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ANNUAL REPORT

FOR PERIOD
JULY 1, 1972 - JUNE 30, 1973
OF THE PROJECT ON

ADAPTING AND TESTING OF AGRICULTURAL SIMULATION MODELS TO SECTOR ANALYSIS

Contract AID/csd-2975
U. S. Agency for International Development

Agricultural Sector Analysis and Simulation Projects
Department of Agricultural Economics
Center for International Studies
Michigan State University
East Lansing, Michigan

June 30, 1973

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I. SUMMARY

A. Statistical Information

1. Adapting and Testing of Agricultural Simulation Models to Sector Analysis--AID/csd-2975
2. Glenn L. Johnson, Department of Agricultural Economics, Michigan State University, East Lansing, Michigan 48823
3. Contract period: 1 July 1971 - 30 June 1974
4. Reporting period: 1 July 1972 - 30 June 1973
5. Total AID funding to date: $685,000
6. Total expenditures and obligations through 30 June 1972: $125,274
7. Total expenditures and obligations for reporting period: $277,163
8. Estimated expenditures for 1 July 1973 - 30 June 1974: $392,321

B. Accomplishments and Utilization

Work progressed during the reporting period on all six project objectives as stated in the Contract (pages 6-8 of this report). In reference to each of those objectives:

(a) The Korean sector analysis report was completed and emphasis was shifted to development of the KASS model and to training Koreans to continue the systems analysis and simulation work. In addition, preliminary investigations were made with the model in cooperation with Korean planners in the preparation of the Fourth Five-Year Plan. In Nigeria, the simulation analyses contributing to Nigeria's "Perspective Plan for Agriculture to 1985" were completed; and two dissertations were completed analyzing Nigeria's cocoa and fisheries industries, and two were begun investigating that country's forestry and kolanut industries. In addition, the Colombian cattle model has been completed, and the dissertation analysis should be done this summer.

(b) Project personnel consulted on the application of the simulation approach with the University of Missouri team under an AID/W contract investigating food production in Tanzania.

(c) Based on the initial ideas outlined in a draft proposal for a software library, an international conference was held in Michigan to determine the feasibility of such a library of simulation components and how to go about instituting it. Work is progressing on that institution.

(d) While marginal improvements are continually being made in the Nigerian model as it is used, major modifications are awaiting implementation in Nigeria. Currently, the major emphasis in Korea is on model development, particularly a RLP farm resource allocation component and a grain management program system.

(e) In addition to dissertation research at MSU and informal training in Korea, a formal training program is being designed at MSU to develop the human capital--domestic as well as LDC--necessary to continue, expand and extend agricultural systems simulation research and analysis.

(f) The software library discussed above is intended to provide much of the "capability to respond to requests ... for simulation and analyses of ... problems at the agricultural sector and sub-sectoral levels," as specified in the contract. As to related sectors, a paper was written for HEW on application of the system simulation approach to health care delivery problems.

In addition, project personnel discussed the system simulation approach at conferences and seminars sponsored by CENTO in Pakistan, FAO in Rome, IBRD in Washington, and others.

II. BACKGROUND AND OBJECTIVES

The empirical work of agricultural economists concerned with the development of agricultural economies and the impacts of technical, institutional and human changes includes the estimation of the paths of various variables through time or of their values at various points in time. Such estimations have been done by both informal and formalized methods, the latter being increasingly computerized in recent years.

Informal projections have been used by agricultural economists for about as long as agricultural economists have addressed themselves to practical problems. When the technical agricultural scientists from crops, soils and animal husbandry first became farm management oriented, they were interested in estimating the consequences for the farm firm following alternative technologies through time. Thus, as these technical people evolved into farm management students--who in turn set the stage for the more specialized and more highly disciplined study of agricultural economics--they made farm plans and, with sequential budgeting, estimated the consequences through time of using alternative farm technologies. On the basis of the projected consequences of following the alternative technological programs, farmers were able to make better decisions than in the absence of such projections.

Retrospectively, there is some reason to suspect that the early farm management workers were more effective with these informal projections in working with farmers than they would have been had they used more formal maximizing models. This follows as it is quite unlikely that the necessary preconditions for applying maximization models were met in the problematic circumstances with which these early farm management workers were operating.

We should consider these preconditions more specifically. A wide range of values were being sought and an equally wide range of difficulties (negative values) were being avoided. Some of these values were monetary,

some nonmonetary; and, in any event, it is unlikely that a common denominator was available which would have permitted the bads to be summed and subtracted from the sum of the various goods involved. Furthermore, there were often serious questions about the second order conditions necessary to guarantee, mathematically, the existence of an optimum. In planning various technological programs, these second order questions involved the sequences in which different actions and projects would be executed. Until these kinds of questions were answered, the usual maximizing computations of economics could not be applied. It was crucial to do a reasonably good job of finding the best sequence in which to carry out these programs before applying maximizing models which assume such problems nonexistent. This is not to say that maximizing procedures cannot and should not be applied to the problem of picking optimum sequences through time; instead, it is to say that the application of maximizing models without first attending to the question of optimum sequence through time would not have been fruitful. Finally, given the uncertainty of projections, a third difficulty involved the selection of a decision rule to use in choosing the best course of action to follow. In some instances, conservative safe rules were appropriate; in other instances, great chances had to be run.

At macro levels, there has been a somewhat similar history. Legislators and government administrators have often been faced with the problem of designing projects, programs and policy. They have had a prescriptive interest in determining the best project, program or policy to follow. The problematic situations in which they have found themselves have, like those in which the farm managers often found themselves, been such that the conditions for applying maximization models as a basis for determining what project, program or policy to prescribe have not been met. Though important at both the micro farm management level and at the public level, it is particularly important that the common denominator which the government administrators and legislators use should handle damages imposed upon some people in order to confer benefits on others. This means that the common denominator has to have interpersonal validity so that bads imposed upon one or more persons can be subtracted from the goods conferred upon others before arriving at prescriptions concerning

which project, program or policy should be advocated. In addition to the common denominator problem, administrators and legislators have faced severe unanswered questions about the sequences in which to carry out various projects, programs and policies. Finally, the macro-decision makers also operate in the presence of uncertainty; hence, they too have faced severe unanswered questions as to the decision-making rule to be employed in selecting what actions to prescribe.

Under these circumstances, legislators and administrators, like the early farm management workers, have turned to projections. They have tried to determine the consequences through time or at different points in time of following alternative projects, programs and policies. Such projections have been used extensively in the U. S. Department of Agriculture and more recently in the President's Council of Economic Advisors. They have also been used extensively by the Army Corps of Engineers and by the Department of the Interior in connection with public works programs affecting agriculture. They are, of course, the "backbone" of planning in AID, FAO, IBRD, etc.

As in farm management, there have been recent attempts to apply maximization models or macro-equilibrium models based on maximization assumptions to the process of determining what projects, programs and policies should be prescribed as "right" to do. However, the preconditions for application of these models have often not been met. As a result, the applications have not always been directly useful, nor have they always contributed much to the establishment of the information--concerning the common denominators, second order conditions and decision-making rules--which must be available and/or agreed upon before prescriptive recommendations can be reached. Severe "credibility gaps" have arisen among public decision makers as a result of using specialized techniques whose assumed preconditions have not been met.

With respect to agricultural sectoral analysis for less developed countries, a relevant study was done by the Consortium for the Study of Nigerian Rural Development. This study had prescriptive objectives. At times, and in parts of the study, equilibrium models and maximization models were employed. However, much attention was given to studying alternative

sequences in which various projects could be executed to improve agricultural research, extension, price control, and taxation projects in Nigeria. With the Nigerian civil war developing, it became abundantly clear that there were no readily available common denominators which could be used in selecting right actions. The investigators spent a great deal of time interacting with both Nigerian and other donor agency decision makers who would affect the future of Nigerian rural development. As a result of these interactions, a great deal of normative information about trade-offs among different objectives was obtained. While the investigations under the Consortium have been completed, the process of interaction still takes place in meetings among Nigerian decision makers, Nigerian academicians, World Bank officials, FAO officials and former CSNRD personnel. Eventually, the preconditions for maximization may be well enough established to permit better prescriptions of right actions.

After completion of the Nigerian consortium studies, a contract was let by AID to Michigan State University to computerize agricultural sector analyses through simulation (AID/csd-1557). The personnel in this project understood the three fundamental difficulties discussed above and were careful to avoid premature application of equilibrium and maximizing models. Generally speaking, they doubted their capacity to define and measure a common denominator for all of the people involved in adjustments which will develop an agricultural economy at the expense of hurting some. For this reason, simulation models were developed to estimate the consequences through time of alternative development projects, programs and policies for an agricultural economy. These consequences were in terms of a number of objectives various groups and individuals would want to attain or avoid. It was felt that such computerized simulation models would become the basis for more effective interactions involving both the important decision makers and the people capable of investigating and analyzing the behavior of an agricultural economy with computerized simulation.

Under AID/csd-1557 a general computerized systems-science simulation model was developed of the Nigerian economy with emphasis on the agricultural

sector. Though MSU was not obligated under the contract to make practical use of this or any such models, the Nigerian model has been applied on two occasions in Nigeria's agricultural development planning process. In addition, work is underway or on the drawing boards for Nigerian investigators to extend the model to agricultural subsectors not covered in the original model and to institutionalize the model and the approach in Nigeria. These points are discussed in more detail in our last Annual Report and in the next section of this Report (page 17).

After completion of AID/csd-1557, AID developed the present contract with MSU (AID/csd-2975) to make further application of general, computerized, systems-science analysis to the practical study of agricultural sectors. The Contract recognizes that the computerized, systems-science, simulation approach: (1) holds real promise for enhancing the state of the art in sector planning, and (2) is one important component of a program that meets the high priority assigned by AID to sector planning.

The basic objective of the project (AID/csd-2975) is to test, apply, and further develop, under field conditions, the simulation model (and components) developed under Contract AID/csd-1557 with the end in view of increasing the usefulness and lowering the cost of policy, program and project development and evaluation. The more specific work objectives are to:

A. Test, adapt, extend and use the computer simulation model developed under AID/csd-1557 in the context of Korea, Nigeria and other countries in designing, developing, and evaluating selected policies, programs and projects. This will be done with host country, third country and international agencies as opportunities and needs arise and as mutually agreed to by TAB/AID/W and the Contractor. In accomplishing this objective, emphasis will be placed on, first, establishing linkages with indigenous institutions and, second, on establishing their capacity to use computerized simulation models to design, analyze, and evaluate their own policies, programs and projects.

B. Test, adapt, extend and use the computer simulation model developed under AID/csd-1557 in designing, developing, analyzing and studying, and/or evaluating selected programs and projects for AID/W and/or USAID Missions in countries mutually selected by AID/W and the Contractor. Here again strong emphasis will be placed on developing institutional linkages between U. S. agencies and U. S. universities to increase capacity to design, analyze and evaluate policies, programs and projects.

C. Establish a software library. The various mathematical models and computational routines which are referred to herein as "software" shall be placed in one or more of the standard computer languages indexed and made available to "borrowers" with appropriate explanations. This will involve generalization of existing components and the provision of a higher order simulation language for the integration and combination of components into configurations required in various institutional and geographic contexts. Such an arrangement is needed to make the model components available on a national and international basis to potential users in donor, lendor and host country agencies.

D. Further develop the computer simulation model on the basis of experience by using it under field conditions. A number of extensions and modifications to the model may be needed. These may include the incorporation of PERT (critical path analysis), the incorporation of further development in the theory of investment and disinvestment as related to supply responses and the solution of certain aggregation problems, the incorporation of PPBS (planning, programming, and budgeting systems) techniques, and the use of various decision rules in estimating entrepreneurial and consumer behavior.

E. Train personnel from host country, donor, and lendor agencies in the use, adaptation and further development of computer simulation models. Initially this will be done concimittantly with and as part of attaining objectives (A), (B), and (C) and as part of the Contractor's regular

educational program. These training programs will be conducted both at MSU and in conjunction with host country and international institutions. This training activity will be important in establishing the international and national linkages and capacities to use computer simulations in designing, analyzing and evaluating developmental policies, programs, and projects. Special training programs at either off-campus or on-campus locations are to be undertaken.

F. Develop the capability to: (1) respond to requests from the U. S. government (including its overseas agencies), international agencies, foreign governments, and grantor and lendor agencies for simulation and analyses of policy, program and project problems at the agricultural sectoral and subsector level, and (2) respond to requests from workers in such related sectors as health, education, industry, transport, population, technological research, nutrition, and public administration for consulting services and, perhaps, joint participation in constructing models in such fields.

III. ACTIVITIES DURING THE REPORTING PERIOD

During fiscal 1973, project work progressed in all six areas designated in the Contract as specific objectives of the project, including in particular the activities outlined in the work plan presented in our last Annual Report. Reporting period activities and accomplishments will be discussed in this section in reference to Korea, Nigeria, other applications, the software library, the training program, and the dissemination of results. These seemingly diverse components of the project's activities are all coordinated as components necessary to accomplish the contractual objective of applying and further developing the generalized system simulation approach in the context of agricultural development problems "with the end in view of increasing the usefulness and lowering the cost of policy, program and project development and evaluation" (page 6 above).

Korean Agricultural Sector Study

While the purpose of this section is to report the Korean activities under Contract AID/csd-2975, it must be remembered that the Korean project was built upon a mutually complementary blending of work under this Contract and under Contract AID/ead-184. Researchers directly supported under these two contracts and their Korean, American and other colleagues comprise the Korean Agricultural Sector Study (KASS) team. Therefore, the following will include a discussion of some of the work performed under Contract 184 and other sources as it complements Contract 2975 activities. An attempt is made throughout the report to separate the KASS activities by the particular contract under which they were performed.

Position in Korea as of 1 July 1972

As of 1 July 1972 the Korean Agricultural Sector Analysis report (Rossmiller, et al., 1972)[1] was in draft form and in the process of being revised for final publication incorporating the results of the review and criticism by AID and ROK.

