PD-ABC-001
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REPORT OF THE MIDTERM EXTERNAL EVALUATION OF THE INTERNATIONAL BENCHMARK SITES NETWORK FOR AGROTECHNOLOGY TRANSFER (IBSNAT) PROJECT

9 JULY TO 14 JULY, 1990

Comprehensive External Evaluation Panel

Johan Bouma
Ray Jensen
David R. MacKenzie, Chairman
Dale N. Moss
Truman Phillips
Frank Alejandro (Ex officio)

Grant number: DAN-4054-A-00-7081-00
Project number: 936-4054
Cooperative Agreement
September 1, 1987 - August 31, 1992
Granted to
College of Tropical Agriculture and Human Resources
University of Hawaii at Manoa

Prepared under Contract PDC-1406-I-00-0034-00, Delivery Order No.2

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IRG

MEMORANDUM OF RECORD

September 7, 1990

SUBJECT: IBSNAT Evaluation Report

TO: File

During the interval between drafting the Evaluation Panel's consensus report and this final report, information has been made available to the Panel Chairman that impacts some of our recommendations. This supplemental information deals with 1) IBSNAT "Buy-Ins" to support Program activities that go beyond the U.S. AID Cooperative Agreement and 2) results of a post-review survey to determine the user profile of DSSAT software.

To remain consistent with the principles of consensus building, and to establish the Final Report in a timely manner, I have decided, as Panel Chairman, to record this additional information as a Memorandum of Record, to be reproduced with the Final Report.

The supplemental information should be considered by the reader when interpreting the Evaluation Panel's recommendations contained in this report.

Sincerely,

David R. MacKenzie

DAVID R. MacKENZIE
Evaluation Panel Chairman

cc:
Evaluation Panel
U.S. AID
IBSNAT

Table 1 presents, in U.S. dollar amounts, current and anticipated buy-ins to IBSNAT.

Table 1

IBSNAT BUY-INS

	Country/Institution	Amount
FY - 1990		
	Malawi (Rockefeller)	110,000
	South Pacific (CIRAD)	100,000
	Guatemala (PSTC)	50,000
	India (FAO)	15,000
	Indonesia (USAID/MUCIA)	10,000
	Botswana (USAID)	1,250
	Australia (CSIRO)	7,500
	India (ICRISAT)	30,000
	Canada (Univ. Guelph)	90,000
	U.S. (Univ. Florida)	45,000
	U.S. (USDA-406, Hawaii)	50,000
	U.S. (USDA-CBAG, P. Rico)	40,000
	U.S. (USDA/ARS, Prosser)	25,000
	U.S. (USDA/ARS, TARC/Mayaguez)	25,000
		598,750
FY - 1991		
	Australia (for LDCs)(Nat'l Univ.)	830,000

Table 2 presents, as a percentage, the breakdown of 62 respondents to a questionnaire distributed by IBSNAT regarding the uses and usefulness of the DSSAT software package.

Table 2

RESPONSE TO THE QUESTIONNAIRE ON DSSAT PACKAGE USE

			%
1. Institutions Involved:		Universities	36
		NARCs	33
		Govt. Agencies	20
		IARCs	11
2. DSSAT Used For:		Research	85
		Planning	20
		Teaching	15
		Extension	12
3. Ease of DSSAT Installation:		Easy	72
		Somewhat Difficult	16
		Needed Help	12
4. DSSAT Component Used For:		Crop Models	90
		Strategy Evaluation	60
		Data Base Management	55
		Weather Estimator	42
5. Crop Models Used:		Maize	69
		Wheat	39
		Soybean	39
		Peanuts	15
6. Additional DSSAT Components Desired:			
Crops	58	Whole Farm	32
Genetic Coefficient	53	Agroforestry/Fruits	27
Pest/Diseases	53	Nutrient/Chemical Movement	
Intercrops	47	Grazing Interface	
Soil Data Estimator	45	CO_2 Enrichment	
7. Request for Additional Training:			69
Those who Could Finance Training:			35
8. DSSAT Usefulness for Decision Making			
		Very Important	29
		Useful	51
		Academic Interest	20

Abbreviations and Acronyms Used in the Report

AGR .....Office of Agriculture/S & T, U.S. AID
ARS .....Agricultural Research Service, U.S. Department of Agriculture
AVRDC .....Asian Vegetable Research and Development Center
BNF .....Biological Nitrogen Fixation
CATIE .....Centro Agronomico Tropical de Investigacion y Ensenanca
CIAT .....International Center for Tropical Agriculture
CIP .....International Potato Center
CRSP .....Collaborative Research Support Program
DBMS .....Data Base Management System
DSSAT .....Decision Support System for Agrotechnology Transfer
GIS.....Geographic Information Systems
IBPGR .....International Board for Plant Genetic Resources
IBSNAT ....International Benchmark Sites Network for Agrotechnology Transfer
IBSRAM ....International Board for Soil Research and Management
ICARDA ....International Center for Agricultural Research in the Dry Areas
ICRISAT ...International Crops Research Institute for the Semi-Arid Tropics
IFDC .....International Fertilizer Development Center
IRRI .....International Rice Research Institute
LDC .....Less Developed Country
NifTAL ....Nitrogen Fixation for Tropical Agricultural Legumes Project
SARSA .....Human Settlements and Natural Resource System Analysis
SMSS .....Soil Management Support Services
TSMM .....Technology of Soil Moisture Management
UH .....University of Hawaii
U.S. AID...United States Agency for International Development

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IBSNAT PROJECT EVALUATION

Executive Summary

The International Benchmark Sites Network for Agrotechnology Transfer (IBSNAT) is a joint project between U.S. AID and the University of Hawaii, funded through a Cooperative Agreement. The intention of the project is to demonstrate the applicability of computer modeling of crop development and yield as an assistance to decision making. The intended applications of the project's discoveries are for less-developed country (LDC) agriculture as a substitute decision making tool. This tool could replace costly and time-consuming agronomic field trials, and would be especially important for resource-poor situations. These applications might include policy decisions, research planning, and farm-level production decisions.

The computer program developed by the project has been titled the Decision Support System for Agrotechnology Transfer (DSSAT). It combines soil, weather and crop information to produce scientifically validated simulations of crop growth and yield. At present four crops are included in the computer program: maize, soybean, wheat and peanut. Other crops are presently under development, and are in various stages of completion.

U.S. AID Washington requested an evaluation of the IBSNAT Project which is midterm in its five-year Cooperative Agreement. A panel

of five scientists representing a mix of scientific disciplines appropriate to the IBSNAT activities, plus an ex officio U.S. AID representative, conducted the evaluation. The Panel was provided with extensive documentation from IBSNAT. They were given written terms of reference, including seven specific questions that were to be considered by the Panel as part of its evaluation. Prior to the on-site review, which was conducted in Hawaii July 9-14, 1990, the Panel chairman met with U.S. AID Washington administrators. This pre-conference meeting provided useful background information for the Panel and set the evaluation in proper perspective.

During the on-site visit, the Panel visited research plots, facilities, university administrators, project managers and the project's Technical Advisory Committee (which functions as a working group), as well as the scientific and technical staff of the project. The Panel also had opportunity to use the DSSAT computer software to explore some specific simulations of individual interest.

Formal presentations and discussions with IBSNAT scientific and technical staff (including their "extended family" through the Technical Advisory Committee) provided valuable information for the Panel's deliberations and its assessments of the activities and linkages of the IBSNAT Project.

In the Panel's view, IBSNAT has made significant accomplishments during the period of its Cooperative Agreement. The Project's cornerstone, DSSAT Version 2.1, with excellent documentation, has been distributed to 162 subscribers around the world. IBSNAT has expanded its data sets and crop models, and continues work to validate the system for assurances to users that the models are providing the best possible information.

The computer program DSSAT is getting both expected and unexpected applications to agriculture. Research scientists around the world are using it to help plan better experimentation. Policy makers are using it to guide their decision making. An unexpected application of the computer program has been made by the U. S. Environmental Protection Agency to study global climate change. Through EPA funding, a team of scientists explored the consequences of increased atmospheric temperatures and precipitation changes that will result as a consequence of predicted increased levels of atmospheric carbon dioxide. The results of this study were recently published (May 1990) in the prestigious journal Nature. Clearly, other aggregate information derived through DSSAT simulation will be used for other applications, such as evaluating sustainable agriculture, tactics of pest management and strategies for whole farming systems perspectives.

