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Final Report: Agricultural Sector Analysis in Thailand

DAE-CARD Sector Analysis Series: No. 16

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FINAL REPORT:

AGRICULTURAL SECTOR ANALYSIS

IN THAILAND

The Di
Office of the l
Ministry of Agriculture and Cooperatives
Royal Thai Government, Bangkok, Thailand

in cooperation with

The Center for Agricultural and Rural Development
Iowa State University, Ames, Iowa 50011

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FOREWORD

The Agricultural Sector Analysis project in Thailand was initiated July 1, 1973, as a cooperative program between the Royal Thai Government and the United States Government. Royal Thai Government participation was provided by the Division of Agricultural Economics of the Ministry of Agricultural and Cooperatives with U.S. participation provided by Iowa State University. Funding for the project was furnished by the United States Agency for International Development and by the Royal Thai Government through the Department of Technical and Economic Cooperation. The project was funded initially for two years. It was subsequently extended to six years ending June 30, 1979.

Purpose of the Agricultural Sector Analysis project was to improve the ability of the Royal Thai Government to make decisions affecting agriculture. In support of project goals, large-scale national and regional models have been constructed that allow evaluation of trade-offs and comparison of alternatives in agricultural policy and developmental programs. The first generation models and complementary research activities have provided detailed and operational policy planning information for use by policymakers and planners in evaluation of agricultural development potentials and policy alternatives. Effective utilization of project output and successful accomplishment of project goals was confirmed by the 1978 Project Evaluation Team which included the following evaluation statements among its numerous positive findings:

The project has succeeded in its mission of establishing a high caliber operational capability for applying agricultural economic analysis to government policy problems in an action setting.

The basic economic logic underlying the modeling of the agricultural sector is sound and the results obtained are reliable.

Models have been used in a variety of ways to aid policy making at national and local levels.

Activities of the project have impacted rural poverty because of the emphasis on incomes in agriculture and low income regions such as the Northeast.

The capability which has been developed has been successfully institutionalized.

Because an influence on major policies affecting agriculture is achieved by a project of this kind at a low cost, relatively speaking, it is a cost effective way of promoting agricultural and income distribution objectives, and thus is cost effective in favorably affecting the lives of Thai rural farmers.

This report summarizes accomplishments of the Agricultural Sector Analysis project in Thailand during a six-year period ending June 30, 1979. Accomplishments described are a result of the cooperative research effort carried out by the Division of Agricultural Economics of the Ministry of Agriculture and Cooperatives, Royal Thai Government, and the Center for Agricultural and Rural Development of Iowa State University.

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INTRODUCTION

Agricultural sector analysis in Thailand originated from a strong desire by the Ministry of Agriculture and Cooperatives (MOAC) and other Royal Thai Government agencies to deal more forcefully and effectively with basic problems facing the agricultural sector and its integration into the national economy. This desire was formally expressed in the summer of 1971 by a request from the Royal Thai Government to the United States Agency for International Development (USAID) for a joint investigation of means to stimulate and improve the agricultural development research and planning capacity of the Royal Thai Government and its operational planning agencies. The resulting joint investigation involved discussions among Royal Thai Government officials including Dr. Somnuk Sriplung, Director, Division of Agricultural Economics, MOAC; USAID staff members in Thailand; and two consultants, Dr. E.O. Heady of Iowa State University and Dr. Arthur J. Coutu of the Agency for International Development in Washington D.C. Result of the investigation was a recommendation that the already functioning agricultural project research project relationship between the Royal Thai Government and the United States Agency for International Development be expanded to incorporate a new project for the purpose of establishing an operational and self-substaining agricultural sector analytical capability and plan implementation system within the Ministry of Agriculture and Cooperatives. Based on this recommendation,

the United States Agency for International Development contracted with Iowa State University to provide the technical assistance to develop the planning capability in the Division of Agricultural Economics (DAE) and to implement a program of in-service training and advanced degree education for DAE staff members. The project was initiated July 1, 1973, and continued in operation through an initial two-year period, a subsequent three-year extension and an additional one-year continuation ending June 30, 1979.

Focus on the project is directed at the 21.8 million people living in rural households which make up 63.6 percent of the nation's population. Average total cash income per rural household in 1970 (5.88 people per household) was $195 from which $120 of farm expenses were paid, leaving $75 net cash income from farming. To supplement farm income, members of the rural household sought employment off the farm which generated an average of another $100 per year. Total rural household income of $175 was less than $30 per capita. In contrast, the average per capita income for urban areas of $315 was more than 10 times greater than that of the rural areas.

The rural poor majority constitutes the sector for which the RTG is developing policies and programs to increase employment and income equity while providing for expanded food production to meet projected consumption and export requirements. Decision-makers face the complex task of choosing and allocating scarce government resources among competing policy or program alternatives which have widely varying impacts on the short and long-run development of the Thai economy. Raising income

levels of the poorest segment of the economy merits attention, but extreme care has to be exercised to identify and develop those alternatives that are complementary rather than competitive to the economic growth of the economy. An inadvertant misallocation of scarce resource could result in even lower income levels for the poor majority and more grievous inequities.

The Division of Agricultural Economics (DAE) of the Ministry of Agriculture and Cooperatives is responsible for policy evaluation related to the Thai agricultural sector. As a means for evaluating the impacts of alternative policies and to provide guidelines for possible programs, the DAE has invested considerable effort and resources in developing an agricultural sector analysis capability. Major emphasis of the sector analysis program has been on the production aspects of the agricultural sector at the national level, which includes measurement of changes in the level of output, resource use, and income at the regional level. Rural poverty and regional development problems received some attention over the 1973-79 period, but need to be given more emphasis in the future.

The Agricultural Sector Analysis project included the construction and application of large-scale national and regional models that allow evaluation of trade-offs or comparison of alternatives in policy and developmental programs. The models and research activities provide detailed and operational policy and planning information for use by administrators and planners in evaluation of development potentials and policy alternatives. The models also are used for developing five-year plans for the agricultural sector and are kept operational for

continuous analysis of alternatives and policy impacts of the agricultural sector, its regional and commodity components, and its interaction with other sectors including international trade. Because of the detail and breadth of the models, they allow evaluation of, and decision-making among, location specific objectives, particular investments or projects, various commodity and resource development possibilities, the most efficient means of stimulating food production and agricultural productivity, and the economic importance of policies directed toward particular regions, income groups, commodities, foreign trade objectives, and national growth goals. The program of work also addressed the means for enhancing the contributions of agriculture to other sectors of the Thai economy with particular concern for employment, income generation and distribution, balance of payments, import substitution, export expansion, poverty elimination and integrated development. It was not expected that first-stage models and research activities could accomplish or be used for all of these purposes. However, the models and research activities are designed and programmed so that subsequent expansion and extension of present model building and research activities can effectively deal with these key policy issues.

Members of the ISU team in Thailand served as an integral part of the DAE staff. While their major function was one of developing the core models which serve as an ongoing means of sector analysis and policy evaluation, they also provided key support and a significant amount of time and effort on complementary activities within the DAE. Auxiliary activities included: analysis and development of policy recommendations

on current and pressing Thai agricultural and economic problems; on-the-job training of DAE personnel in data collection and processing, statistical methods of analysis and computer programming; teaching of formal courses in economic analysis, sector modeling, statistics and computer programming to upgrade DAE staff capabilities; and analysis of other problems of urgency to the DAE in its capacity of making policy recommendations for administrative and policy entities. Thus, ISU personnel served effectively as members of the DAE staff in its general and ongoing functions of research and policy recommendations in addition to carrying out their primary responsibilities for development, quantification and application of the central core models for agricultural sector analysis and policy evaluation.

Highlights of Agricultural Sector Analysis in Thailand

Several characteristics have caused the DAE-ISU Agricultural Sector Analysis effort in Thailand to be unique in comparison with other sector analysis projects.

1. The several facets of sector analysis were accomplished in beginning phases in a relatively short period of time even in the initial absence of a data processing mechanism, basic data banks and trained Thai personnel. National-interregional programming models and regional models were operational in about two years after full initiation of the project. A macro model also was completed in the span of two years. These were rapid accomplishments considering the nature and availability of data, the void in trained and experienced manpower and the necessity to divert an important amount of ISU manpower to on-the-job training, research advisory activities, and policy analysis support service for the DAE.

2. There was a complete meshing and integration of the ISU and Thai staffs in the development and implementation of the models developed and applied. This accomplishment was made possible through excellent working conditions and complete interpersonal trust among DAE and ISU staff members. It also was accomplished through intensive person-to-person training activities on behalf of the ISU staff with the DAE staff.

3. Within the capabilities of their training, the DAE staff was able to comprehend and surround the model developments and applications. They are capable professionals and have, independently, formulated policy questions to be analyzed through them.

4. The major models developed have been applied to the real world and important Thai policy problems. Thai administrators and institutions are acquainted with their availability for their purposes. However, accomplishments to date are small relative to the possibilities posed for the future. While the present models will be extended and updated, their present form allows a wide range of policy analyses and plans exist for a range of policy studies to be implemented through them in future years.

5. The models are detailed and can relate economic impacts back to the zone level. In this sense they contrast to other models which can generate results at only national levels. The Thai models are directed at not only answering "what" at the national level but also the "where, and by how much" at zone levels. Extension of specifications to change and typical farms models will ultimately extend this possibility to the province level.

6. The accomplishment of this project has been recognized by other LDC's of Southeast Asia who have suggested that an Agricultural Sector Analysis Training Center be established by the DAE in Bangkok to train personnel and catalyze similar developments in other countries of this world region.

Objectives of the Sector Analysis Project

The principal project objective was to develop a research and planning capability to guide future agricultural development of Thailand. The research and planning capability included: (a) participation in problem identification, (b) responsibility for assembly of data, specification and construction of models, (c) responsibility for the conduct

and analysis of research; (d) the dissemination of research results, and (e) continued further problem identification-policy analysis.

The primary means used for developing a local staff research capability was through staff members participation in the research process. Organization of Thai and ISU personnel reflected problem focus rather than the traditional scientist/counterpart strategy. An open door policy was observed at all times. Formal post graduate training was supplemented and extended by in-service training and daily participation in all phases of the research process.

AGRICULTURAL SECTOR ANALYSIS

The Agricultural Sector Analysis project was initiated to assist in developing a core unit within the DAE capable of providing information and analysis for high level decision makers of the Royal Thai Government. The unit has been brought into existence and is presently working on overall development strategies as well as policies of day-to-day concern. To permit in-depth and quality analysis of critical policy issues, a set of functional tools have been developed which provide for quantitative evaluation of agricultural alternatives. Predictive models have been constructed and refined for this purpose using linear programming, statistical and econometric techniques. The crop production sector has been modeled at national and agroeconomic zone levels. More detailed models were developed for the four major regions than for the 19 agroeconomic zones. An extended model incorporates both livestock production and crop production and facilitates analysis of the two-way interdependence between these sectors with animals providing power for the crop sector and crops providing feed for the animals. Demand and commodity analysis has progressed to the point where complete demand systems have been developed for several major crops in Thailand. A self-contained macroeconomic model was completed and is being linked to the recursive national crop model. Data bank support activities have progressed to the point where several sections are presently operational and others are nearing completion. Staff development has been accomplished through on-the-job training, formal in-service training courses and higher education training abroad.

Issues Which Determine Policy Research

The Thailand Agricultural Sector Analysis project faced many issues and problems which are similar to those faced by policymakers and researchers in other developing countries. Thailand is concerned about growth in income and employment; in reducing income and employment disparities between rural and urban people, among regions, and between the agricultural sector and the rest of the Kingdom. Thailand is also concerned with expanding the potential for increasing agricultural production to insure adequate food supplies and to earn foreign exchange. Export expansion and import substitution are recurring topics. Thailand has an unusually large and still dominant agricultural sector in terms of GNP, population and export earnings (rice, rubber, cassava, maize). Rapid expansion of domestic demand, primarily in the form of increased population, can slowly erode these important sources of foreign exchange and reduce per capita productivity in the sector. For many years agricultural production has been expanded primarily by land extensive methods, and this cannot be relied upon in the future.

Thailand also faces some rather unique political and economic challenges in large portions of the rural sector where poverty and discontent are common. There appears to be motivation to explore the potential of expanding irrigation, to push for higher participation in multiple cropping and to utilize improved farming technologies. Underemployment is a serious problem for agricultural laborers. Currently, there is a high rate of immigration from low income rural areas into the

urban centers (primarily Bangkok), wh ıtes problems of congestion and unemployment in the nonagricultural economy.

There was no scarcity of issues and problems to be addressed by the project. Issues and research topics which required attention included the following: (a) price and income response for major agricultural commodities including demand analysis and commodity supply responses; (b) land and irrigation expansion potentials and alternative methods for increasing per rai and per capita productivity (new varieties, fertilizer, management); (c) analysis of production alternatives and fertilizer use for rice and upland crops; (d) resource utilization including capital-labor substitution (labor, capital, machines); (e) agricultural marketing and transportation; (f) distributional impacts of national programs on agriculture and of agriculture on the national economy; and (g) relationships between retail prices of selected food crops, foreign exchange earnings, and farm income. The major project work areas are shown in Figure 1.

Research activities designed to address the policy issues and meet the objectives of the project were divided into five areas: (a) national and regional agricultural models and related activities; (b) macroeconomic and impact models (including economic base multipliers and I/O analysis) for national and regional analysis; (c) studies of demand, marketing channels, processing, production response, etc.; (d) data bank maintenance and general survey and statistical support activities; and (e) staff and human resource development.

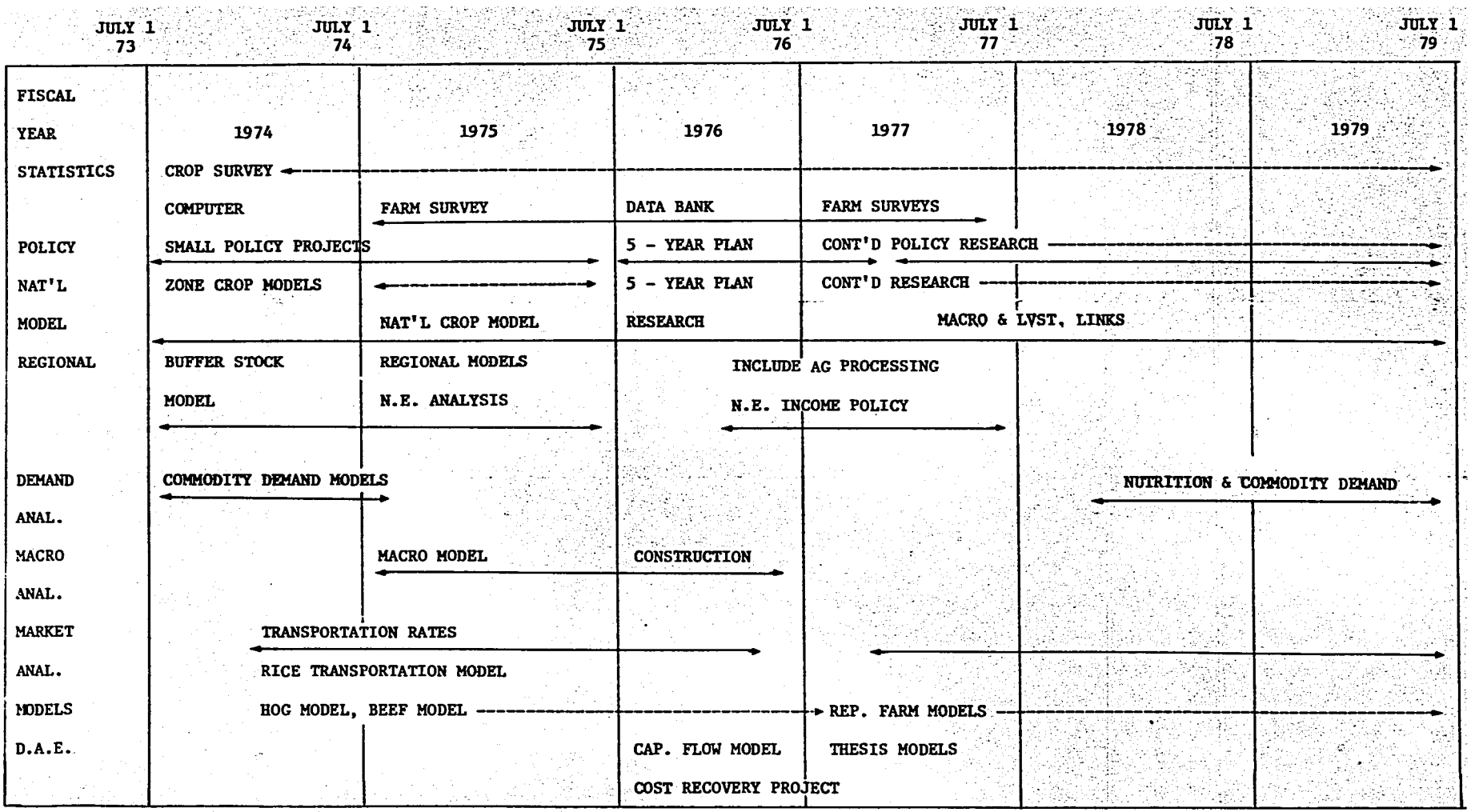

Figure 1. Major project work areas.

