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Summary of Objectives, Activities and Accomplishments of the Agricultural Sector Analysis and Simulation Program, 1967-1979

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Michael H. Abkin
Tom W. Carroll
Glenn L. Johnson
Thomas J. Manetsch
George E. Rossmiller

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Department of
Agricultural Economics
MICHIGAN STATE
UNIVERSITY
East Lansing

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Introduction

This report summarizes the objectives, activities and accomplishments to date of the Agricultural Sector Analysis and Simulation Program of the Michigan State University Department of Agricultural Economics. This Program has evolved under a succession of contracted projects as summarized in Table A.1 and Figure A.1 of Appendix A. A more comprehensive exposition and assessment of the Agricultural Sector Analysis and Simulation Program's philosophy, methodology and Korean experience is given in [3].

A central focus of the Program is development and application of the general system simulation approach to agricultural sector planning and policy analysis. The basic tenets of this approach are summarized in the next section, followed by a brief chronology of the genesis of the Program leading up to its field activities in Korea. The Korean experience and its accomplishments are then outlined with respect to the agricultural sector study, the simulation model development activities, applications to policy analysis, on-campus and on-the-job training, and institutionalization of the models and the approach in Korea. Next, the report briefly describes the Program's software library as a vehicle for preserving and maintaining, as capital stock, generalized simulation models and components. Finally, the report concludes with brief mention of on-going activities and some potential areas for future involvement. The appendices present a list of principal personnel associated with the Program over the past 10 years, a selected bibliography of publications of the Program, and a list of current holdings and documents of the software library.

The General System Simulation Approach

Briefly, the general system simulation approach can be viewed as a broad and flexible means of enhancing an investigative capacity for decision making. The core ingredients of the approach consist of sets of logical frameworks, or models,

both formal and informal, designed to provide information useful in solving sets of interrelated problems within a given subject matter context. Developed in a building block or modular format, the components and models are adaptable and flexible enough that, through innovative combination and use, they can provide information required for the solution of specific problems. The generality of the approach derives from the eclecticism of its philosophic orientation, its use of modeling techniques, the sources and kinds of data and information it employs, and the dimensions of the subject matter it addresses--most importantly time and space.

It makes use of both normative and positive information in (1) analyzing the consequences of alternative courses of action, (2) determining appropriate decision rules to use in prescribing actions for problem solution, and (3) prescribing problem solutions. The approach takes a systematic view in modeling the domain of a problem or the domain of the common parts of problems in a set. It provides for evolutionary adaptation and extension of the models to represent the changing reality they are designed to reflect.

The approach requires that the models be integrated through interaction with administrators, decision makers, and affected people, as part of the problem-solving, decision-making process. It also requires linking and integration with supporting services, such as research institutions, data and information acquisition systems, computer installations, and institutional sources of trained personnel.

Program Genesis

The Agricultural Sector Analysis and Simulation Program began in the mid-1960s when researchers on the Consortium for the Study of Nigerian Rural Development (CSNRD) project considered whether computer modeling techniques might be useful in their Nigerian agricultural sector analysis work by removing some of the drudgery of traditional paper and pencil hand calculations and thereby

allowing them more time to do more and better analysis [1].* They concluded that the CSNRD project was too far along at that time to begin experimentation with approaches and techniques still new and unproven in the socioeconomic arena.

However, upon completion of the CSNRD project in 1968, a new contract was negotiated with the Agency for International Development (Contract AID/csd-1557) to develop and explore the feasibility of a general system simulation approach to agricultural sector planning and policy analysis. Since a wealth of information and expertise on Nigeria had been compiled at MSU in the course of the CSNRD project, it was decided to develop a system simulation model of the agricultural sector of Nigeria, with linkages to the rest of the economy, to serve as a prototype for development of the approach [2]. There was no contractual obligation nor even intention that the model actually be useful to Nigerian policy makers. Nevertheless, in collaboration with Nigerian analysts and officials of the Federal Ministry of Agriculture and Natural Resources, the model was used to make projections which contributed to preparation of a long-run, perspective plan for agriculture in Nigeria.**

On the basis of the positive conclusion from the Nigerian work, a second contract (AID/csd-2975) was negotiated calling for further development of the approach and the models; it also called for their institutionalization and use within the agricultural decision structure of one or more countries.

Under this new project, the MSU Agricultural Sector Analysis and Simulation Program's team began collaboration with the Republic of Korea's Agricultural Economics Research Institute (AERI), an agency of the Ministry of Agriculture and

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*Bracketed references, e.g. [1], may be found in Appendix C.

**Federal Ministry of Agriculture and Natural Resources, Joint Planning Committee. Agricultural Development in Nigeria, 1973-1985. Ibadan, Nigeria: Caxton Press (West Africa) Ltd., 1974.

Fisheries (MAF). The purpose of this collaboration was to develop an investigative capacity for collection and organization of data that would enable analysis and synthesis of agricultural development problems related to planning, policy formation, program development, and project design, implementation and evaluation in the Republic of Korea.

In addition to the field activities in Korea, the Program carried on three related lines of activity at Michigan State University. The first was implementation of the Development Analysis Study Program, a training activity designed to develop the special skills necessary for the modeling and analytical work under the general system simulation approach and workshops designed to improve the understanding of models and their uses by decision makers. The second was the Computer Library for Agricultural Systems Simulation, a library of generalized computer software routines, components and models to be used as capital stock for application in other locations or subject areas of inquiry. Third were the advances in theoretical and methodological research, primarily in economics and systems science, necessary to improve the system of concepts and models available for field application.

The Korean Experience

The Program's field projects in Korea included an initial agricultural sector study, the development of agricultural sector and grain subsector models, the application of these models to policy analysis in the Ministry of Agriculture and Fisheries, the training of Korean counterparts both at MSU and on the job in Korea, and advising on institutional requirements for continued maintenance, development and use of the models and the approach in Korea.

The Korean Agricultural Sector Study Project (KASS)

The Korean collaboration began in 1971 when the government of Korea, AID and MSU reached agreement that AID would finance a nine-month agricultural sector study:

1. to provide a sound analytical base from which MAF could make improved planning, programming and policy decisions for agricultural sector development; and

2. to provide the basis for an AID agricultural sector loan or agricultural project loans through identification of agricultural sector investment priorities.