In order to produce the Agricultural Sector Analysis report under the stringent deadlines imposed, modeling of several simulation components for the agricultural sector model had begun with the initiation of the project. As of 1 July 1972 the simulation model was operational in the form used to produce the projected consequences of the three alternatives and the KASS recommended alternative analyzed in the report. The model consisted of five components: (1) an input/output component linking the agricultural sector with the rest of the economy; (2) a population component; (3) an urban demand component which projects demand for 19 agricultural commodities or commodity groups and one nonagricultural commodity group; (4) a crop production component for 12 crops or crop categories; and (5) a rudimentary livestock component.

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[1] Project papers, reports and publications are listed in Appendix A to this report.

Training activities in progress as of 1 July 1972 included: (1) B. S. Ryu attending a nine-month diploma course in systems science and management at the Asian Institute of Technology, Bangkok, Thailand--funded under the USAID/K participant training program; and (2) a twelve-week introductory systems science course conducted by Dr. Tom Manetsch which had begun on 1 May with four hours of classroom instruction per week and a starting class of thirteen students.

Thus, by 1 July 1972 most of the objectives of this Contract which were coordinated with Contract 184 had either been accomplished or were in the final stages of progress, while other activities under Contract 2975 had progressed well. With respect to Korea, a basic operational (although quite crude) simulation model consisting of the above listed five components was developed and the beginnings of training activities for Korean personnel were underway. The remaining objectives of the project under 2975 in Korea were to operationalize a generalized computerized simulation model of the Korean agricultural sector for use as a tool of economic analysis for planning policy formulation, and program development; and to develop Korean capacity to further develop, refine, update, and use the simulation model.

Reporting Period Activities in Korea

Activities under Contract 2975 during the period 1 July 1972 - 30 June 1973 include model development, training and policy analysis applications.

The Model

The format of the model output was revised to include summary tables and to make the output more user oriented and understandable to the layman. Work on this activity started in September and was fairly well completed by February, although minor modifications are still being incorporated as new consequences of importance are included in the model computations and as dictated by experience in working with model users.

Forrest Gibson began work in June 1972 on developing a grain management program component for the model. This component consists of two separate and definable modules: (1) a government grain management program module, and (2) a private marketing subsector module. This component will interact with the crop production and urban demand/consumption components of the model and will require that pricing be determined endogenously on a seasonal basis. Endogenous price generation of the commodities handled by the grain management program component is accomplished through the supply/demand interaction and transaction mechanism.

The government grain management program subsector module is capable of reflecting the ROKG policy and market activity role under current (or amended) versions of the grain management law. Basically, this model component employs modern feedback control techniques to generate the rates and timing of government buying, storage, and selling of domestic grain supplies necessary to give desired market system responses. Also generated will be import and export timing and levels necessary to maintain government stockpiles at a predetermined level while simultaneously carrying on domestic buying and selling activities. The impact of various grain management program policy alternatives are reflected by the actual observed market price responses to desired price policy goals. The feasibility and efficiency of various grain management program policies are reflected directly by the grain management special account balance.

The private marketing subsector module was developed to account for the market activity behavior of private entrepreneurs in response to the market and policy environment. This module covers all market channels between the urban consumer and food grain supply sources. It links the commodity flow from both the government grain management program module and the crop production component with the urban demand component.

Conceptualization of the grain management program component is nearing completion. The entire component is scheduled to be tested and operational

by September 1973. A KASS working paper has been written describing this component (Gibson, 1973) and a series of five 1 1/2-hour seminars presented by Forrest Gibson to the KASS team and other interested parties on the subject.

Preliminary work was begun by Hartwig de Haen and Jeung Han Lee in June and July 1972 on a recursive linear programming component to make micro level resource allocation projections endogenous in the model. Dr. de Haen continued intensive work on this component in February through May 1973. The RLP component has been tested and is presently operational by itself. A KASS working paper has been written describing this component (de Haen and Lee, 1972) and a series of five 1 1/2-hour seminars presented by Dr. de Haen to the KASS team and other interested parties on the subject.

Inclusion of this component with the others already operational in the simulation model makes the model exceed the capacity of the computer. Thus, all components of the model cannot be run simultaneously. Major modification of the programming of the model as a whole is therefore required in order to incorporate an overlay system whereby model components would be loaded into computer core sequentially only as needed for execution. This revision of the other simulation components is under way, and full linkage of the RLP component with the other components is scheduled to be operational by July 1973.

Tom Carroll began work in October 1972 on laying the basis for improvement of the migration portion of the population component through linking the rate of rural-urban migration to relevant economic and social variables. Two Ph.D. candidates from the East-West Center, Honolulu, Hawaii, worked as part of the KASS team in Korea for three and five months respectively to conduct field surveys and collect data for their Ph.D. dissertation research. They are both presently back at the East-West Center doing the analysis and writing their dissertations. The letter of agreement between MSU and the East-West Center authorizing this work is attached as Appendix B.

One dissertation topic is focused on the economic and social determinants of migration and the other is focused on the economic effects and enterprise adjustments in the agricultural sector influenced by out-migration of rural persons. Both of these dissertations are scheduled for completion in Fall 1973. The data and research findings contained in these theses will be used as the basis for programming the necessary linkages between the migration portion of the population component and the rest of the simulation model in order to make the migration rate endogenous and to reflect the agricultural sector effects of out-migration.

Preliminary discussions and conceptualization of a livestock program component were begun in July and August 1972. As a result of this preliminary work it was determined that a livestock program component could more efficiently be installed after the recursive linear programming component was operationalized. Thus, as work is being completed on the RLP component, Tom Carroll will again pick up work on conceptualization, testing, and operationalization of a livestock component. This work will begin again in July 1973 and is scheduled for completion by March 1974.

In order to better deal with the migration question; the question of urban incomes as they influence demands for agricultural products; and the question of increasing commercialization of the inputs to and the outputs from the agricultural sector, both domestically and internationally, the input/output component linking the agricultural sector and the non-agricultural sector needs further disaggregation. Present thinking by the team indicates that this disaggregation may be carried out in two or three ways depending upon the problem to be addressed. Conceptualization of at least one way of disaggregating the input/output component will begin as a part of the improvement of the migration portion of the population component. At least one and possibly two or three different disaggregations will be accomplished in this component by March 1974.

A user's manual (Carroll, ed., 1973) was prepared by Tom Carroll and the KASS team and published in June 1973. The manual includes: (1) a detailed description of the components used in the simulation model as of

March 1973, (2) the data used for producing the KASS Sector Analysis report, and (3) a glossary of terms.

Development of further components and improvement and modification of existing components will continue to be accomplished as per interaction and decision between KASS, ROK, and AID.

Training

B. S. Ryu completed his nine month diploma course in systems science and management at the Asian Institute of Technology, Bangkok, Thailand, under the USAID/K participant training program and returned to his duties in the Planning Coordinator's office, Ministry of Agriculture and Forestry (MAF), on 1 January 1973. He was originally scheduled to transfer to the Agricultural Economics Research Institute (AERI) upon his return to work directly with the KASS team. Subsequently, the decision was made that he should remain in his former position. This provides KASS with an understanding and sympathetic individual in the office in MAF with which KASS works the most on planning activities with the model. It is likely that Mr. Ryu's staying in the Planning Coordinator's office where he can operate as an informed user will be more advantageous to both MAF and KASS than were he to transfer to AERI and become a direct member of the KASS team.

The introductory systems science course begun on 1 May 1972 by Dr. Tom Manetsch was concluded on 9 August 1972 prior to Dr. Manetsch's return to MSU. This course consisted of four hours of classroom instruction per week, and nine students completed the course--four from AERI, two from the Korean Development Institute, one from the College of Agriculture at Seoul National University and two from RDD/USAID/K.

Mr. Young Sik Kim, AERI, enrolled at Michigan State University in September 1972 as a Ph.D. student in agricultural economics and systems science. He is being supported under the USAID participant training program.

In addition to the two Ph.D. dissertations being written at the East-West Center, discussed earlier, four Korean Ph.D. candidates in

agricultural economics at MSU are developing models related to the project's areas of activities for their dissertations. So far, Contract support has been limited to personnel consulting time. The Korean candidates include: Seong Rhee on a nonagricultural model which will provide an opportunity to model better the interaction between the farm and nonfarm sectors, Seong Woo Lee on Consumption, Jong Tack Yoo on a marketing model, and Jeung Han Lee on "Impacts on Korean Agriculture and Alternative Public Investment and Price Policies: Yield and Related Variables Projections by the System Simulation Approach." This last one, J. H. Lee's, will enable the KASS simulation model to determine crop yields endogenously depending on such factors as research and extension policies and programs, incentives provided the farmers, and the social diffusion of innovations.

During November and December 1972 eight one-hour sessions were conducted for the KASS team and interested AERI personnel by Mr. James Williams, MSU computer programmer, on the operation of the then operating components of the KASS model from the standpoint of their organization on the computer.

During February 1973 Dr. Lloyd Teigen, a Research Associate visiting under the 211d Grant from MSU, conducted a series of three two-hour lectures on linear programming theory for the staff of AERI. This series was presented in anticipation of: (1) the use of LP as part of the trade analysis work to be done by Dr. Teigen, (2) the LP work necessary for some of the analytical work required of the Farm Management Division of AERI, and (3) the installation of the recursive linear programming component into the simulation model by Dr. de Haen.

Two summer workshop seminars, presently in the planning phase, are to be conducted during August 1973. First, four half-day sessions are planned with the objective of familiarizing agricultural decision makers with the role of modern techniques of economic analysis in the decision-making process and of providing the information and understanding necessary

for decision makers to make use of the analytical capacity and base currently operational in the Korean agricultural sector. This session will acquaint selected agricultural decision makers with the KASS model, its strengths and limitations, and how it can be used effectively as an aid in economic analysis as part of the decision-making process.

Secondly, a one-week session will be geared towards researchers and teachers within the Korean research establishment. The objective is to provide a broad understanding of the methodology and techniques of modern economic analysis; to provide an understanding of the role of economic analysis and the economic analyst in the decision-making process; and to motivate researchers to focus some of their research efforts on problems of the Korean agricultural sector of concern to agricultural decision makers. This workshop will also focus heavily on the KASS work and is designed to familiarize selected members of the Korean research establishment with the simulation techniques used in the KASS model as well as with the integration of more traditional methods of analysis in the various KASS model components.

Plans are underway to send at least one, and more likely two or three, AERI personnel to MSU beginning in September 1973 for one year each for intensive training in systems science and quantitative agricultural economic analysis. These activities will be funded under the USAID/K participant training program.

On-the-job training activities within the KASS team in all aspects of model development and maintenance is continuous.

Policy Analysis Application

"Extension" work with the KASS model has focused on cooperation with the Planning Coordinator's office of MAF on projecting demand requirements, supply targets and investment requirements in the agricultural sector under the Economic Planning Board guidelines and assumptions as a first round of development planning for the Fourth Five-Year Plan covering the period 1977-1981. Approximately two and one-half man-months of KASS team effort has gone into this activity so far, and additional effort is contemplated.

Nigeria

Work under AID/csd-2975 in Nigeria during the reporting period can be categorized in four areas: application, implementation, model development and extensions.

Application

At the end of June 1972 work was in progress on the analysis of the results of simulation runs projecting the consequences of some of the policies and programs under consideration by the Editorial Board for the Federal Ministry of Agricultural and Natural Resources' (FMANR) "Perspective Plan for Nigerian Agricultural Development to 1985." As reported in our last annual report, Mike Abkin had completed his analysis of 17 runs concerning food and export crop production modernization programs and tax policies, including consideration of the potential effects of chemical and biological input constraints. His report, "Production Campaigns with Input Constraints and Various Tax Policies: A Simulation Analysis," was submitted to the Editorial Board in June 1972. Earl Kellogg of the University of Illinois made simulation experiments projecting the likely consequences of a number of cattle production and distribution policies and programs. His report, "Investments in Nigeria's Northern Cattle Industry: A Simulation Analysis," was submitted to Nigeria in August 1972.

These reports formed the basis for an analysis performed by the Editorial Board's consultants and written up and included as 87 out of the 821 pages of the Perspective Plan as it was typed in the spring of 1973.

Implementation

At the end of the last reporting period, as reported in our last annual report, Nigeria's FMANR was considering a proposal by its own consultants to transfer the simulation model from East Lansing to Lagos and to institutionalize the model and the generalized system simulation approach within the Ministry's own planning and policy-making process. Major emphasis would be placed on the training of Nigerians to operate, maintain, and extend the model; to analyze the information obtained from simulation experiments; and

to use the approach to build new models as needed to analyze agricultural development problems.

Officials of the FMANR have held off, over the past year, making a decision to initiate the implementation. They repeatedly indicated a desire to go ahead but wanted to await completion and final approval of the Perspective Plan before making the decision. Now that the plan has been published and as a result of contacts in Washington and East Lansing between project director Glenn Johnson and the directors of the FMANR's Federal Department of Agriculture and Federal Department of Fisheries, negotiations are underway between MSU and the FMANR to initiate the implementation project during the coming year.

In addition, these two directors, Barnabus Oloruntoba and Edward Bayagbona, respectively, were paid by the project as consultants for their time in interacting with and providing information to project personnel concerning Nigerian fisheries and crop production.

Model Development

As the Nigerian simulation model was used in the course of the year, improvements and corrections were made as necessary. Most of the improvements were made in the cattle model in conjunction with Earl Kellogg's analysis for the Perspective Plan. These included the incorporation of new data, correcting the calculation sequence, the addition of a sales head tax policy option, and the addition of a beef price control policy option using imports as the control variable.

Other improvements and corrections were marginal, our having decided to await implementation in Nigeria before making major refinements of the model to overcome its most glaring shortcomings. Work in this area will include considerations of farm resource allocations, particularly including labor constraints in the South; rural-urban migration; the disaggregation of food commodities; and updating the nonagricultural model.

