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Comprehensive Resource Inventory and Evaluation System (CRIES)

An Evaluation

March 1978

Office of Agriculture
Development Support Bureau
Agency for International Development

Review Report

of the

Comprehensive Resource Inventory and Evaluation System (CRIES)

by Review Team

Consisting of Trevor G. Arscott,
Ernest E. Hardy, Gerald W. Olson
and John F. Timmons, Chairperson

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Memorandum

TO : See Distribution **DATE:** April 18, 1978

FROM : DS/AGR, Richard E. Suttor

SUBJECT: Evaluation of CRIES Project

The Comprehensive Resource Inventory and Evaluation System (CRIES) is a major DS/AGR project to help LDCs assemble and analyze information on agricultural resources in a manner useful to planners and decision makers. The feasibility and appropriateness of applying existing agricultural resource inventory and evaluation techniques to LDC conditions is being tested in three countries.

Ultimate success will be measured by the extent to which CRIES is used to improve agricultural planning and policy decisions. Although it is not yet possible to make a final judgment, the methodology and procedures have evolved far enough to evaluate CRIES in light of the ultimate goal. A multidisciplinary team recently completed this evaluation. Their report is attached.

If you have any comments or would like additional copies of the report, please write or call me (235-8948). In particular, I would like to know of Missions that are developing or implementing projects that might benefit from The CRIES experience.

Enclosure

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Table of Contents

Page

Summary and Recommendations - 1

Introduction - 9

Study Design and Methodology- 12

The Proposed Model- 15

Data Needs as Prescribed by Model: Sources, Kinds, Quality and Estimating Procedures- - - - - - - - - - - 17

Resource Production Units - 18

Soils Data- 20

Land Area and Land Uses - 25

Production and Land Practices - - - - - - - - - - - - - - - - - - - 27

Crop Yields - 29

Costs and Prices- 30

Remote Sensing- 30

Geographical Referencing- 33

Definitions and Descriptions- 37

Technical and Institutional Arrangements- - - - - - - - - - - - - - 41

Interagency Arrangements- 41

Interdisciplinary Approach- 41

Inter-Country Arrangements- 42

Training Components - 43

Transfer of Technical Skills and Methodology- - - - - - - - - - 45

Administrative Considerations - - - - - - - - - - - - - - - - - - - 47

Planning Horizons and Financing - - - - - - - - - - - - - - - - - - 47

Stabilities within Participating Agencies - - - - - - - - - - - - 47

Cooperation and Staff Competency- - - - - - - - - - - - - - - - - 49

Project Identity- 50

Progress Toward Goals and Objectives - - - - - - - - - - - - - - - - - 51

Long Range Implications and Possible Contributions of CRIES - - - - 53

For Less-Developed Countries - - - - - - - - - - - - - - - - - - - 53

For AID and USDA - 53

For Other U.S. and International Entities
with Responsibilities for Assisting
Developing Countries - 53

For U.S. National Policy Making Entities - - - - - - - - - - - - - 54

Appendix A. Revised Agenda AID/TAB and USDA
CRIES Evaluation, 1/16-19/78 - - - - - - - - - - - - - - 55

Appendix B. Administrative Organization of CRIES - - - - - - - - - 57

References - 59

Summary and Recommendations

Agricultural sector studies as a framework for developmental assistance to less-developed countries have produced only nominal success in achieving their specified objectives. Performance of these studies over the past two decades has ranged from moderately successful to outright failure. There are many reasons for the varied and somewhat disppointing performance of these studies. These reasons include surprise developments within developing countries, esoteric methodologies unadapted and sometimes unadaptable to the country, faulty data base and absence of desire and professional abilities within developing countries to accept, maintain and use imported studies for the intended purposes.

The Review Team concludes that the Comprehensive Resource Inventory and Evaluation System (CRIES) provides the capacity for avoiding pitfalls of earlier studies within agricultural sectors. Indeed, the Team is optimistic that the CRIES approach possesses essential elements of potential success in meeting basic and urgent needs within less-developed countries for identifying their agricultural production potentials and for planning the realization of these potentials. These essential elements are (1) developing a model with capability for analyzing both agricultural production potentials and the means whereby these potentials may be achieved and, (2) developing an information support system for providing data required in application of the model.

The CRIES project has brought together an outstanding staff of professionals representing several disciplines required in developing both the information system and the analytical model. This multidisciplinary staff possesses the mix of competency, motivation, enthusiasm, morale and ability to cooperate as a team, seldom found within multidisciplinary endeavors. An effective relationship

has been established with agricultural policy and research leaders within the Dominican Republic. The Dominican Republic provides an effective laboratory wherein the CRIES approach can be tested and improved with outstanding prospects of success.

However, the CRIES project does possess inherent weaknesses which can become disabling and which threaten the realization of potential success of the project in serving the technical assistance needs of less-developed countries. These weaknesses encompass both administrative and technical problems. The Review Team believes the administrative problems are more serious than the technical problems since administrative problems are beyond the remedial authority of the CRIES staff while technical problems are well within the remedial province of the staff. However, amelioration of technical problems is not likely to take place without solution of administrative problems.

The Review Team approached both of these problem sets, which are highly interrelated, with a strong desire to be constructive and helpful in an assessment of the problems and in the formulation of remedial recommendations which will assist the project in proceeding with the realization of its capabilities and potentials for success.

Administrative problems as interpreted by the Review Team, stem from a fragile and uncertain commitment by USDA and AID on staffing, funding and horizon of the project. Staffing, funding and planning horizons of the project appear dependent upon independent actions of several entities within USDA and AID that have other important responsibilities which compete for scarce staff and funds. Also, these entities undergo reorganization from time to time which increases the future uncertainty of staffing and funding the CRIES project.

These uncertainties are not conducive to effective work and morale of the CRIES staff. Although the Review Team does not pretend to understand the intricacies and complexities of the federal bureaucracy, the Team unanimously agrees that an organizational foundation must be developed which provides CRIES with assurances of staffing, funding and horizon necessary for the work to proceed in an orderly and productive manner. The Review Team recommends that the organizational foundation for CRIES, whatever form it takes, must be supported by a commitment from top eschelons of USDA, AID and any other federal departments involved in the work, to fully recognize CRIES as a continuing unit of administration with an important mission to perform in discharging U.S. responsibilities to developing countries. The development of the analytical model with its applications and particularly the development of the information system, are necessarily long term and continuing activities which require a commensurate time horizon of existence. Nothing has been said thus far about MSU or other possible institutional partners in the CRIES activity since the funds will necessarily come from federal instead of state sources because of the nature of the national commitment to less-developed countries. However, state universities and private entities are, of course, important U.S. resources in undertaking research and training programs needed within agricultural sectors of these countries. It is expected that these state and private institutions will be provided opportunities to continue and expand their participation in research and training activities within developing countries. Presently, however, the Review Team has confined its recommendations to assisting a fledgling entity, CRIES, with an opportunity to develop its full potential in serving the nation's interest and obligation regarding less-developed countries.

Technical problems concerning models, data and analysis within CRIES can be solved by the CRIES staff providing the administrative problems are resolved. Most of these technical problems have been recognized by the staff members who are endeavoring to find appropriate solutions. Most of this report is devoted to these technical problems and possible solutions. Consequently, only major technical problems and recommendations are emphasized in this summary and recommendations section of the report. Other problems and recommendations of a more minor and contributory nature are contained throughout the report with substantiating reasoning and documentation.

Eight major categories of technical problems are summarized in this section including the Team's recommendations. These categories are not necessarily ordered in terms of their relative importance. Also, the eight categories are not to be interpreted as independent of each other. On the contrary, the eight categories are highly interdependent in the further development of CRIES.

First, ambiguities appear to exist within the major thrust of CRIES between the role of and emphasis on the analytical model and the information system. Obviously, a conjoint relationship exists between the two. But this relationship as well as the differences between each should be clarified. Linear programming as developed by CRIES possesses the potential for analyzing the agricultural production potential as well as for analyzing means of achieving the potential with and without specified activities and constraints under alternative scenarios for the future. But the model also possesses an equally important function of specifying data for satisfying the needs of the model in fulfilling its potential. The kinds of data required by the model in one area or country are similar to kinds of data required by the model in another area or country. Only the values of particular coefficients may differ. Also, values of

coefficients may be similar between areas and countries which provide for possible transference of data between areas and countries with varying degrees of accuracy, depending upon differences in soils, water, plant adaptability, climate and other natural factors. Thus, the need exists for developing an informational system for retaining and reusing increments of information as such information is generated and validated. In order to accommodate what the Team understands to be the dual and conjoint thrusts of CRIES, the Review Team recommends that an information system be developed with systematic identification, ordering, classification and description of data that possess retrievability and potential transferability from one geographical area to another in terms of soils, climate, vegetation and practice adaptability, inputs and input responses. The information system should provide for data retrieval and use with minimum data loss, effort, cost and confusion. The system should be regarded as a continuing process into which would be introduced additional data as they become available and verified. This information system would be available to help serve data needs of the model regardless of geographical location of the model's application. The linear programming model would remain constant as an analytical tool with appropriate variations in components of the objective function, activities and constraints. Also, the Review Team further recommends that serious consideration be given to integration of current AID-assisted sectoral analysis work in the Dominican Republic with the CRIES efforts of developing, applying and testing the analytical model and information system.

Second, the several CRIES documents made available to the Review Team contain little evidence that the staff has reviewed reports on the numerous country studies made over the past two decades pertaining to analytical models and information systems used in agricultural sector analysis. The Review Team

recommends that the CRIES staff review these earlier and on-going studies to become familiar with their strengths and weaknesses as they may affect the development, application and testing of the analytical model and information system within the CRIES project in the Dominican Republic.

Third, the CRIES documents reviewed by the Review Team, dealing with developing, applying and testing the analytical model and information system do not appear to consider necessary linkages between the agriculture sector and other sectors of developing countries. Since the agriculture sector is closely related to other sectors of an economy, analytical linkages must be established which accommodate capital and labor allocations, population growth, imports, exports and other vital considerations. The Review Team recommends that the CRIES staff identify and examine these linkages between agriculture and other sectors so that analysis and data used within the agricultural sector may become more relevant to subsequent analysis and choices between sectors.

