of knowledge on the maintenance and improvement of soil fertility. The contribution of symbiotic bacteria to the improvement of soil fertility by fixing free atmospheric nitrogen in the roots of legumes has been known for several decades. The easiness of the application of the inoculation technology to legume seeds has also been well known and usefully employed in developed countries. The yield response and protein increase response in crops has been amply documented with tests and practical field results worldwide. Large collections of dinitrogen fixing strains of Rhizobia have been assembled, and evaluated. Efficient N-fixing strains have been identified and are available from public national and international research centers, such as CIAT. Benefits of inoculation are well known to multiply several fold over costs. BNF technology allows the use of nitrogen as a plant nutrient at a fraction of the cost at which chemical fertilizers could be accessed by farmers.

With this accumulation of considerations it was perfectly logical for the NifTAL project to be created, and given support by the University of Hawaii as a center for diffusion of BNF technology worldwide, and for USAID to actively support with financing and guidance the course of development of the project.

NifTAL has concentrated its activities in a number of key areas, as described below:

1. Studies on soil and other environmental components as limiting factors to BNF. The effect of soil acidity, infertility and water have been top considerations. For example, phosphorus management has been examined in regards to its effect on the symbiosis of rhizobia and legume roots.

2. Studies on the competition of native rhizobia with introduced efficient N-fixing strains and the dynamics of these populations. The effects of rainfall, temperature, photoperiod and soil type were analyzed aiming at predicting rhizobial behavior.

3. Comparison of BNF and chemical N-fertilizers in terms of economics of yield responses vs. costs.

4. NifTAL has created a network of collaborators for jointly working on BNF research and for the supply of technical assistance. This network covers some 22 countries.

5. The training of scientists, technicians and extension workers in rhizobial technology has been a major activity of NifTAL since 1976. The training has been a modular one. Specialized courses have evolved on some of the modules, such as Applied Inoculation Technology for Extension Specialists, and Inoculant Technology. In recent years, courses have been added for development workers (PVOs and Peace Corps). There are basic 6-week courses and specialized extension courses. There are short courses on genetic technologies, serology, and commercial inoculant production. Visiting scientist programs contribute both to the training and outreach. Training materials are produced, such as manuals and photo slides. The courses have been conducted both in Hawaii and overseas. There is, in addition, support for graduate training.

6. Collection and preservation of a germplasm bank of rhizobial strains, their evaluation for N-fixing efficiency under conditions prevailing in developing countries, and making the information and the collections themselves widely available have been standing activities of NifTAL. Rhizobial cultures have been delivered to more than 50 countries.

7. Development of techniques and resources for evaluation of the efficiency of inoculation. Custom antisera have been developed and are available.

8. Development of techniques and carriers for inoculant delivery to seeds of legume plants, insuring thus effectiveness of field nodulation.

9. Testing, assessment, and diffusion of field crop management techniques to assure efficiency of N-fixation through rhizobial inoculation in farmers' fields.

10. The development of workshops, seminars, and programs for visiting scientists, together with a program of publications have gone a long way toward the diffusion of BNF technology, and the exchange of information between workers in the field of BNF worldwide.

11. Establishment of collaborative activities with other institutions sharing the same objectives of development as NifTAL in related fields. Thus, NifTAL has had a technical information

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exchange with Rodale Institute, World Neighbors, TROPSOILS, the Nitrogen Fixing Tree Association (NFTA), which has recently moved from its premises in Oahu to Maui, in order to be lodged at NifTAL.

12. NifTAL has expanded its activities to the area of development of practical small scale production technologies for inoculant delivery packages that could be produced and packaged commercially. It has then gone into the economic analysis of enterprise development preparing a series of guidelines and tools for the support of enterprise development activities. One of these tools is a computer program called FAIME (Financial Analysis for Inoculant Manufacturing Enterprises), purporting to examine financial and technical options, and allocation of resources, and to optimize them in designing an inoculant production facility.

13. The assembly of Case History data from operating facilities in inoculant production and distribution in several countries has been recently added to the NifTAL strategy roster.

14. NifTAL and USAID designed an outreach project to accommodate the interests of PVOs in providing help to smallholding farmers in developing countries, with the mandate of NifTAL to have an effective outreach program in BNF technology diffusion. This was the BNF/LM Project, which was started in five countries in 1989. The project in addition to NifTAL and USAID funding, included a consortium of the following institutions: Africare, Agriculture Cooperative Development Foundation, CARE, Pan American Development Foundation, Peace Corps, Save the Children, Winrock International and World Vision.

1.3 Research Activities on BNF

It is now more than a century since Hellriegel and Wilfarth reported in 1866 their finding of the symbiotic relationship between leguminous plants and rhizobia bacteria, which were also isolated by them. In 1890 two other German scientists, Nobbe and Hiltner, provided evidence of the beneficial effect of inoculating seeds of leguminous plants at planting time with root nodulating bacteria. Over the course of the more than 100 years that elapsed since those significant events, a voluminous body of literature resulting from research on BNF has accumulated. The research on BNF continues unabated at present at a large number of institutions in both developed and developing countries. While it may be debated whether in individual developing countries appropriate research focusing on solutions to BNF problems is a priority, it is undeniable that research has advanced way beyond its practical application with the knowledge already at hand.

In this context one has to visualize the research activities both at NifTAL and the developed country institutions on the one hand and the developing country institutions on the other. It is difficult to generalize on institutions of the latter group, as there is a wide range of capabilities, efficiencies, and resources

in them. How to assess the need and importance of research at NifTAL is a first question.

The existence of research efforts on BNF at a large number of universities and agricultural research centers might put into question the need for research at NifTAL which is a service-oriented center, according to its project description. On the other hand, it would be difficult to rationalize a service center with worldwide projection without a research component. It would not be able to attract capable scientists. It would neither be able to train scientists from developed and developing countries on BNF research techniques and applications without an ongoing research system in operation. Furthermore, without the deep knowledge that scholarship and research bring about on a concentrated area of subject matters, as those related to BNF are, there would not be a solid background available for the range of advisory services that NifTAL is supposed to provide.

The project has been selective to some degree of the types of research it has conducted. Most of the research topics seem to have followed a pattern of fact-finding related to its basic service mandate. Because of the simultaneous support of USAID to NifTAL and to other research centers, especially in the CGIAR group, the latter have refrained in recent years from treading the same grounds as NifTAL. Yet NifTAL by itself is incapable of fulfilling all the practical research goals required to have the BNF technology developed to the point of usefulness and practical application worldwide.

NifTAL has helped in the development of a network of collaborators in research. The Worldwide Rhizobial Ecology Network (WREN) with collaborators from 18 countries has established a research network aimed at predicting response to inoculation under conditions prevailing in different environments and with different species of leguminous plants, and developing models for the predictions. NifTAL acts as a coordinator of WREN. Initial results under standardized research methodology are now available. In addition NifTAL has established collaborative research programs with institutions of a number of countries. These include Malaysia, Ghana, India, Philippines, Zambia, among others. There has also been a joint effort with the IBSNAT project at the University of Hawaii in developing models that would take into account environmental factors in nitrogen fixation as a component of legume plant growth models. With the CGIAR centers there is an ongoing collaboration in germplasm maintenance and evaluation of strains of the various species of Rhizobium.

A succinct register of the research projects conducted by the NifTAL researchers provides fitting proof of the range of subject matters that have received their attention within the confines of their basic target.

1. Rhizobial survival and the ecology of rhizobia in regard to the legume component.

2. Dynamics of soil N and P in regard to root growth.

3. Computer Program MPNES (Most Probable Number Enumeration System) for design of MPN experiments and to generate population estimates for fractional base dilution ratios.

4. N balance in legume crop systems in tropical soils where toxic metals and low pH create special problems to rhizobia, and where P is bound by variable charge clays. Selections of rhizobia strains for efficient N-fixers under these conditions would be an important continuing contribution of NifTAL.

5. Effect of soil organic matter on N2 fixation.

6. Interactions between host variety and legume strains. This type of research should be networked with other country collaborators.

7. Genetics of leghemoblogin in regards to genes for N fixation. It would be especially interesting to concentrate on the Nif duplicate regions and their effect by developing staple allopoliploids in Phaseolus (i.e., coccineus x vulgaris) with reduplication of N-fixing genes.

8. Increase in N fixed through plant breeding in Phaseolus, a low-N fixer, and more apt to use mineral N from the soil than soybeans. Phaseolus beans seem to have five times greater rate of mineral N assimilation than soybeans. This may be due to a greater root surface area per unit of root in Phaseolus. It may be interesting to explore the heterotic effect on root area of Phaseolus coccineus x P. vulgaris crosses, and its effects on N fixation and mineral N absorption.

9. Identification of rhizobial strains and their clustering into groups. Taxonomic methods of identification (serological, genetic, etc.) should be used to understand much better the evolution and affinities, as well as genetic variability and makeup of groups of rhizobia. This type of research is better adapted for doctoral dissertations and collaborative research with universities.

10. Application of adhesives, such as oils, to seeds to adhere more inoculating cells. This should be extended to the incorporation of stimulating chemicals, both organic and inorganic.

11. Effect of crop history and environment on BNF.

12. EFfect of temperature and photoperiod at various altitudes on N2 fixation and nitrogen nutrition on the phenology of leguminous crop species.

13. Studies on native rhizobia in collaboration with scientists of other countries (Ghana, Korea, Zambia, Philippines, India).

14. Maintenance and evaluation of rhizobial world germplasm collection.

15. Studies on inoculant carriers. This study should be expanded to the practical use of rhizobial bacteria in lyophilized or peat protected micro-environments in phosphate fertilizer carriers for pasture fertilization, including grass-legume mixture.

16. Composition of growth media.

17. Forms of gluthamine synthetase from nodule extracts (differentiation through activity bands).

18. Correlation of chlorophyll content of leaves with efficiency of N2 fixation.

19. Support in the development of soybean varieties in Ghana that would not require inoculation, as they would be optimized genetically for symbiosis with local African Bradyrhizobium strains.

20. Intercropping patterns of legume crops with maize, and studies on effects of nodulation on the crop components of intercropping systems.

21. Proportion of N derived from N2 fixation in several maturity groups of soybeans.

22. Joint effect of several crop production inputs in regard to their association with BNF. An important one is P. This is a type of research of major practical importance that needs to be networked with collaborators with NifTAL as a hub. It would have important effects on the distribution of inoculants as an adjunct to other inputs. The INLIT (International Network of Legume Inoculation Trials) and WREN (Worldwide Rhizobial Ecology Network) created to address the technology transfer function of NifTAL should be helpful in supporting these collaborative activities.

In future research efforts of NifTAL it would be well to consider that despite individual interests of research staff, the dedication of the research projects to the solution of BNF-related problems requiring NifTAL research support, should be more highly focused than at present. To qualify this statement it can be observed that while many research projects in the past at NifTAL have had precisely the kind of focus that we are demanding here, some have not. Randomly chosen problems, ranging from one field to another and based on the personal interests of the scientists, should not be the way in which future research projects are selected. That would be the system--free research--likely to be adopted for a solely unversity-financed project. Being a service institution with public funding under a commission of service, NifTAL should be dedicated to a high degree--no less than 90%--to a system of "research by objectives."

Having presented the above views, what is being done in other institutions must be reviewed, as well as areas which are already covered by their research. It is especially in regard to research at the practical level that one must verify what is the research effort expended by the institutions of the less developed countries and others working for them, to ascertain their problems and needs in regard to BNF.

Future research orientation of NifTAL should consider projects in these major areas:

a. Constraints in developing countries, whether environmental, soil based, economic, psychological or of other kinds that curb the responses to inoculation and use of BNF.

b. Inoculum carrier and storage problems.

c. Quality control techniques.

d. Response of farmers to the use of BNF.

e. Comparisons of imported and native strains in legume cross-variety tests in regard to N2 fixation in factorial experiments. These tests could be conducted with collaborators.

f. Testing of new rhizobial strains resulting from genetic manipulation.

g. Incorporation of new genetic traits inducing a higher capacity to fix N2 into varieties of low-N2 fixers such as Phaseolus beans.

h. Dilution techniques.

i. Crop management studies.

NifTAL should strive to have its research results relevant to problems in tropical and sub-tropical agriculture in the developing world and actual and potential impact of the program in developing countries and on farms (AID Evaluation Summary, April 1990).

1.4 BNF Extension Activities

NifTAL conducts extension activities in the areas of Outreach and Education.

The Outreach activities of NifTAL have been directed at providing the information, capabilities and tools needed in developing countries to establish successful BNF programs, leading ultimately to expand the efficient use of high quality inoculants in farmers' fields. Various means have been utilized. They include workshops, visits of scientists and technicians for assessments and for consulting, both to NifTAL and to the collaborating countries.