In addition, the Korean Ministry of Agriculture and Fisheries was interested in the sector study not only as a basis for foreign assistance loans but also to assist in establishing its own investment priorities for budget requests to the Economic Planning Board and ultimately to the National Assembly.

The availability of software components from the Nigerian project that could be reassembled in ways applicable to Korean agriculture and the experience gained in that effort made it possible to assemble the necessary descriptive information about how the Korean agricultural sector was structured, operated and responded to policy alternatives and to project the consequences of following alternative development strategies over a 15-year planning period.

A comprehensive sector study report was completed in nine months [4]. It integrated the traditional pen, paper and desk calculator exercise with the generalized system simulation approach developed by MSU in Nigeria. In addition, a more detailed study of the three main investment priority areas--land and water resource development, agricultural input and product marketing, and agricultural research--was completed during the summer of 1972 [5]. A series of special reports focusing on specific components of Korea's agricultural sector was also published [6-13].

The sector study report, along with the investment priorities study, provided the basis for several major policy decisions by the Korean government and USAID/K. Among the more important were (1) major changes in the administrative structure of collecting and reporting agricultural statistics; (2) the negotiation of a $5 million, five-year agricultural research loan by AID to the Korean government for varietal research on five crop commodities; (3) the negotiation of a $17.2 million AID loan to the Korean government for completion of 66 small-scale irrigation projects; (4) the negotiation of an AID grant to the Korean government for technical assistance in the areas of policy analysis, agricultural outlook, program and project evaluation, and improvement of agricultural statistics under the Korean Agricultural Planning Project (discussed below); (5) the use of the KASS team and its models to provide baseline projections for the preliminary work on the agricultural portion of the Fourth Five-Year Economic Development Plan (discussed below); (6) a general upgrading of the stature and credibility of the Agricultural Economics Research Institute (later renamed the National Agricultural Economics Research Institute, NAERI); and (7) through the reports, a broader understanding by decision makers and staff within the Ministry of Agriculture and Fisheries and elsewhere in the Korean government of the resources available to agriculture, the constraints and limits on agricultural production, how the Korean agricultural sector operates within its economic environment, and the contributions made by Korean agriculture to the total economy.

Had the project ended at this point, it would have been successful by traditional standards of measuring the output and impact of a sector analysis of this kind. However, the first year set the stage for continued intensive work in Korea on the further development of the system simulation models of the agricultural sector and grains subsector, as well as the building of an analytical capacity to surround the models and the institutionalization of that capacity into the governmental decision-making process.

Simulation Model Development

A key element of the general system simulation approach is its conviction that a comprehensive, systematic approach to the decision-making process--including the integration of informal mental and verbal models with, to the extent feasible and appropriate, formal mathematical system simulation models--can significantly improve the quality of public policy. This conviction was borne out in the sector study experience and impacts described above to the extent that the Korean MAF made the commitment to continue the KASS project with MSU--under Contract 2975 until its termination in 1976, and then under Contract AID/ta-C-1322 (to maintain a MSU simulation advisor at NAERI until Korean staff would return from training) through 1977--in order to further develop and use the preliminary model begun for the initial sector study. This commitment also included the assignment of NAERI and other MAF staff to training in systems science and the development and application of simulation models to agricultural policy analysis.

From 1971 to 1974 the major modeling efforts in Korea were directed at developing, testing, modifying, and finally attaining a working set of simulation models. Before questions of institutionalization and use could be seriously raised with Korean decision makers, it had to be proven that models useful to them could, in fact, be developed. This approach to sector analysis was as yet untried from the standpoint of operational usage of a complete, generalized sector model and relevant submodels. In 1974, when a working model had been attained, KASS shifted emphasis to model institutionalization and use. The attainment of a working model also allowed development of model components to tie into and complement the sector model as specific needs were assessed through interaction among KASS personnel and MAF decision makers. To successfully affect such a shift in Korea very likely would have been impossible, however, without the

development of the Korean Agricultural Planning Project (KAPP), as described below.

Korean Agricultural Sector Model

Development of the sector model progressed in the direction of a system of models, together called the Korean Agricultural Sector Model (KASM). Each of the five component models of the KASM system [18-23] covers a principal element of medium-run to long-run agricultural sector analysis. These components are:

1. population and migration--incorporating time-varying age-sex distributions of farm and nonfarm populations and migration between them;
2. crop technology change--including (a) improvements in the quality and quantity of the land base through public investment in land and water development projects, and (b) research, extension and farmer adoption of improved crop varieties and inputs;
3. farm resource allocation and production--where available on-farm land, labor and capital resources are allocated to the production of various crop and livestock commodities;
4. demand-price-foreign trade--determining farm and nonfarm food and nonfood consumption, producer and consumer prices, and foreign trade in agricultural commodities; and
5. national economy--incorporating the important feedback linkages between agriculture and the rest of the economy.

These models interact with one another as components of an integrated system and may be used as such for comprehensive sector analyses. Alternatively, KASM is programmed so that each model may be used independently of the others, or in various combinations, for more narrowly focused, subsector analyses.

Korean Grain Subsector Models

The grain subsector in particular was, and remains, an important and politically sensitive area of government policy in Korea. The government's grain management program buys, imports, stores and markets rice and barley at subsidized prices, and has also subsidized wheat flour prices, in order to support farm income, stabilize consumer prices, encourage grain production, and reduce

import requirements. This program has been a costly one, contributing significantly to government budget deficits and, hence, inflationary pressures.

The KASS team contributed to improving grains policy analysis with the development of a grain management program model (GMP) [24]. The GMP applies feedback control theory to model in detail the day-to-day operation of the grain system from farm and seaport to consumer, including the farm, private market, government market and urban household sectors. The model may be used to explore the likely impacts of alternative policy scenarios on such key variables as grain stocks, prices, consumption, imports and foreign exchange costs, farm income, and government grain management accounts. Alternatively, it may be used as an on-line control tool to prescribe government purchases and releases over time in order to achieve targeted price patterns.

