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A STRATEGY FOR AGRICULTURAL DEVELOPMENT IN THAILAND AND ITS MANPOWER REQUIREMENTS

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Foreword

This paper was prepared as a part of a Midwest Universities Consortium for International Activities, Inc. (MUCIA) study of Agricultural and Veterinary Education, Research, and Extension in Thailand. The members of the study team were as follows:

George H. Axinn, General Director (Michigan State)
William B. Drew, Field Team Leader (Michigan State)
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Bill A. Stout, Agricultural Engineering (Michigan State)
Peter I.Tack, Fisheries (Michigan State)
M. M. Wagner, Agricultural Economics (Illinois)

Each of the last eleven prepared an individual report on his specialty, and each of these is available from MUCIA, 200 Center for International Programs, Michigan State University, East Lansing, Michigan 48823. The over-all report, prepared by General Director George Axinn from the eleven individual reports. This report is entitled Serving Agriculture in Thailand, and is also available from MUCIA.

I profited handsomely from reading the reports of the other ten, and from lengthy discussions with all but Sautter who had left before I arrived. I profited most from my discussions with my traveling companion, M.B. Russell, and with Dr. Delane E. Welsch of the Rockefeller Foundation in Thailand, and with Dr. George W. Hill, then ILO Consultant to the National Economic and Social Development Board. None of these is implicated in the conclusions I reached.

I am indebted to the secretaries of the MUCIA Project and to the secretaries of MUCIA Headquarters in East Lansing for typing earlier drafts of the report. Thanks are due to Linda Schwartz and Elizabeth Postigo of the Department of Agricultural and Applied Economics who typed the final draft.

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Part I.

Opportunities for Agricultural Development in Thailand

Thailand faces an almost unique set of opportunities for agricultural development during the next two decades.[1/] One of these opportunities is to achieve an increase in agricultural output (measured in constant bahts) of 50 per cent or more. The second major opportunity is to achieve these large increases in output while increasing labor force employment in agriculture, and income per family from agriculture.

1. Increasing Agricultural Output

Two alternatives exist for increasing agricultural output. The lesser alternative is to bring additional land into cultivation. There are reported to be approximately 20 million rai that could be brought under cultivation.

The more important alternative is to achieve dramatic increases in crop yields per rai. Crop yields in Thailand are quite low, not only in comparison with developed countries, but also in comparison with other countries in Southeastern and Eastern Asia.

1/ Throughout this paper agriculture is broadly defined to include what in Thailand is sometimes defined separately as agriculture, cooperatives, fisheries, forestry, agricultural aspects of irrigation, livestock, veterinary science, and family economics.

There are two important ways by which Thai yields can be increased. One is by successful adoption of bio-chemical technology -- the use for crops now grown in Thailand of better varieties, more fertilizer, pesticides, and making the optimum quantities of moisture available to the optimum plant population.

The second way to increase yields is made possible by the fact that Thailand has a 365-day growing season. On lands where water can be made available during the dry season, multiple cropping (two or more crops per year) in combination with higher single-crop yields per rai will bring output increases of 50 per cent or more within reach in 20 years or less. Realization of the gains from multiple cropping will require a rapid development of the irrigation potential of Thailand.

The Wagner Report on Agricultural Economics describes Thai agriculture and the conditions under which it takes place well. We won't develop the concepts expressed above any further, except in connection with justifying the suggestions made in this report for achieving the targeted output increases.

2. Increasing Agricultural Employment and Income per Capita

Perhaps more unusual among the developing countries is the opportunity to achieve the output targets while increasing agricultural employment and simultaneously increasing agricultural income per family and per person. We will take the necessary time to show in some detail the necessity for achieving the output targets while preserving a small-scale agriculture.[2/]

2/ Measuring farm scale in rais.

Over-all Manpower Situation in Thailand. By a medium-level NESDB estimate of growth, total population is estimated to increase from 36 million in 1970 to 48.6 million in 1980 and nearly 55.5 million in 1985. (Table 1). The labor force participation rate declined from 85.5 percent of the population 15 years and over in 1960 to 80.6 percent in 1970. Even if the participation rate continue to decline gradually to 77.8 percent in 1985, the labor force will grow from 16.2 million in 1970 to 25.3 million in 1985 (Table 1), an increase of 9 million or almost 56 percent in 15 years.

Even if the nonagricultural percentage of total employment increases further from 22.2 percent in 1970 to 25.2 percent in 1985, the actual number of nonagricultural employees will increase only from 3.6 million in 1970 to 6.4 million in 1985 (Table 1). These appear to be liberal estimates because nonagricultural employment grew about 1.25 million from 1960 to 1970, a period of very rapid growth in the nonfarm sector.

If,as seems likely, the remainder of the labor force must be employed in agriculture to be employed at all, then agricultural employment must rise from 12.6 million in 1970 to 18.9 million in 1985 (Table 1), an increase of a almost 50 percent in fifteen years.

Even if we accept the liberal Fuhs and Vingerhoets (2) estimates of an employment increase in forestry and fisheries from 455 thousand in 1970 to 918 thousand in 1985, we are left with an increase in the farm (crop and livestock) labor force from 12.2 million in 1970 to 18 million in 1985 (Table 2), an increase of about 48 percent in 15 years. Because of the expected reduction in the average size of families, the number of farm

Table 1. Population, Labor Force and Employment Data for Thailand, 1960-1985 (in thousands)

Year	Total Population	Labor Force, 15 and over	Nonagricultural employment	Agricultural employment
1960	26,500	12,730	2,339	10,391
1970	36,032	16,243	3,600	12,643
1975	42,061	18,715	4,360	14,555
1980	48,616	21,739	5,253	16,486
1985	55,451	25,282	6,362	18,920

Source: NESDB for population and labor force data; nonagricultural employment from Fuhs and Vingerhoets (2)*, based on the NSO Labor Force Survey of 1969.

*Numbers in parentheses refer to the numbered references at the end of this Annex.

Table 2. Employment, Labor Force and Land Data for Thailand 1960-1985 (in thousands)

Year	Agricultural employment	Employment in forestry and fisheries	Farm labor force	Number of farm families	Arable area
		(thousands)			(million rai)
1960	10,391	140	10,251	3,698	56.1
1963	n.a.	n.a.	n.a.	3,900	61.7
1970	12,643	455	12,188	4,375	69.0
1975	14,555	607	13,748	5,060	74.6
1980	16,486	772	15,711	n.a.	n.a.
1985	18,920	918	18,002	6,776	78.5

Source: Fuhs and Vingerhoets (2) *

n.a.: not available

*Numbers in parentheses refer to the numbered references at the end of the Annex.

families would increase at a more rapid rate (55 percent) than the farm labor force.

Using FAO data, Fuhs and Vingerhoets (2) estimated that arable land could be increased by 16.8 million rai from 1963 to 1985, 9.5 million rai from 1970 to 1985.[3/] The growth rate in arable land during the 1960-67 period was less than one-half of what it had been in the 1953-60 period (31 percent). Using an average of 15 rai of land per family, the 9.5 million rai would provide farm employment for 0.6 million of the 2,876 million additional farm families that will be formed in 1963-85 period. When they found in the 1963 Census of Agriculture that 35 percent of the farm holders owned 20 rai or more, Fuhs and Vingerhoets (2) assumed that these larger holdings could be divided up to provide farms for approximately another million families. This would leave at least 800,000 farm families unprovided for.

Even for the 600 thousand families on new land, for the million new farms created by subdividing existing "large" holdings, or for the 2.9 million "undisturbed" farms (many less than 5 rai), it will be difficult to achieve an increasing level of living. One-tenth of the families will be on new farmsteads, created out of lands not considered suitable for opening up to agricultural development earlier, even given the energy of large number of Thai farmers in search of better economic opportunities. The subdivided farms will need to produce nearly twice as much per rai just

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3/ The higher figure used in an earlier summary (p. 2) came from an unofficial estimate by an officer of the Land Development Department, MOAC. It seems reasonably clear that 20 million rai is an upper limit to the area of additional land that could be brought under cultivation.

to provide the same level of living as before. Many of the 2.9 million farms not considered to be large enough for subdivision will nevertheless have more members of the family and will have to increase output per rai rapidly in order to improve the consumption level per person.

It becomes clear, then, that even to hold per-person consumption levels for the farm population at current levels will require steady and significant increases in output per rai. What is needed is both a "yield" and a "multiple cropping" revolution. Yields per rai for each crop grown will have to be increased steadily, with the productivity gains coming from: new varieties; better moisture control; more effective control over insects, plant diseases, and weeds. This will require a high quality of research, extension, and better general and technical education for the next generation of farmers in Thailand.

The second revolution that will be required in Thai agriculture is "multiple cropping." The Thai farmer enjoys a 365-day growing season; the requirements for two, three or even more crops per year on each rai are moisture and the appropriate technology. This would include varieties with fewer days to maturity, uniformly maturing varieties, enough equipment for timely performance of the required field operations, and most important, control over the moisture available to the field crops. As before this second revolution will require a high quality of research, extension, and both technical and general education for the farmer.

In effect, these two revolutions could be combined into a "labor-intensive" Green Revolution. Every effort should be made to avoid the substitution of capital for labor, except that necessary to effect the

multiple cropping revolution. The mechanical equipment that would be encouraged would be that appropriate for the highly productive cultivation of a family farm in the 5-10 rai category. In many cases, this might be a low-horsepower, two-wheeled tractor and the related necessary equipment, that might include a low-lift irrigation pump. Services from a larger tractor might be available on a custom basis in regions where these would be required for establishing the multiple cropping system, or for preparing the land for first planting.

The potential effects that yield increases and multiple cropping systems might have on family incomes (and farm output) can be illustrated in Table 3, which gives the economic results of some multiple cropping experiments conducted at Chiang Mai University. These results were obtained from four cropping systems tested with 1972-73 output prices and with medium-term average prices that were lower than the favorable 1972-73 prices. These net revenues were obtained from one rai of land. The management and nitrogen levels believed to be required for the four different cropping systems are shown in the last two columns of Table 3.

At 1972-73 prices the high-management, high-nitrogen production system produced the largest net revenue of 5,142 baht per rai, with the medium-management, medium-nitrogen system close behind at 4,822 baht per rai. At the lower prices, the high-management system was still highest with 1,824 baht, the low-management grain system next at 569 baht. Because of relatively low rice price in each set of price assumptions, rice made little contribution to net revenue under the 1972-73 price assumptions, with negative income under the medium-term assumptions. It is expected that

Table 3. Economic Analysis of Chiang Mai Multiple Cropping Experiments

System	Enterprise	Total Cost	Revenue in 1972-73 Prices		Revenue in Medium Term Prices		Management Level	Nitrogen Level
			Gross	Net	Gross	Net		
	Rice	934	1,108	174	639	-295		
1	Wheat	747	1,440	693	1,200	453	low	low
	Corn	689	1,830	1,141	1,098	409		
	Total	2,370	4,378	2,008	2,937	569		
	Rice	934	1,271	337	734	-200		
2	Tomatoes	2,251	6,286	4,035	2,357	106	medium	medium
	Mungbeans	450	960	510	720	270		
	Total	3,635	8,517	4,882	3,811	176		
	Rice	934	1,230	296	710	-224		
	Snapbeans	704	965	261	772	68		
3	Soybeans	396	1,400	1,004	920	524	medium	low
	Total	2,034	3,595	1,561	2,402	368		
	Rice	934	1,230	296	710	-224		
4	Potatoes	2,163	4,554	2,391	2,846	683	high	high
	Cabbage	1,126	2,482	1,356	1,986	860		
	Sweet corn	136	1,238	1,009	644	505		
	Total	4,359	9,504	5,142	6,186	1,824		

Source: Multiple Cropping Project, Chiang Mai University, June 1974.

farmers would continue to grow rice for some time because it is a staple item in the diet of Thai farm households. Eventually specialization under economic growth would reach a point that many farmers would grow for the market what would maximize their income and purchase rice and other consumption items in the market.

In Chiang Mai province the average size of farm is 7.5 rai. Table 4 shows the estimates of the incomes that might be generated by the four multiple cropping systems on a 7.5-rai farm in Chiang Mai province. Systems 4 (the high-management system) and 2 produce very high incomes under the very favorable 1972-73 prices while systems 4 and 1 (the low-management grain system) do well under the much less favorable medium-term average prices. System 4 produces 4 crops that are sources of income -- rice, potatoes, cabbage and sweet corn. Sweet corn is relay planted in the cabbage before the cabbage is harvested.

Two points should be made with respect to the estimates shown in Tables 3 and 4. Several of the commodities (tomatoes, snapbeans, cabbage, and sweet corn) are not storable without processing. It would be comparatively easy in a region like Chiang Mai to overproduce enough nonstorables to bring farm prices down to low levels.

One solution would be to establish processing facilities for the nonstorables, and this is now being done in the Chiang Mai-Lampang area.

Because rice, wheat, corn, and soybeans are exportable crops, additional farm production would not be likely to depress these prices unless the additional output exceeded the capacity of the marketing system to handle the total production.

Table 4. Estimated Incomes Generated by Four Multiple Cropping Systems on 7.5 -- Rai Farms in Chiang Mai, Under Two Price Assumptions.

System	Price Assumptions	
	1972-73 Prices	Medium-Term Average
	(baht)	
1	15,560	4,268
2	36,615	1,320
3	11,708	2,760
4	38,565	13,630

Source: Computed from Table 4.

The results outlined in Tables 3 and 4 involve higher yields than Chiang Mai farmers usually achieve because the best adapted varieties were selected in varietal trials, the optimum fertilizer applications were selected in fertilizer trials, optimum irrigation and plant protection practices were selected, and so on. To achieve the economic results shown in Tables 3 and 4 farmers would have to achieve the high yields behind the results, and this will be a great challenge to farmers and extension workers.

The remainder of the economic gains that are not due to higher yields are due to the multiple cropping -- in most cases a much more intensive utilization of the land and labor available to the farm family. It should be emphasized that the higher incomes shown can be achieved only by more labor (greater efforts) on the part of the farm family. Not only is more work required of the family but the timeliness of the production operations is also much more important than under the traditional system. A second challenge to extension workers is to motivate farmers to invest more labor and to pay much greater attention to the timeliness of the production operations.

So far we have tried to show why output-increasing knowledge needs to be created and adapted to farm conditions through research. We discuss later some of the alternative means by which the usefulness and relevance of this knowledge could be demonstrated to the farm family through extension programs. But research and extension are only opening wedges for the yield and multiple-cropping revolutions. Much of the new technology enters the farm through purchased inputs -- inputs that are not produced on the farm. These include improved seeds, fertilizer, insect control items,

disease control items, weed control items, mechanical equipment, irrigation water, and so on. We will discuss all these and other needs later under the heading of "infrastructural needs."

Part II.

How to Realize the Agricultural Development Opportunities

Next we discuss several priority elements in the program to increase agricultural output, employment and income per capita. First, we will list the priority items and then discuss them in considerable detail. These priority items are:

1. To achieve really effective agricultural research and extension programs as quickly as possible.

2. To meet other infrastructural needs than the need for relevant research findings, information dissemination, and trained agricultural manpower.

3. To realize the irrigation potential that exists in Thailand.

4. To bring about structural changes in the agricultural institutions of Thailand.

5. To place land development in Thailand on a rational, scientific basis and make land development play an important role in the development of Thai agriculture.