They also include a technology transfer component via supply of rhizobial cultures, inoculants, antisera, plans for inoculant production facilities, and for quality control laboratories. The gathering of economic information for case studies of present inoculant processing organizations is another important effort. The supply of a computer program, FAIME (Financial Analysis for Inoculant Manufacturing Enterprises), is useful in analyzing strategies for allocating resources for start up and operations of commercial inoculant production and marketing firms. Networking with collaborators (INLIT and WREN) provides the permanent bridges through which continuous technology transfer is possible.

Training has become one of the major extension activities of NifTAL. Through sponsorship of its courses by FAO, MIRCEN, IAEA and OECD, in addition to basic USAID support, NifTAL has been able to develop a series of two-week courses and a basic six-week legume/Rhizobia technology course for scientists from developing countries and producers of inoculants, at NifTAL headquarters. Other special courses are provided for extension leaders, PVO workers and Peace Corps volunteers. It has also carried out four-week courses elsewhere, especially in Asia. Advanced training leading to a graduate degree at the University of Hawaii has been given to more than 50 candidates and short term internships and post-graduate residences have also been an important contribution of NifTAL.

In order to expand its extension/outreach activities, NifTAL participated in the establishment of the BNF Regional Resource Center in Bangkok. It conducts a number of outreach activities which encompass technical assistance, the collection and distribution of rhizobial cultures for research and commercial purposes, promotion of BNF commercial companies, hosting of visiting scientists, organizing in-country training courses, short-term and internship programs for visiting scientists and technicians, and interaction with USAID resident missions. NifTAL has one staff resident for the BNFRRC in Thailand. It is proposing to establish another one with a base at ICRAF in Nairobi.

A consortium of seven NGOs, the Peace Corps, and NifTAL launched in November, 1989, a BNF/LM outreach project. It was to last one year, would be conducted as a pilot project and would cost $100,000. The project had sub-projects in Senegal, Uganda, Nepal, Haiti, and Indonesia. The coordinator was Marian von Schaik, Agricultural Officer for Save the Children. The project was extended with an additional $100,000. Most of the consortium's efforts have been directed at outreach, education and demonstration on BNF technology. NifTAL staff have been involved in some of these activities. Workshops have been held by many of the PVOs.

While all these are commendable efforts, it is well to consider the shortcomings in NifTAL's outreach. Except for isolated efforts, NifTAL has barely touched the potential for BNF activity in Latin America. Not only in the cultivated crop areas of the region is

there a need for sustained activity in the field but also in the millions of hectares of highland grazing lands along the Andes mountains, where pasture legumes could give improved sustenance to poor farmers. Additionally, the introduction of packages of lime, rock phosphate, micronutrients and rhizobial cultures adapted to tropical soils could help stabilize the rapidly eroding and degrading soils of the Amazon valley subjected to depredatory, low-input, non-technical, shifting agriculture.

The Latin American example could be repeated in many areas around the world. Asia and Africa have received attention, but in a very superficial manner and in a limited number of countries. For example, Bangladesh has had a US $20 million seeds/fertilizer project financed by USAID but without a BNF component. Madagascar has 50,000 hectares of soybeans but there is no funding for support of a BNF activity there. Except for some activity in Kenya, Uganda, Zambia, Zimbabwe, Ghana, and Egypt, very little attention has been paid to other African countries. The New Independent States that formed the USSR, especially in Central Asia, consist of relatively less-developed countries that could in the future benefit from the NifTAL services.

The results in terms of use of rhizobial inoculum in many developing countries, which have been the focus of NifTAL's activities, are rather disappointing. There are many causes that might explain this situation. Definitely, the lack of enthusiasm, knowledge, means or organization of local Agricultural Extension services are major stumbling blocks on which to lay blame. But this is hardly a new fact. Most extension services in developing countries are known to be inefficient, underbudgeted, or just plain disorganized. Working through such systems has been a hard endeavor in the past, for increasing agricultural production. In some cases, conflicting interests of the bureaucracy produce negative results. In others, precisely the positive action of producing inoculum products by state enterprises and then dumping them at prices below costs, has prevented the entrance of private, competitive, commercial producers/distributors, who would be able to comfortably reach a larger potential market proportion of farmers using inoculum at reasonable prices.

Recognizing these hard facts and then taking steps to remedy them is a necessary component of a redesigned strategy for NifTAL.

1.5 Market Development Activities

For a program designed to expand the use of rhizobial inoculum in a country, there must be three basic factors present: (a) production or importation of sufficient quantities of inoculum to create a starter demand and, later, to meet the expanding demand; (b) a delivery system capable of assuring farmers of the availability of rhizobial inoculum and to deliver it on a constant basis, at an opportune time, at convenient locations to the farm users, and at reasonable prices to both supplier and consumer; (c) availability

and access to technical information on the efficient use of the product.

In order to have a measurable impact on legume crop production, some developing country governments, impatient with the slowness of adoption of BNF technology, have undertaken the task of producing and distributing rhizobial inoculants through wholly state-owned institutions. They have succeeded to the extent of creating a starting impulse. Examples are in Zambia, Zimbabwe, Kenya, Uganda, Egypt, Haiti and Thailand. In Colombia, the State Research Institute, ICA, produces some inoculum in its laboratory. In Peru, one of the universities (Ayacucho University) produced limited amounts of inoculum, having obtained technical and economic assistance from the Swiss Government Technical Assistance. These projects are generally subsidized, with both direct and indirect subsidies. The latter involve investment in buildings, extension system personnel and other staff, and other hidden costs. Prices at which inoculum are sold apparently cover only direct costs of production. However, there is a big difference between the area in legume crops under inoculation and the potential area that could use inoculum. Just as is the case with state seed industries, rhizobial inoculant industries under state control have been incapable of surmounting their built-in production and distribution inefficiencies. Experience shows them to invariably stop their supply at some 5 to 10% of potential market demand, although occasionally with greater costs in subsidies they may go higher for a short period of time.

NifTAL, because of these recognized facts, has recently been requested by USAID to address the "blind spot" in the program, which is: Who will be more efficient in delivering the technology to the farmers, and how will it be done? The answer lies in promoting commercial manufacturing and distribution of rhizobial inoculum in developing countries. In addition to developing possible entrepreneurial activities by local firms, NifTAL has been asked to seek participation of the large BNF suppliers, especially of U.S. based multinational corporations, in entering the markets in developing countries, and contributing with NifTAL to this overall program.

2. Assessment of the BNF Industry as an Integrated Business System from Research to Market

The rhizobial inoculant industry is well established in a number of developed countries, and for several more years it will be in the process of gaining a foothold in some develping countries. In the former group venture capitalists have financed strictly private enterprises. By contrast, in most of the smaller, less developed countries state owned enterprises or research/service institutes have taken the initiative of producing and distributing inoculants.

It is now quite clear that the rhizobial inoculant delivery system in most developing countries has not even begun; in some it has had its start up, but is not capable of further sustained growth where it started due to the absence of a permanent, self-supporting delivery system to the farmers. Further, these developing countries lack a reliable delivery system capable of creating market stimulation, and the permanent synergism between buyers and sellers so crucial in most kinds of production and marketing activities.

NifTAL had acted, during its first phase, as many other scientific institutions have in the past. Its main contacts were members of the scientific and official state communities in other countries; in other words, it contacted its peers. While a technical intercourse took place, a business one did not develop--or if it did, it was limited in scope, amplitude and depth. NifTAL has realized this shortcoming. USAID's new privatization policy is aimed at fostering a stronger reliance on the private sector as an efficient means to agricultural development. NifTAL is working at creating a new strategy which involves stronger perceptions and contacts with the private sector in developing countries.

In this new context a number of questions emerge, which we will attempt to address. What makes inoculant enterprises succeed? What are their characteristics? Why is it that rhizobial inoculant production efforts have led to surpluses in some developing countries without having reached a fraction of the potential demand? We shall review critically and briefly these and related points as they regard the rhizobial inoculant industry.

2.1 Critical Review of Case Histories in Developed Countries

ICD surveyed the field of rhizobial inoculants in the U.S. and in some developed countries by establishing direct contacts, interviews, and collecting publications and resorting to mail information. The results are summarized below.

The inoculant industry in the U.S. is well established and prosperous. About a dozen major companies dominate the market. Some of them have been in business many years. Most are rather small companies. At least one of them is a multinational company

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based in another country (Lipha Tech of France), having acquired a long-standing U.S. company (Nitragin Co.).

The U.S. market caters mostly to soybean inoculants. Following in order of importance in the production and sale of inoculants are alfalfa and clovers, peanuts and other legume crops. Major suppliers of inoculants are Lipha Tech of Milwaukee, Wisconsin; Urbana Laboratories, based in St. Joseph, Missouri; Titre, Inc. (formerly Quad Five) of Ryegate, Montana; Bio-Tal of Eden Prairie, Minnesota, a subsidiary of BioTal Ltd. of Wales, U.K. Other companies recently involved with BNF at various stages of development are Abbott Laboratories, AgBiochem, Inc., Agracetus (joint venture of W. R. Grace & Co. and Cetus Corp.), Celpril Industries, which provides custom prilled pre-inoculated seeds. In the past, Agricultural Laboratories, Inc. of Columbus, Ohio, was an active organization in the BNF field. It does not appear in recent lists of companies. Pioneer Hi-Bred is starting some research on inoculants. Northrup King & Co. of Minneapolis, the world's largest seed company until its acquisition by Sandoz of Switzerland, was in 1976 probably the major seed company involved in research and selling of pre-inoculated alfalfa and clover seed, through its own vacuum patented process, "Noculized." MicroBio GhizoGen Corp. has recently been formed as a joint venture of RhizoGen Corp. of the USA and Agricultural Genetics Co. Ltd. (U.K.). BioTechnica Agriculture International of Cambridge, Massachusetts, works jointly with LH Fermentation Ltd. of U.K.

In Canada, Rhizogen Corp. of Saskatoon, Saskatchewan, and Biotechnica Corp.; in Australia, Bio-Care Technology Pty. Ltd. of Sydney and Woy Woy, NSW, Queensland Inoculants, Towoomba, QLD, Root Nodule Pty. Ltd. of Woy Woy, NSW; in France and Argentina, Liphatech, Inc.; in France, Geostock, Bioprox of Levallois-Perret, and Pioneer France-Maiz Microbial Lab, Ausonne; in the UK, Biotal Ltd., Biotreatment Ltd., New Plant Products Ltd., a trading arm of Agricultural Genetics Ltd., Bird's Eye Walls Ltd., Biotechnica International Ltd., jointly with LH Fermentation Ltd. (U.K.); in Brazil Caraiba Metals S.A., Biomatrix S.A., Agroceres, the largest Brazilian seed company of Sao Paolo, Biobras Bioquimico do Brasil S.A., Agro-quimica Planalto, Ltd., of Passo Fundo, RS, Fecotrigo Central Sul, Cruz Alta, Pa, Industrial Bio-Soja de Inoculantes Ltda, of Sao Joaquim da Barra, SP, Leivas Leite S.A., of Pelotas, RS, Nitral S.A. Industria e Comercio de Inoculantes e Produtos Agricolas, Ltda. Planaltina, DF, Turfal of Curitiba, Pa; in Finland, Elomestari Ltd. of Juva.

Profiles of most of these companies are presented in Appendix 1.

In the U.S. approximately 30 million acres of soybeans are inoculated annually. At about 100 lb of N average fixation per acre, this is equivalent to $375 million dollars worth of fertilizer N each year (Hollaender, Alexander, Ed. "Report of the Public Meeting of Genetic Engineering for Nitrogen Fixation." National Academy of Sciences, U.S. Government Printing Office, Washington, DC, 1977). It is estimated that in Brazil the use of

inoculants on soybeans has until now saved an equivalent of one billion dollars in N fertilizers. In Argentina, five years ago only 5% of the soybean area received inoculants; today 30% of the area is inoculated while soybean acreage has increased 5 times since the early 1980s. Soybean being a new crop in Argentina, most areas are virgin in regard to soil inoculating bacteria Rhizobium japonicum specific for soybeans.

Three domestic labels, "Nitragin" (Lipha Tech), "Research Seeds" (Urbana Laboratories) and "Grip" (Titre) along with the British company Agriculture Genetics Co. which produces "Rhizogen," account for the major portion of the domestic rhizobial inoculant market in the U.S. Other companies play a minor role.