Agricultural Sector Models

National, regional and zone models form the heart of agricultural sector analysis work in Thailand. The models consist of linear programming simulations of agriculture in the various parts of Thailand. Major objectives using these models have included: (1) assessing feasibility of meeting target levels of domestic and export demands; (2) estimating the potentials of new technologies for increasing the productive capacity of Thai agriculture; (3) estimating the effects of alternative development policies on farm income and employment by geographic area; (4) determining efficient locations and levels for production of crops and livestock; and (5) evaluating priorities in the economic development of Thai agriculture. The prime example of use of the agricultural models was the work completed for incorporation into the Fourth Five-Year Plan. The models provided the key results used in the agricultural section of the Plan.

The first generation modeling procedure was based on zone models constructed as building blocks for the regional and national models. The national agricultural model includes more than 40 production activities for 24 spatial units. The spatial units start with the 19 agroeconomic zones, continue upward to the 4 regional levels and are finally aggregated at the Kingdom level. This block construction approach provides the structure and detail for evaluating the impact of agricultural policy alternatives through the system from the national to the regional and finally the zone levels. Thus, the framework is intact for future activities more directly related to regional rural development analysis and/or more specific subregional site-specific analysis. Agroeconomic zones of Thailand are shown in Figure 2.

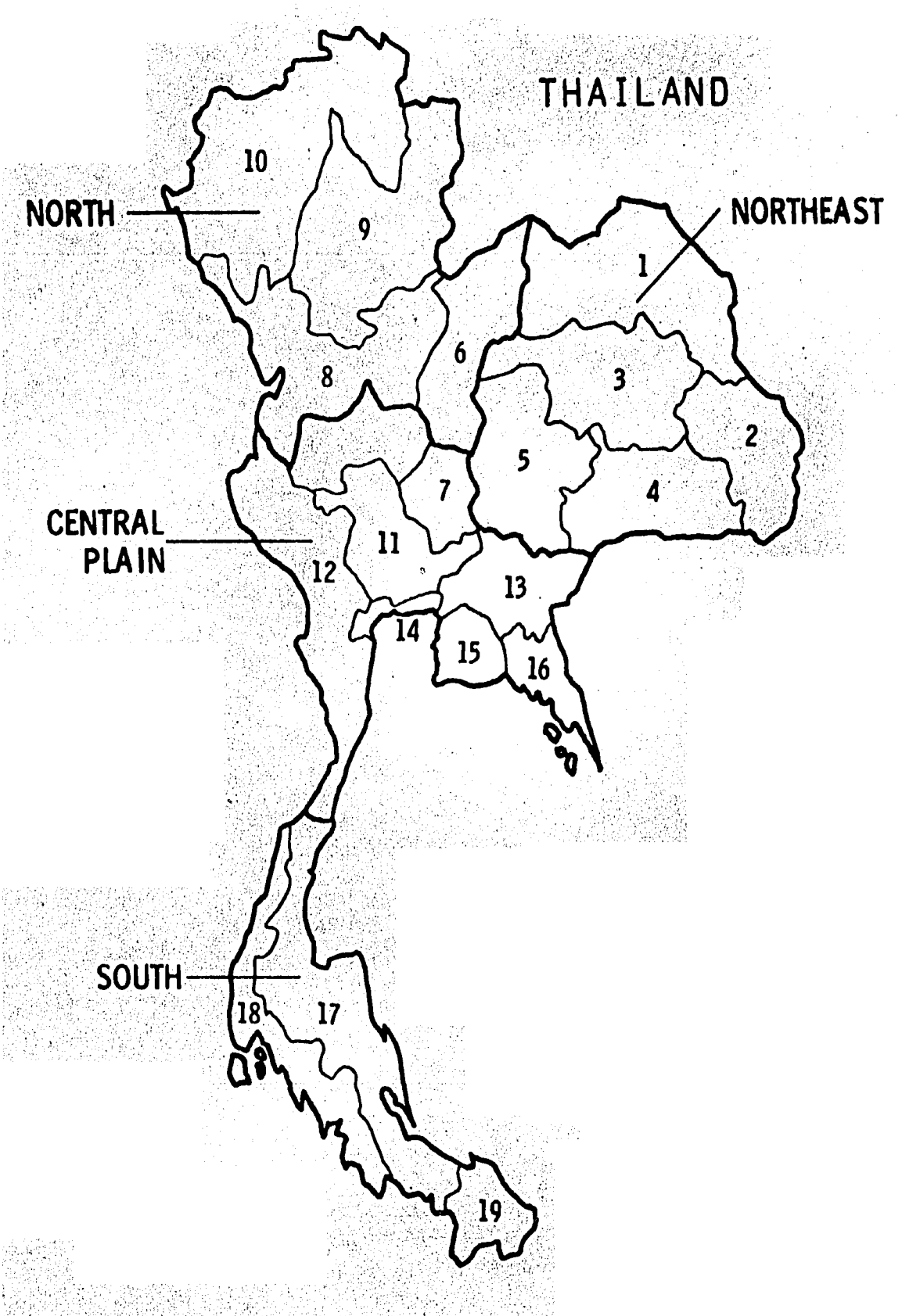

Figure 2. Agroeconomic zones of Thailand

The agricultural models developed allow quantitative analysis of the contributions of strategies toward developmental goals. Thus, the models are used in assessing the effectiveness of alternative strategies, showing the effect specific actions can contribute to goals. Much of planning in the past consisted of enunciating targets without indicating specific program actions to be undertaken and without numerically measuring how various actions would affect goals. The agricultural models make planning a tool for seriously weighing options and guiding programs subsequent to the planning exercise.

Apart from overall planning, the agricultural analysis models can be used in connection with specific policies being contemplated on a current, high priority basis. Analysis of water productivity for a potential loan was but one of many examples of uses already made. Many more applications are likely now that the first generation models have become operational.

The fact that national and regional agricultural models were constructed from 19 detailed zone models, with three land groups in each zone, provides a positive indication that the models reflect much of the variety in conditions that exist in various parts of Thai agriculture. However, even greater detail within zones will be needed for future purposes. There is considerable need for planning smaller site-specific projects and for studies pertaining to income distribution. Distinguishing between agricultural and nonagricultural activities can help evaluation of low income problems. Given severe income differences among regions, and particularly as regards the Northeast, further

in-depth zone analysis will provide additional insights for solving problems of low income and poverty.

Although not explicitly incorporated into the original work plan, rural income generation and other development issues were considered as important problem areas during initial discussions of the agricultural sector analysis project. Initial regional development models were completed and used in analysis of problems of the Northeast. However, even more emphasis needs to be given to rural development issues in the future. Rural development needs emphasis within a rigorous modeling effort where targets and effects can be quantified and rural development planning can focus on increased employment and optimizing the supply of educational, health and related services at specified levels with a minimum cost. Rural industrialization can be directed toward analysis of firm profitability, using some of the same optimization techniques applied to farming. However, many additional activities relating to other sectors and the infrastructure of rural communities need to be included. Project evaluations have recommended more effort on regional rural development analysis and it appears clear that an increased effort in this area is a logical extension of the agricultural sector analysis and modeling effort.

The agricultural sector analysis models which are currently operational and fully institutionalized should be viewed as first generation efforts upon which future revisions and extensions can be based. The original project proposal envisioned the extension of first generation efforts to develop subsequent generations of agricultural analysis models for use by the DAE. Although present models are very detailed and rigorously

defined, initial programming models are conventional in consideration of regional demand, resource use, and commodity relationships as these interact in national and export markets. While the initial models have been of immediate value for examining alternatives of the agricultural sector and in developing the five-year plan, more complete and analytical models need to be developed. Dimensions of the present models need to be extended to cover additional subsector and commodity specific analyses. Future planning calls for development of an integer component so that individal projects can be analyzed in the context of the best national plan with consideration for food production effects, improvement for low income groups, labor utilization, etc.. Future plans also call for a second generation model that will incorporate demand relationships in a nonlinear manner and allow endogenous determination of commodity prices as well as quantities.

Agroeconomic zone models

The basic linear programming models constructed at the agroeconomic zone, regional, and national levels have been fully described in DAE-CARD reports. An overview of the models is presented in the following section.

The crop and livestock enterprises or enterprise techniques included in the models constructed are listed in Table 1. The basic production area for the models is the agroeconomic zone. While not every crop is produced in every zone, there can be one or more production processes for each of the crops and(or) production techniques such as those listed in Table 1. The typical model for the agroeconomic zone (Figure 3)

Table 1. Major crops, and crop production techniques and livestock activities specified by land class and agroeconomic zone in the National Agricultural Model for Thailand

Non-glutinous rice (tp, ov, f)	Cassava
Non-glutinous rice (tp, nv, f)	Sugar cane (fresh)
Non-glutinous rice (bc, ov, f)	Sugar cane (manufacturing)
Non-glutinous rice (bc, nv, f)	Tobacco (native)
Glutinous rice (tp, ov, f)	Tobacco (Virginia)
Glutinous rice (tp, nv, f)	Tobacco (Burley)
Glutinous rice (bc, ov, f)	Tobacco (Turkish)
Glutinous rice (bc, nv, f)	Coconut
Maize for Livestock	Mulberry with native and Hybrid types of sericulture
Maize for human food	Upland non-glutinous rice
Sorghum	Upland glutinous rice
Mung bean	Watermelon
Soybean SJ1	White sesame
Soybean SJ2	Kenaf
Soybean native Jute	
Black bean	Rubber (ov)
Kak bean	Rubber (nv)
Ground nut	Intercropping on replanted rubber
Black sesame	Buffalo
Cotton	Cattle
Castor seed	Swine

Abbreviations used: tp = transplanted; bc = broadcast; nv = new variety; Ov = old variety; f = yield variable with fertilizer

Resource Supplies	Type of Constraint	Crop Production Activities on Land Type				Capitol Borrowing Relatives, Institutions Merchants	Capitol Transfer		Buf. Wk. Unit	Catt. Wk. Unit	Other Livestock Activities		Activities for Grazing and Feed Processing
		Land 1	Land 2	Land 3	Land 4						Household	Commercial	
Land I	≥	1											
Land II Mar.	≥												
			1										
Land II Feb.	≥												
Land III Mar.	≥												
				1									
Land III Feb.	≥												
Land IV Mar.	≥												
					1								
Land IV Feb.	≥												
Labor Mar.	≥												
		a	a	a	a				a	a	a	a	
Labor Feb.	≥												
Capitol Mar.	≥						1						
		a	a	a	a	-1	-1	1	a	a	a	a	
Capitol Feb.	≥							-1					
Inst. Max.	≤												
Relative Max.	≥					-1							
Merchant Max.	≥												
Fallow Land	≤	1	1										a
Other Grazing Land	≥												a
B.Wk.Unit D.C.	≥	a							-1				
B.Wk.Unit W.S.	≥	a	a	a	a				-1				
C.Wk.Unit D.S.	≥									-1			
C.Wk.Unit W.S.	≥									-1			
Roughage D.S.	≥								a	a			-a
Roughage W.S.	≥								a	a			-a
Processed Feed	≥											a	-a
Crop Residue	≤	-a	-a	-a	-a								a
Subsistence D	≤	a	a	a	a				a	a	a	a	a
Objective Func		nr	nr	nr	nr	-r	0	0	nr	nr	nr	nr	nr

Figure 3. Generalized matrix of a crop-livestock model for an agroeconomic zone

contains 30 to 40 enterprises or enterprise production techniques. Nonlinear response of crops to fertilizer inputs is modeled by defining additional production processes with different amounts of fertilizer per land unit.

The section of the programming model at the agroeconomic zone level contains restraints on the monthly or seasonal use of crop land, labor, and capital. Agricultural crop land in each agroeconomic zone is divided into four mutually exclusive classes. These four classes are: (a) Class I land, deep flooding area suitable for only one broadcast rice crop per year; (b) Land II, irrigated rice area, this type of land can also be used for dry season production of rice and other crops if the water supply is adequate; (c) Land III, rainfed rice area, this area is suitable for only one rainy season rice crop per year; and (d) Land IV, upland area; the cropping area suitable for production of upland crops. Dry season crops are possible in some areas.

Additional land classes for fallow land, pasture, and other forest land suitable for grazing are included in the combined crop and livestock models developed by the DAE staff. The crop section of each agroeconomic zone model contains one constraint for each month in which there is a possible use for the crop land. The crop land section of the model can contain up to 48 constraints. Each constraint restricts the use of a particular class of land to be less than or equal to the area of that class of land suitable for crop production in a specific time period.

The total monthly use of labor in each zone is restricted to be less than or equal to the monthly supply of labor in that zone plus migrant labor from other zones.

The use of cash in each month for production expenses is required to be less than or equal to the amount of cash unused from the proceeding month plus borrowings in the current month. Three sources of credit are available to the farmer. These sources in order of increasing interest rates are institutions, relatives, and merchants.

Subsistence demand for rice and other crops requires minimum levels of production for on-farm consumption. Any production in excess of family subsistence requirements can be marketed.

Regional Linear Programming Analysis.

The major purpose of the regional models is for independent studies of specific regional problems. Major use of the regional models also has been to further check feasibility and consistency of policy alternatives from the national model.

Spatial equilibrium models of crop production have been constructed for each of the four major regions of Thailand. Each regional model was constructed by linking the separate zone models in a block diagonal form as shown in Figure 4. No aggregation is involved so each regional model is consistent with the zone models of the region. The markets in each zone within the region are linked by alternative transportation modes and routes. Production is allocated between zones according to the principle of comparative advantage. Crops produced in one zone can be shipped to another zone or even outside the region for consumption. Commodities can also be imported into the region for consumption.