Planned IBSNAT activities include the continued development of data sets and models, as specified in the Cooperative Agreement. The Project also plans to add a socioeconomic dimension to DSSAT that will greatly assist in the understanding of on-farm choices, and the consequences of policy decisions. The Project also plans to add modules that will deal with biological and physical constraints to crop growth. It will do so through open architecture software that will allow desirable applications flexibility. The Project will also add a multiple cropping/crop sequence module that will be particularly useful for small farm evaluations in LDCs.

Throughout the course of the Panel's deliberation, some positive and noteworthy characteristics of the Project became evident. The Panel cites these in its report as Commendations. Three of these are provided in this summary:

- The Panel commends the quality and commitment of the IBSNAT scientific and technical staff. Their outstanding contributions to the Project are noted. Especially noteworthy to the Panel are the contributions through leadership and shared recognition by the Project's Principal Investigator, Goro Uehara. His style of management is no doubt one of the major contributing factors to the Project's success through global collaboration.

- The Panel commends IBSNAT for its success in attracting willing collaborators around the world. This aspect of the Project has meant that the U.S. AID funding has been heavily "leveraged" to the benefit of the primary funding agency and the success of the Project.

- The Panel commends IBSNAT for its foresight in selecting aminimum data set for crop simulations. This decision has strongly contributed to the Project's success through appropriate requirements balanced against realistic expectations from users. The Panel acknowledges the quality of the IBSNAT data sets and recognizes how valuable these collections are to science.

The Panel also made a number of recommendations for the Project to consider. Eight of these have been included in this Summary:

- The Panel appreciates the potential of the proposed intercropping model and recommends that this approach be fostered by IBSNAT.

- The Panel encourages the complementary use of simulation and expert systems and recommends that these applications be directed at the farm level.

- The Panel recognizes the significant potential applications of DSSAT to area and regional planning, and recommends that efforts be devoted to developing scientifically valid aggregation procedures for DSSAT output using Geographic Information Systems (GIS) technology.

- The Panel recognizes that there may be insufficient time remaining in the Cooperative Agreement to accomplish all of the proposed whole-farm systems activities. The Panel recommends that prototype models, perhaps based on synthetic data, be used to demonstrate how the whole-farm system approach can be linked to DSSAT.

- The Panel endorses the emerging pattern of "training the trainer" as it represents an efficient way of disseminating DSSAT to intended users in LDCs. The Panel recommends that the effort be extended beyond the scientific community to include related disciplines, policy makers, lay audiences, extension specialists and others.

- The Panel notes the need for separate validation procedures for the various subprograms within the overall crop simulation programs. There is also a need to improve the quality of the calibration and validation procedures for the overall model (e.g. water movement, root development, photosynthetic

algorithms). The Panel recommends that this need be addressed.

- The Panel strongly recommends that, in future reviews, the U.S. AID Project Officer be permitted to participate as an ex officio panel member. This could have the benefit of providing historical information, programmatic knowledge and perspective to the Panel during its evaluations and deliberations.

- The Panel recognizes the potential value of the application of DSSAT to LDCs and suggests an evaluation of why country missions are not participating in the Project through "buy-ins." This evaluation should then be shared with IBSNAT in furtherance of the Cooperative Agreement.

- The Panel strongly recommends continued support for IBSNAT. The present investment in IBSNAT by U.S. AID is paying handsome dividends. It has attracted additional support which should continue to grow. Long-term plans should be made by U.S. AID to protect its investment in this valuable and successful Project.

During the Project evaluation, the Panel had opportunity to collate some lessons that could be learned from the success of IBSNAT. The Panel chose to include them in its report for the

benefit of other projects that might not otherwise be familiar with IBSNAT. These lessons are:

- A successful project has a conceptual framework that is common to the project participants, with stated and consistently applied goals.

- A shared vision of a process-oriented research approach is instrumental in achieving an effective multidisciplinary team study.

- A working group is an effective networking mechanism to extend a project's membership and enlist the cooperation of other collaborators.

- A network can serve as an effective clearinghouse for information and for the coordination of activities for a research project.

- When a project has intensive data requirements, it is wise to define early the minimum data set and the means for integration of disciplines.

- Open architecture computer programming allows replacement of individual modules which describe aspects of the overall program (e.g. water movement, root development,

photosynthesis algorithms etc.). Thus, other researchers can benefit by testing and incorporating their own modules within the DSSAT package.

- When one puts out a quality product, people will use it.

The Evaluation Panel has concluded that IBSNAT is a well-managed, highly productive project that is worthy of continued support from U.S. AID. Progress to date has been very good and the likelihood of the Project meeting its objectives by the end of the 5 year Cooperative Agreement seems reasonably assured.

INTRODUCTION

Purpose of Review

The Office of Agriculture, Bureau of Science and Technology of the U.S. Agency for International Development (U.S. AID) has been funding the International Benchmark Sites Network for Agrotechnology Transfer (IBSNAT) at the University of Hawaii at Manoa since 1982. Under the current Cooperative Agreement, the Project has been developing a prototype Decision Support System for Agrotechnology Transfer (DSSAT) for certain applications in agriculture. These applications include crop growth simulation models that use natural resource databases to explore relevant choices and enable decision makers to make better choices.

The Project was initiated in 1982 and is presently midterm in its second five-year cycle of funding. It was determined by U.S. AID that a midterm evaluation would serve their needs to monitor the Project's performance and to provide a scientific evaluation for the Project's current and planned activities.

History of the Project

In the late 1970's, U.S. AID sponsored a Benchmark Soils Project that successfully demonstrated the utility of the Soil Conservation Services' soils taxonomy system and the U.N. Food

and Agricultural Organizations land evaluation scheme. The Benchmark Soils Project developed the concept of "agrotechnology transfer by analogy." The Benchmark Soils Project involved the Universities of Hawaii and Puerto Rico and was supported by the Soil Management Support Service (SMSS) of the Soil Conservation Service (SCS).

Based on the success of the Benchmark Soils Project, it was proposed in 1982 that U.S. AID provide financial support for an International Benchmark Sites Network for Agrotechnology Transfer (IBSNAT) Project that would be a continuation of the collaborative efforts of the University of Hawaii and University of Puerto Rico. The IBSNAT Project proposed to bring together, through a Systems Science perspective, the transfer of technology by crop simulation. This would be done by combining the natural resource information of the Benchmark Soils Project with weather information and the then-emerging crop simulation technology. In this way IBSNAT would provide agricultural researchers, policy planners and decision-makers with a "tool" for exploring complex physical and biological relationships.

With the completion of the first phase of the Project on August 31, 1987, U.S. AID provided continuity of funding through a Cooperative Agreement for a five-year period ending August 31, 1992.

Summary of Last Review

From 29 September to 4 October, 1985, a five member panel conducted an evaluation of IBSNAT at the request of U.S. AID. The overall assessment of that panel reported:

- Performance to date ranges from satisfactory to outstanding.
- The probability of successfully achieving the Project's objective (purpose) remains high. The team is not sanguine, however, that this can be adequately accomplished by 1987.
- With the accelerating changes in systems and information technology, the expected impact of IBSNAT results has not only remained valid, but has increased.

A number of recommendations were included in the evaluation panel's report. Virtually all of those recommendations have been acted upon by IBSNAT, to varying degrees.

TERMS OF REFERENCE FOR THE PRESENT REVIEW

This Panel was charged with the following responsibilities:

- Assessing the performance of the Project.
- Evaluating the probability of successfully achieving the Project's objectives.

- Re-validating the expected impact of the Project's objective/purpose to agriculture in less developed countries (LDCs).

In that context, the Panel was asked to address, in addition to other topics, the following issues:

- Are the Project's rationale and objectives, including the programs and input still relevant and significant to developing country needs?

- Is there satisfactory progress on the Project's core output since its inception in 1982? Is it probable that all Project outputs will be completed on schedule and within the parameters of the Project period?

- Are the resultant technologies, methodologies and products of the Project being used by various countries (developed and developing)? What is the scope of such use?

- Is there good cooperation between IBSNAT and other S&T/AGR projects as well as programs of various national and international institutions? What is the general level of interest and collaboration between IBSNAT and other entities in terms of activities and resources?

- How has the Technical Advisory Committee (TAC) guided the Project? What is the extent of its involvement with the Project? In what different ways has the Project benefitted from the committee members -- individually and collectively?