NifTAL, Lipha Tech and the USDA Rhizobia Culture Collection in Beltsville, Maryland, have the three largest world collections of rhizobia cultures. The NifTAL collection may not be of real interest to the major inoculant companies, which use their own strains. One of the companies interviewed indicated that the major interest they may have in the future on NifTAL's collections would be in the results of their research on salinity resistant strains of bacteria. All of these companies have active research and development activities, on strain selection, carriers, stickers, packaging for bacterial survival and ease of application. They conduct field tests and demonstrations with both their own staff and that of distributing companies. Several of them have close liaison and collaboration with public institutions. Lipha Tech has a research agreement with the University of Illinois, while Titre has close relations with Montana State University. Urbana Laboratories has lab facilities at St. Joseph, Missouri, and a 535 acre research farm in central Iowa near Webster. Tests are carried out, however, from Wisconsin to Mississippi. The company engages scientists in selecting and improving its own bacterial strains and developing better applications methods. The company, in addition to microbiologists, has plant pathologists, plant breeders, and general agronomists on its staff.

American companies have special problems to deal with stemming from the large scale of farmers operations. In addition to pre-inoculants, peat-based, Urbana Laboratories have added humus, liquid and clay-based presentations, 100 lb bag size, and up to 3,000 and 6,000 lb bulk presentations. They have introduced into the market row inoculants and planter box inoculants, that avoid the problem of inoculating seed treated with insecticides and fungicides which might affect the rhizobia, if the seed were to be directly inoculated. These are humus, peat and clay presentations in granular form. Grip, distributed by Yellowstone Valley Chemicals, is presented in 35, 250, 500 and 2,000 gram packages, guaranteeing a 2 billion minimum count of rhizobial cells per gram of peat, way above standard quality requirements. Grip comes in patented plastic pouches that provide all the ingredients need for inoculating seed, after mixing the two-pouch Grip system in the field.

In spite of the apparent extensive use of inoculants, prices have been quite low, resulting in limited revenues for industries that rely only on selling rhizobial inoculants. For example, Nitragin Co., the largest seller of inoculants in the U.S., had a total annual volume of sales of $5.4 million before being sold to Allied Corp., owner of Calgene at the time and later sold to Lipha Tech by Allied.

The inoculant industry has developed new forms of marketing evolving from their old direct marketing efforts. Those necessarily had to be conducted directly with dealers rather than with wholesalers, because of the low income resulting from low prices. That scenario of low inoculant prices and direct dealing in itself blocked expansion of inoculant sales, as there were limits to what small capitalized corporations could achieve in marketing with low cost products. It is easy to realize that agribusiness stores would be reluctant to sell and promote such low income products as legume inoculants, when they had much more to gain from the sale of fertilizers. In a newer setting with the appearance of larger companies with more marketing savvy, they are adopting new marketing strategies. For example, Titre Inc., which was formed in 1990 as the producer and seller of "Grip," a product that originated in England, bought the Grip technology from Inotec Technologies of Canada. The Titre inoculant production plant is located in Ryegate, Montana. Its distribution is now entirely contracted with a wholesaler company, Yellowstone International, located in Billings, Montana, which is a subsidiary of United Agri Products, a ConAgra agri-products company. Yellowstone International is responsible for both domestic and international marketing and distribution, utilizing the resources of the giant ConAgra organization. Grip is a high quality product with a unique packaging method (also 1/3 more expensive than competitive products). Currently, Yellowstone International is working on joint efforts that would give Argentina Cooperative Association of Argentina and Hokko, an agri-products distribution company in Brazil, exclusive rights to market Grip in their respective countries. Production would continue in Montana and refrigerated trucks would move the inoculant to Houston, where it would board refrigerated compartments on ships. As can be seen, Titre is playing high stakes while incurring higher costs with its streamlined distribution system. It plays on high quality, availability of the product, and support, dismissing costs as of minor importance in a product which is much less expensive than the alternatives of chemical fertilizers.

Lipha Tech has increased its revenue by having three fully owned production/marketing operations (Lyons, France, where it sells its products under the Biodoz label), but also in Argentina and the U.S. (where it sells under the Nitragin label). Additionally, Lipha Tech has licensed its technology in Mexico and Italy, gaining thus additional revenue through royalty payments. It also has a custom formulation service for large clients. Furthermore, Lipha Tech in addition to being the largest inoculum producer worldwide

is the third largest producer of rodenticides. These are synthesized in their three production facilities (products based on chlorophacinone, bromadiolone and difethialone).

Lipha Tech is ready to supply small scale fermentation equipment to licensees in developing countries, as a way to increase its revenue. Lipha Tech supplies mostly peat-based inoculum, using peat from its own peat mines. Its presentations are for standard seed inoculum, 3.5 and 6.7 oz package sizes; its Pelinoc pellets for use at planting time in the seed box, are of 40 oz (1,134 gr) plus an 8 oz (227 gr) Peigel sticker, package sizes for small seed legumes, and of 54 oz (1,531 gr) plus a 4.7 oz (133 gr) Peigel sticker for large seeded legumes. It also supplies soil implants of 5 lb (2.27 kg) size to treat approximately 1 acre at a rate of 6 oz/1000 foot of row for large seeded legume seeds.

Other inoculant producing companies have their own type of marketing arrangements. For example Urbana Laboratories, the second largest inoculant producer in the U.S. has a distribution system which closely follows the sale of soybean seed mostly in the midwest, as an adjunct to seed through a dealer network. The parent seed company Research Seeds, owners of Urbana Laboratories (a 50 year old company) have an established seed distribution network. Rhizogen Corp. in Canada acts mainly as a marketing and distribution company for Agricultural Genetics Co. of England. MicroBioRhizogen (with a 51% AGC share) is the manufacturing branch. Lipha Tech is an independent company and works through its established representatives worldwide. In the U.S., Argentina and France its production/marketing companies work through their own independent channels. Lipha Tech has expanded its product line of inoculants to cover a wider variety of pasture, grain legume and tree crops. It has also introduced pelleted seed inoculants that are used with seed adherents to treat seed prior to planting, in the planting box or inoculants in pellet form to drop in the soil independently of the insecticide/fungicide treated seed but near it in the planting row.

In Australia the inoculant industry established an early worldwide leadership with its advanced technology and quality control. NifTAL itself adopted many of its industry development leads from the Australian experience. In the past, Australian farmers were on a rotation cropping system involving cereals and legume-grass pastures. BNF inoculants were an important component of this system. With the increased use of chemical fertilizers, continuous cereal crops in a mono- or multiple-cereal crop system became possible. Inoculant sales dropped. They are returning to larger use of inoculants in lays, due to competition in world markets and increased costs of production of cereals, in which fertilizers constitute an important part. Even so, as reported by Bio-Care Technologies Pty. Ltd. they have a rough going, as they state that their demand for inoculants continues to decline. In order to survive in the Biotechnology business they are seeking diversification. They have developed a genetically engineered bacterium (Agrobacterium radiobacter K1026) that controls crown

gall, which they hope to add to their product line. It would thus appear that smaller companies, in order to survive in the developed countries, and weighed down with higher costs, must diversify their product line.

Several inoculant production companies offer in the market molybdenum seed treatments. Since legumes need molybdenum for N2 fixation and molybdenum is scarce in some soils, its use as an adjunct in treating seed with rhizobial inoculum produces visible results and increases the income sources of companies.

In summary, it may be established that inoculum producing companies have to work at higher price levels than they have been accustomed to dealing with in the past (in Grip they vary from $2.90/acre treatment cost for soybeans to $3.50/acre treatment cost for dry beans, to $6.55 to $7.85/acre for peas). They have to modernize their customer base of farmers to pay for their fixed costs and move into the profit fringes. They are going international in order to expand sales. These companies are using other input distribution chains, notably seed chains. They are basing their business not only on seed inoculants but on several related products, and are adding new products in the range of biotechnological inputs. New forms of marketing are being tested by them, through specialized wholesale distribution companies, in some cases, in order to reach a wider market base, and raising selling prices to pay for the additional marketing costs (e.g., Grip which is 1/3 more expensive).

2.2 Critical Review of Case Histories in Developing Countries

NifTAL has conducted some reviews of case histories in the inoculant industries of developing countries, and ample documentation is available at NifTAL. This information is condensed from their reports.

2.2.1 Rhizogin Co., Jakarta, Indonesia

Demand for soybeans, if it were met from local production, would require 1.38 million hectares of soybeans cropped in Indonesia, with an average yield of 1,180 kg/ha by hear 2,000. The current area of soybeans in Indonesia is 400,000 ha, with a goal for the government to reach 1,000,000 ha by 1995, incorporating in the process new lands with no previous history of soybean cropping. This situation will necessitate soil inoculation with efficient N2 fixing strains of *Bradyrhizobium japonicum*. Peanuts and mungbean would be secondary markets for rhizobial inoculum.

Rhizogin-Indonesia is designated by NifTAL as a well managed private company. It provides 70% of the inoculum needed for soybeans, and it is their only product. The company has received NifTAL technology transfer directly from Hawaii and through BNFRC, Bangkok. Technical support has additionally come from the Indonesian Department of Agriculture and local universities.

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Rhizogin uses local peat irradiated with gamma rays. Inoculum is marketed under the trade name "Trisobium" in standard 30 gr packets used to treat 10 kg of seed, the standard amount used by farmers for their average soybean planting area (2,000 sq. meters). They have a retail price of $0.50 (982 rps.) per package. For their approximately 1/2 acre treating area, this amounts to about 1/3 of the U.S. selling price for treating an equivalent area of soybeans. The distribution costs for Rhizogin are nil as the whole production is sold to the Indonesian government, which undertakes the distribution of the inoculum together with the soybean seed, which is under state jurisdiction and produced by a state-owned seed corporation, as well. Some inoculum is sold also by traders in Java, apparently in a minor way at higher prices.

Production output is 10,000 30 gr bags/day. Capacity of production would probably be at this rate enough to treat 440,000 hectares, allowing for 200 working days/year at their recommended rate of 180 gr of inoculant per 65 kg of soybean seed. The design of the plant is based on NifTAL's fermenter system and ancillary facilities. They have a greenhouse and capacity for some minor research on improved strain selection and better packaging materials.

Quality control is considered good based on the strict Australian rules that have been adopted by the Department of Agriculture, which is the enforcer. Real control is, however, less than perfect. In fact, self-control of the producers is more important to quality than that exercised by the outside enforcers.

A critical economic analysis of the Rhizogin operation, with a re-analysis of the data presented by NifTAL, discloses that its break-even point is at a gross margin of $0.48 per unit sold, which means also having to sell 522,000 units per year, which is enough for about 25% of the area presently planted to soybeans. These figures result from assessing an estimate to cost of land and buildings equal to 50% of total investment, judged to be a correct assessment. Land and buildings were valued at zero in the original analysis, which produces a serious bias in the calculations. At the present estimated rate of 1,100,000 units sold, judging from the net profit figures, the operation is successful, and has more room for success as volumes increase.

There is a catch, however. This is the nil cost of marketing and distribution to Rhizogin, as these costs are hidden and almost entirely absorbed by state subsidization. The subsidization is very likely confounded with the subsidization of soybean seeds price, as they use the same delivery system, and the delivery relies heavily on the use of the subsidized agricultural extension system. The efficiency of the whole system is likely to suffer, as a considerable part of the extension agents' working time is dedicated to the equivalent of input delivery functions. This extension system's ill spent energy should correspond to a marketing function directly linked to the price of the input, and whose social cost valued in taxes paid by society and its

inefficient utilization results, among other negative outputs, in the low awareness of the use of inoculum experienced by farmers and, therefore, in a lower level of input use. The increment in the areas using seed inoculation by farmers would cause the system to gain a level of economic self-sufficiency at higher levels of inoculum sales, without the need of hidden government subsidies occurring. In the present situation, the state is assuming the brunt of the marketing/distribution costs of the Rhizogin inoculum, of which the producing company has been freed.

Another production operation in Indonesia is centered at Gadja Mada University. The product sold is Legin, a soybean inoculant. The product is purchased by the government, which distributes it free to farmers entering government sponsored crop improvement schemes. Legin producers estimate the production cost of a 150 gr package of inoculant which they recommend for one hectare of soybeans at 5,000 Rps (equivalent to $2.56). They currently produce 20,000 kg of inoculant per year, enough for over 110,000 ha.

Costs and use recommendations from the two producers of soybean inoculum in Indonesia as reported by NifTAL do not match. A comparison of the figures for the two operations in Indonesia stresses the need to gather economic data more carefully and analyze the industry related information critically, in more detail than has been done thus far.

2.2.2 BNFRC, Bangkok, Thailand

BNFRC (BNF Resource Center) is a wholly state run operation. Its production is 500,000 bags per year, or 28% of the production capacity. The facility has served as a USAID-NifTAL coordinated site for extension service training and BNF research and laboratory related technology transfer.

Local non-sterile peat is used as carrier, and mixed with undiluted broth carrying the rhizobia in 200 gr bags. Each bag is calculated to inoculate one rai (1 rai = 1,600 sq. m.). BNFRC does its own quality control.