The regional crop model of the North is shown in Figure 4. This crop model is composed of four consuming and producing regions,

Resource supplies		Type of constraint	Crop activities[a]				Subsistence demand and marketing activities								Transportation activities												Buying fertilizer activities								Borrowing activity from institution	Transfer capital activities
															Export to Bangkok				Export to center to reg				Import from center to reg				Nitrogen				Phosphorus					
			PZ06	PZ08	PZ09	PZ10	SDZ06	MKZ06	SDZ08	MKZ08	SDZ09	MKZ09	SDZ10	MKZ10	Z06	Z08	Z09	Z10	Z06	Z08	Z09	Z10	Z06	Z08	Z09	Z10	Z06	Z08	Z09	Z10	Z06	Z08	Z09	Z10	Mar to Feb	Mar to Feb
C_i			$-C_1$	$-C_2$	$-C_3$	$-C_4$	$-C_5$	$-C_6$	$-C_7$	$-C_8$	$-C_9$	$-C_{10}$	$-C_{11}$	$-C_{12}$	$-C_{13}$	$-C_{14}$	$-C_{15}$	$-C_{16}$	$-C_{17}$	$-C_{18}$	$-C_{19}$	$-C_{20}$	$-C_{21}$	$-C_{22}$	$-C_{23}$	$-C_{24}$	$-C_{25}$	$-C_{26}$	$-C_{27}$	$-C_{28}$	$-C_{29}$	$-C_{30}$	$-C_{31}$	$-C_{32}$	-0.12____-0.01	0_____0
Land I Mar-Feb		≥	{1}	{1}	{1}																															
Land II Mar-Feb		≥	{1}	{1}	{1}	{1}																														
Land III Mar-Feb		≥	{1}	{1}	{1}	{1}																														
Land IV Mar-Feb		≥	{1}	{1}	{1}	{1}																														
Labor Mar-Feb		≥	{a}	{a}	{a}	{a}																														
Capital Mar-Feb		≥	{1}	{1}	{1}	{1}																													{-1-------1}	{-1-------1}
Transfer yield	Z06	≥	-y				1	1							1				1				-1													
	Z08	≥		-y					1	1						1				1				-1												
	Z09	≥			-y						1	1					1				1				-1											
	Z10	≥				-y							1	1				1				1				-1										
Rows of Subsistence demand	Z06	≤	-y				1																													
	Z08	≤		-y					1																											
	Z09	≤			-y						1																									
	Z10	≤				-y							1																							
Rows of fer, n for rice	Z06	=	n																								-1									
	Z08	=		n																								-1								
	Z09	=			n																								-1							
	Z10	=				n																								-1						
Rows of fer, p for rice	Z06	=	p																												-1					
	Z08	=		p																												-1				
	Z09	=			p																												-1			
	Z10	=				p																												-1		
R.Center of reg.		≥																	-1	-1	-1	-1	1	1	1	1										
R.Exp. to Bangkok		≤													1	1	1	1																		
RD Var Land II wet		≥	1	1	1	1																														
RD Var Land III season		≥	1	1	1	1																														
RD Var Dry season		≥	1	1	1	1																														

Figure 4. Crop model for northern Thailand

[a]There are separate blocks for each agroeconomic zone

agroeconomic zones 6, 8, 9, and 10. The model contains 502 activities and 442 rows of equations. The activities in the model include one or more production processes in each zone for each commodity on each type of land during each season where production has been observed historically. Separate activities have been defined for some commodities whenever a distinct production process could be identified that would affect the resource requirements, costs, and(or) yields. Although this does not provide unlimited resource substitution, it does provide for some basic substitution. As more new activities are defined and the model expanded, further resource substitution will be possible.

In addition to the production activities, the models contains separate supporting activities for each zone. These include: subsistence demand (on-farm consumption) for selected commodities; marketing activities for each commodity; transportation activities among zones and regions; buying of fertilizers (nitrogen and phosphorous); capital borrowing by month from institutions, relatives, and merchants; and capital transfer activities.

The North model has separate bound sets for each zone which include land by type and month, labor by month, capital by month, and capital borrowing by source. In addition to the bound sets for each zone, point demand estimates which were taken from the national model have been added in the form of regional marketing bounds for each commodity. The point demand estimates serve as upper limits for on-farm consumption and off-farm marketing at the prices specified in the model. These restraints force the four zones to compete against one another for a limited region market.

National Interregional Crop Production Model

Because of computer space limitations, it was necessary that the first national linear programming model be more aggregated than the individual agroeconomic zone models. For example, the average zone crop model contained about 80 restrictions. To have constructed a national model without aggregation would have required more than 1,500 equations and would have far exceeded DAE computer capacity. Computational experience with the IBM 16K 1130 compute with 3 disks in the DAE indicated the practical limit was only about 600 equations.

With the above limitations in mind, the DAE-ISU modeling groups have constructed a national interregional model of crop production. The national crop model is composed of aggregated modules of the agroeconomic zones. Within each agroeconomic zone, the monthly constraints for each land class, for labor, and for capital have been aggregated into the seasonal constraints. A national integrated crop-livestock model has been completed recently as a further extension of the first generation crop model.

The current national crop production model contains 550 equations and 1,200 production and transportation processes. A structural outline of the national crop production model is shown in Figure 5. All of the crop production techniques or activities defined at the agroeconomic level have been retained. The aggregation is only in terms of the constraints. Within each agroeconomic zone, there are wet and dry season constraints for each land class and for capital use. The labor supply, however, was subdivided into wet season planting, wet season harvesting and dry season constraints. The subdivision of labor in the wet season corresponded to the peak periods

Prod. Act.	P_1	P_2	P_3	P_4	P_5	P_6	P_8	P_9	P_{10}	P_7	P_{11}	P_{12}	P_{13}	P_{14}	P_{15}	P_{16}	P_{17}	P_{18}	P_{19}	T	T	T	T	T	T	T
Bounds	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B							
Objective	-c	-c	-c	-c	-c	-c	-c	-c	-c	-c	-c	-c	-c	-c	-c	-c	-c	-c	-c	-c	-c	-c	-c	-c	-c	-c
Resource Z1	A																									
" Z2		A																								
" Z3			A																							
" Z4				A																						
" Z5					A																					
Demand N.E.	-Y	-Y	-Y	-Y	-Y															I	I					-I
Resource Z6						A																				
" Z8							A																			
" Z9								A																		
" Z10									A																	
Demand North						-Y	-Y	-Y	-Y												-I	I	I		-I	
Resource Z7										A																
" Z11											A															
" Z12												A														
" Z13													A													
" Z14														A												
" Z15															A											
" Z16																A										
Demand Central									-Y	-Y	-Y	-Y	-Y	-Y	-Y					-I		-I	I	I	I	I
Resource Z17																	A									
" Z18																		A								
" Z19																			A							
Demand South																-Y	-Y	-Y						-I	I	

Figure 5. Schematic diagram of national crop model with 4 consuming regions and 19 agroeconomic producing areas[a]

[a]Estimated size is approximately 400 rows and 1,000 variables.

of labor usage as previously determined in the individual agroeconomic zone models.

National Crop and Livestock Model

National crop planning for Thailand as originally completed by the ISU-DAE team did not emphasize livestock, especially cattle and buffalo. There is a growing concern about the slow rate of growth of cattle and buffalo relative to the future demand for draft power and meat. A basic investigation on production, consumption, and draft power requirements as well as natural resources required to produce the livestock output is necessary for future livestock development planning. It is also necessary to look at livestock side-by-side with crop production due to their complementary and competitive nature in power supply and resource use. Draft animals provide plowing inputs for crop production, and they also compete with crops and other products for the use of scarce land and labor. The method of the current study is to incorporate the livestock component in the 1981 national crop model of Thailand so as to allow for crop-livestock linkages. The model evaluates the productive capacity of the bovine industry assuming a modest change in livestock production techniques. It also is necessary to introduce different types of tractor use because of the competition between animal power and machinery, especially on paddy land and upland cultivation.

A national crop and bovine model for Thailand for the year 1981 has been completed. The model requires an estimate in 1981 of the beginning livestock number by type of bovine, age group and sex. Two demographic aggregate bovine models were constructed to simulate 1977-1981 inventory. The basic data used were obtained from a national survey of bovines between

1974-1976. The models take into account the existing stocks, the calving rate, the young mature animal transfer, domestic disappearance and export of cattle and buffalo by age group and sex. The model has been used to estimate domestic meat consumption consistent with existing inventory data. Future domestic meat consumption is assumed to depend on per capital income and population. The ratio of cattle to buffalo as well as sex disappearances estimated from the demographic bovine models were used as basic data in the national crop and bovine model.

The structure of the national crop and bovine model of Thailand for the year 1981 is summarized as follows. Broadly, the model contains crop and bovine sectors. The crop sector contains major crops of Thailand including glutinous and nonglutinous rice, cassava, maize, kenaf, jute, sugarcane, soybean, tobacco, ground nut, sorghum, sesame, cottonseed, watermelon, mulberry, coconut, rubber, etc. Detail for these crops includes variety, land class and production technique. The livestock sector contains cattle and water buffalo. The production of poultry, hogs, dairy cows, and fisheries is not included at this time. The national crop and bovine model is a spatial linear programming model incorporating 19 producing areas and 4 consuming regions. Each consuming region encompasses several agroeconomic zones or producing areas. Crop products are assembled and shipped from the producing areas to their respective regional shipment points for export to other regions. There are two-way transportation linkages among the 4 consuming regions. For the livestock sector, the transportation linkages take into account the existence of surplus and deficit regions. Determination of surplus and deficit regions based on regional demand and supply

relationships are supported by observed livestock flow data of the Department of Livestock. As a result, the Northeast and North are designated as the livestock surplus region whereas the Central region is a deficit region. The South has been proclaimed a disease-free area, with no livestock allowed to enter this area without permission from the Director General of the Livestock Department. The size of livestock shipments from the South to other regions is negligible according to the statistics from the Livestock Department. The South is thus designated as an isolated livestock region in the national model.

The national crop and bovine model of Thailand maximizes export earning of crops, livestock and the net value of inventory change of livestock. The objective function is maximized subject to a subsistence demand for rice, zone demand for meat, regional nonrice crop demand, given resource availabilities, minimum and maximum crop production levels in each area, income constraints and technology assumed to exist in 1981. Basically, there are five classes of activities in the model: 1) production and inventory activities, including crops and bovine; 2) transfer activities, including transportation of farm commodities between and within regions, transfer of commodities from one use to another and transfer land from one use to another; 3) resource supply activities, including draft power, tractor power and feed supply activities; 4) resource demand activities, including farm credit requirement, fertilizer demand and livestock feed demand; and 5) farm product export, including crops and livestock.

An IBM 370 computer at the Ministry of Commerce, Bangkok was utilized to compute solution to the 1,600 x 4,000 equation model. The computer time required was about three hours.

The results of the national crop and bovine model may be summarized in two parts, the crop sector and the livestock sector. With respect to the crop sector, the productive capacity of Thai agriculture as specified by the national crop and bovine model is capable of meeting the national target set in 1981. The model considers the use of high-yielding varieties, expansion of irrigation area, farm credit, fertilizer, etc., by 19 agroeconomic zones of Thailand. The results of the model suggest needed adjustments in area and production for major crops in each producing zone. However, the cropping adjustment has to take into account minimum levels of crop production and minimum income requirement as constraints. The model points out the comparative advantage of producing certain crops in certain producing areas. For example, to increase rice production from 12.6 to 20.5 million metric tons paddy, the North and Central regions should be planned to produce about 65 percent of the total production, an increase of 68 percent of production from the base year. Likewise, comparative advantages are indicated for the use of land for maize in certain areas in the North, sugarcane in the Central, kenaf in the Northeast and North, etc. The results of the model also specify the use of specific resource input for rice and upland crop to meet national production targets.

It is useful to briefly summarize the results for land, labor and capital for crop production. With respect to land use in the wet season, horizontal expansion of land use may not be possible without intrusion into the forest reserves. In the dry season only 26 percent of total land is engaged in crop production. Increased production could be obtained throug integration of land use with other measures including irrigation, farm

credit. etc. Labor is a less restrictive factor of production than is land, except in the Central region. Seasonal labor is restricted in many producing areas in the Central region where multiple cropping system is commonly practiced. Defining unused labor to include unemployment and underemployment, 49.2 and 77.1 percent of the total labor is unused labor in the wet and dry seasons, respectively. Capital for crops is needed most for rice production in both the wet and dry seasons. Total capital requirements for all crops specified in the model come to 17,070 million baht. This capital requirement could not meet without the expansion of farm credit.

In the livestock sector the problem of expansion of cattle and buffalo was investigated through two sets of models. The first model used was the demographic aggregate bovine models of the South and the rest of the regions. The second model used incorporated the livestock component into the national crop model of Thailand. The demographic bovine model was used to estimate and make projections of the domestic disappearance and livestock inventory by age group and sex between 1974 and 1981. The results of the 1978-1981 projections show that the rate of growth of mature buffalo for both sexes will continue to decline. The growth rate of mature male buffalo is expected to decrease at a faster rate than for females. The rate of decrease of mature male buffalo is projected to be faster than that of the mature male cattle. This may be explained in terms of tractor-buffalo substitution indicated by the national crop and bovine model. Water buffalo account for 71 percent of the national draft animal power used in land cultivation. The national crop and bovine model indicates that the substitution of small tractors for water buffalo will continue. There is a problem of negative

growth rate of mature male buffalo which is most severe in the rice-growing regions of the Central, North and Northeast but not the South. Increased consumption of the by-product buffalo meat together with the tractor-buffalo substitution may explain the depletion of mature male buffalo in these three regions. The results of the 1981 demographic bovine model and the national crop and bovine model both indicate a shortage of mature male cattel in the isolated Southern region. The cattle export target of the South could be fulfilled only at the cost of a reduction of cattle stock of the South or by violating the assumption of zero net smuggling of cattle Further research and planning relating to the population of water buffalo in the three regions and of cattle in the Southern region appear to be needed.

The results for the model indicate that national land use is less restrictive for livestock production than for crop production. About 24.2 million rai or 35 percent of total public idle land is used for animal grazing. The second most important type of land use is nonirrigated paddy land in the dry season totalling 16.0 million rai. Other types of land used are dry season irrigated paddy land, plantation land, dry season flooded paddy land, and woodland. All types of land use are less restrictive for livestock production. Wet season woodland which may be used for both crop and livestock is mostly transferred to crop production, with only a small percentage of woodland used for animal grazing. Seasonal labor used for livestock poses no restriction for livestock production according to the model.

It is interesting to note that the export target, consumption, draft power and tractor requirements are met in the presence of decreasing animal

stocks. In the long run, if more and more tractors, particularly small tractors, replace draft animals but consumption of draft animal meat continues to rise, more production of animals for meat, either buffalo or cattle, may be induced. Since water buffalo are draft-oriented while cattle are more meat-oriented, it is to be expected that the number of draft-oriented water buffalo will continue to decline but the number of meat-oriented cattle will continue to increase. As the adjustment process takes place in the draft power, some farmers may adopt the use of machinery faster than others, with lags in remote areas. If this is the case, policy to slow down the rate of reduction of draft water buffalo (especially in the Northeast, North and Central regions) and promote the bovine meat industry (especially in the Southern region) may be worthy of consideration. Further study relating to cattle and buffalo development in line with the aforementioned discussion is recommended. In addition, an extension of the crop and livestock model to include other activities such as swine and poultry would be desirable, since they are presently of much concern to policy makers.

Consuming Regions for Regional and National Models

Several agroeconomic zones have been combined to form one consuming region. The grouping of the 19 agroeconomic zones (Figure 2) into 4 consuming regions was as follows.