Fourth, probably the most pressing problem confronting CRIES is the availability and quality of data used in the application and testing of the analytical model and the information system. Results of model application and use of the information system will be no better than the accuracy of data utilized. The Review Team recommends that the CRIES staff carefully evaluate all data through consistency tests, error analysis, sensitivity analysis, tracking tests and further review by knowledgeable scientists within the Dominican Republic, International Centers, OAS, FAO, USDA, AID and other agencies. If these attempts fail to improve the accuracy of data, supplemental field surveys may become necessary. Alternatively, proxy data may be used to demonstrate the operation of the model to Dominican counterparts and to demonstrate crucial needs for improving quality of data. More accurate data as they are obtained can replace the proxy data.

Fifth, the concept of internalizing the analytical model and information system emphasized throughout the CRIES documents, raises the question of whether or not the model and information system should be developed indigenously within the country with full participation by the Dominicans from the beginning and in each subsequent detail and step, thus eliminating the connotation of internalizing what might become an external import. Also, the question arises whether or not the seat of operations should be in the Dominican Republic instead of East Lansing where no Dominicans were observed by the Team. In developing the analytical model and correlative information system within the country, the CRIES's staff and Dominican counterparts would become more appreciative of all the limitations and problems extant within the country and could therefore fashion adjustments consistent with indigenous conditions which the model and system must ultimately accommodate. The Review Team simply raises this question and emphasizes its importance without making a specific remedial recommendation.

Sixth, related to the previous problem is the matter of training sufficient numbers of talented and interested Dominicans for participating in the CRIES process as applied to their country. From the documents reviewed by the Team, it is not clear that the training component of CRIES is adequate to prepare a sufficient number of Dominicans in the relevant disciplinary areas to operate the program. Further consideration of this matter is important to the lasting effects and benefits expected from CRIES. There exist many examples throughout the world of programs initiated by outside technicians and terminated when the outside technicians left the country or when the few trained nationals left the country for more lucrative employment elsewhere or for greater personal freedom outside the country. Of course, solution of this problem cannot be

guaranteed. But efforts can be taken to lessen the problem impact through greater and more widespread in-country training programs. The Review Team simply raises this question and emphasizes its importance without making specific recommendations.

Seventh, the matter of extending the CRIES project to Costa Rica and Nicaragua prior to opportunity for fully appraising the project experience in the Dominican Republic, should be considered seriously. The Team understands that certain commitments have already been made to these other countries. However, the Review Team recommends that serious thought be given to a gradual movement into Costa Rica and Nicaragua based upon adequate appraisal of experiences within the Dominican Republic. For example, initial efforts in the other two countries might be limited to improving quality of data required by the analytical model as evidenced by Dominican experience.

Eighth, the problem arises regarding the Dominicans operating the analytical model and information system by themselves as unforeseen problems and irregularities arise in the future. It would appear desirable to maintain professional contacts between U.S. and Dominican technicians over an extended period of time following scheduled cooperation in project development in order to assist in adjusting the model and system to unexpected future events and developments. The Review Team recommends that this continuing consulting assistance be maintained as needed in the future.

Review Report

Comprehensive Resource Inventory and Evaluation System (CRIES)

by Review Team[1/]

Introduction

This report summarizes the Review Team's findings and conclusions resulting from studying the Comprehensive Resource Inventory and Evaluation System Project hereafter termed CRIES. CRIES is a cooperative endeavor by the U.S. Agency for International Development hereafter termed AID, the U.S. Department of Agriculture hereafter termed USDA, and Michigan State University hereafter termed MSU.

The Review Team was selected by the three cooperating agencies and requested to review CRIES and to prepare a report on the results of the Team's review.

The CRIES review process consisted of three parts. First, between December 1, 1977 and January 15, 1978, the Team studied the documents provided by the CRIES staff and cooperating agencies. Second, during the week of January 16-20, the Team met with the CRIES staff in East Lansing, Michigan, to learn more about the project and to discuss in detail the objectives, procedures and expected uses of the project. Appendix A contains the agenda of the East Lansing meeting. During their stay in East Lansing, the Review Team developed an outline for this report and assigned particular sections of the outline to individual team members for drafting the content of these sections.

Between January 21 and March 10, 1978, the Team members prepared drafts of their assigned sections which the Team Chairperson integrated into this report. On February 17, 1978, the Team presented an oral summary of the

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1/ Trevor G. Arscott, Department of Agronomy, Ohio State University; Ernest E. Hardy, Department of Natural Resource, Cornell University; Gerald W. Olson, Department of Agronomy, Cornell University; and John F. Timmons, Department of Economics, Iowa State University, Chairperson.

draft report to the CRIES staff and MSU, USDA and AID administrators in Washington, D.C. Following this meeting, the Team revised the report into its present form and content.

Consistent with the terms of reference provided the Review Team by USDA, MSU and AID, this report is organized under the following headings: (1) Study design and methodology, (2) Technical and institutional arrangements, (3) Administrative considerations, (4) Observed progress toward goals and objectives and (5) Long-range implications and possible contributions of the project. In addition to these five major parts and the Introduction, a Summary and Recommendation section of the report is included which condenses the suggestions and recommendations of the Team. Also, two supplementary documents are appended to the report.

This report is limited largely to the CRIES procedures being applied to the Dominican Republic. Certain observations are made regarding extension of the project to Costa Rica and Nicaragua.

The Team expresses appreciation to MSU, AID and USDA for the opportunity to become better informed on the CRIES project and to provide counsel and suggestions on possible improvements in the work underway. Also, appreciation is expressed to Project Leader, John W. Putman and the entire CRIES staff for the many hospitalities extended the Team while in East Lansing. The Team fully realizes and appreciates the work of the CRIES staff in preparing and in presenting materials in conjunction with the East Lansing review meeting. The entire staff was most patient and cooperative in helping the Team understand the many facets of the project.

Probably the CRIES staff experienced major benefits in the process of preparing materials for the review meeting, as is the case with most review operations. Additional benefits were generated through the dialogue between

the Review Team and the CRIES staff during the East Lansing and Washington, D.C. meetings. Finally, the Review Team sincerely trusts that the CRIES staff will experience additional benefits from studying and reacting to this report which was prepared with the objective of assisting the CRIES staff in improving upon what the Team considers to be an excellent project.

In studying this report, members of the CRIES staff may desire clarification or elaboration on certain issues and points. Members of the Review Team will be glad to respond to any and all questions by the CRIES staff that may arise in studying the report content.

Study Design and Methodology

In reviewing any research project, the reviewer must endeavor to become familiar with its objectives, approach and procedures prerequisite to proceeding with the review process. Therefore, the initial tasks of the Review Team were (1) to articulate the meaning of specific objectives of the CRIES project and (2) to identify and evaluate the proposed methods for achieving these specific objectives. The remaining task of the Review Team was to take the project objectives as given and then proceed to evaluate the efficacy of the methods for achieving the objectives. The conjoint relationships between objectives and methods are crucial in the evaluation process.

The Team discerns certain ambiguities in the objectives of the project which required reconciliation prior to evaluating methods to achieve them. It becomes necessary to discover what the project is and what it is not; what the project is expected to produce and what the project is not expected to produce.

In studying various materials provided the Team, sometimes the objectives appear to include an analysis of the agricultural sector with policy analysis capabilities. Other times, the objectives appear limited to building a resource inventory and informational system with potential for data retrieval and transferability to similar soil, water and climate resource conditions throughout the world.

Let us illustrate these perceived ambiguities. The stated CRIES objectives are:

a. To assist developing countries to develop their capacity to identify and analyze the consequences of alternative policies, programs and prospects for agricultural and rural development in terms of their own multiple economic and social goals.

b. To improve the informational and analytical basis for making decisions on agricultural and rural development strategies, policies and investments.

c. To expand the number and enhance the capability of developing country planning personnel to construct and use an information base and analytical system. 2/

These objectives appear to encompass the area of agricultural sector analysis and planning as conducted in numerous countries over the last two decades. (However, the concept of sector planning has been interpreted differently in content and scope as conducted in various countries.) Yet, in another document,

> CRIES is not a sector model in the strict definition of sector modeling. CRIES has been deliberately restricted to a portion of the agricultural sector--land resources. We chose this approach for several reasons. In the Dominion Republic, others are working on a more complete sector analysis. Furthermore, we feel that modeling in developing countries should be approached in easy, understandable stages. Land seems a logical and basic first step. 3/

Also, "We have stated the objectives of the study as (1) to provide in-country assistance, and (2) to develop a data concept capable of assembling and transferring information among countries." Also, "...the concept of transferability /of data/ assumes great importance. Many projects are directed toward the generation of data of many kinds... It would be very useful to have a more rigorous process... One of the underlying concepts of CRIES is to develop a coordinated, universal system... Hopefully, in time, someone in USDA may become sold on the idea and provide a home and resource support for a coordinated program to classify, catalog and store resource information for all to use." 4/

2/ TA/AGR/ESP "A Proposal for a Comprehensive Resource Inventory and Evaluation System for Agricultural Planning, 1976" as stated in CRIES 77-5, December, 1977, p. 5.
3/ "Introduction," 1-12-78, p. 1. Written statement of presentation at East Lansing meeting. 1-17-78.
4/ Ibid., p. 3.

Furthermore, "CRIES is designed to inventory agricultural resources and to analyze their productive capacity, potential and response with respect to alternative levels and mixes of agricultural production." 5/

Despite these apparent ambiguities, there exists an inherent and necessary linkage between the (1) potential decision analysis capability in policy and program analysis, and (2) the natural resource base as a foundation of facts for analyzing alternative decision options. But it is well to keep clearly in mind the differences as well as the interrelationships between the above two activities being linked. Obviously, policy and program analysis and decision making are severely handicapped by lack of natural resource data and they are seriously endangered and misled by inaccurate data. On the other hand, natural resource data per se become meaningless unless obtained and ordered in a manner conducive to their retrieval and analysis in decision making by a range of decision makers including farmers, input suppliers, output processers and merchandisers and national planners.

The CRIES project has selected and adopted the methodology of linear programming as the primary tool for linking the natural resource base to decision making analysis within the agricultural sector. Thus, linear programming serves the necessary purpose of specifying data needs within an analytical framework that has the capability of ordering and utilizing data for sector analysis. Therefore, it appears to the Team that "other" AID-assisted sector analysis work in the Dominican Republic, should be integrated with the CRIES project.