The production and research costs are financed each year from a state budget allocation, as the BNFRC has no equity funding for those purposes. Fixed costs are given at the unbelievably low figure of $10,800 per year. Subsidized costs are evidently higher. Selling price is fixed by government, and all proceeds from sales revert to government. Selling price is given as 10 baht, or alternatively at the equivalent of $0.32 per bag. The marketing responsibility is held by the Department of Agriculture Extension Service. In one five-year project, a farmer can purchase a kilo of soybean seed for 10 baht (US $0.38) provided that the farmer also purchases inoculum for 10 baht. Under these conditions, it is almost impossible to develop even an approximate economic analysis of the operation.

One thing is evident: the present set up is not conducive to solving the problem of making inoculum available to legume crop planters on a permanent basis, and is not even near the potential demand. There is a definite need for a restudy of the whole inoculum producing and distributing system of Thailand, with a view to establishing a private production/distribution system, similar in large detail to what has been done with the seed industry. USAID and Thailand government officials have been responsible to a large degree for stimulating a new policy that resulted in privatization of most of the seed production/distribution. ICD has participated in the training aspect of the business and technical angles of this industry, with excellent results to the country. It is time that the BNF industry follows suit, since it has in Thailand a good base--the private seed industry--on which to stand for aid in distribution.

There is another recent source of inoculant in Thailand. It is from the Bangkok Seed Co. No more information is available on this.

2.2.3 Department of Soil Science, University of the Philippines at Los Banos (UPLB)

This organization is an example of a university facility for production of inoculum, of which there are a large number in developing countries. This organization produces inoculum for soybeans (1,100 kg/year), for peanut (50 kg/year) and for mungbean (100 kg/year). Their carrier is a mixture of sterilized soil and charcoal. Pure broth is diluted 1:100 and applied in 140 gr bags. With this broth dilution and simple glassware, the estimate of theoretical production capacity at this plant is 18,100,000 bags a year, which is far in excess of what could really be achieved.

The equipment was received from a Japanese grant. It is deemed to be too sophisticated for actual rhizobial inoculant production. The actual equipment used is glass Erlenmeyer flasks to hold the broth.

Soybean production is unimportant in the Philippines. Most of it is imported. Nestlé Philippines Co. is buying inoculant from the UPLB at $0.38 per bag. It then supplies seed and inoculant to farmers, and buys from them the soybean crop.

As in the case of BNFRC, real costs cannot be determined. They are transferred to other departments. Total capital equipment assessment is not realistic as it is not used in the actual production process. Salaried staff costs for example amount to only $2,000 per year.

As in many other cases, university based facilities have been developed with the best of intentions. They have never been able to accomplish more than pilot production and the initial support of locally available high quality inoculants for the start up of BNF programs.

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2.2.4 Nairobi MIRCEN Laboratory

The Nairobi MIRCEN Laboratory was created as a regional leadership center for BNF for East Africa and is located at the University of Nairobi Soil Science and Botany Departments. With the departure of its senior scientists, and to a lesser extent a decline in its available funds the Nairobi MIRCEN stopped being a leadership institution. It ceased having permanent communication with other public sector institutions in the region engaged in similar activities.

The Nairobi MIRCEN is now engaged in producing inoculum for Kenya needs, rather than functioning as a regional center. It has, nevertheless, maintained a sufficient infrastructure to conduct some BNF workshops and training. As a supplier of inoculants it has fallen far short of potential demand in the country. Total production has risen slowly since its start up in 1981, expanding rapidly since 1987 and having reached 1,600 kg in 1990. It uses both locally imported and native strains of Rhizobium. Of total inoculant production in 1990, 40% was for common beans, 23% for alfalfa, 14% for soybeans, and 9% for Desmodium. Inoculants were produced for a total of 19 legume species. The carrier is sterile filter mud, a by-product of sugar processing mills. The inoculant is sold under the name of "Biofix." They have their own internal control. MIRCEN inoculant sales have been stationary at 850 kg in 1989 and 1990, in 100 gr packets.

Increases in soybean yields have been established as 300 kg/ha due to inoculation. It takes only 12 kg of soybeans at current prices to pay for the cost of the inoculant, which in 1990 was sold at 800 Uganda shillings each. It was recommended that each 250 gr unit be sold at $1.00 in 1990 by the BNF/Legume Management Outreach Pilot Project in order to recoup production costs. Three bag units are being used per hectare. Mekerere University has its prices controlled by the Ministry of Agriculture. The Ministry of Agriculture of Uganda has endeavored to control agricultural input prices in the past, but has also been firm in underpaying farmers for their produce through its government controlled Marketing Boards.

Kenya Seed Company, the largest seed company in East Africa, is interested in starting its own rhizobial inoculant production. It has a large distribution system of over 3,500 retail sale outposts and over 18 wholesale distribution companies. The qualified success that this company has had with hybrid seed corn production and distribution (nearly 20,000 MT per year) is an example of its capabilities. It should take over easily the production and distribution of inoculants from MIRCEN once it establishes itself in this area of activity. Other seed companies in Kenya might follow suit.

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2.2.5 Makarere University Inoculant Plant

This unit was established with USAID funding for equipment and supplies. Operating costs which had to come from the University are not forthcoming in sufficient amounts. Furthermore, funds generated from sales go into the general University treasury and are not returned to the Plant.

Non-sterile peat from Kabale peat deposits is used as a carrier. Total production is about 85 kg per year in 250 gr packets. Of this production, 54% is inoculant for soybeans, and 34% for N-fixing trees. The non-sterile inoculant is good for no more than 90 days from preparation.

While it has been established in trials at the Namulonge Research Station that soybeans, Leucaena, and alfalfa respond to inoculation, common (dry) beans show almost no response, in line with observations in other parts of the country and in foreign countries. Since common beans represent the major legume crop in the country (431,000 ha in 1989)--while soybeans are a minor crop (12,000 ha in 1989)--unless a new highly efficient N2-fixing genotype is obtained, this crop will not be an attractive market for inoculants, therefore affecting the whole economic profile of the industry.

ICD was engaged in an attempt to develop, together with the local USAID mission, a private seed company in Uganda. This project was well advanced and would have had the joint participation of a foreign seed company, the Progressive Farmers Association representing large farmers and the Union of Cooperatives representing smaller farmers. The project was aborted for a number of reasons which we will not discuss here. The best possibility for a stable, privately established production of inoculants in Uganda, we submit, would lie with the relaunching of the seed project as it was originally conceived, to be joined by an inoculant production system in which the Makerere University facility could be a producer, with no participation in marketing. In discussions with representatives of pharmaceutical companies in Kampala in 1989, we found they had no interest in establishing themselves at that time in the inoculant industry, as a sideline to their main business in Uganda.

The BNF/LM Outreach Program has had an important presence in Uganda, in which several NGOs and PVOs have collaborated. The ACDI/CAAS Project was a coordinating institution for this project in Uganda. An extremely high concentration of effort appears to have been put on the soybean crop, where responses can be easily seen. The main grain legume crops in the country, however, are common beans and peanuts, which should deserve more research and attention than they have had in the outreach efforts.

2.2.6 Zambia Soil Microbiology Laboratory

The Zambia Soil Microbiology Lab (ZSML) is located at the Mt. Makulu Central Research Station. It is also a project initially funded by USAID, with input from NifTAL and University of Illinois and Southern Illinois University. The ZSML has functions of research on BNF and of inoculant production.

Main problems of this organization are its dual functions supported by a slim budget, which interfere with each other, the problems being compounded by a skeletal staff. The main inoculant produced is for soybeans, followed by small quantities for alfalfa, Leucaena, peanut and dry beans.

Inoculant is produced in 250 gr bags. Sterilized peat obtained from a local deposit at Mongu is used as carrier. Estimated price of inoculant is $0.90 per hectare. Volume of production rose from 26,000 bags in 1988/89 to 36,000 bags in 1989/90 to 52,000 bags in 1990/91. Quality is self-controlled. It is stated that minimum counts are one billion rhizobial living cells per gram of inoculant at the factory. Distribution is done by way of the Zambia Farmers Cooperative Society and the Zambia Seed Company. Inoculants reach mainly large scale farmers, and those located along railroad communication points. While production is 13 MT of inoculant, demand is estimated at 60 MT per year at this time. Small scale farmers have not been reached, and show little awareness especially in the northern and eastern provinces.

Potential industrial producers consulted feel the industry is not viable at present. This leaves the present set up as the only alternative to advance production, unless volume is increased and prices to farmers raised to make the industry economically self-sufficient and is then transferred to the private sector. At present, the ZSML is installing two 100 liter stainless steel fermenters obtained from NifTAL in order to increase its output of inoculants.

2.2.7 Zimbabwe Soil Productivity Research Laboratory

The Zimbabwe Soil Productivity Research Laboratory (ZSPRL), located at the Grasslands Research Station, in Morondera, was established in 1963. Its research activities deal with soil fertility and soil management.

The inoculant carrier is bagacillo (milled sugar cane stalks) for some 95% of the production; the rest is half in agar slants and in broth medium. Of the 99,534 inoculant units sold in 1989/90, some 85% was for soybeans, 10% for peanuts, 2% for beans, 2% for peas and 1% for pasture legumes. Distribution is through farmers' cooperatives and seed companies. It should be stated that 20,000 units of soya inoculant were exported to Zambia, and 240 units for peas were exported to South Africa in December 1989.

2.2.8 Haiti Agroforestry Outreach Project

In Haiti, the main thrust of the efforts to promote inoculant utilization is directed at its use in inoculating N2-fixing legume trees. The production of rhizobial inoculants is being conducted at a private medical laboratory, Medicom, under an agreement with the USAID sponsored Haiti Agroforestry Research Project. The inoculum is purchased by CARE, PADF and Operation Double Harvest (the latter a commercial operation). Their combined nursery tree operations reach 10 million trees per year.

The start of the operation was made through a loan to the medical laboratory to be repaid with the sale of inoculant proceeds. The owner of the lab received training for two weeks at NifTAL.

The lab area is small, 12 x 30 feet. Lab equipment conforms to NifTAL's specifications. Imported sterile peat from Australia is used as carrier. A broth culture of rhizobia with dilution of 1:20 to 1:50 is used. Production runs are timed to coincide with scheduled nursery plantings. Inoculum is kept in cool rooms for two weeks before being used.

3. Constraints to private BNF Enterprise Development

The development of private BNF enterprises lags behind other agribusinesses in their establishment in most developing and intermediately developed countries. Again, when established their growth may not be at a rate that would insure their survival and expansion. An examination of possible reasons that determine this behavior is needed.

It must be admitted, in the first place, that the efforts that NifTAL is now directing to private enterprise development have been launched late in the course of the project. In its initial phase, and partly during the second, NifTAL's audience was formed primarily by the academic and government research, extension, and administrative communities. The time lost must obviously be regained, and the commitment of NifTAL to this new phase of its activities is certainly a major one.

The recent thrust of NifTAL with the help of NGO and PVO agencies in a number of pilot projects in developing countries has met, at the best, with moderate success. In the absence of a permanent agency motivated by profit reasons, which would bring continuity to the supply of inoculants, the well meant actions of the pilot projects of NGO/PVO agencies, in collaboration with NifTAL, while initially helpful, are likely to fall short of achieving a significant and permanent change in the use of BNF technology.

Major constraints to BNF industry development follow:

1. Farmer Awareness and Interest. Inducing farmers to adopt BNF technology on a permanent basis is the first challenge. Farmers may or may not be aware of the existence of the BNF technology. If aware, they may not be convinced that the technology is worthwhile or that it will work as claimed in order to produce significant economic returns. This is a problem for the agricultural extension system workers to tackle. It is no less a problem for the inoculant salesman. A new technology is adopted not when the farmer becomes aware of it, but rather at a second stage, when he decides he wants it badly enough to be willing to pay for it. The joint efforts of extension and sales are needed for the BNF technology to be adopted.

Agricultural extension in many countries is weak. It is poorly motivated, lacks mobility and other physical resources, and is not budgeted well enough to be able to prepare field demonstrations. The personnel are not sufficiently trained in BNF technology; their managers do not budget their time and do not give them or demand from them a minimum of demonstrations, farmer meetings or visits to farm leaders each week. There is poor coordination between extension workers and researchers, and much less between extension workers and salesmen ("the weakest link").

There are cases where demonstrations are not well planned. There are no positive results; the results may even be negative, not because of the technology but because of the poor planning, not lending themselves to be of use. All these are problems which require careful attention.

