MEDIUM SCALE IRRIGATION SYSTEMS IN NORTHEAST THAILAND:

FUTURE DIRECTIONS

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MEDIUM SCALE IRRIGATION SYSTEMS IN NORTHEAST THAILAND: FUTURE DIRECTIONS

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An Applied Study of the Northeast Small Scale Irrigation Project
prepared for the USAID Mission to Thailand
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PREFACE

Appropriate sites for new irrigation development are increasingly hard to find, and new systems are so extensive that they are often neither financially nor economically viable. As a result, many countries elect to rehabilitate and upgrade existing irrigation systems instead. They see rehabilitation[1] as an extremely cost-effective measure due to the sunk costs associated with existing structures, reservoirs, and land; the relatively short construction period; and, in many cases, the presence of experienced farmers who do not require extensive training in irrigation techniques.

However, very few postproject studies specify how well rehabilitation schemes have met their social and economic objectives. Nor do available studies provide firm recommendations to improve future rehabilitation projects.

This study focuses on the USAID/Government of Thailand-funded Northeast Small Scale Irrigation (NESSI) Project and irrigation rehabilitation scheme, which involves seven medium-scale irrigation systems in Northeast Thailand. The study provides detailed postproject analyses of social, economic, and technical factors, and also contributes to our understanding of how medium-scale irrigation systems actually operate in Southeast Asia. Drawing on longitudinal data, the study links improved water management practices to agricultural production practices, which in turn relate to expanding public and private market opportunities.

The study highlights significant regional trends:

- the rapid absorption by the private sector of traditional public-sector activities;
- the critical importance of rapidly expanding market opportunities for non-rice agricultural systems to ensure the success of new or rehabilitated irrigation systems;
- the value of viewing water user associations as not just O&M facilitating bodies, but organizations that potentially can play strong production and marketing roles; and
- the critical necessity of developing regional water resources based on basin-wide dynamics, to minimize conflict and optimize the use of scarce water resources.

Methodologically, the study is innovative for USAID, as it offers an alternative approach to the more traditional project evaluation. The team, consisting primarily of Thai nationals (rather than the typical expatriate evaluation team), worked during an extended period, which allowed an in-depth study of the overall development process. With a single expatriate advisor and five senior Thai experts, the study was also very cost-effective. The addition of a member of ISPAN's permanent staff during document preparation ensured that the study reflects broader issues of interest to other ANE Missions and the Bureau.

This document, while specifically examining a single project in Northeast Thailand, has implications for development and investment plans far beyond Thailand's borders. Issues that emerge in the study must be faced by other countries as they determine the technical and social wisdom of investing in irrigation rehabilitation and upgrading.

[1] In this document, the term *rehabilitation* also encompasses some degree of facility upgrading.

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ACRONYMS AND TERMS

A.I.D.	U.S. Agency for International Development
AIT	Asian Institute of Technology
ALRO	Agricultural Land Reform Office
BAAC	Bank for Agriculture and Agricultural Cooperatives
Baht	Thai currency (US$1 = B25.73 in June 1989)
BOB	Bureau of the Budget
CDD	Community Development Department
Chaek	Smallest command unit served by a single turnover (averaging roughly 250 *rai*)
CTF	Consultant Task Force
DLD	Department of Land Development
DOA	Department of Agriculture
DOAE	Department of Agricultural Extension
DOF	Department of Fisheries
DPW	Department of Public Welfare
DTEC	Department of Technical and Economic Cooperation
ERR	Economic Rate of Return
FPIP	Farmer Participation in Irrigation Project
FPMG	Farmer Production and Marketing Group
Huai	Ephemeral stream
HYV	High-yielding variety
ICO	Irrigation Community Organizer
ISPAN	Irrigation Support Project for Asia and the Near East
Kaset Amphoe	District Agricultural Extension Officer
Kaset Changwat	Provincial Agricultural Extension Officer
Kaset Tambon	Subdistrict Agricultural Extension Worker
KKU	Khon Kaen University
KU	Kasetsart University
LMC	Left Main Canal
MCM	Million cubic meter
MOAC	Ministry of Agriculture and Cooperatives
MOF	Ministry of Finance
MOI	Ministry of the Interior
NESSI	Northeast Small-Scale Irrigation Project
O&M	Operation and Maintenance
O/ANR	Office of Agriculture and Natural Resources
O/TR	Office of Technical Resources
PJC	Private Joint Committee
PWWA	Public Water Works Authority
Rai	Thai land measure = 0.16 hectare (or 6.25 *rai* = 1 *ha*)
RID	Royal Irrigation Department
RMC	Right Main Canal
RTG	Royal Thai Government
SCS	Subject Content Specialist
SWDP	Thai-New Zealand Small Watershed Development Project
TDRI	Thailand Development Research Institute
T&V	Training and Visit System
USAID	U.S. Agency for International Development/Thailand
WUA	Water Users Association
WUG	Water Users Group

EXECUTIVE SUMMARY

Northeast Thailand is the largest and most populated region of the country, but its per capita income and crop yields are the country's lowest. Erratic rainfall and poor soils contribute to its low agricultural production and consequent slow economic growth. Given the region's limited irrigation potential and the fact that many irrigation systems developed during the 1960s have never reached their full potential, a regional priority is to improve and upgrade existing irrigation systems. The Northeast Small Scale Irrigation Project (NESSI) was designed to rehabilitate seven medium-scale irrigation systems dispersed throughout the region and, in so doing, develop a model that could be used to improve farmer income levels at other small- and medium-scale irrigation sites in the Northeast. This study assesses the NESSI approach in terms of effectiveness and replicability, and provides a series of recommendations for the next phase of medium-scale irrigation systems development in the Northeast.

Assessment

1. Institutions

The Central Policy and Project Coordinating Committees, the two national-level committees in the original design, played little direct role in project implementation. Direct involvement at the national level began with the Project Coordinating Subcommittee, which was created when the project needed a means to bring NESSI issues directly to the attention of national officials. Even with its relatively infrequent meetings, the subcommittee appears to have been a useful and responsive entity.

Provincial coordinating committees organized in each of the seven provinces involved served a legitimizing role for the project rather than filling an active working function. The committees' primary utility was to provide an orientation at the beginning of the project and formally create a field working group for each site.

At the sites, field working groups have emerged as very effective coordinating bodies for government agencies and farmers, and clearly have contributed to project implementation. Meetings are held monthly, with fixed agendas that include achievements, plans, and problems. Officers from participating irrigation, extension, and other line agencies attend the meetings, as do officers of water users associations.

2. Water Users Groups

Within a relatively brief four-year period, NESSI has formed chaek groups and revived water users associations (WUAs) inactive since their formation fifteen years earlier, during site construction. Hundreds of chaek groups at nearly all the sites are playing a direct role in on-farm system O&M, involving themselves in decisions about water delivery in farm ditches and contributing labor and cash for maintenance. WUAs have been reactivated and appear to be overseeing site activities, while offering a degree of accountability to members. Royal Thai Government (RTG) staff now meet regularly with farmers and include them in decision-making concerning both water scheduling in the farm ditch and dry season cropping.

However, as NESSI moves toward project completion, shortcomings in the approach are apparent. Farmer participation in system operation has been restricted to the on-farm system, largely to the farm ditch. A more substantive role requires involvement in decision-making on water deliveries throughout the system, from the water source to the chaek. Future project activities need to have long-term goals of improving crop production and increasing farmers' incomes, not just improving water management.

3. Extension

Due to staffing and resource constraints, NESSI's agricultural extension component did not realize many of its goals. A reliance on traditional extension techniques hampered activities. Demonstration plots and field trials were few and limited in scope, with their success depending upon factors often outside the extension worker's control. Department of Agricultural Extension (DOAE) workers responsible

for promoting dry season cropping suffered from inexperience in producing non-rice crops. The Planning and Special Projects Division established a system to monitor production, but these data were not distributed widely within the projects.

During NESSI's early years the private sector, which could have provided technology and markets (as it does in North and Central Thailand), remained in a formative stage in the Northeast. As a result, the private sector was only marginally involved in extension, usually providing information about market demands, rather than playing a technical role. Extension did not provide the leadership role envisioned in the original project design, nor has it proven responsive to the rapidly changing economic climate or the new demands that the region's rapidly expanding private firms have created for cash crops and better-trained farmers.

4. Marketing

Although market demand for vegetables in the Northeast has increased dramatically during the past decade, project staff found it difficult to give farmers technical assistance in improving market activities. The project's only training in marketing skills and marketing studies, provided by consultants, occurred prior to the completion of the sites. When farmers were actually willing and able to produce enough additional dry season crops to need expanded market outlets, market assistance was no longer available under the contract.

Much remains to be done to increase and stabilize agricultural incomes in NESSI sites. Continuing problems in production and marketing include diversified cropping on small-scale farms, non-uniformity in the cropping system, extension staff's inexperience in growing and marketing new crops, farmers' limited access to market outlets, and inefficiencies in transportation, grading, storage, and information dissemination.

5. Economic Analysis

Project analyses have been conducted by the Asian Institute of Technology, USAID, consultants for USAID, the consulting group, and the RTG Bureau of the Budget. These analyses were based on projections and a variety of assumptions. Following these same approaches, a study team analysis, using five-year data for four sites, reveals that two sites have an economic rate of return (ERR) greater than 12 percent and two have ERRs greater than 10 percent. While not as high as ERRs estimated by others, the ERRs are marginally acceptable given NESSI's experimental nature. Field data indicate that family incomes in three study sites have risen from 20 to 50 percent, largely due to expanded wet season yields and increased dry season cropping.

6. Engineering

NESSI's on-farm design, based on small check service areas, leads to good operation and maintenance. However, the design requires a large number of main ditches and unlined farm ditches, which make construction costly. This design's overall cost will limit large-scale implementation of NESSI's design concept.

At several NESSI sites, conflicting demands for irrigation and domestic water put pressure on the Royal Irrigation Department (RID) to find alternative sources. Adding to the strain of increased nonagricultural withdrawals is the inflow of sedimentation that continues to reduce reservoirs' storage capacity.

Current methods to forecast available water for medium-scale reservoirs tend to overestimate inflows, which results in an overly optimistic estimation of irrigation potential. Nor do the methods currently used consider the impact of land use change on firm runoff from the catchment area. The development of numerous small irrigation weirs and reservoirs in the catchment areas during the last decade has further reduced reservoir inflows.

Recommendations

1. Institutions

As designed, NESSI's management structure was far too complex. Based on NESSI experience, additional medium-scale projects in the Northeast need a relatively lean organizational framework. The following are institutional recommendations for Phase II rehabilitation of medium-scale irrigation systems:

- Create a project coordinating subcommittee at the national level and a field working group on-site.
- Develop a mechanism to allow field working groups to form early and to function even after a project is formally completed, thus ensuring that cooperation among line agencies and with farmers continues.

2. Water Users Groups

Presently, WUA formation has no clear home within the government. The team recommends that RID continue as the primary agency for organizing and strengthening water users, since improved water management is the basis for successful group formation.

- The Royal Thai Government should adopt the concept of farmer involvement at all stages of irrigation development, from site design through O&M. The concept should be institutionalized in a Standard Operating Procedure, which establishes clear rights and responsibilities for farmers at all phases of system rehabilitation and operation.
- To strengthen rehabilitation programs, Irrigation Community Organizers (ICOs) should be recruited to work with farmers, beginning with the design phase, until they form viable O&M groups. Two ICOs should be assigned per zoneman and should stay on the job for at least two full seasons.
- In order to further promote dry season cropping, it is critical that water users associations work with zonemen in projecting land for dry season cropping, to ensure that available water supplies are not over committed.

3. Crop Production

Rice will remain the main lowlands crop during the wet season, although in most cases the shift from glutinous to nonglutinous varieties will continue.

- Farmers in NESSI sites should be encouraged to continue expanding the area planted in dry season vegetables, including baby corn, tomatoes, peanuts, and soybeans and other legumes, as these are all demanded by processing plants.
- Training and better technology transfer from the public and private sectors are needed, as well as farmer production and marketing groups, to help farmers produce more and better crops both for processing and for the fresh market.

4. Extension

The following recommendations address adjustment to the new economic climate:

- In the future, subdistrict agricultural officers should take responsibility for helping provide liaison among processing firms, fresh markets, and farmers, preferably through farmer production and marketing groups (FPMGs) and WUAs.
- DOAE must play a new role in the intensively irrigated areas where the private sector is active. In the early stages, while Northeast farmers are still naive about legal contracts, DOAE should develop a standard contract.
- DOAE should also organize a campaign to inform farmers about the concept of market contracting and promote the standard contract.
- In some cases, DOAE staff may want to mediate when problems arise between farmers and private firms.

5. Marketing

The next phase of medium-scale irrigation systems development should emphasize four areas: promoting market-based crop production, improving the existing procurement systems, improving and simplifying market contracts, and establishing market training programs for farmers and DOAE and RID staff.

- Because farmers commonly enter disadvantageous marketing contracts with processing plants and middlemen, new marketing contracts (Appendix F) should be developed to ensure fairness for both parties. Contracts should include more-specific details specifying inputs, price, and delivery requirements.
- Farmers now have limited market outlet options. To improve their procurement systems, some produce, particularly baby corn, tomatoes, soybeans, and peanuts, should be redirected from provincial to national markets.

- Postharvest activities (sorting, grading, and packing) must also be performed in order to expand the market boundary from farms to more distant processing plants. Vegetables for fresh produce markets should be sorted, graded, packed, and delivered by farmers working as production and marketing groups.
- Only 4 of 17 Northeast provinces have Private Joint Committees (PJCs). PJCs should be established in all provinces with rehabilitated systems. Agricultural extension will play an important role linking private entrepreneurs to WUAs.

6. Engineering

Although NESSI design criteria have been proven to work, they are relatively expensive and limit the area that can be rehabilitated using this approach.

- RID should consider increasing the design criteria for chaek service areas to 200-250 rai to reduce construction costs.
- Farmers should contribute labor for constructing farm ditches and sodding to further reduce site-rehabilitation costs.
- Methods employed to estimate reservoir inflows should incorporate both physical characteristics and effects of land use change on runoff, so that inflow estimations better represent actual conditions.
- RID, in coordination with other government agencies, should develop measures against soil erosion in the catchment area to reduce reservoir sedimentation and lengthen the project service life.
- Prior to planning any additional projects, RID should investigate the impact small weirs and reservoirs in the catchment areas have on inflows into all irrigation projects downstream.
- A long-term basin-wide water management study that considers all water demands within a subbasin, such as irrigation, domestic, industrial, and tourist demands, should be carried out in the Northeast and other regions in Thailand.

Implications for Future Regional Development

Thailand's development experience provides a model for other countries in the region. Laos, Cambodia, and Vietnam all look toward Thailand as an economic model they would like to emulate. Indonesia, Malaysia, and the Philippines also are interested in the "Thailand model," particularly its balanced growth between agricultural and industrial exports. Its strong economic base guarantees that Thailand will continue to be a regional development resource for the next two decades.

The secret of Thailand's success has been RTG's willingness to let the private sector do the things it does best. RTG has not hesitated to stop providing services when the private sector demonstrates it can perform the service better and at less cost to the government. Not only has Thailand allowed the private sector to provide such services as air travel, higher education, agricultural inputs, and agricultural exports, it has also encouraged the sector to provide more traditional public services: seed development and multiplication, and agricultural research and extension. The private provision of public services brings the forces of competition into areas of monopoly. In Thailand, these forces have led to better services at a lower price.

With respect to NESSI, the entrance of private-sector processing plants in the region has ensured that farmers can benefit from their labor. When NESSI reservoirs were first constructed in the 1960s, farmers had water but no outlet for their products. The end result was that limited economic incentives prevailed, and farmers did not use the water. That situation contrasts with the Northeast today where, at every location with dry season water, farmers are eager to produce crops and private processing plants are anxious to buy the output. RTG's encouragement of regional private-sector investment ensures that past investments in Northeast water resources development will have a high payoff.

บทสรุปสำหรับผู้บริหาร

ภาคตะวันออกเฉียงเหนือเป็นภูมิภาคที่ใหญ่และมีพลเมืองหนาแน่นที่สุดของของประเทศไทย แต่มีรายได้เฉลี่ยต่อหัวของประชากรและมีผลผลิตทางการเกษตรต่ำที่สุด ปัจจัยสำคัญที่ทำให้มีผลผลิตทางการเกษตรต่ำก็คือ มีปริมาณน้ำฝนที่ไม่แน่นอนและดินมีคุณภาพไม่ดี ดังนั้น การเติบโตทางเศรษฐกิจจึงเป็นไปอย่างช้า เมื่อคำนึงถึงว่าศักยภาพของการชลประทานในภูมิภาคนี้ค่อนข้างจำกัด และโครงการชลประทานหลาย ๆ แห่งที่พัฒนาระหว่างประมาณ พ.ศ.2500 เป็นต้นมา ไม่เคยได้มีการใช้ประโยชน์เต็มศักยภาพที่มีอยู่ ลำดับความสำคัญอันดับแรกในการชลประทานสำหรับภูมิภาคนี้ก็คือการปรับปรุงโครงการชลประทานที่มีอยู่แล้ว โครงการชลประทานขนาดเล็กในภาคตะวันออกเฉียงเหนือ (NESSI) จึงมีขึ้นเพื่อปรับปรุงโครงการชลประทานขนาดกลาง 7 โครงการ ซึ่งกระจายกันอยู่ตามจังหวัดต่าง ๆ ของภูมิภาคนี้ การดำเนินงานของ NESSI ได้มีการพัฒนารูปแบบซึ่งสามารถใช้เพื่อยกระดับรายได้ของเกษตรกรของโครงการชลประทานขนาดเล็กและขนาดกลางอื่น ๆ ของภาคตะวันออกเฉียงเหนือได้ การศึกษาประยุกต์ครั้งนี้ทำการประเมินรูปแบบของ NESSI ทั้งด้านประสิทธิผลและการนำรูปแบบไปใช้ในที่อื่น พร้อมทั้งให้ข้อเสนอแนะสำหรับการปรับปรุงหรือพัฒนาโครงการชลประทานขนาดกลางอื่น ๆ ในภาคตะวันออกเฉียงเหนือด้วย

1. การประเมินผล

สถาบันและองค์กร

โครงการ NESSI มีคณะกรรมการระดับประเทศ 2 ชุด ได้แก่ คณะกรรมการกลางควบคุมนโยบายและคณะอนุกรรมการประสานงานโครงการ คณะกรรมการกลางควบคุมนโยบายมีบทบาทโดยตรงในการดำเนินงานของโครงการน้อยมาก ส่วนคณะอนุกรรมการประสานงานโครงการมีบทบาทในการนำประเด็นปัญหาต่าง ๆ เสนอต่อผู้บริหารระดับนโยบาย คณะอนุกรรมการนี้จัดได้ว่าเป็นสิ่งที่มีประโยชน์แม้ว่าจะมีการประชุมกันน้อยครั้ง

คณะกรรมการประสานงานระดับจังหวัด ซึ่งจัดตั้งขึ้นในแต่ละจังหวัดที่มีโครงการ NESSI อยู่มีบทบาทแค่เป็นพิธีการมากกว่าจะทำเพื่อทำหน้าที่อย่างเต็มที่ ประโยชน์อันดับแรกของคณะกรรมการชุดนี้ก็คือเพื่อทำให้มีการแนะทำโครงการในตอนเริ่มดำเนินการโครงการและทำหน้าที่จัดตั้งคณะทำงานสนามสำหรับแต่ละแห่ง