Properly speaking, to achieve the required levels of trained manpower would enjoy a very high priority, but we shall not include it as a separate priority item. The priority of a particular manpower need is derived from that activity and from the results it is expected to provide. Each priority

item has its own manpower requirements. Part III will be devoted entirely to agricultural manpower requirements, drawing from Part II the requirements for the different priority elements by specialty and by level of training.

1. First Priority -- Achieving Effective Agricultural Research and Extension Programs

For modernizing a traditional agriculture, highest priority goes to the development of an effective research and information dissemination program. Thailand is well along the way to having a good basic agricultural research program. A good foundation already exists for rice, for corn and sorghum, for tobacco, for rubber, and beginnings have been made in other commodities. Most of the discussion on research that follows refers to "adaptive" research, although manpower needs for basic agricultural research will be discussed later. By adaptive research is meant the translation of basic research findings into specific recommendations to farmers and others -- recommendations that apply specifically to particular technical and social environments at farm and village levels.

Adaptive Research Needs: Technical. We begin our discussion with an illustrative list of the kinds of technical research believed to be needed for agricultural development in Thailand:

(1) Variety and hybrid testing

(2) Time of planting

(3) Soil fertility; plant nutrition

(4) Plant population

(5) Weed management

(6) Pest and disease control

(7) Water management

(8) Tillage practices

(9) Crop residue management

(10) Crop interaction

(11) Plant breeding (for multiple cropping systems)

(12) Cropping methods

(13) Plant quality control

(14) Research verification in field trials

(15) Production systems under field conditions

(16) Optimum equipment and sources of farm power (including on-the-farm storage)

(17) Environmental issues

Adaptive Research Needs: Social Science. We follow with an illustrative list of the kinds of social science research needed. It should be emphasized that the outputs of these technical and social science research programs are designed to be inputs for specific extension programs in particular Regional Agricultural Centers (RAC's), Changwats and Amphurs. The list follows.

(1) Benchmark survey

(2) In-depth longitudinal study of key villages

(3) Daily farm and household accounts

(4) Time and motion studies (labor requirements)

(5) Special purpose survey, especially sociological

(6) Costs and returns for different enterprises

(7) Evaluation of input levels

(8) Evaluation of optimal multiple cropping systems: linear programming

(9) Use of simulation to determine optimum intensification paths

(10) Analysis of resource use efficiency

(11) Price analysis (demand and supply analysis) of specific crops

(12) Farm level marketing

(13) Organization, behavior and efficiency of the marketing system

(14) Price behavior

(15) Farmer decision-making frameworks

(16) Farmer decision-making processes

(17) Information flow processes

(18) Socio-economic change due to multiple cropping

Regional Agricultural Centers.[4/] What is suggested here is that the Ministry of Agriculture and Cooperatives (MOAC) begin immediately to develop Regional Agricultural Centers for each appropriately defined Agro-Economic Area (AEA).

How many RAC's would be needed for all of Thailand? This would be a matter to be decided primarily by agronomists, soil scientists, and agricultural economists. It would appear that some number between four[5/] and nineteen[6/] would be optimum. An immediate start should be made on

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4/ It is important to give these stations a designation that reflects their research *and* extension role.

5/ One each for the North, Northeast, Central Plain, and South.

6/ This is the number of agro-economic regions arrived at by the joint MOAC - Iowa State University Project (support by US AID) to develop agricultural planning in Thailand.

the four while more careful investigations are made to determine the optimum number.

Some of the Regional Agricultural Centers should probably be located at or near the state universities -- Chiang Mai, Khon Kaen, and Song Khla -- for those agro-economic areas. It seems to make sense to locate the extension headquarters for each agro-economic region at or near the RAC for that region.

What would be the professional research personnel required at each RAC? One could guess that one or two agronomists, a soil scientist, a plant pathologist, an entomologist, an agricultural engineer, an agricultural economist and when available a rural socialogist. This might be on the minimum side, but would enable a start to be made. The agricultural engineer would be responsible for analysis of power and equipment requirements in the light of information developed by agricultural economists and the others, as well as for water management analysis. The agricultural economist would have three important roles:

(1) economic analysis of the research results on individual crop enterprises and on cropping systems,

(2) analysis of prices and markets for the relevant crops, and

(3) social and economic analysis of the farm households and villages.

Each of these RAC research workers would serve as intellectual back-up for the extension workers in the region being served by the adaptive research station. This back-up would be especially important for the plant pathologist, and the entomologist, but the other research workers could also be called upon for assistance by the extension workers.

Agricultural Extension: Technical and Social Sciences. To transform a traditional agriculture into a modern agriculture requires not only high-quality basic and adaptive research, but also that the output-increasing information created by research reach the farmers. This is a tall order for a country that is heavily agricultural and with several million farm families.

As it presently exists at the field level, the Agricultural Extension Department has two major shortcomings. One shortcoming is that many of the working members are not sufficiently well trained to be effective in dealing with farmers. Their formal education is likely to have been heavy on theory and light on practical experience. Even if these extension workers had, embodied in words, accurate and relevant recommendations to make to interested farmers, many of them would not be able to demonstrate to farmers what is to be done. Many would not be able to plan and execute an effective demonstration plot for farmers to observe.

One way to overcome this deficiency would be to operate a carefully planned retraining program for extension workers. Classes of 10 or 20 extension workers might be organized and operated at the RAC's. The training program might last for six months, with one-half the time being given over to practical instruction (growing out a crop from planning and land preparation right on through to harvest), and one-half to carefully selected classroom instruction. At the end of the practical instruction workers would be able to show farmers by example how to perform the recommended practices and to plan and carry out a demonstration plot. Classroom

instruction would devote some attention to extension techniques and to an understanding of the villager's culture, decision-making framework and processes, as well as material on technical agriculture. Much of the material for classroom instruction would come from the adaptive research done by social scientists.

The second shortcoming in the agricultural extension department -- as it now exists -- is that it does not have available to it enough information to devise and carry out an extension program that would be effective in the villages. Only in the case of rice and possibly of rubber and tobacco is there information available that could be put together and called a "package of practices" that would tell a farmer how to grow out a crop in an optimum manner. Even for rice and tobacco, packages of practices are not available for all regions that grow rice or tobacco. Except for the first trickles of information out of the "Multiple Cropping Program" of Chiang Mai University, and the Department of Agriculture station at Chainat, little or no information is available to extension workers (or to farmers) on how to design or carry out multiple cropping systems in an optimum manner.

The technical and social science output from the RAC's would begin to rectify this informational deficiency. The information flow from these stations would be specifically designed for use by extension workers in their work with farmers and village leaders.

Qualifications Desired for Extension Workers. What we have suggested so far is that an RAC be set up for each appropriately designated AEA, and that the agricultural extension headquarters for the AEA also be located at the RAC. Puting adaptive research and extension for each AEA at the same

location would contribute to solving the extension training problem, and the extension programming problem.

In the next two sections, we discuss two related extension problems -- qualifications and staffing patterns.

There are almost as many extension staffing patterns and as many qualifications suggested for extension workers as there are extension departments around the world. It is clear from experience in developed countries that carefully selected individuals with 16 or more years of formal education, including serious work in agriculture or home economics, can usually function quite effectively as rural change agents with technical competence. It is also clear from experience in some developing countries that carefully selected individuals with as few as 6 or 8 years of formal education can, with 6-12 months of special training, also function effectively, particularly if backed up by competent specialists in the relevant technical fields. Without a miraculous innovation, any scheme to extend information and assistance with lower levels of change-agent qualification would be unlikely to be effective.

Apparently the RTG has accepted a policy of having the majority of extension workers with two years of college, obtained at one of several two-year agricultural colleges. This is a commendable decision although the capacity of these two-year colleges to turn out well trained graduates makes the staffing pattern a crucial decision. It may well be useful to experiment with more than one organization of agricultural extension at the AEA or changwat level.

One other aspect of extension worker qualifications deserves some discussion. If agricultural output and farmers' incomes are both to be increased by means of a veritable revolution in crop yields and multiple cropping, then the quality of farmers' management and the efficiency of farmers' labor will also have to improve considerably. This is more than a matter of exposing the farmer to technical information, more than motivating the farmer to want to earn higher income through increased output of a higher quality, important as that kind of motivation is. Also needed is to begin to build up the farmer's (especially the small farmer) problem-solving capacity, as it applies to efficient farming. General education is an integral element in this upgrading. General education of village youth will extend their learning capacity and make it possible for them to be reached more effectively with output-increasing information.

At present the first four years of schooling are available to almost all school-age youngsters in Thailand. The few children without such opportunities are more likely to be found in the villages. For the next four years of schooling it is a different picture. A village child who completes the fourth grade is hardly half as likely to enroll in the fifth grade or graduate from the eighth as his urban counterpart. For the four years after that the relative disparity in favor of urban youth becomes even greater. These disparities are largely a matter of opportunities. Better opportunities for schooling are available to urban youth than to village youth.

More years of schooling available to rural youth would create an opportunity to provide relevant agricultural information and experience as a part of their general education. Instruction and practical experience in

technical agriculture could probably be inserted in the curriculum as early as the 6th or 7th grade. Even more intensive instruction in agriculture could be included in the years 9-12 for those students unlikely to continue their formal education beyond the 12th grade. College-bound youngsters interested in agriculture would be well-advised to study hard science and mathematics in high school rather than concentrating completely upon vocational agriculture.

It would also be useful if the teaching materials used for village students could be based as much as possible upon the life and culture of the Thai villager rather than upon the life and culture of the urban areas. The lure of the city for rural youngsters could be reduced by less glorification of the city and by making the rural areas into better places to live. Better educational opportunities in rural areas would contribute to this, and would also make it possible for more youth with farming experience to obtain the qualifications for posts in agricultural extension, research, and teaching. Other things being equal, individuals with a farm background are going to be able to communicate more effectively with farmers and to have a better understanding of farm problems. Experience on small farms would also be helpful to extension workers working with small farmers. Urban youth with no farm experience are at a disadvantage as extension agents to farmers.

It is especially important that extension workers be able to demonstrate on the farmer's land the better techniques of production on each crop and a multiple cropping system that will show the farmer how to use his land and labor more efficiently. The best single way to get new yield-increasing

technology and tested multiple cropping systems to the attention of the farmer is to demonstrate them in his village or a nearby village so that he can observe and study them all during the crop season or period of the multiple cropping system. Until a farmer has had a good deal of experience with extension programs, it will be very hard to reach him with a verbal description of what is to be done and the results that can be expected. He is properly skeptical of government representatives and their statements. Unless a newly employed extension worker can show that he has had good practical experience, then his pre-service training and indoctrination should include enough experience so that he can conduct effective demonstrations. Similarly, when new technologies or new cropping systems are to be introduced to farmers, an extension worker's in-service training should include the opportunity to try them out himself before he attempts a farm demonstration.

Extension Staffing Patterns. The ideal staffing pattern for the extension staff remains to be determined. As far as technical extension is concerned, the most important initial function of the extension worker trained at the RAC would be to establish and maintain method and system demonstrations within easy observation of the farmers in the villages in the worker's district. To the extent that the demonstrated methods and systems represent tested and viable opportunities for farmers to improve the welfare of their households enough farmers will be interested so that the innovation will thereafter spread from farmer to farmer. Whether one well-trained extension worker can effectively introduce new technology to one village, or three, or five, or even ten, is a question to be answered on the basis of experience. The answer will depend in part on how many other responsibilities the extension man is assigned. If his primary and exclusive responsibility

is to introduce better technology to farmers, then not only can he operate more system demonstrations in the course of a year, but the demonstrations will inevitably be of higher quality and more effective.

The introduction of new technology is only an entry point for an extension program. As farmers begin to adopt the new system, other problems will arise. A reliable communications link will need to be forged between the Regional Agricultural Center and the households of the villages. There are several ways by which this could be done, including the U.S. system of having enough extension agents (farm advisers) to keep in continuous contact with farm operators, housewives and youth. Even the vaunted U.S. system does not have a very good track record in assisting (in some cases, even in communicating with) low-income farm households.

Another alternative is to have the villagers select one or more of their own number (including women and youth) to serve as a two-way channel of communication between the village and the RAC. Not only would verified, relevant and useful information on agriculture, on livestock, on foresty, on nutrition, on family planning, and so on, move from the center to the village, but the reverse flow would be information from the village to the station on the villagers' perceptions of village and regional needs.

Many other staffing patterns are conceivable, and it may be easy to devise a better one. The indispensable elements are the two-way channel of communications, and the effective link with reliable sources of information, particularly of a technical nature.

If "village agents" or "village reps" (village representatives) are used as integral part of the extension program, then the RAC would

need to gear itself up for operating short courses of a day, three days, a week, or even two weeks designed to transmit valid information from the center to the village households through village agents. It would be especially important in Thailand at this point in time that the communications channels established include small holders and landless laborers in the information network, as well as the more affluent farm households.

Extension Programming and Back-up. Development of an effective extension program is not to be taken lightly. Required is a good deal of technical information from research workers on varieties, fertilizer tests, water responses, plant protection, and so on. Also needed is technical information on the results to be expected from the different cropping systems that are possible at that location. Needed along with these results are socio-economic data on the farm households in the agro-economic area for which the extension program is being worked out. These should include detailed quantitative and qualitative estimates of the land, labor and capital resources presently or potentially available to these farm households. Also needed are economic data in the form of estimates of the prices farmers are likely to have to pay for the required inputs, including hired labor and custom services, what prices they are likely to receive for their outputs, what interest rates on credit are likely to be, and so on. It is especially important that economists provide the program committee with crude estimates of the demand schedules for the commodities that might be produced in that agro-economic region. If export of nonstorables or storables from the agro-economic area is under consideration, then there will be need to check the recommendations with program committees of other affected agro-economic areas.

Economists and statisticians need to combine all these technical and economic data to produce estimates of what crops and what combinations of farm enterprises will generate the largest income for the household's land, labor and capital resources.

From this body of information the extension program for that agro-economic area can be developed. Participants in the planning process should come from the technical and social science research staff of the Regional Agricultural Center, and the extension specialists stationed at the Regional Agricultural Center. The program should take as full account as possible of the agro-economic area, the technical possibilities developed at the center, the economic environment faced by farmers in that agro-economic area, judgments of what inputs and input services are likely to be available to a farmer in that area during the period of the program, and the judgments of the extension staff and village reps as to what kinds of changes farm families are likely to be willing to accept during that period, in the light of the income gains forecast from different alternatives.

It is probably a better strategy to persuade some farmers to make some change in the direction of high-yield, multiple-cropping patterns rather than to attempt to persuade all farmers to make a quantum jump to the economic optimum. Change may come more easily if farmers are encouraged to feel their way into the new techniques and systems. This permits individual reassessment of production risks, based on their observation of demonstrations and experience of other villagers with the recommended practices and systems. This would also permit gradual change in the household preference for income in terms of leisure rather than the large change implied by a jump from wet-season rice to triple cropping, including labor-intensive crops like vegetables.

Changes in the farm households' income-leisure preference functions are much more likely to take place if there are available for purchase such desired private goods as radios, bicycles, sewing machines, medicines, inexpensive fabrics and furniture, and so on, and if there are also available for community purchase such public goods as a village TV set, a village school, a village clinic, a sanitary water supply, and so on. In some ways the availability of consumer goods desired by farm households may be almost as basic to technological change in agriculture as the availability of the new agricultural inputs.

It would seem reasonable to make extension programming an annual affair although it is not likely that year-to-year changes in the agricultural program for the agro-economic region will be large unless new technological possibilities have just been developed or unless considerable changes occurred in the economic environment.