Two major efforts were undertaken, however. One was to convert the model to be compatible on IBM computers in Nigeria. While this work was

almost completed, it was left in abeyance pending a decision on when the transfer to Nigeria will take place. The other work involved reprogramming the model into an overlay structure. Since it had grown too large for efficient operation on MSU's CDC 6500 computer, splitting it into overlays not only made it fit more easily on our own computer but should also facilitate its implementation in Nigeria. A price was paid, however: computer run costs have increased 50 percent as a result of the overlaying.

Extensions

In June 1973 a letter of agreement (see Appendix C) was signed between MSU and the University of Ibadan, Nigeria, providing for the support under 2975 of Cyril Aja's masters degree research at the University of Ibadan in the Department of Agricultural Economics and Extension. Supervised by Professor Samson Olayide, Aja will research the kolanut industry of Western Nigeria with a view to building a simulation model of that industry which will be compatible with the Nigerian simulation model currently located at MSU. As time permits, he will use his model to make projections of relevant policy options. The agreement runs through March 1974 to coincide with our own firm funding commitment. As our base contract is extended, so will the agreement to support Aja for up to one more year.

In addition, during the reporting period two Ph.D. dissertations were completed and one was begun at MSU applying and extending the coverage of the Nigerian simulation model. O. O. Ladipo's thesis investigating and proposing a tentative model of Nigeria's fisheries industry (Ladipo, 1973) was completed in March 1973, and he returned to Nigeria to the Department of Agricultural Economics at the University of Ife to further his fisheries research and simulation modeling. There is a possibility MSU will be asked by Nigeria's Federal Department of Fisheries to assist in that effort under 2975. Contract support for Ladipo's dissertation research was limited to personnel consulting time; in addition, we paid for the production of 50

copies of his thesis for our own distribution in the U. S. and Nigeria. K. Y. Chong's thesis applying the Nigerian simulation model to a more detailed analysis of Western Nigeria's cocoa industry was completed in December 1972 (Chong, 1972). His work was supported by the Contract to the extent of personnel consulting time and computer time. Finally, Felix Nweke has begun researching and modeling Nigeria's forestry industry for his dissertation.

Other Applications

The Colombian regional cattle model being developed by Alvaro Posada for his agricultural economics Ph.D. dissertation (reported in our last annual report) has progressed well, and Posada should complete his dissertation work during summer 1973. The Contract has--in addition to consulting, programming and computer time support--hired Posada onto the project as a short-term staff member to supplement his Rockefeller Foundation support to the extent necessary to enable him to take his modeling and analysis work beyond the requirements of a Ph.D. dissertation and thus make a significant contribution to the Contract's objectives.

Glenn Johnson and Tom Manetsch consulted in 1973 with the University of Missouri team working under another AID contract to look at food production problems in Tanzania. Drs. Johnson and Manetsch advised on the use of the system simulation modeling approach in analyzing the data and making projections of alternative policy options.

Al Halter of the Department of Agricultural Economics at Oregon State University completed in August 1972 simulation policy analyses of the cattle industry of Venezuela using an adaptation of the cattle model originally developed for the Nigerian simulation model. On the basis of those analyses, the government of Venezuela announced new policies for the cattle industry which were a significant departure from previous policies. Negotiations are currently underway between the Venezuelan

government and Oregon State University to extend the simulation analysis to other problems of the agricultural sector. While this work was in no way supported by Contract AID/csd-2975, it is reported here as a spin-off from the Nigerian simulation work.

On 2 January 1973 Dr. Lloyd Teigen, Department of Agricultural Economics, Michigan State University, arrived in Korea for a one-year assignment to analyze selected international dimensions of the Korean agricultural sector. Since he is supported under an AID 211d Grant to MSU, his activities are not reported here; however, he will be making use of existing components of the KASS model in his analyses.

Software Library

Background

Under contracts AID/csd-1557 and AID/csd-2975, in Nigeria and in Korea, the MSU simulation team has developed and applied the generalized system simulation approach to agricultural development analysis and policy making. As part of that effort, a number of models have been built, assembled and computerized. These include, for example, models of production and processing processes; demand and consumption; demographic processes as applied to human, cattle and tree populations; commodity, regional and national accounting; resource allocation decisions; and the diffusion of innovations.

It became clear to us that these and other processes are of general interest in the developing (and developed) world and that generalized models of them could be built and then adapted and assembled in various configurations to help analyze particular problems in particular countries. Therefore, the initiation of development of a software library of such generalized models was written into the present 2975 contract.

Under that charge, a "Draft Proposal for an Agricultural Sector Simulation Library" (Abkin and Pervis, 1972) was written in October 1972

and distributed for comments. With the Draft Proposal as a basis for discussion, a Simulation Library Working Conference was held in March 1973 with representatives from national and international assistance agencies to get some idea of the potential demand for such a library and of how best to go about organizing it. The list of attendees at the conference and the Summary and Plan for Action resulting from it are appended to this report (Appendix D).

Associated with the development of the library is the development and operationalization of a general simulation language to serve as a structure and executive for assembling, testing and operating library components. Tom Manetsch developed a preliminary outline for such a language (Manetsch, 1973).

With this background, the library and its scope were defined, and a work plan for the first year--1 April 1973 - 31 March 1974-- was prepared and is currently being carried out.

Library Definition and Scope

The software library is viewed as a unit which acquires, catalogs, maintains and distributes computer programs and associated documentation. These computer programs are of generalized simulation models and routines designed specifically for the analysis of agricultural development problems and processes. In particular, the library sets standards of admissibility for programs and documentation; catalogs and indexes programs and documentation so as to facilitate their retrieval by users seeking a set of programs to be used in a specific problem analysis; and distributes programs and documentation to users.

To enhance the effectiveness of the library, its functions also include identifying and soliciting needed models; actively bringing programs and documentation up to the library's standards; and providing limited consultation

in identifying and implementing appropriate library programs for a particular application. A subsidiary function of the library in conjunction with the identification and solicitation of models is to survey and catalog ongoing research in agricultural systems modeling and simulation.

It is essential that the library remain closely associated with, if not a part of, one or more organizations charged with model development, research and analysis applications, and training. In the short run these broader functions will be carried out in fulfilling MSU's obligations under its AID contract, AID/csd-2975. In the long run, however, as the library expands and acquires applications experience, it will be desirable, even necessary, that it move from MSU to, or to some association with, one or more national or international development assistance agencies.

Library Work Plan to 31 March 1974

As a result of the conference, the following work plan was prepared:

1. Identify components of the current versions of the Nigerian and Korean models which are likely candidates for the library.
2. Set general standards of admissibility of library models and routines, including such criteria as general applicability, compatibility with other programs, and theoretical and empirical validity.
3. Determine levels and formats of the documentations to be maintained, where levels include indexes, abstracts, verbal and mathematical descriptions and detailed programming manuals.
4. Set minimal programming standards to facilitate linking components for specific applications on a wide range of computing facilities.
5. Establish technical procedures for indexing, cataloging, storing, manipulating, retrieving and distributing library programs and associated documentation.
6. Rework, document and program the components identified in 1 in light of the standards set in 2, 3, and 4.
7. In parallel with 1 - 6, work will proceed on the development of a general simulation language.

8. Develop and implement procedures for publicizing and otherwise disseminating information on the library's available inventory and services.

9. Begin a preliminary survey and annotated bibliography of current agricultural simulation research to identify models and routines in support of our ongoing research and which may be appropriate candidates for inclusion in the library.

10. Provide technical consulting on applying library programs as requested, subject to available resources and the requirements of the Contract.

11. Define the functions of an Advisory Board and, in coordination with AID/W, select its members.

By the end of the current reporting period, progress in carrying out this work plan was fairly well advanced on items 1 - 4 above, these being a necessary basis for work on the remaining items to which the emphasis will shift in fiscal 1974.

Work relating to items 6 and 7 has been underway since fall 1972 by Marc Buchner, graduate research assistant in systems science. Mr. Buchner has been developing an optimal search routine for estimating parameters of a model in order to have the model track observed time series of past behavior of the real-world system (Buchner and Manetsch, 1973). This routine will eventually be included in the library as a feature of the simulation language.

Formal Training Program

Background

The institutionalization of agricultural sector models in developing countries involves a number of essential functions which must all be carried out effectively in order for simulation models to contribute usefully to agricultural sector development. These functions include:

1. Data acquisition, storage and updating
2. Simulation model development
3. Parameter estimation

4. Model testing and validation
5. Use of models in policy analysis
6. Model refinement and updating
7. Model documentation

Experience has shown that this broad array of activities requires not only the integration of many disciplines but also unique kinds of people who can function effectively as members of multidisciplinary teams. These people are not produced by traditional discipline-oriented educational programs, and special programs must be developed whether areas of application are in the U. S. or abroad. In the relatively new area of simulation for agricultural policy analysis in developing countries, an additional problem presents itself in that some of the necessary disciplinary "ingredients" (i.e., system science and computer science) are not usually taught, or not taught appropriately, in the LDC's. It is therefore important to consider alternatives for producing this needed manpower which involve intensive education of foreign professionals in the United States. It might be feasible to conduct less intensive programs (i.e., short courses) in the developing countries.

Kinds of Professional Talent Needed

The seven basic functions listed above are all necessary for successful institutionalization of agricultural sector simulation models. All require a somewhat different mix of professional talent. The carrying-out of each function requires people who are well prepared in at least one discipline and who, at the same time, have varying degrees of expertise in other relevant disciplines. These "overlapping backgrounds" among team members are essential to the operation of a team that is attacking multidisciplinary problems. We can gain insight into the spectrum of personnel requirements for institutionalization by looking carefully at each of these seven functions and asking ourselves:

1. What levels of expertise in what disciplines are required to successfully implement the particular function?
2. For each function, what mix of disciplinary competencies must each specialist have in order for him to be a productive member of the team carrying out that function?

Table I is a rough analysis of the disciplinary and personnel requirements of the "model development" function based on experiences to date in Nigeria and Korea. This analysis assumes that all personnel associated with the function are specialists in one discipline with varying degrees of expertise in other relevant disciplines. The various participants (not necessarily one per discipline) are listed in the leftmost column of the table. Across the top of the table are listed the various disciplines necessary for carrying out the particular function. The rightmost column tabulates the level of involvement required of each disciplinary participant to effectively carry out the indicated function. Level of involvement may range from "none" to "consultant" up through 100 percent.

The numbers in the table denote the appropriate levels of preparation required of each team participant by discipline. Reading across the table, then, we get an educational profile for each team participant. Six levels of disciplinary preparation have been identified:

1. Ph.D.[1] plus experience
2. Master's[1] level plus experience
3. Bachelor's[1] level plus experience
4. Intensive professional course or strong minor plus experience
5. "Short course" plus experience
6. None

Some rough numbers have been inserted in Table I to indicate the kinds of professionals experience has shown are necessary to effectively develop agricultural sector simulation models in Nigeria and Korea. For example, the table indicates that experienced economists at the master's or doctoral level are needed and that they must have varying lesser strengths in systems science, agriculture, computer science, econometrics, public administration, sociology and statistics. The same is true of all participants--the system scientist must have varying levels of preparation in other disciplines, and so forth. The same basic pattern emerges if we examine others of the seven fundamental functions associated with computerized agricultural sector analysis.

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[1]Based on U. S. standards. In certain cases "equivalent experience" may substitute for formal degree work.

Table I

Participant/Discipline Profiles--Model Development Function

Participants	Disciplines								Degree of Involvement
	Various areas of technical agriculture as appropriate, i.e., crop science, soil science, animal science, etc.	Computer Science	Economics	Econometrics	Public Admin. & Policy	Sociology (Areas relevant to rural development)	Systems Science	Statistics	
	Levels of Preparation Required*								
Agriculturalist	1-3	6	5	6	5	4-5	5	5	Consultant
Computer Scientist (Senior programmer)	5	2-3	5	5	5	6	4	4	50-100%
Agr. Economist	3-4	4-5	1-2	1-2	4	4	4	4	50-100%
Econometrician	3-4	4-5	1-2	1-2	4-5	4-5	4	2-3	25-100%
Public Administrator	5	5	4	5	2-3	5	5	5	Consultant
Sociologist	4	6	5	6	5	1-2	5	4-5	Consultant
Statistician									Little or None
Systems Scientist	4-5	4	4	4	5	5	1-2	4	

*Levels of Preparation:
1. Doctorate plus experience
2. Master's plus experience
3. Bachelor's plus experience
4. Intensive professional course (or strong minor) plus experience
5. Short course plus experience
6. None

Programs to Fill the Need

The main conclusion we draw from this is that a variety of educational programs must be available which will provide various levels of preparation for specialists from many fields. Many of these needs can be satisfied by "appropriate" degree programs at the bachelor's, master's, and doctoral levels. "Appropriate" here includes the flexibility to put together degree programs which include necessary related disciplines as part of a major in a particular field. In many cases degree programs at M.S.U. have this flexibility though changes may be needed in particular areas. In another dimension, existing curricula do not contain adequate course offerings to support the needs which exist. Two cases in point: more advanced offerings are needed in the system science area which deal with the development and validation of large scale simulation models; and offerings also appear needed (probably within agricultural economics) in simulation-based agricultural policy analysis.

It is clear, however, that the spectrum of educational needs cannot be met by degree programs alone. There are many qualified and experienced professionals in developing countries (economists, administrators, agriculturalists, etc.) who could become productive members of a simulation-based sector analysis team given well-designed short courses in key areas. These could be offered in the U. S., in the developing countries, or both. In other cases foreign professionals may need intensive work in a particular discipline (for example, an economist may need intensive work in system science) and yet not be able, for one reason or another, to participate in a full degree program in the U. S. In these situations intensive professional non-degree programs of perhaps 3-12 months duration would be useful. These non-degree programs could be based at least in part on the courses offered as part of regular degree programs.

A one-year intensive basic training program, including a new systems science course on advanced simulation methodologies, to partially fill the

need for manpower to institutionalize the generalized simulation approach in LDCs has been designed by Tom Manetsch and is described in Appendix E. The program and the two advanced courses (in agricultural economics and in systems science) described will be implemented on a trial basis, with 2975 support, in the 1973-74 academic year. It is anticipated that initial trainees will include Korean, Nigerian, and U. S. personnel.