2. Government Intervention. The public sector and certain government leaders in a number of developing countries are aware of the benefits of BNF technology. Some have jumped into developing a state owned inoculum production and/or distribution organization. To promote the use of inoculants, they are distributed free or at highly subsidized prices. As a result, the BNF private industry, in competition with the state organizations, is unable to produce net returns of sufficient interest to private investors to encourage them to enter the field. State activities, therefore, continue unchallenged in this area, but volumes of production do not grow enough and the full benefit of the BNF technology on a country wide scale is missed.

3. Product Quality and Its Control. Quality of inoculants coming out of the factory may not be controlled well. Especially with non-sterile peat carriers, shelf life of inoculants is much shorter. Quality control standards are often nonexistent; or they may exist but their enforcement may be beyond the possibilities of the controlling agency. Quality controls at selling points are usually nonexistent, and products that have been sold beyond a shelf-life guarantee period or with no expiration label, continue to enter the market. The result is a bad experience for farmers,

who find the product worthless and generalize their single bad experience to all BNF products.

Even in advanced industrial countries, quality control of the inoculant industry products by state organizations is quite limited. Because of the small economic volume and size of the inoculant industry, the cost of controlling it may be too high in relation to the value of the products. Ultimately, quality control is mainly the responsibility of the inoculant producers. Here is where competition for quality counts and takes care of itself.

4. Product Pricing. Inoculant product pricing is not well regulated by private enterprises, and even less by state owned enterprises. A tendency on the part of consumers and producers to underprice tends to develop weak, undercapitalized industries. Reliance on single products may bring adverse results to private companies. Diversification may be called for.

5. Distribution System. Distribution channels for inoculants in a number of less developed countries are through the public agricultural extension system. This is the worst possible use that can be made of the system. It detracts from its original basic function which is adult education and technology demonstration. The delivery system should be a fully private, profit motivated efficient network of well trained dealers, working with the extension system. The latter should have full time dedication to its basic mandate of technology transfer.

6. Business Environment. The business environment, for a number of reasons, may not be conducive to investment in agribusiness activities by the private sector, and especially in the area of inoculants. In addition to the lack of appropriate investment legislation, there may be a number of disincentives which could be identified. These could range from "red tape" (a subliminal form of opposition to the private sector development) all the way to corruption in the permit process. More often than not, private enterprise competition is discouraged. Monopolistic practices are the rule rather than the exception in developing countries. More than one source of origin for a product, and the possibility of free importation from foreign sources, should bring about consistent quality, sufficient and timely supply, and the possibility of improved guarantees at reasonable prices of the inoculants, thus benefiting inoculant producers, importers, distributors, farmers and, ultimately, the consumers of farm products.

7. Technical Know-How. Technical knowledge is not available to entrepreneurs potentially interested in entering the market of BNF products. Business profiles are not available to industrial promotion organizations. Such profiles ought to be developed on the basis of cost/benefit comparisons of inoculants versus N fertilizers as technical benchmarks for price construction of inoculant products.

8. Enterprise Structure. Small companies centering their production on inoculants may not have a sufficiently large market to thrive on in some countries. Multinational corporations may not be interested in BNF in countries with low turnover of inoculant sales per year as it would be a cottage industry to them, because of the low revenues expected. On the other hand they might, if the BNF products would mesh into a global strategy of selling other biochemical or microbial products.

9. Incomplete Technology. Inadequate information on a number of problems waiting for solutions may be a limiting factor to inoculant industry development. They may not lie in the industrial field proper, but in the agronomic and biological milieu. Technical problems which could be solved by research and development are still waiting for solutions. For example, appropriate rhizobial strains may not be available, or legume grain varieties with high N2-fixing ability have not been developed. Integration with other practices in crop management are still missing. There may be also the inability to isolate failures. Failures occurring in one species may be translated to other species by generalization, rather than by specific research. These are problems that require either research or simply technology transfer through the use of adaptive research and/or resort to database information transfer.

10. Lack of Responsiveness of the Leadership. While some government leaders in some countries display an excess of zeal, there are many others in developing countries where no interest is exhibited by the government leadership in supporting agricultural promotion activities, such as making inoculants available, as there are no large sums of money involved in that kind of project, and no public works to inaugurate. There are the opposite cases, where responsiveness is based on certain group interests that work against the establishment of inoculant industries. Some cases of each type have been identified in specific countries.

11. Unattractive Crop Prices. The establishment of purchase prices for certain grain legume commodities by Commodity Boards of other types of procurement monopolies, usually at the state level, have worked negatively against building a moderate income base by grain legume farmers. The case of peanuts or common beans in a number of countries in Africa, as an example, is a case in point.

The annual rate of growth of common bean production in Latin America between 1964/66 to 1974/76 was 0.27%, at a time of great research and promotion work, that has now subsided because of scarcity of government funds, but also because of the smallness of the yield responses obtained. The main source of growth of bean production in this period was acreage (0.8% increase). However, this was not uniform. Argentina, El Salvador, Colombia and the Dominican Republic increased production respectively, mainly because of the introduction of better varieties. On the other hand, Brazil, the largest producer, experienced sizable drops in

production. The price ratio of the kg of N to the kg of beans varies in Latin America between 0.8 to 1.2 in most countries.

Inoculation responses in common beans, while subject to differential varietal responsiveness, are much more dependent on a complete fertilizer (P included) and management treatment. This requires higher investment, which the farmers may not be willing or able to obtain, because of the low relative ratios of price of grain to price of inputs, plus risk factors due to environment. Under such a set of conditions, use of inoculants would have to be demonstrated as being economically feasible and recommendable.

4. Assessment of NifTAL's Current Strategy on Enterprise Development

NifTAL has accepted a commitment to participate in enterprise development of the inoculant industry. It has established a program of Private Enterprise Development in the inoculant industry, and has hired its first director. This initiative covers the promotion of the inoculant industry, especially in the less developed countries, through supporting either its formation *in situ*, or through promoting the participation in the inoculant products delivery process of private enterprises with production facilities elsewhere.

NifTAL conceives its participation in this program as that of a catalyst, a promoter and a services supplier, all in one.

In discharging its responsibilities, NifTAL must review past experiences, diagnose existing problems, and draft as a memo to itself a full inventory of good and bad experiences, major constraints to the inoculant industry development that have been singled out, and analyze the lessons learned from such experiences.

The present exercise was meant to bring forward in a position paper such experiences, so they would be discussed in a workshop from which recommendations might emerge. As mentioned before this exercise will try to fulfill, with the obvious limitations imposed by a more restricted number of viewpoints, what are believed to be the major "lessons learned" and the information gaps requiring further research and survey.

4.1 Lessons Learned from Enterprise Performance

BNF products and services have the advantage of not being recognized as harmful to the environment. They are known to be quite effective in promoting N2 fixation in legume pastures, grain and tree species. The technology is clean and simple. The techniques of production and quality control have been worked out and are easy to master and apply. To a reasonable extent inoculants have been promoted and made known to most everyone, from farmers to politicians, completing in their exposure all the links in the chain of public and private actors in the following functions:

research -> technology transfer -> promotion -> production -> extension -> adoption -> evaluation and the feedback process.

Finally, to say that the cost to farmers of adopting this technology is low is an understatement. The reality is that it has been sold cheap. And by being cheap, in spite of all the remarkable advantages it offers, listed above, it is regarded as a cheap technology by the potential investment community.

It may be that the inoculant business has not taken off in some countries because investors recognize that the profit potential is limited. The limitation to profits may have stemmed from the fact that the state had pioneered the industry not as an industry but as a state service-orineted activity, with subsidies and all the ensuing well known standards of such a type of activity. It might have been caused on the other hand by the lack of a sufficiently large market on the short to medium term to justify entering that field.

A set of operating inoculant producing/marketing enterprises in a few developing countries have been examined by NifTAL in two ways; either by way of simplified case studies or through economic analysis using the FAIME package. In Section 3 in the present document such experiences have been reviewed critically. More detailed documentation is available at NifTAL. We have added some additional ones from critical literature review.

Lessons learned from studies on this group of enterprises might be summarized as follows:

1. A major factor in the start up of the inoculant enterprises has been the leadership exerted by some well trained individuals, and the support given them by NifTAL in the technological aspects as well as the support provided by government in the promotional and distribution aspect.

2. Inoculant enterprises in most countries are still viewed more as service-oriented activites in terms of the supply of inoculants than as a business-based ones, justifying thereby strong government intervention in production, distribution, or price regulation.

3. No case is known where inoculant enterprises in any developing country have reached anywhere near the market potential in inoculant use, with the possible exception of the use of inoculants in soybeans in Brazil, which may be a borderline case between the developed and developing countries, especially when dealing with mechanized large scale soybean farming there.

4. With a few exceptions inoculant enterprises have a very incomplete grasp of business objectives and the required planning, strategies, and induction of resources needed to accomplish them.

5. While enterprises in developed countries tend to view inoculants as components of a product mix, with variants of presentation, with micrometabolite chemicals added, or with adaptation to forms of delivery, covering, in so doing, an array of legume species, in developing countries there is a tendency to be single product enterprises, or at the most enterprises dealing with a few species. They, furthermore, limit themselves to one type or few types of carrier presentations. This strategy in itself, affects negatively the economic viability of the enterprise.

6. There has been a most serious divorce between the high skills and technological know-how exhibited in the production phase and th achievement of high quality of inoculum when leaving the production plant, and the pitiful ignorance of marketing and distribution system principles, which result in the loss of what was so carefully obtained. There have been serious doubts and misgivings expressed by both NifTAL staff and others in other institutions and in several workshops, including some at CIAT, about the final quality of inoculants when they reach the farmer.

7. Quality control standards that have been adopted by some governmental agencies in developing countries, are usually copied from other countries. Of course, they usually copy the most stringent standards, and the Australian being the most stringent are, therefore, the most popular among developing country controlling agencies. Usually 10 billion bacteria/gram is the lower limit of live bacteria accepted in an inoculant package in any of the developing countries studied. These standards are, however, rarely enforced with regularity and consistency by the controlling agencies. This leaves the enterprises with the responsibility of supplying the end user, at his farm, products that maintain the highest quality levels.

8. Coordination and collaboration between enterprises, and enterprise alliances do not appear to be in place in most developing countries aimed at expanding the delivery system of rhizobial inoculants. These alliances can be horizontal and vertical. In horizontal alliances, two enterprises, such as a seed company and an inoculant company combine efforts to market inoculants together with certain seed varieties. In vertical alliances, wholesalers and retailers work in a pyramidal form to achieve a greater coverage of the market. In both cases, a price structure of the products, capable of satisfying the profit needs and the necessity of covering costs of demonstrations, inventory build up, marketing and distribution, does not exist.

9. It is interesting to compare the former enterprises with those of developed countries, in order to draw some conclusions.

The inoculant producing enterprises of the developed countries are mature organizations. Many of them have experienced ownership turnover, several cycles of capitalization and changes of management. They cater in many cases to a global market. Those

whose business activities are restricted to their national boundaries have actively developed their market. They can work on predictable market demand figures and well planned production/ distribution forecasts. Their management is professional. Responsiveness to the profit motive drives their decisions.

These are elements seldom found in incipient peer organizations in developing countries, which furthermore are embedded in the public sector. Management is usually technically advanced, but does not appear to grasp sound business principles. This may be the Achilles' heel impeding long term growth in this sector.

10. Size of operation is not necessarily a precondition for success. More failures and higher risk could be found in large poorly managed organizations than in some small well managed ones in the agribusiness field. In particular, the use of dilution techniques and modular equipment, which would allow for growth without large initial investment offers interesting opportunities for small companies in the inoculant industry. Product diversification is more likely to take place, on the other hand, in larger companies providing for a wider economic and financial support base to their growth. By diversification is meant having more than one product in the marketing/distribution stream.

In regard to the use of sterile versus non-sterile techniques for inoculum production, the latter technique persists in some campanies in less developed countries. The non-sterile system requires a larger fermenter capacity to grow the rhizobial broth than the non-sterile technique to produce a given quantity of inoculum. For example, in order to inoculate 500,000 hectares, the inoculum requirements are 325,000 kg. This quantity of inoculum can be produced in one or more fermenters with a total capacity of 2,166 liters with the sterile carrier system; with the non-sterile carrier system a fermenter capacity of 108,323 liters would be needed, with the concurrent higher capital and operating costs.

11. Capital investment costs decrease for fermentation systems with the dilution technique; for example, using dilution factors of 1:50 or 1:100 for rhizobial inoculant production in sterile carrier pouches reduces fermentation capacity by approximately the same factor. This technique is perfectly suited for smaller companies in developing countries that might thus be able to keep their production costs down and their profit margins high on low production volumes, thus insuring survival and profitability for the company. Sterile carriers can at the same time be better carriers in the sense that the numbers of live rhizobium cells per gram would be higher, and survivability longer, insuring better quality. Smaller companies with lower investment levels could thus be made profitable in smaller market areas, or under competition.