ที่ระดับโครงการชลประทาน คณะทำงานสนามจะเป็นองค์กรที่เห็นได้ชัดว่ามีประสิทธิผลมากในการประสานงานระหว่างหน่วยงานของรัฐบาลต่าง ๆ และเกษตรกร คณะทำงานสนามมีการประชุมรายเดือนซึ่งมีผู้เข้าร่วมประชุมจากฝ่ายกรมชลประทาน กรมส่งเสริมการเกษตร และกรมอื่น ๆ พร้อมทั้งตัวแทนของสมาคมผู้ใช้น้ำ การประชุมจะมีวาระการประชุมที่วางแผนไว้อย่างดี เช่น ผลการดำเนินงาน แผนการดำเนินงานต่อไป และปัญหาอุปสรรคที่มีเป็นต้น

กลุ่มผู้ใช้น้ำและสมาคมผู้ใช้น้ำ

ในระยะเวลา 4 ปีที่ผ่านมาโครงการ NESSI ได้จัดตั้งกลุ่มผู้ใช้น้ำประจำแฉกส่งน้ำและรื้อฟื้นสมาคมผู้ใช้น้ำต่าง ๆ ซึ่งเคยจัดตั้งมากว่า 15 ปีที่แล้ว ซึ่งมีบทบาทและกิจกรรมน้อยมากหลังจากการจัดตั้ง กลุ่มผู้ใช้น้ำหลายร้อยกลุ่มที่จัดตั้งขึ้นในทุกๆ อ่างเก็บน้ำ ภายใต้โครงการ NESSI เป็นผู้ที่มีบทบาทโดยตรงในการส่งน้ำและบำรุงรักษาระบบส่งน้ำในแปลงนา กลุ่มผู้ใช้น้ำจะร่วมทำการตัดสินใจในเรื่องการส่งน้ำในคูส่งน้ำ ในการมีส่วนร่วมด้านแรงงานและค่าใช้จ่ายในการบำรุงรักษา สมาคมผู้ใช้น้ำซึ่ง NESSI รื้อฟื้นขึ้นมาใหม่เมื่อเห็นว่าเกษตรกรมีความพร้อมก็มีบทบาทในการดูแลกิจกรรมทั้งหมดในแต่ละโครงการชลประทาน พร้อมกับเป็นที่พึ่งพาของสมาชิกทั้งหมด เจ้าหน้าที่ของรัฐทุกหน่วยงานที่เกี่ยวข้องก็มีการพบปะกับเกษตรกร และให้เกษตรกรมีส่วนร่วมในการตัดสินใจในเรื่องกำหนดการส่งน้ำในคูส่งน้ำ และแผนการเพาะปลูกพืชฤดูแล้ง เป็นต้น

อย่างไรก็ดี ในขณะที่โครงการ NESSI ใกล้จะสิ้นสุดโครงการ ข้ออ่อนของวิธีการก็เริ่มปรากฏให้เห็น ตัวอย่างเช่น การมีส่วนร่วมของเกษตรกรจะจำกัดอยู่ในเฉพาะระบบแปลงนา โดยเฉพาะอย่างยิ่งกับคูส่งน้ำ เกษตรกรน่าจะมีส่วนร่วมมากขึ้นในการตัดสินใจในเรื่องการส่งน้ำตลอดทั้งระบบจากอ่างเก็บน้ำไปสู่คูส่งน้ำ

การส่งเสริมการเกษตร

งานส่งเสริมการเกษตรมีเกษตรจังหวัดและเกษตรอำเภอเป็นผู้รับผิดชอบ มีเกษตรตำบลในพื้นที่โครงการเป็นผู้ดำเนินงาน และกองแผนงานและโครงการพิเศษ กรมส่งเสริมการเกษตร เป็นผู้สนับสนุนโครงการและติดตามการปฏิบัติงานให้เป็นไปตามวัตถุประสงค์ของโครงการ

กิจกรรมส่งเสริมในพื้นที่โครงการยังเป็นการส่งเสริมปกติ เช่นเดียวกับการส่งเสริมการเกษตรทั่ว ๆ ไป คือ มีการจัดทำแปลงทดสอบพืช แปลงส่งเสริม แปลงทดสอบระบบปลูกพืช วันสาธิต การทัศนศึกษา และการฝึกอบรมเกษตรกร ซึ่งการจัดงานวันสาธิตค่อนข้างประสบผลสำเร็จดี ในการติดตามประเมินผลนั้นยังไม่มีการศึกษาวิจัยอย่างจริงจังเกี่ยวกับวิธีการส่งเสริมที่มีประสิทธิภาพในโครงการ เช่น การถ่ายทอดเทคโนโลยี การใช้สื่อที่เหมาะสม การส่งเสริมร่วมกับเอกชนเพื่อพัฒนาเกษตร เป็นต้น ซึ่งเป็นสิ่งที่จำเป็นต่อการพัฒนารูปแบบการส่งเสริมในโครงการ

ปัญหาโดยทั่วไปเจ้าหน้าที่ทั้งฝ่ายชลประทานและส่งเสริมการเกษตรต่างมีภาระงานมาก ขาดความรู้ความชำนาญในการเกษตรชลประทาน งบประมาณจำกัดและพื้นที่รับผิดชอบกว้างเกินไป เพราะงานเกษตรชลประทานต้องมีการปฏิบัติอย่างเข้มข้นทุกฤดูกาลเพาะปลูก ซึ่งทั้งสองฝ่ายเห็นควรให้เพิ่มเจ้าหน้าที่ให้มากขึ้น นอกจากนั้นในการส่งเสริมยังไม่มีการติดต่อประสานงานกับโรงงานเอกชนอย่างจริงจัง เพราะปัญหาการเป็นข้าราชการอาจจะมีข้อครหาต่าง ๆ ได้

การตลาด

องค์กรตลาดในภาคตะวันออกเฉียงเหนือ ซึ่งมีส่วนเกี่ยวข้องกับการซื้อขายผลิตผลเกษตรในพื้นที่ที่ทำการศึกษา คือ โรงงานแปรรูปอาหาร หน่วยธุรกิจเกษตรที่ค้าผลิตผลจำพวกพืชน้ำมัน ศูนย์กลางตลาดซื้อขายผักสด และเอเย่นต์ตลาดเมล็ดพันธุ์ ปัจจุบันนี้โรงงานแปรรูปอาหารมีอยู่ทั้งหมด 8 ประเภทซึ่งได้แก่โรงงานแปรรูปผักและผลไม้โรงงานผลิตซ็อสมะเขือเทศ โรงงานกะเทาะเมล็ดถั่วลิสง โรงแช่แข็งผลผลิตเกษตร โรงงานผลิตพริกป่นและซ็อสพริก โรงงานทำขิงผง โรงงานผลิตผักดองเค็ม และโรงสีถั่วเขียว โรงงานต่างๆ เหล่านี้นับว่าสำคัญคือ โรงงานแปรรูปผักและผลไม้ซึ่งมีอยู่ทั้งหมด 7 โรง ในจังหวัดร้อยเอ็ด ยโสธร ขอนแก่น หนองคาย สกลนครและบุรีรัมย์ กำลังการผลิตจริงสำหรับข้าวโพดฝักอ่อนประมาณ 23,000 ตัน ต่อปี และมะเขือเทศประมาณ 10,000 ตันต่อปี โรงงานผลิตซ็อสมะเขือเทศ มีอยู่ทั้งหมด 5 โรง ในจังหวัดหนองคาย กำลังการผลิตจริงมากกว่า 170,000 ตันต่อปี นอกจากนี้โรงงานกะเทาะเมล็ดถั่วลิสงมีทั้งหมด 27 โรง ส่วนใหญ่อยู่ทางตอนล่างของภาคคือ นครราชสีมา สุรินทร์ ศรีสะเกษและอุบลราชธานี นอกจากนี้ยังมีที่กาฬสินธุ์และอุดรธานี

หน่วยธุรกิจเกษตรที่ค้าผลิตผลจำพวกพืชน้ำมัน (ถั่วเหลือง ถั่วลิสง ถั่วเขียว) คือ พ่อค้าขายส่งระดับจังหวัด และศูนย์ขยายพันธุ์พืชของกรมส่งเสริมการเกษตร ปัจจุบันนี้มีพ่อค้าขายส่งระดับจังหวัดมากกว่า 200 ราย ซึ่งกระจายอยู่ตามจังหวัดต่าง ๆ ของภาคตะวันออกเฉียงเหนือ แต่แหล่งที่สำคัญอยู่ในจังหวัดนครราชสีมา บุรีรัมย์ สุรินทร์ ศรีสะเกษ อุบลราชธานี ขอนแก่น และยโสธร ศูนย์ขยายพันธุ์อยู่ในจังหวัดร้อยเอ็ด กาฬสินธุ์ ขอนแก่น นครราชสีมา สุรินทร์ อุบลราชธานี สกลนคร และอุดรธานี สำหรับศูนย์กลางตลาดผักสดนั้นในภาคมีตลาดขายส่งผักทั้งหมด 31 แห่ง (แต่ละจังหวัดมีตลาดขายส่งผักอย่างน้อยหนึ่งตลาด) ตลาดสำคัญที่สุดของภาคคือ ตลาดชุมพลและตลาดประชาในจังหวัดนครราชสีมา ส่วนเอเย่นต์ตลาดเมล็ดพันธุ์ มี 2 ประเภท คือ พ่อค้าเมล็ดพันธุ์เอกชน ส่วนมากซื้อขายเมล็ดพันธุ์มากและศูนย์ขยายพันธุ์จะทำการซื้อขายเมล็ดพันธุ์พืชน้ำมัน

ระบบตลาดหรือระบบการซื้อขาย (Procurement system) แบ่งออกได้เป็น 2 ระบบ คือ ระบบการซื้อขายในตลาดทั่วไป (Spot or current market)และระบบการซื้อขายแบบตลาดข้อตกลง (Procurement by contracts) ผลิตผลเกษตรที่อยู่ในระบบการซื้อขายของตลาดทั่วไป ในพื้นที่โครงการชลประทานห้วยแอ่งและห้วยขี้เหล็กมีถั่วลิสง เห็ดฟางและผักสดต่าง ๆ ในเขตพื้นที่โครงการชลประทานห้วยจรเข้มาก ส่วนมากก็มีถั่วเขียว ส่วนผลิตผลที่ซื้อขายแบบตลาดข้อตกลง มีข้าวโพดผักอ่อนในห้วยแอ่ง โดยมีการทำข้อตกลงการผลิต (Production contract) ระหว่างพ่อค้าคนกลางและเกษตรกร พ่อค้าจะจ่าย ค่าจ้าง (100 บาท/3 วัน) และเค่าเช่าที่ดินให้กับเกษตรกร ส่วนผลผลิตที่เก็บเกี่ยวจะเป็นของพ่อค้า นอกจากนี้ยังมีการซื้อขายข้าวโพดผักอ่อนและมะเขือเทศในเขตพื้นที่โครงการชลประทานห้วยแอ่ง มะเขือเทศและถั่วเหลืองในพื้นที่โครงการชลประทานขี้เหล็กและถั่วลิสงในพื้นที่โครงการชลประทานห้วยจรเข้มาก ซึ่งเป็นประเภทข้อตกลงการตลาด (Marketing or procurement contract) โดยโรงงานหรือพ่อค้าผู้ซื้อจะประกันราคาขั้นต่ำและปริมาณผลผลิตที่จะรับซื้อจากเกษตรกร

ปัญหาต่างๆ ที่เกษตรกรในพื้นที่โครงการชลประทานขนาดเล็กกำลังประสบแบ่งออกได้เป็น 2 ประเภทคือ ปัญหาการผลิตที่มีผลกระทบต่อการตลาด และปัญหาการตลาดโดยเฉพาะกล่าวคือ ปัญหาการผลิตได้แก่ เกษตรกรแต่ละรายมีพื้นที่เพาะปลูกขนาดเล็กและปลูกพืชมากชนิดเกินไป ระบบการเพาะปลูกไม่เป็นรูปแบบเดียวกัน (no uniformity) และเกษตรกรขาดประสบการณ์ในการปลูกพืชใหม่ๆ สำหรับปัญหาการตลาด ได้แก่ แหล่งจำหน่ายผลิตผลมีอยู่จำกัด (เพราะขาดเจ้าหน้าที่ฝ่ายตลาดในพื้นที่ช่วยติดต่อตลาดให้) สัญญาหรือข้อตกลงการตลาดที่ทำขึ้นระหว่างพ่อค้าและเกษตรกรระบุไม่ชัดเจน (ส่วนใหญ่เกษตรกรเป็นฝ่ายเสียเปรียบมากกว่าพ่อค้า) เจ้าหน้าที่ส่งเสริมการเกษตร เจ้าหน้าที่ฝ่ายสนามของโครงการชลประทาน ประธานสมาคมผู้ใช้น้ำและหัวหน้ากลุ่มผู้ใช้น้ำขาดประสบการณ์และ

ความรู้ทางด้านการตลาด นอกจากนี้ผลการดำเนินงานทางการตลาดไม่มีประสิทธิภาพ เพราะการขนส่งมักจัดโดยแต่ละบุคคล ส่วนน้อยที่จะช่วยกันวางแผนการขนส่งโดยกลุ่มเกษตรกร ไม่มีการคัดเลือกคุณภาพและจัดชั้นมาตรฐานของผลิตผลก่อนที่จะนำไปจำหน่าย →และขาดสิ่งอำนวยความสะดวกต่างๆ เช่น ห้องเย็น สำหรับใช้ในการเก็บรักษาผลผลิต (ข้าวโพดฝักอ่อน มะเขือเทศ และผักอื่นๆ)

การวิเคราะห์ทางเศรษฐศาสตร์

การวิเคราะห์ทางเศรษฐศาสตร์ได้มีผู้ทำการวิเคราะห์มาหลายครั้งแล้ว เช่น สถาบันเทคโนโลยีแห่งเอเชีย USAID ที่ปรึกษาของ USAID วิศวกรที่ปรึกษาและสำนักงบประมาณ โดยอาศัยสมมุติฐานและการคาดการณ์ต่าง ๆ กัน การวิเคราะห์ครั้งนี้ก็อาศัยวิธีการที่คล้ายคลึงกับที่เคยทำมาแล้ว โดยใช้ข้อมูลแท้จริงที่ผ่านมา 5 ปีของโครงการ NESSI 4 แห่ง และได้ผลว่ามีอยู่สองแห่งคือ อ่างเก็บน้ำห้วยขี้เหล็กและอ่างเก็บน้ำพุทธอุทยาน ได้ค่า ERR มากกว่า 12% และอีกสองแห่งคือ อ่างเก็บน้ำห้วยแอ่งและอ่างเก็บน้ำห้วยจรเข้มาก ได้ค่า EER มากกว่า 10% ซึ่งถือว่าเป็นที่ยอมรับได้เมื่อคำนึงว่าโครงการ NESSI มีลักษณะเป็นโครงการนำร่อง จากข้อมูลสนามใน NESSI 3 แห่ง ที่ทำการศึกษาละเอียดได้แก่ อ่างเก็บน้ำห้วยแอ่ง อ่างเก็บน้ำห้วยขี้หลีกและอ่างเก็บน้ำห้วยจรเข้มาก พบว่าเกษตรกรมีรายได้ครอบครัวเพิ่มขึ้น 20 ถึง 50% ซึ่งรายได้ที่เพิ่มส่วนใหญ่มาจาก ผลผลิตข้าวนาปีที่เพิ่มขึ้นและจากการเพาะปลูกพืชฤดูแล้ง

ด้านวิศวกรรม

การออกแบบระบบแปลงนาของ NESSI ใช้หลักว่าให้พื้นที่แฉกส่งน้ำมีขนาดเล็ก และมีจำนวนเกษตรกรที่จะได้รับน้ำประมาณ 10-20 ครอบครัว ซึ่งได้แสดงให้เห็นชัดเจนว่าเป็นการออกแบบที่ดี และนำไปสู่การส่งน้ำและบำรุงรักษาที่มีประสิทธิผล อย่างไรก็ตาม การออกแบบนี้จะทำให้มีจำนวนคูส่งน้ำหลักที่คาดด้วยคอนกรีตและคูส่งน้ำในแปลงนาเป็นจำนวนมาก ซึ่งทำให้ค่าก่อสร้างสูงมาก ดังนั้นค่าก่อสร้างทั้งหมดของการออกแบบเช่นนี้จะจำกัดการขยายการดำเนินงานการปรับปรุงโครงการชลประทานขนาดกลาง โดยใช้วิธีการแบบ NESSI

ในอ่างเก็บน้ำหลาย ๆ แห่งในโครงการ NESSI ความต้องการใช้น้ำเพื่อการอุปโภคและบริโภคของชุมชนเมืองจะแข่งขันกับความต้องการใช้น้ำเพื่อการเกษตร ดังนั้นจึงสร้างความกดดันให้กับกรมชลประทานในการหาแหล่งน้ำอื่น ๆ มาเสริมอ่างเก็บน้ำนั้น ยกตัวอย่างเช่น อ่างเก็บน้ำห้วยจรเข้มาก นอกจากการใช้น้ำที่ไม่ใช่เพื่อการเกษตรที่ทำให้ปริมาณน้ำต้นทุนในอ่างเก็บน้ำลดลงมากแล้ว ปริมาณตะกอนที่พัดพามาจากการชะล้างหน้าดินในพื้นที่ลุ่มน้ำก็ทำให้ความเก็บกักของอ่างเก็บน้ำลดลงอยู่ตลอดเวลาด้วย

วิธีการที่ใช้คำนวณปริมาณน้ำท่าที่ไหลเข้าสู่อ่างเก็บน้ำขนาดกลางเหล่านี้ให้ค่าที่ค่อนข้างจะสูงไป และทำให้การหาศักยภาพทางชลประทานมีผลไปทางด้านดีจนเกินไป นอกจากนั้นแล้ววิธีการคำนวณปริมาณน้ำท่าเหล่านี้ไม่ได้คำนึงถึงผลกระทบการเปลี่ยนแปลงการใช้ที่ดินในพื้นที่ลุ่มน้ำซึ่งมีผลต่อปริมาณน้ำท่าที่ไหลลงสู่อ่างเก็บน้ำด้วย และที่สำคัญที่สุดอีกอย่างก็คือการสร้างฝายและอ่างเก็บน้ำขนาดเล็ก บริเวณลำห้วยสาขา ในพื้นที่ลุ่มน้ำเป็นจำนวนมากในระยะ 10 ปีที่ผ่านมาส่งผลให้ปริมาณน้ำท่าที่ไหลลงอ่างเก็บน้ำขนาดกลางเหล่านี้ลดลงไปด้วย

2. ข้อเสนอแนะ

สถาบันและองค์กร

โครงสร้างของการจัดการของ NESSI ที่วางไว้มีความยุ่งยากซับซ้อนเกินไปและเกินความจำเป็น จากบทเรียนโครงการ NESSI โครงการชลประทานขนาดกลางอื่น ๆ ที่จะทำการปรับปรุงหรือสร้างใหม่ ควรจะมีโครงสร้างการบริหารจัดการที่ง่ายต่อการดำเนินงาน ดังนั้นข้อเสนอแนะสำหรับสถาบันและองค์กรมีดังนี้