Dissemination of Results

Project activities during the reporting period were extensive in the area of disseminating information concerning the generalized system simulation approach. Our dissemination efforts can be grouped in two areas: conferences and seminars; and publications.

Conferences and Seminars

1. Hartwig de Haen and Glenn Johnson attended an ADC Conference on Recursive Programming held at IBRD's EDI in November 1972 (de Haen, 1972).

2. Mike Abkin and Ed Rossmiller attended by invitation the CENTO Workshop for Agricultural Planners held in Islamabad, Pakistan, 27 November - 4 December 1972. They delivered a paper (Abkin and Rossmiller, 1972) and made preliminary contacts with Pakistani and Turkish officials concerning application of the system simulation approach in those countries.

3. Glenn Johnson attended the FAO Workshop on Simulation held in Rome, Italy, 6-9 December 1972.

4. K. Y. Chong presented a paper (Chong, 1973) at the Sixth Hawaii International Conference on Systems Sciences held at the University of Hawaii, 9-11 January 1973.

5. Several project team members prepared and presented a two-day review of our approach and work on 29-30 January 1973, as part of the

IBRD Colloquium on Advanced Methodologies for Agricultural Investment and Policy Analysis. The outline of the team's presentation is attached as Appendix F. For his presentation, Glenn Johnson prepared a paper outlining the historical and philosophical background of the project (Johnson, 1973).

6. Glenn Johnson organized and attended the joint TACAC (Trans-Atlantic Committee on Agricultural Change)/Simulation Conference at Traverse City, Michigan, 8-15 February 1973. At this conference 2975 results were examined and criticized and considerable attention was given to theoretical issues which need to be resolved in order to improve simulation modeling.

7. Glenn Johnson wrote a paper (Johnson, 1972) discussing health care delivery application of the system simulation approach. The paper was to be presented at an HEW conference in Albuquerque in January 1973, however the conference was cancelled and the paper submitted directly to HEW.

8. Tom Manetsch presented a seminar on the KASS model and results on 3 April 1973 as part of the Agricultural Development Workshop series in MSU's Department of Agricultural Economics.

9. Tom Manetsch gave a series of seminars during spring 1973 on the KASS model for Koreans working and studying at MSU.

10. Mike Abkin and Tom Manetsch prepared a paper to be presented at the IFAC-IFORS Conference on Systems Approaches to Developing Countries (Abkin, Manetsch, et al., 1973) held in Algiers, Algeria, 28-31 May 1973. Although the paper was accepted and appears in the conference proceedings, unfortunately no one from the project was able to attend the conference itself to formally present the paper.

11. On 29 April 1973, Dong Hi Kim and H. H. Suh made a 40 minute presentation on KASS as one of 6 presentations at the annual meeting of the Korean Agricultural Economics Association.

12. Glenn Johnson and Mike Abkin spoke on the project's activities on 18 May 1973 at the weekly luncheon of the MSU chapter of the Society for International Development.

Publications

1. The Olayide, Abkin, Johnson paper cited in our last annual report--describing the results of simulation runs made by Dr. Samson Olayide of the Department of Agricultural Economics and Extension at the University of Ibadan, Nigeria, during his visit to East Lansing in December 1971--was published in March 1973 in the Nigerian Journal of Economic and Social Studies (Olayide, Abkin and Johnson, 1973).

2. A paper by Abkin and Manetsch (1972) was published in September 1972 in the IEEE Transactions on Systems, Man, and Cybernetics. This paper described the southern regional submodel of the Nigerian simulation model.

3. A paper by Abkin (1972) giving an overview of the Nigerian model and the generalized system simulation approach appeared in the "Simulation Today" series in the November 1972 issue of Simulation. This paper was a summary of the IFAC-IFORS Conference paper cited above.

4. A paper presenting the results of 17 policy simulation runs with the Nigerian model will appear in the August 1973 issue of the American Journal of Agricultural Economics (Abkin, Hayenga, et al., 1973).

5. Findings of the Korean Agricultural Sector Study were reported in the December 1972 issue of the Korean Journal of Agricultural Economics (Kim and Rossmiller, 1972).

6. The KASS project and its results were also discussed in the December 1972 issue of the Korean language journal of the Korean Ministry of Agriculture and Forestry, Agricultural Economics (Suh, 1972).

7. Glenn Johnson and Lewis Zerby (of the MSU Department of Philosophy) published a book in 1973 on economic analysis and prescription vis-à-vis the normative-positive debate (Johnson and Zerby, 1973). Although the work was not directly supported by 2975, it does draw on the project's experiences and much of the philosophy expressed in the book has found its way into the project's approach.

8. Finally, we report here (and attach as Appendix G) not project publications but three published reviews (and Tom Manetsch's reply to one of them) of the project's final report under AID/csd-1557, T. J. Manetsch et al., A Generalized Simulation Approach to Agricultural Sector Analysis with Special Reference to Nigeria, Nov. 1971.

a. H. J. Highland in Simuletter, Vol. IV, p. 107, Oct. 1972--a publication of the Special Interest Group on Simulation of the ACM.

b. R. deNeufville in IEEE Transactions on Systems, Man, and Cybernetics, SMC-3: 208-209, March 1973. Reply by T. J. Manetsch will appear in the same journal, Volume SMC-3, in September 1973.

c. R. F. Wynn in The Economic Journal, pp. 327-329, March 1973.

IV. EXPENDITURES AND CONTRACTOR RESOURCES

Personnel

The project staff in Korea and in the U. S. individually and collectively have worked with Korean, Nigerian and Colombian counterparts in developing the respective simulation models and applications. They all have assumed various leadership responsibilities within the project according to their disciplines and work assignments.

The following individuals were employed during the period 1 July 1972 through 30 June 1973 to carry out the terms of the contract:

1. Professor Glenn L. Johnson
   Project Director
   Post: U. S.
2. Dr. George E. Rossmiller
   Field Project Leader
   Post: Seoul, Korea
3. Dr. Michael H. Abkin
   Regular Staff Member
   Post: U. S.
4. Dr. Edward Bayagbona
   Consultant
   Post: U. S.
5. Mr. Marcus Buchner
   Graduate Assistant
   Post: U. S.
6. Dr. Tom W. Carroll
   Regular Staff Member
   Post: U. S. and Seoul, Korea
7. Mrs. Kay Cooper
   Secretary
   Post: Seoul, Korea
8. Dr. Hartwig de Haen
   Short Term Staff Member
   Consultant
   Post: U. S. and Seoul, Korea
9. Mr. Forrest Gibson
   Regular Staff Member
   Post: U. S. and Seoul, Korea
10. Dr. Earl Kellogg
    Consultant
    Post: U. S.
11. Mr. Seong Woo Lee
    Graduate Assistant
    Post: U. S.
12. Professor Thomas J. Manetsch
    Regular Staff Member
    Post: U. S. and Seoul, Korea
13. Dr. L. L. McQuitty
    Consultant
    Post: U. S.
14. Mr. Barnabus Oloruntoba
    Consultant
    Post: U. S.
15. Mr. Keith Olson
    Regular Staff Member
    Post: Seoul, Korea
16. Mrs. Gloria Page
    Programmer
    Post: U. S.
17. Miss Judy Pardee
    Secretary
    Post: U. S.
18. Mr. Dennis Pervis
    Regular Staff Member
    Post: U. S.
19. Mrs. Janet Poncin
    Secretary
    Post: Seoul, Korea
20. Mr. Alvaro Posada
    Short Term Staff Member
    Post: U. S.
21. Mr. Bert M. Pulaski
    Short Term Staff Member
    Administrative Assistant
    Post: U. S.
22. Mr. James Williams
    Regular Staff Member
    Post: Seoul, Korea
23. Mr. Christopher Wolf
    Regular Staff Member
    Post: U. S.

Administrative Relations with USAID/Korea and AID/W

The Mission continues to meet its contractual obligations to the Michigan State University project. Cooperation in providing necessary advice and support have been excellent. The cooperation of Francis Jones, Food and Agriculture Officer, the General Services Office and Mrs. Dodie Gullion in providing this support is acknowledged with thanks. The TAB office and contracting office have cooperated to their utmost ability to provide the necessary contractual and program support.

Logistic Support

Logistic support has been one of the functions of the Mission. However, plans for Michigan State University to become self-sufficient and independent of USAID logistic support are in the early stages of discussion.

Budget and Expenditures

The provisions of Amendment 4 to Contract AID/csd-2975 have provided firm funding for the continuance of the project to 31 March 1974. Extensi of firm funding beyond that date to the end of the contract period, i.e., 30 June 1974, is under discussion.

The last Annual Report covers the activities related to expenditures for the period 7/1/71 to 6/30/72. Other sections of the present report describe the activities performed during this reporting period. In addition, Contract resources were expanded in pursuing the development of project activities in Nigeria, Pakistan and the Philippines. The $57,563 difference between the last two columns of Table III below is being carried into the next budget reporting period.

V. WORK PLAN AND BUDGET FORECAST FOR 1 JULY 1973 - 30 JUNE 1974

In this section, the work plan for the next reporting period will be broken down by the major areas of activity planned (Korea, the software

Table II

Approved Budget

	Firm Budget From 7/1/71 To 6/30/73	Firm Budget From 7/1/73 To 3/31/74	Budget From 4/1/74 To 6/30/74	Total Budget From 7/1/71 To 6/30/74
Salaries	$227,003	$112,500	$37,500	$377,004
Consultants	7,200	3,750	1,250	11,700
Fringes	33,214	19,125	6,375	58,714
Overhead	115,037	56,250	18,750	190,037
Travel	21,427	6,375	2,125	29,928
Equipment	12,000	3,000	1,000	16,000
Other Direct Costs	37,617	16,500	5,500	59,617
Allowances	7,000	7,500	2,500	17,000
Sub-Contracts*	--	--	--	--
TOTAL	$460,000	$225,000	$75,000	$760,000

*Authorized by Contracting Officer.

Table III

Summary of Budget and Actual/Estimated

Expenditures to Date

	Total Expenditures From 7/1/71 To 6/30/72	From 7/1/72 To 6/30/73	From 7/1/71 To 6/30/73	Firm Budget From 7/1/71 To 6/30/73
Salaries	$ 61,154	$144,312	$205,466	$227,003
Consultants	1,700	1,365	3,065	7,200
Fringes	5,024	15,446	20,470	33,214
Overhead	32,442	71,291	103,733	115,037
Travel	11,859	10,525	22,384	24,427
Equipment	478	1,632	2,110	12,000
Other Direct Costs	12,617	19,533	32,150	37,617
Allowances	--	7,677	7,677	7,000
Sub-Contracts*	--	5,382	5,382	--
TOTAL	$125,274	$277,163	$402,437	$460,000

*Authorized by Contracting Officer.

library, the training program, and general activities) and a budget forecast will be presented.

Under the terms of the Contract as currently stated, the next reporting period will be the final one. As such, the activities outlined here will accomplish the specific objectives set out in the contract's "Statement of Work" (pages 6-8 above). However, it is clear that there is continuing need for this type of applied research. Therefore, plans will have to be laid and finances developed before June of 1974 to: (1) prevent dispersal of the personnel developed under this project, and (2) to provide financial resources to continue this activity. It is planned, therefore, to establish before June 1974 a capability at MSU to be used beyond June 1974 to respond to requests from the U. S. government (including its overseas agencies), international agencies, foreign governments, and grantor and lendor agencies for simulation analyses of policy, program and project problems at the agricultural sectoral and sub-sectoral levels. Because it is also clear that the approach followed in AID/csd-1557 and under this Contract is likely to be useful at the macro socioeconomic level and related sectors as well, at both sectoral and sub-sectoral levels--such as health, education, industry, transport, population, technological research, nutrition, public administration, etc.--the capacity referred to above will also be able to respond to requests from workers in such fields, particularly those in other AID research contracts, for consulting services and perhaps joint participation in constructing models in such areas. Essential components in the development and utilization of this capacity are the training program and software library activities to be developed over the coming year as discussed earlier in this Report and below. Therefore, it is desirable that the present contract either be extended beyond 1974 or replaced with a new contract. To that end, a research proposal is being prepared for the further development and utilization of this capacity beyond June 1974.

Korea Work Plan

1. Continue extensive model development and testing, including (but not limited to) the grain management component, the RLP resource

allocation component, the crop yield determination component, and the initial design of the livestock component and the nonagricultural component to provide the important linkages between agriculture and the rest of the economy.

2. Continue intensive training activities--including lectures, workshops, seminars and on-the-job experience in Korea and more formal programs on the MSU campus--in order to build the Korean human capacity necessary to carry on the generalized system simulation approach in Korea.

3. Work with USAID/K and the Korean government to build the Korean institutional capacity necessary to carry on the generalized system simulation approach in Korea.

4. Continue to work with Korean officials, as requested, on planning and policy analysis applications of the simulation model.

Training Program Work Plan

1. Conduct the pilot training program in the 1973-1974 academic year with 5-10 LDC and U. S. trainees, including two new courses (one on simulation-based agricultural policy analysis and the other on advanced simulation methodologies) and intensive simulation project courses for selected trainees (Appendix E).

2. In preparation for full development of the training program in succeeding years, develop candidate selection procedures; develop flexible admission procedures with the MSU administration; and evaluate and revise as necessary the program content based on experience in the pilot program.

3. Consult with external agencies (AID, FAO, IBRD, etc.) on the long-run development and operation of the program (e.g., content, candidate selection, funding, etc.).

Software Library Work Plan

1. Complete preparation of the library's standards and operations manuals, and shift emphasis to developing library components and the simulation language based on experience with the Nigerian and Korean models.

2. Apply the library components as requested and subject to available resources and the objectives of the Contract, providing technical consulting if necessary.

3. Begin a preliminary survey and annotated bibliography of current agricultural simulation research to identify models and routines in support of our ongoing research and which may be appropriate candidates for inclusio in the library.