Inoculant companies in developed countries have advanced research programs, including their own strain collection, selection, preservation and utilization projects. This potential comes with size of company, capital investments, capacity to pay for research activities and their respective research workers out of profits, which are a product of the formula: price times sales volume minus costs. These factual concepts cannot be ignored. Low prices bring about low capitalization and a death warrant, sooner or later, to any company which cannot compensate for low prices with extra large sales volumes. Most agricultural supply companies in developing countries, either by design or through coercion of the government, are supposed to transfer part of their earnings to the farmers through low prices of farm inputs, including inoculants. Farmers, as well, are victimized by governments through either low commodity prices paid to them by government monopolies, or through the lack of protection of their fragile agricultural commodity markets, in the developing countries, when thrown into the maelstrom of the global market competition without timed safeguards.

4.2 Assessment of NifTAL's Current Strategy on Enterprise Development

Recognizing that the "missing link" of establishment and reinforcement of a sustainable private enterprise-based production and/or delivery system was, in fact, the major bottleneck to widespread use of rhizobial inoculants in developing countries, NifTAL has in the last period of its existence started shifting more attention to actions of promotion of the private inoculant enterprises.

One of the strategies that NifTAL conceived was to first start by building up inoculant use awareness among farmers in developing countries. This was planned through their formal program to which they added as a new methodology the formation of links with PVO/NGO organizations. Through this linkage it was thought, counting on the good will and resources, especially field offices and agricultural grass roots of those PVOs in some countries, outreach activities would be fortified.

An example of such an approach was the Consortium of NifTAL with seven PVOs and the Peace Corp in the BNF/LM outreach Pilot Project initiated in 1988. This project reflects the minute scale of their action. It was dedicated to just four countries: Haiti, Uganda, Nepal and Senegal. Furthermore, by looking at this roster of countries, it does not take much reasoning to assess that their selection was probably due more to humanitarian reasons, and the existence of PVO ground offices in them, than to the likelihood of a sustainable success. Guidelines other than just the humanitarian are necessarily required for country selection, the most important ones being those related to political, markets, business environment, technical and a few others that might give high hopes for the likelihood for success. These farmer awareness programs have had mixed success and require further evaluation.

In a country development strategy for "permanent" inoculant use diffusion, development of farmer awareness of the benefits of inoculant use is granted to be a first step in that strategy. A necessary second step should be a planned action to stimulate a permanent inoculant delivery system following the first. This is translated into the establishment and consolidation/privatization of private enterprises dedicated to the activities of inoculant production/importation/marketing/distribution.

The continuation of government supported institutions in poor countries as delivery systems for inoculants or for any other inputs is a utopia. None of these state enterprises has the familiarity or experience for working in a profit-oriented, competitive environment. They may be able to keep records of costs, production, sales, and income, as a matter of fact. Few of them are able to master the use of those records to transfer them into data useful to cut costs and improve efficiency. Furthermore, annual budgets are assured to come from central budgets, insuring them against any inefficiencies. Directors of thes enterprises

seldom have control of prices. Prices are usually the lowest possible, and make it impossible to impose some sort of financial order to the enterprise. The use of the Agricultural Extension System as a subsidized delivery system for inoculants, further complicates real cost accounting.

Jobs in the state inoculant enterprise/agencies are secure but poorly paid, as per the information obtained by NifTAL and examined by ICD. Usually jobs are subsidized by the central budget, through some intermediary organization. Incentives for advancement are nonexistent, or of the kind that require political backstopping. In some cases, production parameters are dictated by political leaders sitting outside the enterprise in some government institution. The morale of middle level and low management and operators is likely to be low, as has been noted in similar organizations in many developing countries. This is a poor guarantee for product quality, or even continuity of the operation.

State finances in many less developed countries, with some qualified exceptions, are in a state of utter disarry, and charging them with more subsidization responsibilities is not only unrealistic but a contribution to the continuation or expansion of the distress experienced by other urgent services, which are the proper province of the state. The advice of added subsidization is not worthy of the high moral quality and technical standards that external advisors are supposed to have. <u>It is strongly recommended that NifTAL abstain from continuing to support state inoculum producing enterprises, unless it is with a clear view to end the participation of the state in their ownership and operation, and only through a transition period that leads to their privatization</u>. Furthermore, it is advisable that NifTAL assume a strong leadership position in creating the right environment and attitudes in government circles for the beginning of privatization efforts of the inoculum state producing organizations, with real incentive programs, and a commitment to a time table. This commitment could be part of a real wider commitment to the privatization of all types of state-owned agricultural production organizations.

In assuming such a responsibility, NifTAL must do its own soul searching and understand far better than it has in the past that its real function is as an actor in the worldwide dilemma of food production and nutrition, and improvement of the well-being of the citizens of the world. In the footsteps of other organizations that have accepted the challenge of providing support to a worldwide clientele, such as the research centers of the CGIAR organization, NifTAL should be ready to accept a similar challenge. So far, in reality, NifTAL has not fulfilled such a commitment.

Persistence in maintaining a pilot project approach in half a dozen countries, providing for a few workshops, generating some active correspondence with members of an academic and government community in a couple dozen countries, and training 50 people is good enough

for window dressing, but it does not represent a real commitment to worldwide change. Nor does it address the complacency of state delivery systems which are known to be doomed in the end. It does not contribute to NifTAL's experience to persist in working with third world countries which are unusually rich, where their finances due to industrial exports (Thailand) or oil exports (Indonesia) allow them luxuries with subsidies which 99% of all the other countries in the world can ill afford. These will not be the models that NifTAL wishes to exploit.

NifTAL's management and its supporters should realize that there is impatience with organizations that are just supported for pilot projects. Actions in the world should be of a global nature. It is perhaps fatuous to bring this reminder at a time when financial constraints for support of NifTAL will be more stringent that at any other time in its past. Yet if NifTAL is a believer in its products, in the expertise it has accumulated and in the benefits that its technology and services will bring the world, it should redefine its objectives and its policy. If being within a university imposes a straight jacket on NifTAL, and the University of Hawaii is not willing to accept such a major responsibility, other mechanisms could be found, and must be found. The problem areas are of such large magnitude that institutional arrangements and finances can and must be secured.

NifTAL is the only institution that could provide a worldwide service similar to those provided by CGIAR centers in their respective fields, in the field of soil inoculants for N2 fixation. No other organization even remotely approaches the capabilities of NifTAL as an institution, and the experience of its staff. A third phase for NifTAL and a masterplan for its future role must be developed as soon as possible. It should not be exclusively done in-house, to avoid a possible inbreeding effect. It should define global objectives, a master strategy and tactics to conquer them, define resource need, and a system to obtain them.

ICD would at this stage propose that USAID and NifTAL support a firm proposal along the lines suggested in the last paragraph. It would be difficult for the ICD staff and advisers who prepared this report to indicate what those objectives should be. Only their general outline has been suggested. A more detailed, concentrated exercise, such as a possible 2-month detailed study of NifTAL's future thrust, with participation of NifTAL management itself, University of Hawaii management, advisers from the CGIAR group, industry, and USAID leading to "The NifTAL Master Plan of the Next Decade" is our indicated advice.

4.3 Information Gaps, Data Collection and Analysis Needs, and Priorities for Further Research

In previous sections of this study we have reveiwed the activities of NifTAL in pursuance of its mandate in the promotion of the use of inoculants in developing countries. We have learned that NifTAL has had a major part of its outreach activities concentrated geographically in Southeast Asia and in Africa. His strategy has left other world regions devoid of or with much less attention from NifTAL. With the exception of one or two countries in Latin America, little action has been seen there from NifTAL on BNF industry promotion. Reasons for this concentration of action, and for minimized activities in other countries (India, Pakistan, Central Asian Republics, China, West Africa, Latin America and the Caribbean) have merited the explanation that they are due to funding shortages. It may have to do to a lesser extent with the distribution of USAID country programs and their funding and the interest displayed by their Agricultural Officers on BNF technology. Yet this persistent geographical unbalance may be due to other causes. Geographical strategy reassessments are in order, they need to be reflected upon and corrected when necessary.

Following the reasonging postulated above, it would be important for NifTAL to survey the opportunities that exist in several of the regions and countries that have not been receiving NifTAL's support for the formation and expansion of the inoculant industry, with a sharp focus on the industry development itself. ICD had planned to develop such a study but the shortage of funds assigned to the preparation of the present document prevented such a detailed analysis.

In parallel with the former proposed survey, a survey should be made on the technology inventory in existence in each of the selected countries on BNF with reference to following groups of crops: (a) legume grain crops; (b) legume/grass mixed pastures in the cool tropical highland regions; (c) legume/grass mixed pastures in warm tropical regions; (d) green manure crops; (e) legume trees used for fuel, forage, shade and other uses. This survey should stress the potential in specific countries for inoculant use and crop yield increases, based on area and production statistics, and advances in research in situ and on transferrable technology. As an example, in India, Latin America and in some Middle Eastern countries, extensive grain legume growing areas might benefit from the use of inoculants. In the high altitudes of the Andes great potential exists for temperate grasses in mixed alfalfa, clover, sanfoin, or vetch with grass or oats. The use of inoculants is quite limited in those areas.

Collection, classification and analysis of research results and other pertinent information concerning inoculation of legume crops in developing countries, leading to country information profiles and research gaps, would create a useful matrix to guide future research efforts. In 1984, a program conducted by CIAT and

financed by UNDP was started under the title "Evaluation, Selection and Agronomic Management of the Symbiosis Legume-Rhizobium." Scientists from CIAT participated in the program together with scientists from a number of national research programs of a number of African and Latin American countries. This network intended to coordinate efforts of microbiologists and agronomists in BNF basic information development under standardized procedures. NifTAL, MIRCEN and CIAT joined resources in this network, providing courses, planning experiments and conducting a workshop, dealing with beans and tropical forage legumes. The network conducted standardized test on beans and the following tropical pasture legume species: (Pueraria phaseoloides, Desmodium ovalifolium, Stylosanthes guianensis, Centrosema spp.). Results were extremely variable. Positive responses to inoculation were reported in Panama, while in Brazil they were negative on inoculant strains sent by CIAT. Mixed positive and negative responses were found in Mexico. The first came from native strains and undisturbed soils. The negative results came from neutral soils. In Cuba, positive responses were obtained in the Matanzas province; low responses came from Bayanero province; no responses appeared in the Pinar del Rio province. In Brazil no responses or low ones were reported from Bahia. In the soybean growing region of the Department of Santa Cruz, Bolivia, even with phosphorus fertilization, no responses to inoculation came out in the tests, in which the widely grown and adapted soybean variety IAC8 (Brazilian) was planted. On the other hand in the Department of Cesar in northern Colombia inoculated soybean yields were equivalent to those obtained wtih 150-200 kg N/Ha. This array of contradictory results has possible explanations, not attributable to the standardized testing procedures.

Another case is the frequent inoculant failure attributed to poor competitiveness of introduced, efficient N2 fixing strains against native strains. Additionally, effects of different environments on strain competitiveness have been studied in Hawaii. Similar studies are required in other countries, under their perhaps more variable or severe environmental limitations. The validation of the findings made in Hawaii, when transferred to other regions through appropriate predictive models would help very much in the understanding of the relationships between strains of rhizobias, various environmental factors, and crop management factors.

The above test results are indicative of the fragmentary status of the information that has been accumulated. It also depicts clearly its empirical nature, and its dearth of environmental detailed data. In the absence of estimations of some basic standard parameters, which could be easily determined, interpretative studies cannot lend themselves to shed light on problem areas in the use of inoculants, This situation obviously needs correction through concerted action of international and national research centers, with the incorporation of NifTAL's technical leadership and valuable inputs.

One example of distribution links of seed to inoculants in developing countries is the case of Indonesia. There the state follows a policy of distributing both inputs under a reinforcement of incentives policy. The price of subsidized seed is kept low if inoculant is bought for it. Another case was in Peru. During the late 1950s and through the 1960s large scale irrigation projects were finished and farmers planted alfalfa under irrigation as a colonizer crop, in order to form agricultural soil, and add organic matter and nitrogen to skeletal, virgin, desert soils. A local company by the name of Hortus S.A. produced, processed, and sold large quantities of alfalfa seed with tropical adaptation to the neutral or high pH soils of the coast. Alfalfa seed was sold with an inoculant (Nitragin). In the case of Urbana Laboratories, the master company is a seed company (Research Seeds). It makes it easier to link in a sales campaign two complementary products, and this is even more attractive, when both are produced by the same group.