- มีเฉพาะอนุกรรมการประสานงานโครงการระดับชาติ และคณะทำงานระดับโครงการ
- ต้องพัฒนากลไกที่จะเอื้อต่อการจัดตั้งคณะทำงานระดับโครงการให้เร็วที่สุดและให้มีหน้าที่ต่อเนื่องไปตลอดแม้ว่าโครงการจะเสร็จสิ้นสมบูรณ์ไปแล้วก็ตามเพื่อประสานความร่วมมือระหว่างหน่วยงานและเกษตรกรอย่างต่อเนื่อง

กลุ่มผู้ใช้น้ำและสมาคมผู้ใช้น้ำ

กรมชลประทานควรเป็นหน่วยงานหลักในการจัดตั้งและสร้างความเข้มแข็งให้กับกลุ่มผู้ใช้น้ำต่อไป เพราะเป็นหน่วยงานที่เกี่ยวข้องในการจัดการน้ำโดยตรง ซึ่งจะเป็นฐานการจัดตั้งกลุ่มผู้ใช้น้ำที่ประสบความสำเร็จได้ ข้อเสนอแนะต่าง ๆ มีดังนี้

- รัฐบาลรับหลักการที่จะให้เกษตรกรมีส่วนร่วมในทุกขั้นตอนของการพัฒนาระบบชลประทาน คือตั้งแต่การออกแบบจนถึงการส่งน้ำและบำรุงรักษา และกำหนดวิธีการดำเนินการที่แน่นอนที่ทำให้เกษตรกรมีสิทธิและหน้าที่ชัดเจนในทุกขั้นตอนของการปรับปรุงโครงการชลประทานขนาดกลางหรือการพัฒนาโครงการชลประทานขนาดกลาง

- ในการปรับปรุงโครงการชลประทานขนาดกลางหรือการพัฒนาโครงการขึ้นใหม่ควรจะมีนักประสานงานชุมชนชลประทาน (นปช.) ที่จะทำงานอย่างใกล้ชิดกับเกษตรกรตั้งแต่ช่วงสำรวจออกแบบจนกระทั่งกลุ่มผู้ใช้น้ำที่จัดตั้งมีความเข้มแข็งเพียงพอที่จะดำเนินงานส่งน้ำและบำรุงรักษา จำนวน นปช.ที่เหมาะสมคือ นปช. 2 คน ต่อ พนักงานส่งน้ำ 1 คน และ นปช.ควรอยู่ประจำโครงการอย่างน้อยสองฤดูกาลเพาะปลูก
- สำหรับการส่งเสริมเพาะปลูกพืชฤดูแล้ง สมาคมผู้ใช้น้ำต้องเป็นผู้มีบทบาทสำคัญร่วมกับพนักงานส่งน้ำในการกำหนดพื้นที่การปลูกพืชฤดูแล้งเพื่อไม่ให้มีพื้นที่เพาะปลูกมากไปกว่าจำนวนน้ำที่สามารถจะส่งได้

การปลูกพืช

ในโครงการชลประทานทั้งสามแห่งที่ศึกษาข้าวยังเป็นพืชหลักที่เกษตรกรปลูกในฤดูฝนและฤดูแล้ง โดยมีน้ำชลประทานช่วย ในฤดูแล้งในเขตชลประทานที่มีน้ำเพียงพอกสิกรจะปลูกพืชหลายชนิดที่ทางโครงการได้ไปแนะนำส่งเสริม เช่น ถั่วลิสง แตงโม ข้าวโพด และผักชนิดต่าง ๆ เช่น แตงกวา ถั่วฝักยาว พริก ฟักทอง มะเขือ พืชที่ปลูกในฤดูแล้งกสิกรได้ทำการปลูกมาเป็นเวลานาน จนมีความชำนาญและประสบการณ์มากพอสมควร พืชเหล่านี้ได้พัฒนาจนเหมาะกับสภาพแวดล้อมของท้องถิ่น และมีตลาดทั้งในท้องถิ่นและในเมืองใกล้เคียง คำแนะนำในการปลูกพืชที่จะเพิ่มรายได้ของกสิกรจะต้องคำนึงถึงหลายปัจจัยที่เกี่ยวข้องดังต่อไปนี้

1. ความต้องการของตลาด ปัจจุบันในภาคตะวันเฉียงเหนือได้มีโรงงานแปรรูปและอาหารกระป๋องมากมาย โรงงานเหล่านี้ต้องการผลิตภัณฑ์จากพืชเพื่อป้อนโรงงานจำนวนมาก และต้องการในปริมาณที่สม่ำเสมอเกือบตลอดปี ราคาซื้อขายสามารถรู้ได้ล่วงหน้าเป็นเวลานาน โรงงานเหล่านี้มีเป้าหมายตลาดคือต่างประเทศ การผลิตพืชในเขตชลประทานจึงควรมุ่งผลิตเพื่อส่งโรงงาน เพราะจะได้ราคาดีและแน่นอน
2. คุณภาพของผลิตผล เนื่องจากเป้าหมายคือ โรงงานแปรรูป ซึ่งเน้นเรื่องคุณภาพเป็นอย่างมาก เพราะเป็นการผลิตเพื่อส่งออก การผลิตในเขตชลประทานสามารถควบคุมคุณภาพของผลผลิตได้ดีกว่าการผลิตในเขตน้ำฝน และเป็นผลิตผลที่มีราคาดี
3. ดินทางด้านความอุดมสมบูรณ์และการพังทลาย เนื่องจากดินภาคตะวันออกเฉียงเหนือเป็นดินร่วนปนทราย และมีความอุดมสมบูรณ์ต่ำ การเพาะปลูกจึงควรคำนึงถึงการรักษาความอุดมสมบูรณ์และป้องกันการพังทลายของดิน จึงควรส่งเสริมให้ปลูกพืชตระกูลถั่ว เช่น ถั่วลิสง ถั่วเหลือง และถั่วเขียว เพื่อช่วยเพิ่มความอุดมสมบูรณ์ของดินและควรใช้วิธีการปลูกที่จะลดการพังทลายของดิน เช่น การปลูกถั่วแซมมันสำปะหลัง จะช่วยลดการชะล้างผิวดินได้

4. ระบบการเพาะปลูกเดิม ระบบเดิมที่ปลูกอยู่แล้ว ส่วนใหญ่เป็นระบบที่เหมาะสมกับสภาพแวดล้อม และเศรษฐกิจสังคมอยู่แล้ว ควรจะต้องรักษาไว้ เช่น ข้าว เป็นพืชอาหารหลักที่เกษตรกรต้องปลูก เพื่อบริโภคในครัวเรือน นอกจากนี้ยังมีตลาดดีด้วย คือระบบเดิมเกษตรกรมีความรู้ความชำนาญอยู่แล้ว ทั้งระดับท้องถิ่น จังหวัดและภูมิภาค พืชใหม่ที่แนะนำควรจะมาเสริมกับพืชเก่า ไม่ใช่นำของใหม่เข้ามาทั้งหมด

จากปัจจัยดังกล่าวข้างต้นนี้ จึงได้เสนอแนะในเรื่อง ระบบการปลูกพืชในเขตชลประทานของโครงการ ดังนี้

ก. ห้วยแอ่ง

ข้าวเป็นพืชหลักในฤดูฝน ซึ่งนิยมใช้ข้าวพันธุ์ กข 6 สำหรับที่ดอนจะมีการปลูกมันสำปะหลังเป็นหลัก ในฤดูแล้งมีการทำนาปรัง เนื่องจากในฤดูฝนการทำนาไม่ได้ผลเพราะฝนแล้ง พืชอื่นได้แก่ ถั่วลิสง แตงโม ข้าวโพดหวานและข้าวโพดเหนียว สำหรับผักได้แก่ พริก แฟง ถั่วฝักยาว และมะเขือ

ข้อแนะนำคือ ให้คงปลูกพืชต่าง ๆ เช่นเดิม แล้วเพิ่มพืชอื่นที่ตลาดต้องการมาก โดยเฉพาะโรงงานแปรรูป การปลูกมันสำปะหลังในปัจจุบันทำให้มีการพังทะลายของดินมาก ดินถูกชะล้างลงไปในอ่าง ทำให้อ่างตื้นเขินได้ง่าย จึงควรหาพืชอื่นทดแทน หรือไม่ก็อาจใช้ถั่วลิสงปลูกแซมระหว่างแถวมันสำปะหลัง จะลดการพังทลายและเพิ่มความอุดมสมบูรณ์ของดิน ฤดูฝนอาจปลูกถั่วลิสง และข้าวโพดฝักอ่อน ได้เพราะตลาดต้องการมาก ในฤดูแล้งเพิ่มพืชอื่น เช่น มะเขือเทศ และถั่วเหลืองชนิดฝักอ่อน เพราะโรงงานแปรรูปต้องการมาก

ข. ห้วยขี้เหล็ก

พืชหลักคือข้าวซึ่งนิยมใช้พันธุ์ กข 6 กข 8 ข้าวหอมมะลิ 105 และข้าวเหนียวสันป่าตอง พืชไร่มีมันสำปะหลังและอ้อยเป็นหลัก ฤดูแล้งมีถั่วลิสงและผักชนิดต่าง ๆ คือ แตงกวา ถั่วฝักยาว มะเขือ กะหล่ำปลี กะหล่ำดอก และฟักทอง

ข้อแนะนำสำหรับการปลูกพืชเพิ่มขึ้นคือ ปลูกถั่วลิสงแซมมันสำปะหลัง เพื่อลดการพังทะลายของดิน เพิ่มความอุดมสมบูรณ์และเป็นที่ต้องการของตลาด ในฤดูแล้งพืชที่แนะนำเพิ่มคือ มะเขือเทศ ถั่วเหลือง และข้าวโพดฝักอ่อน ซึ่งเป็นที่ต้องการของโรงงานแปรรูป

ค. ห้วยจรเข้มาก

พื้นที่นอกเขตชลประทานกสิกรปลูกข้าวเป็นหลักในฤดูฝน และในฤดูแล้งปลูกแตงกวา ข้าวโพด ข้าวเหนียว ถั่วพุ่ม ถั่วเขียว ถั่วลิสงและผักชนิดต่าง ๆ โดยอาศัยบ่อน้ำตื้น หรือปลูกตามริมห้วยที่สามารถรดน้ำได้ พืชที่ควรปลูกเพิ่มคือ ถั่วลิสง ในฤดูฝน เพราะสามารถทนแล้งได้

สำหรับในเขตชลประทานในฤดูฝนกสิกรปลูกข้าวและข้าวโพด ข้าวเหนียว ในฤดูแล้งมีถั่วลิสง ถั่วเขียว งา ข้าวโพดข้าวเหนียว เห็ดฟาง กระเทียม หอม แตงกวา และผักชนิดต่างๆ พืชที่แนะนำเพิ่มเติมคือ ถั่วลิสงสำหรับฤดูฝน ส่วนในฤดูแล้งควรปลูกมะเขือเทศ พริก และถั่วเหลือง พืชเหล่านี้เป็นที่ต้องการของโรงงานและตลาดท้องถิ่น

การส่งเสริมการเกษตร

เนื่องจาก การพัฒนาการเกษตรชลประทานในพื้นที่ชลประทาน ต้องพัฒนาให้เกษตรกรปลูกพืชเพื่อการค้าหรืออุตสาหกรรมเกษตร ฉะนั้นโรงงานเอกชนจึงมีบทบาทที่สำคัญมาก และการปลูกพืชเศรษฐกิจเพื่อการค้านั้นสามารถทำได้ในเขตชลประทานของอีสาน เช่นเดียวกับภูมิภาคอื่นๆ การส่งเสริมการเกษตรในเขตชลประทานขนาดกลางจึงมีข้อเสนอแนะดังนี้

- ต้องส่งเสริมการเกษตรให้ครบวงจรอย่างจริงจัง โดยพัฒนาศักยภาพกลุ่มของเกษตรต่าง ๆ ให้มีประสิทธิภาพมากขึ้น เช่น กลุ่มผู้ผลิต กลุ่มผู้ใช้น้ำ เป็นต้น
- เกษตรจังหวัดควรพิจารณาให้เจ้าหน้าที่ส่งเสริมการเกษตร หรือเกษตรตำบลอื่น ๆ ได้มาร่วมให้ความช่วยเหลือเกษตรตำบลในพื้นที่ชลประทาน โดยเฉพาะในฤดูแล้ง และถ้าเป็นไปได้ควรเพิ่มเจ้าหน้าที่ส่งเสริมในเขตเกษตรชลประทานให้มากขึ้น
- เจ้าหน้าที่ส่งเสริมควรมีบทบาทเป็นผู้ประสานงานระหว่างโรงงานเอกชน และเกษตรกรโดยผ่านทางผู้ผลิตหรือกลุ่มผู้ใช้น้ำ
- กรมส่งเสริมการเกษตรควรพัฒนาหรือจัดทำรูปแบบสัญญาที่ยุติธรรมเหมาะสมระหว่างโรงงานเอกชนและเกษตรกร และควบคุมดูแลให้เป็นไปตามข้อตกลง และในบางกรณีเจ้าหน้าที่ส่งเสริมควรเป็นผู้ไกล่เกลี่ยหรือเป็นคนกลางแก้ไขปัญหาที่เกิดขึ้นระหว่างเอกชนกับเกษตรกร
- ทำการรณรงค์ให้ความรู้แก่เกษตรกรเกี่ยวกับการผลิตตามสัญญา หรือตลาดคู่สัญญา เพื่อให้เกษตรกรเข้าใจและผลิตพืชเศรษฐกิจตามสัญญา นอกจากนั้นเจ้าหน้าที่ส่งเสริมควรเป็นผู้สนับสนุนการดำเนินงานของฝ่ายส่งเสริมการเกษตร หรือเจ้าหน้าที่สนามของเอกชนซึ่งจะสามารถลดภาระหน้าที่การส่งเสริมของเจ้าหน้าที่รัฐได้อีกด้วย

ข้อเสนอแนะสำหรับแนวทางปรับปรุงและพัฒนาการตลาดมีดังนี้

1. ส่งเสริมให้เกษตรกรปลูกพืชที่มีตลาดรองรับและศักยภาพตลาดสูง
   - o พืชที่มีการซื้อขายแบบตลาดข้อตกลง ได้แก่ ข้าวโพดฝักอ่อน มะเขือเทศ ถั่วเหลืองและถั่วเขียว
   - o พืชที่ซื้อขายในตลาดทั่วไป ได้แก่ ถั่วลิสง เห็ดฟาง พริก และถั่วฝักยาว
2. ปรับปรุงตลาดข้อตกลง
   - o จัดตั้ง "กลุ่มเกษตรกรเพื่อการผลิตและการตลาด"
   - o ส่งเสริมให้มีการทำสัญญาการตลาดผลิตผลระหว่างพ่อค้าและกลุ่มเกษตรกรเพื่อการผลิตและการตลาด
   - o ปรับปรุงรายละเอียดของสัญญาการตลาดให้มีความยุติธรรมกับเกษตรกร (ผู้ขาย) และพ่อค้า (ผู้ซื้อ)
3. ปรับปรุงระบบตลาดทั่วไป
   - o ปรับปรุงระบบตลาดผักประเภทแปรรูป (ข้าวโพดฝักอ่อน มะเขือเทศ) ถั่วเหลือง และถั่วลิสง
     - o ส่งเสริมให้มีการจำหน่ายผลิตผลไปยังวิถีการตลาดส่งออกเพื่อเพิ่มบรรยากาศการแข่งขันในตลาด
     - o จัดสร้างสิ่งอำนวยความสะดวก เช่น ห้องเย็นในระดับฟาร์ม (ท้องถิ่น) โดยพ่อค้าส่งออกหรือพ่อค้าขายส่ง
   - o ปรับปรุงระบบตลาดผลิตผลเกษตรจำพวกพืชน้ำมัน (ถั่วลิสง และถั่วเขียว)
     - o ส่งเสริมให้มีการจำหน่ายผลิตผลไปตลาดขายส่งระดับจังหวัด (แทนที่จะอาศัยแหล่งรับซื้อของศูนย์ขยายพันธุ์พืช และพ่อค้าท้องที่เท่านั้น)
     - o ปรับปรุงกิจกรรมการตลาดก่อนส่งมอบผลิตผล เช่น การจัดชั้นสินค้าการขนส่ง การรวบรวมและการกระจายข่าวสารการตลาด
   - o ปรับปรุงระบบตลาดผักสด
     - o สนับสนุนให้มีการจำหน่ายผักไปตลาดขายส่งผักระดับจังหวัดและระดับภูมิภาค
     - o ส่งเสริมให้มีการขนส่งผักไปตลาดขายส่งโดยกลุ่มเกษตรกร
     - o เพิ่มกิจกรรมการตลาดก่อนจำหน่าย อาทิ การคัดเลือกคุณภาพการจัดแบ่งชั้นและการบรรจุหีบห่อ
4. จัดโปรแกรมฝึกอบรมการตลาดและผลิตคู่มือการตลาดให้กับเจ้าหน้าที่ส่งเสริมการเกษตรและเจ้าหน้าที่อื่น ๆ ที่เกี่ยวข้องในพื้นที่โครงการชลประทานขนาดกลางในภาคตะวันออกเฉียงเหนือ

5. ส่งเสริมให้หน่วยธุรกิจเอกชนติดต่อกับเกษตรกรผู้ผลิต
   - o จัดตั้ง "คณะกรรมการร่วมภาคเอกชนระดับจังหวัด"
   - o ให้เกษตรจังหวัดมีบทบาทสำคัญในการเป็นสื่อนำการผลิตและการจำหน่าย