Northeast	Agroeconomic zones 1, 2, 3, 4, and 5
North	Agroeconomic zones 6, 8, 9, and 10
Central	Agroeconomic zones 7, 11, 12, 13, 14, 15, and 16
South	Agroeconomic zones 17, 18, and 19

Noncentral cities at the gateway to each region were chosen as shipment points between consuming regions. Initial policy analysis has been concerned with the feasibility of meeting export targets. The noncentral cities chosen in each region reflect existing gateway points for regional flows of imports and exports.

Transportation activities allow marketed rice to be shipped between agroeconomic zones within each consuming region. However, a fixed transportation pattern is assumed for the remaining crops in the model. The pattern of transportation between agroeconomic zones within each consuming region was predetermined in the following way. First, a farm-to-market and processing charge was added to farm production costs for each crop activity. In addition, the cost of transportation from the zone of production to the noncentral shipment city was added to the production cost of each activity. That is, the cost of cassava production in Zone 1 in the Northeast includes the farm-level costs plus farm-to-market and processing costs within Zone 1 plus the cost of shipping the product from Zone 1 to Zone 5.

The selection of shipment points and treatment of interconsuming region assembly charges attempt to reflect the optimal (and existing) pattern of commodity flows which would be obtained from a much larger model.

The models constructed for regional analysis allow more detail about interzone transportation and marketing problems. The interaction between the more aggregated (national) model and less aggregative (regional) models involves the selection of viable activities from the less aggregative models for the more aggregative models. In turn, more aggregative models provide regional or zone price levels and(or) production targets.

The initial structure of the national model is not permanent but changes with data development and computer capacity

Farm Level Models

The construction of models which represent specific types and sizes of farms was not initiated in FY 1977. Ministry level support for the expansion of the modeling effort resulted from previous research for the Fourth Five-Year Plan. A report of that research to a meeting of the governors of the 71 changwats of Thailand led to a request for changwat-level planning. The DAE was able to assign research leaders who had recently completed M.S. degrees to this task. Several of the leaders had received degrees under the AID education component of this project.

Estimation of a common set of planning coefficients for all models from the farm level to the Kingdom level has recently been completed. Initiation of the farm-level modeling coincided with the effort to update the coefficients in all the planning models. The new coefficients incorporate data from two general farm surveys which have been completed since the initial labor and capital coefficients in the models were estimated. Crop yields have been updated previously. With the exception of the fertilizer response, yield reestimation was independent of the labor and capital coefficients.

Classifying farms by type was accomplished by grouping farms that have the same land characteristics together. Thus, only those farms which have land usable for paddy rice production are classified as paddy rice farms. This farm type is further divided into farms on irrigated land and non-irrigated land within each land consolidation area. A third farm type produces only field crops. Six different farm types are identified for modeling purposes.

The frequency distribution of net income from the 1975 general farm survey was used as a major criteria for dividing farms by size. Farms in the survey were grouped according to the frequency distribution of each of the farm types. Farms which dominated the distribution were aggregated to give medium-sized farms. Small-sized farms were identified as those units falling below the medium-sized farms and large-sized farms include those units above the medium-sized farms. Three different categories of land ownership also were identified.

Representative farms were divided according to the six types, three sizes and three land ownership categories. This gives a total of 54 possible type-size-ownership classes.

Coefficients to represent the characteristics of the different farm types were calculated from data collected by three general farm surveys (1973, 1975, 1976). Farm observations from these surveys were combined using a system of dummy variables to reflect the size, type, irrigation, year and changwat characteristics. This method provides the detailed farm characteristics necessary for creating a modeling system based on consistent data and reliable estimating procedures.

RURAL DEVELOPMENT ANALYSIS

An emerging focus of interest has developed in Thailand for expanding and extending the present agricultural analysis and planning evaluation effort to incorporate integrated rural development analysis and planning at the regional and province levels. National goals can be aided by a strong rural development effort which provides more detailed analysis and policy guidelines in keeping with the specific problems of the individual regions. Regional rural development analysis is a logical continuation of present sector analysis efforts and can incorporate rigorous analysis which quantifies targets and effects. Rural development analysis also provides a foundation for planning education, health and related services at specified levels and qualities at minimum costs.

Special considerations for integrated rural development analysis exist in pursuing the special interest of the Thai government in improving the productivity and incomes of the poorer half of the rural population. Models which are currently operational are designed to provide insights on proposals affecting farmers as a group, and farmers as a group are the largest single component of the "poorest" population. These models also help to evaluate programs designed to assist individual zones and regions which are at an apparent economic or social welfare disadvantage with respect to the remainder of the country.

Present agricultural models and analysis can be expanded and extended to incorporate additional rural development concepts in order to provide insights on the "poorest" elements within a particular zone or region

or within the farming community in general. Greater disaggregation by farm type and farm size will be needed before this can be done. More information also will be required on questions such as sources of off-farm employment (very significant for small farmers) and the buying-selling behavior of the poorest farmers. For poor farmers with little marketable surplus, reserved use demand for stocks available for sale may be proportionally great and the income effects of price increases or the role of expectations may be such that the quantity sold may not respond to price changes in the manner generally expected.

It further can be hypothesized that the current distribution of agricultural income within a zone or a region may be relatively equal, but poorer, in comparison with income distributions found in other countries. Concentrations of economic power growing out of agricultural land scarcities have probably been relatively less important in the Thai agricultural sector. Models being developed will be able to make useful statements about the directions of changes in land values, and in the rental values of other scarce resources, under alternative policies. This will give insight into the question of the ultimate effects of alternative policies on income distribution taking into consideration the ownership distribution of the scarce agricultural resources.

To the extent that the poorer half of the rural population is concentrated geographically, the design of research efforts and models poses a smaller barrier to their usefulness for analysis of the rural poor. This gives further emphasis for expanding and extending present efforts to provide greater concentration of analysis and policy recommendations at the regional and subregional levels in support of overall integrated rural development efforts.

Integrated Input-Output and Social Account Systems

Work on integrated rural development analysis was begun during the latter part of the agricultural sector analysis project. Initial effort was directed at construction of a rural development model incorporating the use of regional input-output and social accounts for agricultural policy analysis. This effort expanded the work of the agricultural sector analysis program of the DAE by building a set of accounts for tracing the impacts of agricultural policy from the agricultural production sector to other sectors of the economy and back, again, to agriculture. Much of the work completed under the agricultural sector analysis program relates directly to, and can be freely utilized by, the integrated rural development analysis effort. The linear programming models, the demand analysis, the analysis of production and marketing alternatives, the econometric models for linking agriculture to the national economy, and the previous work on data collection and storage all are essential elements necessary for building the expanded series of economic and social accounts for regional rural development models.

Numerous benefits flow from the building and use of an integrated rural development system of input-output and social accounts. Results of this type of model are used for sector and project evaluation. Agricultural and non-agricultural investments are ranked according to different investment criteria. Investment minimization criterion provides consistent project ranking with cost-benefit-ratios weighted by the direct and indirect effects of proposed investments. The integrated model thus provides a comprehensive approach to agricultural planning which takes into account resource scarcities

in the prioritizing of investment alternatives. Community and regional economic effects of agricultural sectors can be determined on a sector by sector basis. Thus, the two-way flow of economic change stemming from a major development effort can be simulated initially and later traced as the actual development proceeds.

A demonstration system is being designed and implemented as an initial test of feasibility and usefulness of the integrated rural development model The geographical area selected for the test case modeling is the Northeast region of Thailand. This prototype region is one of the more disadvantaged areas of Thailand and includes a large segment of the rural poor. The region had a population of 11.7 million in 1970 with a total of 1.9 million households of which 1.5 million (79%) were agricultural. Significant differences are apparent between rural/urban sectors of the region. For example, agriculture has 3.75 economically active members per household while there are only 1.3 per nonagricultural household. The average farm unit generated $106 of revenue but required farm expenditures of $60 leaving an annual net income of $46 per household or only $12 per economically active household member. Average cash income from off-farm employment was $54 per agricultural household for an additional $14 per economically active member.

A significant effort has already been made to establish a data base and develop first generation crop models for the Northeast region. Results of the analysis have permitted studies of labor productivity, employment, income, production patterns and resource use. However, the first generation models are limited in the sense that they do not permit the identification of recipients of the income benefits or employment generation. An expansion

of the analytical capability of the present models to include input-output and social accounts analysis will provide for the identification of income and employment beneficiaries by group and site; such as, rural or urban, landowner or renter, owner operator or hired labor, permanent hired labor or hourly hired labor, etc. Such an effort will utilize in place capabilities to provide an immediate input into rural development analysis.

Social Account Models

Social account models represent one of the more promising analytical methodologies for rural development analysis. These models quantify the interactions among the production, trade, government, service and household sectors. Models of this type can be designed to provide a capability for evaluation of income and expenditure patterns in detailed form. Interaction effects of alternative policies among the various sectors can be traced through the system.

Figure 6 provides a schematic representation of a conventional social account model (SAM). The production sector of this model can be represented by the linear programming agricultural models expanded to include both input and processing sectors. The nonagricultural sector includes services, transportation, trade, finance, construction and other subsectors of significance to the individual region. The household sector is divided into relevant groups for each region such as farm owner-operators, farm renters, agricultural laborers, nonagricultural proprietors, nonagricultural laborers, etc. The government sector can be delineated to include national, changwat, and local

Receipts / Expenditures	Production	Households*	Government*	Firms*	Capital	Rest of World	Total Receipts
Production	Inter-industry transactions	Expenditure			Delivery of investment goods	Export of goods	Total Gross Value of Output
Households*	Value added accruing to households	Interhousehold transfers and loans	Government transfers to households	Profit distributed to households		Income from abroad	Total Current Receipts
Government*	Value added accruing to government	Taxes paid by households		Taxes paid by firms		Government receipts from abroad	Total Government Receipts
Firms*	Value added accruing to firms					Income of firms from abroad	Total Current Receipts
Capital		Household savings	Government savings	Firm savings		Net capital flow	Total Receipts
Rest of World	Import of intermediate goods	Expenditure on imports	Repayment of debt to rest of world	Payments to rest of world	Import of capital goods		Total Payments Abroad
Total Expenditures	Total Cost of Production	Total Household Expenditure	Total Government Outlay	Total Firm Expenditure	Total Capital Payments	Total Receipts from Abroad	Grand Total

[a]Households, government and firms represent the institutional sectors of the social accounts model.

Figure 6. Social accounts model representing major sectors of the model and possible interactions among the sectors

government levels. Other sectors can include similar subdivisions and the world component would be defined to represent activities external to the region or area of the base case. A system developed in this fashion is useful for analyzing alternative policies for the region or area for which it would be developed or several areas or regions could be aggregated to a higher level of economic and social planning for decision making. For example, it is possible to expand a set of regional models to an aggregate system which shows the regional interactions and trade-offs.

Initial project work on development of a social accounts model (SAM) for Thailand was performed by Wilbur R. Maki during a short-term assignment with the Division of Agricultural Economics in 1978. A complete description of the social accounts modeling system developed for Thailand is provided in his final report which focuses on the construction and use of regional social accounts for agricultural policy analysis.[1] The social accounts modeling effort further extends the current work of the Agricultural Sector Analysis (ASA) program in the Division of Agricultural Economics. It does so by building a set of accounts for tracing the impacts of agricultural policy from the agricultural production center to other sectors of the economy and back again to agriculture.

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[1] Maki, Wilbur R. "Regional Input-Output and Social Accounting Systems for Agricultural Sector Analysis, Agro-Economic Zone 3, Northeast Thailand," report prepared for the DAE-ISU Agricultural Sector Analysis Project, Division of Agricultural Economics, Ministry of Agricultural and Cooperatives, Bangkok, Thailand and Center for Agricultural and Rural Development, Iowa State University, Ames, Iowa. July 1978.

Much of the work completed under the ASA program relates directly to this new effort. The linear programming models, the farm and market surveys, the analysis of production and marketing alternatives for farmers in the several regions and subregions of Thailand, the econometric models for linking the agriculture sector to the national economy, and the reports and discussions on data needs in agricultural policy design and implementation all are essential elements in building the expanded series of economic and social accounts.

The principal objective of the social accounts modeling effort was to provide an assessment of the data and modeling requirements for integrated rural development systems analysis. A demonstration system was designed and implemented as an initial test of feasibility and usefulness. Four changwats in Northeast Thailand (Kohn Kaen, Kalasin, Maha Sarakham and Roi Et) were selected as the geographical area for data and model development. The selected geographical area is characterized by an above average economic dependence on agriculture. More than 90 percent of the economically active population is engaged in farming as the principal, if not only, remunerative and productive activity. This area faces severe land and water restrictions in the expansion of its agricultural productivity. Much concern is expressed about the urgent need for new public investment in local infrastructure, especially in irrigation systems, which can facilitate small farm improvements and create new employment opportunities.

The integrated rural development system provides a statistical data base for relating the individual studies of the ASA program to the total

rural community in Northeast Thailand. The study starts with the building of a set of regional input-output accounts for a test area, a subregion of Northeast Thailand. These accounts are then expanded into a system of social accounts which include not only the agricultural and related production relationships within the extended rural community, but also the consumption patterns, the factor input requirements, the tax and other policy provisions affecting productive activity in the subregion, the institutional arrangements, the savings and investment relationship and the flow of imports and exports between each industry and sector in the subregion and the rest of the nation. Use of the expanded system of regional input-output and social accounts with the ASA models also is examined. Finally, an assessment of the data and technical requirements for implementing the accounting system completes the study's objectives.

Timing of the integrated rural development and social accounts study was particularly appropriate. Massive public investments in farm irrigation systems, farm-to-market roads, and basic community facilities are being proposed for Northeast Thailand. A start in this direction has been made with a 10 million baht, 10-year, program for farm irrigation development in the Northeast. What public investments to make, when, where, and how much are the difficult questions of economic planning which are faced repeatedly as the government moves ahead on its commitment. The underlying purpose of this study was to provide part of the supporting statistics for planning the capital improvements most urgently needed in farming and for keeping track of the economic effects of these investments.

MACRO-MODELING ANALYSIS AND LINKAGE

Macro model development for the Thai economy was undertaken to supplement the various models developed for the agricultural sector. This activity was undertaken not only because of the importance of national economic policies on employment, prices, and other variables in agriculture, but also because various policies enacted in behalf of agriculture also impact on other sectors of the economy.

The macro modeling activity evolved in two separate but related forms. First generation macroeconometric models were initially constructed as "stand-alone" models of the Thai economy and treat the agricultural sector in a fairly aggregative manner. This direction was taken to allow analysis of the effects of particular policies on the broad economic aggregates of the economy in a time series framework. However, the ultimate purpose of the macroeconometric modeling effort was to link econometric models of the national economy with linear programming models of the agricultural sector. Identifying and quantifying the linkages between the agricultural and nonagricultural sectors is desirable to properly analyze the effect of agricultural policies on the nonagricultural sector and vice versa.

The macroeconometric models developed so far represent two "self-contained" models of the Thai economy. They have considerable disaggregation in the nonagricultural sector but give a fairly aggregated treatment to the agricultural sector. Model I is a 45 equation model constructed specifically as linear in both parameters and variables. Model II is a 55 equation model that remains linear in the parameters

but allows for nonlinearities in the variables and includes a monetary and price sector.

Model I is a completely "real" model in that there is no consideration of the monetary sector and, therefore, no consideration of the determination of various price levels. The macroeconometric model was constructed as linear in both parameters and variables since the national agricultural model is in a totally linear form and the initial problems of linkage will be reduced if the macro-model is likewise linear in all regards. The monetary and price sector was excluded from the initial macro-model because of the complexity of this sector in Thailand and the urgency for having a complete model operational at an early date.