The back-up function for extension programs is very important. Under the best of conditions in a modern agriculture, unexpected problems arise. There is often need to have the expert advice of highly qualified specialists on these problems for individual farmers or for large groups of farmers to have the expert advice of a highly qualified specialist on a particular, unexpected, production or economic problem. Early on it might be expected that the research staff of the RAC would be able to make themselves available as back-up resources to extension workers in the agro-economic area. Eventually the extension department would want to have, in each of the agro-economic areas, extension specialists in the appropriate categories. These specialists, among other things, could take some of the back-up load off the station research workers, who would still be available to back-stop the

extension specialists. Extension specialists would also participate in extension program planning, and in training other extension workers.

A Suggested Organizational Structure for Agricultural Extension in Thailand. It is obvious that many alternative organizations are possible for accomplishing the goals of agricultural extension. This report has suggested the creation in Thailand of Regional Agricultural Centers, one for each agro-economic area, to serve, among other purposes, as a link between research relevant to that AEA, and as a point at which to focus the development of an overall extension program (OEP) for that AEA.

It may be useful at this point in the discussion to outline in some detail one alternative for making the extension program reach out to all the villages in the AEA. Once the RAC Extension Program Committee arrives at a first-cut but complete program for that region, then a series of meetings (2 or 3 days in length) would be held at the RAC, one meeting for each changwat in the AEA. Besides the relevant RAC research workers and extension specialists, the participants would be all the village representatives from changwat villages; extension workers in the changwat, including those from the Agricultural Extension Department, the Livestock Department, the Forestry Department, the Fisheries Department, and the Royal Irrigation Department (zone men, for example). Participants would be invited from the vocational agriculture schools in the changwat, from the agriculture departments of the comprehensive schools, from each credit agency operating in that changwat (including any private bank or other private institution making agricultural loans), from each agricultural cooperative, each farm supply store, each land development study and/or settlement project, land

reform activity, Accelerated Rural Development Area, or tribal development group -- any of these units operating in the changwat.

The OEP would be presented carefully and in detail. New technologies and new systems would be demonstrated at the RAC. The research results on which the program is based would be summarized, duplicated in summary form, and copies handed out to all of the participants. Economists would report on the price outlook for program commodities, and on the prospective availability in the changwat market towns of the important inputs for the upcoming year.

Field and station personnel -- all participants -- would be invited to ask questions about the detailed programs, and to react to the programs. It would often turn out that information reported from field personnel would require changes in the OEP or lead to some adjustments in a particular changwat, or to further investigations by station personnel. A session would be scheduled to give field personnel an opportunity to suggest to the RAC research staff the kinds of research they believe are most needed by the people they are working with. These suggestions would be screened carefully by RAC extension and research workers; useful suggestions on adaptive research might be incorporated in the RAC research program for the next year, or forwarded to the research committee of the appropriate department, for suggestions related to more basic forms of agricultural research.

Similarly, research workers at each of the regional agricultural centers would go at least once a year to one or more of the national agricultural (or livestock, forestry, fisheries or irrigation) experiment

stations for one or two days to hear detailed reports on completed and on-going research, and to make suggestions of their own on basic agricultural research needed by the people in their AEA.

In addition to adaptive research, extension program development, extension program dissemination, and extension program back-up, the other major function of the RAC would be as a training center for all agricultural field personnel in the AEA. For this training function, each RAC would need three more professional workers -- an agricultural information officer, an extension training officer, and a rural sociologist.

In conjunction with the extension specialists (from agricultural extension, livestock, fisheries, forestry, and irrigation), and with the advice of the appropriate research specialists, the training and information officers would design and operate in-service and pre-service training programs for all the different kinds of field workers in the AEA -- changwat and amphur extension workers of all types, credit fieldmen, vocational agriculture teachers, village representatives, and so on. For workers who cannot get away from their job for very long, the in-service training would be in the form of short courses. For workers who could be spared from their work for longer periods, training programs should be designed for newly hired and other extension workers.

In general, the in-service programs of the training branch of the RAC should include the following kinds of material:

(1) Extension programs of that AEA.

(2) Detailed social and economic information on the villages of the AEA.

(3) Extension techniques.

(4) Substantive education in the relevant agricultural sciences.

It may be added in passing that, in addition to assisting the training officer with materials for the in-service and pre-service the Agricultural Information Officer will also prepare materials on the extension program of the AEA for the media -- newspapers, radio, TV, and so on.

In addition to assisting with the planning and execution of the different training programs, the Rural Sociologist would also join with the agricultural economist in conducting socio-economic surveys of the villages in the AEA, and do research in the different aspects of information dissemination to rural people.

Livestock, Forestry and Fisheries Extension. Not only is Thailand favorably endowed with agricultural resources -- some land remaining to be brought under cultivation (some of this is potentially irrigable), and good land already under cultivation on which output and income can be increased markedly (sometimes by the addition of irrigation) -- but also is endowed with land and water resources well suited for livestock, forestry, and fisheries production. As with agriculture, the problem is to achieve the full productive potential of these resources.

Also as with agriculture, an important part of the effort to increase livestock forestry and fisheries output will be research to discover that potential, what will be required to reach that potential, and how those requirements can be made acceptable to the involved people at the lowest social cost. The research likely to be needed in these three sectors and in irrigation is discussed elsewhere in this report. What we want to do

here is to assume that the needed research results in livestock, forestry and fisheries are already beginning to become available, and to discuss the problem of bringing these results and other relevant and available resources to bear upon the problems that require solution before substantial output increases can be achieved. This brings us inevitably to the problem of extension, or information dissemination.

The Ministry of Agriculture and Cooperatives (MOAC) is composed of several semi-autonomous departments and one division. At the present time these include Agriculture, Agricultural Extension, Livestock, Forestry, Fisheries, Irrigation, Land Development, and the Division of Agricultural Economics. Not too long ago, there was a Rice Department that has since been amalgamated into the Agriculture Department. Also not too long ago there was no Department of Agricultural Extension, but the extension activities of the Agriculture Department (and the former Rice Department) have been pulled out of those departments and set up as a separate department. Thus there is now no formal link between the research of the Agriculture Department, and the extension activities of the Agricultural Extension Department. The extension activities dealing with livestock, forestry and fisheries remain with these departments.

The complementarity (and the competitiveness) of these departments is obvious. Crops, forests and livestock compete for land; crops, forests, livestock, irrigation, and fisheries compete for water. Forestry practices influence the available supply of water to the water-using activities. Livestock production requires the products of land in the form of feed and forage.

Almost entirely, crop, livestock, and forestry production take place in the rural areas, in the villages. Fishery production usually takes place in fishing or farming villages, but may also be found in urban centers. Some factory-type livestock production (eggs, poultry, meat, and swine, for example) might sometimes be found in or near urban areas in some countries.

To do their job, extension workers (whether posted in the Agricultural Extension, Livestock, Forestry or Fisheries Department) must carry their programs to the villages. The efforts of all departments are explicitly intended to improve the welfare of village families and villages, as well as to increase national output. Thus to the extent that a potential exists for focusing the programs of all these departments, it is found in the village household and the village. It doesn't require much imagination to see not only the potential for the MOAC to speak to village households and villages with five or six or seven voices, but with that many messages that may well not be congruent one with another. Indeed some of the messages may be directly contradictory with others. Even if the programs do not cancel each other out completely, the multiple sources of the technical assistance messages are certainly going to confuse the farmer and reduce the total effectiveness of the technical assistance.

Just as the extension program for agriculture (i.e., crop production) needs to be carefully integrated so that all its elements are consistent and mutually supportive, so do the information dissemination programs for livestock, forestry, fisheries, and irrigation. Vocational agriculture and rural adult education, as well, need to be carefully integrated into the program of technical assistance to the villages.

One model for doing this is outlined below. If there were in livestock, forestry, fisheries and irrigation relevant adaptive research that needed to be done at the regional agricultural center, then the parent department would be invited to post trained people at the RAC to conduct the needed research. The writer believes there would be good reason to have one or more livestock research specialists at each RAC; he is not sure about the need for at least one forestry or fisheries research worker in each AEA. That is an empirical question to be answered by knowledgeable people. The principle is that there should be department research people posted there if it is appropriate.

In any case, there should be extension specialists from livestock, forestry and fisheries (and possibly irrigation) posted at each RAC. Each of these specialists would participate in developing the over-all extension program for the particular agro-economic area. If livestock enterprises were found to be technically and economically feasible, then the livestock specialist would work with the agronomist, the soil scientist, and the economist in working out a livestock element in the over-all extension program, including village demonstrations of the potential of the livestock enterprise. In addition the extension livestock specialist would cooperate in the preparation of recommendations along the lines of forage crops (improved pasture) and disease control programs for work animals, introduction of new farm animal germ plasm, and so on.

Because there is likely to be a severe fuelwood shortage in Thailand in the intermediate future, the extension forester would devote some of

his time to the development of programs to establish fuelwood forests on village lands not suitable for crops or improved pasture. This would be in the form of recommended tree varieties, criteria for site and variety selection, provision of seeds or seedlings, and planning fuelwood demonstrations in the villages. If a village had more suitable-only-for-forest land than required for farm fuelwood production, then the extension foresters would develop programs to establish commercial forests with the same kind of assistance, and to encourage the owners (whether individual farmer or village) to protect the forest from fire and trespassers, to thin it, and otherwise to assist it to grow to an economically mature stand of valuable timber, that would provide employment for villagers.

If there were any opportunities in the agro-economic area for fish production, then the extension fisheries specialist would develop programs for fish production and harvesting to be carried out by villagers. This might include stocking rice paddies, tanks, lakes, and rivers with fish that could be caught and added to the villagers' intake of animal protein.

Where commercial fishing potential exists the extension fisheries specialist would prepare programs that would deal with fish production, marketing, storage, and processing. The extension fisheries specialist would be one link in the two-way communications channel between fisheries research and outlook, and the village fisherman.

While there may not be an extension irrigation specialist at the RAC it would be helpful if there were. Then he could be the link between the over-all extension program (including irrigation recommendations) and the

Royal Irrigation Department (RID) zone men (and ditchtenders) who are in almost daily contact with irrigating farmers.

Even without an extension irrigation specialist, the agricultural engineers, the agronomists, and the soil scientists at the RAC should prepare programs and recommendations with regard to farmers' irrigation practices, and to irrigation-system activities that impinge on the farmers. These should be tested and finalized, and the zone men should attend the changwat meeting at which the over-all extension program is presented to and discussed by all the extension workers in that changwat. It is desirable to tie the RID personnel who are in touch with farmers in with the flows of relevant information, and to include them in the plans for in-service training programs at the RAC.

Other Extension-Type Activities. Thailand has a rather well-developed system of vocational education, especially in vocational agriculture (see the report of the MUCIA advisor on Agricultural Education). Presently functioning are 15-year schools (junior colleges), 13-year schools (high schools) and lower-level schools that are reportedly being phased out. One of the most important employers of the 15-year and the 13-year graduates is the Agricultural Extension Department. Generally, these schools appear to have a fairly good reputation, with one possible weakness that some of the unreformed schools have not been able to develop an adequate program of practical farming experience. Some weakness has also been reported in the instruction dealing with irrigated agriculture.

It has been strongly suggested elsewhere in this report that all second (5th-7th grades) and third (8th-10th grades) level comprehensive schools in the rural areas introduce a substantial module of instruction

in agriculture (including a heavy dose of integrated practical experience, such as growing out a crop from land preparation to harvest), for those students likely to terminate their formal education at that level.

Finally, there is well along in the process of development in the Ministry of Education an adult education program focusing on the problems of literacy both in the rural as well as the urban areas of Thailand. There are already in place some trained individuals and some carefully worked out materials for use with adult villagers, a combination that has proved to be effective on a small scale. The question is how rapidly this program can be expanded; the danger is that ambitious expansion plans will outrun the supply of good supervisors and teachers, and relevant materials, losing the effectiveness so laboriously achieved.

The reason for describing existent or needed capacity in vocational agriculture at two levels, in comprehensive schools with agricultural programs at two levels, and in adult education is to argue for a closer integration of these agricultural education activities with the extension program developed at the regional agricultural center and carried out in the villages. If the technical schools teaching vocational agriculture or the general schools with agricultural programs are not already operating year-round demonstration plots at the schools where farm families and students can see them daily, then a high priority should be assigned to their initiation. If vocational agriculture teachers cannot personally operate a field demonstration, then they should be given enough in-service training at the regional agricultural center so that they will be able to do so effectively.

The classroom materials and the field demonstrations at the technical schools (for agriculture) and at the comprehensive schools with agricultural programs should be based as completely as possible upon the over-all extension program worked out annually at the RAC for that agro-economic area. The materials developed for use in the adult literacy program in the villages should include relevant materials from that extension program.

This is to say that the vocational agriculture and village adult literacy teachers should be made an integral part of the agricultural information dissemination network centered at the RAC for the agro-economic area. For example, if the extension program worked out by the Extension Program Committee for the next year is unveiled at a three-day or week-long Outlook and Situation meeting for extension workers in that agro-economic area, then arrangements should be worked out so that the vocational agriculture and village adult literacy teachers can and do attend the Annual Outlook and Situation meeting. These teachers should be treated as full-fledged members of the agricultural information dissemination network because of their opportunities to educate:

1) Students in the technical schools teaching vocational agriculture; many of them will go into agricultural extension, into vocational agriculture teaching, or into private enterprise serving agriculture; some of them will go back to the farm.

2) Agriculture students in the comprehensive schools; some of them will continue their education along agricultural lines; some of them will return to the farm; many of them now represent good pipelines to village farmers.

3) Farmers in the vicinity of the schools, through the demonstration plots operated throughout the year.

4) Farmers and other villagers attending the adult literacy training offered in the villages.

The linkages described above are potentially too productive and too inexpensive in terms of real resources required not to take advantage of them. Any other educational institution already linked to agriculture in the villages should also be tied into the agricultural information dissemination network if possible; the Community Development School east of Saraburi would be a good example.

Summary and Conclusions. In discussing the development of effective research and extension programs, we have concentrated on the development of a closely integrated adaptive research and extension program. This assumes that the basic agricultural research system is geared up to meet the needs of Thai agriculture. This assumption isn't entirely warranted, as is evident from discussion elsewhere in this study (especially Parts II.4 and III) and in other studies in this MUCIA Report (agricultural research, e.g.). But a good deal of basic research capacity already exists, and much is being done to build on and improve the capacity already in existence.

The discussion centers here on developing an effective network of adaptive research stations that will be taking relevant information from the national research stations or from anywhere in the world, testing it for local conditions, and translating it with the required socio-economic information into an agricultural program for that agro-economic area. This adaptive research needs to be closely linked with the agricultural extension program for that AEA.

These regional agricultural centers need to be decentralized to bring them closer to the local problems to which they are intended to respond than to Bangkok. They need to be organized so that the adaptive research and extension are mutually supportive. They need to be organized so that trained workers in the AEA feel program responsibility to the AEA program,

as well as administrative responsibility to whatever department they belong to. Extension programs need to be built upon a firm basis of social and economic information about the villages and the villagers. AEA staff -- research or extension -- need to dedicate themselves to a steady improvement in the quality of life in the villages. The key words in this summary are decentralization, responsiveness, coordination, and dedication.

2. Second Priority -- Meeting Other Infrastructural Needs Than the Need for Relevant Research Findings, Information Dissemination and Trained Agricultural Manpower

It will avail the farmer and the nation little or nothing if relevant research results are made available to him through extension demonstrations but one or more of the essential inputs is not available at the right place at the right time at the right price.