4. Begin consideration of the library's long-run institutionalization, including the establishment, in coordination with TAB/AID/W, of an advisory board.

General Activities Work Plan

1. Carry out support of the Nigerian kolanut study as specified in the Letter of Agreement (Appendix C).

2. Continue support of the Ph.D. dissertations described in Section III of this Report, including the Nigerian forestry research, the Colombian cattle study and the several Korean studies.

3. In conjunction with other activities, continue the development of methodological and theoretical issues relating to the generalized system simulation approach.

4. As requested and subject to available resources and to mutual agreement with TAB/AID/W:

a) continue high-level extension activities through consulting, seminars, conferences and published reports with AID/W, USAID missions and/or other federal and international agencies;

b) begin in at least one more country (i.e., other than Korea) to develop an indigenous capacity to build, maintain, develop and apply generalized system simulation models for agricultural development policy, program and project analyses; and

c) be increasingly responsive to requests from host countries, USAID missions, AID/W and international donor and lendor agencies for research assistance and training programs.

Budget Forecast and Summary

The following projected expenditures and budget for the remainder of the Contract are the minimum of what is needed to carry out the terms of the Contract.

Table IV

Budget and Expenditures Forecast

1 July 1973 - 30 June 1974

Items	Firm Budget From 7/1/73 To 3/31/74	Projected Expenditures From 7/1/73 To 3/31/74	Projected Budget From 4/1/74 To 6/30/74	Projected Expenditures From 4/1/74 To 6/30/74	Total Budget From 7/1/73 To 6/30/74	Total Projected Expenditures From 7/1/73 To 6/30/74
Salaries	$112,500	$127,232	$37,500	$ 51,564	$150,000	$178,796
Consultants	3,750	5,000	1,250	3,250	5,000	8,250
Fringe Benefits	19,125	19,083	6,375	7,733	25,500	28,816
Overhead	56,250	78,322	18,750	28,355	75,000	106,677
Travel	6,375	11,433	2,125	4,975	8,500	16,408
Equipment	3,000	3,000	1,000	2,000	4,000	5,000
Other Direct Costs	16,500	29,025	5,500	8,400	22,000	37,425
Allowances	7,500	3,199	2,500	1,066	10,000	4,265
Sub-Contracts	--	7,004	--	1,680	--	8,684
TOTAL	$225,000	$283,298	$75,000	$109,023	$300,000	$392,321
Carryover	57,563	--	--	--	57,563	--
GRAND TOTAL	$282,563	$283,298	$75,000	$109,023	$357,563	$392,321
Rounded Figures	($283,000)	($283,000)				

The following table summarizes the budget and actual/estimated and projected expenditures by line item for the entire contract period.

Table V

Budget and Expenditures Summary

Items	Approved Budget From 7/1/71 To 6/30/74	Actual/Estimated and Projected Expenditures From 7/1/71 To 6/30/74
Salaries	$377,004	$384,262
Consultants	11,700	11,315
Fringe Benefits	58,714	47,286
Overhead	190,037	210,410
Travel	29,928	38,792
Equipment	16,000	7,110
Other Direct Costs	59,617	69,575
Allowances	17,000	11,942
Sub-Contracts	--	14,066
TOTAL	$760,000	$794,750

The additional $34,750 needed to complete the project according to the work plan will be a subject of discussion with TAB and the Contracting Officer.

VI. APPENDICES

Appendix A

Project Papers and Reports

Conferences and Seminars

Abkin, M. H., Manetsch, T. J.; and the MSU Agricultural Sector Simulation Team. "A Generalized System Simulation Approach to Agricultural Development Planning and Policy Making." IFAC-IFORS Conference on Systems Approaches to Developing Countries. Algiers, Algeria. May 1973.

Abkin, M. H.; and Rossmiller, G. E. "Sector Analysis and the General System Simulation Approach to Agricultural Development Planning." CENTO Workshop for Agricultural Planners. Islamabad, Pakistan. November 1972.

Chong, K. Y. "Some Illustrative Policy Runs Using the Nigerian Agricultural System Simulation Model for Development Planning." Sixth Hawaii International Conference on Systems Sciences. Honolulu, Hawaii. January 1973.

de Haen, H. "Application of Recursive Decision Systems in Agricultural Sector Analysis." ADC Conference on Recursive Programming. Washington, D. C. November 1972.

Johnson, Glenn L. "General, Systems-Science, Simulation Analysis--An Introduction." IBRD Colloquium on Advanced Methodologies for Agricultural Investment and Policy Analysis. Washington, D. C. January 1973.

Publications

Abkin, M. H. "System Simulation and Policy Making for Economic Development." Simulation Today #7. Simulation. Vol. 20, November 1972.

Abkin, M. H.; Hayenga, M. L.; and the MSU Agricultural Sector Simulation Team. "System Simulation of Agricultural Development: Some Nigerian Policy Comparisons." American Journal of Agricultural Economics. August 1973.

Abkin, M. H.; and Manetsch, T. J. "A Development-Planning Oriented Simulation Model of the Agricultural Economy of Southern Nigeria." IEEE Transactions on Systems, Man, and Cybernetics. SMC-2:472-486. September 1972.

Johnson, G. L.; and Zerby, L. K. What Economists Do About Values: Case Studies of and Questions They Don't Dare Ask. East Lansing: Michigan State University Press, 1973.

Kim, D. H.; and Rossmiller, G. E. "Broad Development Perspective for Korean Agricultural Sector." Korean Journal of Agricultural Economics. Vol. XIV. December 1972.

Manetsch, T. J. "A Reply to 'Review of A Generalized Simulation Approach to Agricultural Sector Analysis With Special Reference to Nigeria' by Richard de Neufville," IEEE Transactions on Systems, Man and Cybernetics. SMC-3. September 1973. (See Appendix F)

Olayide, S. O.; Abkin, M. H.; and Johnson, G. L. "Agriculture and the Growth of the Nigerian Economy: Results of Policy Simulation Experiments." Nigerian Journal of Social and Economic Studies. March 1973.

Suh, H. H. "An Introduction to Korean Agricultural Sector Analysis and Summary of Major Results." Agricultural Economics, Ministry of Agriculture and Fisheries. Vol. II. December 1972. (in Korean)

Other Papers and Reports

Abkin, M. H.; and Pervis, D. W. "Draft Proposal for an Agricultural Sector Simulation Library." Project Paper. October 1972.

Buchner, M.; and Manetsch, T. J. "Automatic Parameter Estimation in Large Scale Simulation Models." Project Working Paper 73-2. May 1973.

Carroll, T. W. (ed.) "The User's Manual." KASS Special Report 9. June 1973.

Chong, K. Y. A Simulation Policy Analysis of the Western Nigerian Cocoa Industry. Unpublished Ph.D. dissertation. Michigan State University. 1972.

Gibson, F. J. "Development of a Grain Management Simulation Model." KASS Working Paper 73-1. January 1973.

de Haen, H.; and Lee, J. H. "Dynamic Model of Farm Resource Allocation for Agricultural Planning in Korea--System Simulation Approach." KASS Working Paper 72-1. August 1972.

Johnson, Glenn L. "Solving Health Care Problems With the Simulation Approach." HEW Health Care Delivery Conference (cancelled; paper submitted directly to the National Center for Health Services, HEW). December 1972.

Kellogg, E. D. "Investment in Nigeria's Northern Cattle Industry: A Simulation Analysis." Report to the Perspective Plan Editorial Board, FMANR, Nigeria. August 1972.

Ladipo, O. O. General System Analysis and Simulation Approach: A Preliminary Application to Nigerian Fisheries. Unpublished Ph.D. dissertation. Michigan State University. 1973.

Manetsch, T. J. "A Simulation Language to Facilitate the Development and Use of Simulation Models in Policy, Program and Project Analysis--Preliminary Outlines." Project Working Paper 73-1. March 1973.

Manetsch, T. J.; and Kim, S. G. "KASSIM Description of a Preliminary Grain Management System Model." KASS Working Paper 72-1. July 1972.

Rossmiller, G. E.; et al., Korean Agricultural Sector Analysis and Recommended Development Strategies, 1971-1985. Ministry of Agriculture and Fisheries, Seoul, Korea; and Department of Agricultural Economics, Michigan State University, East Lansing, Michigan. 1972. (also translated into Korean)

Rossmiller, G. E. "Short and Long Term KASS Development Issues." KASS Issue Paper No. 2. 12 April 1973.

Rossmiller, G. E.; and Kim, D. H. "Proposal for Wider Use and Development of the Korean Agricultural Sector Study." KASS Paper. 1972.

Rossmiller, G. E.; and Suh, H. H. "The Problem and Consequences of Discrepencies Between Official Statistical Series: The Grain Production Example." KASS Issue Paper No. 1. 27 March 1973. (For internal MAF use only--not for quote or distribution.)

Suh, H. H.; and Ryu, B. S. "Use of the KASS Model in Preliminary Planning for the Fourth Five-Year Plan." KASS Issue Paper No. 3. 1 May 1973.

Appendix B-1

INSTITUTIONAL SERVICES CONTRACT

THIS AGREEMENT, made this 13th day of October, 1972, by and between the Michigan State University, East Lansing, Michigan, hereinafter referred to as MSU, and between the University of Hawaii for the East-West Center, Honolulu, Hawaii, hereinafter referred to as UH/EWC.

WITNESSETH:

THAT WHEREAS, MSU, through Contract AID/csd 2975, desires to obtain data gathered by Kang Sik Park and Seyoul Kim as to what the returns are to employment in agriculture; and, as to what the returns are to employment in nonagriculture pursuits (whether a worker had to locate physically, or merely change jobs from farm work to non-farm work nearby, etc.) in the Republic of South Korea.

WHEREAS, the UH/EWC intends to collect such data and agrees that all raw data collected, the final summaries of their analyses, and two copies of each thesis will be made availble to MSU.

NOW, THEREFORE, UH/EWC hereby agrees to perform such services as are specified, and MSU hereby agrees to reimburse the UH/EWC for expenses incurred in collecting such data in accordance with the following terms and conditions:

1. All services to be rendered by UH/EWC under this Agreement shall commence not later than September 1, 1972 and shall be completed by January 31, 1973.

- All raw data collected will be at MSU's disposal as will summaries of such data and manuscripts and/or theses produced therefrom.

- The UH/EWC will submit itemized statements in requesting reimbursement for expenses, the total of which shall not exceed $5,500.00.

- Reimbursement will be made in accordance with the attached budget schedule.

Reimbursement requests should be sent to the Director, Research and Contract Division, Michigan State University, East Lansing, Michigan, 48823 as often as deemed necessary but not more than once a month.

The University of Hawaii for the East-West Center agrees to the relevant provisions of Contract AID/csd 2975, copies which are attached.

IN WITNESS WHEREOF, the parties hereto have caused this Agreement to be executed as of this day and year first above written.

EAST-WEST CENTER

By Everett Kleinjan
Title:

UNIVERSITY OF HAWAII

By
Title:

MICHIGAN STATE UNIVERSITY

By
Title:

Budget Schedule

I.	Stipends for University of Hawaii/East-West Center Participants Involved in Data Collection		$2,331.00
	Seyeul Kim	$1,036.00	
	Kang Sik Park	1,295.00	
II.	Field Expenses for University of Hawaii/East-West Center Participants Involved in Data Collection		501.00
	Per diem	280.50	
	Travel costs	220.50	
III.	Enumerator Expenses		1,557.00
	Stipend	558.00	
	Per diem	558.00	
	Travel	441.00	
IV.	Other Direct Costs		1,111.00
	Printed questionaires and supplies	250.00	
	Typing services and mailing	300.00	
	Statistical and computer services	450.00	
	Miscellaneous	111.00	
	TOTAL		$5,500.00

Appendix B-2

INSTITUTIONAL SERVICES CONTRACT

THIS AGREEMENT, made this 1st day of March, 1973, by and between the Michigan State University, East Lansing, Michigan, hereinafter referred to as MSU, and between the University of Hawaii for the East-West Center, Honolulu, Hawaii, hereinafter referred to as UH/EWC.

W I T N E S S E T H:

THAT WHEREAS, MSU, through Contract AID/csd 2975, desires to obtain information gathered and analyzed by Kang Sik Park as to what the returns are to employment in agriculture in the Republic of South Korea.

WHEREAS, the UH/EWC intends to collect and analyze such data and agrees that all raw data collected, the final summaries of his analyses, and two copies of this thesis will be made available to MSU.

NOW, THEREFORE, UH/EWC hereby agrees to perform such services as are specified, and MSU hereby agrees to reimburse the UH/EWC for expenses incurred in collecting such data in accordance with the following terms and conditions:

1. All services to be rendered by UH/EWC under this Agreement shall commence not later than March 1, 1973 and shall be completed by June 30, 1973.

2. All raw data collected will be at MSU's disposal as will summaries of such data and manuscripts and/or thesis produced therefrom.

3. The UH/EWC will submit itemized statements in requesting reimbursement for expenses, the total of which shall not exceed $2,000.00.

4. Reimbursement will be made in accordance with the attached budget schedule.

Reimbursement requests should be sent to the Director, Research and Contract Division, Michigan State University, East Lansing, Michigan, 48823 as often as deemed necessary but not more than once a month.

The University of Hawaii for the East-West Center agrees to the relevant provisions of Contract AID/csd 2975, copies which are attached.

IN WITNESS WHEREOF, the parties hereto have caused this Agreement to be executed as of this day and year first above written.