ด้านวิศวกรรม

ข้อเสนอแนะด้านวิศวกรรมมีดังนี้

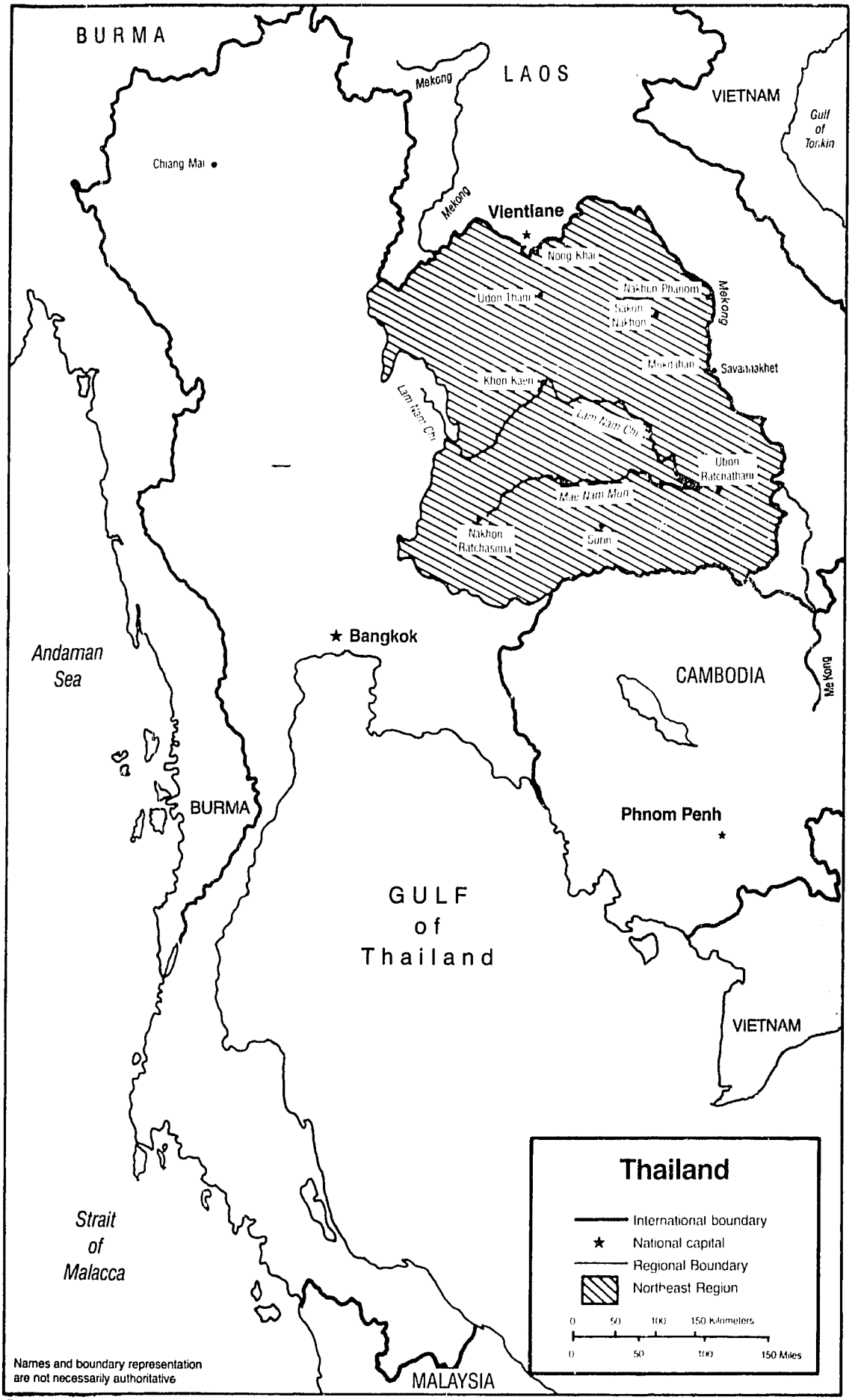
- o กรมชลประทานน่าจะพิจารณาเพิ่มเกณฑ์การออกแบบพื้นที่แฉกส่งน้ำเป็น 200-250 ไร่ เพื่อลดค่าก่อสร้าง
- o ให้เกษตรกรมีส่วนร่วมมากขึ้น เช่น การมีส่วนร่วมให้แรงงานโดยไม่ต้องคิดค่าจ้างในการขุดคูส่งน้ำในแปลงนา และการปลูกหญ้าเป็นต้น เพื่อลดค่าใช้จ่ายในการปรับปรงโครงการชลประทานขนาดกลางที่มีศักยภาพ หรือโครงการที่จะสร้างใหม่ ซึ่งจะเสริมสร้างความรู้สึกเป็นเจ้าของของเกษตรกรให้มีมากขึ้น อันจะส่งผลไปสู่การใช้ประโยชน์และบำรุงรักษาอย่างเต็มที่ จากเกษตรกร
- o ใช้วิธีการคำนวณปริมาณน้ำท่าเข้าสู่อ่างเก็บน้ำ ซึ่งคำนึงถึงลักษณะทางกายภาพของพื้นที่ลุ่มน้ำและผลของกรเปลี่ยนแปลงการใช้ที่ดินในพื้นที่ลุ่มน้ำต่อปริมาณน้ำท่าด้วย เพื่อที่จะได้ค่าปริมาณน้ำท่าลงสู่อ่างเก็บน้ำนั้น สมเหตุผลกับสภาพที่แท้จริง
- o กรมชลประทานควรจะประสานงานกับหน่วยงานรัฐบาลอื่น ๆ ในการพัฒนาวิธีการลดการชะล้างหน้าดินในพื้นที่ลุ่มน้ำ เพื่อลดอัตราการตกตะกอนในอ่างเก็บน้ำและเพิ่มอายุการใช้งานลงอ่างเก็บน้ำ
- o ก่อนการวางแผนโครงการขนาดกลางขึ้นใหม่ กรมชลประทานควรจะศึกษาผลกระทบของฝายและอ่างเก็บน้ำขนาดเล็ก ที่สร้างในพื้นที่รับน้ำ ที่มีต่อปริมาณน้ำท่าที่ไหลลงอ่างเก็บน้ำขนาดกลางด้านท้ายน้ำให้ดีเสียก่อน
- o ควรจะมีการศึกษาการจัดการน้ำในลุ่มน้ำในระยะยาว ในการศึกษาให้คำนึงถึงความต้องการใช้น้ำทุกด้านที่มีในลุ่มน้ำสาขาทุกสาขา เช่น ความต้องการน้ำชลประทาน อุปโภคบริโภคของชุมชนเมือง อุตสาหกรรมและการท่องเที่ยว และควรทำการศึกษาเช่นนี้สำหรับลุ่มน้ำในภาคตะวันออกเฉียงเหนือและภาคอื่น ๆ ด้วย

ความหมายต่อการพัฒนาภูมิภาคเอเชียตะวันออกเฉียงใต้ในอนาคต

ประสบการณ์การพัฒนาของประเทศไทยจะเป็นบทเรียนให้กับประเทศอื่น ๆ ที่อยู่ในภูมิภาคนี้ ประเทศสาธารณรัฐประชาธิปไตยประชาชนลาว ประเทศกัมพูชาและประเทศเวียตนามต่างก็มองประเทศไทยว่าเป็นต้นแบบของการพัฒนาเศรษฐกิจ ประเทศอินโดนีเซีย ประเทศมาเลยเซีย และประเทศฟิลิปปินส์ ก็มีความสนใจในประเทศไทย ทางด้านความสามารถในด้านการสร้างสมดุลย์ระหว่างการขยายตัวทางภาคเกษตรกรรมและภาคอุตสาหกรรมส่งออก ด้วยฐานเศรษฐกิจที่มีความเข้มแข็งนี้จะทำให้ประเทศไทยยังคงเป็นแหล่งพัฒนาของภูมิภาคนี้ต่อไปในสองทศวรรษหน้านี้

ปัจจัยในความสำเร็จของประเทศไทยขึ้นกับการที่รัฐบาลยอมรับในบทบาทของภาคเอกชน และได้ให้ภาคเอกชนดำเนินการตามความสามารถของเขา รัฐบาลจะไม่รีรอในการถอนตัวจากการให้บริการ เมื่อเห็นว่าภาคเอกชนสามารถทำได้ดีกว่าและถูกกว่า รัฐบาลไม่เพียงแต่ยอมให้เอกชนมาให้การบริการในเรื่องสายการบิน การศึกษาระดับสูง การจัดหาวัตถุการเกษตร การส่งออกผลิตผลการเกษตร เท่านั้น รัฐบาลยังกระตุ้นให้ภาคเอกชนมีบทบาทมากขึ้นในการให้บริการสาธารณชนอื่น ๆ เช่น การพัฒนาและขยายเมล็ดพันธุ์พืช การส่งเสริมการเกษตรและการวิจัย แม้ว่าโดยทั่วไปการให้ภาคเอกชนมาให้บริการสาธารณชนมักจะทำให้การแข่งขันกลายเป็นการผูกขาด แต่สำหรับของประเทศไทยการแข่งขันได้นำไปสู่การบริการที่ดีขึ้นด้วยค่าใช้จ่ายที่ลดลง

สำหรับโครงการ NESSI การมีบทบาทของภาคเอกชนในรูปของโรงงานต่าง ๆ ในภูมิภาคนี้ได้ทำให้เกษตรกรได้รับประโยชน์เพิ่มทางด้านแรงงาน เมื่อโครงการชลประทานขนาดกลางเริ่มมีขึ้นในช่วงปี 2503 นั้น เกษตรกรมีน้ำแต่ไม่มีตลาดสำหรับผลิตผลของเขา ซึ่งทำให้การใช้ประโยชน์จากน้ำมีค่อนข้างจำกัด แต่ในปัจจุบัน ในภาคตะวันออกเฉียงเหนือและภูมิภาคอื่น ๆ ที่มีน้ำต้นทุนสำหรับการเพาะปลูกพืชฤดูแล้ง เกษตรกรมีความกระตือรือร้นที่จะทำการเพาะปลูกและภาคเอกชนก็รอรับที่จะซื้อผลผลิต และการที่รัฐบาลได้ส่งเสริมให้ภาคเอกชนทำการลงทุนในภาคตะวันออกเฉียงเหนือ จะทำให้การลงทุนพัฒนาโครงการชลประทานต่าง ๆ ได้รับผลตอบแทนที่คุ้มค่า



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1

BACKGROUND AND PURPOSE OF THE APPLIED STUDY

1.1 Study Background

In December 1988, USAID/Bangkok requested the Irrigation Support Project for Asia and the Near East (ISPAN) to conduct an applied study of the Northeast Small Scale Irrigation Project (NESSI). The study was designed to describe and assess NESSI's positive and negative aspects, and also to set the direction for the next stage of medium-scale irrigation development in the Northeast. Scheduled to end in October 1989, NESSI was to identify, test, and refine a replicable approach for improving irrigation management and agricultural production for seven medium-size reservoirs scattered throughout the Northeast. The project undertook a diversified program, which included physical system improvements, water user organizations, interagency coordination, training, and marketing initiatives.

Over two hundred medium-scale reservoirs in Northeast Thailand are potential locations for the approach NESSI sought to define. These systems, many of which were developed in the 1960s with USAID assistance, are among the most underused irrigation resources in the Northeast. The Royal Irrigation Department (RID) has estimated that these reservoirs, ranging in size from 5 to 30 million cubic meters (mcm), could eventually command an irrigable area of over 1,000,000 rai. Most of these reservoirs, however, are inefficiently used at present and realize only a fraction of their potential.

The Royal Thai Government (RTG) regards NESSI as the first phase in developing and improving medium-scale irrigation systems in the region. Phase II is expected to expand upon the NESSI experience both by continuing uncompleted activities in the original sites and by moving into new sites within the region. NESSI contained a significant construction component through which main canals were rehabilitated and main ditches and farm ditches constructed. Phase II will likely deemphasize construction and focus on sustaining farmer organizations, operation and maintenance, and marketing linkages.

1.2 Study Objectives

The NESSI Applied Study takes the place of a standard project evaluation, which measures success against end-of-project indicators. This study is meant to be primarily a forward-thinking effort with the following major purposes:

- to describe and assess NESSI, both in terms of individual elements and as an integrated package;
- to identify those elements of NESSI that should be perpetuated and transferred to other potential sites;
- to establish guidelines for potential or incomplete activities, such as marketing initiatives; and
- to provide recommendations concerning the modification and institutionalization of NESSI elements suitable both for further development in the seven NESSI sites and for transfer to other regional sites.

1.3 Study Approach

The study began on 1 March 1989 with a three-day team planning meeting in Bangkok, which included team members, USAID and RID staff, and representatives of the Department of Technical and Economic Cooperation (DTEC), the Department of Agricultural Extension (DOAE), the World Bank, and the Consultant Task Force (CTF). The team-planning exercise was designed to clarify study objectives, determine individual responsibilities, and finalize technical and administrative issues.

After completing the exercise, the team moved to Khon Kaen, where they worked out of the Water Resource and Environmental Institute at Khon Kaen University (KKU).

Fieldwork began with team visits to all seven project sites to familiarize members with the conditions at each. These visits were complemented by information and data gathered from various sources: the NESSI office, about 20 km outside of Khon Kaen; provincial and district irrigation and agricultural extension offices; and TEAM Engineering. Given the time and resources available for the study, it was not possible to study all seven sites in depth. In keeping with the Scope of Work (Appendix A), the team selected three sites that capture the elements envisioned in NESSI: Huai Aeng in Roi Et Province, Huai Khilek in Mukdahan, and Huai Chorakhe Mak in Buri Ram. These sites reflect diversity of location, crop production, and development level. Huai Aeng, as the first system completed, was selected so the team could assess the impacts of the most mature system a few years after completion. Huai Khilek was selected to represent the rolling terrain of the high-rainfall areas of eastern Northeast and because of its links to markets in the northeast parts of the region. Huai Chorakhe Mak was selected to represent the more erratic rainfall areas of southern Northeast and also to represent a system that is still in the process of rehabilitation. Table 1 presents characteristics of the three selected sites.

Team members also visited the Lam Nam Oon Integrated Rural Development Project at Sakon Nakhon. Lam Nam Oon offers marketing initiatives and both water user group and O&M activities, which provide interesting comparisons with the NESSI approach. Operating policies and marketing initiatives from Lam Nam Oon might be incorporated into a Phase II program for medium-scale irrigation systems development. In addition, the team made visits to processing plants, general oilseed wholesalers, fresh vegetable wholesale markets, and seed markets in every Northeast province.

In addition to extensive interviews with farmers and government officers, team members conducted two field surveys. In each of the three commands, zonemen interviewed landholders regarding cropping and landholding patterns, on- and off-farm income, O&M practices and preferences, marketing arrangements, and agricultural extension services. A smaller survey was conducted to examine the changing role of women in agriculture. The marketing specialist collected price data from the provincial agricultural and commerce offices, and mapped the effective range of regional processing plants and markets. The team drew upon extensive agro-ecological studies conducted in each of the NESSI sites by KKU in 1987-88, and utilized the numerous documents (Appendix B) published as part of the NESSI Project. Appendix C lists individuals contacted in Bangkok and the Northeast as part of the study.

Table 1

Description of the NESSI Applied Study Sites

	Huai Aeng	Huai Chorakhe Mak	Huai Khilek
Years cank constructed	1962-65	1962-63	1963-64
Years system rehabilitated	1982-86	1986-88	1985-88
Storage (mcm)	17.48	20.30	22.1
Watershed (km^2)	147.50	90.25	80.6
Command area preproject (rai)	18,691	12,500	9,000
Command area 1986-7 (rai)	21,066	9,165	8,632
Area irrigated dry season 1986-7 (rai)	4,000	1,540	1,050
Main canals (km.)	16.37	23.58	25.20
No. farmers	2,214	780	620
No. villages	23	14	15

Source: TEAM Consulting Engineers, Ltd.

The NESSI Applied Study covered a period of three and one-half months, which permitted team members to repeatedly visit the three project sites. The extended study period also permitted the team to collect and analyze a more varied body of both primary and secondary data than would have been possible otherwise.

The study concluded with team presentations to USAID on June 12 and a half-day presentation at RID to USAID, RID, DTEC, and other government agencies on 19 June 1989. A final presentation was made on 6 October at the NESSI Policy Conference in Pattaya.

1.4 Team Composition

The study team was led by an American economist, Dr. Sam H. Johnson III, from the Department of Agricultural Economics at the University of Illinois. He was in-country during the first and last months of the study. During Dr. Johnson's six-week absence from Thailand, Dr. Sanguan Patamatamkul, irrigation engineer/deputy team leader, of the Water Resources and Environmental Institute at KKU, supervised team activities. Other members included Dr. Terd Charoenwatana, agronomist, and Dr. Adul Apinantara, agricultural extension specialist, both of KKU, and Dr. Kanda Paranakian, rural sociologist, and Dr. Apisith Issariyanukula, marketing specialist, of Kasetsart University. Dr. Peter Reiss, a staff member of ISPAN's Technical Support Center, took part in writing the report during the last month of the study.

1.5 The NESSI Project

In August 1980, the Royal Thai Government and USAID/Thailand signed an agreement for the five-year NESSI Project. The project sought to establish a sustainable system for increasing agricultural productivity and income of more than 30,000 rural poor within the potential command areas of seven existing medium-sized reservoirs in the Northeast.

1.5.1 Constraints to Agricultural Growth in NESSI Sites

Northeast Thailand has the lowest crop yields per area of any region in the country. One of the main reasons for this is unreliable seasonable rainfall (see Figure 1). Erratic rainfall in the region constrains agricultural production and growth, and creates a need for irrigation to stabilize and increase agricultural production. Yet, irrigation development programs in the Northeast have not automatically led to rapid yield increases; often these systems were unused due to a lack of distribution systems. The first priority for improved water use in the Northeast is better distribution through improving and upgrading existing irrigation systems.

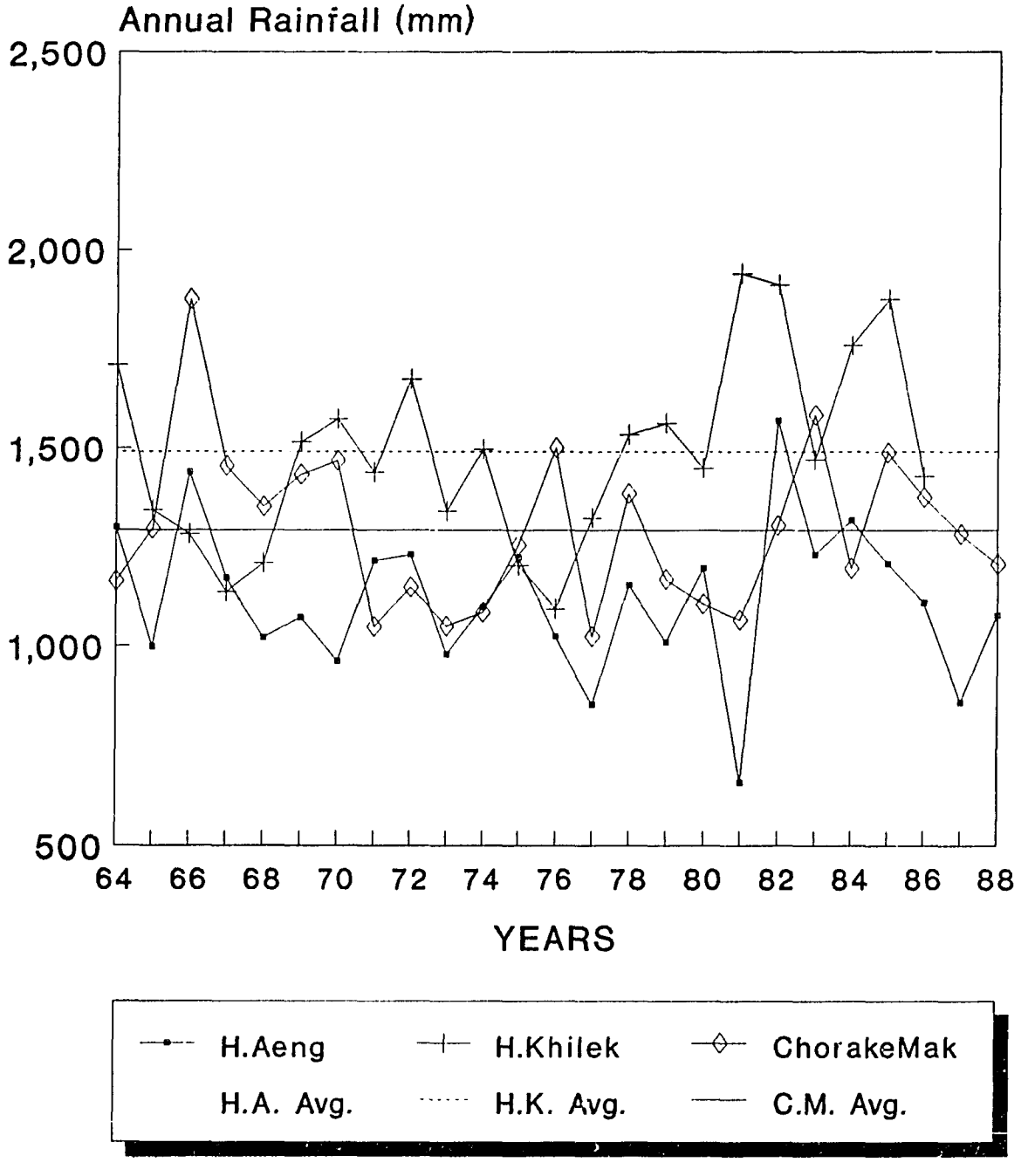
NESSI's feasibility and design stages identified numerous problems to be addressed in improving crop production and farmer incomes within the command areas of the seven systems. Many reservoirs and their delivery systems required design modifications, considerable rehabilitation, and extension of their canal systems in order to reach their water delivery and use potential. Construction and/or improvement of the on-farm structures (ditches and gates) were needed in many cases, and the construction of related infrastructure such as service roads was usually required.