The second macro-model, Model II, is a self-contained model which corrects some of the limitations of the first model. It varies from Model I in the following ways: (1) Model II allows for nonlinearities in the variables; (2) private consumption figures are specified in per capita figures rather than in levels; (3) three of the four import equations are specified in per capita terms rather than in levels; (4) gross fixed capital formulation equations have been disaggregated from two to seven equations; (5) six of the seven output equations are spe ified in a modified Cobb-Douglas production form and the seventh in an output per worker form; and (6) an elementary monetary and price sector has been added to monetize the model and to capture the effects of changes on the real sectors of the model.

The government expenditure, export and income distribution equations remain unchanged from Model I.

The equations used in both models were estimated using Ordinary Least Squares methods from annual time series data for the sample period

1962-1974. Two-stage regression cannot be used directly because the number of predetermined variables exceeds the number of time series observations. Future efforts to improve the models will consider the use of principal components analysis to estimate the first-stage regressions in addition to further extending the time series data base.

Particular attention is given to interactions between the two sectors in order that the effects of various policy alternatives can be measured with respect to levels of agricultural and nonagricultural employment as well as total demands for labor, capital, and land resources. These variables have important implications for patterns of labor migration, the absorption of new labor in the economy where productivity is greatest, and the relative income levels of the two sectors.

Linkage Between Macro and Agricultural Sector Models

The linkages at the national level between the agricultural and the nonagricultural sectors are modeled through an interface between the macro economic model and the national linear programming model. The interface will allow those people in policy-making positions to relate the effects to changes in one sector (in this case, agriculture) to the remaining sectors of the economy. It also is desirable to know the impacts of changes in the nonagricultural sectors on the agricultural sector. In the macro-model the Gross Domestic Product of Thailand's economy is divided into seven major sectors which are consistent with the National Income Accounts. The variables of the macro model which represent the subaccounts in each sector are shown in

Table 2. The second version of the macro model which was used for the linkage contains 55 equations including 9 accounting identities. The relationship or content of each variable of the macro model or account with respect to the agricultural or nonagricultural sectors is also shown in Table 2.

The linkage as outlined in Figure 7 retains the essential structure of the macro model but substitutes a disaggregated programming model of agricultural crop and livestock production processing, marketing and transportation for all or part of the relevant macro equations.

The combined macro-agriculture production model is recursive in two senses. First the combined system is recursive in the traditional sense that current year variables are dependent in part on their values in previous years. However, within each year the models are recursive in the sense that the agriculture model depends on macro equations to set or parially determine domestic demand for agricultural products, exports, labor supply, and other factors which affect agricultural inputs and outputs. The outputs from the agricultural model then become predetermined variables which are used to solve the remaining eauations of the macro model. The current period result of the combined macro-LP system are then used to update the agricultural and macro model for the following year.

The macroeconometric models provide a consistent means for projecting the national accounts. Of primary concern in Thailand are the linkages of the agricultural sector with the rest of the economy. The first use will be to obtain consistent and reproducible macro information. Linkages with the nonagricultural sectors are particularly important in a country like Thailand

Table 2. Variables in Macro Model II classified according to whether they contain identifiable agricultural or nonagricultural components

	Macro variable	Agricultural component	Non-Agricultural componants
	Consumption Sector		
FBI	Food, beverages, tobacco	X	X
RFLHHD	Rent, fuel, light, household operation		X
COPE	Clothing & other personal expense	X	X
FFHHE	Furniture, furnishings household equip.		X
SERV	Consumption of services		X
TC	Consumption transportation & communication		X
RE	Recreation & entertainment		X
	Government Sector		
GADJP	Administration, Defense, Justice, Police		X
GSEVP	Services		X
GTC	Transportation and communication		X
	Export Sector		
XRICE	Export of Rice	X	
XRUB	" Rubber	X	
XMZE	" Maize	X	
XTAP	" Cassava	X	
XMFG	" Manufactured goods	X	X
XOTH	" Exports other goods	X	X
XSERV	" Exports services		
	Imports		
IMP1	Consumer goods	X	X
IMP2	Intermediate products and raw materials for consumer goods	X	X
IMP3	Capital goods, raw materials for capital goods, fertilizer	X	X

Table 2. (Continued)

	Macro variable	Agricultural component	Non-Agricultural components
IMP4	Fuel and Lubericant imports		X
IMP5	Other imports		X
Serv I	Service imports (exogenous)		X
	Capital formation		
AGINV	Agricultural investment	X	
MANINV	Manufacturing investment	X	X
CONSINV	Construction investment		X
TCINV	Transportation Communication investment	X	X
WRTINV	Wholesale Retail Trade Investment	X	X
SERVINV	Service investment		X
	Output equations (value added)		
CROPOUT	Crop output	X	
OTHAG	Other Agricultural output	X	
MGDP	Manufacturing output	X	X
CONSAT	Construction output		X
WRTOUT	Output wholesale & retail trade	X	X
SERGDP	Output of Services		X
TCOUT	Total output transportation and communication		X
OTHOUT	Other output		
	Income distribution Equations		
COMP	Compensation of employees	X	X
FY	Farm income	X	
YUE	Income unicorporated enterprises		X
YPROP	Income from property	X	X
IDAX	Indirect taxes	X	X

I. Update
1. Policy instruments based on previous results
2. Population projection, farm, nonfarm population
3. Imports and domestic production of inputs used in agricultural production (forward linkage)
4. Update demand equations for population changes, PDY-1, previous consumption levels
5. Determine nonagricultural employment

↓

II. Agricultural Sector Model (ASM)
1. Determine output of agricultural products exogenous to the recursive linear programming (RLP) model.
2. Determine remaining land, labor, capital supplies available for use in the RLP.
3. Set flexability coefficients for RLP
4. Solve RLP, sum for agricultural output, employment, other resource use.
5. Evaluate commodity models to determine realized wholesale price, domestic consumption, exports.
6. Calculate farm price, retail price, farm income.
7. Determine value added from agricultural processing
8. Calculate value added from agricultural purchases from nonagricultural sector.

↓

III. Macro Econometric Model (MM)
Solve remaining macro econometric model equations using the agricultural related variables as predetermined variables.
The remaining items include:
1. Consumption of nonagricultural commodities
2. Government expenditure
3. Output of nonagricultural commodities
4. Exports of nonagricultural commodities
5. Gross domestic product, national income
6. Distribution of national income, personal disposable income
7. Investment, depreciation, capital stock.

Figure 7. Sequence of operations involved in the interface between the agricultural sector and the nonagricultural sector

where the ag sector is very large. It is important to trace the intersectoral impacts of alternative plans for the ag sector. It is expected that inter-agency support for Ministry programs will be enhanced if the extent of inter-sectoral linkages are estimated in advance. At this time, only the reduced form multipliers from the macroeconometric model have been applied for import evaluation. This information was reported as a part of the Agricultural Sector Plan alternatives at the June, 1976, conference on the Fourth Five-Year Plan.

COMMODITY DEMAND ANALYSIS

Commodity demand analysis has contributed to three primary objectives. First, it has provided fixed point estimates of domestic and export demand for each of the commodities which appear in the interregional competition models of Thailand's agriculture. These estimates were made for each consuming region in the model. In addition, the work has yielded estimates of the market demand relationships which relate consumption and prices for agricultural commodities. Such price-quantity relationships assist government policymakers in decisions involving policies on export policies and domestic consumption. They also are to be incorporated into the second generation interregional competition model in order to provide a capability for modeling the determination of agricultural prices, production and consumption simultaneously. Lastly, the research has contributed to development of a capability within the DAE's Marketing Branch for constructing and using statistical demand models in independent studies requiring prediction and evaluation.

Commodity demand analysis which attempts to estimate demand equations and explain the factors that influence consumer behavior can be divided into two different groups. The first group focuses attention on a single commodity such as maize, rice, or beef, while overall relationships among the quantities demanded of all commodities in the budget remain in the background. The second group of studies is concerned primarily with the interdependent nature of demand among several

products. Both types of studies have been carried out for agricultural commodities in Thailand.

Single commodity demand analysis has concentrated on kenaf, glutinous and nonglutinous rice, mungbeans, maize, sugar, cotton, and rubber. Econo metric models have been specified for these commodities and demand estimates have been completed. Data assembly on components of supply and demand for soybeans, soybean cake and soybean oil has been completed and initial estimates have been made.

Interdependent demand relationships among agricultural products have been estimated for 18 commodities in Thailand. Direct, cross-price, and income elasticities were estimated for individual products. An analysis of farm retail price spreads also was completed as a related part of the interdependent demand study.

The rice model has been expanded to include an international trade section incorporating production, demand and stock components for the ASEAN countries. This model is now being used in analyzing policies related to ASEAN preferential trade in rice where Thailand is the major surplus producer and the remaining four ASEAN countries importers of rice or, in the case of the Philippines, nearly self-sufficient.

Results from the commodity demand analyses are currently being used to determine the impact of price changes on production variables and market conditions. They are also being used to estimate the impact alternative government export targets on domestic prices and stocks.

TRANSPORTATION, PROCESSING AND MARKETING ANALYSIS

Major efforts in this research area have focused on the analysis of marketing channels, transportation networks, and capacities and costs of alternative milling and processing facilities. Basic objectives were to find efficient ways to transport, process and market individual commodities as well as to provide inputs into the larger sector models. Users of data from this research activity have included both policy-makers and research personnel working with other modeling operations.

Data collected and analyzed on transportation activities included identification of the location of services by mode and distances between provinces. Various methods were used to estimate transportation costs and a computer program was developed to calculate and list these costs from province to province for all of Thailand. Transportation cost tables include costs for truck, rail and barge single mode shipments as well as truck-rail and truck-barge multiple mode shipments. In addition, ocean freight rates have been collected and assembled for shipments to Thailand's major foreign customers.

Transportation models with multiple modes of transport were built and solutions obtained for rice, sugarcane and rubber. Solutions from these models show what commodity trade patterns and implied prices would be when total transportation costs are minimized. The implied prices from solutions of the rice models at the zone and province levels were statistically compared to their real world price counterparts using linear regression techniques. The comparisons showed the implied

prices from the models give a good description of the real world spatial price relationships at both the zone and province levels. Basically, the model provides a means for analyzing improvements needed and possible in the transportation sector of Thai agricultural commodity markets in order that farm prices and incomes can be improved.

A basic model also was designed to describe the marketing functions of transportation, storage and processing (TSP) for paddy rice. Following the collection of information on processing and storage activities, similar TSP models have been completed for sugarcane, kenaf, and cassava. From the work done on TSP models, detailed transportation and processing activities have been developed for use in advanced versions of the national agricultural model.

DATA BASE, COMPUTER AND STATISTICAL SUPPORT ACTIVITIES

The present analytical capacity of the DAE is supported by statistical and computer groups which are responsible for survey design, collection, and processing of data from the agricultural sector of the Thai economy. This data base supports the policy analysis, farm management and marketing sections of the DAE. During the past six years both the computer and statistical groups have developed into effective support units generating the data needed through the use of computerized summary and statistical analysis routines. Up-to-date statistical procedures are being used, and, for the most part, estimated coefficients

are reasonable and highly significant statistically. Confidence in research results has been enhanced by data and coefficient estimates that are based on extensive surveys which are calibrated to real conditions and are checked by Thai professionals with years of experience and proven judgments on Thai agriculture.

The data bank system of storage and retrieval plays an important role in providing access to key data. Approximately 7,400 characteristics from the General Farm Survey of 2516/17 are stored. Users can perform addition, subtraction, multiplication, or division on any of the information. The survey information is accessible by Changwat, agroeconomic zone, regional, or Kingdom totals as either tabular or punched output. Over four million pieces of information are available from the 2516/17 General Farm Survey and a similar number will be available from the 2518/19 survey. A second part of the data storage system provides a master frame listing of approximately 50,000 villages. Storage information for each village includes such items as number of farms and major crops grown. A third part of the data effort includes the maintenance and storage of agricultural price series. Monthly price data are available at the Kingdom level for approximately 200 commodities for up to 30 years. Further data storage and retrieval is planned for farm data originating from the farm record keeping program.

Statistical support activities have included both survey design and processing and development of computer software for statistical analysis of data. Surveys processed to date as part of the modeling and sector analysis activity include General Farm Surveys for 2514/15

(hand tabulated), 2516/17 and 2518/19. Special farm yield surveys also have been completed for rice (2516, 2517), kenaf (2517), maize (2518), second crop rice (2518, 2519), crop production (2518, 2519), and rice stocks (2519). Analysis programs for two and three stage cluster sampling have written and are presently in operation. Computer software programs have also been developed for: (1) reduced form of set of simultaneous linear equations; (2) Gauss-Seidel technique for solving simultaneous equations which may include nonlinear equations; (3) input-output analysis; (4) factor analysis and stepwise regression; and (5) multiple regression and two-stage least square analysis. Plans for the future include maintenance of present software programs, expansion of some programs to extend analysis options and development of additional software for data bank storage and statistical analysis.

Over the life of the sector modeling program, DAE personnel have gained valuable experience with computer applications as applied to research and survey processing. Capacity of the IBM 1130 computer has been increased from an 8K word-1 disk drive machine to a 16K word-3 disk machine. Actual use of the computer also increased from 1345 CPU hours in 1974 to 5563 hours in 1976, which represented near maximum use of the computer when maintenance time, power failures, and other down time was taken into consideration. In order to reduce the heavy load on the DAE computer facilities, arrangements have been made to use the IBM-370 computer of the Bureau of Business Economics.

SPECIAL STUDIES

Numerous special studies were completed in support of the agricultural sector analysis project. The research areas have included such diverse topics as analysis of irrigation and fertilizer experiments, commodity analysis, development of population models, construction of buffer stock models, and development of minimum cost models. Most of the studies have been summarized in previous reports. This section provides an overview of two recent special studies of the ASEAN rice security reserves and the nutritional impacts of development policy.

ASEAN Rice Security Reserves

World food problems have induced countries around the world to concentrate more on how to protect the world from possible catastrophe arising out of food shortages. Four major factors, namely, population, increases in the prices of oil and its products, natural calamities, and depletion of world food stocks have been held responsible for current problems. The World Food Council which was created to establish food security made a number of proposals, one of which was to create world food reserves.

All five member countries of the Association of South East Asian Nations (ASEAN) namely, Indonesia, Malaysia, the Philippines, Singapore, and Thailand have expressed their positive view on the establishment of a food security reserve system within the region. Being the main staple of the ASEAN people, rice has been unanimously selected as the first food item to start the regional food security program with. Having been the region's leading producer and exporter of rice, Thailand was asked to lead other

countries of the ASEAN in a study to shed more light on how to implement the program. With close cooperation of the Iowa State University Sector Analysis Team in Thailand, the present study was carried out to partially fulfill this need.