Infrastructural Needs. These essential inputs could be distributed to farmers either by the public sector or by the private sector. Because the Thai people seem to prefer to rely on the private sector for the provision of many services, we will assume that responsibility for distributing most of these inputs will lie with the private sector. This means that distribution organizations will have to be set up that reach all the way to the villages in all parts of the country. It may well be that private farm supply stores will spring up in all the large villages -- stores that stock seeds, fertilizer, pesticides, mechanical equipment and spare parts, gasoline and diesel fuel, lubricants, low-lift irrigation pumps, and so on. Or it may be that the Department of Agriculture or the Department of Agricultural Extension will distribute seeds and fertilizer to farmers according to their

orders. Another possibility would be local associations of farmers (farmer cooperatives) which will amalgamate themselves into purchasing cooperatives.

Two aspects of the distribution system are very important. One is the timely availability of the whole bundle of inputs that embody the new technology. One possible reason for preferring private-sector distribution of the farm inputs is that the free enterprise system provides incentives for doing the job well and disincentives for doing it poorly. Even this is no insurance of socially useful performance by monopolists, if competition does not develop. Public distribution can be reliable if it is carefully organized; incentives and disincentives for the bureaucrats could help insure reliability.

Another important aspect of the distribution system is its efficiency. It is important to achieve efficiency so that the inputs can be sold as cheaply as possible to farmers (or to farmers' associations) and still cover the cost, whatever distribution system is chosen. Another important input for higher yields and successful multiple cropping is irrigation water. This will come in for separate discussion later.

The indispensability of purchased inputs to the yield and multiple-cropping revolutions raises another infrastructural problem, the problem of credit. To achieve higher yields and to keep the much more intensive cropping from quickly stripping the soil of its nutrients, the farmer must use a good deal of fertilizer. Usually, the new seeds are purchased. Herbicides, insecticides and disease control items are necessary to insure high yields, particularly under multiple cropping. If mechanical equipment is used, fuels, lubricants, and spare parts are necessary.

At the beginning of their introduction to modern farming, few farmers would be in a sufficiently favorable cash position not to need short-term credit. Those who succeed at modern farming would probably soon have a cash flow large enough that short-term credit would not be needed except in cases of emergency or disaster. Purchase of mechanical equipment, such as two-wheeled tractors or low-lift pumps, would require medium-term credit. Both short-term and medium-term credit should be supervised credit, which is to say, a production credit loan or a farm equipment loan should be a part of an agreement by the farmer to adopt modern methods and systems. Credit supervision would mean that his efforts would be supervised and assisted if assistance was needed. Making both loans and repayments in kind has worked in some countries.

Special efforts should be made to see that credit reaches small farmers and on as favorable terms as possible. Interest rates should be kept as low as possible, consistent with the opportunity value of the loanable funds. If credit to small farmers is to be subsidized, it would probably be better that the cost of administering (supervising) small loans to subsidized, rather than the interest rate.

Should agricultural credit be an activity of the private sector, the public sector, or both? Arguments can be mustered on each side. If the provision of credit to farmers is to be done by the private sector, the banks (or other institutions) will have to develop the capacity for supervising and collecting a multitude of small loans, many of which will run for only a few months. The credit "fieldmen" will have to know a good deal about modern farming, which means some technical training.

The fieldmen would need to be in continuous contact with the input sellers and with the extension workers, to understand the agricultural program that the farmer agrees to follow.

The same requirements would hold if the responsibility for agricultural credit is placed in the public sector. The arguments against the public sector are the chronically poor collection record achieved by public credit agencies in many developing countries, and the likelihood that politics will enter into the administration of the credit program, to the detriment of the program.

Still another infrastructural need is for efficient and effective output markets. For some of the principal export commodities (rice, corn, and soybeans, e.g.) markets that work pretty well seem to be available, although even here there may be some question as to whether the pricing mechanism provides adequate rewards for high quality and adequate penalties for poor quality. More serious questions can be raised on the marketing of kenaf and cassava, for example. Even more serious questions can be raised about the performance of other marketing services than pricing, such as storage, transport, grading, market news, minor processing (such as rubber), market finance, wholesaling, major processing and so on.

One of the future sources of agricultural productivity available to Thailand would be realized through greater farm and regional specialization. A prime prerequisite for specialization programs would be the existence of a reliable and efficient marketing system -- a system that would inspire confidence on the part of the farmer. Otherwise, there will be no way to persuade the farmer to commit himself to specialization.

After all, when he specializes, that is when he enters the market economy, he is making his family's welfare depend upon his ability to sell his specialty crops at satisfactory prices and to buy their consumption items (that he formerly produced) at satisfactory prices.

Other national goals may have still more infrastructural requirements. Should the Thai society decide upon a goal of increasing agricultural employment by placing an upper limit upon the size of individual holdings then a land reform organization would need to be created in order to administer the program in such a way as to increase output and social equity, as well as farm employment.

If heavy reliance is placed upon agricultural cooperatives to perform some of the local infrastructural functions such as input marketing, farm credit, output marketing, agricultural extension, and distribution of irrigation water, then locally run cooperatives would have to be nurtured into existence and helped to achieve competent, energetic, and honest management. In developing or developed countries, effective farmer cooperatives have been very hard to develop. Competent management is usually very scarce, and cooperatives find it difficult to obtain good management or to keep it. In their beginning stages, cooperatives must depend very much upon timely cooperation and assistance from government agencies, and these have not always been forthcoming. Nonetheless farm cooperatives are an alternative worth considering for meeting some of the infrastructural needs of farmers; where cooperatives work well, as in Taiwan, they are a great advantage to the farmers and the society.

Manufacture of Production Inputs and Consumer Goods. In our earlier discussion of infrastructural requirements, we devoted much of the discussion to how to get the productive, new inputs into the hands of the farmers. First, these have to be brought into existence. This can be done in only two ways. These inputs can be produced in the country, or they can be imported. If local production is technically feasible, then the question of whether to make the necessary investments to be able to produce locally, or to import becomes an economic question.

Whichever is optimum, following up on the decision takes a lot of doing on the part of the government, whether the input is improved seeds, fertilizer (nitrogen, phosphorus, potash, lime or minor elements), chemical pesticides, insect, disease or weed control chemicals, mechanical equipment, irrigation water, and so on. If the decision is to have the private sector produce any input, then government efforts must be designed to create an environment that will attract entrepreneurs to attempt the needful, and to facilitate their accomplishment of the desired results, including the development of a distribution system, if that is needed. In a developing country, the government must run good interference and provide a good deal of assistance to a private entrepreneur initiating the manufacture of these required inputs. Even after production and distribution are successfully initiated, the government must maintain an interested surveillance over the performance, with a particular concern for the efficiency and the level of prices that must be charged to cover the resource costs of production. High prices for inputs like fertilizer can sharply reduce farmers' utilization and the output that is potentially available from the new technology. The essential point is that even private production of agricultural inputs

requires a great deal of carefully planned public action. In general, the same conclusions follow for the production of consumer goods, especially those consumer goods whose availability will shift farmers' income-leisure preference functions in the direction of income.

If the decision is to produce the inputs in the public sector, then the responsibilities of the government would be multiplied considerably. In general, the track record of government manufacturing plants has not been good, although some of the socialized countries have succeeded in establishing manufacturing plants and operating them effectively. When difficulties have arisen with public enterprises, they have been inefficiency and unresponsiveness, probably due in no small measure to the absence of incentives and disincentives for the manager-bureaucrats.

If economic analysis reveals that importation is a better policy than domestic manufacture, then the government responsibilities would still be substantial, perhaps not as great for "managing" the importation as for "managing" the manufacture.

A mixed strategy is possible. This would consist of allowing imports to begin to build up a demand for the input item; again it would be helpful in stimulating demand if the domestic prices for the input item could be kept as low as possible. Simultaneously with the import and promotion stage, the government would set out to plan a manufacturing facility, large enough to be efficient, and get it built.

The problems of producing improved crop seeds and irrigation water have not been specifically discussed as agricultural inputs. These two input items are so important to the modernization of agriculture that they will come in for separate discussion later.

Much of what was said above about agricultural inputs needed for modernization would also apply to domestically unavailable consumer goods for which the demand among rural people might be high. As before, the responsibility for identifying and seeing that they are made available either through importation or domestic manufacture would fall heavily on the RTG.

3. Third Priority -- Realizing Thailand's Irrigation Potential

It must be obvious by now that the writer feels that the magnitude of Thailand's agricultural production potential depends to a considerable extent on the land area that can be brought economically under irrigation. Additional irrigation water could be had from three sources:

(1) Flowing rivers where weirs are used to raise the level of the water high enough for the water to flow by gravity onto the land to be irrigated; water can also be pumped from the river onto farmers' lands.

(2) Surface water can be stored in reservoirs or in smaller tanks where satisfactory sites are found; gravity flow is usual, but pumping can be used.

(3) Groundwater requires pumping unless artesian flows are available.

It is predictable that continued population and income growth in most of the world will continue to shift upward the export demand for both foodgrains and feedgrains. It will probably be in Thailand's best interests to develop the irrigation capacity by whatever means and wherever it can be done economically. It is important that all the irrigation systems be designed carefully, taking account of the crops to be grown, the likely size of farms, and the optimum source of field power. It is important that the systems be operated efficiently for the crops being grown and generate public revenues reflecting the value of dry-season water to farmers.

What is needed next is to complete the technical and economic investigations of Thailand's water resources so that water resource projects can be planned and developed without unnecessary delay. Many of the possible water resource projects will only affect Thailand, but one of the largest series of water resource developments -- the Mekong River Valley scheme -- will involve Laos, Cambodia, and South Vietnam now, and might eventually involve Burma and the People's Republic of China (PRC) where the Mekong River rises. Earlier studies of Mekong River Valley development need to be dusted off, and reevaluated in the light of current energy and food prices. If some or all of the projects studied prove to be economically feasible, then a great deal of international negotiation would be necessary. As mentioned in the section on policy studies, the complementarity and the trade-offs for the potential water storage capacity, among electric power, irrigation, flood control, and navigation need to be estimated carefully in the light of technical and economic conditions expected to prevail during the next several decades.

Once an agreement is reached on the Mekong River Valley Authority among the affected nations, technical and economic assistance could probably be counted on from international donors.

As far as water resource developments that affect only Thailand, the same needs exist but the problem is simplified by having no requirement for an international agreement. This means that internal water resources can be developed much more rapidly than the international resources, if indeed it turns out that the internal projects are economically feasible.

It is important that the water resource projects be designed in such a way that employment will be maximized, as long as there is no sacrifice

in efficiency. It is equally important that the irrigation projects be designed, constructed, and operated to provide maximum employment, again subject to the constraint of little or no sacrifice in efficiency. It is important that irrigation projects be designed and operated with the assistance of agricultural professionals so that the systems can be operated optimally, not only from an engineering viewpoint, but also from agricultural and economic points of view. Finally, it is important that the RID fieldmen (zone men) who come in frequent contact with farmers be made an integral part of the agricultural information dissemination network.

Irrigation Systems as Elements in the Agricultural Infrastructure. Another infrastructural element that merits serious investigation is the operation of irrigation systems, especially in their relations to the farmers. Particularly in the Northeast, water is apparently available to some of the farmers in the dry season but often little is used (6). Sometimes the fault seems to be with the system, sometime on-farm distributaries have not been put in place for some reason, and sometimes the household can earn more income in other ways during the dry season. Also in the Northeast some farmers look for extension information on irrigated crops to RID employees (ditchtenders) who may not be trained in technical agriculture but some of them may be farmers (7). In the mountainous parts of Thailand, the use of limited supplies of water for irrigation is given a low priority -- behind electric power, flood control, and navigation -- in part because the use of water for irrigation does not product any government revenue.[7/]

7/ See Parts II.4(3) and II.4(4) for discussions of two suggested policy studies, irrigation vs. electric power, and energy policy.

All these examples appear to show that the nation's water resources are not now being managed in such a way that water is making its full contribution to national welfare. There are good reasons for believing that agricultural research, agricultural extension, and management of irrigation systems need to be much more closely coordinated than is apparently the case. In some cases at least, it appears there should be more input from agricultural specialists[8/] in the design and operation of irrigation systems. Knowledge of what crops are likely to be grown and in what seasons should enter into the design and the operational plans of each project. If the design does not call for project preparation of the farmer's lands for effective irrigation, then there should be plans to provide the farmer with the technical advice if he is to do the work himself or if he is to have it done for him on a custom basis. Plans to accomplish the on-farm distribution and drainage system should be an integral part of the project, even if they are not a part of the construction contract. If RID ditchtenders already enjoy the respect of the farmers, then arrangements should be made to give them enough assistance (training, information and technical back-up, for example) that they can function effectively as workers in the information dissemination system.

Since water in the dry season is an output-increasing and an income-increasing input to farmers, then attention should be given to the possibility of charging farmers for the water, just as for any other productive input. In light of the world demand for agricultural products, it can be predicted

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8/ Agricultural engineers, agronomists, soil scientists and agricultural economists.

that much of that part of Thailand's water resources that can be economically harnessed will have greater value to the society as irrigation water than as a source of electric power. As such, it should have a higher priority in use and will if farmers pay what the water is worth to them. There may turn out to be considerable complementarity in these two uses of water.

What we are trying to say in this discussion of irrigation infrastructure is that irrigation water is too essential an input to be ignored. It is an essential part of the efforts to raise yields per rai and to increase incomes and output through multiple cropping that will increase the intensities of land and labor use. The potential gains from improved varieties, fertilizer, pesticides, and multiple cropping depend very heavily on greater year-round control over moisture availability than farmers in much of Thailand now enjoy.

4. Fourth Priority - Bringing About Structural Changes in the Agricultural Institutions of Thailand

Establishing a successful agricultural development program - especially a successful research and extension program - will require some changes in the traditional way of doing things in the Thai federal bureaucracy.

In general, the Thai departments follow a line organization, typified by a military unit. In general, authority flows in a straight line from top to bottom, and the Director General (DG) is the administratively responsible officer, and is also responsible for the program carried out by the department. Even though a Ministry may be composed of several departments, the Minister and the Deputy Minister have only limited influence over departmental programs.

We suggest for consideration several changes in institutional structure that we believe would facilitate agricultural development in Thailand. The first of these has to do with the reward system for highly trained professionals in the MOAC and in the universities.

For a talented individual in a line organization, the path to the greatest rewards in salary and prestige lies in command channels, seeking successively higher administrative posts. This is the case, irrespective of how talented a research worker or extension worker (or in the case of universities, a teacher) the individual is. What is suggested here is that high salaries and prestige be available for a talented person who does an outstanding job of research, extension, or teaching. In many ways, these talents are more rare in Thailand than administrative talents, and there may be a net loss to the society if a highly skilled researcher becomes a Deputy DG, if a highly skilled extension worker becomes an extension administrator, or if a really good teacher becomes a department head or even a dean. And this may well be what is happening when newly-capped Ph.D.'s return to Thailand, and turn to administration in a few years.

What is suggested here is that talented and highly competent research workers, extension workers, or professors be able to work toward the title of "Distinguished Scientist," or "Distinguished Scholar," or "Distinguished Professor," or some other prestigious title indicating how highly his country regards his work. These should be much more numerous than administrators. Such an individual might also anticipate earning greater material rewards than he would obtain by turning to administration. This would tilt the incentive system somewhat more in favor of services the country needs badly at the moment.