In addition to capital improvements needed in existing systems, many other constraints needed to be overcome before water available from improved irrigation systems could lead to increased agricultural yields. Maintenance of existing systems was poor and irrigation water, when available, was generally poorly managed within the system. Cropping patterns and cultural practices did not maximize returns, and cropping intensities were well below their potential. Farmer access to agricultural inputs, such as quality extension services, low-cost credit, proper fertilizer, pesticides, and seeds was generally inadequate. Marketing problems were important constraints, and farmers needed dependable market access and attractive prices before they would invest money and labor to improve yields.

1.5.2 Project Objectives and Approach

NESSI was expected to address the major constraints to improved productivity through a package of construction, training, demonstrations, and expatriate and local technical assistance. Key elements were to include the following:

- improvement of deteriorated embankments;
- rehabilitation, extension, and improvement of main canal systems;



Based on rain gauges at each site

Figure 1

Annual Rainfall in NESSI Applied Study Sites
1964-1988

- design and construction of effective on-farm distribution systems;
- organization of water user associations to encourage farmer participation in operation and maintenance;
- development of training programs for farmers and RTG personnel;
- coordination and participation of local government agencies; and
- marketing initiatives in the agro-industrial sector.

NESSI's purpose was to identify, test, and refine a replicable approach for accomplishing these objectives in the command areas of the seven selected irrigation systems. These seven systems were to determine the replication potential of the approach and, through training RTG staff, provide a pool of experienced manpower to expand the effort into other regional sites.

2

NESSI PROJECT SITES

NESSI Project area spreads across 7 of the 17 provinces in Northeast Thailand (Figure 2). These provinces—Mahasarakam, Roi Et, Kalasin, Mukdaharn, Ubon Ratchatani, Buri Ram, and Nakorn Ratchasima—represent widely diverse environmental, cultural, social, and economic conditions. Similarly, the seven project sites—Huai Aeng, Huai Kaeng, Huai Khilek, Huai Chorakhe Mak, Lam Chamuak, Huai Talat, and Phuttha Utthayan—vary technically, physically, and institutionally. As such, lessons learned from the NESSI experience have wide applicability with respect to improving other medium-scale irrigation systems across most of Northeast Thailand.

2.1 Political Setting

Northeast Thailand, covering 170,000 sq. km., encompasses one-third of the land area of the Kingdom of Thailand, and the region's 18 million people constitute approximately one-third of Thailand's total population. Due to low and unstable agricultural production from erratic rainfall and generally poor soils, per capita income is the lowest in the country. In 1985, average per capita income of the agricultural population in Northeast Thailand was 3,023 baht, compared with 7,922 baht in Central Thailand[1]. There is also a substantial diversity within the region between the incomes of rural farmers and urban residents (in 1985, the ratio was about 1:6). Despite comprising 89 percent of the total labor force, the rural population's income amounts to only 40 percent of the region's gross income.

Because of the natural barrier created by the Korat Plateau[2], the Northeast has historically been isolated from central Thailand. After World War II, rural infrastructure in the Northeast was minimal. The region's infrastructure has improved considerably in recent decades, although it was not until early 1960 that, with the assistance of the U.S. Government, an all-weather road was completed from Bangkok through the Northeast to Nong Khai on the banks of the Mekong River. Educational facilities have also improved and now over 80 percent of the population are estimated to have completed primary school.

As the majority of the population in the Northeast speak Esarn dialect, which is closer to the Lao language than to Central Thai, there has historically been a cultural as well as a physical division between the Northeast region and the rest of the country. This division was accentuated during and after the Vietnam War. With the large population base and low income levels in the Northeast, the RTG began in the 1950s to make a stronger effort to diffuse social unrest that existed in the area. This effort entailed a higher level of investment in programs to reduce poverty and increase the range of economic opportunities for the population.

A major element in the RTG's investment program was the development of available water sources for irrigation, which included construction of large dams on the Pong, Pao, Nam Oon, Dom Noi, Takong, and Pra Pleung Rivers. During the late 1950s and 1960s, the RID constructed over 200 small to medium irrigation projects in Northeast Thailand[3]. These systems range from 2,000 to 30,000 rai in service area size. In addition, over 2,000 small-scale systems were completed to provide increased irrigation capacity as well as domestic water. Three-fourths of these systems have storage capacity of less than 5 million cubic meters (mcm) and only 10 percent have capacities in excess of 10 mcm. The National Energy Authority developed river pumping schemes to serve farmers along such rivers as the Mun and the Chi, and different RTG agencies also instituted a number of drilling programs to determine the feasibility of groundwater development in the Northeast[4].

A second aspect of the RTG scheme for improving economic conditions in the Northeast was increased investment in agricultural research and outreach, which included forming the Northeastern Agricultural Research Center at Tha Phra as well as

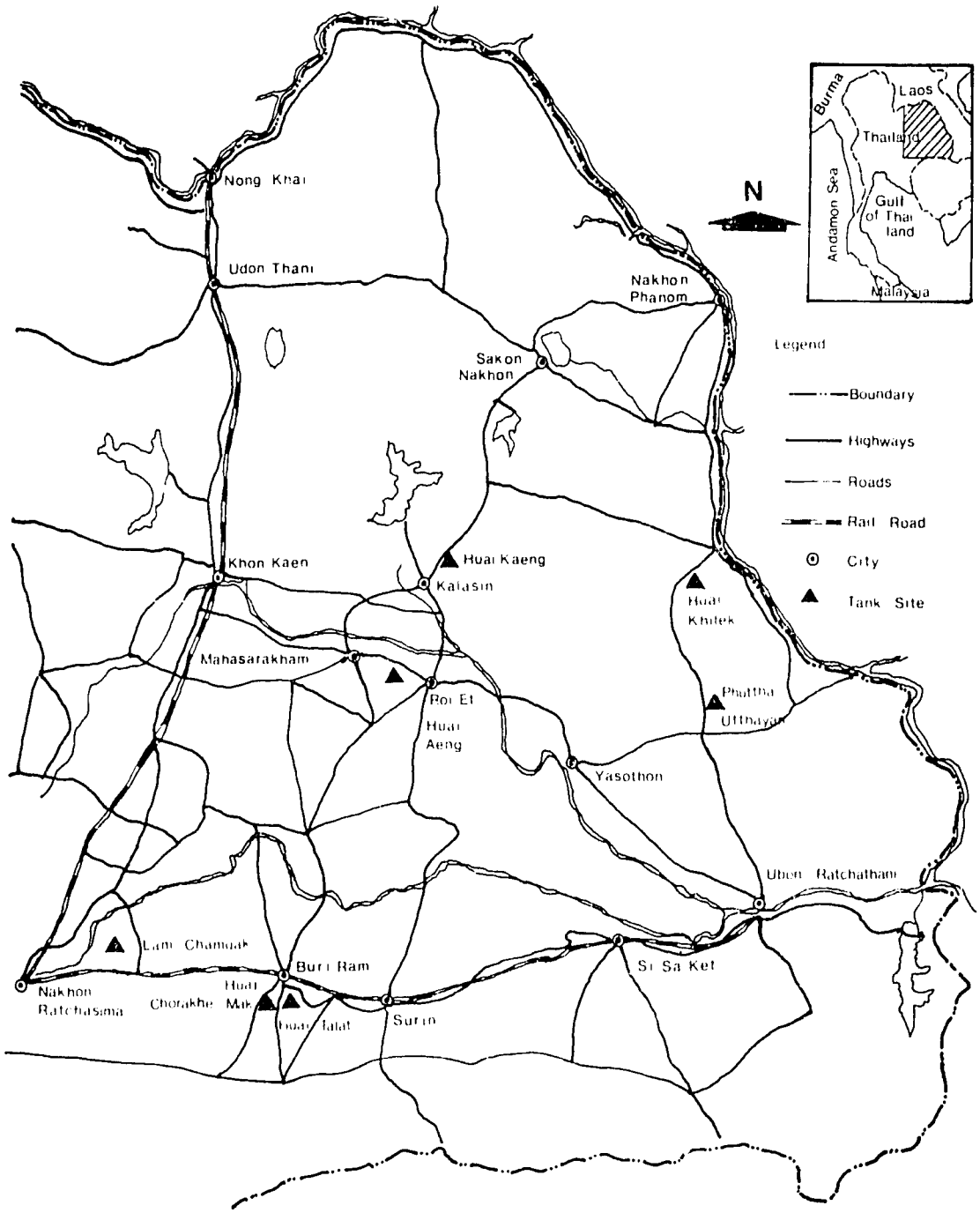


Figure 2

Tank Site Locations

expanding agricultural experiment stations in the region. In conjunction with these activities, the RTG committed a large percentage of its development funds to expanding rural roads and other infrastructure. The government also created additional rural and secondary schools and institutions for training additional teachers, and increased the number of colleges and vocational schools. In 1964, RTG established KKU as a regional university to serve the rapidly expanding Northeast population.

2.2 Social Setting

Four different ethnic groups, Thai, Lao, Khmer, and Phu Thai, are found in the project area. Although over 90 percent of the project-area residents are local to the area, each ethnic group speaks a distinctly different language; thus, linguistic problems do exist. Religious conflicts, however, are not a factor in the project sites because most inhabitants are Buddhists.

Around 60,000[5] people live in 9,800 households in the service area of NESSI's seven sites. Previously, families in the Northeast were very large, with 8-10 children. But at present, families have 2 to 4 children as a result of Thailand's active and very successful family planning program, and steadily increasing income levels.

Table 2 details basic characteristics of the population. On the average, 81.6 percent of the project population have a grade 4 education, 7.5 percent have less than a grade 4 education, and 4.4 percent have higher than a grade 4 education. Over 84 percent of the families live in their own homes separate from parents or parents-in-law.

Around 90 percent of the villagers in the NESSI area are farmers cultivating rice and other cash crops for a living. The majority of the villagers own their own land except for Buri Ram's two sites, Chorakhe Mak and Huai Talat, where there is a relatively high degree of tenancy. Farm size in general is small, averaging about 18.6 rai per household in the seven sites, with very little site-to-site variation.

Rice is the dominant crop of the Northeast, especially during the wet season. Rice grown in the project sites is either the more traditional nonglutinous rice or, in areas where the Lao population dominates, glutinous rice. Glutinous rice is the main crop in Huai Aeng, Huai Kaeng, Huai Khilek, and Phuttha Utthayan; in the other three sites—Huai Chorakhe Mak, Huai Talat, and Lam Chamuak—nonglutinous rice is the predominant crop[6].

Table 2

Population Profile in NESSI Project Area, 1983-84

No. of Site	Total Household	Population	Population Per Household	Ethnic Origin	(%) Grade 4 Education
Huai Aeng	2,023	11,598	5.7	Lao	89.7
Huai Kaeng	1,060	5,969	5.6	Lao	90.0
Huai Khilek	611	4,041	6.7	Lao Phu Thai	76.2
Phuttha Utthayan	1,725	10,664	6.2	Lao	90.0
Huai Chorakhe Mak	1,565	9,465	6.1	Khmer Lao	74.2
Huai Talat	1,572	11,919	7.6	Khmer	69.9
Lam Chamuak	1,275	7,738	6.1	Thai Lao	81.1
Total	9,831	61,394	6.3 (average)		81.6 (average)

Source: Final Report of Consultant Task Force for Northeast Small Scale Irrigation Project, Appendix A. Bangkok, September 1985

Given the erratic rainfall in the Northeast, most families place high priority on self-sufficiency in rice. When possible, a family stores rice stocks sufficient to feed its members for a year. After filling the rice barn, families sell any surplus rice, but with small land holdings and uncertain rainfall, this type of income is not available every year.

On higher land, farmers grow cassava, kenaf, and other less water-demanding crops. In addition to crop production, livestock raising and fishing are important activities of the rural population. Most Northeast families supplement their incomes from outside sources[7]. Traditionally, young and older males and unmarried females have gone to Bangkok or the South to work during the dry season. After working outside the region for three to five months, these individuals usually return to the village prior to the rainy season.

2.3 Environmental Setting

Northeast Thailand is surrounded by 400 meter mountains in the South and 1300 meter mountains in the West, with the Mekong River serving as a natural border with Laos in the North and East. Hills to the south define the border between Northeast Thailand and Kampuchea. Average elevation is between 200-230 meters above mean sea level. Except for the rugged, hilly areas along the southern and western boundaries of the region and the low mountains south of Udorn Thani and Sakon Nakhon, the Northeast consists mainly of an undulating plain with highly weathered soils that are saline in some areas and lateritic in other areas. Runoff from the monsoon rains is drained from four-fifths of the entire region by the two major rivers, the Mun and the Chi. These rivers converge near Ubol and flow into the Mekong River in Laos.

Thailand's climate is classified as tropical savanna, according to Koppen's climatic classification. There are three seasons: the rainy season, winter (cool), and summer (hot and dry). These three seasons are influenced by the southwest and northeast monsoons. The rainy season lasts from May to October and has a bimodal type of distribution, with the first peak (a result of the southwest monsoon) in May to June and the second peak (a result of the northeast monsoon) in July to October. Early season rains are usually lighter than in the second season and also tend to be more variable in their onset. Second season rains are usually heavier and more frequent than the first peak.

As seen in Figure 3, Northeast Thailand can be divided into three distinct zones based on the average rainfall received:

- areas receiving 1,400 mm of rainfall and above, which include those lying in the northern and eastern parts of the region;
- areas receiving less than 1,200 mm of rainfall, mainly comprising land in the western part of the region; and
- areas receiving between 1,200 to 1,400 mm of rainfall, which include the central and southern parts of the region.

Based on this distinction, it should be possible to divide the seven NESSI sites as follows: Huai Khilek and Phuttha Utthayan fall in the areas receiving more than 1,400 mm of annual rainfall; Lam Chamuak is located in the area receiving less than 1,200 mm of annual rainfall; and Huai Aeng, Huai Kaeng, Huai Chorakhe Mak, and Huai Talat are in the central and southern area, where the annual rainfall varies from 1,200 mm to 1,400 mm, Table 3 provides historical rainfall averages for the seven NESSI sites.

Data in Table 3 indicate that, in general, rainfall patterns at the seven sites fit very well with the expected rainfall. Huai Aeng's annual rainfall is less than 1,200 mm, which, although it is in the central area, indicates that it is right on the eastern boundary of the drier western part of the region that juts into Mahasarakam Province (see Figure 3). Total average rainfall is important, but the deviation around the average is equally important. The relatively high standard deviation for Lam Chamuak serves as a warning flag, indicating extremely variable rainfall patterns for that particular site. Recent research at the University has found that localized annual, weekly, and daily rainfall variation is far more important than the simple average annual rainfall[8]. Appendix D provides expanded details of the environmental conditions at each of the three study sites.

2.4 Economic Setting

Income levels in Northeast Thailand are the lowest in the country. NESSI was designed to address this problem at the seven sites and, in addition, was to develop a replicable model that can be used to improve income levels at other medium-size reservoir sites in the region.

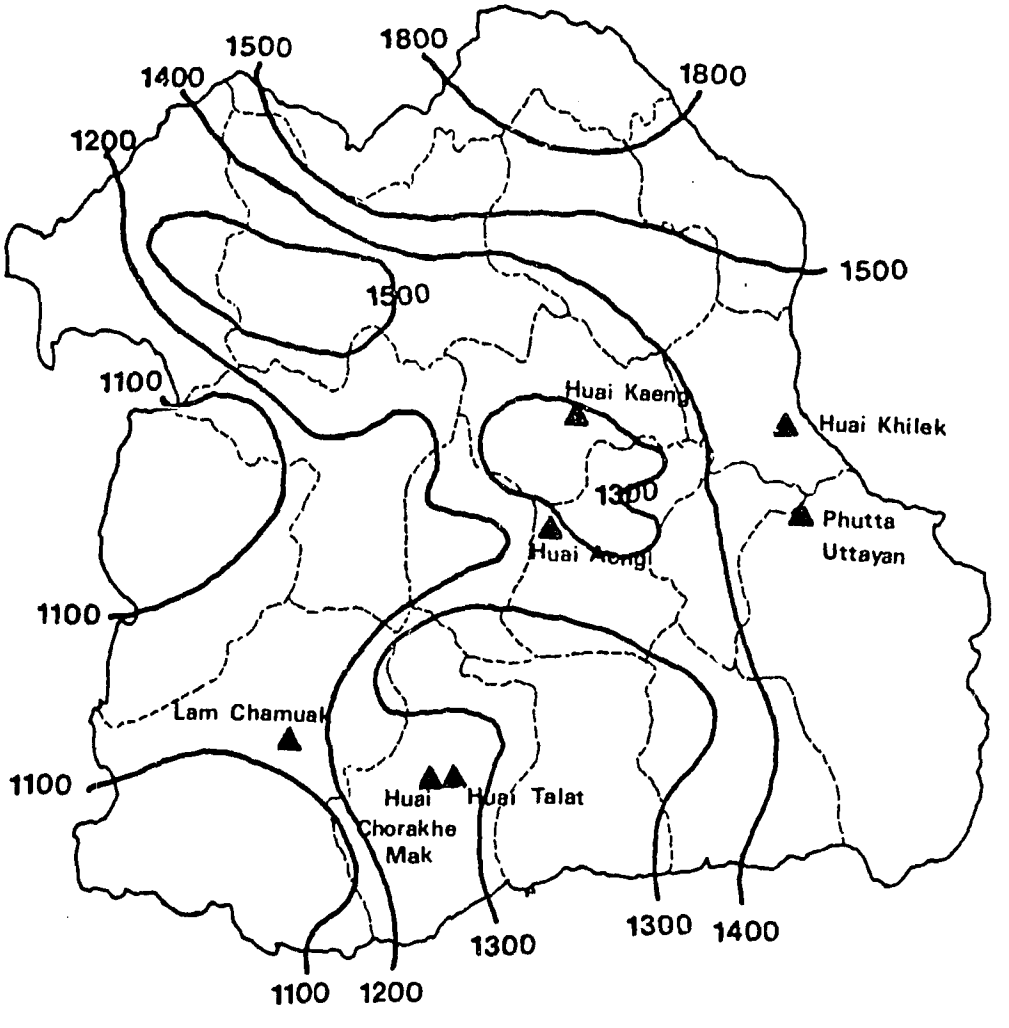


Figure 3

Isohytes for Annual Rainfall, Northeast Thailand

Table 3

Rainfall and Evaporation Characteristics of NESSI Sites

Site	Rainfall (mm) Minimum	Maximum	Average	Annual Pan Evaporation	Mean Daily Potential ET
Huai Aeng[1]	689.1	1,497.3	1,118 (118)[8]	1,834 mm	4.96 mm/day
Huai Kaeng[2]	1,112.6	1,539.7	1,271 (227)	1,863 mm	4.96 mm/day
Huai Khilek[3]	1,136.6	1,711.0	1,490 (235)	1,940 mm	5.03 mm/day
Phuttha Utthayan[4]	805.3	1,905.9	1,476 (282)	2,226 mm	4.91 mm/day
Huai Chorakhe Mak[5]	1,024.1	1,945.7	1,292 (196)	2,289 mm	4.67 mm/day
Huai Talat[6]	1,004.6	2,191.0	1,462 (328)	2,289 mm	4.67 mm/day
Lam Chamuak[7]	802.0	1,815.1	1,172 (220)	1,925 mm	4.55 mm/day

1 1964-1988 data
2 1970-1986 data
3 1964-1986 data
4 1962-1986 data
5 1963-1988 data
6 1963-1988 data
7 1962-1988 data
8 Standard deviation

Source: Inception Report for Northeast Small Scale Irrigation Project. Consultant Task Force. Bangkok, November 1982. Supplemented by data collected by Study Team.