5/ CRIES Working Series No. 77-5, USDA, AID and MSU. December, 1977. pp. 1-3.

The Proposed Model

The Team notes that the CRIES staff examined several analytical models including simulation and linear programming. Linear programming was selected for linking data needs to planning and for its decision analysis potential. Because of the rather large reservoir of experiences with sector planning and data problems over the past two decades in less-developed countries, it would appear advisable for the CRIES staff to examine these experiences and to provide evidence of such examination in the project activities. This range of experiences reflecting various degrees of success and failure, provides important knowledge of the potentialities as well as on the pitfalls in the selection and application of analytical models in the agricultural sectors of developing countries.

Instead of developing an analytical framework from the reservoir of experiences in less-developed countries, the CRIES project relies heavily upon U.S. experiences with modeling in National Water Assessment by the Water Resources Council and the Forest Range Environmental Program Analytical System. Possibly a careful review of the work performed in the sector analysis studies in other countries including Columbia, Korea, Thailand and Nigeria (but not excluding other countries) would be useful in the Dominican Republic. Of course, care must be exercised in varying the analysis to fit the particular needs and conditions in specific countries.

It would appear useful to develop the analytical framework with two conjoint purposes in mind. One purpose includes development of an analytical model with the (1) potential for analyzing the agricultural sector with respect to production possibilities under various scenarios of outputs and inputs,

costs and prices and alternative institutions and (2) ability to specify data needs, data reliability, data processing and data transferability.

The second purpose includes an informational system with the potential for ordering, classifying, retrieval and application of data on soils, water, climate and plant life in a manner that would provide data transferability to other areas of the world for purposes of predicting vegetative and technological adaptations and input response. The CRIES project appears to provide an excellent opportunity to develop the foundation for such an information bank and system in an orderly manner that would accommodate increments of additional data as they become available and tested and as specified as necessary for future agricultural planning throughout the world. Otherwise, these data that are obtained in specific countries may become lost, disorganized or forgotten and are unavailable for further and future utilization.

In developing and applying models with their data needs within the agricultural sector of the Dominican Republic, it should be emphasized that the agricultural sector is not a complete entity unto itself but instead it consists of only one sector within a national economy composed of many sectors. Therefore, the model must be designed to provide essential linkages with other sectors within the national economy involving capital, labor, population movements, foreign trade and other pertinent variables. Eventually, allocative uses and tradeoffs between and among resource inputs and outputs among sectors of the economy will constitute primary considerations within as well as among sectors. The agricultural model must accommodate and contribute to decision making at the macro as well as the agricultural sector levels of the national economy.

It would appear desirable for the analytical model to embrace sensitivity analysis in providing the relative importance of change affecting particular components of the model. Such analysis also would contribute to assessing data quality of particular coefficients generated in applying the model.

Data Needs as Prescribed by Model:
Sources, Kinds, Quality and
Estimating Procedures

Data needed for both (1) the analytical model and for (2) the informational system are highly interrelated. Data specified by the linear programming model (1) could not only serve the needs for decision analysis within the agricultural sector including essential linkages with other sectors but also (2) could provide data for the information system with assurances of relevancy in future applications.

Major data needs emphasized in the CRIES project are classed as follows:

(1) inventory of the quantity and quality of land resources identified in such a way as to be relatively homogeneous planning units,

(2) a set of current crop activities for each land unit with currently practiced production technique yields and production costs,

(3) a set of national and regional crop production goals. 6/

These needs require further examination in terms of providing necessary linkages with other sectors and the information system discussed above.

Quality of data becomes paramount for satisfying needs of the analytical model as well as for the information system. Performance of the model will be no better than the data used in its application. Unreliable data entering the information system would render the system useless and possibly dangerous.

6/ Ibid., pp. 13-15.

The CRIES project recognizes the importance of data quality as well as the importance of the model in data specification as follows:

> Given that the analysis of Dominican Republic resource use is handicapped by an inconsistent and inadequate data base, an analytical model is needed that can document inconsistencies and identify inadequacies... The exercise of estimating technical coefficients...and objective function values provides a disciplined way of identifying missing and inconsistent data. 7/

Sensitivity analysis assists in indicating the significance of particular data which in turn emphasizes the importance of data quality. Also, error analysis and tracking tests may be used to test data reliability. In instances where data are found to be inaccurate, measures should be undertaken to remedy the deficiencies. These measures include field surveys and consultation with researchers in the Dominican Republic, FAO, AID, OAS, USDA and International Research Centers in Mexico and Columbia. It may become necessary to use proxy data in demonstrating to the Dominican counterparts how the model functions and the urgent need for reliable data. Proxy data can be replaced with more accurate data as rapidly as such data becomes available.

Specific comments on data needs and data quality are detailed in the following sections concerned with the Resource Production Unit (hereafter termed RPU) concept, land area and land use estimates, and estimating procedures applied to land uses, crop yields, costs, remote sensing, referencing and definitions.

Resource Production Unit (RPU)

For purposes of CRIES, the RPU concept appears valid in trying to obtain working units of area sufficiently homogeneous with respect to agrophysical features so that average estimates of agricultural responses for each of the designated RPU's can be anticipated. Similarly, the same agricultural response will be expected in all of the same RPU's located in different situations throughout the study area which is in this case the Dominican Republic.

7/ Ibid., p. 8

It is also recognized by the CRIES study that actual agricultural responses will differ within the RPU as presently delineated and that only with more precise soil and plant life zone data (such as the family and series levels of soil classification) would such variation be eliminated. This refinement could ultimately result in more RPU.

The question arises as to the effects of permanent man-made modifications such as drainage, irrigation, and land surface modifications, upon the estimated average agricultural responses. These will be significant and therefore if relatively large in area, can be delineated as separate RPU. If occupying a large area within an RPU, they may be designated by an appropriate subscript to the RPU's, e.g. RPU Number 28 could contain a subarea of 28I where I signifies irrigation.

The concept of RPU appears sound. On the basis of the available data and their reliability, the criteria used for developing the RPU is perhaps the best alternative at this stage in the development of the project. However, qualifications of estimated coefficients for possible variance should be emphasized in the use of data and in results obtained from their use.

The number of RPU's developed for the Dominican Republic appears to be appropriate in light of the existing levels of classification of the two principal components--soil resources and plant life zones, on which they are based. Appropriate consideration is being given to the influence of permanent man-made modifications, such as irrigation, landforming and drainage in determining the addition or reduction of the number of RPU's as determined by soil and plant life zone factors. Such considerations should be clearly associated with designation of RPU's.

The criteria used in defining the RPU are clearly specified in the Land Resource Base Report.[8/] and the limitations are pointed out. Caution against misconceptions relative to equating RPU boundaries with soil boundaries and false expectations of things like homogeneous yields within the same RPU is sufficiently documented but may require continuing reiteration throughout the study and particularly in interpreting study results.

Basically, the CRIES project is an assemblage of pre-existing resource inventory data and agricultural statistics into a planning format by which computer models can be formulated to assist in developmental decisions at the national level. Entry of the data into the computer is achieved for a country with a geographic cellular system consisting of cells of one square kilometer size. Information on soils and plant life zones is used to formulate areal RPU's to which all other agricultural statistical data are related as much as is possible. The RPU is essentially a regional planning area within the country to which resources can be allocated in developmental programs in accord with the production potential and the needs of the population.

Soils Data

The soil information is perhaps the most important basic data of CRIES. Soil resources are important resources of any country, and those most likely to be damaged by mismanagement; thus, insidious erosion can irreversibly harm the soils so that production is depressed in lowlands as well as highlands far into the future. Haiti is a good example with which to compare the Dominican Republic in this regard. For this reason the soil input into CRIES is critical. Unfortunately, no field work was budgeted for soil survey in the CRIES project (only about $10,000 was allowed for the soil data gathering).

8/ Land Resource Base Report. CRIES No. 77-1. December, 1977.

All soils data input into the system have been a standardization and generalization of the information already available in each country put together in an excellent fashion by Dr. Ellis G. Knox (Consultant for CRIES from Soil and Land Use Technology, Inc.). Each country has different organizations for soil survey. The Dominican Republic has local soil surveys as well as soil surveys published by the Organization of American States and the Food and Agriculture Organization of the United Nations. Nicaragua has fairly good soil information for the Pacific side, but relatively little soil data for the Atlantic side. Costa Rica has a great variety of different kinds of soil surveys developed by numerous agencies, institutions and universities. General soil information on all of the countries is available from the World Soil Geography Unit of the Soil Conservation Service of the U.S. Department of Agriculture.

To illustrate the soil information derived for CRIES by Dr. Ellis G. Knox, descriptions of soil map units and a soil map of the Dominican Republic were reviewed. Symbols of the World Soil Map of the World Soil Geography Unit of the Soil Conservation Service were used along with the nomenclature of Soil Taxonomy (Soil Survey Staff, 1975). The soil map unit symbols have three parts: (1) the symbol of the dominant soils, (2) the numerator of a fraction that shows the geomorphic landform, and (3) the denominator of a fraction that indicates the soil parent material or the material underlying the soil.

The landforms of the Dominican Republic are dissected terraces (DT), fans at bases of mountains (F), floodplains (FP), Karst topography (K), level plains (L), mountains (M), rolling and hilly terrain (RH), steep hills (S), terraces (T), undulating plains (U), undulating and rolling plains (UR) and swamps (WS). The underlying materials are unconsolidated alluvium (A),

unconsolidated lacustrine alluvium (LA), limestone (LS), limestone and shale (LSS), unconsolidated marine sediments (M), mixed acid and basic igneous and metamorphic rocks (RB) and volcanic tuff (T). Double symbols indicate associations of groups of soils. Thus, DOAa F/A - DOAa RH/LS has mostly variable kinds of Typic Camorthids on fans and uplands underlain by alluvium and limestone. Similarly, the DOAa RH/LSS soil map unit has predominately Typic Camborthids on erosional rolling and hilly uplands over limestone and shale with slopes mostly less than 30 percent; the EOHj L/LA soil map unit has mostly Ustic Torriorthents on level plains over lacustrine and alluvial materials; the EOUdk UR/LS soil map unit has mostly Skeletal Lithic Ustorthents on undulating and rolling plains over limestone; the ITYf S/T soil map unit has mostly Lithic Dystropepts on erosional hills over tuff with slopes generally steeper than 30 percent; and the ITYs M/RB soil map unit has Shallow Typic Dystropepts on mountains over igneous and metamorphic rocks mostly steeper than 30 percent. Each soil map unit description includes also estimated soil properties and special features of the dominant soils.