- How effective is the technical/informational network established by IBSNAT and other scientists, throughout the world? Briefly describe its scope and possible impact.

- Are there Project performance and management issues/concerns which affect efficiency, effectiveness, impact and sustainability?

METHODOLOGY OF REVIEW

Initial U.S. AID contacts

On June 29, 1990, the Panel chairman met with U.S. AID officials in Rosslyn, Virginia, to discuss the planned review of IBSNAT. The U.S. AID officials included Dr. David Bathrick, Dr. Tejpal Gill, and Dr. Frank Alejandro. In addition, Dr. Robert A. Delemarre of the International Resources Group attended. During the course of the conversation, discussions turned to the use of computer models to increase the efficiency of decision-making and research policy-making and planning. It was noted that there was increased excitement in the application of computer simulation

for such topics as global climate change and sustainable agriculture. The challenge to a project like IBSNAT is to link state-of-the-art technology to third world farmers.

During the conversation it was noted that IBSNAT is attracting interest of the International Agricultural Research Centers who see DSSAT's application as a decision tool. The IBSNAT approach also seems to be particularly appropriate to those institutions that don't have the money to directly research all relevant questions, and would like to eliminate some of the choices based on crop simulations for interpretation of physical and biological interactions. It was noted that there is today a need to maximize the use of limited resources and to increase the efficiency of their allocation. The challenges to agricultural research are greater than ever, and that the cost of research to maintain our current levels of production continues to be a drain on our limited resources. The IBSNAT methodology is seen as one way of perhaps increasing the efficiency of making choices as well as providing better communication linkages throughout the agricultural community.

The interest of U.S. AID, it was noted, is directed toward small-scale farmers, many of whom are engaged in mixed agricultural production systems. The Panel was therefore asked to judge the appropriateness of IBSNAT to the small-scale farmers, especially those engaged in multiple cropping.

It was noted that there are those who are skeptical of the use of computer simulation as a tool to assist the small-scale farmer of the tropics. The charge to the Panel was, then, to conduct a scientifically based evaluation of the likelihood of IBSNAT making useful contributions.

Panel make-up

The Panel that was assembled to conduct the IBSNAT evaluation included, by design, established agricultural scientists knowledgeable in one or more of the following disciplines: meteorology and climatology; crop modeling; socioeconomic perspective; international agricultural development; crop modeling; crop improvement; crop protection; and soils and water relations. All of the Panel members had experience, either directly or indirectly, in computer modeling, statistics and prediction technology. The Panel membership and a brief description of each is presented as Appendix A.

Site visits

The Panel arrived in Honolulu, Hawaii, on July 8, 1990. On the morning of July 9, 1990, the Panel assembled for an organizational meeting on the campus of the University of Hawaii at Manoa. Later that morning the Panel and representatives from IBSNAT flew to the island of Maui to visit research sites at Kula

(high elevation), Makawao (mid elevation) and Paia (low elevation). The last site is also the site of NifTAL Project of the University of Hawaii (also funded by U.S. AID).

The visit to Maui gave the Panel an opportunity to visit the research sites and to observe the specific biological, climatological, and physical factors being studied. This information is being used by IBSNAT for the development of certain components of the simulation models. The Panel returned to Honolulu on the evening of the same day.

Conferencing

On the morning of July 10, the Panel met with the Dean of the College of Tropical Agriculture and Human Resources, University of Hawaii for a briefing on aspects of IBSNAT. The Panel then met with the Director of the Research Corporation for the University of Hawaii which serves as the management and service office of the IBSNAT Cooperative Agreement. Following that conference, the Panel, IBSNAT staff and members of the IBSNAT Technical Advisory Committee (TAC) flew to Kona on the Island of Hawaii (a.k.a. The Big Island) for a four-day conference and review of IBSNAT. It was by intention that the TAC met concurrently with the Panel. This provided the Panel opportunity for direct consultation with TAC. This was judged to be a valuable source of information for the Panel.

Consensus building

Based on the written information supplied to the Panel by IBSNAT; the charge to the panel by U.S. AID; our visit to the research sites; our assessment of IBSNAT activities in cross-linkages to other projects; and our conferences with IBSNAT staff, and the TAC, the Panel has prepared this report as a consensus document. Our findings evaluate the accomplishments of IBSNAT since the last evaluation. We provide a compilation of proposed activities through the end of the current Cooperative Agreement. We also provide assessments of the Project's likelihood of success, the constraints faced and the lessons to be learned. These are then complemented by activities and changes that are needed for the Project to meet its objectives. These are given as recommendations.

PROPOSED OBJECTIVES OF THE PROJECT

As stated by the Project, IBSNAT's goal is to improve LDC farm performance and increase the family income of resource-poor farmers by enabling them to make better choices. This could come from better integration of new crops, products and practices within existing farming systems without sacrificing the stability or sustainability of production.

To attain this goal, the Project has three objectives:

- Produce a prototype decision support system consisting of databases and decision aids useful to decision makers operating at the policy and farm levels.
- Validate components of the decision support system to enable users throughout the tropics to simulate and evaluate alternative agronomic, economic and environmental strategies.
- Demonstrate the utility of the decision support system through case studies.

The premise of IBSNAT is that computer simulation can be used as a tool to make better judgements on the allocation of resources. This tool could be used by both agricultural researchers and production agriculture decision makers, whether at the farm level or (in the aggregate) for an area or region. This premise is based on the argument that the experimental method, systematically applied to specific questions, is a better alternative to trial and error solutions. However, in some cases the experimental method has significant limitations. This is particularly true in complex physical and biological interactions which do not lend themselves well to reductionist methodology.

Systems Science offers a more holistic approach to the study of complex physical and biological interactions. But trying to

understand those interactions quite often exceeds the capacity of the interested individual -- researcher, extension specialist, or policy maker. Herein lies the application of computer simulation for the evaluation of complex associations; to help make better choices. This rationale is precisely the approach of IBSNAT, which proposes to develop a prototype Decision Support System for Agrotechnology Transfer (DSSAT).

ACCOMPLISHMENTS SINCE LAST REVIEW

This Panel reviewed the 1985 report of the midterm External Evaluation of the IBSNAT Project to establish a baseline for determining the progress of the Project since the last review. It was decided by the Panel to review the Project's accomplishments in the areas of:

- Applications
- Model development
- Data sets
- Communication
- Project management

Applications

The major accomplishment of IBSNAT since the last review has been the release and distribution of DSSAT Version 2.1; software and

manuals. The distribution of 162 copies of DSSAT is strong testament to the interest that the Project has attracted. DSSAT's distribution to more than 30 developing countries (62 copies) is judged by the Panel to be significant.

Several examples of the application of DSSAT to the farm-level were cited during the course of the Panel's discussions. One of these was an evaluation of the impact of increased access to fertilizer for farmers in India (see Box 1).

The International Fertilizer Development Center (IFDC) is using DSSAT to assist Indian sorghum farmers in making the best use of their limited resources. Using soils data obtained from FAO and weather data from the Indian Meteorological Services, DSSAT simulated 25 years of sorghum growing to create 20%, 50% and 80% probability maps for grain yield, net return, nitrogen loss, growing season length and other parameters. The output maps from the simulation identify fertilizer responsive areas, regions with high yields and high returns, and locations with low nitrogen losses. The information is also considered valuable for making policy decisions regarding fertilizer subsidies and the allocation of fertilizers through the national marketing and distribution system.

Box 1 - India

Interest has also developed in using DSSAT to aggregate information to look at regional relationships. This Geographic Information System (GIS) approach has application to studies of global climate change and sustainable agriculture. One such application recently led to a publication in the prestigious journal Nature. This study, initiated by the U. S. Environmental Protection Agency, looked at the effects of carbon dioxide on crop production in twenty different countries (see Box 2).

The EPA was mandated in 1989 to undertake an international study of the possible effects of global climate change on world food supplies and distribution. The IBSNAT Project was contacted to cooperate in this study. An agreement was developed between U.S. EPA and U.S. AID for the IBSNAT Project to assist in the study by supplying modified DSSAT models to the EPA. IBSNAT also assisted by training the international participants in the use of the software and by modifying certain crop models for this particular DSSAT application. Participants from 22 countries are working as a team to complete this evaluation. One of the studies was recently published in Nature (Adams, et al. 1990. Global Climate Change and U.S. Agriculture. Nature vol. 345; 219-224). More studies are planned.