2.4.1 Preproject Economic Conditions

Based on benchmark data collected prior to project implementation project (Table 4), real per capita rural income in the project sites was less than US$150, with almost all of this income coming from crops produced during the wet season, off-farm employment, and livestock production.

Table 4

Average Preproject Net Household Income (1978-1979)

Site	Net On-Farm Income[1] (baht)[2]	Net Off-Farm Income (baht)	Total Net Income (baht)	Per Capita Income (baht)
Huai Aeng	14,580	3,925	18,505	2,549
Huai Kaeng	14,505	2,554	17,059	2,437
Huai Khilek	12,005	3,806	15,811	1,935
Phuttha Utthayan	18,300	6,807	25,107	3,787
Huai Chorakhe Mak	10,684	3,648	14,332	2,126
Huai Talat	26,526	3,543	30,069	3,905
Lam Chamuak	26,914	5,680	32,594	4,179
Average	17,645	4,280	21,925	2,988

1 Based on "without project" farm budgets.
2 1978 one US dollar equaled 20 Thai baht.

Source: AIT Feasibility Study of the Rehabilitation of Tank Irrigation Systems in Northeast Thailand: Volume 1-Main Report. Bangkok: USAID, 1980.

Table 5

Farm Situation in NESSI Project Area, 1979

Site	Average Farmland Per Household (rai)	Person (rai)	Average Rice Yield (kg/rai)	Major Crops	% Area in Dry Season Crops[1]
Huai Aeng	17.7	3.1	200-300	Glutinous rice	2.87 percent
Huai Kaeng	20.5	3.6	200-300	Glutinous rice, cassava	0.68 percent
Huai Khilek	17.7	2.6	200-350	Glutinous rice, cane, cassava	0.98 percent
Phuttha Utthayan	16.9	1.4	200-400	Glutinous rice, corn	0.48 percent
Huai Chorakhe Mak	18.4	3.0	200-350	Ordinary rice	0.02 percent
Huai Talat	21.8	2.9	270-400	Ordinary rice	
Lam Chamuak	17.5	2.9	240-350	Ordinary rice, cassava	5.46 percent

1 Calculated as percentage of wet season cultivated area. Excludes rice.

Source: AIT Feasibility Study of the Rehabilitation of Tank Irrigation Systems in Northeast Thailand: Volume 1-Main Report. Bangkok: USAID, November 1980.

Additional field data collected at project initiation are presented in Table 5. Land holding sizes were uniformly small, with rice the dominant crop. Yields were very low. Non-rice crop production in the dry season was limited to a very small area. Irrigation development in the Northeast, including the NESSI Project, had as a primary goal increasing agricultural income, particularly income from dry season crop production. In addition to promoting increased dry season production, Northeast irrigation development was designed to promote increased use of high-yielding varieties (HYVs) of rice and higher levels of fertilizer and other agricultural chemicals.

Prior to project implementation, use of agricultural chemicals and HYVs was very limited and, as a result, crop yields were generally quite low. Preproject surveys reported that although virtually all farmers used fertilizer on their rice, the average amount applied was only 8.35 kg/rai: well below the recommended level. On average, less than 50 percent of the rice land was planted in recommended HYVs and, as a consequence, the weighted wet season rice yields were around 230 kg/rai[9].

2.4.2 Postproject Economic Conditions

Per capita income in Thailand has increased significantly over the past ten years. Increases in Central and Northern Thailand have been extremely rapid; income increases in the South and Northeast, while slower, have been consistent across the entire time period. Adoption of new HYVs and the increased use of agricultural chemicals have played a major role in raising rural income. These innovations have occurred in both rainfed and irrigated areas. Therefore, at least for the wet season, some positive economic changes in NESSI sites would have occurred even if the project had not been implemented.

Due to staggered timing in developing the seven different sites and delays related to RTG funding approval, economic improvement varied across NESSI sites. As a consequence, although rapid changes can be identified in all sites, the magnitude of change, which relates to the time farmers have to adjust to new conditions, is still relatively uneven.

In order to document changes, the team studied DOAE socioeconomic data for each season, which extension staff had collected using a 5 percent sampling frame (approximately 50 farmers at each site). In addition, 100 farmers at each site were surveyed to provide up-to-date information and data unavailable from the extension staff. A third source of data was the NESSI office outside Khon Kaen, and the final source was technical and socioeconomic data gathered by TEAM Engineering's water management engineer and economist. The following material is drawn from all of these sources.

One obvious change that has occurred in the project area is increased overall rice production, reflecting (a) the rapid adoption of modern seeds and inputs and (b) the switch in the glutinous-rice-eating sites to a larger percentage of land planted to high-yielding, nonglutinous rice. Data presented in Table 6 document these changes in the three study sites (and Phuttha Utthayan). There has been a definite trend toward a more balanced mix between area planted to glutinous rice and area planted to nonglutinous rice. This shift has been a major objective of agricultural extension staff, who have

Table 6

Wet Season Rice Yields, Mix, and Fertilizer Use at Four NESSI Sites, Preproject to 1988

Site	Rice Yields		Rice Mix		Fertilizer Use	
	Glut.	Regular	Glut.	Regular	Glut.	Regular
	(kg/ha)		(kg/ha)		(kg/ha)	
Huai Aeng						
preproject	220	200	18,000		8.35[1]	
initial year	280	290	14,985	3,515		
86[2]	409	454	14,114	6,952		
87[2]	345	438	13,693	7,373	47-52	
88[3]	313	391	65%[5]	35%[5]	42	48
Huai Khilek						
preproject	230	220	9,000		8.35[1]	
initial year	239					
86[2]	427	498	884	156		
87[2]	482	473	4,254	694	25-38	
88[3]	325	398	80%[5]	20%[5]	43	23
Chorakhe Mak						
preproject	200	260	12,500		8.35[1]	
initial year	287	308				
86[2]		599	1,575			
87[2]		546	0	3,972		
88[2]		500	0	9,600[4]		
88[3]		491		100%[5]		22
Phuttha Utthayan						
preproject	230	250	12,000		8.35[1]	
initial year	240	250				
86[2]	315		8,410	3,604		
87[2]	335	400	7,208	4,806		
88[2]	409	398	5,647	6,367		

1 NESSI sites, 1978-79.
2 Reported by DOAE field staff based on survey using a 5% sampling frame.
3 Taken from field survey data collected for Study Team in May 1989.
4 After completion of farm ditches during 1989.
5 Percentages of area planted as reported in May 1989 field survey.

been trying to persuade farmers to plant nonglutinous rice because it usually commands a higher price and is much easier to market. Along with a shift toward growing more nonglutinous rice, there has been a significant move toward fertilizer use. For example, in 1983, only half the farmers that DOAE staff interviewed in Huai Aeng used fertilizer on their wet season rice; in 1986 and 1987, all those interviewed were using fertilizer.

In the four sites detailed in the table, both glutinous and nonglutinous rice yields have almost doubled over the past eight years. In addition to increased fertilizer use, higher yields can be traced to adoption of proper HYVs. DOAE data indicate that during the 1987 wet season, 89 percent of the farmers in Huai Aeng, 100 percent in Huai Chorakhe Mak, and 70 percent in Huai Khilek used recommended varieties. Weighted yield for glutinous and nonglutinous wet season rice was 400 kg/rai, compared with the average of 285 kg/rai that the Ministry of Agriculture and Cooperatives (MOAC)[10] reported for major season rice from Northeast irrigated land.

Although wet season agricultural productivity gains in the project area have been impressive, it is the increased dry season cropping activities that have pleased RID and DOAE staff. Prior to the project, average dry season crop area, based on area cultivated during the wet season, was less than 5 percent, and much of that land was planted to cassava, tobacco, and kenaf. However, farmers in the project sites now produce a wide range of dry season crops, including tomatoes, baby corn, sweet corn, peanuts, soybeans, chilies, and other vegetables. The rapid expansion of canning and food processing facilities in the Northeast, accompanied by the increased recognition that the Northeast is climatically a very good region to produce high-quality seed, has brought about a dramatic change in dry season farming.

Table 7, while documenting the rapid expansion of dry season crops, also illustrates farmers' responsiveness in the sites to varying market conditions. Depending on price and expected market conditions, farmers have been experimenting with a wide range of crops. Thus, crops grown vary by location and by year. In addition, total dry season cropped area depends upon the level of rainfall; the decline in area planted during the 1988/89 dry season reflects the dry conditions that prevailed in most of the Northeast during that season. At all sites, wide variability in total area cropped during the dry season is typical of new irrigation systems, which tend to fluctuate as users and operators learn to maximize system operation. Unfortunately, erratic rainfall patterns in Northeast Thailand may make it very difficult to stabilize the area served during the dry season. This issue is addressed further in the engineering sections.

Table 7

Dry Season Crop Production in NESSI Sites

Site rai)	CROP AREA (rai) Sweet Corn	Peanut	Soybean	Vegetables	Chilis	Mungbeans	Water Melons	Other	Total
Huai Aeng	21,066[1]								
86/87	1,910		1,282		952	9		618	4,771
87/88	1,305		731		337	28		709	3,150
88/89	1,311		520		264		101	264[3]	2,433
Huai Khilek	8,625[1]								
86/87									
87/88	374		168		1,388		162	193	2,285
88/89	132		58	181	532	245	15	3[3]	1,166
Chorakhe Mak	9,600[2]								
86/87									
87/88	30	16				465			534
88/89		269		49		490	7	16[3]	831
Phuttha Utthayan	12,014[1]								
86/87	380	26	7	265	11		12	23	725
87/88	1,431	394	16	1,216	57		209	175	3,398
88/8	1,122	878	149	611	14		1,236	81	4,091

[1] Irrigated area (rai).
[2] Irrigated area (rai) after completion of all farm ditches.
[3] Fish ponds.

Notes–Chapter 2

1. Source: Office of Agricultural Economics, Office of the National Economic and Social Development Board.

2. Because of the Korat Plateau, Northeast Thailand is part of the Mekong River watershed and drains into the South China Sea, while North and Central Thailand drain into the Chao Phya River and eventually into the Gulf of Siam.

3. Many of these systems were built with assistance from USAID. In contrast to NESSI's rehabilitation costs, these systems could be constructed very inexpensively in the 1960s, given the low construction costs and minimal distribution system provided.

4. Asian Institute of Technology. "Water for the Northeast: A Strategy for the Development of Small-Scale Water Resources; Vol. 1: Main Report." Bangkok, September 1978.

5. The original Project Paper, based on AIT preliminary social data, estimated 30,000 people living in the NESSI command area. However, surveys undertaken as part of the project found in excess of 60,000 people that would benefit directly from the project.

6. Final Report of Consultant Task Force for the Northeast Small Sale Irrigation Project, Appendix A. "Socio-Economic Conditions in NESSI Project Areas 1983-1984." Parsons-TEAM, Contract No. 493-0312-01 & 02. Bangkok, September 1985: Volume 11.

7. Economic studies show that often 50 percent of the family income in the Northeast comes from off-farm sources.

8. Grandstaff, Terry B. "Environment and Economic Diversity in Northeast Thailand." *Sustainable Rural Development in Asia*. Khon Kaen: Khon Kaen University, July 1988.

9. AIT Feasibility Study of the Rehabilitation of Tank Irrigation Systems in Northeast Thailand: Volume 1-Main Report. Bangkok: USAID, November 1980.

10. Agricultural Statistics in Brief Crop Year 1987/88. Center for Agricultural Statistics, Office of Agricultural Economics, Ministry of Agricultural & Co-Operatives. Bangkok: Agricultural Statistics No. 405, June 1988.

3

ASSESSMENT OF NESSI EXPERIENCE

This chapter assesses significant aspects of NESSI and identifies positive and negative findings related to project design and implementation. NESSI was designed as an innovative project to develop a replicable model for RTG to use in improving over 200 small and medium reservoirs in Northeast Thailand. As the project evolved, a number of changes were made in the original design, including reducing chack and associated water users group size and increasing the number of laterals and farm ditches. Due to a significant underestimation of the costs to rehabilitate the system, as originally approved, funding was available to rehabilitate only four of the original seven sites. The consequent need for more funds slowed project implementation and completion at all seven sites.

3.1 NESSI Institutions

This section assesses strengths and weaknesses of NESSI's final institutional structure. The Project Paper envisioned a relatively complex institutional management structure; however, only certain elements of that structure were implemented. Although it is difficult at this stage to determine why some project elements were omitted, Chamberlain's 1985 management review of NESSI[1] provides an excellent discussion of midproject management issues. Interested readers are encouraged to read his paper, since that material is not repeated here.

3.1.1 Original Project Management Design

As formulated in the Project Paper, NESSI was to operate under the supervision of policy and project committees that would serve as coordinating bodies for a number of ministries and agencies (Figure 4). Below these coordinating committees, site- and command-level groups were to carry out the actual implementation. The plan was ambitious in attempting to coordinate a number of local government agencies and water users in running the project. Major participants in NESSI implementation were expected to include the following:

- **Central Policy Committee for Irrigated Agriculture.** Chaired by an MOAC undersecretary, the Central Policy Committee included representatives of the Ministry of Finance (MOF), Ministry of the Interior (MOI), and Bank for Agriculture and Agricultural Cooperatives (BAAC). The committee's function was to provide a consistent policy framework for irrigated agricultural projects.

- **Project Coordinating Committee.** The Project Coordinating Committee was to serve as a forum for coordinating departments involved in implementing government projects. Chaired by a deputy undersecretary of the MOAC, other agencies represented were to include the Royal Irrigation Department (RID) and the Departments of Agricultural Extension (DOAE), Agriculture (DOA), Land Development (DLD), Community Development (CDD), Technical and Economic Cooperation (DTEC), and Fisheries (DOF), in addition to the Bank for Agriculture and Agricultural Cooperatives (BAAC). The committee was expected to prioritize project implementation activities.

- **Project Manager.** RID and the DOAE were expected to station full-time project co-managers at the Northeast Agricultural Development Center (Tha Phra) to coordinate and monitor the project's field activities. These project managers were to serve as an extension of the Project Coordination Committee and ensure that each site team was supported and progressing satisfactorily. As well, they were to serve as liaisons to their own line agencies.

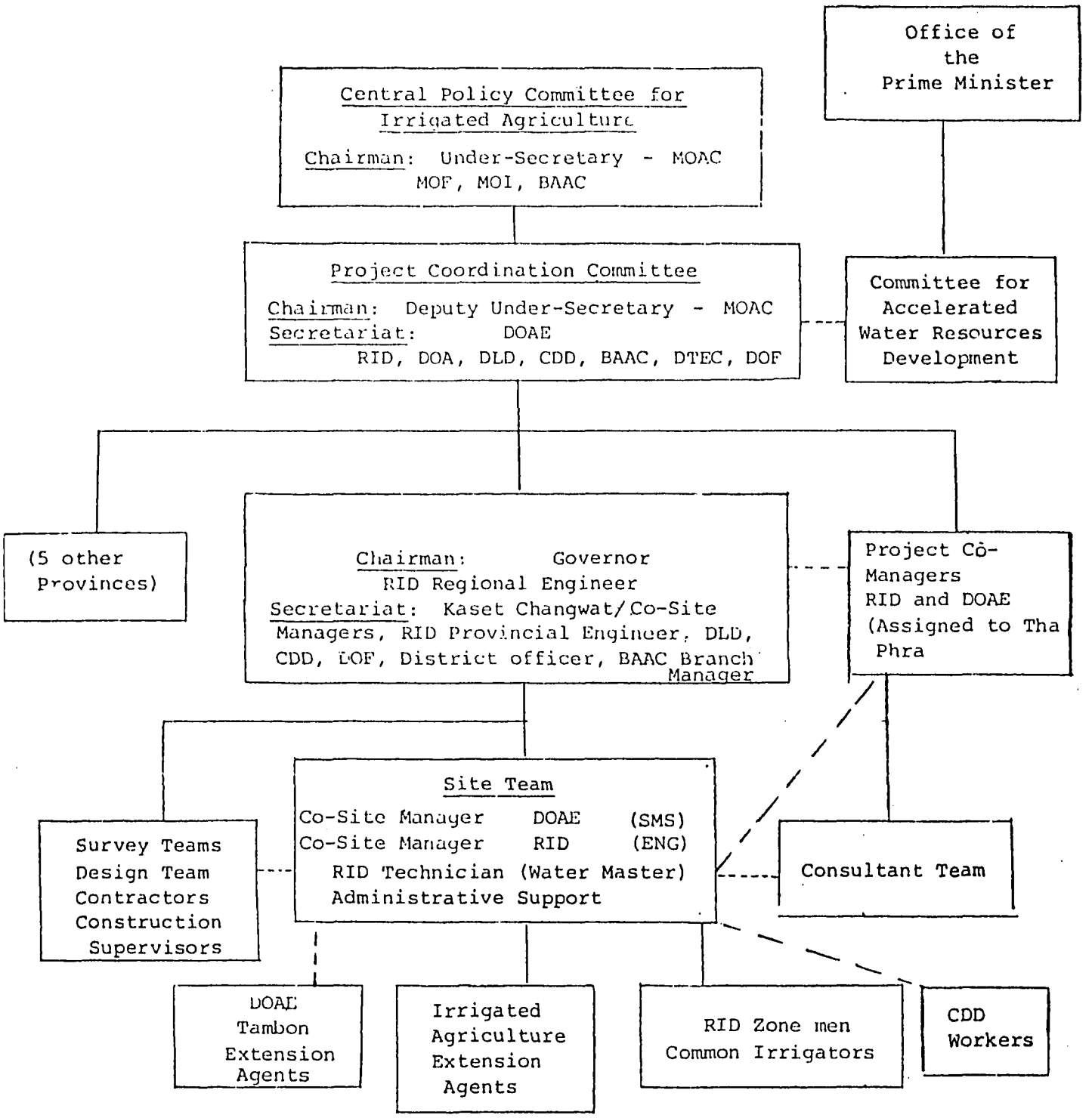


Figure 4

NESSI Organizational Diagram

From Project Paper

- **Province Operations Committee.** The committee was established exclusively for the operation of NESSI. Chaired by the governor of the province, the committee was to be responsible for initiating much of the project activity. Committee members (RID, DLD, BAAC, DOAE, CDD, and DOF) were to resolve implementation problems and ensure that required inputs were provided to project teams in a timely manner.

- **Site Teams.** As originally designed, project activities at each site were to be carried out by a team composed of site co-managers (RID engineer and DOAE subject matter specialist), RID site personnel (O&M unit chief and zonemen), CDD, and DOAE extension agents. Site teams were to be supported by the consultant team, which was to provide technical expertise and on-the-job training for team members.