Plant life zones were also used according to the delineations made by Holdridge[9/]. These map units show the relationships existing between climate and other environmental factors by quantitatively relating biotemperature, precipitation and humidity. Since the soil map units also contain elements of temperature and moisture regimes of soils, the plant life zones generally had similar boundaries as geomorphic groupings of soil map units--but in a few cases the boundaries of the plant life zones were different from the soil boundaries. The general soil map of the Dominican Republic had about 40 units, and the plant life zones numbered less than 10.

9/ Holdridge, L. R. Life Zone Ecology, Revised Edition, Tropical Service Center, San Jose, Costa Rica. August, 1967.

Resource Production Units were formulated from the general soil map and the plant life zones. The RPU is defined as a unit of land with components sufficiently homogeneous with respect to agronomical factors of soil, climate and water resources to be depicted by one or a few unique estimates of agricultural factors such as crop adaptability and input-output coefficients. Obviously, each RPU has a set of related soils (which may or may not be highly contrasting) in a similar geomorphic setting; the soil contrast within each RPU is unique and different from that in each of the other RPU area map separations. The CRIES RPU descriptions for units 2, 10 and 17 illustrate the type of production areas in the Dominican Republic. The mountain areas (RPU #2) have soils that are extremely variable, but the soils have relatively low agricultural potential due to the predominate steep slopes. The estuaries and tidal flats (RPU # 10) are wet and saline in places. The RPU #17 has good soils in about 90 percent of these areas on terraces, footslopes and pediments over water-deposited sediments--these areas are some of the most potentially productive in the Dominican Republic and are already producing a wide variety of crops.

Since the RPU is the basic area of aggregation of CRIES data within the country, the square kilometer grid cells within each RPU area can be evaluated in terms of the data for each cell. Computer analyses can be used to illustrate the differences between each RPU and the variability within each RPU in terms of agricultural production functions. Generally, the past work described to the Team in oral and written form was judged to be good. Several areas of opportunity in soil survey interpretations, however, are being neglected due to understaffing of pedologists (soil scientists). Not even a single fulltime pedologist is presently working with the large staff of CRIES economists at Michigan State University.

Due to faulty local economic data, the CRIES staff should concentrate on accumulation of as much data of a primary nature as is possible to relate to soil map units and resource production units. Thus, aerial photographic interpretation and satellite imagery can be used very effectively to map land use and crop acreages to be related to soils. These primary data are much more reliable than revised secondary census data of questionable origin. At the same time, statistical samplings and ground truth should be formulated to improve future statistical gatherings. The computer and the grid system of CRIES affords marvelous opportunities to relate all kinds of land use data and production functions to the soils upon which land use and agricultural production are based.

Soil survey interpretations should be developed and expanded in the CRIES project as far as is possible, particularly in Nicaragua and Costa Rica where modeling work is just getting started. The CRIES grid cell computer model gives many excellent opportunities to outline alternative production programs based on the hard primary soils data. Ratings should be made of the soils for suitabilities, capabilities, limitations and hazards for alternative cropping patterns--based on the soil characteristics. Grid cell maps can readily be printed by the computer (based on soil information) to show areas best and worst suited for corn, beans, coconuts, sugar cane, yucca, rice, tobacco, coffee, bananas and other crops--and to show responses of these soil areas to irrigation, fertilization, interplanting, sequential cropping and other possible feasible management situations. The CRIES project will only be effective through the outputs of valid data and maps and these outputs will be more accurate and reliable if based on the hard primary data of the soil survey inputs.

Land Area and Land Use

There are numerous sources of data for obtaining quite accurate information concerning area and use of land. But these sources require particular technical skills and considerable time to prepare the data. Possible sources of data are discussed under the following five topics: (1) government publications; (2) information from knowledgeable people and secondary sources; (3) in certain cases, institutional sources are useful including World Bank, OAS, UN and FAO; (4) data may have to be prepared by the field units of CRIES if no other sources are acceptable; and (5) remote sensing sources, including low and high altitude photography, as well as satellite imagery.

In most cases it will be very productive to combine input from numbers 1, 2, 3 and 5 above. If other sources seem inappropriate, No. 5 alone could provide the total data input very satisfactorily in most areas.

Government publications are frequently suspect as sources of land use information for a variety of reasons. Yet, they are the source of information used in generating the international institutional data such as for FAO, World Bank or OAS. It is not always feasible to develop land use figures that are grossly different from those provided by the host country government unit. It might be necessary, however, to incorporate "factors" of adjustment within the model to assist in developing more realistic data.

Of the land use information that was generated for the CRIES, the information based on the soil interpretation information, although crude by some standards, appeared to be the most reliable of the sources discussed. Other data and methods of converting them to suitable input units to satisfy the model often seemed to be characterized by serious weaknesses. Variations on individual crops were so great (almost 100 percent for yucca) that credibility is seriously questioned.

The most unsettling part of the procedures for preparation of data for the model appear to be the manipulation or "crunching" if you will of the host country data to fit the model. This appeared to be too drastic an approach. At least a minimum number of "best estimates" could be obtained from knowledgeable individuals in the country. This could be a rather simple, inexpensive way of improving data.

Land area, as such, can be quite well identified from any of several sources, including aerial photographs, high altitude photography, or even satellite imagery. The total land mass of the country should not be in question. But there are a number of ways that could be explored for obtaining better information about land use.

The most valuable single approach would be a rather quick interpretation of aerial photography. Even high altitude imagery, when properly interpreted should provide a 10 to 20 unit classification inventory for a very low cost. And it could be prepared relatively quickly. For example, the problem of inter-cropping and multiple cropping could be handled in the description phase of the classification system.

Sample areas, where the interpretation was carried out in detail and supplemented with ground truth information could provide an excellent basis for acquiring less-biased data. Extrapolation to larger areas could be undertaken with the help of local respondents.[10/]

The field sample areas could be established on a rather permanent basis. They could be of use in many stages of the project for writing classification descriptions, testing the accuracy of interpreted data from photographs and space imagery and for testing the capability of the model when decision making data are presented.

10/ Conklin, H.E.; DeLozada, A.S.; Methods for Studying Land in New Areas; (Mimeograph) Department of Agric. Economics, Cornell University. 1960.

Another area of value to explore would be the use of sample design techniques to obtain low-cost data. There are systems that have recently been developed that could cut the cost of data acquisition dramatically. They have been tested in actual use situations and have been found to have very high accuracy levels.[11/] The basic approach is to base the sample selection on points that are geographically located. A sample of points can be drawn by statistical means, and the sum of points in various land uses can be converted to percentages of land in the selected uses. This procedure can be used to advantage on large or small areas (RPU or a whole country) and has proven to be very inexpensive and essentially unbiased. In addition, it can be used with intermixed scales of photography or other geographically referenceable sources of data. Field sample areas, if developed, would serve to verify or establish the accuracy of the point sample data acquisition system.

These approaches appear worth considering. The land use data, as currently developed, leaves doubts regarding accuracy particularly if decisions are desired between closely related economic benefits.

Production and Land Practices

Data pertaining to production and practices involved in production, suffer from the same problems as do other data. These problems were not a lack of data but rather a great variation between data from various sources. This should not be unexpected in view of the fact that in a tropical country one deals with several crops some of which are annual, some perennial. Harvesting methods vary widely depending upon uses and production practices which do not necessarily reflect the nature of soil, climate or markets.

11/ Zeimitz, K.A.; Dillon, E; Otte, R.C.; and Hardy, E.E. Dynamics of Land Use in Fast Growth Areas; USDA, Ag. Econ. Report No. 325. 1976.

In attempting to obtain data used in the Dominican Republic, raw data had to be adjusted because of inherent gaps and inconsistencies. At times these adjustments, while mathematically feasible, were agronomically questionable.

The complexity of multiple cropping patterns in the tropics appears to lend further confusion when attempts are made to fit these practices into the model. For purposes of treating data pertaining to multiple cropping, oversimplification seems to occur in that multiple cropping data are classified only as interplanted and noninterplanted (solo).

Multiple cropping can be divided into intercropping systems and sequential cropping systems and this is recognized for purposes of CRIES. However, practices within these two classifications are overlooked. For example, intercropping involves: (a) mixed intercropping consisting of two or more crops grown simultaneously with no distinct row arrangement (very popular in the Carribbean Islands); (b) row intercropping consisting of growing two or more crops simultaneously with one or more of the crops planted in rows; (c) strip intercropping consisting of growing two or more crops simultaneously in different strips wide enough to permit independent cultivation but narrow enough for the crops to interact agronomically; and (d) relay intercropping consisting of growing two or more crops simultaneously during part of each one's life cycle. A second crop is planted after the first but before the first crop is ready for harvest.

Sequential cropping that is the growing of two or more crops in sequence on the same land area per year with the succeeding crop being planted after the first is harvested involves double, triple, quadruple and ratoon cropping.

Undoubtedly, at least part of the discrepancies encountered in the production data can be explained by the diverse multiple cropping systems explained above. Because of the obvious errors in these and other data, and the possibility

of results being unqualified and misinterpreted, the Team suggests that "proxy" data be used in the model for demonstration purposes until such time as refinements and improvement can be made in the kinds, sources and quality of the production data.

One positive aspect pertaining to the use and manipulation of these and other data for purposes of the CRIES model is that it emphasizes to those agencies in the Dominican Republic responsible for data collection the pressing need for better data and data collection methods. The recognition of these needs should result in an increased desire for improved data quality.