It may be said in passing that the kind of reward system described above is a comparatively recent organizational innovation. Only in the last decade or decade and a half has this kind of possibility existed in the U.S. Department of Agriculture. The innovation was adopted earlier by leading universities in the U.S.

Another suggested change also relates to the incentive system and is somewhat related to the discussion above. The headquarters - the seat of power - for each of the MOAC department is in or near Bangkok. Because rewards follow administrative lines, nearly every ambitious professional in the MOAC departments prefers to be in Bankok, where the quality of his work can be "noticed" by the administrative superior, and increase his advancement probability. (Another reason is that the amenities of life available to a resident of the Bangkok Metropolitan Area are superior to those in the rest of the country.)

What is suggested here is that, if necessary, MOAC departments be authorized to offer greater rewards for the same work outside Bangkok. Steps should be taken to try to improve the amenities outside Bangkok. Serious efforts should be made to see that field professionals have equal (or even better) chances at promotion than those posted in Bangkok. The accomplishments of field personnel should be better recognized and publicized more widely. Newly employed professionals should be made to understand before hire that they can expect most of their career in the field, and should be made to feel pride in serving their country at a research station, rather than feeling they have been banished to Siberia. All this has been emphasized because it is a truism that the agricultural problems of Thailand cannot be solved in Bangkok.

The third suggestion for structural change has more to do with budgeting and preparing agricultural development programs. This is that the RGT move toward the use of program planning and budgeting (PPB) for agricultural development programs. There is a vast literature on PPB, but for illustrative purposes we will outline briefly how PPB might be applied to the problem of initiating an OEP in an AEA.

Such a program would involve personnel from the following departments: Agriculture, Agricultural Extension, Livestock, Forestry and Fisheries. A regional agricultural center would be involved, with all the logistic support that implies. Also involved are the offices and organic transportation of all the personnel mentioned above.

The program would be planned and budgeted as a unit, so that the resource costs of the program could be compared with the benefits expected from the program. The benefits would be estimated as carefully as they could be, and would be -- for an AEA -- in the form of additional value of agricultural output, and in the form of additional incomes received by farmers, and by firms providing infrastructural services to farmers. If desirable, more than one level of program could be presented although PPB costs would rise rapidly as the number of program levels worked out in detail rose. NESDB and BOB would evaluate the program as a unit, and look carefully at the estimates. Authorization of a program and approval of a program level would automatically carry with it budgetary approval of the program elements from each of the different cooperating departments. There would be no risk that a livestock improvement program by the Livestock Department would be approved, but a supporting forage or feedgrain program submitted by the Agriculture Department would not be approved.

It seems obvious that consideration of agricultural programs by NESDB, BOB, and the Cabinet would be made much easier if agricultural budget submissions were presented in the PPB format. Comparison of agricultural programs with other submissions would be greatly facilitated by the use of the PPB form.

Perhaps the greatest advantage that might be realized from the use of this innovation would be the encouragement it would provide to separate departments not only to plan together, but to operate joint programs together. Without some such mechanism it is difficult to see how an integrated, effective extension program can be worked out and put into effect, given the existing organization of the MOAC.

The essence of the change is this. DG's would retain full administrative control over their departments, but their control over the different departmental programs would be somewhat diluted although not as much as might appear at first glance. Programs would be worked out at the AEA level on the basis of optimizing rather than arbitrary criteria. Whatever department had the greater expertise and the largest program relevance would be likely to have the largest responsibility for developing and operating the detailed program.

One essential aspect of this proposal is that it represents a decentralization of program formulation, a badly needed step in Thailand, in the opinion of this writer. Program development needs very much to be brought closer to where the problems are. Action people in the field should have some role in program development, though not necessarily a dominant one.

Policy Studies in Thailand. Another relatively small (budgetwise) structural change suggested is the development of a minimum level of research capability for policy analysis, particularly of agricultural policy problems.

At the present time, Thailand faces several important policy decisions that will have considerable influence on the rate and direction of agricultural and economic development in the short and in the long run. Five of these might be mentioned briefly.

(1) Rubber Rehabilitation Policy. RTG has a policy of subsidizing the replacement of old rubber trees in the South. Because funds and field staff are limited, much of the limited subsidy has gone to large holders, to the disadvantage of the thousands of small holders. Many small holders have been unable to learn of the program, or to qualify if they learned of it. There are several issues here, including how much the RTG can now afford to invest in rubber production in the light of the improved competitive position of natural rubber due to the energy situation; whether in the interest of increasing rubber production and employment, small holders should not be favored rather than penalized in the rubber rehabilitation scheme; whether new plantings should not be subsidized or at least encouraged if the Land Development Department certifies the existence of land suitable for rubber production; whether an extension program to assist small and larger holders to market higher qualities of rubber would not now be justified; and whether the rubber research and extension programs are now adequate in the light of the changed demand situation.

(2) The Rice Premium - much has been written of the export tax on rice. One question at issue is the extent to which low domestic prices hold down fertilizer utilization by farmers, and thus reduce yields per rai and rais

planted to rice. Table 3, based on Chiang Mai experiments, shows clearly that at medium-term average prices, fertilized rice made a negative contribution to income. This issue of the rice premium calls for a careful, thorough analysis.

(3) Energy Policy. Recent, worldwide sharp rises in the price of petroleum call for a re-examination of RTG energy policies, with careful attention to the needs for energy in Thai agricultural development. Thailand's future energy supplies will come from one or more of these sources:

a) Off-shore petroleum and/or natural gas from the Gulf of Thailand.

b) Petroleum products from oil shale.

c) Electric power from Mekong River Valley hydro projects--both Thailand's share of the power and power that might be purchased from Laos.

d) Petroleum purchased in the world market at high prices, which may be expected to ease down as greater supplies induced by high prices overtake reduced demands also induced by high prices. A crucial question in whether the O.P.E.C. cartel can hang together at the current level of prices.

A great deal of technical and economic investigation is required before action can be taken with respect to alternatives a, b and c. It appears reasonable for the RTG to proceed without delay with these three investigations, and also to form a study group of economists and energy specialists to evaluate and draw the policy implications from the three investigations, whenever results begin to become available. The balance of payments question is central to the analysis.

(4) Irrigation vs. Electric Power - a policy study closely related to 3 above is the question of using Thailand's harnessable water resources for electric power generation or for growing irrigated crops. We

stipulate that wherever it is technically and economically feasible, water should be used for both purposes.

The policy issue arises when electric power can be generated only at the cost of less irrigation and vice versa. This trade-off needs to be analyzed carefully to ascertain which use of the water would add most to gross domestic product (GDP), to total employment, and to the balance of payments.

(5) Limitation on the Export of Large Livestock - RTG has placed a limitation on the export of large livestock, for the announced purpose of assuring an adequate supply of work animals for small farmers. A careful investigation should be made of the effect of the limitation on the supply of work animals, on the supply of meat, on GDP, and on the balance of payments.

What is suggested here is that RGT establish an Institute of Policy Studies, a joint activity among the universities of Thailand. It might be no more than a Director and budget, designed to provide the Prime Minister and Cabinet with valid, in-depth analyses of important policy issues. At the request of the Prime Minister and Cabinet, the Director would use some of his budget to commission an analysis of the designated policy issue. The Director might obtain economists from Thammasat, agricultural economists from Kasetsart, sociologists and political scientists from Thammasat and Chulalongkorn, technical agriculturists from Kasetsart, and of course competent scientists and scholars from any of the other universities where they are available. The studies might require from three weeks to two years; the crucial qualities are rigor, depth and relevance. The important

characteristic of the analysts is their quality and their competence, not their numbers which would be small.

5. Fifth Priority - Making Land Development Play an Important Role in Agricultural Development

Qualified observers have estimated that there may be in Thailand as many as 20 million additional rai suitable for growing crops but not yet brought under cultivation. It is not to be expected that this land is, on the average, as good as that already under cultivation, but it is nonetheless an important natural resource.

The question is how to bring this land under cultivation in such a way as to obtain a joint maximum of employment and output, without clearing land that is unsuitable for cultivation and should be left in forests.

The agency responsible for most of the survey and other work before settlement takes place is the Land Development Department (LDD), another department of the MOAC. LDD has four major responsibilities:

(1) Soil surveys

(2) Land classification, detailed land capability studies

(3) Soil conservation

(4) Land policy

All the country has been surveyed; the surveys show the principal soil series. The next phase is to make land capability studies, which are much more useful in delineating areas suitable for cultivation and settlement. These are under way, with 9 or 10 changwats (out of 71) completed. These studies are needed, not only for the land to be brought under cultivation for the first time but also for land to be brought under irrigation.

What is suggested here is that the LDD be given enough resources to carry forward the detailed (1/50,000) land classification studies more rapidly (only about 10 percent of the country has been done). In making selections of changwats to be done, the LDD should give highest priority to those changwats likely to have the most land suitable for bringing under cultivation for the first time, and those changwats likely to have the most potential for irrigation, either from surface water or from groundwater.

Another need that may be mentioned at this point is for more rapid progress in completing cadastral surveys, particularly of lands likely to be used for multiple cropping. To be used as legal collateral for a loan in Thailand, land must be owned in fee simple, which requires a cadastral survey. Cadastral surveys are the responsibility of the Land Department of the Ministry of Interior. Only about 10-15 percent of the country has had a cadastral survey, with only about 5 or 6 changwats completed per year, and it is reported that emphasis has been on the changwats where urban land transactions have been taking place. It is suggested here that resources be found to accelerate the work of cadastral surveys, emphasizing agricultural areas and particularly those where multiple cropping is likely to develop. It is here, among other places, that agricultural credit will become very important.

Serious consideration should also be given to establishment of one or more survey teams in the Soil Conservation Division to begin experimentally to survey the areas in Thailand most likely to experience soil erosion, in order to ascertain the nature and magnitude of the problem. When the survey techniques have been mastered, then the survey work can be expanded and some attention also directed toward working out solutions that are feasible for

farmers to carry out with technical assistance. These soil conservation programs should probably be worked out, tested and demonstrated at the RAC, before a program with the farmers is attempted.

The fourth division in the LDD, the Land Policy Division is responsible for research into all the aspects of land tenure, development, and settlement policies. As far as land tenure is concerned, a primary need is to learn more about the actual land tenure situation in the different changwats, and for the different types of farming in Thailand. Not much is known in detail about the size of farmers' holdings, or of operating units, or of the nature of the rental and purchase contracts in use in the different sections of the country, or of the suitability for modern agriculture of the tenancy agreements in use, and so on.

The LDD has some agricultural economists with B.Sc. degrees who would be quite capable under competent supervision of conducting field surveys to begin to learn more about land tenure in Thailand. It is suggested here that the Land Policy Division explore the possibility of contracting with the Kasetsart University Department of Agricultural Economics to obtain the loan of one or more good land economists to train and supervise two or three teams of LDD agricultural economists in the conduct of field surveys on the land tenure situation. These surveys should be based on sample designs that will permit valid inferences to be drawn from the findings. The LDD should be authorized to employ one or more Thais trained in land economics whenever trained Thais with an M.Sc. became available from Kasetsart University or abroad. These individuals could then begin to assume the supervisory roles played by the Kasetsart University land economists.

Once the descriptive studies are well under way, then more analytical studies of the tenure problems uncovered by the descriptive research will be needed. These could be done by the Kasetsart University Department of Agricultural Economics, or by the Land Policy Division whenever qualified economists became available, or in collaboration. These analytical studies will generate recommendations for needed legislation, for tenure policy changes, and for tenure programs. There is little doubt that the LDD (particularly the Land Policy Division) will need more highly trained personnel than it now has, if it is to participate effectively in all the activities outlined above.

From ongoing activities reported in the newspapers, study is also needed of the safeguards that surround the conditions under which farmers can alienate their lands in order to obtain credit.

Part III

Trained Manpower Needed for Agricultural Development in Thailand

Now we begin our analysis of agricultural manpower needs by looking at the manpower needs in relation to the opportunities for agricultural development, and in relation to the five priorities for realization of these opportunities. We need to know the manpower needs, not simply by the years of training and experience required, but also according to different specialties relevant to agricultural development. It is increasingly the case that a rather high degree of specialization is needed to reach the creativity and proficiency levels required for research, teaching and extension. Only at the lower skill levels is there relative ease to transfer from one job to the other.

We need to look not only at the demand for manpower in terms of specialties and levels of competence but also at the existing supply of manpower by specialties and competences, and at the annual capacities of the agricultural higher education system to produce the different specialties and competences.

It is not easy to arrive at estimates of Thailand's needs for additional trained agricultural manpower during the next two or three decades. This is the case whether we are defining needs by specialty or by level of training or competence. Here we are as always defining agriculture in the broadest sense, to include what in Thailand is called agriculture, but also livestock, veterinary science, forestry, fisheries and home economics.

Several factors enter into this exercise. First, the needs are not easy to specify. These arise in several categories: analytical research; university teaching; descriptive research; junior college teaching; extension specialist; technician at a research station; extension agent; vocational agriculture teacher in a technical school, in a comprehensive high school, or in a junior high school; private sector activities requiring technical and/or managerial competence in agriculture; and so on. The picture becomes even more complicated when we attempt to specify the level of training that should be attached to each. As eventual goals, we might offer the following suggestions for match-ups between needs and training levels.

(1) Analytical research -- not lower than a M.Sc.; a liberal sprinkling of Ph.D's.

(2) University teachers -- same, not only because they are expected to supervise graduate student research, but also because they are expected to carry on analytical research along with their teaching.

(3) Descriptive research -- under careful supervision, this can be done by B.Sc.'s or even certificate holders. Supervision should be done by an experienced Ph.D. or M.Sc.

(4) Junior college teaching -- at least a B.Sc., and preferably an M.Sc.

(5) Extension specialist -- at least a B.Sc. with the appropriate major, but should be a M.Sc. eventually.

(6) Technician at a research station -- graduate of a technical school, at least.

(7) Extension agent -- should be at least a certificate holder from a technical school, with special training.

(8) Vocational agriculture teacher in a technical school -- B.Sc. with an appropriate major and valid practical training.

(9) Vocational agriculture teacher in a comprehensive high school -- at least a technical school certificate with valid practical training.

(10) Vocational agriculture teacher in a comprehensive junior high school -- same.

(11) Private sector activity -- here the level is not prescribable. It might be anything from a Certificate to a Ph.D. Private employers are likely to be able to bid away any public agriculture professional who is interested in private employment of whatever level of training. The important factors are the training that is relevant to the employment, and the interest and temperament of the individual.

Before we even attempt to measure the supplies against the needs for each of the specialties (disciplines) involved, let us discuss the Thai capacity to produce some or all of these trained individuals. Most of this capacity for B.Sc.'s and M.Sc.'s is found at Kasetsart University but both Chieng Mai and Khon Kaen already have Faculties of Agriculture, and will soon be turning out B.Sc.'s in several specialties. Song Khla has plans for a Faculty of Agriculture.

K.U. has several departments with strong on-going M.Sc. programs -- the ones most mentioned to the writer as being of good quality were Soil Science, Plant Science, Animal Science, Agricultural Economics and Fisheries

Biology. Plant Protection (Entomology and Plant Pathology) and Forestry are reported to be building well. The first five departments probably need to strengthen their M.Sc. programs further, but are at the same time strong enough to start planning for a Ph.D. program. A feasible goal might be to plan to admit Ph.D. students in about five years, to turn out the first Ph.D. in nine or ten years.