It is suggested from these few examples, to which many more could be added in various BNF research and development and technical outreach fields, which include inoculant production, packing and presentation, mode of application, transportation, storage, marketing and demonstration techniques, it would be most desirable if priorities for further BNF research would be identified. They would be oriented to solving practical problems like the few examples selected and indicated above. Critical problem areas and knowledge gaps need to be identified and discussed by groups of competent scientists and technical managers and staff of major inoculant companies management and technical personnel. The identified problems and knowledge gaps need to be cataloged and prioritized in terms of importance, hoping that a consensus could be reached at this phase. Then the problems should be tackled systematically through "mission oriented" basic and applied research, by the research and technical community, leading to a greater effectiveness of inoculant use.

5. Linkages to Other Programs

Formal and informal linkages exist between NifTAL and other public, private and international programs on BNF research and development and on outreach. The participation of some institutions such as MIRCEN and the international research centers of the CGIAR group have been well documented and underpin the need for NifTAL to establish cooperation linkages, and even alliances with other institutions in order to judiciously use complementary resources toward the accomplishments of NifTAL's objectives.

Relationships with other organizations with similar or complementary objectives to those of NifTAL have shown to be effective. One of the best types of working relationships has been established between CIAT and NifTAL. Other centers of the CGIAR group, on the contrary, have been deemphasizing research on BNF. It would be interesting to find out why they have done so. Have

their priorities, which include the dropping of BNF research, resulted from a screening process leading to a more concentrated action on smaller areas? Has this new view been produced because of their perception of smaller payoffs to investment in the BNF area? Lack of sufficient funding to the Centers as a whole, could lead their management to deciee to trim budgets, starting with technologies that in their view are not primary targets for their research. Their visualization of their own institutional comparative advantage vis-à-vis NifTAL's may have led them to abandon the field. Even at CIAT, BNF research has dwindled considerably, and it appears that there is more of a service factor in the components of their activities than there is of research. Such activities as maintenance of collections of rhizobial strains can be assimilated more to service than to research.

Universities of developing and developed countries and National Agricultural Research Programs are an important source of new research information. University based BNF research/outreach programs seem to be quite active in some developing countries. There is a basic necessity to gather and process these studies. As mentioned before, guidelines to develop basic data collection formats are required.

A most important linkage which should be established formally is that of the NifTAL project with the IBSNAT project and its successor consortium at the expiration of the USAID grant. The development of nitrogen fixing components in the system analysis of growth and dry matter addition in legume crops, under variables affecting N2 fixation are a necessary component of legume crop prediction models. The demand for predictive models for pastures such as alfalfa and clover swards, pure and mixed, offers opportunities for additional cooperation in modeling for N2 fixation variable in these crops. In the future, interest in tree crop modeling might also arise. One important model is that of green manure crops in the tropics. With growing seasons of 365 days per year, green manures can see extensive use in the tropics, especially where rainfall distribution allows for two or more full length crops per year, with a short green manure crop.

The collaborative links between NifTAL and the private sector enterprises in developed countries need to be reinforced. This is a point that should be stressed. In the developed world, especially in the U.S., Australia, Canada, France, the U.K., and other countries and in some of the more advanced borderline countries, there are rhizobial inoculant producing companies that might be willing to expand their business to other parts of the world. There might be countries where it is not feasible to install new enterprises for the production of their own inoculants on a profitable basis. The development of good distribution facilities in these countries with the selection of capable local private sector representatives plus the supply of full or partially manufactured inoculants from the developed country firms, with the

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addition of a possible backstopping and advice from NifTAL might be a possibility to explore.

There might be opportunities also for some consulting work on a paid basis for NifTAL in longer and more involved commitments with enterprises of developed countries on a contractual basis. There would have to be legal counsel advice on this possibility, and in general for the rendering of services to private enterprises resulting from a project which has been publicly funded.

NifTAL has developed some processes for production of inoculants based on its own model for a fermenter. The NifTAL fermenter is a true innovation, which has met with interest and is presently being used in several countries. The technology is appropriate as to size of production and quality of resulting product to small and medium size companies in developing countries. It would be interesting for NifTAL to improve further on this technology. The linkage with Agricultural Engineering and Microbiology Departments at the University of Hawaii, and other universities and institutions for this activity would be important.

Realizing that quality control by government will at best be an incompletely realized activity, quality control will and must be done by the inoculant producing companies themselves. They will be required to print guarantees on their labels, and will need to reinspect by sampling packages at various periods of time on the shelf of their distributors. For this purpose they will have to develop a statistical sampling procedure. Their samples would then be taken back to their laboratories to check whether their live bacteria numbers are within permissible limits. If they are not, substitution of lots will have to be made. Under this condition of sampling, the state authorities will forfeit the need to establish their own regular sampling and testing, which would demand more laboratories and routine analysis, which might then become an end in itself with large expenses which would not be justified in light of the smallness of the market being controlled. This creates an opportunity for developing a strong rapport between the state and the inoculant producing enterprises. The state officials could inspect the quality control records of the enterprises at random and conduct spot checks to insure consumer protection for the guarantees contained in the labels.

NifTAL should help develop quick quality control checks that might be conducted by inoculating test varieties in portable plastic pouches, and measuring after a few days number and size of nodules, under standardized conditions. Only after lots fail to pass these tests, cell counts would be conducted. This would help everyone, even the farmer to compare product quality.

6. BNF Products Business Model

A BNF Products enterprise model can be depicted only in general terms. It may vary among companies. Some companies may stress some components to the detriment of others. Other enterprises might abstain from participating altogether in some areas. Finally, and especially with larger companies the full array of activities presented next, would be conducted by them.

A model BNF products enterprise should include the following components, presented graphically in Organigram No. 1 and explained below.

a) Stockholders Annual and Extraordinary Meetings

The enterprise is owned by its shareholders. They, except in the case of small or medium size companies, do not run the enterprise. They appoint, either directly or through proxies, Directors who represent a given number of shares each and will run the company through the process of approving major decisions at regularly scheduled Board Meetings. The Directors are elected for the period of time established in the Statutes. There is usually a provision for a Chairman of the Board and for a Managing Director, or a Manager who may not be a director. Auditors for the accounts of the firm are also nominated by the Stockholders at their annual meeting. Stockholders are presented with a Report and Annual Balance describing the activities and results of the company and their future plans. The Stockholders may or may not approve the report that they receive, and in consideration of their interests take further action.

b) Board of Directors

The Board of Directors decides on the structure of the company, on its objectives, strategies, plans, resources needed. It approves the amount of loan requests, their duration and use. Personnel policies, sales, prices, profit targets, distribution and marketing strategies, research objectives and their aim, product mix and quality levels, systems of quality control, and destination of investments and profits. The Board supervises the development of the plans it has approved and takes appropriate steps, based on its analysis. The Chairman of the Board is the person designated by the Board to supervise the functioning of the company on a daily basis, and to see that the plan approved by the Board is basically being complied with.

c) Managing Director or Chief Executive Officer

The higher managing officer at the operating level is the Managing Director or Chief Executive Officer. In an inoculant producing enterprise he is responsible for controlling all the activities of the departments, supervising their performance periodically. He should be in a position to detect failures in production, delays

in some actions, which might bring lack of coordination with other productive steps. He should be vigilant of the research activities in terms of the projects presented for his ultimate approval and the resources used and time employed. The CEO is expected to be capable of monitoring expenses, profits, and costs of production on a regular basis. He is the interface with the world external to the company. He is expected to deal with the higher levels that his enterprise requires from the business world and from the official world.

d) Administrative Department

An Administrative Department is responsible for the functions assigned to each of his sections as follows:

(a) Accounting. In this area expenses, income, and their nature are recorded. Cost accounting and profits are analyzed and ratios obtained. Control of bank accounts, accounts payable and accounts receivable, loans and collections are effected here. Inventory control company-wide is conducted here. Regular reports and monthly and annual balances are prepared. Corrective actions are made when needed and proposed to the CEO.

(b) Personnel. The functions of maintenance of personnel records, the payment roll, presentation of attendance records, accumulated benefits; personnel evaluation, and the control and performance of other obligations concerning personnel, are the responsibility of the staff of this section.

(c) Procurement. This section is charged with the responsibility of procuring or purchasing the goods and services demanded by the production, research, and administration processes of the company, and keeping an updated control of the inventory of purchased goods assigned to them at the company warehouses under their control.

e) Auditing or Control Department

The Auditing and Control Department reports both to the CEO and to the Chairman of the Board, cross-checking and auditing at the same time the various activities of the company, but especially the progression of the flow of money. This is done on a permanent basis.

f) Research and Development Department

The Research Department of an inoculant producing enterprise pursues research projects leading to the improvement of the strains of N-fixing bacteria, either through genetic manipulation of the genes of the bacteria, or by selecting from an array or collection of Rhizobium strains, the more efficient fixers and survivors for any given crop and geographical or soils area. It experiments also with various carriers, means of sterilizing them, chemical additives to the carriers, presentations of the product, packaging, storage, and other factors to insure that the product arrives at

the farm gate in good condition and helps the farmer achieve what he expects he will get for his money. The staff of the Department lays out tests in various locations in order to predict the outcome of new strains, and the effect of various treatments in combination with inoculants. Some tests may be done in the laboratory, others in green or screenhouses, while many are conducted in the field on the crops for which the company sells products. This list is not inclusive of all possible activities; it describes some of the more important ones as an illustration.

g) Production Department

The responsibility of planning the production, on a time basis, requisitioning also the raw materials which will be used, including carriers and the microbial broth quantities required are typical of the decisions that the Production Department will make. It will organize the packing and sterilizing of carriers, the production of broth of inoculants in fermenters in the quantities, opportunities and times needed for the production of each batch of inoculants. It will proceed to perform the actual process of inoculating the carrier, maturing the packages, and storing them under appropriate conditions. Usually it will carry its own standard quality controls for each batch of inoculants produced. In this way it will be able to monitor its own procedures and methods based on an ongoing production quality control. In some companies this department may be charged with increasing the initial inoculant strains. As an alternative the last function mentioned may be part of the responsibilities of the R & D Department.

h) Marketing Department

The Marketing Department is the one responsible for developing the functions of marketing and distribution. Marketing is the set of activities that consist of positioning one or more products in the market, finding their right niche, and investigating about their demand. It monitors responses of users to the product presentation, quality and price, and the satisfaction they derive from its use, as well as negative factors to be corrected. The Marketing Department in an inoculant enterprise would be given additional responsibility to carry out demonstrations of products in farmers' plots; it would distribute free samples, and would work with farm leaders to induce them to transfer the right technology to their neighbors. It would investigate factors of marketing and distribution that would affect prices and would propose the price structure to management. It would also establish the publicity by media and other forms needed to convey information to the community of farmers, extension leaders, government leaders, and business community leaders, as well as to other agents of change.

Through its distribution function, the Marketing Department arranges for the physical distribution of inoculant products to the wholesalers and dealers, on the basis of commercial orders. They are responsible for credit and payments, as well as collections on

arrears, if any. The salesmen of this department should visit farmers, as part of their function to insure that problems of farmers are known and attended to, and to interface with dealers to establish a three-way information linkage: dealer-farmer-salesman. Usually salesmen of agricultural input products have been sufficiently well trained to perform their function in a satisfactory manner. The further addition of extension agents to form a four way linkage has been extremely satisfactory. This linkage, encouraged by input supply companies has been tried in an informal but sufficiently ample manner on the coastal valleys of Peru, with the participation of public, private extension workers (from Farmer Valley Association's own Experiment Stations) input company salesmen and technical personnel, farm leaders and farmers, for obtaining a synergistic effect on technology transfer. The results have been satisfactory; yields of most crops in the coastal valleys of Peru have consistently rated among the highest in the tropical areas of the world. This system is potentially very effective and its ample diffusion is recommended, with leadership being assumed by the Marketing Department of the inoculant company.

This department is generally charged with the responsibility of inventory control of salable products in its warehouses, and for maintaining them under proper condition to insure their high quality at the time of dispatch, through transportation, and at the time of delivery to the dealer.

i) Quality Control Department

The function of quality control may deserve--for larger companies with sufficient inoculant production to justify it--to be located in an independent department. The Quality Control Department will be responsible for establishing quality standards of all carrier materials, assure the status and limits of probability of their sterility; it will sample and test for live rhizobium bacteria in the final products at the factory outlet and after receiving samples from its own warehouse and from dealers, in order to insure that products in the field as yet unsold are within the limits of guarantee. Products which are below guarantee limits should be reported and possibly exchanged at the dealer's shelf.