- **Water Users Associations.** Management and maintenance of the on-farm structures were to rest with the water users associations. The project was expected to test various WUA models at different sites, attempt to decentralize management so that WUAs could better represent small farmers, define a more equitable system of collecting water user fees to defray the distribution system's O&M costs, and test arrangements for cost recovery from farmers.

3.1.2 Institutions in Operation

The NESSI design introduced a hierarchy of committees that ranged from the senior government level, for setting consistent policies in irrigation development, to the field level, for ensuring smooth project implementation. In fact, the two national committees, Central Policy and Project Coordinating, played no direct role in implementation and had a negligible effect upon the project. The Project Coordinating Committee is an existing forum for reviewing progress on all projects, rather than for focusing on NESSI alone.

Direct involvement at the national level began with the Project Coordinating Subcommittee, which was created to bring NESSI issues directly to the attention of national officials. Meeting once or twice a year, the subcommittee could act as project advocate, taking the case for more funding to higher levels of the RTG. Even with its relatively infrequent meetings, the subcommittee appears to have been a useful and responsive entity.

At the provincial level, NESSI's coordinating committees served a legitimizing role rather than functioning as real working committees. Created in all seven provinces, their primary functions appear to have been to inform governors about the project (usually their one and only meeting unless a new governor was appointed) and to formally create a field working group for each site. As designed, the committees were outside the existing provincial structure because in each province, progress on projects is reviewed monthly in a meeting chaired by the governor and attended by the senior provincial official of each agency. The RID provincial engineer attends this meeting after first being briefed about NESSI and other RID projects, and reports progress to the governor. Therefore, a separate committee for NESSI at the provincial level appears to be a duplication, and it is not surprising that the committee rarely met.

Site teams, representing a number of government line agencies, have worked productively during project implementation. The design scheme for site co-managers was not carried out; DOAE never appointed a co-manager at any site, but the department was involved through the district agricultural officer and the subdistrict agricultural worker. At the sites, field working groups have emerged as very effective coordinating bodies (Figure 5). Meeting each month, the members work through a fixed agenda that includes the previous month's achievements, plans for the next month's implementation, and special problems. Minutes are kept and circulated to participants.

Meetings of the field working group are attended by officers from RID (O&M unit chief and zonemen), DOAE (district and subdistrict officers), and sometimes DLD, CDD, BAAC, and DOF. The WUA is represented by its president, who may be accompanied by members of the administrative committee. In Huai Aeng, the main ditch leaders also attend; farmers are paid 5 baht for each meeting they attend and fined 10 baht for those they miss. At most sites, the DOAE chairs the meeting, but in Huai Khilek the chair rotates among members and has included WUA officers. At Lam Chamuak, a working group has not yet been officially formed by the provincial coordinating committee because of the severe water shortage at the site.

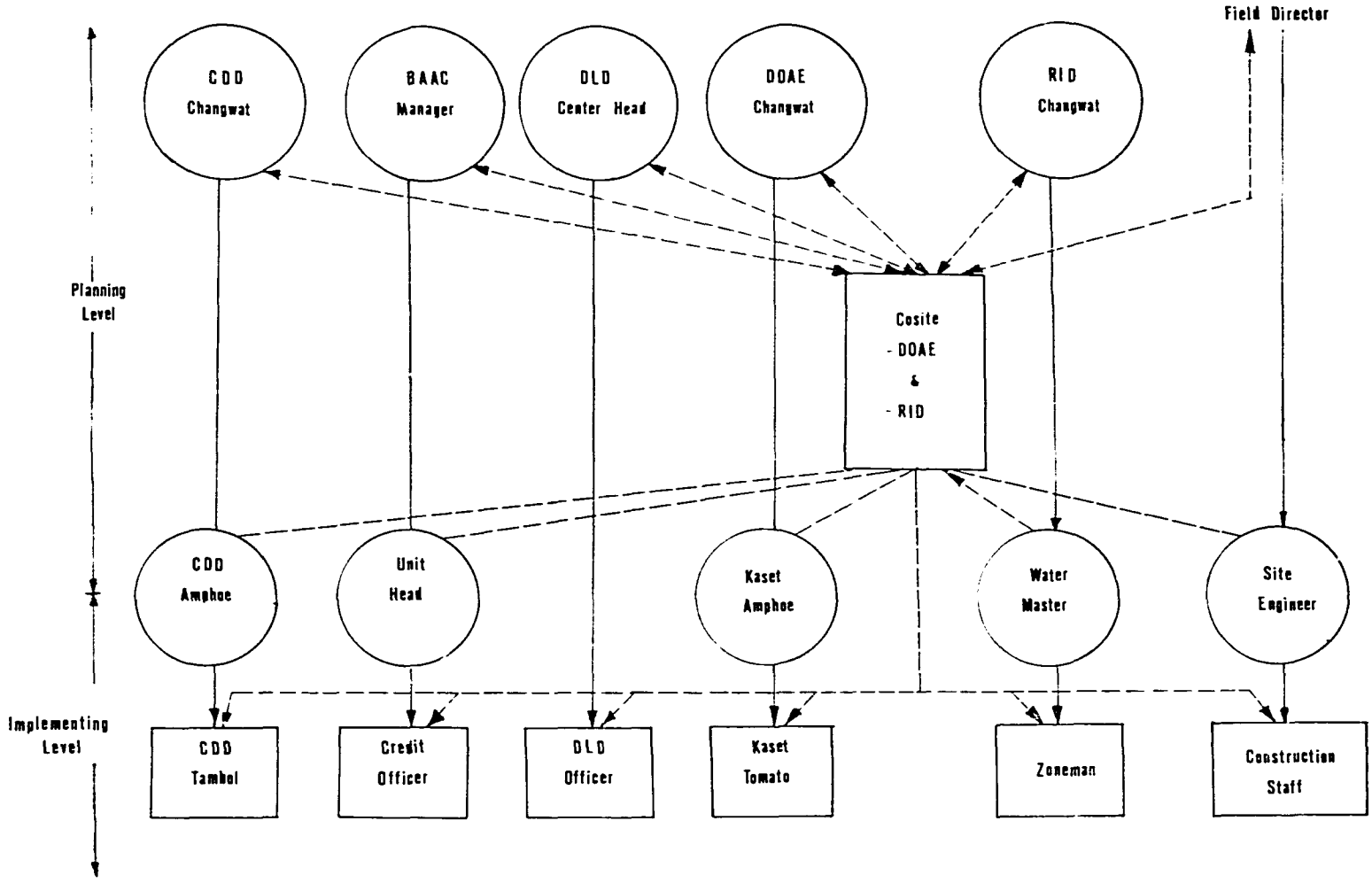


Figure 5

Working Group Organization

To NESSI's credit, project implementation has not closely followed the over-elaborate design. The two most effective entities grew out of implementation requirements. At the national level, NESSI required a voice, and the Coordinating Subcommittee has filled that role. At the local level, the field working groups have clearly contributed to the project and appear to be an important element. However, there is a question of what will happen to the working groups once the project is completed.

3.2 Water Users

NESSI's design emphasizes improved farmer participation in the operation and maintenance of on-farm water management systems. Prior to NESSI, water users' lack of involvement contributed significantly to inefficient water use and poor maintenance in public irrigation systems. Through NESSI, RID and other line agencies have sought to change their relationship with farmers, offering them greater responsibility for operating and maintaining the system and thereby reducing the agencies' own O&M burden. NESSI was expected to experiment with different approaches for organizing water users groups, decentralize management to be more representative of small farmers, identify an equitable system of water user O&M fees, and test arrangements for cost recovery for capital improvements. This section discusses the NESSI approach and assesses its strengths and weaknesses.

3.2.1 Early Water Users Designs and Initiatives

Pre-NESSI Attempts

Prior to NESSI site rehabilitation, water in the seven systems was often unreliable and inequitably distributed. The water delivery system of most medium-scale irrigation sites throughout the Northeast included only main canals and a limited number of laterals. In a number of cases, RID had installed outlets, normally constant head orifices, on canals and laterals that farmers with adjacent land used. Water was usually passed field-to-field, starting with those adjacent to the canals and laterals, but right-of-way was sometimes refused. Farmers at the tail rarely received water. Farmers called the canals klong lom, "wind canals," because they carried no water. There are reports of frequent water theft and conflicts over water. When water was available, the delivery system was based on continuous flow.

NESSI's efforts to organize water users groups followed attempts begun over twenty years ago to create water users associations at RID sites. In the 1960s, roughly 200 WUAs, nearly half of them in the Northeast, were registered under the provincial governor's office soon after construction was completed. WUAs were expected to be multipurpose, performing credit and marketing functions in addition to their O&M responsibilities. Farmers were obliged to pay 20 baht as a membership fee. In most cases, fees collected were used for officers' travel expenses, but no records were kept and farmers are now unable to account for how the funds were used. Early WUAs had an elaborate organizational structure with many officers, but lacked a clear sense of purpose and responsibility. With no continuing efforts by RID and other agencies to help them develop, most WUAs stopped functioning soon after their creation. However, all NESSI sites had WUAs, and they were registered in the 1960s at the time of construction.

Initial NESSI Designs for Water Users Groups

The 1980 USAID Project Paper included WUAs as the only farmer organization at the sites; O&M and fee collection were their implicit functions. Soon after project implementation began in 1982, the Consultant Task Force (CTF) identified a need for smaller chacks and a second tier of organized groups at the chack level. After reducing chack area, groups below a single turnout were formed to have mainly O&M responsibilities. However, in 1984, CTF proposed and RTG concurred that villages in project areas be organized as marketing units, independent of water users groups, to focus on production only.

Originally, chaek groups were expected to range from 20 to 50 members working an area of 300 to 500 rai[2]. Chaek boundaries were determined by hydrological conditions and were largely due to the original NESSI technical design that included few lateral canals. WUAs, carry-overs from the 1960s, were expected to serve as federations of these chaek groups and included all water users at the site. RID intended to reactivate these groups, which remained legally registered despite their long period of inactivity. Delivery systems in NESSI were designed to use rotation rather than continuous flow between canals and within a chaek, depending upon water availability.

A Change in the Final Design Criteria

In 1982, RID designed and installed the first section of the rehabilitated system at Huai Aeng, to serve as a pilot area of 500 rai. The design for Huai Aeng and the other six sites included left and right main canals and a limited number of laterals. However, an assessment of the operation of Huai Aeng revealed severe operational and organizational problems. Although technical aspects were considered acceptable, the on-farm system as designed created problems in establishing an effective farmer organization at the chaek level. In most cases, on-farm ditches in Huai Aeng fed directly from the main canals, resulting in rotational units that were too large to allow for a manageable farmer organization.

A visit by RID officers to India and the Philippines suggested an alternate design based on an increase in the number of lined laterals and unlined on-farm ditches. In the redesign, laterals were renamed main ditches. Lateral maintenance falls under RID, which must also compensate farmers for the right-of-way. All ditches, whether main or farm, are by definition part of the on-farm system and therefore the responsibility of farmers. Chaeks were reduced to 100-150 rai, serving roughly 10 to 15 farmers (although some chaeks might have fewer farmers). Chaek groups continue to be informal; under Thai law they are not legal entities, although in practice they are the primary contact point for RTG staff.

The division of site systems into smaller tertiary units, comparable to the NESSI chaek, has been adopted by RID as part of its standard approach. This change in the final design criteria of the physical system is arguably the most significant contribution that NESSI will have made to RID's development of medium-scale irrigation systems in the Northeast. Changes in chaek size created smaller and more effective farmer groups, which are better able to manage water delivery and system maintenance.

3.2.2 The NESSI Approach to Organizing Water Users

Chaek Groups

According to the NESSI approach, RTG staff are to meet regularly with farmers and assist them in developing chaek groups. Prior to completion of site rehabilitation, the RID zoneman and a DOAE extension worker make an initial visit to farmers who work together in a chaek. At the meeting, they discuss the reasons for chaek groups, elect a group leader, and review the rules and regulations for the group, including determining the level of penalties for infractions (Appendix E).

In consultation with the zoneman, chaek leaders determine a water delivery plan and schedule for water rotation, initiate a maintenance plan, supervise O&M activities on the farm ditch, resolve conflicts over water or refer them to RID staff, oversee the collection of O&M and other fees, and convene chaek group meetings as needed. Leaders are assisted by an assistant group leader and a field investigator (*nai truat na*), who reviews reports of rules violations.

Main Ditch Groups

Chaek groups are joined into main ditch groups with an elected leader. On average, there are about six chaek groups on a main ditch. Meetings of the main ditch group are the arena for chaek group leaders to discuss labor mobilization and main ditch maintenance. Meetings are held regularly to schedule maintenance and are occasionally convened to discuss special problems as they arise.

Main Canal Groups

Main ditch groups are organized into main canal groups. Meetings of main ditch leaders as a canal group are held as required to discuss issues of importance to that part of the system.

Water Users Associations

Water users associations are viewed as multipurpose organizations, with responsibilities for O&M, increasing production, and marketing. This broad mandate mirrors earlier aborted WUA attempts in the 1960s. Specifically, WUAs work with RTG line agencies in project implementation, promote chaek group activities, seek agricultural credit and inputs, and market produce from the site. WUAs hold monthly meetings of the administrative committees, which include people in charge of agriculture, irrigation, credit, and marketing; an auditor; and village representatives. Unlike WUAs elsewhere, those in the NESSI sites have policing functions. A special committee composed of chaek group leaders is formed to ensure that the water delivery schedule is followed and to investigate all reports of obstructions and damages to the system.

WUAs are led by a president, elected to a two-year term by the general membership, who appoints an administrative committee. WUAs maintain their own accounts in the BAAC or commercial banks with funds that chaek leaders collect as fees from members, including a one-time membership fee; an O&M fee agreed to by each WUA; fines for not participating in farm ditch cleaning; profits from purchasing inputs and selling them to members; fish pond charges; and donations. WUAs are expected to use their funds to cover honoraria for the chaek leaders, farm ditch and main ditch maintenance, and WUA activities—an honorarium for the president, travel expenses for official business, and supplies. Huai Aeng, Huai Kaeng, and Phuttha Utthayan WUAs have used their funds to provide RID staff with fuel and supplies. Accounts are kept for members' review at a yearly open meeting, when a progress report and workplan are presented to members. On occasion, special WUA meetings are convened to resolve conflicts over water or to discuss extraordinary uses of the WUA fund, such as for purchasing fuel for pumping water from the reservoir during periods of severe water shortage.

3.2.3 NESSI in Operation

Farmer Participation

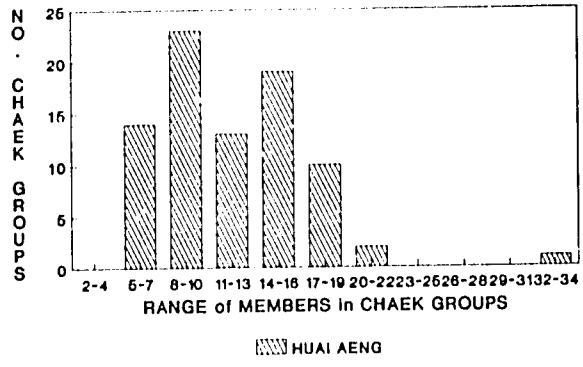
A gap exists between the spirit of the NESSI design and actual project implementation. According to the design, water users were to play a more responsible role in both the operation and the maintenance of the irrigation system. Farmers have, in fact, been given a decision-making role in allocating and scheduling water in the farm ditch, which moves their role beyond maintenance alone. However, with the exception of Huai Aeng, where the main ditch group leader can sometimes get the key to open the gate, farmers continue to play a restricted role in the system operations above the farm ditch, where they only monitor operation. RID officers decide how and when water will be distributed in the main ditches, although main ditch group leaders and main canal group leaders often police the rotation system schedule. Farmers are expected to maintain main ditches as part of the on-farm system.

Farmers first learned of site rehabilitation from a contract construction team, shortly before the work began. Meeting with a large group of farmers, the team reviewed the plan, disclosed that the work would take roughly 12 to 24 months, informed farmers that water delivery would be disrupted, and requested permission for uncompensated rights-of-way for farm ditches and tree removal. Only for main canal preparation were farmers compensated for land or tree removal.

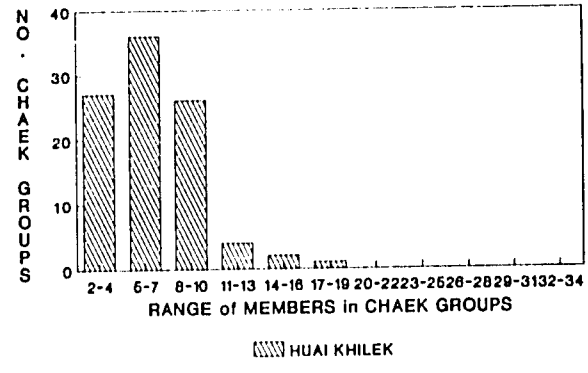
Immediately after completing the site, the RID zoneman and a DOAE extension worker called a water users meeting to discuss the need for chaek groups. In preparation for the meeting, RID staff reviewed the ownership map to determine the names of farmers who shared water from the same turnout and to update listings. This meeting lasted only a few hours and usually resulted in farmers agreeing to form a chaek group and abide by RID's proposed rules and regulations. At the same meeting, a leader was selected. RID staff estimate that it takes about a month to form all the chaek groups in a site.

Chaek group formation. Only during the last four years, with the completion of the project sites, have chaek groups been formed on nearly all farm ditches. When rehabilitation is completed on remaining canals, groups will be formed there as well. To date, existing groups have agreed to the prescribed rules and regulations and have selected a leader. Chaek groups have been most successful in managing water rotation from farm ditch to field and in mobilizing labor to maintain both main and farm ditches. In the project, chaek group size rarely exceeds 20 farmers. Figure 6 illustrates the variation in group size at the three Applied Study sites: an average of 12 at Huai Aeng, 6 at Huai Khilek, and 13 at Huai Chorakhe Mak. This variation reflects a difference in land-holding size at the three sites.

VARIATIONS IN SIZE OF CHAEK GROUPS
HUAI AENG, ROI ET PROVINCE, 1989



VARIATIONS IN SIZE OF CHAEK GROUPS
HUAI KHILEK, MUKDAHAN PROVINCE, 1989



VARIATIONS IN SIZE OF CHAEK GROUPS
CHORAKHE MAK, BURI RAM PROVINCE, 1989

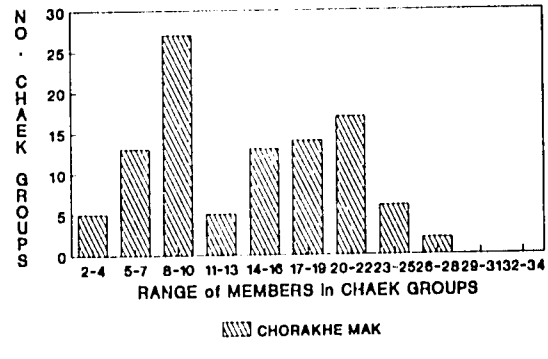


Figure 6

Size of Chaek Groups

Water rotation. NESSI's emphasis on farmer participation in system operation and maintenance requires an unusual degree of decision-making among the members of chaek groups and WUAs. Chaek group control over farm ditch rotation has been most successful at sites with sufficient water. Farmers receive water on rotation according to crop demands and water availability. At the head of each farm ditch is a water-delivery schedule board, which sets the rotation and shows when each farmer is entitled to water. This board, a NESSI innovation, is found only at project sites. Farmers are expected to pay an O&M fee each season they grow a crop. In Huai Aeng and Huai Khilek, farmers agreed to pay 1 baht/rai in the wet season and 5 baht/rai in the dry, 10 baht/rai for a fish pond and 20 baht/rai for raising ducks. Table 8 indicates the average fee paid and the labor contribution for O&M by farmers in 1988-89, based on interviews with 100 farmers at each of three NESSI sites. RID staff expect that O&M fee collection will begin in Huai Chorakhe Mak when site rehabilitation is completed.