A spin-off of the GMP was the annual grain price policy analyzer (AGPPA). This simple, static model was designed for analysis of the semi-annual government purchase price decisions--rice in the fall and barley in the spring. It consists of two linear, three-commodity demand systems--one each for farm and nonfarm consumption of rice, barley and wheat--along with equations relating average farm and urban prices to assumed government purchase and release prices and equations accounting for income, import and foreign exchange requirements, and government grain management program costs.

The Planning Project

In the summer of 1972, shortly after MAF had given approval for further adaptation and development of the KASS models, MAF and AID began discussions about assistance in establishing a modern planning system (including institutionalization of the KASS models) to provide more timely and useful analysis for solving problems in the agricultural sector.

The resulting project, named the Korean Agricultural Planning Project (KAPP), began in 1974 as one of the three interrelated components of the MAF/AID Agricultural Planning Project. These components were:

1. the ongoing MSU/Korean Agricultural Sector Study Project (KASS), which was responsible for developing and helping to institutionalize the agricultural sector and subsector models;
2. the new Korean Agricultural Planning Project (KAPP); and
3. a training component to educate Koreans in model development and in the disciplines required for effectively using a modern planning system.

The main objective of KAPP was "to increase the capacity of the Ministry of Agriculture and Fisheries and through it the government of the Republic of Korea for sound planning, agricultural policy formulation, program development, and project design and execution toward more rapid and effective development of the agricultural sector." The final project design called for a team of four specialists to work with appropriate agencies of MAF in the areas of (1) policy analysis, (2) agricultural outlook, (3) program and project analysis, and (4) agricultural statistics.

KASS was designed to be developed into an analytical support unit for MAF with the capability of using large and complex computerized models for analysis of Korean agricultural development problems. KAPP, on the other hand, was designed, in part, to help introduce the use of KASS models into the decision making structure of MAF and to help MAF decision makers identify, interpret and analyze their policy problems. KAPP personnel, together with Korean decision makers, worked with the KASS team on applications of the models and the development of new model components that would contribute to policy needs and also supplied data for the models. They helped KASS in understanding priority policy and development questions of concern to MAF. Thus, KAPP provided the interim linkage between KASS and the decision makers that was crucial to the effectiveness of the investigative unit. To ensure that the survival of the

investigative capacity being built in Korea would not depend upon MSU or AID remaining within the structure, MSU and AID activities were designed to be supportive of and integrated with, but not replacements for, the indigenous institutional structure.

KASS/KAPP Policy Analyses

Although it may never be possible to trace all of the impacts which the KASS/KAPP activities may have had and may yet have on policy-making processes and substantive policy in Korea, there are certain policy analysis accomplishments which can be identified. These are enumerated below.

1. Population Projections

In early discussion of MAF's Fourth Five-Year Plan, a decision had to be made to use population projections of the MAF Statistics Bureau or of KASM, or for the Ministry to generate other projections. After due consideration and a discussion at a seminar attended by representatives of all the bureaus and non-Ministry advisors, the KASM projections were chosen. The rationale was that the underlying theory and assumptions of KASM more closely resembled reality than did those of other available projections and would be better than any others that could be produced on short notice by the Ministry.

Accepting these projections essentially meant that farm and nonfarm food consumption projections in the plan would be based on KASM population projections. Further, farm labor force estimates from the model would underlie planning for mechanization and wage rates in the farm sector.

2. Livestock Planning

The overriding livestock policy objective defined by MAF was to reduce imports of feed grains as a way of conserving scarce foreign exchange. Subsidiary and conflicting objectives were to meet consumer demands for livestock and

poultry products and to do so without undue increases in consumer prices. Additional information was sought on the specific effects of alternative techniques for restraining growth--taxes on imported feed stuffs, taxes on livestock per se, or other disincentives.

Interchange between decision makers in the Livestock Bureau and KASM analysts and modelers defined and clarified the objectives and alternative assumptions needed for the analysis and identified the data needed on input-output coefficients and prices. The exchange was beneficial to both modelers and decision makers: data requirements and constraining growth assumptions of the modeling effort forced Ministry planners to rethink programs for feasibility and consistency and forced the model to be adapted to meet policy needs more realistically. An additional bonus for all future analysis was the opportunity to improve and update the model's data and structural assumptions.

Although the initial request from the Ministry was for only one set of projections, further discussion led to the inclusion of several alternatives. The alternatives thus analyzed and refined by discussions with the Livestock Bureau were combined with information from other sources to form the basis for livestock policy decisions in the Fourth Five-Year Plan.

3. Land and Water Development: Long-Range Planning

KASS/KAPP analysts cooperated with planners at Korea's Agricultural Development Corporation (ADC) to evaluate various alternatives for the future development of land and water resources over a 25-year planning horizon [68,69]. Since KASM's technology change component was not yet operational at that time, ADC economists developed a polyperiod linear programming model to select a mix of land-base development projects with the objective of maximizing total production of food grains over the 1977-2001 period, subject to investment and other constraints. Output from the LP model was used to modify the basic exogenous

assumptions on yields, changes in paddy and upland, and double-crop ratios within KASM. Output from KASM was used to compare and analyze alternative land-base development strategies with respect to impacts on self-sufficiency in food grains, farm income, nutrition levels, cropping patterns, and trade balances. This application and the one described below illustrate the flexibility with which KASM can be linked to other formal and informal models to handle specific long-range planning exercises.

4. Food Processing, Marketing and Distribution

The basis for sound planning to meet anticipated future demands on the marketing and processing system is projection, over some planning horizon, of the likely increases in the flows of agricultural commodities through marketing channels and processing facilities. Such projections must be based on a consistent set of assumptions which will determine the level and mix of demand for, and the production and supply of, agricultural commodities. That is, domestic production plus imports must fulfill domestic requirements plus export demands.

This analysis [83], conducted in cooperation with the Marketing Division of MAF, began by using KASM to make a consistent set of projections of demand, supply, prices, imports/exports, population, and income for Korea for the period 1975/85 under reasonable grains price and other policy assumptions. These basic projections were then used as input to paper and pencil projections, to 1985, of commodity-specific capacity and investment requirements for storage, transportation, market facilities and processing facilities. In addition, this exercise pointed the way to additional, more detailed analyses to be done by MAF in formulating a long-range food marketing plan.