7. Conclusions and Recommendations to NifTAL on Strategies for BNF Industry and Market Development of Inoculants

As a result of a workshop held by NifTAL in collaboration with PVOs and the Peace Corps, which had targeted several developing countries, consensus was reached that some aspects of BNF technology are presently ready to be employed by the small holder farmer. Greatest benefits appear from inoculating legumes introduced into new areas rather than continuing to inoculate in areas where there is a history of rotations including legumes, and where there is persistence of rhizobial inoculum in the soil. Only after the rhizobial populations dwindle down after years of lack of legume crops, or under poor soil and environmental conditions that

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might affect survival of rhizobium populations, re-inoculation might be deemed necessary.

Certain important grain legume crops such as Phaseolus beans have shown to be non-responsive to inoculation, depriving the inoculant market of a large potential user crop. Yet it has been reported recently that the introduction of genes for high potential nitrogen fixation into common beans has been achieved. Should this technology be extended by plant breeders to more common bean varieties around the world, the market for inoculants would also expand considerably. In addition, conventional breeding for grain legume crops has been rather unimaginative. while breeders of other species have had considerable breakthroughs, achieving the higher yields possible through use of heterosis, legume breeders have been slow to adopt this technology. Only recently the first commercial legume hybrid, a pigeon-pea hybrid, has been released in India. At the University of Hawaii, promising tests of legume tree hybrids give hope for the use of heterosis potential in legume tree species. High yielding common bean hybrids might be obtained in the future. This development would considerably expand the inoculant industry. It would seem to be, therefore, the right combination for a seed company to work with.

NifTAL in planning its future course should not lose sight of the advances in farmer awareness and readiness to accept the new technology, while on the other hand it should also become familiar and give the support it may, to the development of better plant genotypes capable of using the BNF technology.

The Director of Private Enterprise Development of NifTAL, Mr. Tom Carr, has prepared a brief on "Commercial Legume Inoculant Production and Marketing," which we have discussed with him and with Dr. Paul Singleton, Director General of NifTAL. The new initiative postulated by NifTAL is based on the promotion of private sector investment in the inoculant industry and in the marketing of inoculants. It assumes the main beneficiary to be the farmer. It could be argued just as well that the ultimate beneficiary will be the consumer of farm products, through lower costs of the farm products, and higher nutritional quality (higher protein content).

Assistance to the private sector from NifTAL is presented as the general perspective by which NifTAL will unfold its future activities in this new project. This requires translation into the means and modes of action to be used.

In the case of new industries the assistance of NifTAL should be straightforward. Assistance with technology, inoculants, training and backstopping in the start up period are undoubtedly the way that NifTAL's assistance will be more effective. It should not be neglected that some additional training in the case studies available to NifTAL on start ups and problems of other companies will help the new enterprise. Furthermore, some economic and

financial analysis support, including the use of FAIME and other resources will add considerable value to the help package.

For existing industries that are under state direct or indirect control, or where their inoculant selling prices are controlled, the approach that NifTAL ought to follow will be different. NifTAL should become a strong advocate of privatization and ending price controls. Price is an area in which the state should not meddle. Interference from the state in pricing is one of the most critical areas affecting the industry. It should be an area into which NifTAL carefully but with utmost firmness must insist that the state relax its control, preferably at once. Should the state be afraid of misconduct among the enterprises because of a passing stage of monopoly, it could still devise transitory controls through taxation disincentives negotiated with the existing enterprises. It could, as an example, put into effect a reverse progressive taxation on prices when below a certain threshold and a progressive taxation when above the price threshold, when three or fewer companies participate in a given market. Prices should be such that the farmer will get his products at no less than and perhaps slightly more than the border prices for similar products imported from abroad.

For state owned industries in the inoculant field, and which are highly successful but subsidized, whatever the external institutional varnish under which they are presented (mixed company, university laboratory or institute, research station department, etc.), the ultimate aim, whenever possible, should be their privatization. The privatization process could be, nevertheless, lengthened under some circumstances, but preferably not, as long processes tend to go nowhere. Preparations should be made for the industry to be transferred to private shareholders, on a timetable of 12 to 18 months as a maximum. The transfer process should be under auction in public bidding. Usually workers in the industry could be given an option to pay for some 10% of the shares over a period of time, but the rest of the shares should be auctioned. Workers could also participate in competitive bidding for a portion of the balance of the shares.

Private sector enterprises are more stable because of the conditions under which they operate. Better salaries and motivation of personnel, better budget control, not necessarily larger financial outlays, but directed to proper channels of expense and at the right time; clear objectives and ways of approaching them, usually present a substantial difference with the behavior of public sector owned or managed enterprises. But not all private sector enterprises are successful. Many of them fail. It is precisely here that NifTAL can be of help in insuring that the juvenile development period of the enterprises it promotes, is passed with a minimum of problems. When mature, the inoculant industries will be more likely to fare well on their own.

The elimination of the agricultural extension system as a vehicle for physical distribution of the inoculants from the private or public inoculant producing enterprises should be the next objective of NifTAL's advice. The extension system should be dedicated to its primary and fundamental reason of being, which is the education of the farmer through training and demonstrations in the art and science of farming. Extension agents should not be used, at taxpayers cost to subsidize the distribution system of the state owned or private enterprises. The enterprises should pick up the full cost of distribution, include it in their own total costs, expand their marketing budget, cost it as well, add the cost of using dealers as a permanent distribution resource, and charge the full cost to the farmer. The farmer should pay it if the technology is correct and gives him advantages (i.e., against the equivalent cost of fertilizers). If prices paid for the crop commodity to the farmer are controlled by the government, such prices should be released from control, to allow the farmer also better income and control over his choice of the technology level (and its cost) that he may wish to adopt.

NifTAL should next design its policies of private sector support in a global manner. It should investigate and develop a comprehensive database of the inoculum industry worldwide. This database should include for every country of the world the companies and public institutions that do the following:

(a) Research and development on BNF
(b) Maintenance of rhizobial strain collections
(c) Production of commercial rhizobial inoculants
(d) Import, export of rhizobial inoculants
(e) Marketing and distribution of rhizobial inoculants

A list of companies and profiles for some is included in the Appendix. NifTAL should make a complete survey to form an updated database.

Through contacts with USAID missions in all countries under USAID-local government joint development agreements, NifTAL should make available to their respective country development corporations profiles of three standard sizes of idealized inoculum companies, which could be promoted to entice the entry of new investors, even if there are already inoculant companies in existence. Should any of the USAID missions be sufficiently well convinced that there is a priority for such an industry in their target country, NifTAL should avail itself of the opportunity to close a deal with the local USAID mission to promote such enterprises, when deemed feasible.

In selecting target countries, NifTAL should adopt the Guideline Policy concept. A series of considerations should be built into a document entitled something like "A Guideline Policy Paper on Target Countries for Private Enterprise Development in the Inoculant Industry Subsector." Conditions for NifTAL's involvement

should be prearranged. These would include willingness of the government to cooperate, the existence of an appropriate business environment (which should be tested with a series of stringent tests), the possible existence of a market for inoculants leading to a reasonable success potential for private enterprise activities, the human and institutional resources available, and the presence of entrepreneurs who might invest in inoculant enterprise activities. Countries should be prioritized on the basis of these Guidelines, and actions of NifTAL in the business promotion area should go accordingly in order of priorities. This is not to say that NifTAL should not also work on an opportunistic basis. It may be that some USAID mission in a given country is ready and willing to support NifTAL's private business project, ahead of its priority status. NifTAL should then discuss the option and take positive action, provided that there is a reasonable opportunity for success. NifTAL should not get involved in any country where any private business project is doubtful or sure not to be successful.

NifTAL should develop for a number of target countries what might be called "BNF Country Profiles." These could be published guides for prospective investors in BNF enterprises. Make these guides available to them through non-restrictive distribution, through both government and independent channels. Of the latter, there are Chambers of Commerce, Industrial Development Administrations and private Industry Associations and other similar institutions. These profiles would depict the inoculant industry, its potentials and limitations, investment costs and profit potential range. Sources of information and possibility of NifTAL support should be mentioned.

Linkages should be established with the Farmers Associations, Industrial Promotion Organizations, and Chambers of Commerce in various countries to promote BNF technology. In particular, the Seed Industry and Trade Association of any of a number of countries is a very likely partner in either the promotion of the production of inoculants, their distribution or both.

Interested businessmen identified in the search for interested parties should be invited to local, regional or even national or international workshops, where NifTAL would expose them to the benefits that they could expect to derive from investment in BNF enterprises.

While quality control is definitely a need for having a good product, NifTAL should revert from its former policy of unloading that responsibility fully on the government institutions. Quality control is unlikely to be the watchdog it pretends to be, when handled by the state, if experiences with seeds control, which comes from a much larger economic subsector is a guideline. Quality control should be established through a consumer protection law for agro-inputs into which a section for inoculants with its own standards of quality should be inserted. Inoculant companies

should label their products with the guarantee they are willing to supply, not lower than the minimum standards imposed by government. The firm itself should establish its own quality control in order to comply with its own guarantees which could have standards higher than the law's minimum.

NifTAL could enter into agreements with corporations to supply them with the results of mutually contracted research and development. NifTAL should be allowed to patent inventions and to license them. In both cases cited above, the provisions of the Federal Technology Transfer Act of 1986 of the U.S. should be useful as guidelines. Legal counsel would be needed in defining options which NifTAL could exercise in contractual agreements with corporations in the U.S. and elsewhere.

NifTAL should not ignore the reality of the existence of inoculant producing corporations in the U.S. and in other countries, who have invested considerable sums of money in research, production and marketing. While NifTAL may not be at ease in promoting anyone's brand products, it could incorporate the products of any of these firms, initially for no fee, and later for a fee, in comparative studies of performance of the inoculant products in a few key representative crops and locations, as a stimulus to the development of country testing by local agencies to follow up. NifTAL could also cooperate with these companies in supplying them free of charge with information and advice, which would allow them to independently conduct their marketing efforts without undue repetition and waste of efforts. As it has been doing in the past, NifTAL could exchange technical information with such companies, allowing them, as well as companies of less developed countries to obtain full benefit from NifTAL's projects. The contacts with U.S. and other companies, whether national or multinational, should be extended as well to their potential interest in investing in less developed countries in the inoculant industry or in expanding their distribution network.

Sources of peat, both sterilized and non-sterile from different parts of the world, could be of interest as carriers of inoculants to manufacturers in other countries. NifTAL could make a study of these sources and supply the information, and update it from time to time.

NifTAL should take the initiative and initiate case studies in a few typical target countries on the inoculant industry. The studies should be conducted independently of NifTAL, although contracted by NifTAL, in order to avoid the trap of trying to be "nice" in order to maintain working contacts for the institution in some key countries. Whatever the results, they should be analyzed in detail by NifTAL, and if appropriate and necessary they should be brought to the attention of the appropriate parties and decision makers in those countries. Comparisons between the results of the country profiles of their inoculum industry could be appropriate reference material for workshops on industry development.

A most important feature of the New NifTAL Inoculant Industry Project should be the development of workshops and training as a key component of its outreach activity. These would require planning as to their opportunity, contents and locations.

NifTAL has embarked on an ambitious enterprise. Supporting the development of private enterprises for the production and marketing of rhizobial inoculants is not a new area of action for NifTAL, but the new scope and degree of commitment are. NifTAL is basically a research and outreach institution, with primarily a service mandate. After discovering that the major bottleneck to its mandate was the uncertainty of sustained and secure availability of inoculants, at reasonable prices, on a larger basis of usage than had been reached with government efforts, it became clear to both NifTAL and USAID, that action on expanding the participation of the private sector was of the utmost importance to the efforts that had accumulated at that point.

The Industry Council for Development, which was called in to advise on the steps to be taken by NifTAL in its future activities on business promotion enterprise, appreciates the opportunity of having been of service in the course of this study and gladly presents the ideas expressed in this document. We believe that NifTAL after reading and reflecting on these lines, of advice, will have a clearer view on how to readjust its promotional policy, and put it into sharper focus, keeping in perspective the magnitude of its mandate and global nature.

NifTAL will need to influence with a promotional approach not only target country beneficiaries, but also the USAID country missions, from which added support in human expertise and funding can be obtained.

NifTAL will also have to develop alliances with organizations of the international private sector and other support institutions to engage them in key phases of its future strategy. The extent to which NifTAL will be able to organize its collaborative links and use all the resources that it has at its disposal and those that can be tapped outside its own, and apply them without distractions to reach clearly defined objectives in inoculant enterprise promotion, will be reflected in its success in fulfilling its mandate.

ICD ORGANIGRAM NO. 1
NifTAL Report

Organigram of a Model BNF Enterprise

Stockholders Regular
and Extraordinary Meetings

Board of Directors
Chairman of the Board

Chief Executive Officer

Administrative Dept.

Research Dept.

Production Dept.

Marketing Dept.

Sections:

Accounting
Personnel
Procurement

Auditing
Control
Dept.

Quality
Control
Dept.

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