EAST-WEST CENTER

By _____
Title: MAR 27 1973

UNIVERSITY OF HAWAII

By _____
Title: Acting

MICHIGAN STATE UNIVERSITY

By _____
Title: R. E. WILKINSON
Vice President for Business and Finance

Budget Schedule

I.	**Stipend for University of Hawaii/East-West Center Participant Involved in Data Collection**	
	Kang Sik Park (March 1 - June 30, 1973)	$1,020.00
II.	**Statistical and Computer Services**	680.00
III.	**Publication Costs for Thesis and/or Manuscript Work**	300.00
	TOTAL CONTRACT AMOUNT	$2,000.00

Appendix C

MEMORANDUM OF UNDERSTANDING BETWEEN
MICHIGAN STATE UNIVERSITY, CONTRACTOR—CONTRACT AID/csd-2975
THE SIMULATION PROJECT
AND
THE DEPARTMENT OF AGRICULTURAL ECONOMICS
UNIVERSITY OF IBADAN

This Memorandum of Understanding is entered into effective June 1 1973 between the Simulation Project (Contract AID/csd-2975) with its principal offices at Michigan State University, East Lansing, Michigan, U.S.A., and the Department of Agricultural Economics, University of Ibadan, with its principal offices in Ibadan, Nigeria.

Whereas, Contract No. AID/csd-2975, a Contract between U.S.A.I.D. and Michigan State University encourages the conduct of joint cooperative studies and the training of developing country scholars and their U.S. colleagues in the use and actual development of simulation models, this agreement is within the scope and goals of the Contract.

Now therefore in furtherance of the purposes of such an understanding, Michigan State University, Contractor for Contract AID/csd-2975 and the Department of Agricultural Economics at the University of Ibadan mutually agree as follows.

I. SCOPE

Need for Study

In Michigan State University's Nigerian simulation work under contract AID/csd-1557, relatively little interaction took place with Nigerian experts and policy makers. While this was acceptable under

the objectives of that contract, it resulted in a number of important deficiencies from the point of view of the model's relevance and applicability in Nigeria. In particular, the model's treatment of important certain labor problems, inflation and certain commodities was rudimentary.

The study here proposed would meet one of these deficiencies, namely, it would model Nigeria's kolanut industry, an important cash crop in Western Nigeria's agricultural economy and thus a competitor with cocoa for productive resources.

In terms of AID/csd-2975, this study meets our obligation to respond to requests for application of the generalized system simulation approach in LDC's. In addition, it would increase the relevance of the current Nigerian model while at the same time train Nigerian personnel in the use of the approach—thus increasing the opportunities for success of the long run implementation project anticipated for Nigeria.

II. OBJECTIVES OF THE STUDY

The objectives of this study, then, will be:

1. The analysis of the structure and problems of Nigeria's kolanut industry, including its place in the total agricultural and national economy;
2. The construction of a generalized system simulation model to investigate, and facilitate the formulation of alternative policies, programs and/or projects for the kolanut industry, and which would

be compatible with the larger Nigerian model developed at MSU and now being modified, extended and improved by Nigerian scholars; and

3. To provide Cyril Aja with the necessary information and tools to become an intermediate level applier of systems-science, simulation models.

III. PLAN OF OPERATION

Mr. Aja, under the direction, supervision and assistance of Dr. Samson O. Olayide and Dr. Francis S. Idachaba of the Department of Agricultural Economics And Extension, University of Ibadan will:

1. Prepare within the first nine weeks of this agreement a more specific and detailed plan of work and a timetable suitable to obtain the goals and objectives of this agreement using the plans below as a frame of reference.
2. Develop a generalized simulation model of the kolanut industry.
3. Assemble, with the assistance of field research assistants, necessary data to estimate the parameters of the model
   a. by collection of primary data directly from producers, middlemen and consumers
   b. including secondary statistics from published sources
   c. and now published technical, institutional and behavioral data and information from experts, other nonpublished sources, and published sources.
4. Incorporate the information into the model and use the model to simulate the consequences of alternative programs, projects and policies designed to solve the problems of the kolanut industry in Southern Nigeria.

5. Insure that the model developed be so that it may be incorporated into the Nigerian Simulation Model.

IV. PROJECT PERSONNEL AND INPUTS

1. Mr. Cyril Aja reading for his Masters of Science degree, will be the principal of the above mentioned scope of work. He will be closely guided and, if necessary, assisted by Drs. Olayide and Idachaba who will be available for information and guidance in gathering the necessary information to develop this model. They will supervise and advise him in the preparation and publication of research. If his research does not qualify as an MSc thesis at the University of Ibadan, they will be responsible for preparation of a report fulfilling the objectives of this contract.

2. Michigan State University will provide a qualified systems scientist and/or agricultural economist during the first, during the sixth to eighth month, and during the final two months of this agreement for a total period of no longer than nine weeks to inspect progress and if called upon, to advise and assist in finalizing the research done under this agreement.

V. REPORTS AND REVIEWS

1. Comprehensive quarterly reports will be submitted by Mr. Aja and reviewed and commented on by Drs. Olayide and Idachaba and sent to the Project Director of the Simulation Project. These reports will be due 15 days after October 31, 1973, December 31, 1973, March 31, 1974 and June 30, 1974.

2. A review of the reports by the Project Director will determine whether the project should be continued at full support and extended with the prime contract.

VI. SUMMARY

Therefore, in consideration of the above, Contract AID/csd-2975 has expressed an interest in supporting this project to the extent of paying Mr. Cyril Aja's graduate student stipend, supporting him with three field assistants, furnishing travel transportation expenses and other direct costs including computer costs for a period of one year, and, possibly, another eight months, contingent upon the extension of the basic contract, Contract AID/csd-2975.

Mr. Aja will be directed and supervised by Dr. Samson Olayide, and Dr. Francis S. Idachaba, Department of Agricultural Economics, University of Ibadan. The results of his research would be published either as a thesis that would suffice to obtain his Masters of Science degree or as an independent report. 100 copies of an independent report will be furnished to MSU under the terms of this agreement. The results will be made available to MSU, USAID/Lagos and AID/Washington for use as part of the public domain.

VII. PERSONNEL AND BUDGET

1. For the purpose of this memorandum of understanding the staffing plan and budget is within the budget limitations of the prime contract and will be supported by Michigan State University Contract AID/csd-2975 under the provisions of the basic contract.

2. The firm budget is for period June 1, 1973 through March 31, 1974. The basic contract is firmly funded until March 31, 1974. As the projected budget in this agreement is contingent upon extension of the basic contract, MSU cannot be held responsible for funds in the projected period. Therefore, the projected budget will be contingent upon:

   a. the basic contract, Contract AID/csd-2975 being extended, and

   b. the Project Director's approval of the progress of the development of the model by Mr. Aja and his supervisors.

		Firm Budget (U.S. Dollars) Fm 6/1/73 To 3/31/74	Projected* Budget Fm 4/1/74 To 11/30/74	Total Budget Fm 6/1/73 To 11/30/74
Salaries				
Cyril Aja, Grad. Student $144 per month	$1,728	$5,184	$2,016	$7,200
3 Field Assistants @ $96 per month	3,456			
Travel				
Student, Field Assistants and Supervisors $100 per month		1,200	700	1,900
Equipment				
3 bicycles @ $100 each	300	700	---	700
1 Mobylette/Honda	400			
Other Direct Costs				
Computer	500	845	555	1,400
Typing, Stencils, Supplies	345			
		$7,929	$3,271	$11,200

*The availability of these funds are contingent upon the extension of Contract AID/csd-2975 and the Project Director's approval of the progress of work.

Now therefore, the Department of Agricultural Economics, University of Ibadan agrees to perform such services as specified in this agreement and Michigan State University hereby agrees to reimburse the University of Ibadan for the expenses

incurred in Mr. Cyril Aja's graduate work in accordance with the following terms:

1. All services to be rendered under this agreement shall commence not later than June 1, 1973 and will continue until at least March 31, 1974. The extension until November 30, 1974 is contingent upon extension of Contract AID/csd-2975 and satisfactory performance through March 31, 1974.
2. All raw data collected will be at MSU's disposal as will summaries of such data and manuscripts and/or a thesis produced therefrom.
3. The University of Ibadan will submit itemized statements in reimbursement for expenses, the total of which shall not exceed $7,929 during the first twelve months of the agreement.
4. Reimbursement will be made in accordance with the budget schedule and line items. Reimbursement requests should be sent to the Director, Research and Contract Division, Michigan State University, East Lansing, Michigan 48823 as often as deemed necessary but not more than once a month.
5. The Department of Agricultural Economics, University of Ibadan, agrees to the relevant provisions of Contract AID/csd-2975, copies of which are attached.

IN WITNESS WHEREOF the parties hereto have caused this Agreement to be executed as of this day and year above written.

Samson O. Olayide
Department of Agric. Economics

H. Oritsejolomi Thomas
Vice-Chancellor
University of Ibadan

Michigan State University
STEPHEN H. TERRY

Appendix D

SUMMARY OF THE SIMULATION LIBRARY WORKING CONFERENCE MARCH 29-30, 1973

Prepared and presented by
Michel Petit

This will mainly be my interpretation of what has happened at this conference--not so much reproducing the discussion and how it went but mainly where do we stand and what are the remaining questions. However, I think it's better to place it in perspective by reminding ourselves of the historical background. I think the question which was put to us to begin with is that this MSU team, having undertaken some sector studies in simulation, systems science, etc., in the process has accumulated some capital. And the problem is how to save this capital, how to conserve it. This is how the idea of a library has come about. The library will have a function to keep it (the capital) up, to maintain it and to disseminate it. But, as appeared clearly I think, this capital requires complementary inputs--in particular, expertise --and this is why the idea of a passive library (perhaps it would be better to call it a clearinghouse, but we have used the word passive so I will keep it) is not sufficient. In this, I think, a consensus was reached.

Then the question is: What can be done? In order to answer this question, I think it best to start with asking the question: What are the long run needs? Here again I think a consensus was reached. In particular, it was part of the point which was repeated several times that there is clearly a need for developing analytical capacity, particularly in LDC's, for policy and decisions in economic planning. I will not elaborate on this since it has already been clearly and more elaborately said. As I see it, the first group this morning discussed whether an international body should be set up in order to satisfy this need. Various things have been said about how it should be done and what kind of needs could be satisfied. I would link what was said this morning with the emphasis that was placed yesterday by

some of us on the dissemination of information, the first function which appeared on the board yesterday.

Once these needs are identified (that does not mean that they are clearly specified), the next question is: Can the MSU production be used in this respect to satisfy these needs? First, I think everybody recognized that there is what Jacques Vercueil called a slant, what in French we would say is the influence of the problématique. By this we mean the entire set of questions and assumptions which are closely related together (assumptions are not independent of the questions and the questions are not independent either of the assumptions) and are the basis for developing the tools for conducting the analysis. So, I think everybody recognizes that there is necessarily a slant. But, in spite of that slant, it was not considered impossible to still start a library from this. And I think we have pretty much resolved, between ourselves at least, the issue of the techniques; that is, it is very clear that such a library should be opened to any kind of techniques which could prove themselves useful. I think that there is pretty much of a consensus on that.

Well, having answered yes to that question--that the MSU production can be used--that does not tell us how it can be used, which raises a few questions. I think the fact that we have not solved all of these questions is particularly exemplified, or illustrated, by the diverging points of view of Groups II and III this morning. It is true, as Glenn Johnson said, that those two groups are not really conflicting; however, I think the word divergence between the two groups is appropriate. It seems to me that Group II addressed itself to the question: What could MSU do as a first step towards fulfilling the long run needs which we identified earlier. And we came up with a list

of priorities* giving some advice and from which I believe it is possible to permit some action, as Glenn will probably tell us. But even within this question, two subquestions remain which have not been satisfactorily treated, I think, during this conference. One is: What is a transferrable component? This was something which we used all the time during the discussions and we have not come up with a real answer to that question; and I don't think we could, anyway. But it may be a very crucial question--if a transferrable component is something very simple, then there is no use putting up the library. The other question which was not completely resolved is: What importance should be given to what was called at some stages a simulation language (in Tom's paper that he distributed to us) or a computing system, i.e., the assembly part of it? I see that as an unresolved question.

The other group addressed itself not so much to the question: What could MSU do as a first step?, but to the other question: How should the MSU team allocate its time over the next few months, recognizing (and this is particularly due to the composition of the group, where members of the team were probably in the majority) that the most limiting resource is their time. It is not surprising, then, that this group, addressing itself to another question, comes up with the answer that the most important thing to do is training.

My question concerning those questions is whether we in Group II did not waste some amount of time because we addressed ourselves to the question which was put to us. That is, having been taught that as analysts we should try to help decision makers in solving the problems which they face, one other thing to do is to question the way they put the questions. Perhaps it is

significant that the relevant question was the question addressed by Group III: What should the MSU team do? That's not my problem but Glenn Johnson's, and I think that's a nice introduction.

*The priorities outlined in Group II were:

1. Documentation and generalization of the most useful existing components (including cataloging and indexing and perhaps including test data)
2. Encourage others to contribute compatible, generalizable and documentable components
3. Provide documented components to potential users
4. Assist users as much as possible in the use of components (some controversy over the word "assist")
5. Conduct active search for new components
6. Data bank of what has been used in developing components
7. Development of computing systems (simulation language)

PLAN FOR ACTION OF THE SIMULATION LIBRARY WORKING CONFERENCE MARCH 29-30, 1973

Prepared and presented by
Glenn L. Johnson, Project Director

I would like to express my appreciation to all who attended the conference. You have been extremely helpful, and we at MSU appreciate the time and resources you and your agencies have devoted to helping us and AID think out the problems of developing a software library. As Ed Rossmiller will probably be project director before the summer is over, my comments about the future should be interpreted accordingly. In any event my comments will be divided into two parts dealing with the near future with assured funding and the longer term looking beyond currently assured funding.

I view the short run as the 15 months ending July 1974. We have two short-run topics to discuss: one is the role of the library in the short run and the other is our (MSU's) other responsibilities under the MSU contract AID/csd-2975 project. The MSU project will obviously continue developing software components to put into models. For instance, a grain management component is important and will have high priority. Further, better models of the livestock component are needed. A large number of other developments will also be a part of the project. The project will continue its advising and consulting services, some at no cost to the requesting person or agency since costs are covered under 2975 but others with extra costs to be covered by country missions, host countries, and other agencies. Our short-run library work will have to be balanced against other project objectives. Training will have a heavy priority in the overall project. Tom Manetsch has made considerable progress in this respect. In this connection we should note that other MSU resources are available to support training programs.