Box 2 - Environmental Protection Agency

A similar GIS application of DSSAT has been undertaken in Puerto Rico to study the consequence of certain types of crop production (see Box 3).

Scientists in Puerto Rico are using DSSAT to develop a soil erosion model for rice and bean production on nitrogen leaching, soil loss and other factors. Cropping pattern effects will be useful to guide decision makers in developing land-use and environmental policies. This specific application uses three areas in Western Puerto Rico selected for demonstration of the technology. Soil and weather data have been digitized and validation experiments are in progress. Output from the system will be thematic maps and tables aggregated for regional interpretation.

Box 3 - Puerto Rico

Models

Significant progress has been made by IBSNAT in the development of the crop models for the DSSAT program. Four crop models (maize, wheat, soybean and peanut) are now available and 8 others are under development at this time. Each model operates on the

minimum data set and each has been calibrated using specified protocols. This aspect of the Project is progressing very well.

These crop growth models represent the core of DSSAT. They are used to simulate the development and productivity of crops. The models are "driven" by daily weather inputs, soil conditions and other factors.

Specific accomplishments in crop modeling since the last evaluation include:

- Completion of the peanut model
- Validation of four crop models (wheat, maize, soybean and peanut)
- Development of a functional model for barley
- Development and testing of a potato model
- Development of sorghum, millet and rice models
- Development and calibration of a dry bean model

These crop growth model efforts (development and validation) are considered by the Panel to be impressive. It is important to note that much of the crop modeling effort has been done through collaboration, especially with those scientists who serve on the Technical Advisory Committee of IBSNAT. Some of the activities in crop growth modeling have been supported through subcontracts, but much of the work has been accomplished gratis to the Project.

One crop, cassava, has not received much crop modeling attention, although it was specified in the Cooperative Agreement. This is because no collaborator has been identified.

In summary, the progress on crop modeling by IBSNAT has been exceptional and considerably more than could have been expected had there not been "leveraging" of activities through collaboration.

Data Sets

A particularly strong point of the IBSNAT crop models is their sensitivity to cultivar differences. Without this attribute, technology transfer would not be possible since individual cultivar performance is a major component of cropping technology. In order to build that sensitivity into the crop growth models, it was necessary to determine those factors that lead to cultivar differences in growth and development. These factors are then incorporated into the DSSAT models as genetic coefficients. Genetic coefficients describe the quantitative growth responses of a cultivar to environmental conditions. This aspect of the crop growth models represents a limitation to DSSAT, as many genetic coefficients are not known and must be determined experimentally.

To solve this problem, IBSNAT is developing an application of expert systems to assist in deriving genetic coefficients from minimum data sets for cultivars. The successful completion of this expert system will be a key element in future versions of DSSAT.

In addition to the crop models, DSSAT offers data sets on weather, crop management, soil and crop responses. This information has been gathered by IBSNAT collaborators at numerous locations worldwide. However, at present there are no socioeconomic or pest/disease data sets in the system. IBSNAT proposes to collect these data sets as future activities.

The successful assembling of the IBSNAT data sets has been the result of concentrated efforts to standardize experimental designs and information collection procedures. Consequently, IBSNAT receives uniform data sets from collaborators willing to support the program. The data sets are important in developing crop growth models, modifying existing models, and verifying and calibrating models. The data sets play an important and useful role as information that can be used for many types of scientific studies that go beyond DSSAT. About 85 data sets are available, including:

- Maize = 40
- Soybeans = 20
- Wheat = 15
- Peanuts = 10

It is self-evident that, if one is to use crop simulation, long-term weather information is necessary to adequately assess crop performance in a particular region. In many LDCs, weather information is scarce or non-existent; and when available, it may not be the desired information or it may not be directly observed. To address this inadequacy, IBSNAT collaborators are using two weather generators. It is recognized by IBSNAT that these two weather generators may not accurately synthesize weather data, especially in the tropics. Activities are underway to develop a new weather simulator that will perform more satisfactorily for tropical conditions.

Communication

IBSNAT has been successful in communicating its results through publications, symposia, training courses, workshops and other mechanisms. IBSNAT collaborators continue to publish scientific papers and provide information to the scientific community at conferences and workshops dealing with simulation modeling and/or agrotechnology transfer. The Panel recognizes the need to publish some complete and detailed case studies, including a candid account of model calibration and validation procedures. The Project does distribute the Agrotechnology Transfer newsletter to 3500 subscribers around the globe. This newsletter contains important information on applications of DSSAT, experiences of users with the program, and other useful information.

With the release of DSSAT 2.1, IBSNAT published its excellent software documentation to assist users in the use of the program. The Project sponsored a very successful symposium on "Decision Support Systems for Agrotechnology Transfer" at the 1989 annual meeting of the American Society of Agronomy. This meeting was reported to be judged by participants as an excellent activity, with appeal to a wide scientific audience.

An extensive DSSAT training program for groups and individuals has been in progress in several locations. These include the Universities of Hawaii and Florida, the International Fertilizer Development Center, and at host institutions in Malaysia, Bangladesh, Jordan and Venezuela. The frequency of training programs has been constrained due to a lack of funds to support the activity. However, in some countries, such as Thailand, efforts are being made to "train the trainers" for a multiplier effect (see Box 4). This would seem to be a worthwhile mechanism for DSSAT training, and should be considered for other regions.

Project management

The overall management of the IBSNAT Project is judged by the Panel to be excellent. The Project has made good choices in hiring, the distribution of resources, its methods of procurement, and other management considerations. Strong support by the College Administration was noted by the Panel. The

Thailand has been very effective in developing a strategy called "training the trainers." Scientists from both the Department of Land Development and the Department of Agriculture have participated in IBSNAT-organized workshops in Venezuela and Malaysia. Additional training of three scientists at the University of Hawaii in a one-month training course proved sufficient for Thai scientists to conduct their own workshops in Bangkok and Rayong. The training material, which IBSNAT provided, was translated into Thai and the workshop was conducted in Thai. Scientists from several Thai institutions and governmental departments participated in the workshop. This national level approach to training effectively multiplies the IBSNAT contribution in Thailand. Several Thai scientists have progressed sufficiently to collect minimum data sets and work on developing crop models.

Box 4 - Thailand

management services provided by the Research Corporation of the University of Hawaii were judged by the Panel to be outstanding. These services were provided to the Project at very low overhead (3%) and have greatly facilitated Project activities.

PROPOSED ACTIVITIES

Production agriculture

The IBSNAT experience has shown that certain factors of the environment are much more important to crop growth and yield than are others. It is known that crop phenology is largely controlled by temperature and photoperiod. The rate of crop growth, on the other hand, is driven by the intensity and duration of solar radiation, modified by the soil and aerial environments. Different crops, however, respond differently to these physical factors. Moreover, differences between crop

cultivars must be considered if one wishes to evaluate cultivar performance at the farm production level.

Inasmuch as one of IBSNAT's objectives is to facilitate choices at the farm level, all of these factors must be considered. Specific activities have been undertaken by IBSNAT to provide the information necessary for valid crop simulations. The minimum data sets and the crop growth models have demonstrated their applicability for modeling farm level agricultural production.

In many cases it has been possible to use existing crop growth models and data sets. In other applications the information to derive crop models has been missing. IBSNAT is working to fill these "information gaps" by directly engaging in research as well as enlisting the support of collaborators who may or may not receive IBSNAT support. This "leveraging" of IBSNAT resources has been important to the Project's progress.

IBSNAT proposes activities to deal with the present needs in the following areas:

- Continued work on the validation of additional crop models, which would then be incorporated into DSSAT. At present there are only four crop models available for simulation. Eventually it is planned that DSSAT will contain 12 crop growth models. Accommodating this expanded menu of crops

will require a restructuring of the DSSAT shell, which would then be released as a new version of DSSAT.

- DSSAT contains two weather generators to "simulate" weather information for a specific site when there are no existing weather data. One weather generator uses daily weather data from similar sites and, based on the statistical variance, generates "simulated" weather for crop model testing. The second weather generator uses monthly averages to do essentially the same thing. As presently constructed, the two weather generators do not work well for tropical conditions. Consequently, IBSNAT, through a collaborator, is working to develop a new weather generator that does not have this deficiency.