5. Grains Policy

In the late 1960s and early 1970s Korea placed heavy emphasis on reducing its dependence on foreign sources for its major food grain needs (primarily rice, barley and wheat). Rice was (and remains) by far the most important staple food in Korea, the per capita consumption of rice alone consistently being at least 30 percent greater than that of barley and wheat combined and accounting for about 45 percent of the total daily calorie intake of the population. Because of this, and because the price Korea had to pay for imported rice was running on the order of twice that of wheat or barley, major efforts were placed on achieving self-sufficiency in rice and, to a lesser extent, barley. Wheat production in Korea was relatively small and declining during that period, with little potential for significant increases, so wheat was not included in the self-sufficiency targets.

The rice and barley self-sufficiency goals were pursued in Korea by a mixture of production and consumption policies. On the production side, paddy land improvement projects were carried out, not only to improve the productivity of land for rice production, but also to expand the acreage of potential double-crop land for winter barley (and wheat); a succession of higher yielding varieties was introduced and extended; fertilizer was subsidized; restrictions were placed on non-rice use of paddy land; and rice and barley farm prices were supported by government subsidy. On the demand side, barley and wheat consumption were encouraged over rice through a package of consumer price subsidies, banning rice in public eating places two days a week, requiring the serving of a mixture of rice and barley in restaurants and school lunches, releasing government-held grain only in mixed form, prohibiting the use of rice in alcoholic beverages, and reducing the milling rate of rice.

These efforts proved successful. Since 1976 Korea has been essentially self-sufficient in rice and barley, except for the barley crop failure due to bad weather

in 1977. In fact, the concern was shifting to rice surpluses and to encouraging more wheat production in competition with barley, an inferior good. Thus, by 1978 the government had removed all the quantity controls on rice consumption and established a wheat research institute to improve the biological and technical potential for domestic wheat production.

The KASS and KAPP teams contributed to analytical support for these policy shifts on several specific occasions and, indeed, on a continuous basis through daily contact and informal discussions with counterparts and other MAF officials. While one may never be able to identify direct or indirect impacts these involvements may have had on actual policy decisions, two of them are summarized here for illustrative purposes.

a. The Grains Policy Task Force. Beginning in 1974, an interministerial task force was formed, including KASS/KAPP analysts, to advise and recommend on government actions to get through the short-term dislocations caused by dwindling government rice stocks and skyrocketing world grain prices. The task force idea was relatively new in the Korean context; however, this first experience encouraged continuation of the task force for purposes of analyzing and making recommendations for the government's semi-annual rice and barley purchase price decisions [70-73].

For these annual purchase price analyses, the annual grains price policy analyzer (AGPPA) was developed as a simplified spin-off of the grain management program model (GMP). NAERI's experience with AGPPA illustrates the point that even simple, quantitative structures can be useful as tools for partial analysis.

AGPPA is a very simple, static model to be used to analyze annual government grains pricing decisions. Korean analysts at NAERI, with very little assistance from MSU personnel, used AGPPA on several occasions at the request of the MAF Food Bureau to analyze rice and barley government purchase price

options. Based on the first of these experiences, they concluded that AGPPA was too simple and identified a number of ways in which it could be modified to improve its analytical power. Some of these were researched and included in AGPPA for later analyses.

There are lessons to be learned from this experience concerning the advantages of model simplicity--from the point of view of encouraging counterparts to study and use the models and, thereby, of providing opportunities for them to further develop the models in ways they themselves see as necessary to increase the models' usefulness.

Another important result of the Grains Policy Task Force experiences was the realization on the part of MAF decision makers that grains pricing decisions, indeed all their food management decisions, could not be made satisfactorily on a commodity-by-commodity basis. The interactions among the grain commodities, both in production and consumption, require broader analyses and policy orientations. This realization resulted in a major change in the process of setting grains policy.

b. Rice Price and Consumption Policy. With the recent attainment of rice self-sufficiency, indeed surpluses, Korean government officials became aware of the problems of rice storage and the need for reorientation of the restrictive consumption policy. At domestic prices double the world price, rice exports could only come at the cost of substantial government subsidies. With this in mind, the Korean Agricultural Sector Model (KASM) was used to make projections of four alternative rice consumption policy assumptions. Specifically, since the focus of the analysis was on only one commodity and on only the consumption of that commodity, only the DEMAND model of KASM was used for this partial analysis. Exogenous population and commodity-specific production projections were made consistent with targets of Korea's Fourth Five-Year Development Plan. In spite of

this limited scope, the use of DEMAND nevertheless enabled the analysis to consider cross-effects of rice policy on other commodities and the consequent feedback effects on rice.

The four policy alternatives considered included (1) a continuation of present policies; (2) a partial phasing out of the rice consumption restrictions; (3) alternative 2 plus allowing the price to be market determined by demand and supply conditions; and (4) alternative 3 plus increasing desired rice stocks for emergency reserves and completely phasing out the consumption restrictions. The simulation results showed alternative 3 to hold the most promise for reducing rice surpluses and stock requirements and increasing consumption. However, the concomitant reduction in prices would not be consistent with the government's use of the rice price as an income transfer mechanism for Korean farmers.

Although we cannot say how much, if any, influence these and other analyses may have had on eventual decisions, Korea has since completely removed the rice consumption restrictions, is searching for alternative means of supporting farm income, and is even considering ways to relax restrictions on the use of paddy land for other than rice production.

Training

The development and application of models at the project, subsector, and sector levels in developing countries involve a number of essential functions that must all be carried out effectively in order for the models to contribute usefully to agricultural sector development. These functions include:

1. Data acquisition, storage and updating
2. Model development
3. Estimation of model parameters
4. Model testing
5. Use of models in decision and analysis
6. Model refinement and updating
7. Model documentation

Experience has shown that carrying out these functions effectively requires not only the integration of many disciplines but also unique kinds of people who perform well as members of multidisciplinary teams. Team members which are required include agriculturalists, computer programmers, and statisticians at various levels of disciplinary competence and experience.

A variety of educational programs must be available that will provide various levels of preparation for specialists from many fields. Many of these needs can be satisfied by flexible degree programs at the bachelor's, master's and doctoral levels. It is also clear 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 quantitative sector analysis team, given well-designed short courses or training programs in key areas.