Crop Yields

A neglected area of soil survey interpretations of the CRIES project involves use of specific soils and specific soil characteristics in determination of present and potential crop yields under different management systems. Presently the CRIES staff is using economic census data and local economic survey data to make crop yield estimates and predictions. Although heroic efforts have been made to interpret these data, they are often conflicting, inconsistent and appear faulty at least in the case of yucca. From the perspective of soils, it appears better for the CRIES staff to rank the soils for their productivity based on the soil characteristics.[12/] Then high and low yield values for each crop for each soil could be assigned from experiment station results, data of experimental agronomy trials on farmer fields and consultations with local agronomists and soil scientists in the Dominican Republic and other countries. With yield data on a few key soils, estimates of yields could be made for all of the soils from the rankings based on the

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12/ Olson, G. W. Training Key People in Soil Survey Interpretations in Latin America, Cornell Agronomy Mimeograph 75-8. Department of Agronomy, Cornell University, Ithaca, New York. 1975.

soil properties. Using this procedure, reliable estimates for present and potential yields of all crops on all soils under different management conditions could be made with minimal effort and maximum benefit to the CRIES computer modeling process. The yield of each soil could be assigned its relative proportionate importance to each square kilometer cell and to each RPU based on the soil map unit descriptions and the RPU area descriptions.

This procedure would relate the economic production output statistics to specific soil characteristics from which the agricultural production was derived in the first place. These procedures are used in all of the recent hundreds of published soil survey reports of the Cooperative Soil Survey in the United States. The CRIES staff should carefully study these soil survey reports particularly reports for tropical areas including Hawaii, Puerto Rico and the Virgin Islands for their possible use within the RPU's in the Dominican Republic.13/

Costs and Prices

Costs of production are derived from the 1976 SEA Cost of Production Report14/ and applied to land use activities on a RPU basis. Apparently, this SEA survey will be continued periodically to reflect changes in technology, inflation and other secular changes. It is not clear from the materials studied by the Review Team that the input costs were varied for weighted differences by crops within RPU. Also, it is not clear just how these costs would apply to normative changes in land use and technologies in the future.

While costs of inputs are sufficient for the cost-minimizing linear program, future uses of land must be weighted by output values which change with domestic and export demands, if the analytical model is to provide the capability of analyzing future dynamic changes of land use by alternative crop activities.

13/ Rivera, L. H. et al, Soil Survey of the Virgin Islands. U.S. Government Printing Office, Washington, D.C. 80 pages and 32 soil map sheets at 1:15,840 scale. 1970.

14/ SEA, Officina de Planification. Coordination and Evaluation. Diagnostico y Estrategia del Sector Agropecuario. 1975.

Remote Sensing

A substantial amount of funds were budgeted for the use of remote sensing for this project. A staff of highly qualified and very talented young scientists is available to work with remotely sensed data. The use of remotely sensed data would solve many of the resource data problems. Yet, remote sensing has been used very little in the project.

Considering the above circumstances, the Team was concerned about the lo output of data derived from remote sensing. NASA is listed as a contributor of $47,000 of support, yet all that seems to have been prepared was a false color infra red photograph of rather limited value.

There exist a variety of techniques that can be used with remotely sensed imagery that should (1) support the development of resource production units, (2) yield area measurements within bounds of a small number of hectares (3) identify land forms and inter-climatic areas, and (4) provide supporting evidence of socio-cultural-economic conditions.

Remote sensing includes photography, aerial photos, high altitude photography, multispectral imagery of all types and from all altitudes including satellite. It would appear that for $47,000 the whole country could have been photographed in at least one workable imagery format. Remote sensing can be conducted by a variety of techniques, some of which are extremely simple with little cost. For example, consider the use of $12 stereo glasses or a $300 micro-reader for high altitude imagery.[15/]

Imagery can be processed in a variety of ways to identify most desired features and many crops. These processes can be carried out for as little as a few hundred dollars per satellite scene (10,000 sq. mi.). Yet, the contribution from the interested sponsor was not able to produce such highly useful products.

15/ Hardy, E.E. and Hunt, L.E. Testing Low Cost Interpretation Systems for Updating Land Use Inventories. 10th Symposium on Remote Sensing, Ann Arbor, Mich. Oct. 1975, and Hardy. E.E. et. al. Skylab Report. Photo Enhancement Processes of Remotely Acquired Imagery. NASA, 1974.

The Team suggests the best source of data for this project from remote sensing would be high altitude color transparencies at scales of approximately 1:80,000 or 1:100,000. With simple equipment and straightforward manual techniques, interpretations can be made at scales of 1:8,000 to 1:10,000. This would offer the detail needed, yet in direct viewing procedures whole RPU units or groups of RPU's would be readily visible and identifiable.

By combining seasonality considerations (for specific crops) it is possible to obtain highly detailed information about crops, areas of land used and even crude estimates of yield and total production. It is very beneficial to have available an aircraft for acquisition of this information. If these approaches are undertaken, then the field sample areas combined with sample design techniques offer a worthwhile approach to low-cost data acquisition from unbiased sources which will be useful over periods of many years.

Another major benefit of remote sensing, even of the more or less inferior types, is that it provides an inexpensive way of screening and possibly eliminating areas where it is obvious the alternatives are too limited to spend time and funds to investigate further. This is accomplished through the combination of land form analysis, along with a good understanding of the on-ground situation.

If low-cost approaches are attempted, the results may be just as useful as those obtained by sophisticated methods. There are two major advantages in addition to low costs. First, much of the technical work can be easily explained to host country technicians. This is one of the major factors affecting the long-range success of this kind of a project. They usually are not able to leave the country as soon as they are trained. Second, the

host country will not become dependent on an outside source for its data needs. The outside source would be beyond the control of the host country and might become suspect.

Low-cost approaches include: 1) manual interpretation of imagery; 2) sample designs, combined with test areas; 3) photographic enhancement of images; 4) projection techniques that allow for scale changes to most any desired size; and 5) color separation processes that allow color coding of areas of specified crops or land use.

The equipment costs for some of these approaches is minimal (hundreds of dollars) and the most expensive systems cost less than $15,000.

In summary, remote sensing should be able to provide a considerable part of the data needs for CRIES. In some areas, it could provide practically all of the land area and land use data. Unfortunately, it has not been used effectively. This does not appear to be the fault of the CRIES staff. It is evidently a matter of concern of one or more of the sponsoring agencies. There is a whole area to be explored here. The rewards could be extremely great. The lack of greater use of remote sensing on a project for which it seems to be so admirably suited is a disappointment.

The Team suggests reexamination of available remote sensing techniques in their use as an integral part of the data acquisition process.

Geographical Referencing

The main problem in trying to geographically reference natural resources is the fundamental one of applying a square grid to a round ball. In order to work within the framework of requirements of modern computers the procedure is to reduce all information to numbers and make the computer accept them and

provide answers on request. This process requires the intermixing of several arts and sciences. If improperly mixed we receive a "garbage in - garbage out" result from the computer. If properly organized, the approach accomplishes useable products.

The process of geographic referencing requires a knowledge of basic plane geometry concepts, some understanding of the problems of cartography, a thorough knowledge of classification theory and an understanding of computer potentials. From these fields of science and art it becomes possible to develop a "systematic" approach to assess information from a variety of sources reducing it to numerical forms and identifying its location in such a way that the computer can process the data to answers through numerical or graphic displays that are properly located on a display.

Two basic approaches are usually proposed by computer scientists, the "curvilinear" or "random polygon" system or the grid system. By far, the most productive and economical and the most versatile of the two is the grid system. The CRIES project has elected to work with grid units in its basic computer organization.

There is much to be understood about the grid system before it is attempted. It has a zonal system that must be acknowledged and it must be reasonably certain of assigning the right data to the correct land mass.

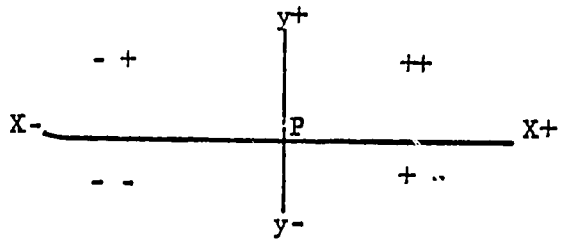
Coordinate numbering systems are usually termed identifiers for grid systems. This can be misleading. Some changes are needed in the CRIES project to accommodate the proper numbering approach. Reference was made to three different numbering systems but they are not compatible.

If a coordinate numbering system is to be accurately used reference should be made to the original work of René Descartes and his development

of the Cartesian coordinate system. This identifies the point at which two right angle lines cross as the point of origin for data. It is not simply a matter of moving the numbers over to a cell of area enclosed by the horizontal and perpendicular lines because in the coordinate numbering systems one dot or point can represent one of four different land mass areas, depending on which quadrant of the x-y coordinate system is used.[16/] The important point to realize is that a coordinate numbering system locates points about which any volume of data may be assembled. But one must know which of four possible areas is to be represented by the point if accurate maps or statistical data are to be prepared by computer processing.

The coordinate system is based on the X axis in the horizontal position, and the y axis in perpendicular position. By convention, all areas above the x axis are rated positive and those below are negative. In the case of the y axis, all areas to the right are rated positive, those to the left are negative.

This system provides four combinations each of which is served by different approaches to the coordinate numbering process.



This results in the following quadrant approaches:

Upper right	++
Lower right	+-
Lower left	--
Upper left	-+

Depending on the numbering system the point P where x and y intersect can represent the land area of any of the four quadrants.

16/ Oakley, C.O. Analytic Geometry, Barnes and Noble, Inc. New York. 1957

The upper right quadrant (++) is the area located by the point (P) if the UTM coordinate system is used. That is based on northings read from the Equator and eastings based upon selected longitudinal lines. The correct reading approach is to the right and then up. This directs identification to the upper right or ++ quadrant. Point P is numerically represented by 0,0, and the point that would be represented by 1,1, is actually located one cell unit above and to the right of point 0,0 at a 45° angle.

If a numbering system based upon rows and columns is to be used, it would be read to the right of P and then down. This would locate area in the lower right quadrant or the +,- section. This area when applied to a land mass situation is a different physical area than that represented by the upper right (++) quadrant even though the same point (P) is used to locate both areas.

Because the above situation exists, it is possible to have all of the data in a study erroneously representing selected land areas. In certain instances, (the case of long, skinny map units) the error could be 100 percent. In areas where the RPU's are larger and more circular in shape the error would be associated with boundary cells and would be represented as a much smaller percentage error.