Work under our project will continue to be general. We look for components and elements for constructing models from many of the different iron boxes (or paper bags) discussed at this conference. We will draw on theories, information and data from disciplines other than economics. Our work will continue to be general enough in a philosophic sense to address problem solving. We will have to do library work to support our own project in the future as in the past. It is clear, whether or not a national or international software library is ever established, that we should point our short-run library work in the direction of contributing to the establishment of such a library. Thus, we will work towards making a systematic contribution to establishing such a library within our resources and in view of our other responsibilities, noting that we must first service the MSU project and MSU. Additional costs will be incurred in carrying out documentation and indexing for a library to be located at a place other than MSU; such extra costs will have to be covered--presumably by AID. We will be prepared to receive inputs into the library and issue them to others within the resources available to the project or to be made available by AID for doing such work. In the short run the library will be passive since advising and consulting services will be provided under AID/csd-2975. Consulting and advising work obviously complement library work.

In the long run advising and consulting will have to be provided by an active library more self-sufficient unto itself. In the long run it is clear that the library should not be located at MSU. As project director I feel personally that it would not be appropriate or efficient to locate the library in any university. Preferably an international agency but

possibly a national agency is envisioned. MSU would render substantial support to the development of such a library and would be one of its greatest users if it is effectively organized and supported. MSU would look to the library as an agency in which to place and obtain transferrable elements and components. We will also assist the library with consulting and advising services to users of the library.

Over the next 15 months and longer, depending on how AID functions and is or is not reorganized, MSU will negotiate with AID on the library. Financing will be required above present commitments in both the long and short run. Work begins on each financing package about 15 months ahead; thus we will work with AID on long-run software library financing. We are already working with AID on financing a training component to overcome personnel constraints at MSU and in user countries. We will work with AID to establish an advisory group while the library is at MSU under an AID contract. Such an advisory group cannot, however, be a governing board if for an MSU/AID contract.

MSU will cooperate with agencies other than AID in both the long and short pulls. In the short run we are prepared to cooperate with such agencies with respect to the library at no cost since AID has provided funds for such purposes. In the long run we will be prepared to work with other groups as well as for AID at cost and will cooperate closely with AID in working out those arrangements.

SIMULATION LIBRARY WORKING CONFERENCE
March 29-30, 1973
Attendees

Hugo Caceres, Director
Documentation and Information Unit
Organization of American States
San Jose, Costa Rica

Arthur Coutu
Department of State
Bureau for Technical Assistance
Agency for International Development
Washington, DC 20523

John Ferris
Department of Agricultural Economics
Michigan State University
East Lansing, MI 48823

Albert Halter
Department of Agricultural Economics
Oregon State University
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Appendix E

Description of a Professional Training Program in System Science and Quantitative Methods for Potential Developers of Agricultural Sector Models (the Basic Training Program)

The training needs outlined above are substantial. In this section we will outline one important component of a broader program required to meet the needs which have been identified. We will call this the "Basic Training Program." The component described is an intensive one, with a duration of one year or longer, designed to train people who will eventually become developers of decision making models for the agricultural sector. This component is a basic one in the sense that, once in place, a variety of less intensive short training programs can be designed from the parts that make up the Basic Training Program.

The primary objective of the Basic Training Program is to produce professionals who can eventually function as productive developers and "appliers" of agricultural sector models in developing countries. Such people, as key members of multidisciplinary teams, will be responsible for model development and/or adaption, validation, application to policy questions and refinement and updating through time. In the event that a candidate for this program does not have adequate preparation in related fields such as agricultural economics, areas of technical agriculture, etc., the program would also provide selected supplementary study as needed.

This program is designed to "stand alone" as a one-year postgraduate professional program or to serve as a core for a regular graduate program in System Science or related discipline at M.S.U. In the former case

it will train qualified professionals from foreign countries who cannot, for one reason or another, undertake a full master's or doctoral program in the U. S. The program is considered minimum preparation for professionals who will function as developers and appliers of decision-oriented models (see Table I). For this reason, trainees should be encouraged to undertake a full graduate program, preferably at the doctoral level, wherever possible. This program can also contribute to the development of personnel embarking on careers relating to domestic applications of systems analysis and simulation. It therefore has external economies for the institution in which it is implemented.

It should be emphasized that this program should be viewed as but one component of a larger program designed to make available all the human and other resources required to carry out the functions necessary for successful model development and applications to sector analyses. The larger program might well include short courses in various disciplines, intensive training of computer programmers, etc. Each country would have to be carefully considered to determine the specific training and other needs that exist and detailed programs must be assembled to meet those needs. This clearly requires close coordination among the host country government, the U. S. educational institution, the U. S. Mission, etc.

Prerequisites for Entrance into the Basic Training Program

In order to attain these objectives the participants in the program must be carefully selected. Pertinent criteria include:

a. Formal training and experience in a relevant discipline--agricultural economics, engineering, an area of technical agriculture, etc.

b. A "flair" for quantitative methods and solid preparation in basic mathematics and statistics which includes:[1]

   i. College mathematics through differential and integral calculus (at least one year)

   ii. A course in probability theory preferably based on the calculus

   iii. One or more courses in statistics--preferably including regression analysis

c. Participants should be appropriately located in the institutional structure of a country that is seriously interested in the use of models as aids in agricultural policy, program and project analysis.

d. At least two participants from each country (to increase the likelihood of successful adoption by participating countries. In cases where suitable expertise already exists in a particular country this prerequisite can be waived.)

e. There should be high probability that individual participants will be actively involved in problems of agricultural sector analysis for a considerable period of time upon return to their home countries.

f. Adequate facility with the English language.

g. Adequate "infrastructure" in participating countries (computers, programmers, data acquisition, etc.).

Careful screening and selection procedures must be established to ensure that necessary criteria are satisfied. Procedures might include aptitude tests (designed specifically for this program), interviews, and carefully solicited personal references. In all cases, studies should be carried out to examine the feasibility of institutionalizing models in particular countries. These would identify specific training needs

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[1] Candidates essentially qualified but weak in specific quantitative areas could remove deficiencies in a number of ways including spending an additional term at M.S.U. doing remedial work.

and promising candidates for professional programs such as this one (as well as identify other infrastructural gaps to be filled).

Description of Program Content

While the primary program objective is to develop skills in model construction, adaption and application, a related objective is to give participants breadth needed to function as part of a multidisciplinary team (see Table I). The program must therefore include short courses and regular courses, as needed by specific individuals, in such fields as economics, areas of technical agriculture and sociology. In what follows we will outline the "core" required to accomplish the primary program objective with the understanding that this must be supplemented according to needs of individual participants for "broadening." The program is designed for a nominal duration of one year with lengthening or shortening possible in unusual cases. The program can also be used as a core for a formal graduate program--a preferable option as discussed above.

Technical Core for the Basic Training Program

The following courses are considered as an essential technical core (course numbers are those at Michigan State University):

Basic Computer Science (CPS 120 and/or 300)	3-6 hrs.
Mathematics (Theory of Matrices--MTH 334)	4 hrs.
System Science	
Linear System Theory (SYS 810)	3 hrs.

Systems Methodology and Simulation (SYS 811)	3 hrs.
System Project (SYS 813 or equivalent thesis work)	9 hrs.
Advanced Systems Methodology and Simulation (SYS 8xx to be developed)[1/]	3 hrs.
Mathematical Programming	
EC 833 or SYS 465 or SYS 828	3 hrs.
Econometrics AEC 835 (if not taken previously)	3 hrs.
Computer Models in Agricultural Sector Analysis-- with Computer Laboratory (AEC 8xx to be developed)	3 hrs.
TOTAL HOURS	31-37 hrs.

The technical core therefore includes about 34 quarter hours of work. This includes intensive practical project and laboratory work as well as formal course work. A qualified participant can complete this core plus some "broadening" work and/or electives in a period of one year.

A possible time schedule for this program, based on one full year, is as follows:

Fall	Winter	Spring	Summer
SYS 810 (3)	SYS 811 (3)	SYS 813 (3) (Proj.)	SYS 813 (6) (Proj.)
CPS 120 (3)	AEC 8xx (3)	SYS 8xx (3)	AEC 835 (3)
MTH 334 (4)	CPS 300 (3)	AEC 833 (3)	
10 credits	9 credits	9 credits	9 credits

Clearly there is room in this program for "broadening" electives.

Requirements for Program Implementation

In addition to the development of careful screening and selection procedures mentioned above, at least two new courses must be developed.

[1/] See the Appendix for a tentative outline for this course.

These are the courses in advanced system simulation (SYS 8xx) and the course in simulation based decision analysis (AEC 8xx). An important factor in the success of the program will be the effectiveness of the practical elements of the program--the system projects and the policy analysis laboratories. In order to achieve desired program results these practical areas must receive intensive attention from experienced teaching staff. For example, a reasonable teaching load for a professor directing ten student projects might be full time (the equivalent of about four hours per student per week). Clearly, the professional program outlined above would require external funding for its development and ongoing support.

Preliminary Description of a New Course
"Advanced Systems Methodology and Simulation"
SYS 8xx (3 credits)

Prerequisite: SYS 811 or equivalent background

Objectives and Background

A primary objective of this course is to present advanced material useful in the development and application of large scale simulation models for system design and/or management. The course is designed to directly supplement the material currently taught in SYS 811 at MSU. This new material should be of proven or potential usefulness in simulation studies of large systems. Much of the course material is suggested by MSU experience in agricultural sector simulation studies in Nigeria and Korea. The course will be suitable for professional non-degree programs, for foreign nationals coming to the U. S. for work in systems analysis related to agricultural development, system science graduate majors and graduate students from other departments using system science as a minor field. This course will be particularly suited to the needs of foreign professionals coming to the U. S. for intensive work in System Science in preparation for work in sector simulation in their home countries.

Course Outline

4 weeks

1. Development of Large Scale Models

   a. Building block approach--component interface design, linking model components, linkages to sub-optimization routines, use of overlays

b. Input/output processing

c. Executive routine design

d. Model testing and validation--gross tests of validity; sensitivity analyses; automatic historical tracking using direct search techniques, response surfaces, etc.

e. Monte Carlo capability

f. Model update and refinement

3 weeks

2. Model Application

a. Development of direct interaction with decision makers (involving modifications of policy inputs during simulation)

b. A critical examination of the simulation based interactive decision making process with emphasis on means of enhancing its effectiveness

c. Theory for operating simulation models in an optimization mode (to maximize or minimize a performance criterion of interest to decision makers)

3 weeks

3. Case Studies of Representative Large Scale Simulation Models

Detailed study and critique of selected large scale models

Appendix F

World Bank Colloquium on Advanced Methodologies for Agricultural Investment and Policy Analysis

Generalized Sector Simulation Approach

January 29-30, 1973

January 29, A. M.

I. INTRODUCTION--Johnson (45 minutes*)

- A. Historical background--seat of the pants projections, CSNRD, contract 1557, KASS, etc.
- B. Aspects of problems encountered in sector analysis that create need for systems approach and simulation
- C. Background of team required to do multidisciplinary work
- D. Role of simulation in sector analysis
- E. Relation of LP, RLP, systems of simultaneous equations, etc.
- F. Discussion

II. OVERVIEW OF APPROACH--Hayenga, Halter (60 minutes)

- A. Problem definition
- B. Math modeling
- C. Computer implementation
- D. Testing and validation
- E. Policy applications by interactions with decision makers
- F. Discussion

III. BASIC THEORY UNDERLYING CONSTRUCTION OF SECTOR MODELS (4 1/2 hours)

- A. Introduction--Manetsch (5 minutes)

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*All times are to include question-and-answer and discussion periods.

B. Modeling continuous time aggregative phenomena with differential equations (65 minutes)

1. Stock-flow relationships--Manetsch (15 minutes)

2. Delays--Manetsch (20 minutes)

3. Examples of macro-approximation theory--Abkin (30 minutes)

January 29, P. M.

C. Results from linear systems theory--Abkin (60 minutes)

D. Introduction to on-line feedback control theory--Manetsch (40 minutes)

E. Numerical implementation of models on digital computers--Manetsch (60 minutes)

1. Function generation

2. Numerical integration

3. Generation of random variables

4. Simulation of time delays

5. Building block approach to overall model development

F. Discussion (40 minutes)

IV. INTRODUCTION TO POLICY CAPABILITIES OF NIGERIAN MODEL--Abkin (15 minutes)

January 30, A. M.

V. DETAILED DISCUSSION OF MSU SIMULATION MODELS (3 hours)

A. Introduction (global Nigeria model structure)--Halter (10 minutes)

B. Northern Nigeria region model structure--Halter (35 minutes)

C. Southern Nigeria region model structure--Abkin (35 minutes)

D. Nonagricultural model structure (Nigeria)--Halter (15 minutes)

E. Population model structure (Korea and Nigeria)--Hayenga (15 minutes)

F. Results of Nigeria model tests (data, tracking, sensitivity analysis, Monte Carlo, etc.)--Abkin (30 minutes)

G. LP model of Korean farm resource allocation--Lee, J. H. (20 minutes)

H. Discussion (25 minutes)

January 30, P. M.