A case in point is special short-term training for decision makers and administrators. Such training, in the form of short courses or workshop-seminars, can be offered directly in the developing countries. This was done to a limited extent during the course of the Korean projects. A week-long seminar was held in the summer of 1973 for government officials from the Ministry of Agriculture, staff from the College of Agriculture at Seoul National University, and a smattering of personnel from other governmental agencies. Although the event was generally regarded as successful in introducing the system simulation approach and its capabilities, lessons were learned that can lead to improvement in the quality of such an experience:

1. More time is needed for such a seminar--two weeks is probably a minimum.

2. More needs to be said about the practical applications of a wider range of quantitative methods (benefit/cost analysis, linear programming, perhaps PERT, etc.).

3. More "hands on" experience in the use of quantitative methods in decision making is needed.

4. A revised format is needed that eases the problem of busy people being called away by the demands of their jobs.

There is also a need for longer-term non-degree training for economists, researchers and certain other professionals who need a more in-depth understanding of the system simulation approach and related techniques. Such people usually work closely with, if not as a part of, a system simulation team. As part of the Korean projects, a one-year non-degree training program--the Development Analysis Study Program--was designed to address these needs. This program was offered three successive years at Michigan State University--primarily for Korean agricultural economists associated with the MSU Korean project but also including both U.S. students and students from other countries. The program included basic courses in systems science and computer science and allowed participants to select a range of courses needed to enhance quantitative skills and broaden their background for work as part of a multidisciplinary team. The program also included a relatively intensive emphasis on practical projects that applied the methods learned.

A final, key element in the projects' training activities derived from the day-to-day model development work with Korean counterparts in an on-the-job training mode. Included here were special seminars and tutorial sessions held on the structure of the models and how to run them. In addition, experience was gained in the process of collaboration on applications of the models to policy analysis.

In sum, seven NAERI and MAF staff members and two Korean university faculty members went through MSU's Development Analysis Study Program. Of these, two received M.S. degrees in systems science, one a Ph.D. degree in systems science, and two M.S. degrees in agricultural economics. The remainder, who already held post-graduate degrees in agricultural economics, were in non-degree programs.

In addition, three other Korean researchers with advanced degrees in agricultural economics from other institutions (one Ph.D. and two M.S.) were working as part of NAERI's KASS team.

Therefore, at the time of the MSU projects' termination in Korea at the end of 1977, NAERI had a core staff with the potential to maintain, build upon and use the analytical capability developed over the previous six years. However, there was a real possibility, arising from institutional considerations, that NAERI would not be able to realize that potential. The projects' institutionalization efforts are discussed below.

Institutionalization

From their beginning, the Agricultural Sector Analysis and Simulation Program's field activities in Korea had as a major objective the institutionalization of the general system simulation approach within the indigenous capacity for public decision making related to agricultural sector development. In this context, "institutionalization" referred to building an institutional infrastructure to support continued development, maintenance and utilization of the approach and its models. This infrastructure was seen as encompassing the issues of institutional linkages, manpower, and data acquisition.

Following the completion of the initial sector study in the summer of 1972, attention of the KASS team turned mainly to model development until spring 1974. During this period some efforts were made to strengthen linkages with relevant indigenous institutions, and interactions with decision makers on model conceptualization took place, but major institutionalization questions were not addressed to any significant degree. Two changes, however, took place in December 1973 that improved the internal organizational environment of the KASS team. First, the Agricultural Economics Research Institute was reorganized into the National Agricultural Economics Research Institute (NAERI). This change in name

recognized the broader role being carried out by NAERI after its removal from the Office of Rural Development in 1970 and its increasing involvement in the planning and policy analysis functions in MAF. Second, during this reorganization a new division, the Agricultural Sector Analysis Division, was created in NAERI with responsibility for carrying out the KASS team activities. Thus, the KASS activity was upgraded in status to a permanent division from its earlier temporary existence as a task force.

Furthermore, concentrated efforts by KASS and KAPP personnel strengthened the crucial linkages with other Korean governmental and nongovernmental institutions. Informal working relationships with action agencies in MAF and other government units, research institutes and universities were improved and extended through the establishment of problem-oriented task forces. Examples include the grain policy task force discussed above and a task force constituted to provide MAF with analysis and input into the development of the Fourth Five-Year Economic Development Plan.

Perhaps one of the most difficult problems was the location, both within the MAF organization and physically, of NAERI and its KASS analytical unit. NAERI, as an institute of the Ministry of Agriculture and Fisheries, was not considered a part of MAF proper. This reduced its direct role with MAF action agencies in providing analytical input into the decision-making process. Furthermore, it was physically located outside of the ministry building, which also tended to add to its isolation.

In addition, a critical manpower problem, one which was largely beyond NAERI's power to deal with, stemmed from NAERI's institutional position as a government agency, its staff being in the civil service system and thus subject to regular government pay scales. NAERI could not compete for highly trained professionals with universities, private industry and autonomous research

institutes, where salaries were generally two to three times civil service levels and where there were greater opportunities for advancement. Therefore, NAERI had difficulty retaining staff members who returned from training and was limited in the recruitment of new members to recent graduates with little or no experience.

In spring 1975 the opportunity arose through AID auspices to brief the deputy prime minister (who was also minister of the Economic Planning Board) and the minister of agriculture and fisheries on progress in model development and use, future potentials of the models in helping decision makers, and problems of institutionalizing the models and breaking the government salary barriers in order to attract and hold qualified scientists. In addition, a seminar was held for senior MAF officials on the use and development of the models. This seminar stressed that successful institutionalization of the NAERI/KASS activity (i.e., the general system simulation approach) would depend on NAERI and MAF decision makers working together so closely that the models would eventually belong more to the rest of MAF than to NAERI.

Again, in the spring of 1977, MAF and KAPP sponsored an Agricultural Development Policy Seminar, which brought together participants from MAF, universities, NAERI and other ministries to discuss and debate emerging issues in food and agriculture in Korea. Included was a session on the KASS/KAPP methodological approaches to policy analysis. Numerous opportunities arose throughout the seminar to discuss the practical usefulness of the KASS models for policy analysis and to increase understanding of them. As a result, there was broader interest at MAF in continued maintenance and utilization of the models.