These departments (Soil Science, Plant Science, Animal Science, Agricultural Economics, Fisheries Biology, and perhaps others) are strong enough now to be of considerable assistance to CMU, KKU and Song Khla in building up under-graduate programs. The scenario might be as follows. Existing or prospective agricultural faculty at CMU, KKU and Song Khla might over a period of several years be sent to KU for M.Sc's. After two years of teaching and research upon their return to their parent institution, the better faculty might be selected for Ph.D. training (some abroad, some at KU).

These three faculties of agriculture need to be developed carefully but as rapidly as possible, giving full consideration to quality. At the present time the departmental faculties at KU are very much preoccupied with large undergraduate programs. The M.Sc. programs at KU could be improved and expanded, and the Ph.D. planning could go faster, if CMU, KKU and Song Khla could take some of the undergraduate training burden away from KU. At the present time, some of the KU departments are each turning out a hundred or so undergraduates a year, 10-20 M.Sc's.

Perhaps it would be useful at this point to specify the full list of relevant specialties by listing the departments and options that represent these specialties. These are as follows, with the department listed before the option:

Agricultural Economics, Agribusiness

Agricultural Economics, General

Agricultural Education

Agricultural Engineering, Irrigation

Agricultural Engineering, Mechanization

Animal Science, Nutrition

Animal Science, Production

Entomology

Experimental Statistics

Fisheries Biology

Fisheries, Processing

Fisheries Production

Forestry, Production

Forest Products Processing

Home Economics, Nutrition

Home Economics, General

Plant Pathology

Plant Science

Rural Sociology

Soil Science

Veterinary Science

1. Employment in the Private Sector

By and large, the KU departments have taken as their teaching mission the development of individuals to fill the civil service positions in MOAC. During the next stage of agricultural development in Thailand, the

private sector will play a much larger role than in the past. This fact will not only alter the numbers that will be needed, but will also require some modifications in curricula or the creation of new curricula. The KU Faculty of Economics and Business already has made plans to initiate an undergraduate program in agribusiness to begin to meet some of the needs in the private sector for business-trained people with a good working understanding of technical agriculture. Other departments may wish to consider similar programs -- Agricultural Engineering, Agronomy, Fisheries and Forestry are possibilities that come to mind quickly -- or several departments may wish to create an opportunity for their undergraduates to "minor" in agribusiness. Among the employments that may open for agribusiness majors and minors are the following: agricultural credit fieldmen for private and public lenders, agricultural loan officers with banks and other lending agencies; managerial, staff and sales positions with farm supply firms (handling or importing fertilizer, pesticides, pumps, mechanical equipment, seeds, and so on); managerial, staff and purchasing positions with firms purchasing, exporting, processing, transporting, or storing farm commodities; and so on.

We have concluded that the role of the public sector in the next phase of agricultural development in Thailand will increase substantially. From this, it follows that many more of the graduates (B.Sc., M.Sc. and Ph.D.) of the universities will find employment in the private sector. We also concluded that departmental curricula may need some modification, or even that new curricula may need to be developed, to meet these new requirements for highly trained personnel.

We need some kind of crude estimate of the magnitudes of these increases in demand for university graduates with training in agriculture (broadly defined). We will do this by specialty (university department or option) and by the percentages of future graduates we guess might reasonably be expected to find employment in the private sector.

University department, option	Percentage range
Agricultural economics, agribusiness	60-70
Fisheries, processing	40-50
Animal science, nutrition	30-40
Forest products, processing	30-40
Home economics, nutrition	30-40
Veterinary science	30-40
Agricultural engineering, mechanization	20-30
Agricultural economics, general	20-30
Agricultural engineering, irrigation	10-20
Animal science, production	10-20
Entomology	10-20
Fisheries, production	10-20
Plant science	10-20
Soil science	10-20
Agricultural education	5-10
Experimental statistics	5-10
Forestry, production	5-10
Home economics, general	5-10

University department, option (continued)	Percentage range
Plant pathology	5-10
Fisheries biology	5-10
Rural sociology	5-10

For the whole group of graduates, this averages out to around 20 percent of the total number. We believe an over-all estimate of 20 percent is conservative - conservative enough for the individual percentages to be considered seriously by the concerned departments in planning the numbers of student places needed in the future.

2. New agricultural specialties needed in Thailand.

The list on pages 67-68 includes several specialties for which no training capacity now exists in the form needed. Consideration needs to be given to the introduction of these specialties; these needs should be described, discussed and justified if possible.

Rural Sociology. One need is rural sociology, which will be important in the creation of an effective extension program, and an effective infra-structure throughout the rural areas of Thailand. While rural sociology is a branch of sociology, it is often differentiated from general or urban sociology because rural cultures are often quite different from urban cultures even in the same country.

On the other hand, if a program in rural sociology is initiated in Thailand (say, at KU) then the program should build on and utilize existing strengths in sociology at Chulalongkorn and Thammasat. For example,

Chulalongkorn has a good Institute of Population Studies (IPS) which has focused on demography, both in rural and urban areas of Thailand.

At this point, it may be useful to make a brief diversion in order to emphasize that population growth will be an important factor in the rate of economic progress that Thailand is able to achieve in the intermediate and long-run future. As noted above, IPS has a good research program in demographic studies, both from an economic as well as a sociological viewpoint. What is needed to balance out the macro approach of existing programs is additional concentration on the micro side. Birth rates are the result of a very large number of decisions made in the household, influenced both by economic and social factors. Careful study of these economic and social factors that influence household demographic decisions would provide an improved information base for any effort by the Thai society to influence the rate of population growth. Better understanding of demographic decisions of rural populations would be a very crucial foundation for this effort.

Agricultural Engineering. Two other professional skills badly needed in Thailand can be and sometimes are included in one department in a faculty of agriculture. Agricultural engineering can include as specialties concern with the sources of agricultural power, including mechanical power and related equipment, and concern with both the land and water aspects of irrigation.

Arriving at the optimum use of mechanical power and irrigation is so important to the welfare of Thailand that it would be foolish to neglect these two aspects of agricultural development. The potential role of

irrigation in agricultural development is too great -- as has been concluded earlier -- not to involve agricultural engineers and agricultural economists in the design, evaluation, construction, and operation of irrigation projects.

The other major concern of agricultural engineers is with the application of (human, animal, and mechanical) power to farming. The problem here is that the leaders of a developing country will become so preoccupied with modernizing a traditional agriculture that they will swing the pendulum too far in the direction of mechanical power, with the inevitable but not immediate result that a large-scale (and very efficient) agriculture will be the consequence. The substitution of capital for labor will inexorably decrease the employment of labor in agriculture and will push labor out of the rural areas into the urban areas and into the metropolitan areas. One of the overwhelming needs of the developing countries in Asia is for engineers to develop farm equipment that will increase labor efficiency and incomes on small farms. It is not always recognized that the farming systems in the developed countries were designed (and effectively so) for agricultural economics with a relative scarcity of labor and a relative abundance of capital.

It is usually sensible for a developing country to borrow as much of the bio-chemical agricultural technology from the developed countries as is economically feasible. Any developing country that borrows the whole bundle of agricultural technology used in developed countries will also find itself with the capital-intensive, mechanical technology that may be far from optimum for the economic environment. Unfortunately, almost the only alternative a developing country has is to develop its own labor-intensive

but output-increasing mechanical technology, and this is a tall order for a country just beginning to build up research and development capacity. Nevertheless, it is too important an alternative for a developing country to neglect. It may be helpful to remember that the developed countries developed capital-intensive technology, not because it was easier or more natural to develop, but because; in the particular economic environment, it was more rewarding for the innovator and for the society to develop technology that substituted abundant capital for scarce labor. What developing countries need is a reward system (and an opportunity) for innovative individuals to develop output-increasing technology that will use more labor and less capital per unit of output. One small step a developing country can take is to encourage the training of agricultural engineers, challenge them, and give them a real opportunity to respond.

Experimental Statistics. Another urgent need at Kasetsart is for a qualitatively better and quantitatively larger program in analytical (or experimental) statistics. Even now, with several departments having strong M.Sc. programs, a weak link in these programs is the work in statistical analysis available to their graduate students (particularly in the technical departments). Current practice is for a departmental faculty member who also has some qualification in statistics to teach statistics to the graduate students in that department. Each department that deals with the problem in this way is allocating to this purpose scarce faculty resources badly needed for other teaching and research. The quality of teaching may not in all cases be what is desirable, and a proliferation of courses may result from each department attempting to meet its own needs independently. It would appear to be far more efficient to establish a

good department of experimental statistics to teach all the statistics courses needed by undergraduate and graduate students in the Faculties of Agriculture, Economics and Business, Fisheries and Forestry. As far as applied statistics is concerned, the needed sequences would be three - one for plant sciences and forestry, one for livestock and fisheries, and one for the social sciences (economics, sociology, business and agricultural education).

It should be mentioned in passing that the applied statistics appropriate to the social sciences is different from that appropriate to those agricultural sciences based on the natural sciences. Regression analysis and sampling methods are probably the two most important statistical skills for social scientists although other methodologies are also quite relevant.

Even if the highest level of graduate training to be offered at Kasetsart University was the M.Sc., development of a good experimental statistics department could be easily justified, in the interest of efficiency and improvement in the quality of instruction.

When we begin to think seriously about the initiation at Kasetsart University of Ph.D. programs for several of the agricultural sciences, then the problem of analytical statistics becomes even more acute. If the present system was extended to provide the statistics needed for Ph.D. students, the inefficiency would be magnified substantially, and the quality problem would become even more serious. At the Ph.D. level, graduate students need to have the option of taking a year of mathematical statistics as well as at least one year of the kind of applied statistics that is most appropriate to the major field.

Understanding of experimental statistics by agricultural scientists is not an end in itself. The reason for having M.Sc.'s and Ph.D.'s in the agricultural sciences in Thailand is to prepare them to do the analytical research that is so badly needed as a foundation for a sound agricultural development. By using better statistical methods in the design, data collection, and analysis stages of agricultural research, Thai agricultural scientists could produce a greater volume of research findings that would be more efficient, more relevant, and more accurate.

Another important role of statisticians in an agricultural research program is to consult with agricultural scientists on their research programs -- not only in statistical analysis and interpretation of the findings, but in the design and data collection stage as well. The availability of this kind of "software" is particularly valuable when the research worker encounters any kind of design or analysis problem that is out of the ordinary. Competent statistical consulting services should be readily available to plant scientists, animal scientists, and social scientists.

It is suggested here that Kasetsart University be encouraged and supported in the rapid development of a high-quality Department of Experimental Statistics, with the capacity to perform all the functions listed above. Not only should it provide courses for undergraduates and graduate students in the other departments, but it should plan to offer a B.Sc., and M.Sc., and eventually a Ph.D. for majors in Statistics. This department should also design and begin to offer as soon as possible three strong minor programs in statistics for (1) plant sciences, (2) animal sciences, and (3) social sciences, both at the M.Sc. and the Ph.D. level.

Each major station[9/] in Thailand would eventually want to have on the staff a Ph.D. statistician, and three other statistical consultants who might have either an M.Sc. in Statistics, with a minor in plant science, animal science and social science respectively, or an M.Sc. in plant science, animal science, and social science respectively, with a strong minor in Statistics. The three statisticians would consult with research workers in the plant sciences, animal sciences, and social sciences, respectively, while the senior statistician would help consultants and research workers out with the more difficult, intractable, statistical problems. The senior statistician would also advise the research director and the research committee on the over-all problems of research design and analysis at that station.

Much of the work of MOAC's Division of Agricultural Economics is involved in the estimation of agricultural statistics -- commodity hectarages, outputs, and prices; commodity stocks and exports; inputs used by crops; socio-economic data on farm households and villages in Thailand; and so on. As agricultural development proceeds, more detailed and more accurate estimates will be needed for decision-making use in connection with the different agricultural development programs.

9/ The suggestions in this report would place the optimum number of major stations at no more than nineteen; some of these would be national (basic) experiment stations for important commodities, in combination with the regional agricultural center for that agro-economic area. Other ARS's would be operated in conjunction with universities or technical schools. These suggestions appear to be largely consistent with the recommendations of Moseman, Haworth (9), and Russell of the M.U.C.I.A. team.

It would probably facilitate the program of the Division of Agricultural Economics (and perhaps of other statistical reporting agencies elsewhere in the government), if the Kasetsart University Departments of Experimental Statistics and Agricultural Economics combined forces to operate a degree program to train agricultural statisticians. If B.Sc. or M.Sc. holders obtained some understanding of technical agriculture, in addition to a major in experimental statistics or agricultural economics and a minor in the other, then they ought to be quite employable and useful as agricultural statisticians. Individuals with these qualifications and some practical experience would also be able to supervise the socio-economic surveys described below.

Each Thai University Faculty of Agriculture would also eventually need to have a Department of Statistics, although most if not all of the instruction might be done by the four statisticians of the research station associated with that university (see footnote 9).

Home Economics. Another important series of related specialties will be badly needed in Thailand during the next several decades. These specialties are often lumped together under the collective term of home economics (also called human ecology). Among the fields of home economics that seem likely to be important in the process of rural area development are family planning, human nutrition, child development, household economics and household decision-making processes, role of women in rural area development, food science, and so on. Existing capacity in Thailand for higher education as for research in the fields of home economics is very limited, but the situation is kept from being hopeless by the enthusiasm and dedication of the small number of trained people.

What seems to be needed at this point in time is to develop plans for and initiate a carefully thought-out program in home economics education at the B.Sc. level (and later on at the M.Sc. and Ph.D. levels). It is not clear to the writer whether these capacities should be developed at one or at several of the possible locations in Thai educational institutions. It may well be that pluralism is the best strategy at this stage. The second need is to develop and initiate a small (until the capacity for a larger program is available) but high-quality research program in the different fields of home economics.

For a better and more detailed discussion of this whole set of problems see the fine report by MUCIA Advisor Paolucci.

New Fields Needed in Existing KU Departments. In addition to the essentially new specialties that will be needed for agricultural development and that are discussed above, there are new fields (subspecialties) in existing departments that will also be quite important to future agricultural development. Some of these suggestions are discussed below.

(1) Economics of irrigation. We have already emphasized the importance we believe irrigation will have in Thailand's future agricultural development. There are three aspects of irrigation for which economic analysis is essential.

The first is the use of water on each farm. Water is to be treated like any other input (fertilizer, for example), and its use extended on each farm to the point where the additional net income generated by another unit of water is just equal to the total costs associated with the use of that increment of water. If no charge is made to the farmer for the water

(at present, none is), then a shadow price will have to be worked out, and availability on each farm restricted to what is dictated by the shadow price of water. But all of this kind of analysis is quite familiar to a branch of agricultural economics called farm management.

A second aspect has to do with the economics of operating an irrigation system. The rules under which a system is operated should be designed with two criteria in mind. First, the total value of output from a given quantum of water should be maximized. To do this, the operating agency must have accurate information on the optimum cropping systems for the particular project. Determination of optimum systems is primarily a problem in economic analysis, using all the relevant technical data. Second, over time each rai in the command area should be subjected to the same risk of not having enough water, unless differential water charges reflect accurately different risks of not having enough dry-season water for a crop.

A third economic aspect of irrigation has to do with the evaluation of prospective irrigation projects. Benefit-cost analysis is the analytical tool must often used to evaluate water resource projects in relation to other uses of the country's scarce resources. A great deal of technical, economic and social information is needed before a valid judgment can be offered. Ultimately, it becomes a problem in economic analysis.