With time series data relating to rice productions, consumption and trade as well as population of all member countries of the ASEAN and per capita domestic disappearances, 14 econometric equations (5 population equations, 4 rice production equations, 4 net imports of rice equations, and 1 Thai-Others export equation) were arrived at. A computer program was written allowing stochastic simulation of a hypothetical rice security scheme of the ASEAN be conducted. With a set of parameters; namely, beginning Thailand private rice stocks of 1.32 million tons; beginning regional rice buffer stocks of 0 and 250,000 tons; maximum Thai private stock of 1.5 million tons; maximum buffer stocks of 0, 50,000, 100,000, 150,000, 200,000, and 250,000 tons; releasing percentages of buffer stock of 70, 80 and 90; ASEAN preference percentage of 90 and minimum Thai rice exports to non-ASEAN countries of 0, 100,000 and 200,000 tons the model was run with 200 replications of a six-year duration. Results of the program were expressed in terms of country rice productions, net imports from the rest of the world, Thai rice exports to non-ASEAN countries, per capita domestic disappearances, probabilities of meeting ASEAN import preferences, probabilities of meeting minimum Thai-Others exports, probabilities that both the Thai private stocks and the ASEAN buffer stocks become zero and probabilities that both reach their maximum. Among all the variables of interest, the effects of beginning buffer stock, sizes of the buffer stock, releasing

percentages of the buffer stock and minimum Thai-Others exports on the probabilities of meeting the ASEAN import preferences were traced out.

Results of the study show that the beginning buffer stock of 250,000 tons when compared with that of zero tons tends to increase the probabilities of meeting ASEAN import preferences by a greater magnitude in Year 3 of the simulation than in Year 6. This calls for a supplemental cost study which could relate the cost of starting the food program with a specified amount of rice stocks and, thus, increasing the chances of meeting the preferences.

The relevant maximum size of the buffer stock found in the study was 50,000 tons. Possible reasons for this low requirement for a buffer stock are that besides rice from the buffer stock, the model also allows the ASEAN countries to have access to the Thai private stocks and rice exports from the rest of the world.

Release percentages of the buffer stock were found to be insignificant in the study. It is believed that their effects are evened out from year to year of the study.

Increases in minimum Thai rice exports to other countries besides the ASEAN were found to reduce the probabilities of meeting ASEAN import preferences by 1 to 2 percent for every 100,000 tons. How much should this minimum Thai rice export be, depends on how much of such export Thailand feels necessary to maintain for the sake of its trading and political relationships with others.

Finally, needed revisions for the improvement of this ASEAN rice security reserves model include more reliable data from the participating

countries, the inclusion of the role of price in the demand and supply analysis and the consideration of other country stocks besides Thailand.

Nutritional Impacts of Development Policy

Economists have been made increasingly aware that consumption measures of food intake may not reflect the true nutritional status of rural households. Further, development economists are becoming increasingly aware that certain development policies themselves may adversely or positively affect the nutritional status of households at risk of malnutrition. The research in this area was initiated at the request of the Director of the DAE because of such nutritional concerns. The DAE is also represented on various committees responsible for the formulation of nutrition policy for Thailand.

To date the work on the nutrition aspect of the agricultural sector modeling has been limited to the construction of minimum cost diet models. These models have been useful in determining which nutrients are likely to be limiting or deficient in the diet of any particular income group and which foods are the cheapest source of these scarce nutrients.

However, the minimum cost diet may not be very appealing. A simple method of modifying the linear programming model has been devised so that consumers' preferences are considered in the selection of foods which meet nutritional requirements. The long-range objective of this study is to explore the nutrition-related consequences of economic development policy.

The method proposed here would assume that consumers make rational consumption choices according to conventional demand analysis. That is, consumers will adjust their consumption of each commodity according to the price of that commodity, the price of substitutes and complementary

commodities and the level of income. The functional variables will later be expanded to reflect other sociodemographic variables such as educational level of mothers, presence of health care, and presence of other community development programs.

The method proposed is to minimize the cost of changing from a diet chosen by consumers (under conventional demand analysis) to a diet which meets nutrient requirements. The approach merges conventional consumer demand theory with nutritional constraints for minimum and maximum levels of food nutrients in the diet.

While utility functions are not comparable between consumers, empirical demand relations can be constructed which give an operational means of considering consumer choices. Empirical demand relationships are commonly stated so that the quantity consumed is a function of its own price, the price of substitutes, and money income. One simple such algebraic relationship is the power function where the quantity needed (desired) of X_1 and X_2 is just a function of money income

$$X_1DES = b_1Y^{B_{13}}$$

$$X_2DES = b_2Y^{B_{23}}$$

The programming model then minimizes any change from the consumer's preferred diet to another diet which meets nutrition requirements. If the consumer's preferred diet does meet nutritional requirements, no change is made.

A schematic diagram of a simple diet model is shown in Figure 7. The model in Figure 8 contains only three commodities--rice, meat and vegetables for simplicity. The model is structured so that the diet chosen (desired)

	Rice Consumption			Meat Consumption			Vegetable Consumption		
	Rice DES	Rice INC	Rice DEC	Meat DES	Meat Increase	Meat Decrease	Veg. Desired	Veg. Increase	Veg. Decrease
Bound	FXR		UBR	FXM		UBM	FXV		UBV
Objective	0	CR	CR	0	CM	CM	0	CV	CV
Diet Cost $\leq$	CR	CR	-CR	CM	-CM	-CM	CV	CV	-CV
Protein $\leq$	a_1	a_1	$-a_1$	b_1	$+b_1$	$-b_1$	C_1	C_1	$-C_1$
Fat $\leq$	a_2	a_2	$-a_2$	b_2	$+b_2$	$-b_2$	C_2	C_2	$-C_2$
Vitamin $\leq$	a_3	a_3	$-a_3$	b_3	$+b_3$	$-b_3$	C_3	C_3	$-C_3$
Calories $\geq$	a_4	a_4	$-a_4$	b_4	$+b_4$	$-b_4$	C_4	C_4	$-C_4$

where

$FXR = A_R Y^{\beta R}$, FXR is the desired level of rice demand as given by a specified level of income. B_R is the income elasticity of demand for rice

$FXM = A_m Y^{\beta m}$, FXM is desired level of meat consumption for a specified level of income. B_m is the income elasticity of demand for meat

(UBM = FXM)

$FXV = A_v Y^{\beta v}$, FXV is the desired level of vegetable consumption for a specified level of income. B_v is the income elasticity of demand for vegetables

Figure 8. Schematic diagram of linear programming tableau of model to minimize the cost of moving to a diet which meets nutrient requirements from a diet desired on the basis of income change

by the consumer with a particular income, RICE DES, MEAT DES, and VEG DES will be chosen by the model if that diet meets all dietary restraints. The activities RICE DES, MEAT DES, and BEG DES are assigned fixed bounds. The fixed bounds are determined by the income consumption equations shown in Figure 8. Two additional activities are provided to represent increases or decreases in the desired consumption of each commodity. Activity RICE INC represents an increase in consumption from RICE DES if necessary to meet nutritional constraints. Activity RICE DEC represents a decrease in consumption of rice from the desired level if necessary to meet a nutrient constraint.

The increase and decrease activities for meat and vegetables perform similar functions.

The objective function of this problem is to minimize the cost of changing from the diet selected by the consumer to a diet which meets nutritional requirements. If the mix of commodities chosen by the consumer meets all nutritional requirements, the program will not change that diet. The second equation measures the actual cost of the diet. Since activity RICE DEC represents a decrease in rice consumption, each unit of this activity sells back the cost of one unit of rice and subtracts the contribution of one unit of rice from each nutrient constraint.

The research described above is only a beginning step in what, hopefully, will be a much larger integrated analysis of the agricultural and nutritional aspects of development. AID/W has expressed interest and agreed to provide a consultant to explore and evaluate the possibilities of extending research in the area. The users in Thailand are the MOAC for direct use in developing the agricultural plan and the planners directly responsible for developing the health and nutrition component of the Development Plan for Thailand. It is expected the results also will be of interest to the international community as world experience in this area is limited at the present time.

STAFF DEVELOPMENT

Professional development of DAE staff members has included formal training programs, in-service courses and on-the-job learning experiences. At the beginning of the project the DAE staff included one person with a Ph.D. degree (the Director), 30 staff members with training at the M.S. level and a large number of additional staff members trained at the B.S. and technical school levels.

The higher education programs include two types of training. The first category involves sending staff members to continue their education abroad while the second category involves staff members continuing their higher education in domestic institutions. The formal education programs have been strongly supported by the Agency for International Development as well as the Agricultural Development Council, FAO and the Ford Foundation. The educational qualifications of professional staff members of the DAE are summarized in Table 3.

Table 3. Educational qualifications of professional staff members of the Department of Agricultural Economics

Educational Levels	1976	1977	1978	1979	1980
Active Staff					
Ph.D. from abroad	1	3	5	10	15
M.S. from abroad	50	52	60	61	61
M.S. from Thai Univ.	10	13	16	16	16
B.S. from abroad	4	4	4	4	4
B.S. from Thai Univ.	162	162	162	162	162
In-training Staff					
Ph.D. training abroad	12	12	10	5	--
M.S. training abroad	9	9	1	--	--
M.S. training in Thailand	3	3	--	--	--

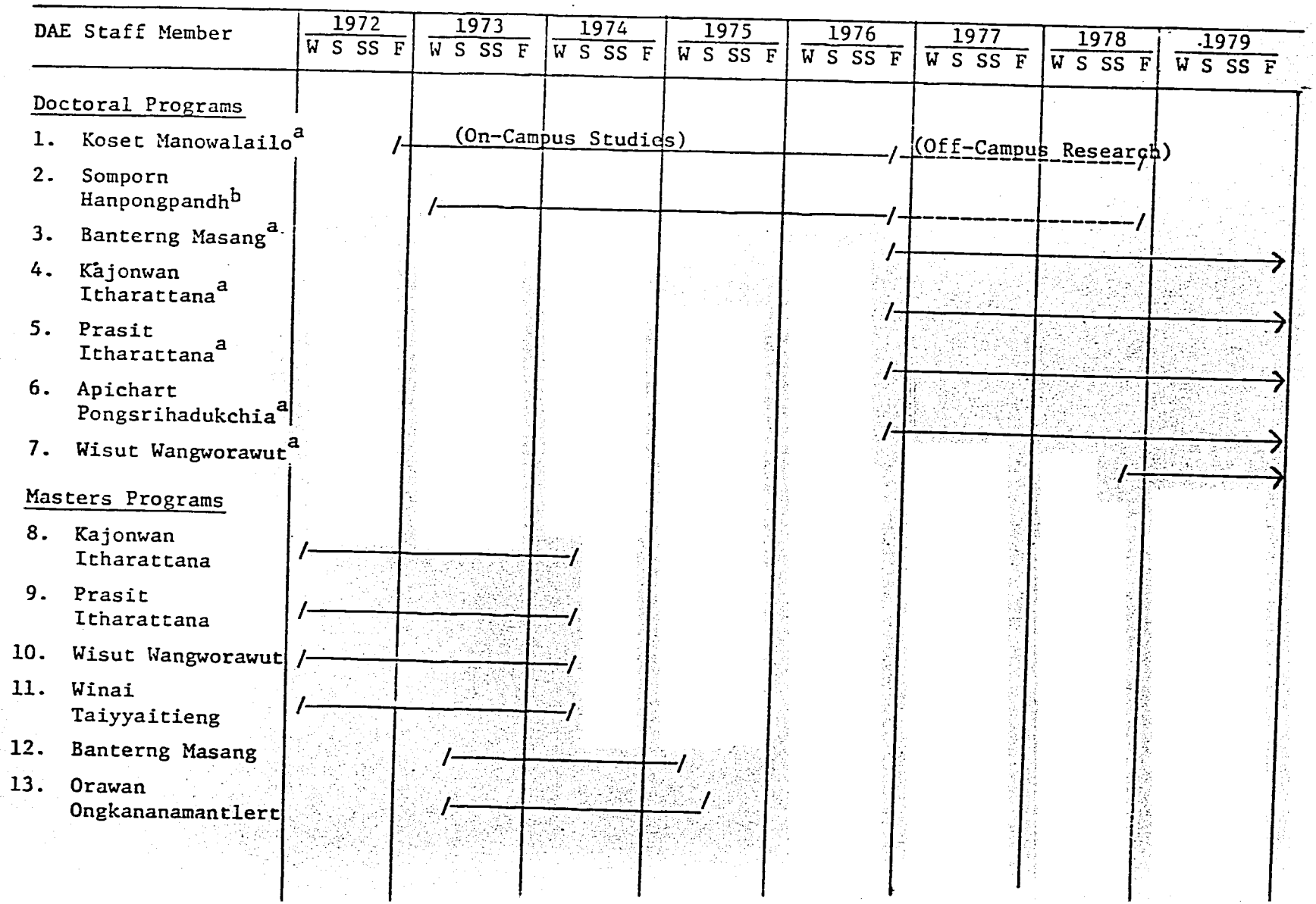
In-service training courses were offered to DAE staff members during the period of the sector analysis project. Typically, three training courses of two months duration have been offered to 20-30 staff members each year. Courses offered have included training in subject matters such as mathematics for agricultural policy economists, linear programming, computer programming, econometrics, simulation, economic theory, and statistics. The courses have improved the working ability and efficiency of participants who have also gained a better understanding of their work objectives in a more global context.

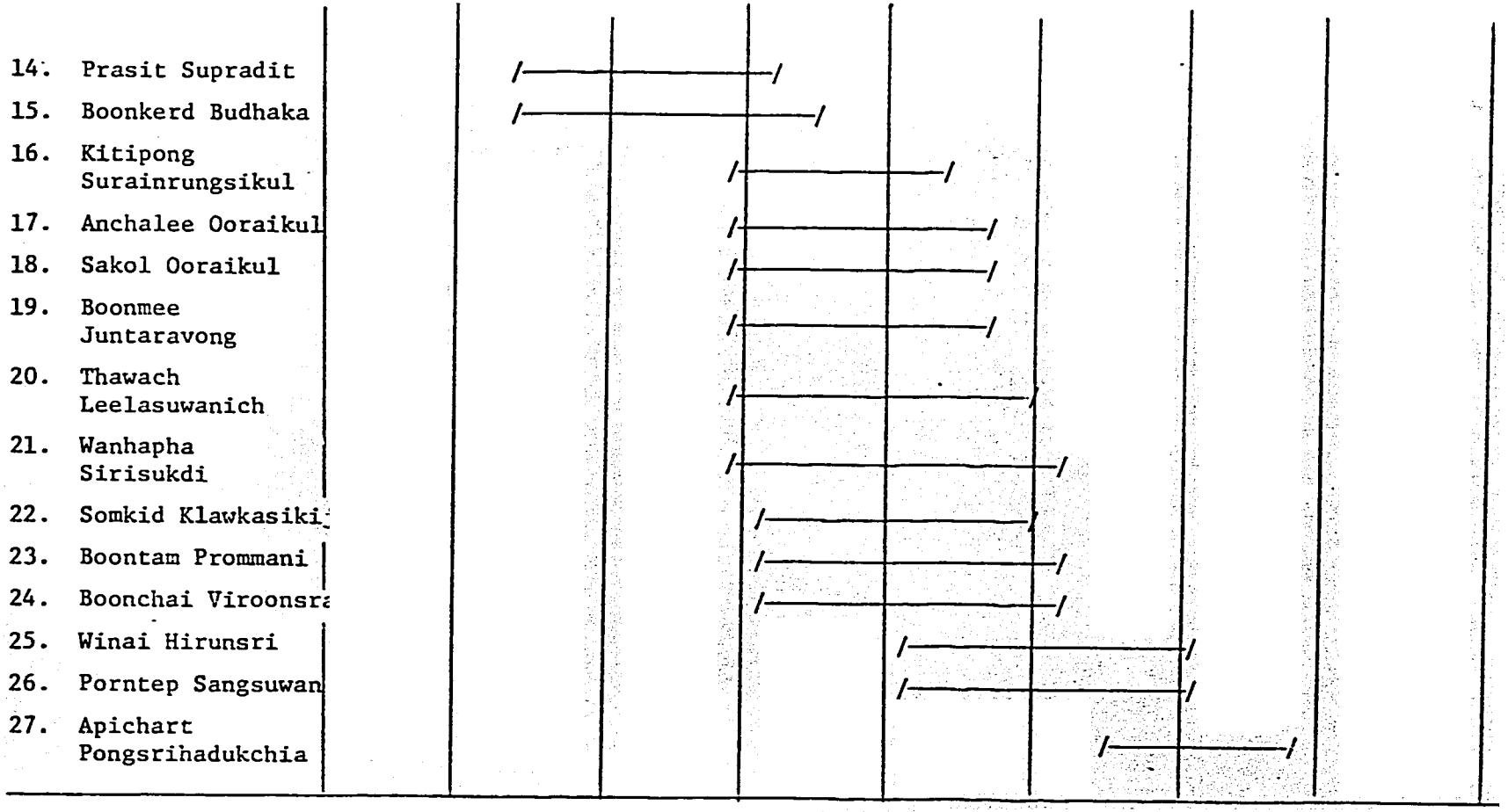
On-the-job training conducted in the DAE involved participation of both senior professionals who directed the research projects and technical staff

members who assisted them closely. Senior staff members thus had two jobs, one as researchers and the other as teachers. This practice has been followed so that technical staff members learn research methods and techniques in order to improve their ability to conduct independent research projects.