These briefings and seminars generated a great deal of interest and discussion at the highest levels of the Korean government on the future of NAERI and its KASS models. However, a difference of opinion developed. One group felt that NAERI should be incorporated into the Korean Development Institute (KDI), which

carries out long-term economic and social research and policy analysis for the government of Korea. This merger would utilize research resources more effectively through joint use of facilities and research materials and through better coordination among sectoral economists. This would also solve the salary problem, since KDI is authorized to pay salaries competitive with, or higher than, university salaries. A second group, which included most of the agriculturalists, felt that successful short-term economic and policy analysis of agricultural problems requires close interaction between the analysts and the decision makers in MAF and ready access to data would be seriously curtailed if NAERI were a part of KDI and thus more remote from MAF. There also would be a tendency for KDI-NAERI to emphasize long-term research at the expense of the short-term analyses needed by MAF decision makers.

The issue was resolved in 1978, after the MSU team's departure, when a new MAF minister made the decision to abolish NAERI and replace it with a new institute, the Korea Rural Economics Institute (KREI). KREI was specifically created to overcome the budget and manpower problems discussed above. Although largely government funded, it is formally a nongovernmental organization. Thus free from civil service regulations, KREI is empowered to offer salaries and fringe benefits competitive with private industry and universities to attract an experienced, Ph.D.-level staff. Furthermore, through its staff and Board of Directors, close working relationships are maintained with government and other users of its research and analysis output.

Korean Conclusions

It is unfortunate that the main perspective of the Korean projects tended to center on the KASS models. The written objectives of the MSU-AID contract focused on model development, testing and application. The attention of interested people, both inside and outside of Korea, tended to focus on the models.

Project staff tended to emphasize the models in their discussions. Admittedly, the models were an important component of the project. However, when viewed from an institution-building perspective, the truly critical aspect was the development of the investigative unit with a cadre of trained personnel capable of using, adapting and further developing the models as a tool in analyzing a wide variety of planning and policy problems. The most complex and challenging dimension of this process was the institutionalization of the investigative unit into the decision making structure, with appropriate linkages to decision makers and to support and service agencies.

Project staff were often asked: "When will the job in Korea be finished?" "When will the model be completed?" "When will you finish the final report and wind up the operation?" The answer to all these questions was, "If we are successful, never." Once the KASS investigative unit is fully institutionalized into the decision structure, it must continue to be relevant and useful to decision makers to remain an effective part of that institutional structure. It must continually adapt, update and develop its analytical tools and models as the agricultural systems they represent change. It must continue to adjust its abilities to accommodate itself to the changing nature of the problems confronting the decision makers. Thus, the job is never completed and a "final report" was not an objective.

The Software Library

From the beginning with the Nigerian simulation project, the Agricultural Sector Analysis and Simulation Program recognized the potential advantages of viewing simulation models and components as capital stock which could be augmented and modified through investment and maintenance (model development) activities and which could provide a flow of analytical services. That is, the structure of components and models, as distinct from the data on initial conditions

and parameter values, can be generalized and transferred to systems and applications other than those for which they were originally designed. For example, a distributed delay demographic cohort-survival model can represent, with appropriate reinterpretation of variables, populations of people, animals, trees or machines. Similarly, a generalized demand model can be used to simulate consumer behavior in Nigeria, Korea or the U.S.

Therefore, a campus-based activity of the Program under Contract 2975 was the design and establishment of the Computer Library for Agricultural Systems Simulation (CLASS). In order to insure the compatibility and transferability of its models, CLASS has established standards for (1) the inclusion and dissemination of software in the library, (2) computer programs, and (3) model documentation. Currently included in CLASS are software and associated documentations (Appendix D) ranging from simple table look-up routines to a parameter estimation package and a beef enterprise model.

Current and Prospective Activities

Building upon these Nigerian and Korean experiences, ongoing and prospective activities of the Agricultural Sector Analysis and Simulation Program are directed towards transferring, adapting and applying the general system simulation approach and, where appropriate, models to other countries and contexts.

The former Foreign Demand and Competition Division (FDCD) of the Economics, Statistics and Cooperatives Service (ESCS) of the USDA was conducting a series of country market studies, including the construction of models which FDCD could use on a continuing basis to update these analyses of U.S. trade prospects with various countries. Under a cooperative research agreement (No. 12-17-05-8-2199-X) between FDCD and MSU, the Korean agricultural sector model was adapted for purposes of USDA Korea market studies. Two of the five KASM components--resource allocation and production, and demand-price-foreign

trade--were modified and used, with inputs from the others treated exogenously. In addition, the commodity disaggregations were redefined to emphasize those of major interest to USDA analysts--rice, barley, wheat, corn, soybeans, fats and oils, and livestock products. This revised model was documented and transferred to the USDA computer in Washington.

For several years, the ESCS has been developing a system of simulation model components for long-run projections of the U.S. agricultural sector performance in the aggregate and with commodity and regional disaggregations. This system is called NIRAP--National Interregional Agricultural Projections. Initially, the NIRAP components were developed and run independently of one another, linkage being effected "off line." More recently, an effort has been underway to link them formally on the computer to step dynamically through time. The Agricultural Sector Analysis and Simulation Program is participating in this effort through another USDA-MSU cooperative research agreement (No. 58-319-W-8-2464-X).

In an international dimension, the Food and Agriculture Program of the International Institute for Applied Systems Analysis (IIASA) in Austria is developing a system of national-level simulation models representing 80 percent of the world's population, food production and food trade. These models are linked in a general equilibrium, world trade framework in order to examine the long-run impacts of national-level food and agriculture policies--domestic as well as aid and trade--on the distribution of food and hunger in the world and on the course of development in the LDCs. MSU is developing a preliminary, aggregate model of the U.S. food and agriculture system to link with IIASA's global system. Collaboration with USDA will be essential for the design and construction of a more detailed, policy-oriented U.S. model which will not only be linkable to IIASA's system but, more importantly, will also be relevant and useful for other USDA policy analysis purposes.