What is suggested here is that the Kasetsart University Department of Agricultural Economics add two well-trained resource economists to their faculty, to teach resource economics to undergraduate and graduate students, to conduct research on the economic problems of irrigation, and to consult with public agencies concerned with irrigation. This would not only include

the Royal Irrigation Department, but also field stations working on irrigation problems would also wish to have their irrigation project leaders consult periodically with irrigation economists. The irrigation economists turned out by the Kasetsart University Department of Agricultural Economics at the B.Sc. and M.Sc. level would find employment principally in the RID, but also in any of the major research stations with an important research responsibility for irrigation.

(2) Economics of Energy Use in Agriculture. One other kind of economic analysis needed now in Thailand relates to the use of energy. Rises in the price of petroleum over the last two years have affected drastically and adversely the balance of payments of countries relying upon imported petroleum as a principal source of energy. Because Thailand falls in this category, it is important that this different supply situation for energy be considered in making resource allocation decisions. Much of Thailand's electricity and power for transportation comes from imported petroleum. If agricultural development is to include the application of more mechanical power in place of human or animal power either for field operations or water pumping, then the role of petroleum-based energy will become even more important in the Thai economy.

What is suggested here is that the Kasetsart University Department of Agricultural Economics add a well-trained energy economist to their faculty to teach courses in the economics of energy, to keep up carefully through his research with the demand-supply changes in all form of energy, and to consult with the public agencies concerned with the energy situation. This would include the Electric Generating Agency (EGA) and the RID, and

any research program related to the level of mechanization in Thai agriculture. Eventually, there would be need for a second energy economist, who would also concern himself with the environmental aspects of energy use, and of a modernized agriculture.

(3) Economics of Forestry and Fisheries. The MUCIA advisors on forestry and fisheries have suggested that each faculty needs the benefits of economic analysis, in connection with production, processing and marketing. That is to say each faculty needs at least one analytical economist, to conduct research and to consult with fisheries and forestry scientists on their technical research. Additional well-qualified economists will be needed in each department as they become available.

What is suggested here in addition is that the Kasetsart University Department of Agricultural Economics also add to its faculty as soon as possible a qualified fisheries economist and a qualified forestry economist. Each would offer courses in the micro-economics and macro-economics of fisheries and forestry to undergraduate and graduate students in fisheries and forestry, and to students in agricultural economics, and to others; they should also conduct research in their specialties, and cooperate closely with economists in the Departments of Fisheries and Forestry.

(4) Program Planning and Budgeting. Still another suggestion for the Kasetsart University Department of Agricultural Economics or the Thammasat Department of Economics is to develop and offer a course available to seniors or M.Sc. students on "Program Planning and Budgeting" (PPB). At Kasetsart this course could be developed and taught by one of the resource economists

suggested as additions to the departmental faculty. It would be designed for students interested in the planning and evaluation of development projects and programs, particularly for those aiming toward professional careers in planning or evaluation agencies (e.g., the National Economic and Social Development Board, or the Bureau of the Budget), or in the planning divisions of developmental ministries or departments (like Agriculture, Agricultural Extension, Fisheries, Forestry, Irrigation, or Land Development). PPB would facilitate and improve the quality of planning, budgeting and evaluation of agricultural development projects and policies in Thailand. Program control and program accountability would be increased. Cooperation and coordination among different departments with an interest and a role in the same comprehensive programs would be encouraged by budgeting for integrated programs with budget elements for each cooperating department rather than having independent line-item budgets for each department for all purposes and programs.

(5) Income Distribution Effects of Agricultural Development Policies and Programs. Even when agricultural development efforts in developing countries achieve substantial increases in the output of agricultural commodities, more often than not this is done at the expense of increasing income inequality among farmers. Another side effect is often to decrease the total number of families engaged in farming (or to increase output much more rapidly than labor employment in agriculture). These unfortunate — and I believe unnecessary — results come about from programs or policies that encourage or permit mechanization that substitutes capital for large amounts of labor, that provide irrigation water to farmers at less than

the marginal value product of water to farmers, that provide other production inputs to farmers at costs less than their marginal value products, that fail to encourage or force the division of farms larger than the optimum size, that fail to tax land and other agricultural equipment at their productive values, and from many other development policies and programs evaluated only for their efficiency effects.

In many of the illustrative examples given above, the efficiency gains can be largely or wholly achieved without incurring the undesirable equity effects, by giving more careful consideration in the program planning or policy formulation stages to the potential equity effects.

What is suggested here is that a small start be made in this direction by encouraging the Kasetsart University to add to the faculty of the Department of Agricultural Economics a highly trained income distribution economist, with a good understanding of the economics of agriculture. This economist would teach a couple of graduate courses (one in income distribution economics, another in the income distribution effects of agricultural policies and programs), conduct research into the income distribution effects of existing agricultural development programs, or of agricultural development programs under consideration, and consult with the public agencies responsible for evaluating policies and programs such as the MOAC, the NESDB, and the Bureau of the Budget, among others. Eventually, this type of analysis would require the services of additional highly trained economists. It should be emphasized that in the initial stages of this income distribution analysis, it would consist largely in the estimating of the agricultural employment effects of existent or potential agricultural

policies and programs. Eventually it would work its way into more sophisticated but also important analyses of equity effects.

3. Estimating the Present Supply of Trained Agricultural Manpower.

Earlier we referred to the difficulty of estimating Thailand's needs for trained agricultural manpower.[10/] Not least is the difficulty of estimating the present numbers of professional research station staff, say in the Department of Agriculture, along with their capability of doing independent analytical or descriptive research in their specialty. It is not difficult to determine numbers, specialties, education and experience of the staff at each research station. The problem is to translate these numbers into "effectives", the number of staff who would be capable of useful, independent research if they were placed in a more favorable environment and given a challenging opportunity.

It might be expected that, in most of the field stations, the ratio of "effectives" to the number of individuals with research-qualifying training would not be high. Even for the station staff once endowed with relevant training, an inquisitive spirit, and energy, the research pattern frequently observed in the field would soon have a deadening, stultifying influence on any potential once present. This pattern is for the "desk scientist" in Bangkok to design the research, work out the procedures and communicate them to his "counterpart" at the field station. The counterpart lays out the plots (or other research) according to instructions and

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10/ See page 61ff.

transmits the resulting data back to our desk scientist who analyzes and interprets the results, and publishes them. Small wonder then that the potential creative skills seldom develop but atrophy before fruiting!

What is badly needed at this point in time is for agricultural research (in the broad sense) to be reorganized into major research stations that would include the regional agricultural centers, and the several national research programs (the national Corn and Sorghum Program at Farm Suwan is an example). Then the needs for professional personnel at all these research stations could be conservatively estimated by specialty and grade, for nonprofessional personnel by skill category, and for land and equipment.

These professional personnel needs could be matched against the present supply of personnel by making a complete list of professional "research" personnel now at all the stations, and at departmental and division headquarters. Each of these individuals on this list would be evaluated carefully by independent, blue-ribbon panels for each specialty to determine whether each individual is now capable of carrying on independent research in his specialty at the level implied by his grade. Those checked affirmatively would be considered to be the present supply of agricultural research workers in Thailand.

The supply by specialty and grade would be matched against the needs by specialty and grade. One would guess that there might be surpluses to needs in some specialties and grades, deficits in others. The supply of grade 4 (mostly technicians) staff is likely to be in surplus for many specialties and perhaps even in grade 3 for some specialties. Careful evaluation might reveal shortages in many specialties at the level of research

proficiency implied by grade 1 and 2. Here we are thinking about grade 1 as a research team leader, actively engaged in research himself, rather than as a more or less full-time research administrator. In matching supplies against needs in grades 1 and 2 by specialties, one would wish to estimate the number of potential grade 1 and grade 2 scientists among the younger staff members who have obtained their graduate degrees during the last few years. The question is whether they can perform at the level indicated (1 or 2).

As we described it earlier, the evaluation exercise would yield four sets of information.

(1) The number of research slots in the major research stations that could be filled by people now on board, or by those who will finish graduate studies here or abroad and be available for assignment during the next three years.

(2) The number of research slots in the major research stations that need to be filled as quickly as possible, during the next five years if possible.

(3) The number of research workers if any, who are judged to be effective in their specialty and grade, but who are surplus in terms of earlier defined needs. This number is likely to be small; if it is, these individuals would be fitted into the program in slots where they can be most useful.

(4) The number of research staff by specialty and grade who were found by the evaluation procedure to be no longer capable of independent research at the indicated level. What to do with these people? We believe they are

potentially an important resource for the agricultural development program. With wise handling, they could become valuable parts of the over-all agricultural program. Nearly all of these individuals have technical training, at the junior college or at B.Sc. or M.Sc. levels. With special training in extension techniques and some refresher training in their specialty, we believe the grade 2's and 3's (B.Sc. and M.Sc. holders) could become useful extension specialists and be stationed at the regional agricultural centers.

The redundant grade 4's are likely to be junior college graduates with more general training in agriculture. Many of them have served as technicians at the research stations. Again we believe that, with some extension training and refresher courses in agriculture, they could serve very well as extension agents, at the amphur or changwat level. Their experience as technicians would make it easy for them to conduct (or to learn to conduct) single-crop and multiple-cropping demonstrations in the villages. During the phase of the agricultural program consisting of increasing crop yields and introducing multiple cropping, demonstrations and trials are likely to be the most important and most useful single agricultural extension technique.

These erstwhile research workers would appear to have most of the competences necessary to communicate with the appropriate research workers at the adaptive research station, and to conduct trials and demonstrations. The skills that they would need to be assisted in developing would be in communicating with farmers and farm leaders, in the case of the extension agents, and in communicating with farmers and extension agents in the case of the extension specialists. In-service and pre-service training for extension agents in that agro-economic area would be established at each RAC. In-service and pre-service training for

each extension specialty would be set up at the national station most appropriate for that specialty.

One further aspect of the research supply situation needs to be discussed. This is the research component of the Kasetsart University Faculties of Agriculture, Forestry, Fisheries, and Economics and Business; the CMU Faculty of Agriculture; the Khon Kaen University Faculty of Agriculture, and, when they are established, the Song Khla University Faculties of Agriculture and Fisheries.

Thai universities, particularly Kasetsart, have been leading the way in upgrading their faculties by supporting them while they pursue graduate studies at home or abroad. The numbers of returned scholars and scientists, and the numbers who will be available in the next two or three years are quite large. There is every reason to expect that the vast majority will be able and anxious to spend some of their work time in the serious conduct of research, if they are offered encouragement and an opportunity. A cursory investigation revealed that few of the research-trained faculty members have such heavy teaching loads that they would not have time to do any research.

What needs to be done is to institutionalize support for the faculty capable of, and interested in, doing useful research. Traditionally university faculties have had little funding for research, although Kasetsart University has made a breakthrough in obtaining some support for faculty research. There is some support from MOAC departments for the research of some Kasetsart University faculty members, but this could almost be said to be on a personal rather than an institutional basis.

In order for the country to take full advantage of the useful research that these highly qualified individuals are capable of doing, the MOAC departments need to set up good opportunities for qualified faculty to do some of the research needed in the departmental programs. It should be emphasized that departments need not provide support for just any research the faculty wishes to do, but it should be for research that needs to be done as an integral part of the departmental research program. This will require some patient good-faith negotiation on both sides, and some monitoring of the progress of this "contract" research by in-house departmental researchers working on the same kinds of problems in the same specialty, in order to insure that the results are of good quality and get fed into the information network as soon as they become available. By all means, these arrangements should be standardized and made a part of the national agricultural research system as soon as possible.

It might be expected that the university faculties would choose research projects (or lines of research) more in the direction of basic agricultural research rather than adaptive research, but this generalization cannot be carried very far. Because of their other commitments (largely to teaching and consulting), it would probably not be wise to attempt to involve faculty in producing research findings that are needed at the earliest possible instant.

In addition to the research results produced directly by university agricultural faculties, the second most important benefit of this arrangement would be involvement of graduate students doing thesis research in the same kinds of problems as the university faculties are working on. This would produce additional useful research results, and would increase the relevance and improve the quality of the graduate programs.

The need for socio-economic surveys of the villages of Thailand is very pressing. Before adaptive research or extension programs can be designed for each of the agro-economic areas of Thailand, much more needs to be known about the farm households -- their resources, their capacities, and their preference -- and the village communities -- their capacities and their potentials. Information is needed on farm practices; on the land tenure, credit, and tax situations; on input and output markets; on other local organization; and so on. Fortunately, this survey research is descriptive, but it does need to be done carefully and accurately.

Many of the agencies we have been discussing have professionally trained individuals who would be quite capable of conducting these surveys under skilled supervision. These are found in the university social science departments, in the division of agricultural economics, in the land development department, and perhaps in other departments. Agriculture teachers in technical and comprehensive schools would also be prime candidates. As far as surveys of villageswhere forestry, fisheries, or livestock is important, there would be workers in the Forestry, Fisheries and Livestock Departments who would also have this capability.

What is needed is to mobilize this underutilized capacity. The requirements would be assistance in preparing the questionnaires and in designing the sample, supervision in the conduct of the survey, and assistance in analyzing the results of the surveys. There might be some competence in the university social science departments that could be contracted for until

economists, statisticians, or sociologists are turned out (probably at the M.Sc. level) by the university social science and statistics departments. Eventually, each regional agricultural center would require a social scientist or social statistician with this level and type of skill; the Departments of Land Development, Fisheries, Forestry, Livestock, the RID and the Division of Agricultural Economics would also be able to make good use of these skills to complement staff resources not now being utilized up to their full capacity. All of these public agencies need badly to have survey results available for use in designing research, extension, and action programs.

4. Guesstimates of Trained Manpower Needs by Specialty and Level of Competence.

What follows is a largely qualitative discussion, by departments or by departmental options, of the needs for trained agricultural manpower (usually at the M.Sc. or Ph.D. level), with some indication of the nature of the need. K.U. departments marked with an asterisk, would probably be encouraged to start planning to offer a Ph.D. in a few years. Other departments are believed to be not far enough along with present B.Sc. and M.Sc. programs to initiate Ph.D. planning now.

We have tried as hard as we could to take account of the qualified manpower on hand, and that in the pipeline (in training in Thailand or abroad). However, it must be admitted that no real basis was available to the writer by which to evaluate the quality of those on hand, or in the pipeline, although this is obviously the most important determinant of needs.

Agricultural economics.[11] The urgent needs are at the highest level (Ph.D.) for faculty for the Kasetsart University Department to offer the Ph.D., for analytical research (Ph.D. and M.Sc.) at the national research stations, at the regional agricultural centers, in the Division of Agricultural Economics, and in the Land Development Division. At least two of the Ph.D.'s for Kasetsart University should be in natural resource economics. To begin to meet the need for M.Sc.'s with analytical capacity, Kasetsart University will need to double their capacity at the M.Sc. level. Chieng Mai, Khon Kaen, and Song Khla should organize programs as soon as they can obtain the necessary faculty. Needs for M.Sc.'s would be in all options - agribusiness, production economics, resource economics, and marketing. The most acute needs at the B.Sc. level are likely to be for the agribusiness option, but the other options will also be needed in goodly numbers.