- IBSNAT has an ongoing effort to collect minimum data sets which are recognized as valuable for validating crop models. This activity must continue and must be supplemented with efforts to assure correctness and completeness of the data sets.

- A recognized major deficiency of the DSSAT system at the present time is that it does not consider the impact of pests and diseases in the crop models. Significant effort is now being directed to this deficiency by coupling pest and disease models to DSSAT. More realistic crop

simulations should result. This is, however, not an easy task as the crops of concern have a large number of unique pests and diseases. Furthermore, consideration is being given by IBSNAT to interpreting this information through a geographic information system. Such an approach would not be easy and considerable resources will be needed for this activity. Without adequate resources and personnel, this aspect of DSSAT will certainly be limited.

- The ability of IBSNAT to be responsive to applications of DSSAT to whole farm modeling and sustainable agriculture issues will depend heavily on the success of the development of the intercropping model. Significant progress is being made on this intercropping model. It is anticipated that the next version of DSSAT will contain this component.

- IBSNAT is giving consideration to expanding its activities in the application of DSSAT to socioeconomic issues in a whole-farm systems perspective. These activities will include validation of the crop models at the farm level and the conduct of research to provide a taxonomy of farming types, production environments, and general infrastructure as data to "drive" the whole-farm models.

- Strong consideration is being given by IBSNAT to collecting data on behavioral characteristics of farmers, and the

social, political and policy factors that affect farmers' decisions. The approach proposed by IBSNAT is to develop a rule-based model to help examine the dynamics of technology adoption, and then link this "interpreter" to crop models, whole farm models and geographic information systems. Current activities include planning this research. But more extensive activities await adequate funding. Attempts to interest U.S. AID missions to participate through "buy-ins" have not been successful.

Research planning

Some applications of DSSAT are being made in research planning. This is perhaps the most active area of IBSNAT users, as an extended network. Opportunities to explore modifications to crops, cultural practices and other potentially variable biological factors can be assessed through their interaction with the physical world.

Policy development

DSSAT is also applied at the policy level as a tool to explore choices and assist in making decisions. Some of the applications that are being pursued by IBSNAT through its extended network include policy development in the context of research planning, exploration of policy decisions as they impact food security,

policies determining cultural infrastructure, and programs planning agricultural policy. One specific example of this type of application is given in Box 5.

Venezuela was an early collaborator in IBSNAT, beginning in 1984. Originally, there were 10 scientists involved in validating DSSAT, using information and data from problem-oriented experiments. Venezuela's involvement in IBSNAT has allowed several interesting applications. One particularly interesting application, currently underway, is the use of DSSAT in a national, comprehensive land-use planning activity that will be implemented next year, established around data obtained from the IBSNAT validation sites in Venezuela.

Box 5 - Venezuela

Whole-farm systems

Since the external program evaluation 5 years ago, the application of DSSAT to large scale evaluations has taken on new meaning. It has now become more obvious that DSSAT can be applied to topics such as whole-farm systems evaluation, global climate change, and sustainable agriculture. Indeed, when IBSNAT was being organized nearly a decade ago, the use of process-base crop models in studying the effects of global climate change on agricultural production was not visualized. Consequently, such applications are not part of the original work plan.

Aggregated information

It is highly likely that IBSNAT models will be used in future studies to aggregate information for regional-scale evaluation. An example of this might include the effects of changes in the

earth's stratospheric ozone layer and the impact of UV-B radiation on crop growth.

DSSAT will also likely be used for simulation studies of sustainable agriculture models. This application will test the consequences of certain practices on soil nitrogen, the impact of crop sequence on crop residues, etc. and how each would effect crop production in the long term. Other sustainable agricultural factors that will likely be studied include the physical and chemical processes that determine the movement and transformation of chemicals (such as pesticides and nitrates) in the soil. The existing soil/water module in the DSSAT package is based on a simple water-capacity concept with little data requirements. This module, however, may well be inadequate for defining transport of nitrates and pesticides at least in some soils. Modules which define such transport by mechanistic process description, should be tested within the DSSAT package.

Each of these proposed activities is currently underway within IBSNAT, either directly or through its extended network. Specific recommendations regarding these activities are made later in this report.

ASSESSMENTS

The "Scope of the Evaluation" requested by U.S. AID Washington presented seven questions that have been addressed by the Panel.

Our responses to these questions represent the consensus of the Panel. They are based on the responses received from the IBSNAT participants.

1. Are the Project's rationale and objectives, including the programs and input, still relevant and significant to developing country needs?

Yes. In fact, they are possibly more relevant than when the program was first started. Efforts are now underway to show that the technology can be applied to developing country needs and information on this is provided elsewhere in this report.

2. Is there satisfactory progress on the Project's core outputs since its inception in 1982? Is it probable that all Project outputs be completed on schedule and within the parameters of the Project period?

The Panel's response to this question is a mixed yes and no. Many of the activities, especially in research applications of the DSSAT system are making excellent progress. The publications produced by the Project have been excellent and well received. The Panel does have some concern for the successful demonstration of DSSAT at the farm level. Part of this concern is for the socioeconomic component, as it is doubtful that this can be completed in the remaining two years of funding.

3. Are the resultant technologies, methodologies and products being used by various countries (developed and developing)? What is the scope of such use?

We asked IBSNAT staff to update a 1987 report table that describes specific IBSNAT progress in various countries (see our Table 1). The Panel recognizes that most of these applications are within the scientific community, rather than with farm-level agriculture. There are, however, a large number of unanticipated DSSAT users (such as the U.S. Environmental Protection Agency's the global climate change study).

4. Is there good cooperation between IBSNAT and other S&T/AGR projects, as well as programs of various national and international institutions? What is the general level of interest and collaboration between IBSNAT and other entities in terms of activities and resources?

Table 2 is an assessment by the Panel of the cross-linkages that have been established by IBSNAT with related projects. The projects that were considered were found in the Cooperative Agreement and represent a computer search that turned up everything likely to have some compatibility with the IBSNAT activities. Of course, it is not expected that all listed projects will want to have cross-linkages of any significant degree. It is, however, impressive, that many projects have

strong association with the IBSNAT network. These linkages are reflected in the values given in Table 2.

5. How has the Technical Advisory Committee guided the Project? What is the extent of its involvement with the Project? In what different ways has the Project benefited from the committee members -- individually and collectively?

The Technical Advisory Committee is more a working committee than an oversight committee. It provides guidance to the Project on all technical and scientific details of the program. It was noted by the Panel that there are no changes made to the software without explicit TAC approval. They have very valid reasons for this fixed arrangement.

TAC also represents the main mechanism for leveraging the program through collaborators. We recognize the enormous contributions to IBSNAT made by TAC members, many of whom receive no research support, but choose to conduct appropriate research and contribute scientific information to IBSNAT in many meaningful ways.

6. How effective is the technical/informational network established by IBSNAT and other scientists, throughout the world? Briefly describe its scope and possible impact.

The IBSNAT global network is top-notch. Information presented in our Tables 1, 2, and 3; the extent of the Agrotechnology Transfer newsletter mailing list; the number of DSSAT subscribers, all provide documentation of the extent and success of this network.

7. Are there Project performance and management issues/concerns which affect efficiency, effectiveness, impact and sustainability?

The IBSNAT Project is very well managed. The Panel has nothing but praise for this aspect of the Project. The Panel did note, however, that IBSNAT is sometimes unable to respond to some requests. For instance, IBSNAT recently declined an invitation to conduct a DSSAT symposium in Japan. That effort could have provided valuable linkages to LDCs. There were no funds to support the symposium. This was truly unfortunate for the Project.

Another constraint to the Project caught the attention of the Panel. As originally proposed in the Cooperative Agreement, U.S. AID country missions would identify and support specific activities of IBSNAT. None of these "buy-ins" have materialized. IBSNAT has no explanation for this lack of interest. This has been particularly hard on the socioeconomic component of the Project.

Assessments analysis

As part of its "scope of evaluation," the Panel conducted an assessments analysis of the activities of the Project. The topics assessed were selected from the Cooperative Agreement, and the analysis was conducted through discussion and a table of values was developed by Panel consensus. The Panel's assessments of IBSNAT activities are presented as Table 3. As indicated in the table caption, the activities were assessed on a scale of 1 (low activity) to 5 (high activity). Many of the proposed activities (as identified in the Cooperative Agreement) are well underway and some are reaching completion. "Output 1" activities are well along and seem to be receiving high priority from IBSNAT. Much of Output 1 is directed at developing the genetic coefficients for the crop simulation models. These appear to be progressing on schedule. Other activities in "Output 1" include the development of the socioeconomic data model and the expanded pest/disease management database. These two activities are proceeding somewhat slower. This probably reflects the greater complexity of these topics. However, progress is being made and the Panel feels comfortable with that level of progress.