Many of the DAE staff members who received advanced training abroad participated in higher education degree programs at Iowa State University. Figure 9 provides a time-phased summary of 27 higher education programs at Iowa State University. Twenty DAE staff members have completed M.S. programs at ISU, two additional staff members completed their Ph.D. programs in fall quarter of 1978, and another five staff members are currently enrolled in Ph.D. programs.

Figure 9. Time-phased representation of graduate training programs completed, or being completed, by DAE staff members at Iowa State University, 1972 to 1979





[a]Previously completed M.S. degree at Iowa State University.

[b]Previously completed M.S. degree at North Carolina State University.

NOTE: Time lines are approximate since final work may have been completed late in a quarter with the degree awarded in absentia during the following quarter.

DISSEMINATION OF RESULTS

The major method by which results have been disseminated in Thailand and internationally was by the use of public conferences, seminars, and published reports. The public meetings, which permitted a direct interaction between the audience and the author of the paper, have worked well in Thailand where reports written in English may receive only nominal attention. The papers presented were then distributed to universities and other agencies in Thailand for further dissemination.

A listing of the seminar and conference participation by DAE-ISU team members is given in the following section. This is followed by a listing of papers and research reports from the project. The list is not complete since numerous papers written in the Thai language were presented at meetings with no ISU attendance and only nominal ISU staff participation and involvement in the preparation.

Conferences and Seminars

The methods and results of the sector analysis project in Thailand were presented at two regional meetings in South-East Asia during FY77. A paper, "Agricultural Sector Analysis Planning in Thailand," which described the project was presented by Dr. Somnuk Sriplung at a meeting of the ASEAN Agricultural Representatives in Surakarta, Indonesia, during August of 1976. The paper was well received and a resolution was adopted to establish a regional agricultural development training center in Thailand. The resolution was later approved by the ASEAN Ministers.

A joint ISU-DAE presentation of the Thailand project was made at the First Regional Agricultural Sector Analysis Seminar held during November 1976 in Singapore. The seminar was sponsored by the Agricultural Development Council. The members of the Thailand sector analysis team who attended the Singapore conference and papers presented were:

Dr. Somnuk Sriplung	"The Framework of Agricultural Development Planning Activities of DAE/ISU in Thailand."
Mr. Prapai Vongmonta	"Applications of the Regional Crop Model of Thailand."
Mr. Chomlong Sakadidee	"Livestock Model" and "Rice Transportation, Storage and Processing Model."
Dr. Herbert Fullerton	"Future Plans for Agricultural Sector Analysis in Thailand."
Dr. Charles Framingham	"Interaction between the Policy Maker and the Policy Analyst."
Dr. Arthur Stoecker	"National Crop Model of Thailand, Structure and Application."

The purpose of the conference was to share sector analysis planning experiences from countries where sector analysis projects are in process with countries which have potential interests in developing a sector analysis project. The conference was attended by representatives from Thailand, Korea, Phillipines, Malaysia, Indonesia, Pakistan and Nepal. Members of international agencies including ADC, FAO and AID also participated.

A second regional agricultural sector analysis conference was held in Cebu City, Phillipines, from November 6 to 9 of 1977. Professionals attending the conference included representatives from Korea, Japan, Malaysia, Indonesia, India, Republic of China and the Philippines. Representatives from international development agencies such as FAO, ADC, AID and the World Bank also participated in the second regional conference. Members of the Thailand sector analysis team who attended the Philippines conference and the papers presented were as follows:

Dr. Somnuk Sriplung	"ASEAN Agricultural Development Training Center."
Mr. Boontam Prommani	"Incorporating Farm Level Characteristics in Regional Models, the Thailand Case."
Mr. Kasem Sirisukhodom and Dr. Ken Nicol	"Accomodating Agricultural and Processing Sectors in Policy Analysis Using ASA Models."
Dr. Arthur Stoecker	"Structural Models for Policy Analysis."
Dr. Neal Walker	"Problems in Linking Models of Firms to Regional Models and Regional Models to National Models."

The purpose of the second regional seminar was the same as that of the preceding seminar as described previously.

Sector Analysis Publications

A. Annual Project Reports

1. Annual Report: Agricultural Sector Analysis in Thailand. FY-1974. Iowa State University, Ames, Iowa, June 1974.

2. Annual Report: Agricultural Sector Analysis in Thailand, FY-1975, DAE-CARD Sector Analysis Series No. 2, February 1977.

3. Annual Report: Agricultural Sector Analysis in Thailand, FY-1976, DAE-CARD Sector Analysis Series No. 6, June 1977.

4. Annual Report: Agricultural Sector Analysis in Thailand. FY-1977. DAE-CARD Sector Analysis Series No. 12, August 1978.

B. Conference Papers

(The Agricultural Economics Society of Thailand, Bangkok, Thailand, December 1973):

5. Research Strategies for National Agricultural Planning in Thailand by DAE and ISU Team. (Lee Blakeslee, Arthur Stoecker, Keith Rogers)

(The Food and Agricultural Organization Sector Analysis Seminar, Bangkok Thailand, 19-21 June 1975):

6. Macro and Sector Linkage Models by James A. Stephenson.

7. DAE/ISU Marketing Research in Thailand by Dennis Conley.

8. Sector Analysis Planning in Thailand by Somnuk Sripiung.

9. National Crop Model by Arthur L. Stoecker.

10. Regional Sector Analysis in Thailand by Keith D. Rogers.

11. Demand Analysis Applications by Thongchi Petcharatana.

12. Agricultural Statistics Center by Laurence Kinyon.

(The Agricultural Development Council Seminar on Agricultural Development Planning in Thailand, Bangkok, Thailand, 29-30 July 1975):

13. A National Crop Model of Thailand in B.E. 2524 by Arthur L. Stoecker and Kanok Khatikarn.

14. The Northeast Region Crop Model by Keith D. Rogers and Prasit Itharattana.

15. Zone Crop Models of the Central Region by Arthur L. Stoecker and Chamlong Sakdidee.

16. Econometric Modeling by James A. Stephenson.

17. Income Elasticity of Demand for Foods by Prasit Supradit.

18. Agricultural Demand Analysis by Thongchai Petcharattana and Leroy Blakeslee.

19. Effects of Transport Changes on Rice Agriculture by Dennis Conley and Chamnong Vatana.

20. Role of the DAE in Agricultural Development Planning by Somnuk Sriplung.

(Division of Agricultural Economics Fourth Five-Year Agricultural Development Plan Seminar, Bangkok, Thailand, 22 June, 1976):

21. Crop Model for Thailand Fourth Five-Year Plan Development Guidelines. Revised publication available under the Title National Crop Model for Thailand by A. Stoecker and K. Khatikarn, Division of Agricultural Economics, Ministry of Agriculture and Cooperatives, Agricultural Economics Research Bulletin No. 17, August B.E. 2519.

22. Thailand Fourth Five-Year Agricultural Development Plan B.E. 2524 Guidelines. Revised Publication available under the Title: Agricultural Development Planning in Thailand: Some Supporting Analysis by C. F. Framingham, A. L. Stoecker, K. Khatikarn, S. Sriplung and E. O. Heady, Iowa State University and DAE, MOAC, Royal Thai Government, February 1977.

23. Agricultural Sector Analysis Planning in Thailand by Dr. Somnuk Sriplung (Paper presented at meeting of ASEAN Agricultural Representatives in Surakarta, Indonesia August 1976).

(The First Agricultural Development Council Regional Seminar on Agricultural Sector Analysis, Singapore, Rep. of Singapore, 8-11 November, 1976):

24. The Framework of Agricultural Development Planning Activities of DAE/ISU in Thailand by Somnuk Sriplung, A. L. Stoecker and E. O. Heady.

25. Applications of The Regional Crop Model of Thailand by Prapai Vongmonta and Herbert H. Fullerton.

26. Livestock and Rice Transportation, Storage and Processing Models by Chamlong Sakdidee and Somnuk Sriplung.

27. Future Plans for Agricultural Sector Analysis in Thailand by Herbert H. Fullerton.

28. Interaction Between the Policy Maker and the Policy Analyst by Charles F. Framingham and Somnuk Sriplung.

29. National Crop Model of Thailand: Structure and Application by Arthur L. Stoecker and Kanok Khatikarn.

(The Second Agricultural Development Council Regional Seminar on Agricultural Sector Analysis, Cebu City, Phillipines, 6-9 November 1977):

30. ASEAN Agricultural Development Training Center by Somnuk Sriplung.

31. Incorporating Farm Level Characteristics in Regional Models, The Thailand Case by Boontam Prommani, Ken Nicol, Arthur Stoecker and Neal Walker.

32. Accommodating Agricultural and Processing Sectors in Policy Analysis Using ASA Models by Ken Nicol, Kasem Sirisukhodom and Somnuk Sriplung

33. Structural Models for Planning Analysis by Arthur Stoecker, Ken Nicol and Somnuk Sriplung.

34. Problems in Linking Models of Firms to Regional Models and Regional Models to National Models by Neal Walker.

DAE-CARD Sector Analysis Publications

35. Agricultural Employment and Migration in Northeast Thailand: Application of a Regional Planning Model, Center for Agricultural and Rural Development, Iowa State University, DAE-CARD Sector Analysis Series No. 1, December 1976 by Keith Rogers and Prasit Itharattana.

36. Macro Econometric Analysis of Economic Activity in Thailand, 1962-1974 by James A. Stephenson and Kajonwan Itharattana, Center for Rural and Agricultural Development, Iowa State University, DAE-CARD Sector Analysis Series No. 3, March 1977.

37. Agricultural Development Planning in Thailand: Some Supporting Analysis by Charles Framingham, Arthur Stoecker, Kanok Khatikarn, Somnuk Sriplung and Earl Heady, Center for Agricultural and Rural Development, Iowa State University, DAE-CARD Sector Analysis Series No. 4, March 1977.

38. Kenaf Demand in Thailand by Leroy Blakeslee L. and Thongchai Petcharatana, Center for Rural and Agricultural Development, Iowa State University, DAE-CARD Sector Analysis Series No. 5, June 1977.

39. Singapore Symposium: Agricultural Sector Analysis in Thailand, (Papers presented at the First Regional Seminar on Sector Analysis in Singapore) Center for Rural and Agricultural Development, Iowa State University, DAE-CARD Sector Analysis Series No. 7, July 1977.

40. Agricultural Supply Response in Northeast Thailand: Production, Resources, Income, and Policy Implications by Rogers, Keith and Prasit Itharattana, Center for Agricultural and Rural Development, Iowa State University, DAE-CARD Sector Analysis Series No. 8, October 1977.

41. Potential Effects of Changes in Truck Transportation on the Value of Production and Incomes in Thailand's Rice Agriculture by Dennis Conley, Chamnong Vathana and Earl O. Heady, Center for Agricultural and Rural Development, Iowa State University, DAE-CARD Sector Analysis Series No. 9, March 1978.

42. Consumer Demand for Food Commodities in Thailand by Bahram Dadgostar et al., Center for Agricultural and Rural Development, Iowa State University, DAE-CARD Sector Analysis Series No. 10, March 1978.

43. Structure of a Recursive Model for Policy Analysis in Thailand by A. L. Stoecker, Ken Nicol, Somnuk Sriplung, Center for Agricultural and Rural Development, Iowa State University, DAE-CARD Sector Analysis Series No. 11, August 1978.

44. A Normative Study of the Supply Response of Rice in Thailand by Doeke C. Faber, Earl O. Heady, Wayne D. Ellingson, A. L. Stoecker, and Kenneth J. Nicol, Center for Agricultural and Rural Development, Iowa State University, DAE-CARD Sector Analysis Series No. 13, August 1978.

45. A Simulation Model of World Rice Economy with Special Reference to Thailand by Hiren Sarkar, Center for Agricultural and Rural Development, Iowa State University, DAE-CARD Sector Analysis Series No. 14, August 1978.

46. A National Crop Model of Agriculture in Thailand: A Mathematical Programming Approach by Arthur L. Stoecker, Center for Agricultural and Rural Development, Iowa State University, DAE-CARD Sector Analysis Series No. 15, February 1979.

PROJECT PERSONNEL

The agricultural sector analysis project in Thailand was a team effort. Both long-term and short-term personnel from Iowa State University served as an integral part of the Division of Agricultural Economics staff. Approximately 100 members of the DAE staff worked directly with ISU team members during the contract period. Many additional DAE staff members were indirectly associated with the project. Among the four subdivisions of the DAE, namely, Administration and Regional Agricultural Economics Branch, the Agricultural Policy and Planning Branch, the Agricultural Economics Research Branch, and the Center for Agricultural Statistics, principal interations with ISU staff occurred with the latter three subdivisions.

The resident ISU team varied from 3 to 6 professionals during the contract period. Twenty short-term consultations provided additional support to the project. More than 24 man-years of professional staff time was assigned to project activities in Thailand during the contract period. Staff inputs of ISU personnel are shown in Table 4. Figure 10 shows the seven positions in which the eleven long-term ISU staff members served along with the name and period of participation of each individual professional.

Table 4. Summary of ISU Staff Inputs in Thailand Shown in Order of Dates of Service From Initiation of Project Through June 30, 1979

	Name	Position	Assignment	Person/ Months
1.	Dr. Keith D. Rogers	Chief of Party, Resource and Regional Development	7/18/73-7/13/75	23.7
2.	Dr. Earl O. Heady	Senior Technical Advisor	7/21/73-8/31/73	1.3
3.	Dr. Leroy L. Blakeslee	Demand and Agricultural Projection	8/1/73-2/1/75	18.0
4.	Dr. Arthur L. Stoecker	Linear Programmer & Chief of Party 7/1/75 - 6/30/77	8/5/73-8/18/77	48.5
5.	Dr. Jerry A. Fedeler	Marketing and Participant Training	1/14/74-2/16/74	1.0
6.	Dr. Dennis M. Conley	Agro-Industry, Marketing, Transportation	1/26/74-2/8/76	25.0
7.	Dr. Earl O. Heady	Senior Technical Advisor	4/9/74-4/25/74	0.5
8.	Dr. Earl O. Heady	Senior Technical Advisor	7/2/74-8/20/74	1.6
9.	Dr. J. T. Scott	Marketing Consultant	7/16/74-7/31/74	0.5
10.	Mr. Lawrence Kinvon	Research Statistician	7/22/74-7/3/78	47.5
11.	Dr. James A. Stephenson	Applied Econometrician	8/29/74-8/6/76	23.0
12.	Dr. Jerry A. Fedeler	Marketing and Contract Negotiation	12/4/74-12/21/74	0.6
13.	Dean Lee Kolmer	Administration Visit	2/17/75-2/22/75	0.3
14.	Dr. J. T. Scott	Marketing Consultant	2/17/75-2/22/75	0.3
15.	Dr. Charles F. Framingham	Policy Analyst	7/28/75-12/6/76	17.0
16.	Dr. Leroy L. Blakeslee	Demand Consultant	8/16/75-9/7/75	0.7

Table 4 continued.