Agricultural education.[12] As a department in the Faculty of Agriculture performing the functions we have in mind for it, this department does not now exist. The suggested functions are to train some of the vocational agriculture instructors for the technical schools, some of the vocational agriculture instructors for the comprehensive schools (some would presumably come from the technical schools), and to prepare (hopefully from mature individuals with successful extension or agricultural education experience) extension training officers for the regional

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11/ For much more detail on agricultural economics, see the full report of MUCIA Advisor Wagner. This section is intended to be a brief summary of Wagner's Report.

12/ See the complete report by MUCIA Advisor Marvin.

agricultural centers and the national research stations. The department would grant B.Sc.'s and M.Sc.'s, with an initial goal of 20-25 B.Sc.'s and 6-8 M.Sc.'s. Because nearly all the graduates of the department would go out as instructors or training officers, the practical training should be quite rigorous.

To initiate such a department as this, a minimum faculty would probably be on the order of 4 Ph.D.'s and 4 M.Sc.'s. There are already some Thai individuals with the qualifications, if they could be attracted into the department.

Agricultural engineering.[13/] No department as visualized here exists; in Thailand, agricultural engineering is more engineering than agriculture and is in a Faculty of Engineering. The two primary fields of an agricultural engineering department as visualized here would be irrigation, the use of irrigation water in agriculture, and mechanization, the use of mechanical power in agriculture. The needs are for research workers in mechanization and irrigation at the appropriate national research stations and regional agricultural centers, for extension specialists in mechanization and irrigation at the appropriate regional agricultural centers, and for agricultural engineers to assist in the planning, design, and operation of irrigation systems. Serious consideration should be given to the initiation of a research program at an appropriate national research station to design and develop agricultural equipment for the technical and economic conditions found in Thailand.

13/ See the complete report of MUCIA Advisor Stout, who addresses himself largely to the mechanization needs.

To initiate such a Department of Agricultural Engineering in the Kasetsart University Faculty of Agriculture would probably require at least six instructors (perhaps 3 Ph.D.'s and 3 M.Sc.'s) in each option, Agricultural Engineering (Mechanization) and Agricultural Engineering (Irrigation), even if the department took full advantage of all the relevant courses in the Faculty of Engineering. The department should initiate as soon as possible an undergraduate program that will turn out 12-15 B.Sc.'s annually. As soon after that as the out-turn of the undergraduate program can be stepped up to 20-25, an M.Sc. program should be initiated. If the Thai society takes seriously the challenge of having a labor-intensive agriculture that will produce a joint maximum of output and employment, then the department should be encouraged to initiate a Ph.D. program in Agricultural Engineering (Mechanization) as soon as a fine program is possible. Some of the design engineers for a research program could come from Mechanical Engineering or Physics, now established in other Thai universities

Because it will be several years before even a B.Sc. in Agricultural Engineering can come out of the pipeline, it will be necessary to train abroad the minimum requirements for the national stations, the regional agricultural centers, and the Kasetsart University Faculty. Time could be saved if Thais with a good academic record and a degree in mechanical engineering could be recruited for graduate study abroad in agricultural engineering (mechanization), and if Thais with a good academic record and a degree in civil engineering could be recruited for graduate study abroad in agricultural engineering (irrigation).

It is estimated that not less than 24 agricultural engineers would need to be trained abroad before agricultural engineers would begin to come out of the pipeline. About one-half of these would be at the M.Sc. level, about one-half at the Ph.D. level. The needs at the B.Sc. level could presumably be filled by inservice training of B.Sc. mechanical engineers and civil engineers from Thai faculties of engineering.

Animal science.[14/] Here too the urgent needs are at the highest level of competence (Ph.D.) for faculty for the Kasetsart University Department of Animal Science to offer the Ph.D., at Ph.D. and M.Sc. levels for analytical research at the appropriate national research stations, and at the regional agricultural centers. To begin to meet the need for M.Sc's with analytical capacity, Kasetsart University would need to double their output capacity. At the B.Sc. level, Khon Kaen and possibly Chieng Mai should organize programs as soon as they can obtain the necessary faculty. Some degree holders at all three levels will probably be sucked into the private sector, but the vast majority would be needed in national and adaptive research, and as extension specialists, and as faculty at Kasetsart University, at Khon Kaen, and possibly at Chieng Mai.

The Department at Kasetsart is reported to have a good M.Sc. program, and would be able to train faculty at that level for the Khon Kaen and Chieng Mai faculties. Perhaps as few as 6 or 8 additional Ph.D.'s in

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14/ See the complete report of MUCIA Advisor Harshbarger.

Animal Nutrition, Animal Breeding or Animal Production would be enough, if the Kasetsart University department could increase the output of M.Sc.'s.

Entomology and plant pathology. Not long ago the former Department of Plant Protection was separated into separate Departments of Entomology and Plant Pathology. At present each is reported to be small but of good quality.

A transformation from traditional agriculture to a modern high-yield agriculture with multiple cropping would greatly magnify the importance of these two disciplines. This is because a land-intensive, high-yield agriculture has a much heavier incidence of insect and disease problems than a traditional agriculture.

For the time being at least, each department needs enough additional Ph.D.'s and M.Sc.'s to mount an effective M.Sc. program in each department. Some additional entomologists and plant pathologists will be needed to serve in a research capacity in each of the national and regional agricultural centers, and to serve as extension specialists in each of the RAC's. It is not clear to the writer how many of each would be required to meet minimum needs before the two departments can begin to turn out goodly numbers of B.Sc.'s and M.Sc.'s. It may be on the order of 12-15 each, equally divided between M.Sc.'s and Ph.D.'s.

Experimental statistics.[15/] The present Kasetsart University Department of Statistics does not yet resemble the Department of Experimental

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15/ See (11), for a report on statistics by Larry Nelson. A more rapid rate of growth is suggested here, to keep pace with the rapid expansion in analytical research in agriculture.

Statistics suggested here. The goal should be a degree-granting department eventually at all three levels, with strong minor programs in statistics for M.Sc. and Ph.D. students in the plant sciences, animal sciences and social sciences.

Thus the needs during the period before the Experimental Statistics Department starts to turn out M.Sc.'s would be for faculty at Kasetsart University, station statisticians at the national and regional agricultural centers, and agricultural statisticians for the Division of Agricultural Economics. With the present supply, a dozen each at the M.Sc. and Ph.D. level might be required, divided between specialties in plant science, animal science, social science, and mathematical statistics. Candidates could be sought from well-qualified B.Sc.'s in plant science, animal science, social science, and mathematics, as well as in statistics. The principal prerequisite for the science majors would be aptitude and training in mathematics and statistics.

Fisheries.[16/] The MUCIA Fisheries Advisor has recommended 24 Ph.D.'s and 4 M.Sc.'s -- 6 Ph.D.'s and 3 M.Sc.'s for the Kasetsart faculty, 7 Ph.D.'s for research in Department of Fisheries, 2 Ph.D.'s and 1 M.Sc. for research and extension in the fisheries marketing organization, and 8 Ph.D.'s for extension and administration at Kasetsart University and the Department of Fisheries. It is believed that the Ph.D.'s and M.Sc.'s, would enable the Kasetsart Faculty of Fisheries to initiate a Ph.D. program,

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16/ See the complete report by MUCIA Advisor Tack.

and to improve the M.Sc. program. It would also lead to the additional competence and to more effective fisheries marketing, fisheries extension, and stronger research in inland fisheries.

Forestry.[17/] The MUCIA Advisor suggested upgrading the undergraduate and the M.Sc. program in forestry, some expansion and qualitative improvement in research and extension. Since we concur here in the need to accelerate the reforestation program, some expansion would also be needed in the B.Sc. program.

Upgrading the quality of the curriculum both at the M.Sc. and B.Sc. levels, and expansion and improvement of the research program would probably require 4-6 Ph.D.'s in forestry, at least 1 or 2 of them in Forest Economics. If extension foresters are needed at a dozen or so of the regional agricultural centers, presumably this need could be met from the improved M.Sc. program. An expanded research program would require additional professionals, but this need too could probably be met from the expanded M.Sc. program. The Department and the Faculty of Forestry might wish to give some research attention to the social problems that arise in connection with administering the national forest reserves.

Home economics.[18/] The overwhelming needs in home economics at the present time is to initiate high-quality baccalaureate degree programs in the four most urgent fields of home economics -- family planning, nutrition, child development, and household economics. The minimum

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17/ See the complete report by MUCIA Advisor James.

18/ See the complete report by MUCIA Advisor Paolucci.

initial staffing goals for each of these four fields would be six -- Three at the M.Sc. level and three at the Ph.D. level. These home economists would be able to initiate small research programs, although most of their time would be taken up in planning teaching programs, teaching, and consulting. When these initial goals have been met, it would then be possible to make much better estimates of the need for graduates (B.Sc.'s, M.Sc.'s, and Ph.D.'s) in the different fields of home economics -- for teachers, for research workers, for extension workers, for private industry, and so on.

Plant science. From the verbal reports we have received, the professional personnel situation for plant science may be as favorable as for any specialty we are considering. The Kasetsart University department gets very good marks from its evaluators. This important field includes plant breeding, which has received a good deal of attention from the Department of Agriculture. Yet even here there are shortcomings to be remedied. There is a well developed program in rice, in corn and sorghum, in tobacco (under the Tobacco Monopoly), in rubber, and the makings of a good program in kenaf. Cotton, wheat, fruits, vegetables, and forage crops do not appear to be very far along in terms of variety development, and in variety testing in relation to moisture and fertilizer regimes.

A primary need would be to initiate a Ph.D. program at Kasetsart while strengthening the existing M.Sc. program. Individuals with the competence and other qualities to be research team leaders are needed for the agronomy

programs not very far off the ground. The primary research needs as opposed to teaching would be in the national research stations in variety development, in fertilizer and moisture testing of promising varieties.

Rural sociology. We believe that a Rural Sociology Department should be initiated at Kasetsart, to focus first upon the information dissemination aspects of technical change, then later to take up rural demography, rural community power structures, and other fields of rural sociology. To initiate an undergraduate program in rural sociology, it might be appropriate to have three Ph.D.'s and three M.Sc.'s. These could probably be obtained most rapidly by recruiting for training abroad six high-aptitude sociology graduates from Thammasat or Chulalongkorn. The most urgent needs for research sociologists would be at the regional agricultural centers, but some of these might also be filled with sociology graduates, who would be given an opportunity later to do graduate work in Rural Sociology. When the department was well established and ready to branch out into other problem areas in rural sociology, additional rural sociologists with graduate degrees will be required.

Soils.[19/] The Kasetsart University Soils Department is reported to have developed a fine department with a good M.Sc. program. Because soils research and extension will play an important role in the next stage of Thailand's agricultural development, it is suggested here that the department initiate planning for a Ph.D. degree. The most urgent needs are for high-quality research workers at the national research stations

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19/ See the report on soil science by MUCIA Advisor Russell.

and at the regional agricultural centers, for soil scientists to assist in water resource investigations, planning and evaluation, and for soil scientists to assist in the detailed land classification surveys. It is suggested here that 6 Ph.D.'s be trained abroad, 3 for the Soils Department, and 3 for the research stations. It is believed that the remainder of the needs can be met from the M.Sc. program.

Veterinary science.[20/] Even if senior veterinarians are placed at each of the regional agricultural centers, to organize animal public health programs, it is believed that needs can be met out of the current rate of output. The degree programs may need to be improved to make tham more relevant to a national livestock program.

Part IV.

Agricultural Manpower Projects Suggested for Consideration By the World Bank.

What follows below is an attempt to suggest agricultural manpower development projects for consideration by IBRD staff -- projects that appear to be technically and economically feasible and that would make substantial contributions to future increases in agricultural output and employment. Because the needs have been discussed in considerable detail earlier in this report, these suggested projects will only be identified here.

(1) Reorganization, rationalization, and coordination of research in agriculture, in fisheries, forestry, irrigation, and livestock. We

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20/ See the complete report by MUCIA Advisor Sautter.

are including here what has been described earlier as national (commodity) research programs and regional agricultural centers. FAO Consultant Haworth has made a complete, in-depth evaluation of agricultural research, and has made excellent and perceptive recommendations to the MOAC Department of Agriculture (9). Most of these recommendations would apply as well, with a little modification, to fisheries, forestry, irrigation, and livestock research.

(2) This is a parallel project to (1), and should be carried out simultaneously -- reorganizing, rationalizing and coordinating extension in agriculture, fisheries, forestry, irrigation and livestock around the regional agricultural centers suggested in (1) above.

(3) Developing a fine department of experimental statistics in the Faculty of Agriculture at Kasetsart, and excellent programs of statistical analysis in each of the MOAC departments and independent divisions.

(4) Developing a fine department of agricultural engineering in the Faculty of Agriculture at Kasetsart; this department should concern itself with technical irrigation and mechanization problems, with problem-oriented research activities and with undergraduate and graduate instruction and degree programs. The MOAC Irrigation Department should be assisted in developing an excellent program of irrigation research (including the economics of irrigation), and the MOAC Department of Agriculture should be assisted in developing a fine program of research in mechanization at the national stations and at the regional agricultural centers. This mechanization research program should also include economic analysis of mechanization, both at the micro (farm) level and at the macro (employment) level.

(5) Developing a fine human ecology (home economics) department at Kasetsart or Mahidol University. Here we are including family planning, nutrition, household management, and child development in human ecology, starting with undergraduate instruction.

(6) Expand and improve other departments -- animal science, plant science, entomology, plant pathology, fisheries, forestry, soils and veterinary science.

(7) Accelerating the rate of coverage of the rubber rehabilitation scheme by providing additional funds and extension staff so that small holders can be better assisted, and so that new plantings can be covered by the scheme.

(8) Developing (in the Royal Irrigation Department or in a semi-autonomous public agency) the capacity to investigate, evaluate and design new water resource projects, and the same capacity for the rehabilitation of existing projects. Investigations should include groundwater as well as surface water. Project investigations for any water use -- irrigation, electric power, navigation, flood control, or any other use -- should be concentrated in one agency so that the optimum allocation of water to the different uses can be worked out. Design and evaluation of irrigation projects should be based upon the optimum combinations of farm enterprises for that technical and economic environment, upon the possibilities for multiple cropping, and should include provisions either for irrigation structures on the farm or for supervision of the farmer in his development of these structures. Above all, it should be designed to include drainage.

(9) Accelerating the rate of expansion of fisheries research capacity, and the rate of coverage of fisheries extension. In need of particular emphasis is research and extension in inland fisheries, fish processing, and fish marketing.

(10) Accelerating the rate of reforestation through improvement and use of the forestry village concept.

(11) Accelerating the rate of coverage of detailed land classification studies and cadastral surveys of agricultural land.

(12) Expand and improve social sciences at Kasetsart:

a) Develop a Department of Rural Sociology with undergraduate and graduate instruction and curricula, and with research emphasizing innovations and information dissemination, and rural population. This department would want to cooperate with the sociologists in Thammasat and Chulalongkorn, and make full use of their strengths and that of the IPS.

b) Develop in the Kasetsart University Department of Agricultural Economics additional strength in natural resource economics, in PPB, and in income distribution. Undergraduate and graduate instruction and research are needed in the micro and macroeconomics of irrigation, fisheries, forestry, energy utilization, and environmental quality. Additional faculty will be needed to specialize in these important problem areas.

c) Develop a Department of Agricultural Education to train vocational agriculture teachers for junior colleges, comprehensive high schools, and comprehensive junior high schools, and training officers for the regional agricultural centers, and national research programs.

d) Consider the possibility of developing a Department of Information and Agricultural Journalism, to train individuals to assist in the dissemination by mass media and all other means the technical and economic information needed for agricultural development.

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