Under "Output 2," the crop models are progressing pretty much on schedule. The pest/disease models and the whole-farm models are making slower progress. The reasons for this are discussed later in this report.

For "Output 3," computer software has been developed to some impressive lengths. The release of DSSAT 2.1 (with documentation) has been a true milestone for the Project.

"Output 4" is intended to expand the dimensions of DSSAT to undertake specific aspects of modeling. These include soil phosphorous and potassium, intercrop modeling, agroforestry and some case studies of specific countries. Some progress is being made on these. The Panel's judgement on these activities are reflected in the values in the table. The agroforestry activity ended for reasons beyond the control of IBSNAT.

"Output 5" focuses on the development of the IBSNAT network. Very significant progress is being made on this topic for many areas.

"Output 6" deals with the application of DSSAT to locations with specific agriculture problems. Progress is being made in this area as well.

"Output 7" would strengthen the IBSNAT network of collaborators and end-users. Impressive progress by IBSNAT has been made here as well. It is particularly noteworthy that the publications of IBSNAT have contributed very significantly to this output. They support the IBSNAT workshops and seminars by supplying information.

Likelihood of success

The Panel feels strongly (and uniformly) that IBSNAT has a very good likelihood for successful attainment of most of its objectives during the remainder of the Project's term. The current level of activities, their previous accomplishments and the commitment of the IBSNAT personnel, all weigh in favor of a successful outcome.

Constraints

The one reservation that the Panel has regarding its assessment of IBSNAT's likely success are the limitations imposed by constraints beyond their control. As mentioned earlier, lack of funding has repeatedly been a problem, causing IBSNAT to decline invitations and opportunities to expand its research network.

There will likely be some success in applying DSSAT to whole-farm systems analysis. But these applications will probably not be fully implemented by the end of this Cooperative Agreement. This is simply because there is too much to do, and the resources are too limited.

Lessons learned

During the course of our assessments, we were provided opportunity to develop some lessons from the IBSNAT experience. These lessons are not so much for the benefit of the IBSNAT Project members themselves, as they have already learned them. We share them with those who may wish to benefit from the IBSNAT experience.

- A successful project has a conceptual framework that is common to the project participants, with stated and consistently applied goals.

- A shared vision of a process-oriented research approach is instrumental in achieving an effective multidisciplinary team study.

- A working group is an effective networking mechanism to extend a project's membership and enlist the cooperation of other collaborators.

- A network can serve as an effective clearing house for information and for the coordination of activities for a research project.

- When a project has intensive data requirements, it is wise to define early the minimum data set and the means for integration of disciplines.

- Open architecture computer programming allows replacement of individual modules which describe aspects of the overall program (e.g. water movement, root development, photosynthesis algorithms etc.). Thus, other researchers can benefit by testing and incorporating their own modules within the DSSAT package.

- When one puts out a quality product, people will use it.

COMMENDATIONS

During the course of the review, the Panel observed some very positive attributes of the Project that seemed to deserve some notation. These items are listed below.

- The Panel commends the quality and commitment of the IBSNAT scientific and technical staff. Their outstanding contributions to the Project are noted. Especially noteworthy to the Panel are the contributions through leadership and shared recognition by the Project's Principal Investigator, Goro Uehara. His style of management is no

doubt one of the major contributing factors to the Project's success through global collaboration.

- The Panel commends IBSNAT for its success in attracting willing collaborators around the world. This aspect of the Project has meant that the U.S. AID funding has been heavily "leveraged" to the benefit of the primary funding agency and the success of the Project.

- The Panel commends IBSNAT on the quality of the science base upon which the Project is founded. The applications of the Systems Science perspective to agricultural crop modeling is commendable.

- The Panel commends IBSNAT for its foresight in selecting a minimum data set for crop simulations. This decision has strongly contributed to the Project's success through appropriate requirements balanced against realistic expectations from users. The Panel acknowledges the quality of the IBSNAT data sets and recognizes how valuable these collections are to science.

- The Panel commends IBSNAT for its progress in technology transfer through DSSAT. To date, 162 copies of the program have been distributed, with 62 copies sent to LDCs. (Note: recipients of DSSAT are permitted to electronically copy the

software, so it is highly likely that the program is well distributed beyond the direct records of IBSNAT.)

- The Panel commends the Project for successfully providing continuity of program services and direction throughout its history.

- The Panel commends IBSNAT on the quality of the technical publications and manuals.

- The Panel commends the Administrators of the College of Tropical Agriculture and Human Resources, University of Hawaii at Manoa for its very positive financial and administrative support of IBSNAT, and the Research Corporation of the University of Hawaii for its excellent management support.

RECOMMENDATIONS

During the course of the Panel's deliberations, a number of recommendations were identified. These recommendations have been carefully considered by the Panel, and have been organized by groups with the intention of providing carefully considered advice to IBSNAT.

DSSAT development

- The Panel fully appreciates the positive contributions of the minimum data set concept to the success of DSSAT. We question, however, the potential limitations that may result from this strategy when attempting to apply the DSSAT concept to broader applications such as sustainable agriculture modeling. The Panel recommends that IBSNAT consider an evaluation of present v. expanded data requirements vis-a-vis various submodels being considered for future versions of DSSAT.

- The Panel encourages the continued application of the structured programming approach to DSSAT, which allows replacement of modules with certain subprograms within the overall DSSAT package. The panel recommends that additional resources be applied to this activity.

- The Panel appreciates the potential of the proposed intercropping model and recommends that this approach be fostered by IBSNAT.

- The Panel appreciates the potential of the proposed pest/disease coupling activities and recommends that this approach be fostered by IBSNAT.

- The Panel further recommends that IBSNAT continue to develop the nutrient modules and the rhizobium extension to the legume crop models as very worthwhile to the Project's goals.

- The Panel encourages the complementary use of simulation and expert systems and recommends that these applications be directed at the farm level.

- The Panel recognizes that genetic coefficients are necessary to run the crop models for specific cultivars and that collecting data in controlled environments to derive genetic coefficients is not possible for the numerous cultivars that will be encountered in applying DSSAT in LDCs. Therefore, the panel recommends that a significant effort be maintained to develop an expert system which can derive genetic coefficients from field generated minimum data sets.

- The Panel recommends that consideration be given to developing calibration and validation assessments based on statistical procedures as an integral part of DSSAT.

- The Panel recognizes the significant potential applications of DSSAT to area and regional planning, and recommends that efforts be devoted to developing scientifically valid

aggregation procedures for DSSAT output using Geographic Information Systems (GIS) technology.

- The Panel notes the lack of detailed description of the DSSAT crop growth models which may give the appearance of "black box" simulation. The Panel thus recommends that IBSNAT give consideration to publishing more detailed descriptions of the DSSAT crop growth models, including major assumptions.

Technology transfer

- The Panel notes the importance of demonstrating the applicability of technology transfer as DSSAT applications to farm-level agriculture, policy analysis, research planning, etc. The Panel recommends that at least one example be completed for each category of application. This documentation will be essential for technology transfer evaluations and as justification for further funding.

- The Panel recommends that the targeted socioeconomic case studies in Guatemala, Venezuela and Malawi be undertaken soon, and as resources permit.

- The Panel recognized that there may be insufficient time remaining in the Cooperative Agreement to accomplish all of

the proposed whole-farm systems activities. The Panel recommends that prctotype models, perhaps based on synthetic data, be used to demonstrate how the whole-farm system approach can be linked to DSSAT.

- The Panel endorses the emerging pattern of "training the trainer" as it represents an efficient way of disseminating DSSAT to intended users. The Panel recommends that the effort be extended beyond the scientific community to include related disciplines, policy makers, lay audiences, extension specialists, and others.

Documentation of Program Success

- The Panel recommends that IBSNAT conduct a survey of DSSAT users to record successful applications of the system to agricultural issues. This information would be useful in clarifying who uses the system for various types of applications, and would also help document the Project's contributions. The survey might be done through the Agrotechnology Transfer newsletter, or some other mechanism.