The CRIES report identifies the use of both of these coordinate systems. In addition it refers to the numbering of cells sequentially from 1 to n in a rank and column system. These are not compatible numbering systems and steps should be taken to eliminate this source of error in the computer processing phase.

There are suggestions that the curvilinear or polygon approach to data processing would be more sophisticated. It is also much more expensive, more difficult to explain to an audience of users and a much weaker tool where time lapse analysis is desired.

Generalization of area data is a factor when coordinate numbering systems are used. The degree of generalization is associated with the size of the cell that is used. In the case of the CRIES project it is one square kilometer or 247.1 acres. If simple data input systems are used, based on "dominant" land use or cover for each cell, the maximum error for any one kl^2 would be $\frac{247.1}{2}$ The same situation will hold for boundary cells of the RPU's.

The grid system when properly established produces an extremely efficient, unbiased sample resource. The cells can be chosen in a number of ways to represent any desired percentage of area within a study zone.

All data for each cell should be treated and recorded independently of any other data. With independent data records for each cell, reaggregation procedures allow preparation of information for other recognizeable units besides the RPU such as watersheds, political subdivisions, regions, etc.

The purists and the sophisticates of the fields of art and science that must be incorporated in the geographic referencing process will have comments about this approach, many of them of a negative nature. But excessive technical excellence may not stand in the way of progress. This system may not satisfy the cartographer, the mathematician or the computer specialist. However, it is cheap, effective, rapid and easily understood.

Definitions and Descriptions

The key to transferability of data from one area of the world to another hinges on the ability to define and describe areas properly. Without description one cannot recognize areas of like resources in other parts of the world. The descriptions of areas (RPU in this case) must include technically described characteristics and equal attention must be given to social and economic characteristics as well.

The definition and description effort associated with most inventory projects is usually the weakest part of the effort. Yet, if one intends to do a good enough job so that the inventory may be carried out a second time for a time-lapse analysis study or for improvements in the data source, one must have written descriptions of the classification units. They must be so complete and so accurate that a different technician can use them as guides to his work and come up with essentially the same decisions. This should be the case even though the technician has not had the experience or assistance of anyone who worked on the previous project.

It is a difficult task to meet such rigorous requirements as those stated above. Description is frequently the most boring task associated with a resource inventory. After all, the staff members know what the units look like. They may not really care very much about writing down a detailed description. But after all the data have been compiled, all the maps drawn and forgotten, the only thing of value that remains from multimillion dollar research efforts is description. Its life span of value and accuracy continues indefinitely while the data may change in accuracy and usefulness after acquisition.[17/]

A workable classification system relies on three major components: (1) comprehensiveness, (2) unique description and (3) discrete assignment. They are only as useful as the weakest component allows them to be. And the weakest component is almost always description. But it is only through the description process that discrete assignment of units in the classification system is possible. And that one step is the one that determines the suitability of the classification system and the success of the project. If data

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17/ Klimm, L.E., Mere Description (Essay) in Economic Geography, Vol. XXXV, Clark University. 1970.

units are inadequately described and thereby inappropriately assigned in the classification system, their fidelity and usefulness is destroyed. The problem is that this can happen without recognition.

The description of each unit should be as lengthy as is needed to assemble all the detail necessary for one unfamiliar with the project. It is not a simple glossary of terms. The description identifies what the classification unit is, the range of inclusions within its continuum (all items in a classification occur in some form of a continuum) the parameters of the unit, the items that closely resemble the unit but are not included and what the unit does not include.

The key identifiers should be from unbiased sources. This is one of the fine characteristics of remote sensing, especially air photos, in developing classification systems. Technicians commonly use basic identifiers including soil, topography, climate, etc to form the basic input segment. But in addition, gains are experienced by describing the unit in terms relative to economics, cultural features, management practices, plant or vegetative cover, structures, etc.

When secondary sources of data are used, a rigorous attempt should be made to acquire the detailed descriptions used in preparing the material. The soil maps and bulletins are frequently the only secondary source of information that provides an adequate and systematic approach to the description process. As an alternative example, frequent users of USGS topographic quadrangles may be completely uninformed about the accuracy standards the maps are supposed to meet. Yet those standards are the definitions.

All secondary data sources should have the same attention given to their descriptions as given to the primary sources of data. It is not enough to

simply say the data was provided by a certain agency. To make the transferability concept work, one needs to know how, when, where and why the data were gathered and above all what are its inherent biases and limitations.

A final problem frequently surfaces relative to inventory processes. Too often the user for whom the project is intended, or others who could make use of the data, are turned away from any degree of reliance on the results because of the "black box" mystery that confronts them. If the user audience has no understanding of computer capabilities, the print-out is a complete mystery to them. The "mystery" can be lessened or removed entirely if appropriate documentation of the project is maintained. Description of the classification units is the foundation of that documentation.

Technical and Institutional Arrangements

Institutional and technical arrangements among the participating agencies within the U.S., within the Dominican Republic and between the U.S. entities and the Dominican entities are crucial to the success of CRIES. This part of the report discusses these arrangements in terms of interagency arrangements, interdisciplinary approach, intercountry arrangements, training components and transfer of technical skills and methodology to country nationals.

Interagency Arrangements

CRIES has generated what appears to be an excellent framework for interagency cooperation as illustrated in Figures 1 and 2 shown in Appendix B. AID, USDA, ARS, SCS and ERS, and MSU provide essential personnel and funds for the project. Some of the problems in extending these arrangements to fulfill the CRIES objectives were considered earlier in Administrative Considerations.

It is less than clear to the Review Team how the Dominican agencies are participating in the project within the Dominican Republic. Although technical and institutional arrangements among these Dominican agencies are perhaps more important to the ultimate success of CRIES than U.S. agency arrangements, both sets of agencies are crucial to project success within the CRIES framework. The Review Team does not have sufficient information, however, to evaluate the Dominican interagency arrangements.

Interdisciplinary Approach

Within the host countries there frequently are major sources of data in limited form, located at specialized research stations, operated by either public or private institutions. These sources, plus the reliance on input from knowledgeable people are frequently the best sources available.[18/]

18/ Conklin, H.E., and DeLozada, A.S., Methods for Studying Land in New Areas. Ag. Econ. Mimeograph, Cornell University, 1960.

The documentation of the RPU requires input from a number of disciplines including natural and social science sources. These sources will not be readily or uniformly available throughout the study process. So it will be necessary to allow the design configuration to have enough flexibility to handle the various sources of data for input.

The interdisciplinary approach and its significance are fairly well recognized for most of the project. But the significance of the botanical selection process was not easily identified in the reports. James A. Duke's[19/] presentation identified the key to the use of the model for predictive purposes. This needs more attention and a clearly identified pattern or program for application.

The uses of the model can be expanded if a broader approach is taken toward identifying interdisciplinary needs and applications of the acquired data. Training for these applications may be necessary. Once the data have been acquired and geographically referenced, it can be reaggregated to suit the needs of many users. These include river basin study groups, geographic regions, economic areas, botanical studies, insect damage, etc.

In another sense, there is a need for some additional inputs. Information for RPU and groups of RPU should be presented in small enough units to make the mini-computer concept workable. Projects often consume large amounts of time and money developing macro-concepts when perhaps a small calculator and a limited amount of labor would generate comparable results.

Inter-Country Arrangements

In developing conjointly the analytical model and the information system, the next step is testing through application of the model and the system in a developing country. Both the model and the system are expected to have general

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19/ Presentation at East Lansing meeting, January 16, 1978.

application and use in the developing countries. Therefore, the Dominican Republic provides the opportunity for testing and further developing the model and system. Also, the Dominican Republic is the immediate beneficiary of both model and system. In a large measure, the Dominican Republic is a partner in the development through application of both model and system. In this respect the Dominican Republic serves as a testing ground and preview for problems likely to be encountered in developing countries.

Therefore, intercountry arrangements bear the responsibility of a partnership. The site of East Lansing for development of the model and system and the site of Dominican Republic as the site of application raises both questions and problems. Of course, these questions and problems can be resolved through close collaboration of the two staffs (U.S. and Dominican) on the many intricacies of CRIES both in East Lansing and in the Dominican Republic. The Review Team did not see or have the opportunity to dialog with Dominicans at the East Lansing conference in order to gain greater insight into their participation in the project.

Training Components

Aspects of training and technical followup in the use of CRIES data are extremely important if the system is to be effectively continued by local personnel in the countries involved. It appeared to the Team that all of the potential users of the CRIES analyses had not been identified and that adequate provisions for training of large numbers of local people in the operation of the system had not been provided. Partly, at least, this situation appeared to be due to constraints of the AID contract which assumes that training programs will be initiated and handled administratively by the AID program within each country. Any any rate, training components of all aspects of the

CRIES project should be strengthened and broadened as much as is possible within the Dominican Republic. The CRIES material would also adapt itself to a wider audience through teaching in regional centers. A Team member has recently had beneficial experiences of teaching soil survey interpretations at regional centers of CIDIAT (Centro Interamericano de Desarrollo Integral de Aguas y Tierras) at the University of the Andes in Merida, Venezuela, and SEARCA (Southeast Asian Regional Center for Graduate Study and Research in Agriculture) at the University of the Philippines at Los Banos. These regional teaching centers as well as others would likely be receptive to offering of short courses and extended courses relating to CRIES project materials.

There is a lot to be concerned about in establishing training programs and to establish technical staffs in host countries. Generally speaking, those who are sent to the U.S. for advanced academic degrees might well become educated out of the pool of available personnel for the project. Another danger exists in educating only the high-ranked officials in the host country, as they frequently change positions for any of a number of reasons.

A good way to guarantee available technically trained personnel would appear to be to train the technical staff in their language and in their country. That group would not possess the mobility to change positions or move to other countries as easily as the higher levels of officials and probably would remain as functional technical staff for the CRIES project for much greater periods of time. A few higher level staff would need to be trained in the application procedures, however. Most of the work of the technical staff can be broken down to relatively small learning units and the staff in the host country should learn the routines rather quickly.[20]

20/ Personal experience of Gerald W. Olson in training technicians.