VI. MODEL APPLICATIONS TO POLICY AND PROGRAM ANALYSIS AND DESIGN (2 hours)

A. Discussion of typical policy runs (Nigeria) with on-line teletype demonstration--Abkin (45 minutes)

B. Summary of Korean experience--Manetsch (40 minutes)

C. Model extensions to other areas (Venezuela, Colombia)--Halter (20 minutes)

D. Discussion (15 minutes)

VII. PROBLEMS AND AREAS FOR FURTHER DEVELOPMENT--Panel approach including all team members (1 1/2 hours)

A. Data problems--Halter (20 minutes)

B. Validation--positive and normative--Johnson, Manetsch (15 minutes)

C. Implementation in LDCs including training--Manetsch (20 minutes)

D. Software library--Abkin (10 minutes)

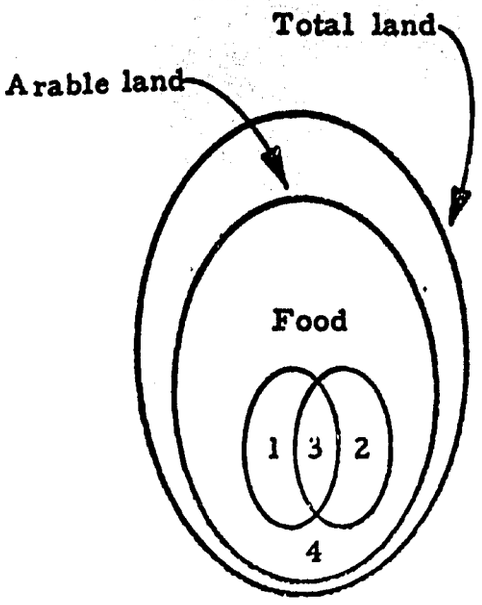
E. Theoretical problems--economic and system science--Johnson, Manetsch (10 minutes)

F. Discussion and wrap-up--Johnson (15 minutes)

VIII. AUDIENCE PARTICIPATION (evening)

On-line terminal use of Nigeria model by colloquium participants to explore further policy questions.

Appendix G



Book Review • Book Review • Book Review

A GENERALIZED SIMULATION APPROACH TO AGRICULTURAL SECTOR ANALYSIS With Special Reference to Nigeria

This 362-page hardbound volume was produced by the Michigan State University Simulation Team for the USAID under the leadership of Professor Glenn L. Johnson, project director. The volume, available from Michigan State University at East Lansing, MI or Professor Johnson of the Department of Agricultural Economics, is a comprehensive study that is both well illustrated and well documented.

The object of the project was to develop the general system simulation approach to studying agricultural development to a point where it would be applicable and operational. Nigeria was selected because of widespread experience in Nigeria at Michigan State University and because of its diversity. The research team proceeded to build component models of various aspect of the economy and finally integrated these into a complex whole.

Even for those not interested in agricultural models or the model of Nigeria, Chapter III, "The Systems Analysis Approach and Simulation Methods," is a very well presented, logically organized overview for both the student studying and the specialist practicing simulation methods. The team's recognition of the statistical problems involved in running a simulation model is commendable. Their testing the model against historical data provided them with one reasonable test of the accuracy of the simulation of various components.

Another worthwhile portion of this book, from a general simulation viewpoint, are pages 344 - 349. Therein is contained a well-presented section on the shortcomings of their approach and the model itself, some indication of the costs and requirements for developing new simulation models in this area, and probably most refreshing of all, a section on the prerequisites for successful application of the models presented in the study. The volume has merit from both a theoretical and applications point of view. - hjh □

A Generalized Simulation Approach to Agricultural Sector Analysis with Special Reference to Nigeria—Thomas J. Manetsch *et al.* (East Lansing, Mich.: Michigan State University Press, 1971, 362 pp.).

Reviewed by Richard de Neufville, Civil Engineering Systems Laboratory, Massachusetts Institute of Technology, Cambridge, Mass. 02139.

This book provides an interesting example of the use of systems approaches to a large-scale public problem. It suggests some important issues which need to be considered carefully by all those who are concerned with how systems analysis should be used. My colleague Robert Stickney and I plan to use this book as a case study for our graduate students, and we commend it for this purpose.

In fairness, I should point out that the text will have a limited appeal to IEEE readers. The subject is quite specialized and over two-thirds of the content is devoted to the particulars of the agricultural model. Most of that I am not competent to discuss. What concerns us here is the way the authors have chosen to approach their problem, how they have allocated their analytical resources, and the lessons we can learn from this experience.

Systems analysts, such as myself, recognize that the development of efficient computers has fostered the introduction of many important analytical tools, of which the simulation technique used here is just one example. We tend to take as an article of faith that these new methods will eventually revolutionize the planning for complex public projects. In this vein, academic systems analysts tend to feel that it is appropriate to teach many methodological courses, and consultants in the field tend to use these techniques wherever possible. But when we are truthful with ourselves, we have to admit that we collectively have little experience with the application of systems analysis to real problems. Indeed, we have few guidelines as to when, in what context, or for what purpose a particular approach should be used.

At most, we now have hypotheses about what techniques will ultimately prove to be most suitable to different classes of problems, and about how different methods of analysis can best be organized into an effective planning process. As these hypotheses cannot be tested by conventional experiments, we will be forced to consider the evidence of case studies of actual applications of systems analysis to real problems. It is in this connection that the present text may be most interesting to readers here.

The problem treated by the Michigan State group is, essentially, that of helping officials concerned with economic development determine the best investment and management program for the agricultural sector. They apparently spent some 30 man-years on the project: or, as a very crude estimate of my own, something like one million dollars. As the authors admit, the effort is still, despite the tremendous effort expended, incomplete and imperfect. Furthermore, the project was viewed as a feasibility study of using detailed systems models for developmental planning, rather than an actual application.

Most of the analytical effort was directed at modeling the agricultural sector for a very large region. Simulation was used throughout for this purpose. Unless I misread the detail, only some 22 different policies were tried using the model. The major conclusion to be drawn from the study "is that a technological transformation of agricultural export crop production is necessary for sustained growth." (That is, as we should all know: output is limited by available resources unless you can find a way to use them more effectively.)

An obvious issue raised by this analysis is whether the underlying model is valid. This is a fundamental question of any planning effort, and is treated with respectful caution by the authors in what I found to be a very balanced way. As they point out somewhat more elegantly, the simulation model may be wrong in some sense; but it is quite unclear that a more accurate representation is likely to come in this context simply by application of econometric or other statistical techniques. Their discussion of this topic is well worth reading.

The more interesting questions from our point of view, however, are perhaps the following:

What is the most appropriate allocation of the effort between modeling and the analysis of alternative policies?

What is the appropriate mix of analytic techniques themselves? Should all analytical effort be devoted to simulation or to any other single technique?

What, finally, is the appropriate level of detail for the work? What kinds of conclusions can be obtained and are they worth the effort involved?

These questions should, I suggest, be at the forefront of any analyst's mind as he or she begins a task. The answers to these issues are, naturally, closely intertwined and highly dependent upon the context. The present text provides the analyst or student with an interesting opportunity to examine these questions for a particular real case and come to his own conclusions. I suggest that he do so.

For the record, my own answers to the issues raised are as follows. My impression is that the Michigan State study decided early on to commit itself to a simulation analysis and, consequently, was forced to devote most of its resources to a very expensive effort in detailed modeling and programming. In retrospect, a lesson of the case study is that it might well have been better to seek out cheaper means of analysis that might first permit one to explore the major effect of broad alternative policies. Subsequently, one could focus on the particular policies which seem to offer the greatest opportunities, and to examine them, possibly with a simulation, in great detail.

Explicitly, I am suggesting that we might be best advised to consider a systems analysis as an iterative process in which we formulate models and explore policies at an increasing level of detail. This has the advantage, incidentally, that we may conveniently terminate the analysis and cut expenses if we discover that the only possible conclusions are trivial--which happens all too frequently, at least in my own field of transportation. Furthermore, I would specifically advocate that we consider using simpler, deterministic optimization approaches as screening models, which will help us select critical policy areas for refined analysis by simulation. This is an approach which has worked well in problems of regional development of water resources and transportation systems.

These conclusions naturally do not flow unambiguously from the evidence of the case study developed by the team from Michigan State. Readers are encouraged to examine the record and form their own conclusions. The study is well presented and the authors deserve great credit for making it available.

IEEE Transactions on Systems, Man and Cybernetics, Sept. 1973

A Reply to Review of

"A Generalized Simulation Approach to Agricultural Sector Analysis With Special Reference to Nigeria,"

Richard de Neufville, SMC Transactions, March 1973.

On behalf of the team at Michigan State University responsible for this study I would like to thank Professor de Neufville for his thoughtful and useful review. I would also like to take this opportunity to discuss several points raised in the review and to mention some recent developments related to the study.

It will help put the study in proper perspective to say that the total effort including modeling and applications involved about 10 man-years and approximately $350,000 (not 30 man-years). However, this study was able to draw upon an intensive 30 man-year study into problems and processes of Nigerian rural development carried out previously by the Consortium for the Study of Nigerian Rural Development (CSNRD). Though much of this work was not useful in model development, some of it was very valuable in providing estimates for model parameters and, perhaps more importantly, in providing insights into the kinds of policy questions likely to be important enough to explore in detail in a simulation model.

With respect to the range of policy questions addressed by the model, a total of 22 distinct investment variables are available as control or policy inputs (in general these introduce new technology into the production of key food and export commodities). In addition, approximately 20 controls are available which determine regulatory variables such as commodity prices, tax rates and production input subsidies. By allocating public resources in different combinations to the 22 investments and giving alternative values to the regulatory variables (22 such combinations were run and reported

to illustrate how the model may be applied), the user of the model can address hundreds of nontrivial policy questions. These include "how much should be invested?" "where should it be invested?" (with respect to commodities and regions within the country), "when should it be invested?" and "what are the effects of alternative regulatory policies upon the attainment of a range of development goals?" It should be noted that, while the objective of the project was to explore the feasibility of developing and using simulation models as aids in planning agricultural sector development, model results have entered the policy formulation process in Nigeria. It should also be noted that the approach taken and some of the simulation components used in the Nigerian study have been applied in constructing models in the Republic of Korea and in Venezuela which are providing inputs to the decision making processes.

Professor de Neufville raises the important question of the allocation of analytical resources in a large-scale system study. The point is well taken that all eggs do not belong in one large "global simulation basket." Smaller--more specific analyses can provide insights into areas which need more detailed attention and can, in themselves, answer certain kinds of planning and management questions. In the case at hand, the prior CSNRD study did much of this kind of analysis and identified important policy questions which needed further study, including analysis of important interactions among policies and goals. The Nigerian simulation model was an attempt to "put it all together" and study a set of relevant policy questions in a complex interactive system. This is not to say that such a model stands alone as a tool for decision making in this context. We are convinced, too, that a stable of models and analytical tools is needed to

address the range of important questions that exist at different levels of the decision-making hierarchy; in different regions of a country; in different industries; in different phases of public development activities (planning, management, project design, and project implementation); etc.

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A Generalised Simulation Approach to Agricultural Sector Analysis with Special Reference to Nigeria. By T. J. MANETSCH *et al.* (East Lansing, Michigan: Michigan State University, 1971. Pp. xvii + 362.)

THIS volume reports on the efforts of a team of ten, including agricultural economists, system scientists, computer programmers and a political scientist, to build a model of the Nigerian economy with the express purpose of using it to trace the impact of different agricultural policies, such as increasing the prices paid by marketing boards to producers of exported crops and the adoption of various modernisation programmes aimed at improving agricultural productivity, on G.D.P., foreign exchange earnings, output from other sectors of the economy, etc. The model used is made up of three sub-models: (i) a Northern livestock and annual crop model, (ii) a Southern perennial-annual crop model and (iii) a model of the national economy. Within each region four different cropping zones are identified and for each of these zones an attempt is made to predict the allocation of land to different crops, the input-output characteristics of which are affected by the discovery, promotion and acceptance of new techniques and materials. Similar production relationships are developed for beef and milk in a separate component of the Northern model. These predictions are in turn used to determine levels of income, taxation, expenditures on inputs and consumer goods, etc., for the agricultural sector. Interactions with other sectors are traced through an input–output table and this is a modification which helps to close a serious gap in an earlier version of the study.

For the most part the behavioural relationships used are crude. A typical example is to produce a figure for the amount of land used for cash crops along the following lines: decide on how much land someone can cultivate, adjust this by a "mechanisation coefficient," take away the amount of land required for the cultivator's subsistence and multiply the result by (i) the available labour force adjusted by a factor to isolate those who are interested in producing cash crops (a factor which approaches 1 at a rate depending on "existing conditions . . . or other variables such as extension programs") and (ii) a profitability coefficient adjusted by "parameters that determine the magnitude of response to profitability." It is especially disappointing to see much the same kind of analysis used even where better techniques and theory are available and when so much promise is held out for the analytical flexibility of the simulation approach to mathematical modelling. This applies to the explanations offered for the allocation of land to different cash crops and for the price level of marketed foods.

The authors claim that their approach to simulation is a general one on the grounds that specialised techniques like mathematical programming, input–output analysis, cost-benefit analysis, etc., may be used wherever they are found helpful while information on how things work in practice need not be confined to the kind of results that might be ideally sought by econometric analysis. However, most models built specifically for the purposes of simulation have tended to be unrestrained so far as techniques of analysis are concerned. The real issue is surely rather one of how far are the simulators in development economics prepared to go without theory and without substantial evidence to support their functional relationships, theoretical or otherwise? The impression given by this study is one of

preoccupation with the need to provide answers to questions of policy to the point of using whatever information and relationships can be found, however rough and ready they may be. This is an approach to simulation which therefore contrasts sharply with that found in applied econometrics where explanation and verification remain all-important.

The authors do what they can to test the consistency of their model and the accuracy of its predictions, but it is difficult enough to detect error, let alone trace its source, given the available data. The task of obtaining long-term forecasts for a developing economy presents its own problems of course and the results of sensitivity tests on some of the parameters used are presented. However, it appears that the authors pin most of their hopes of solving policy problems on some sort of a learning process in which one proceeds from the definition of a problem to the formulation, simulation, verification, refinement and application of a model in a way which often involves repeating earlier stages given "information acquired during a subsequent stage." Interactions with those responsible for policy are seen to be an important part of this process. To the extent that views are expressed on the desirability of predicted outcomes and new experiments are suggested, this kind of interaction has also been seen as a means of avoiding the problem of specifying the social welfare function of policy-makers. It is a pity that the authors found Nigerian civil servants too busy with the problems of the civil war and the aftermath for it to have been prudent to explore their ideas in practice. Thus we are denied the proof of the pudding.

R. F. WYNN

University of Liverpool.