- The Agrotechnology Transfer newsletter should continue to publish successful applications of DSSAT to: record these accomplishments; share the experiences with other users; and document the success of IBSNAT.

Technical recommendations

- The Panel expresses some concern for problems that may be generated when simulations are run for areas where minimum data sets for weather do not exist. The concern is based on the technical requirement that the set be somehow validated before it is used for crop growth simulation. Validation may be especially problematic for some users, under some circumstances. The Panel recommends that this concern be addressed by the TAC.

- The Panel expresses its concern for the degree of validity for the weather generators presently installed in DSSAT. The Panel recognizes the ongoing development of other weather generators and screens, and recommends that IBSNAT continue to give this activity high priority.

IBSNAT/TAC

- The Panel notes the need for separate validation procedures for the various subprograms within the overall crop simulation programs. There is also a need to improve the quality of the calibration and validation procedures for the overall model (e.g. water movement, root development, photosynthetic algorithms). The Panel recommends that this need be addressed.

- The Panel recommends that serious consideration be given to changing the name of the Technical Advisory Committee to "Working Group," or some similar designation. As presently named, the Committee could be assumed to have oversight responsibilities. In this role questions of conflict of interest could be raised. As a working group committee, such questions would not be of issue and the present activities could be continued. [Note: Whether or not an oversight committee is needed by IBSNAT was not considered by the Panel.]

S&T/AGR/U.S. AID

- The Panel strongly recommends that, in future reviews, the U.S. AID Project Officer be permitted to participate as an ex officio panel member. This could have the benefit of providing historical information, programmatic knowledge and perspective to the Panel during its evaluations and deliberations.

- The Panel recommends that S&T consider establishing a mechanism for supplemental funding for Cooperative Agreements to allow better flexibility to projects presented with unanticipated opportunities and unique situations. [Note: IBSNAT has declined an invitation to conduct a DSSAT symposium in Japan for lack of funds. This lost opportunity

means that linkages that could have been developed through that pathway have been lost and/or delayed. The amount of funds needed for the symposium would have been modest but are beyond IBSNAT's resources as their budgets are fixed and committed.]

- The Panel recognizes the potential value of the application of DSSAT to LDCs and suggests an evaluation of why country missions are not participating in the Project through "buy-ins." This evaluation should be shared with IBSNAT in furtherance of the Cooperative Agreement.

- The Panel strongly recommends continued support for IBSNAT. The present investment in IBSNAT by U.S. AID is paying handsome dividends. It has attracted additional support which should continue to grow. Long-term plans should be made by U.S. AID to protect its investment in this valuable and successful Project.

CONCLUSIONS

IBSNAT is a healthy, viable and well-managed project that deserves continued support from U.S. AID. The Panel is thoroughly impressed with the accomplishments to date and we concur with the Project's plans for future activities. The likelihood of the Project meeting most of its objectives by the

end of the five-year Cooperative Agreement seems reasonably assured. We offer this conclusion without reservation and with the hope and recommendation that U.S. AID funding for IBSNAT will be continued.

Appendix A. Review Panel Biographies

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Ray E. Jensen is a consulting meteorologist specializing in agricultural meteorology and climatology programs, services and training. He retired in 1986 from the National Oceanic and Atmospheric Administration's National Weather Service. During National Weather Service career, his positions included weather forecaster, climatologist, agricultural meteorologist and Director of the Pacific and Southern Regions of the National Weather Service. In 1973, he established the nation's first agricultural meteorology weather and service center at Auburn, Alabama, which provided research and real-time agricultural meteorology services for agricultural interests in the southeastern United States. He participated in several efforts dealing with climatic change and agricultural production and the use of crop models in real-time estimation of crop yields. From 1986 to 1988, he was Executive Director of the Applied Systems Institute in Norman, Oklahoma. While there, he was instrumental in establishing an environmental and flash flood monitoring and warning system at Tulsa, Oklahoma, which utilized prototype Doppler radar rainfall and storm data in emergency management decision aids. He has served on several National Academy of Science panels and has served as consultant to several government agencies and the Spanish Meteorological Service. He is a Fellow of the American Meteorological Society.

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David R. MacKenzie is Director of the USDA's National Biological Impact Assessment Program. This program facilitates the safe field testing of genetically modified organisms. Additionally, Dr. MacKenzie serves as Principal Plant Scientist in the Plant and Animal Science Division of the Cooperative State Research Service. He is presently Co-chair of the USDA's Advisory Committee on Plant Genomic Mapping, and serves on the National Association of State Universities and Land Grant Colleges' Committee on Biotechnology. He is currently Chair of the Agriculture Research Institute's Biotechnology Panel. He has been directly involved in developing USDA's budget documentation for the National Initiative for Research on Agriculture, Food and the Environment. He serves as a consultant to the World Bank and the U.N.'s Food and Agricultural Organization on crop protection research. From 1983 to 1989 he was Head of the Department of Plant Pathology and Crop Physiology at Louisiana State University and prior to that he was a plant breeder and plant pathologist at the Pennsylvania State University. From 1970 to 1974, he worked with the Rockefeller Foundation stationed in Mexico (Wheat Program at CIMMYT), Philippines (IRRI Multiple Cropping Project) and Taiwan (AVRDC's Head of Plant Breeding Department).

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Dale N. Moss is a professor of crop physiology at Oregon State University. He chairs the Oregon Agricultural Experiment Station Committee on Systems Research and Modeling. He served as Head of the Crop Science Department from 1977 to 1983, before returning to crop physiology research. He served as a member of U.S. AID Research Advisory Committee for eight years and was a member of the IBSNAT Review Team in 1985. Before that, he had reviewed the Benchmark Soils Project as a member of U.S. AID RAC in 1980. Thus he brings continuity to the review effort. He has researched factors limiting crop yield for more than 30 years. He served as President of the Crop Science Society of America in 1977 and as President of the American Society of Agronomy in 1986.

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Truman P. Phillips is Director of the Centre for Food Security and Professor in the Department of Agricultural Economics and Business at the University of Guelph. The Centre is devoted to the development of policies and programs which promote stable access to food to all individuals and households in a region or country. He has 19 years of experience in research related to developing countries. He has been a member of strategic reviews of the tropical root programs of IITA and CIAT. He has been a consultant to IDRC, CIDA, World Bank, EDI of the World Bank and FAO. His most recent activities have included a farming systems research project in the Caribbean; contribution to CIDA's guidelines on food security; assessment of food security in Jamaica; and the assessment of household food security in Indonesia, Malaysia, the Philippines and Thailand. He makes extensive use of microcomputers and has offered numerous courses on spreadsheet and data base programs.

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Appendix B. IBSNAT participants.

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Appendix C

TENTATIVE PROGRAM FOR IBSNAT REVIEW
July 8 to 14, 1990

Sunday, July 8

Arrive in Honolulu. Accommodations at the Outrigger Prince Kuhio for Review Panel.

Monday, July 9

7:45 am	Review Panel assemble in OPK lobby for transportation to the University of Hawaii.
8:15 am	Meeting of the Review Panel chaired by D. MacKenzie. **Sherman 103**
9:15 am	Briefing with Uehara and description of MauiNet. **St. John Lobby**
9:45 am	Depart for the airport from St. John Lab.
10:40 am	Depart for Maui--Aloha flt. 410; (arrival: 11:07 am)
11:30 am	Meet with County Administrator in Kahului.
12:00 n	Lunch at Kula.
1:30 pm	Arrive at Haleakala site--genetic coefficient experiments.
2:30 pm	Depart Haleakala site for Kuiaha, Haiku.
2:45 pm	At Kuiaha.
3:10 pm	Depart Kuiaha for NifTAL.
3:30 pm	Arrive at NifTAL.
4:30 pm	Depart NifTAL for airport.
5:20 pm	Depart Kahului for Honolulu on Aloha flt. 421.
5:45 pm	Arrive in Honolulu. Transportation to hotel.