In another area, the Latin American Planning Network project is an AID-funded cooperative effort of the Costa Rica-based Inter-American Institute of Agricultural Sciences (IICA), Iowa State University and Michigan State University. The primary focus of this project is to (1) identify a potential role for IICA in assisting countries of Latin America and the Caribbean to improve their systems of agricultural planning and policy analysis, and (2) develop IICA's capacity to carry out that role. During 1978 and 1979, surveys, in-depth studies, and a series of conferences were carried out in the region to assess the present status of, and needs with respect to, agricultural planning, policy analysis, and decision making in the region in order to identify priority areas where IICA could make a contribution. The Agricultural Sector Analysis and Simulation Program is now working with IICA and Iowa State University to design training programs which IICA can conduct in this area and to develop training materials for those programs.

In sum, we anticipate continued significant opportunities to further develop, apply and transfer the general system simulation approach to agricultural planning and policy analysis in both developing and developed countries and in international environments.

Michigan Agricultural Experiment Station Journal Article Number 9267

APPENDIX A

CONTRACTS SUMMARY

Manpower and budget data for the contracted projects to date of the Agricultural Sector Analysis and Simulation Program are summarized in Table A.1. The budget figures shown do not include the direct and indirect costs to Nigeria and Korea associated with their participation in the projects. The chronological and programmatic relationships of these projects through 1977 are displayed in Figure A.1. Other ongoing and prospective activities of the Program are not shown here.

TABLE A.1

Contracted Projects of the Agricultural Sector Analysis and Simulation Program, 1968-79

Project	Duration	Contract No.	Amount (approx.)	MSU Professional Manpower (MM)* Field* (Korea)	Campus (MSU)	Total
Agricultural Sector Models	67.06.30-71.11.30	AID/csd-1557	$ 390,000	0	36	36
Korean Agricultural Sector Study	71.09.01-73.12.31	AID/ead-184	333,000	80	9	89
Adapting and Testing of Agricultural Simulation Models to Sector Analysis	71.07.01-77.12.31	AID/csd-2975	1,603,000	241	293	534
Korean Simulation Model Advisory Service	76.07.01-77.12.31	AID/ta-C-1322	98,000	18	0	18
Korean Agricultural Planning Project	74.03.01-77.12.31	MSU/ROKG joint project financed by AID grant to ROKG	697,000	110	0	110
Agricultural Sector of the Republic of Korea and Import Demand for Grains, Oilseeds and Feed Products	77.10.01-78.12.31	USDA-12-17-05-8-2199-X	20,000	0	5	5
Annualization and Integration of Additional NIRAP Components	78.10.01-80.09.30	USDA-58-319-W-8-2464-X	20,000	0		

*MM = man months

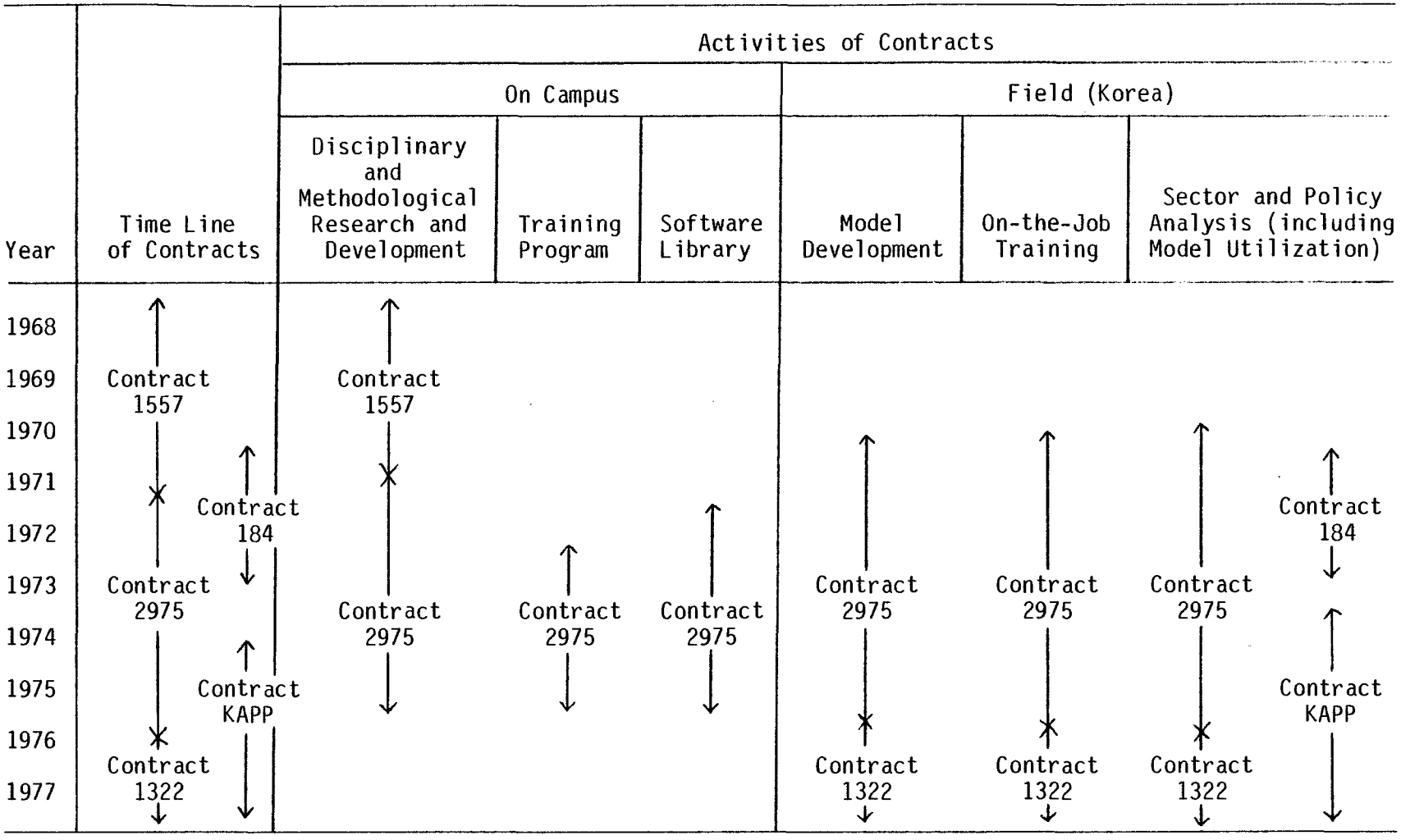

FIGURE A.1

Activities and Contracts of the Agricultural Sector Analysis and Simulation Program