Transfer of Technical Skills and Methodology

The life span of the project needs to be reconsidered. It will take 18 months to 2 years to initiate operation of this program in a country. And the real value of the effort can only be recognized when the results of the data acquisition and manipulation processes are applied to macro- or micro-decision making procedures. Each country will need advisory staff to maintain the user function after completion of the major project.

It was brought out in the review discussions that there is a continuing need to get the data used. Within the country there appears to be a lack of contacts through "professional networks" to aid the lone individual(s) who is responsible for getting the model and system into use. And there are major problems related to cultural attitudes toward information especially if it's provided from an outside source and through a technology that is not easily understood. The host country team must have access to help from the donor nation for a continuing period of time. During the initial years the assistance should be in residence in the host country. After that, assistance should be readily available on a "call" basis. Without this followup arrangement, the reports and legacy of CRIES may well become another addition on a few library shelves.

Within the data acquisition process the institutional and management concepts become critical factors. Management problems may be illustrated in the case of large holdings that are managed for commercial production of one or two crops with adequate technical and capital resources. In contrast, a neighboring 100 hectare area may be owned or worked by many families, with little technical skill and limited capital resources. These two areas may have identical natural resources, but other factors will influence operations to the point the similarities may not be recognized.

Local institutional arrangements may be the major limiting factor to obtaining the desired results of applying information from the CRIES project. Essentially the land tenure systems and political realities extant in each situation are factors well beyond the reach or control of the CRIES program. They may have to be accepted as a "given," but accounted for in the design phase of the project.

Local users of the CRIES products may well be expanded beyond uses currently identified. These will vary in each country but there will be continual opportunities to apply the results at local government levels or to extend it to individual decision makers.

Administrative Considerations

Administrative considerations are particularly crucial to the successful development of CRIES because of the number of agencies and disciplines involved in the project as referenced earlier in this report. The Review Team feels that certain weaknesses exist within the administrative arrangements that may well threaten or severely limit the CRIES potential. These weaknesses as well as the strengths are reviewed under the following headings of planning horizon and financing, stabilities within participating agencies, competency of and cooperation among technical staff and CRIES project identity. Some of these weaknesses are beyond the authority of the CRIES staff to remedy.

Planning Horizons and Financing

The tasks of CRIES in developing an analytical model and an information system to serve the needs of developing countries through estimating their agricultural production potential and developing the means for realizing this potential is a long-term effort. Success of this effort demands a commensurate long-term planning horizon with adequate financing assured. The planning horizon must be longer than the testing and application period allocated for the Dominican Republic. The horizon must be longer than the expected extensions of the model and system to Costa Rica and Nicaragua. Part of the problem lies in the instabilities and commitment of the participating agencies within the U.S. and within the Dominican Republic which is the subject of the following section.

Stabilities within Participating Agencies

The CRIES program reflects many of the problems commonly encountered in such projects. There seems to be a lack of stability, especially of personnel, among the various support agencies. These problems, ironically, are beyond

the grasp of any one group to solve. It is not possible for any one group member to tell or ask another member to do things differently.

The Team recognizes and deplores some of the problem areas related to support within various agencies. The Team was very favorably impressed with the enthusiasm and competence of the staff individuals but realized that weaknesses in agency arrangements need attention.

The MSU staff members, although some were only fractionally committed to the CRIES project, appeared to be secure and knowledgeable about their position within CRIES. However, other staff members are working under soft money positions, which suggest a turnover in personnel in the near future.

The USDA personnel were very competent in their selected fields of activities but the Team got the impression of concern that some of them were: 1) located at stations inconvenient to the needs of the CRIES project, 2) heavily committed to other projects which precluded concentration on the CRIES work and 3) unsure of their agency's interest and intentions to have them continue their affiliation with the CRIES project.

The NASA involvement was a disappointment. It indicates a lack of interest and little imagination and the Team wondered why they were involved at all. With their vast supply of technical capabilities, why did their input appear to be only a few false color IR prints? There are far more useful products they could supply. For the money they received they could have supplied high altitude color transparencies with which RPU's could be identified and described in greater detail. These comments are not aimed at the MSU NASA applications team. They are contributing all they can. But the NASA support has not been sufficient to allow them to make the kinds of contributions they are capable of providing.

The AID staff participation appeared to be appropriate to the committee. They are providing funds, fiscal administration, technical advice and other necessary logistic and strategic services. They are also assisting in understanding the needs of countries involved in the project. The Team noted no serious complaints or problems about the AID contribution but rather accepted their efforts as a major contribution that was well received.

The CRIES project is really a long-term effort that is being "squeezed" into a short-term budget framework. The Team recognizes the fact that long-term projects (over 3 years) are rarely funded. But this is a case where 5 years should be the minimum period considered and additional years would be much more logical. Under the present time frame, there is time enough only to develop the system, test it in one (possibly two) country, make recommendations from the machine processed data, then drop out of sight. To be effective, the CRIES project needs to remain active long enough to test the validity of the recommendations and to add new data in a cycle of inputs to generate an iterative process.

The committee considered the above problems and believes there is a need for the federal government and the universities to develop a new working relationship for long-term projects. The CRIES project is a fine example of the need. Possibly Title XII may provide the answers.

Cooperation and Staff Competency

Based upon the limited amount of time spent with the technical and administrative personnel involved with the CRIES project, it was clearly demonstrated that there exists a great deal of cooperation between all parties and disciplines involved. Furthermore, the staff demonstrated a high degree of competency. Both of these qualities speak well for insuring a high degree of success in obtaining the objectives of the project.

Removal of any administrative barriers such as uncertainties for financing and planning horizons will further strengthen cooperation and competency of the project personnel.

Project Identity

The CRIES project deserves and requires a strong commitment and project identity by the federal agencies within which the project is lodged, namely AID and USDA. This identity should be recognized through designation and commitment by the top administrations of the agencies. The commitment should be expressed through planning horizons and budgeting commensurate with the project goals of developing the analytical model and information system urgently needed in improving agricultural productivity in developing countries. CRIES should not be a start and stop operation as has too often characterized U.S. technical assistance to developing countries.

Progress Toward Goals and Objectives

The stated objectives of the CRIES project are: 1) To provide in-country assistance to developing countries in analyzing the extent, quality and use options of agricultural resources and estimating the impact of alternative policy and programs in terms of multiple economic and social goals; and 2) to develop a coordinated data concept, data system and analytical framework adaptable to many countries and capable of accumulating and transferring consistent information among countries to improve forecasts of regional and worldwide food potential.[21/]

The CRIES project is about 17 months old. Ultimately, its success will be determined by the degree to which it has improved the ability of countries in which it is applied, to formulate a comprehensive and sound agricultural information system and analytical model which can be used in estimating agricultural productive potentials and to improving agricultural planning and policy decisions in the achievement of these potentials.

At its present stage of development, the project has provided assistance to the Dominican Republic (and a lesser extent to Nicaragua and Costa Rica) by underlining the need for identification and improvement in the kinds, sources and quality of their agricultural resource and production data. The extent to which this need has permeated the thinking of the Dominican agencies and personnel responsibilities for action to fulfill this need is not yet clear.

The mechanics of using available resource and agricultural data to build an information system and to estimate alternative policies and programs has also been demonstrated for the Dominican Republic. Where the significant gap exists is in the confidence that can be placed in the information (data) that is available for formulating the information system and analyzing resulting data.

21/ Background Information for the Evaluation Team, Supporting Materials for CRIES Evaluation, p. 1, 1977.

The inception of similar work in Costa Rica and Nicaragua begins to fulfill the first part of the second stated objectives, namely, to develop a coordinated data concept, data system and analytical framework adaptable to many countries, etc. Only by experiencing and recognizing inherent differences in data availability, land base knowledge, etc. will such a coordinated data concept and multiple approach system become feasible.

On the other hand, the desirability of moving into other countries (Costa Rica and Nicaragua), before attaining a sufficient degree of refinement and improvement in the Dominican information system, may be questioned.

It is suggested that for purposes of demonstrating the analytical capability of the CRIES programming model in Costa Rica and Nicaragua, "proxy" data could be used and emphasis could be placed upon information collection and improvement in all three countries involved through accelerated and increased education and training of professionals relative to the project objectives and data needs.

Long-Range Implications and Possible Contributions of CRIES

The long-range implications and possible contributions of CRIES as envisioned within the project carry the approval of the Review Team. The uses of the project pertain to the developing countries and to U.S. efforts to assist these countries. Uses of CRIES also extends to U.S. policies concerning developing countries. These implications and uses are discussed briefly in the following sections.

For Less-Developed Countries

The residual beneficiary of CRIES consists of the less-developed countries to whom the U.S. renders technical assistance. Through their use of the analytical model and information system with the assistance of U.S. technical personnel, the potentials of their agricultural sector may be estimated and means for achieving these potentials may be analyzed and selected. Thus, the U.S. will be better able to help less-developed countries to help themselves.

For AID and USDA

CRIES will provide AID and USDA with an analytical model and information system for assisting less-developed countries. Through experiences gained in the Dominican Republic, and other countries, the model and system can be continually improved as essential elements of technical assistance to less-developed countries. Also, results obtained from the use of the model and system may be used for estimating credit needs and capacities of developing countries in negotiating loans with national and international credit agencies as a part of capital assistance to these countries.

For Other U.S. and International Entities with Responsibilities for Assisting Developing Countries

The model and information system would be useful to foundations, universities, international centers, OAS, FAO and other regional and international agencies in carrying out their responsibilities for assisting developing countries.

For U.S. National Policy Making Entities

Results from applications of the model and system could be useful to the U.S. Congress and the executive agencies in developing legislation and programs which affect the agricultural sector of developing countries. Knowledge of agricultural production potentials of developing countries with the means and scenarios for fulfilling these potentials would help the U.S. to appraise policy effects on developing economies in terms of whether such effects were encouraging or discouraging agricultural development in developing countries. Future policies of Public Law 480 type which appears to hurt as well as help certain countries could be tested with information and analysis generated by CRIES.

Appendix A

REVISED AGENDA
AID/TAB & USDA
CRIES EVALUATION
January 16-19, 1978

Monday, January 16

6:30 p.m. - Separate Dinner Meetings
1. Evaluation team
-to get acquainted and discuss organizational arrangements and procedures
2. CRIES Staff and others
-general orientation, discussion, etc.