Tuesday, July 10

8:15 am	Check out of Outrigger Prince Kuhio.
9:00 am	Meeting with Dean Kefford and CTAHR Administration. **Gilmore 212**
10:00 am	Meeting with Dr. Fujio Matsuda, Executive Director, the Research Corporation of the University of Hawaii. **Research Corporation Office.**
11:00 am	Depart for airport.
12:10 pm	Depart Honolulu for Kona on Hawaiian Airlines flt 356.
12:49 pm	Arrive in Kona. Lunch and check-in at Kona Hilton.
3:15 pm	Introduction of participants. Discussion of review format and schedule.
4:00 pm	Overview--G. Uehara and J.W. Jones
4:30 pm	Plenary session on DSSAT--J.W. Jones Description, demonstration and discussion.

5:45 pm End of session.
6:00 pm Refreshments and cocktails.

Wednesday, July 11

8:00 am IBSNAT Review--Agenda prepared by Review Panel.
Progress: Project outputs
DSSAT
Crop Model and MDS
to Applications programs and weather generators
Genetic Coefficients
Pest/disease coupling
Intercrop model
Nutrient and water balance submodels
4:30 pm Whole Farm Systems

Thursday, July 12

8:00 am Applications and Acceptance
Collaborator/User networks
Training
Publications
to Project Management
U.S.AID/UHM/RCUH
TAC
Workplans
4:30 pm Beyond IBSNAT

Friday, July 13

8:00 am Meeting and report writing by Review Panel. **Endeavor Room**
Meeting of TAC. **Resolution Room**
12:00 n Lunch
1:30 pm Resume meetings.
4:00 pm Review Panel report.

Saturday, July 14

8:30 am Completion of final draft copy of report--Review Panel. **Endeavor Room**
Meeting of TAC. **Resolution Room**

Depart Kona for Honolulu on Saturday.

Clerical and administrative support will be available to the Review Panel. A hospitality room, to be determined, will be used for this purpose.

IBSNAT Review Agenda: 11 - 12 July 1990

Wednesday 11 July 1990
8:00 a.m. - 12:00 p.m.

I. Applications: (each topic 30 minutes each)

Topic	Discussion Leader
1. Policy	Barry Dent
2. Production Agriculture	Henry Nix
3. Research Planning	Henry Nix
4. GIS	Jim Jones
5. Whole-Farm Systems	Barry Dent
6. Global Climate Change	Jim Jones
7. Sustainable Agriculture	Joe Ritchie

Wednesday, 11 July 1990
1:00 p.m. - 5:00 p.m.

II. Science Topics: (Each topic: 20 minutes each)

Topic	Discussion Leader
A. Models	
1. Crop Growth and Production	Joe Ritchie
a) Genetic Coefficients	Tony Hunt
b) Nitrogen Fixation	Gerrit Hoogenboom
c) Pest/Disease Coupling	Paul Teng
d) Crop Selection	Goro Uehara
2. Crop Sequencing	Jim Jones
3. Intercropping	Bob Caldwell
B. Data	
1. Weather and Weather Generators	Jim Jones
2. Nutrients	Upendra Singh
3. Water Status	Joe Ritchie
4. Crop Model Validation	Tony Hunt
5. Crop Management	Juan Comerma
6. Socioeconomic	Barry Dent

Thursday, 12 July 1990
8:00 a.m. - 11:00 a.m.

I. Communications: (Each topic: 20 minutes each)

1. Publications	Renee Moulun
2. Collaborators and Users	Gordon Tsuji
3. Linkages to Other Projects	Goro Uehara
4. Training and Outreach	Fred Beinroth
5. Expert Systems	Jim Jones
6. Computer Programming	Agatha Tang

11:00 a.m. - 12:00 p.m.

II. Project Management Topics: (Each topic 20 minutes each)

Topic	Discussion Leader
1. U.S. AID/UHM/RCUH	Gordon Tsuji
2. Technical Advisory Committee	Goro Uehara
3. Work Plans	Fred Beinroth

Table 1. Summary of IBSNAT collaborator involvement.

	Activities										
	1	2	3	4	5	6	7	8	9	10	11
Collaborators											
Model Development											
Additions											
ARS/Prosser		x		x			R		x	A,B	x
ARS/Mayaquez				x			R	x	x	C	x
Edinburgh School of Agriculture	x	x		x	x	x			x	A,B	x
Model Validation											
Additions											
India		x	x		x		C,L	x	x	C,D	x
Guatemala	x				x		L	x	x	C	
Malawi			x			x	C		x	C,D	
Zimbabwe			x			x			x	C,D	x
Mali			x		x				x	C,D	x
Niger			x		x				x	C,D	x
Egypt			x		x				x	C,D	x
Pakistan	x		x							C,D	x
Botswana							C			C,D	x

Deletions: Panama

KEY

Activities:
1. Signed memorandum of agreement
2. Participation in planning and organizational meeting
3. Host for workshop
4. Participation in systems analysis/modeling workshop
5. Selection and characterization of Benchmark site
6. Participation in orientation workshop
7. Experiments installed to collect MDS for cereals (C), grain legumes (L), and/or root crops (R).
8. MDS collected and submitted
9. Application of DBMS and DSSAT
10. Technology generator, A; Software generator, B; data generator, C; or technology user, D.
11. Provides funding: (indicates if institution contributes its own funds to activity)

Table 2. Evaluations of the collaborative linkages between IBSNAT U.S. AID related national and international programs with activities relevant to IBSNAT. Values represent a scale of 1 (low level of linkage) to 5 (highly linked) and are the consensus of the review Panel.

Soil Management Support Services (SMSS)	5
Soil Management CRSP (TropSoils)	4
Technology of Soil Moisture Management (TSMM)	1
Water Management Synthesis II (WMSII)	1
Biotechnology-Tissue Culture for Crop Production	1
Improved BNF through Biotech (BNF)	5
CRSP-Sorghum/Millet	3
CRSP-Beans and Cowpea	4
CRSP-Peanuts	4
Spring and Winter Wheat	1
Post Harvest Grain System	1
Control of Barley Diseases	1
Integrated Pest Management and Environmental Protection	2
Development Strategies for Fragile Lands	1
Agricultural Policy Analysis	1
International Fertilizer Development Center (IFDC)	5
International Rice Research Institute (IRRI)	4
International Maize and Wheat Improvement Center	3
International Center for Tropical Agriculture (CIAT)	4

Table 2. cont'd.

International Potato Center (CIP)	2
International Crops Research Institute for the Semi-Arid Tropics (ICRISAT)	5
International Center for Agricultural Research in the Dry Areas (ICARDA)	4
International Board for Plant Genetic Resources (IBPGR)	1
Asian Vegetable Research and Development Center (AVRDC)	2
International Board for Soil Research and Management (IBSRAM)	2
Human Settlements and Natural Resource System Analysis (SARSA)	1
Technology Development Transfer and Feedback Systems in Agriculture	1
Communication /or Technology Transfer	1
Office of Forestry, Environment and Natural Resources	1
Environmental Planning Management	1
Forest Resources Management	1
Forestry-Fuelwood Research and Development	3

Table 3. Assessment of the performance of IBSNAT output targets by the evaluation Panel. Numbers represent consensus evaluations of current attainments on a scale of 1 (low attainment) to 5 (virtually completed). A value of "x" was given to topics which reflect heterogeneous activity.

Output	Performance Assessment (1-5)
Output 1	
DSSAT Expansion and Validation	
DBMS Extension	4
New Categories	2
Replication Costs	x
Identify Genetic Coefficients	3
I.D. Individuals	2
Develop Manual	5
Distribute Data Sheets	5
Conduct Gen. Coef. Training Wkshps.	1
Develop Software for Genetic Coefficients	4
Collaborate Min. Number. Nurseries	1
Establish Experimental Sites	5
Validate Genetic Coefficients	3
Create Weather Generator	5
Develop Socio-Economic Model	1
Expand Pest Management Data Base	1
Establish Data Files for Pest Cat.	3
Output 2	
Design Aids	
Simulation models	
Crop Models	5
Pest Models	3
Whole-farm Models	2
Expert Systems	2
Output 3	
Computer Software	5
Dialogue Generator	1
Command Generator	1

Table 3. cont'd.

Output 4

Expand DSSAT	
Soil Nutrient Submodels	4
Intercropping Model	4
Agroforestry	1
Case Studies	3

Output 5

Viable Network	
Technology Generators	1
Software Generators	5
Validators and Data Generation	2
Technology Users--farm	1
--research	5

Output 6

Applications	
Documentation	5
Field	2

Output 7

Acceptance	
Workshops, Seminars, and Meetings	5
Training	x
Data Sheets and Instructions	5
Servicing Requests	5