APPENDIX B

PRINCIPAL PERSONNEL OF THE AGRICULTURAL SECTOR ANALYSIS AND SIMULATION PROGRAM

MSU

Michael H. Abkin	System Scientist
Marcus R. Buchner	System Scientist
Derek R. Byerlee	Agricultural Economist
Tom W. Carroll	Social System Scientist
Kuong-Yuan Chong	Agricultural Economist
David W. Culver	Agricultural Economist
Hartwig de Haen	Agricultural Economist
Stanley W. Driskell	Agricultural Economist
Richard D. Duvick	Agricultural Economist
Forrest J. Gibson	System Scientist
Albert N. Halter	Agricultural Economist
Martin E. Hanratty	Resource Economist
Marvin L. Hayenga	Agricultural Economist
Gary R. Ingvaldson	System Scientist-Programmer
Glenn L. Johnson	Agricultural Economist
Francis C. Jones	Agricultural Economist
Earl D. Kellogg	Agricultural Economist
Herbert C. Kriesel	Agricultural Economist
Thomas J. Manetsch	System Scientist
Fred A. Mangum, Jr.	Agricultural Economist
Keith Olsen	Computer Programmer
Gloria Page	Computer Programmer
Dennis Pervis	Agricultural Economist
Bert M. Pulaski	Administrative Officer
George E. Rossmiller	Agricultural Economist
Lloyd D. Teigen	Agricultural Economist
Alan R. Thodey	Agricultural Economist
Mark Turnquist	System Scientist
James Williams	Computer Programmer
Claudia S. Winer	System Scientist-Programmer
Chris Wolf	Computer Programmer

NIGERIA/KOREA

Yong-Jae Joo	Agricultural Economist
Chul-Ho Kim	Agricultural Economist
Dong-Hi Kim	Agricultural Economist
Dong-Min Kim	Agricultural Economist
Jeong-Bae Kim	Agricultural Economist
Jeong-Boo Kim	Agricultural Economist
Sang-Gee Kim	Agricultural Economist
Young-Sik Kim	Agricultural Economist
Bu-Kwon Lee	Agricultural Economist/System Scientist
Hyo-Bok Lee	Computer Programmer
Jeung-Han Lee	Agricultural Economist
Nai-Soo Lee	Agricultural Economist
Sang-Won Lee	Agricultural Economist/System Scientist

NIGERIA/KOREA (continued)

Sun-Jeung Lee	Agricultural Economist
Samson O. Olayide	Agricultural Economist
Kyong-Sook Park	Agricultural Economist
Sung-Joo Park	System Scientist
Han-Hyeck Suh	Agricultural Economist
Hong-Do Whang	Agricultural Economist

APPENDIX C

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APPENDIX D

COMPUTER LIBRARY FOR AGRICULTURAL SYSTEM SIMULATION: HOLDINGS AS OF DECEMBER 1978

Models of Agricultural Systems

AGM-1 Northern Nigeria Beef Industry Model

AGM-2 Nigerian Agricultural Sector Simulation Model

AGM-3 Beef Cattle Enterprise Simulation Model

AGM-4 Korean Agricultural Simulation Model (KASM3)

AGM-5 Grain Management Program Model (GMP)

Components for Agricultural Systems Analysis

AGC-1 AGACC: Accounting routine for the agricultural sector

AGC-2 AGPPA: Annual grain price policy analyzer

Demographic Components

DEM-1 DEMOGC: Demography with distributed age cohorts

DEM-2 DEMOGD: Demography with discrete age cohorts

Specialized Techniques

SPT-1 PERT: Program evaluation and review technique

SPT-2 DULPDX/DULPLX: Linear programming subroutines

SPT-3 SYSOPT: Interactive optimization and parameter estimation component

Simulation Languages

SML-1 PAL: Policy analysis language

SML-2 SIMEX 1: FORTRAN executive program for continuous flow simulation models

Utility Routines

UTR-1 Distributed delay routines: DEL, DELS, DELF, DELLF, DELVF, DELLVF

UTR-2 Table functions: TABEL, TABEX, TABUL, TABUX

CLASS Documents

Number	Title
1	"Computer Library for Agricultural Systems Simulation: A Progress Report," Michael H. Abkin and Tom W. Carroll. (July 1976)
2	"Software Standards Manual." (July 1976)
3	"Policy Analysis Language, Version 2.3, Programmer's Guide for CDC Cyber Computers," Claudia S. Winer and Chris Wolf. (July 1976)
4	"Policy Analysis Language, Version 2.3, Reference Manual," Claudia S. Winer and Chris Wolf. (July 1976)
5	"Policy Analysis Language, Version 2.3, Guide to Using a PAL Program," Claudia S. Winer and Chris Wolf. (July 1976)
6	"DEMOGC: Demography with Distributed Age Cohorts," Michael H. Abkin and Chris Wolf. (July 1976)
7	"DEMOGD: Demography with Discrete Age Cohorts," Michael H. Abkin and Chris Wolf. (July 1976)
8	"Distributed Delay Routines: DEL, DELS, DELF, DELLF, DELVF, DELLVF," Michael H. Abkin and Chris Wolf. (July 1976)
9	"Table Functions: TABEL, TABEX, TABUL, TABUX," Michael H. Abkin, Chris Wolf, and Tom W. Carroll. (July 1976)
10	"AGACC: Accounting Routine for the Agricultural Sector," Dennis Pervis and Chris Wolf. (July 1976)
11	"User's Guide for the Beef Cattle Enterprise Simulation Model," Michael R. Jaske. (July 1976)
12	"User's Guide to SYSOPT: An Interactive System Optimization Computer Program," Marcus Buchner. (October 1976)
13	"A FORTRAN Executive Program for Continuous Flow Simulation Models - SIMEXI," Chris Wolf and Thomas J. Manetsch. (October 1976)
14	"Policy Analysis Language, Version 2.3, Programmer's Guide for IBM 370 Computers," Claudis S. Winer and Chris Wolf. (April 1977)