	Name	Position	Assignment	Person/ Months
17.	Dr. Earl O. Heady	Senior Technical Advisor	12/5/75-12/12/75	0.3
18.	Dr. Herbert Fullerton	Regional Economist	1/8/75-6/6/75	17.6
19.	Dr. Leroy Blakeslee	Demand Consultant	4/5/76-4/25/76	0.7
20.	Dr. Keith D. Rogers	Regional Consultant Acting Chief of Party	6/5/76-7/24/76	1.6
21.	Dr. Kenneth Nicol	Policy Analyst & Chief of Party 7/1/77 - 6/23/78	1/9/77-6/23/78	17.5
22.	Dr. Neal Walker	Linear Programmer	1/18/77-6/17/78	17.0
23.	Dr. Earl O. Heady	Administrative Visit	2/28/77-3/8/77	.3
24.	Dr. James A. Stephenson	Macroeconomist	6/1/77-7/2/77	1.0
25.	Dr. Keith D. Rogers	Demographic Consultant	7/1/77-7/30/77	1.0
26.	Dr. Randall A. Hoffmann	Administrative Visit	7/16/77-7/27/77	0.3
27.	Dr. Leroy Blakeslee	Demand Consultant	7/25/77-8/13/77	0.7
28.	Dr. Arthur L. Stoecker		10/10/77-11/10/77	1.0
29.	Dr. Wayne D. Ellingson		11/1/77 4/30/79	8.0
30.	Dr. Herbert Fullerton		5/24/78-6/5/78	0.3
31.	Dr. Arthur L. Stoecker		6/2/78 7/31/78	1.0

Table 4 continued.

	Name	Position	Assignment	Person/ Month
32.	Dr. Wilbur Maki	Social Accounts Consultant	6/25/78-7/22/78	1.0
33.	Dr. Earl O. Heady	Administrative Visit	7/22/78-8/1/78	0.3
34.	Dr. Kenneth J. Nicol	Policy Analysis Consultant	12/04/78 12/18/78	0.5
		GRAND TOTAL: Person/Months		290.6
		Person/Years		24.2

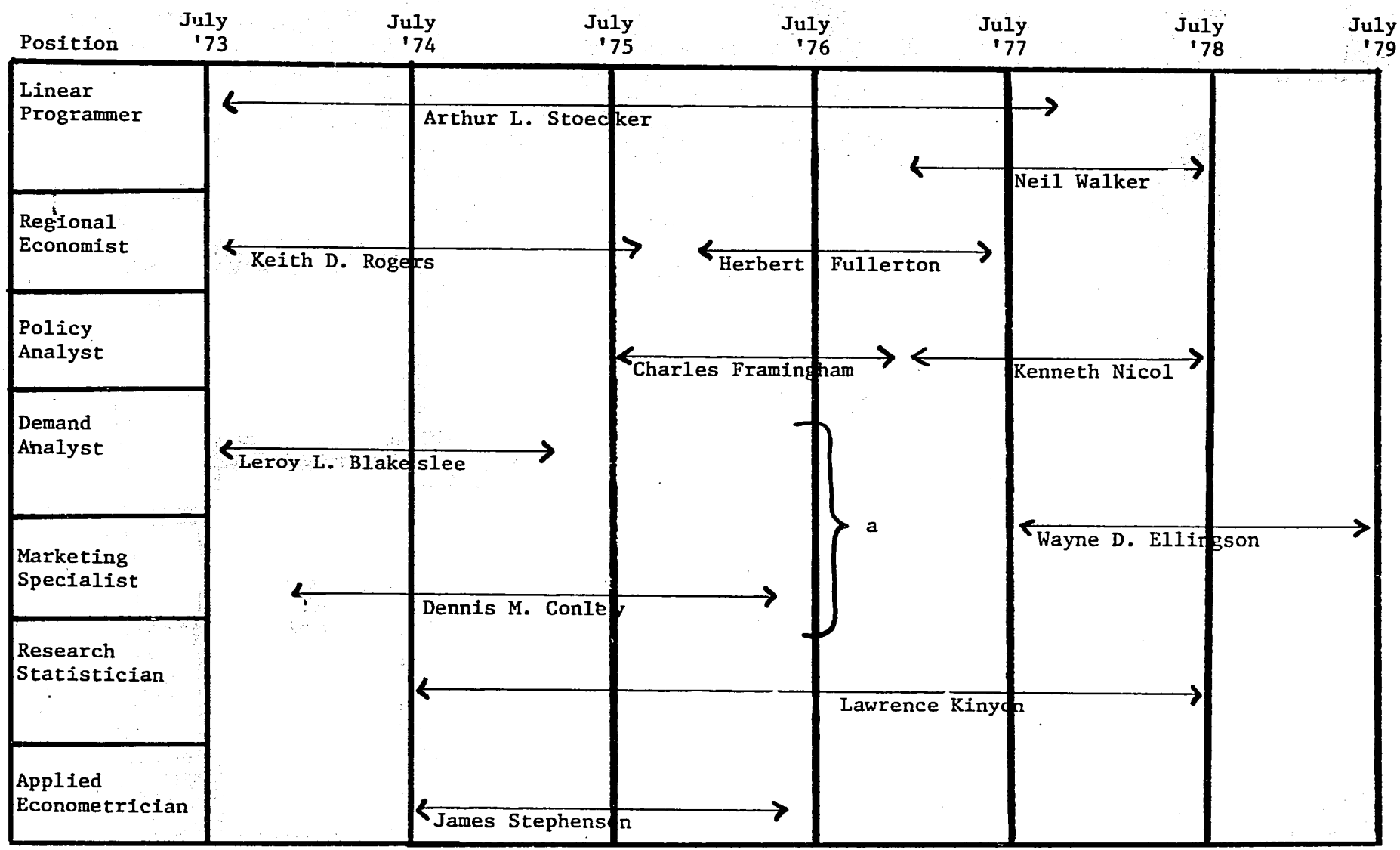


Figure 10. Long-term staff assigned to the Agricultural Sector Analysis Project in Thailand

[a]Positions combined.

PROJECT EVALUATION RESULTS

Three major evaluations of the project were carried out during the life of the project. The issues considered in the evaluations were similar in that all of the evaluations were concerned with: (1) validity and appropriateness of the analytical work and data; (2) contributions to policy; and (3) institutionalization.

The methods used in the evaluations also were similar. In each case a joint Thai-U.S. evaluation team was assembled in Bangkok for a period of up to two weeks. The team members attended formal briefing sessions featuring presentations by DAE-ISU project staff, talked in depth with the staff, reviewed written project materials, interviewed users and others outside the DAE having a concern for the project, and conferred among themselves to reach a team consensus. In every evaluation, the team met with DAE-ISU sector analysis staff for an oral debriefing and a summarization of major project evaluation conclusions.

The third project evaluation was carried out in Bangkok during the last week of July and the first week of August, 1978. The third evaluation differed somewhat from the first two, not only in coming at the end of more than a year of additional effort, but in being charged with considering overall accomplishments of the project since its initiation in 1973. The team also was asked to give more attention to rural poverty than previous evaluations because of an increase in the policy concern for the rural poor by both the Thai and U.S.

governments. The team further was requested to examine how the project has addressed the needs of those on Thailand's smaller farms and to make recommendations in this context on how best to meet the needs of the rural poor in the future.

Members of the 1978 project evaluation team were as follows:

Dr. Warin Wonghanchao (Co-Chairman)
Dean of the Economics Faculty
Chulalongkorn University

Dr. Georgy S. Tolley (Co-Chairman)
Professor of Economics
University of Chicago

Dr. Tongroj On-chan
Professor of Agricultural Economics
Kasetsart University

Mr. Sombong Pattamavichaiporn
Technical Services Division
Department of Technical and Economic Cooperation
Royal Thai Government

The 1978 project evaluation team met first with DAE-ISU staff members to finalize the terms of reference. Subsequently the evaluation team attended briefing sessions on the project, reviewed written program reports, and consulted individually with DAE-ISU staff members. A summary of program reports prepared by DAE-ISU personnel for the 1978 evaluation is found in Table 5.

A final report entitled, "Agricultural Sector Analysis in Thailand: 1978 Evaluation of the Five-Year Report," was prepared by the Project Evaluation Team and submitted to USAID/Thailand in October of 1978. The report confirmed the successful accomplishment of project goals and

Table 5. Summary of program reports prepared by DAE-ISU personnel for the 1978 evaluation.

Author	Report Title
Mr. Narong Sorthang	National Crop Model.
Dr. Koset Manowalailao	Summary of the National Crop and Bovine Model of Thailand.
Mr. Praphai Wongmontha	The Regional Crop Model of Thailand.
Mr. Wayne D. Ellingson	Commodity Demand Analysis.
Mr. Chamnon Watana	Transportation, Storage, and Processing Model for Rice.
Dr. James A. Stephenson and Mrs. Kajonwan Itharattana	Macroeconometric Analysis of Economic Activity in Thailand, 1967-1974.
Miss Yaovares Banduknl	Linkage Between the Macroeconometric Model and the Recursive National LP Model.
Mr. Boontham Prommanee	Farm Level Models.
Mr. Kasem Sirienkhodum	Support Sectors for Agriculture.
Dr. Kenneth Nichol and Dr. Somnuk Sriplung	Incorporating Rural Development Parameters in the DAE Sector Analysis Capability.
Mr. Vinar Taryarthieng	Demographic Model.
Dr. Somporn Hanpongpandh	Asean Rice Security Reserves: A Simulation Approach.
Mr. Vinia Hirunsri	Statistical Center Activities and Computer Services.
Mr. Narrong Chuptokob	Policy Capabilities Supported by ASA Project Models.

effective utilization of project output. The following evaluation statements were included among the numerous positive findings of the 1978 Project Evaluation Team:

> In the opinion of the review team, the project has succeeded in its mission of establishing a high caliber operation capability by applying agricultural economics analysis to government policy problems in an action setting.
>
> The basic economic logic underlying the modeling of the agricultural sector is sound and the results obtained are reliable.
>
> Models have been used in a variety of ways to aid policy making at the national and local levels.
>
> Most of the activities of the project have impacted rural poverty because of the emphasis on incomes in agriculture and low income regions such as the Northeast.
>
> The capability which has been developed has been successfully institutionalized.
>
> Because an influence on major policies affecting agriculture is achieved by a project of this kind at low cost, relatively speaking, it is a cost effective way of promoting agricultural and income distribution objectives and thus is cost effective in favorably affecting the lives of Thai rural farmers.
>
> From the many actual uses of the project tools in policy making, it is clear the project has been highly successful.
>
> Agricultural Sector Analysis as developed in the project is an operational policy tool. The results are used directly for policy and not primarily for those in the academic community or others who might, or might not, take the extra step of making the results policy relevant.
>
> The project has trained people, adding to the intellectual assets of Thailand. It has contributed to the upgrading of an arm of government through its direct and indirect effects on the DAE.

> Finally, the project has added a new component to the agricultural economics profession in Thailand. The by-product of interactions of Agricultural Sector Analysis personnel with other agricultural economists enhances the agricultural economics profession in the nation and contributes to the ultimate wider development of research knowledge about the agricultural economy of the country.

The 1978 Project Evaluation Team made ten recommendations for future implementation. The first recommendation dealt specifically with future project requirements, as follows:

> 1. Additional technical assistance will be needed to complete the development of models nearing completion. This could be done by temporary consulting help.
>
> If the full development of rural development and poverty capability is to take place, a full-fledged continuation of the project would be necessary with a resident team.

The professional and support resources necessary for fully implementing this recommendation are described in, "Analysis of the Agricultural Sector: Agricultural and Integrated Rural Development Analysis," proposal submitted to the Agency for International Development for extending and expanding the scope of work and implementation of project activities initiated under contract No. AID/CM/SA-C-73-19, Center for Agricultural and Rural Development, Iowa State University, Ames, Iowa, March 1978.

The remaining nine recommendations were primarily concerned with administrative procedures such as upgrading of the Division of Agricultural Economics and improving two-way communication with other government agencies and with the academic communities in both the public and private sectors. These recommendations are summarized on

pages 77 to 79 of the 1978 project evaluation report, "Agricultural Sector Analysis in Thailand: 1978 Evaluation of the Five-Year Report," Bangkok, Thailand, October 1978.

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DAE-CARD SECTOR ANALYSIS SERIES

No. 1. Rogers, Keith D. and Prasit Itharattana. "Agricultural Employment and Migration in Northeast Thailand: Application of a Regional Planning Model." December 1976.

No. 2. Center for Agricultural and Rural Development. "Annual Report: Agricultural Sector Analysis in Thailand." February 1977.

No. 3. Stephenson, James A. And Kajonwan Itharattana. "Macroeconometric Analysis of Economic Activity in Thailand, 1962-1974." March 1977.

No. 4. Framingham, Charles F. et al. "Agricultural Development Planning in Thailand: Some Supporting Analysis," March 1977.

No. 5. Blakeslee, Leroy and Thongchai Petcharatana. "Kenaf Demand in Thailand." June 1977.

No. 6. Center for Agricultural and Rural Development. "Third Annual Report: Agricultural Sector Analysis in Thailand." June 1977.

No. 7. Center for Agricultural and Rural Development. "Singapore Symposium: Agricultural Sector Analysis in Thailand." July 1977.

No. 8. Rogers, Keith and Prasit Itharattana. "Agricultural Supply Response in Northeast Thailand: Production, Resources, Income, and Policy Implications." October 1977.

No. 9. Conley, Dennis M., Chamnong Vathana and Earl O. Heady. "Potential Effects of Changes in Truck Transportation on the Value of Production and Incomes in Thailand's Rice Agriculture." March 1978.

No. 10. Dadgostar, Bahram et al. "Consumer Demand for Food Commodities in Thailand." March 1978.

No. 11. Stoecker, A. L., Kenneth Nicol, and Somnuk Sriplung. "Structure of a Recursive Model for Policy Analysis in Thailand." August 1978.

No. 12. Stoecker, A. L., Earl O. Heady, and Randall A. Hoffmann. "Fourth Annual Report: Agricultural Sector Analysis in Thailand." August 1978.

No. 13. Faber, Doeke C., Earl O. Heady, Wayne D. Ellingson, A. L. Stoecker, and Kenneth J. Nicol. "A Normative Study of the Supply Response of Rice in Thailand." August 1978.

No. 14 Sarkar, Hiren. "A Simulation Model of the World Rice Economy with Special Reference to Thailand." August 1978.

No. 15 Stoecker, A. L. "A National Crop Model of Agriculture in Thailand; A Mathematical Programming Approach." March 1979.

No. 16 "Final Report: Agricultural Sector Analysis in Thailand." April 1979.

For a complete listing of all Center publications, write the Center for Agricultural and Rural Development, 578 East Hall, Iowa State University, Ames, Iowa 50011.

THE END