8:00 p.m. - Executive Session
A short session of the Evaluation team, MSU Department Chairmen, AID Representative, ESCS Deputy administrator and study leader to finalize procedures and agenda

Tuesday, January 17

8:30-8:45 a.m	-Opening Remarks and Introductions,	Putman Riley Vlasin
8:45-9:15 a.m.	-Evaluation team remarks	Timmons
	-AID, ESCS/DC and MSU. Remarks on Evaluation	Suttor Schertz Riley/Vlasin
9:15-9:45 a.m.	-Introduction of CRIES	Putman
9:45-10:15 am	-Discussion	
10:15-10:45 am	-Land Base Methodology	
	Soil Survey	Ackerson/Knox
	Plant Life Zones	Atchley
	RPUs	Group
10:45-11:30 am	-Discussion	
11:30-1:00 p.m.	LUNCH	
1:00-1:30 p.m.	-The Geographic Data File	Tilmann
1:30-2:00 p.m.	-Discussion	
2:00-2:30 p.m.	-Data Sources, Country totals, and Land Use	Harrington
2:30-2:50 p.m.	-Discussion	
2:50-3:00 p.m.	-Remote Sensing Tests	Tilmann

3:00-3:10 p.m.-Discussion

3:10-3:30 p.m.-Production techniques, yields and Costs-- First Generation System — Johnson

3:30-4:00 p.m.-Discussion

4:00-4:30 p.m.-Production Techniques, Yields, New Crops and Transferability — Duke

4:30-5:00 p.m.-Discussion

6:00-7:30 p.m.-Attitude calibration — Putman's house

8:00 p.m. -Group Dinner

Wednesday, January 18

8:30-9:00 a.m.-CRIES Analytical System Overall Philosophy and the CRIES Analytical System — Putman

9:00-9:30 a.m.-Discussion

9:30-9:45 a.m.-The Working System and Haverly — Lodwick

9:45-10:00 am - Discussion

10:00-10:30 am -Future of CRIES — Putman

10:30-11:30 am -Wrap up of Evaluation team Questions — Timmons

11:30-1:00 p.m.-LUNCH

1:00-4:30 p.m.-Separate Sessions
1. Evaluation team
2. CRIES staff

Thursday, January 19

8:30-11:00 am -Joint meeting(s) of CRIES Staff and Evaluation Team, together or in subject matter groups.

11:00-11:30 am -Preliminary Reflections of Evaluation TEam

11:30-1:00 p.m.-LUNCH

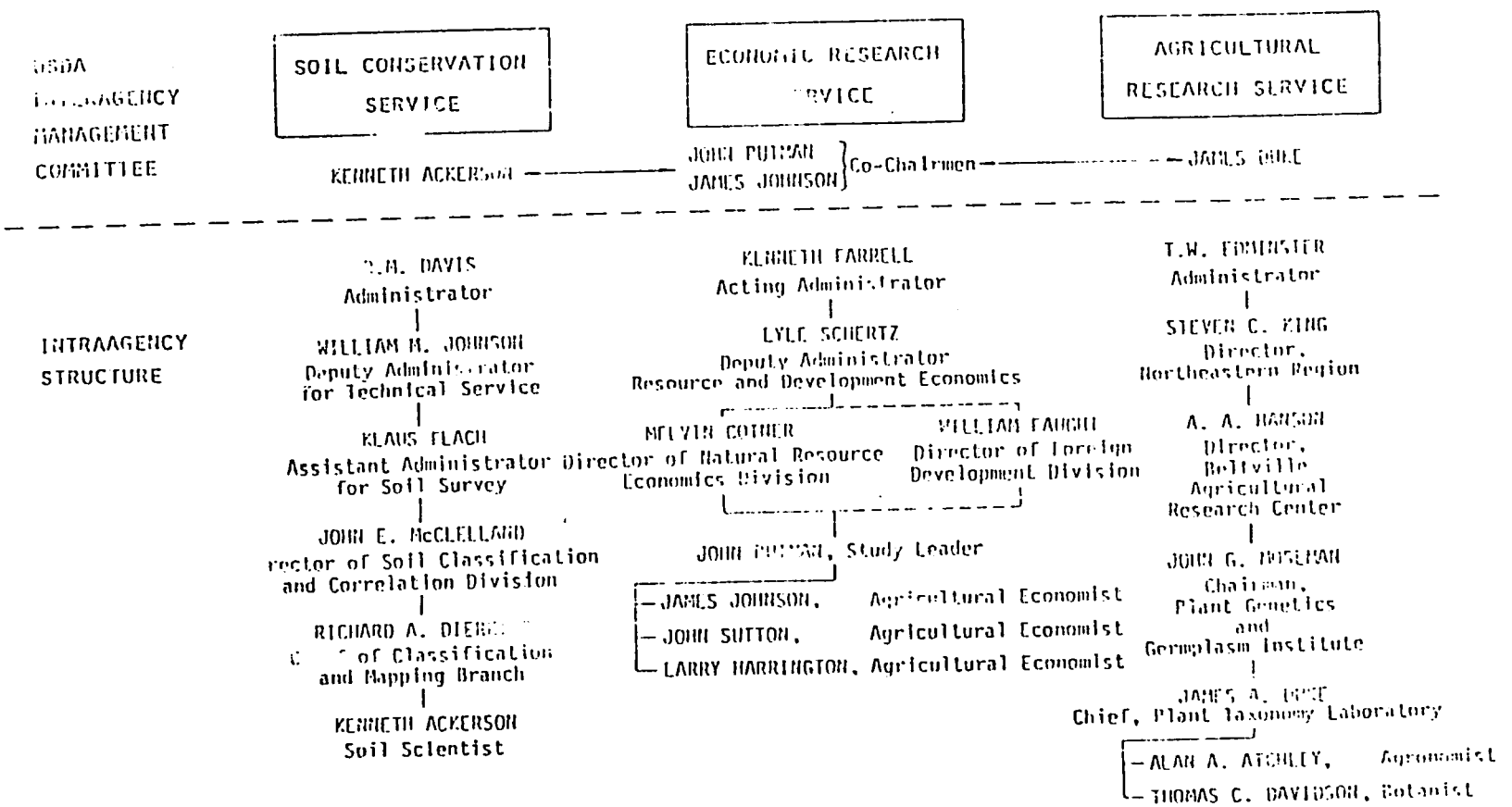
1:00 p.m. - Plane time
Separate Sessions
1. Evaluation Team session to plan evaluation report

2. CRIES staff session to plan CRIES evaluation report of CRIES

Figure 1

AGRICULTURAL PRODUCTION POTENTIAL STUDIES--
DEVELOPING COUNTRIES

USDA INTERAGENCY AND INTRAAGENCY MANAGEMENT AND COORDINATION



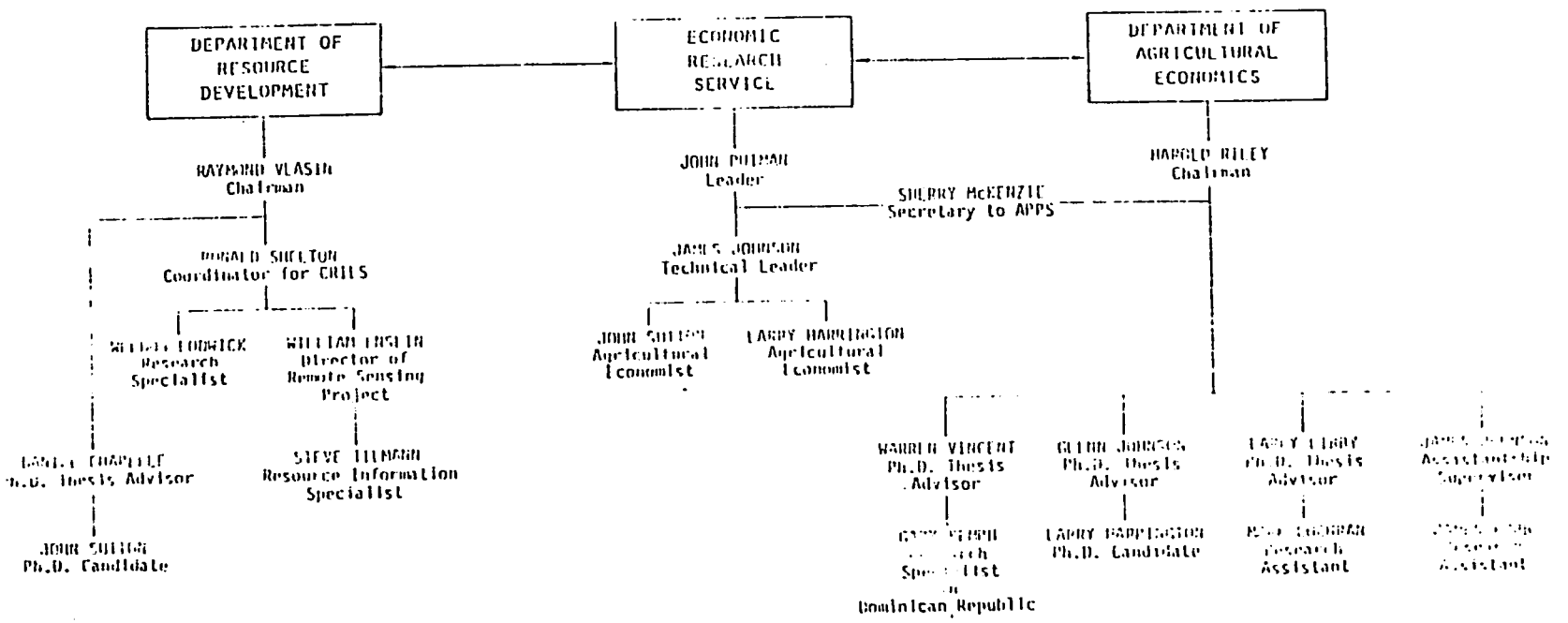
Appendix B

Administrative Organization of CRIES

Figure 2

AGRICULTURAL PRODUCTION POTENTIAL STUDIES--
DEVELOPING COUNTRIES

MANAGEMENT AND COORDINATION OF THE MICHIGAN STATE UNIVERSITY
AND ECONOMIC RESEARCH SERVICE COOPERATIVE AGREEMENT



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