Dry Season Cropping

With NESSI, contact between water users and RID staff has grown in both frequency and importance. At least monthly, there are interactions through the field working groups. WUA representatives and RID staff discuss dry season crops to be grown, water allocation, water scheduling, and on-farm system maintenance. Meetings are particularly important before the dry season, when water in the reservoirs can serve only a portion of the total service area. CTF staff projections indicate that, on average, 40 percent of the service area in NESSI sites will be irrigated during the dry season. Cropped area may be far lower during an unusually dry season, as it was last year in Huai Khilek when only 10 percent of the total service area could be irrigated. Interviews with farmers suggested that many would not grow dry season crops because of off-farm employment opportunities, or because they lack confidence in the water reliability in their chaek or anticipate problems with marketing dry season crops.

At the beginning of each dry season, the RID zoneman and his gate keepers and canal keepers formally survey each farmer to determine interest in growing a dry season crop. At that time, the surveyors question the farmers about preferred crop type and area. Following the survey, the zoneman tabulates the data and reports his findings to the chiefs of the O&M unit (formerly water master) and the provincial irrigation project. If the expressed demand to grow dry season crops exceeds the available water supply, farmers are selected who agree to grow the crop promoted by the RID or crops that consume less water: dry season rice is always discouraged. In 1988-89, Huai Aeng and Huai Khilek both wanted more water than was available. Huai Aeng's dry season crop survey, for example, indicated that farmers wanted to cultivate 1,822 rai; however, water was available for only 831.

Table 8

Farmer Contributions for O&M at Three NESSI Sites
1988-89

Contribution	Huai Aeng	Huai Khilek	Huai Chorakhe Mak[1]
Average O&M fee (baht)	23.7	6.4	0
No. farmers	100	56	0
Average no. days labor	5.2	2.6	2.4
No. farmers	95	99	83
Cash in O&M Bank Account as of 5/89	26,082	7,443	

[1] Due to water shortages and incomplete on-farm ditches, O&M fees have not been collected yet.

Source: Applied Study team field survey

When the water supply is less than required, the zoneman tries to concentrate dry season cropping in certain selected areas in the site. Concentration is often done by persuading a landowner near a main canal to permit other farmers to cultivate portions of his land, so that the irrigated plots are contiguous. Although the farmers do not pay him for the use of his land, the landholder does gain a residual benefit from the fertilizer they apply. However, farmers do not like to use their inputs on another's land and do so reluctantly.

In mid-March of each year, shortly before or after the dry season harvest, RID's zoneman meets with farmers. The meeting may be confined to a single chaek group but more often includes farmers from a number of groups. The zoneman discusses gate closing at the end of the dry season, maintenance scheduling for the chaek group to mobilize labor, water delivery scheduling during the wet season, and problems with dry season cropping that year. Sometimes WUA officials will attend these meetings and describe a recent observation tour, made through the project, to another Northeast irrigated area.

Water Users Associations

All the sites have reactivated their WUAs, usually by first creating chaek groups linked to an administrative committee. At some of the sites, the committee members are those who served on it before NESSI. Meetings of the administrative committee are held occasionally, rather than monthly as designed. Policing committees, a NESSI innovation, have failed to materialize: no such committee has been formed at any site. RID project staff believe that WUAs have not yet reached a level of organization that warrants a policing committee or position. Nor has the position of field investigator been filled in any of the chaek groups; in practice, chaek leaders investigate violations of rules and regulations.

At one NESSI site, the WUA has begun to take on marketing functions. Farmers in Huai Khilek marketed their tomatoes in 1989, with WUA assistance. However, Huai Khilek is atypical of the NESSI sites because it is situated in a Land Settlement Scheme, which is under the Department of Public Welfare (DPW). Department staff arranged for an agent from a King's project processing plant in Sakon Nakhon to visit Huai Khilek and contract with farmers. The WUA administrative committee then assisted with the sale and transportation. Although the WUA was able to build upon DPW arrangements in this instance, it is unlikely that the association could have provided the marketing assistance on its own. DPW staff have already assigned the WUA administrative committee responsibility for determining farmer interest in growing a dry season crop in 1989-90. The committee is expected to visit farmers three times to assure survey reliability and then give the results to DPW for workplan preparation. (RID staff conducts this survey in the other NESSI sites.) DPW provides seed and fertilizer to farmers through Huai Khilek's WUA. Last year, the WUA was selected as the best performing WUA in RID Region V and placed in national competition for a special award (Appendix E).

Probably the most important formal interaction between water users and RTG officers takes place monthly, in the field working group meetings. The meeting is attended by the O&M unit chief and zoneman from RID, the district officer and field extension worker from DOAE, other line agency officers, and the president and other officers of the WUA. Each reports monthly progress and discusses new or ongoing problems. Field working group meetings provide a regular opportunity for the WUA president to present problems the WUA faces and seek solutions from those attending.

3.2.4 Impact on Women

Two factors appear to have affected the role women play in crop production and on- and off-farm income-generating activities: site rehabilitation, leading to a better water supply for dry season cropping, and the burgeoning market and processing systems of the Northeast. During the last five years, the number of females hired for dry season activities has increased in two of the three study sites. Unfortunately, 1988/89 was a dry year and, consequently, dry season production was seriously reduced. However, from field observations it is clear that the bulk of dry season agricultural activities are managed and operated by women. In contrast to the practice in many countries, men and women in Thailand play similar roles in agricultural production and generally receive the same daily wage (Table 9).

Table 9

A Comparison of On-Farm Household/Hired Labor and Wages for Men and Women in the Applied Study Sites

Labor and Wages of Men and Women	Huai Aeng	Huai Khilek	Huai Chorakhe Mak
Household labor/adult men	2.5	2.5	2.0
Household labor/adult women	2.3	2.4	2.3
Household labor/male children	1.5	1.6	1.5
Household labor/female children	1.3	1.9	1.4
Wet season hired labor/adult men	9	5	5
Wet season hired labor/adult women	10	3	13
Dry season hired labor/adult men	2	3	6
Dry season hired labor/adult women	3	6	3
Wages (baht/day)/adult men	35	32	30
Wages (baht/day)/adult women	35	34	30
Total males hired/5 yrs. ago	223	100	361
Total males hired/currently	243	40	542
Total females hired/5 yrs. ago	256	80	424
Total females hired/currently	225	111	1032

Source: Applied Study team survey of roughly 100 water users in each site.

Off-farm employment in Northeast processing plants is a new and significant source of income for women. In the sites studied, three large plants and a number of smaller ones employ women to prepare fresh produce for processing and canning and to work on the assembly line. At the Universe Food Co. plant in Roi Et, 250 women of all ages clean baby corn. They are paid by the kilogram and work on a flexible schedule, often coming to work after the children leave for school. Universe Food also employs over 600 women on the assembly line for 60 baht/day, roughly twice the daily rate for agricultural labor. In Yasothon, 160 work at the Boon Siri Food Cannery, and in Sakon, approximately 70 percent of the 400 employees at Nakhon Royal Project Food Products are women. Five plants in Nakon Ratchasima employ women in smaller numbers to shell groundnuts, prepare chili powder, and make soybean and corn cakes (Table F-1).

3.2.5 Water User Leadership and Technical Training

Training for water users has focused exclusively on WUA officers and chack group leaders. Every year, before wet season cropping, a one-day program has been scheduled for 100 to 200 chack group leaders from the sites. Training emphasized technical information—O&M, fish ponds, soil improvement, livestock, and crop production—which participants were expected to share with group members. In June 1988, a three-day leadership workshop was held for WUA and chack group officers from all seven sites. The program, for 49 participants, included 90-minute sessions on public speaking, conducting meetings, group relations, leadership development, role playing for problem-solving, bookkeeping, and marketing principles. Training material was largely presented by lecture, and even problem-solving was more theoretical than practical. There was no attempt to deal with ongoing or recurrent problems, nor was there any follow-up with participants.

3.2.6 Water Users Group Sustainability

Project implementation to date indicates that both the availability and reliability of the system's water are preconditions for water user group viability. Water shortages in both wet and dry seasons occur regularly in the NESSI sites, as well as in much of the Northeast. In areas that receive a relatively sufficient water supply, chack groups show the greatest member involvement and activity. In Huai Aeng, it was observed that chack groups with adequate dry season water set a schedule for water delivery on the chack and followed it, participated more in maintenance activities, paid the O&M fee, decreased conflict considerably, and seemed to have

no problems with members violating rules and regulations

However, evidence from project sites suggests that in areas either of severe and regular water shortage or of overabundance, attempts to organize viable chack groups are largely futile. Organizational inputs cannot replace water supply. For example, in a bad section of Huai Aeng's left main canal (LMC), where flooding is frequent and attempts at dry season farming have been unsuccessful, chack groups are largely inactive. Their leaders attended no WUA meetings, no O&M fees are collected, and members argue frequently with RID officers about which crops to grow in the dry season.

Although vital, an adequate and dependable water supply does not in itself ensure the viability of the group. For the group to succeed, its members must first feel a sense of ownership. Unfortunately, the method used by NESSI staff to organize farmers has done little to instill a sense of shared purpose among chack group members. RID staff allow virtually no lead time for farmers to organize and select a leader; instead, RID presents the farmers with rules and regulations for a chack group, rules the farmers may not fully understand. The farmers are first contacted by construction teams shortly before construction begins, then by RTG officers shortly before it ends. But at no time are the farmers given a role, even advisory, in the construction work itself. Although occasional changes are made in design or construction, based upon farmer requests, the irrigation canal system is usually presented to farmers as a completed package. RID then tells the farmers that the on-farm system belongs to water users, who should assume a sense of ownership and responsibility for it. Yet the way systems are now rehabilitated and operated makes farmers unlikely to develop a strong sense of ownership of even the on-farm system.

Further undermining organizing efforts is the shortness of vision of line agency field staff. Although concentrated efforts have been made to form water users groups at different levels, from farm ditch to the entire site, the full potential of these groups appears to go unrecognized. Greater O&M participation should not be the sole goal for group formation. Project activities also need to address long-term goals, such as improving crop production and increasing farmer incomes. With little agricultural extension and even less marketing support, water users have not been encouraged to expand their organizational role beyond water inputs and the related irrigation management requirements.

3.2.7 Another Approach to Organizing Water Users in Northeast Medium-Scale Irrigation Systems

In 1985, with partial funding from the A.I.D. Water Management Synthesis II Project, RID introduced an alternative approach to organizing water users: the Farmer Participation in Irrigation Project (FPIP). Funding for the project was later picked up by the Ford Foundation. Until recently, FPIP was implemented at five sites, including two NESSI project areas, Lam Chamuak and Huai Khilek. The first FPIP site, Lam Chamuak, was selected because rehabilitation was more than a year away. FPIP focuses on three elements:

- working with farmers during the preconstruction period and continuing through completion to system operation;
- employing "process documentation" to record the actions and events stemming from project implementation; and
- institutionalizing a "learning process" in RID to improve the rehabilitation and management processes through increased farmer participation.

The key vehicle for FPIP implementation is irrigation community organizers (ICOs), social science and education graduates who, after training, live in the project area. Use of ICOs is an adaptation of the approach first developed in the Philippines by the National Irrigation Administration (NIA). Initially, ICOs were assigned to work with roughly 150 water users in chacks along a stretch of the main canal, but the ratio has now changed to one ICO per 200 to 250 farmers. ICOs stay in an area for at least two cropping seasons.

The ICO's first responsibilities are to compile a list of water users in the chacks, meet many of them informally and individually, discuss his/her reasons for living in the area, and elicit the names of potential group leaders. Within a month, the ICO requests a first meeting of the chack members. A second meeting is chaired by a leader chosen by member consensus. During that and subsequent meetings, discussions of real and potential water use problems lead to an identification of mutually agreed-to rules and penalties, and members sign their names to a codified list. Farmers also formally agree to cede land for farm ditch construction. The different chack groups vary somewhat in the definition of these rules; however, the formulation of rules has been an effective group-building activity.

Lead time, which at Lam Chamuak was more than nine months, has now shortened to four to six months, a period considered adequate for initial organizing activities.

During the design phase, ICOs work with farmers in reviewing plans and then convey the water users' reactions to the site engineers (i.e., requests for changes in turnout location and farm ditch direction, or for additional drain culverts). During construction, ICOs meet repeatedly with each chack group to update the work schedule and attempt to resolve problems over compensation for ceded construction land. During the O&M phase of the system, ICOs meet with chack groups to discuss water delivery plans, encourage the groups to clean the main and farm ditches before each cropping season, monitor the rotation, and help zonemen carry out a survey to determine farmer interest in growing dry season crops.

The approach has shown these strengths:

- farmer preference for ICO participation;
- more-realistic feedback of project activities, leading to a smoother implementation;
- decreased conflict as farmers organized and understood their roles and responsibilities in the system; and
- increased interest among water users in dry season cropping due to ICO support.

However, this approach requires an understanding and commitment by concerned line agency staff, who are not always interested in the approach and are not encouraged by their superiors to take part. As a result, ICOs are sometimes assigned technical responsibilities that take them away from their organizing duties.

3.2.8 A Summary of NESSI Implementation Strengths and Weaknesses

In summary, based on the relatively short period of NESSI attempts to organize chack groups and revitalize WUAs at project sites, a number of strengths and weaknesses are apparent in the NESSI implementation process.

Strengths

- Project staff are beginning to use a more systematic approach toward organizing water user groups.
- Farmers participate in monthly field working group meetings.
- Chack size has been reduced.
- On the chack, farmers participate more in water allocation and scheduling, with their role not limited to maintenance alone.
- A water delivery board has been installed at the head of each farm ditch to help farmers with rotation monitoring.
- Inter- and intrachack conflicts over water use have decreased.
- WUAs have reactivated, with regular meetings and a degree of accountability to members.
- An O&M fee is collected from WUA members for the association's use.

Weaknesses

- Virtually no lead time is devoted to preparing farmers to understand the NESSI approach and to organize them into chack groups.
- Line agency staff lack a clear understanding of the rationale behind the NESSI concept.
- Water users are excluded from playing a role both before and during rehabilitation.
- Chack groups or WUAs are not encouraged to play a larger role in marketing and technology transfer.
- Involvement in operation is largely limited to the farm ditch, with no substantive role in allocating or scheduling water in the main ditch and main canal.
- Training programs have ignored chack group members who are not officers or who are women.

- Training has focused on WUA and chack group leaders but has not provided necessary management skills in a practical context.

- No monitoring of water users group implementation or experimentation with different approaches has occurred, as was called for in the project design.

- Line agencies lack vision concerning future roles and approaches to further strengthen chack groups and WUAs; thus, these groups rarely look beyond water inputs.

On the whole, NESSI has made a positive contribution to farmer participation in water management. In a relatively short four-year period, NESSI formed chack groups and revived WUAs at all seven sites. Hundreds of chack groups are now playing some direct role in on-farm system O&M, becoming involved in decisions about water delivery in farm ditches, and contributing labor and cash for maintenance. WUAs have been reactivated and appear to be overseeing site activities, while offering a degree of accountability to members. RTG officials now meet regularly with farmers and include them in decision making concerning water scheduling in the farm ditch and dry season cropping.

However, as NESSI moves toward project completion, shortcomings in the approach are apparent. Farmer participation in operation has been restricted to the on-farm system, and largely to the farm ditch. A more substantive role requires that farmers be involved in water-delivery decisions throughout the system, from the main canal to farmers' fields. Nor should farmer participation and improved water management be ends in themselves. NESSI's objectives were to improve agricultural production and increase incomes for farmers in the Northeast; however, the project has yet to develop an approach that reaches beyond a water management focus. To achieve its original goals, the project will need an effective system for technology transfer through a public extension program, and production/marketing support with sustained private-sector participation.

3.3 Extension Program

One of NESSI's innovative aspects was an approach that envisioned a management role for the Department of Agricultural Extension that nearly equaled RID's. NESSI's design was developed recognizing that a major problem with Northeast irrigation systems was a lack of coordination among RTG agencies. As indicated in the institutional section, NESSI organization relied heavily on coordination committees at the national and provincial level and working groups at the site level. Working groups have proven successful in resolving local problems and stimulating interagency cooperation. This section assesses DOAE actions in the project and identifies positive and negative findings related to the design and implementation of NESSI agricultural extension efforts.

3.3.1 DOAE Role in NESSI Management

The NESSI Coordinating Subcommittee, chaired by a Deputy Permanent Secretary of Agriculture, and representing DOAE, RID, DOA, DLD, CDD, BAAC, DOF, and DTEC, has proven to work quite well. The secretary represents the Project Division of MOAC, with NESSI's project manager serving as assistant secretary. At the provincial level, a monthly meeting, chaired by the governor, reviews the progress of all projects. In contrast to the separate provincial-level NESSI committee proposed originally, the provincial monthly meeting has served a coordinating role.

NESSI's original design included full-time project co-managers to be stationed in Khon Kaen (at Tha Phra). At each site location a team with co-managers, the RID engineer, and a DOAE subject matter specialist was to be formed. DOAE never filled the full-time project co-manager position, nor were DOAE co-managers appointed at any of the sites. However, DOAE's Planning and Special Projects Division has taken responsibility for activities that occur in all sites, and activities specific to each are managed by provincial- or district-level extension offices. At the site level, field working committees, which include district extension officers and RID water masters, have evolved into an effective management entity. The effectiveness of these groups varies from site to site, but in the three sites studied, they meet on a monthly basis and play an active role in project planning and implementation.

Expatriate agricultural extension technical assistance was provided under the original contract, but as with the marketing specialist, it was scheduled too early in the project to be available when actually needed. Planning of extension activities has become the responsibility of the local DOAE staff, supplemented by special staffing and Bangkok-based staff from the Planning and Special Projects Division.

3.3.2 DOAE Project Special Staffing

NESSI funds were used to hire two extension workers for each site: one had a B.Sc. in agriculture, the other a diploma in agriculture. In Huai Aeng, an additional diploma holder was recruited for a pilot area that policy makers wanted to make into a model. These NESSI extension workers helped the subdistrict extension agents with their field activities in the NESSI area. When not busy in the project, NESSI extension agents worked in the provincial offices carrying out assignments for provincial agricultural officers. Subdistrict extension agents complained that, at times, NESSI extension agents spent too much time in the provincial offices and too little time in the field. This problem was partially caused by the lack of available housing in the project area, but it reflected a continuing problem: attracting and keeping well trained extension personnel in the field.

Even with additional staff, subdistrict agricultural agents were responsible for approximately 1,000 families. With other duties outside the irrigated areas and routine administrative activities, local extension staff in the NESSI sites were too understaffed to address the complex technology transfer, production, and marketing extension requirements of multiple-cropped, irrigated agriculture.

3.3.3 DOAE Project Activities

Although more emphasis was placed on production due to the project's additional budgetary funds, NESSI extension activities included a number of traditional extension programs used in other areas of the country:

Trial plots. Crops that DOAE wished to test in the area were planted in trial plots at the various sites. These plots were usually planned by DOAE subject matter specialists and managed by local project staff. The area covered by trial plots of field crops was very small. In Huai Aeng, eight rai of peanuts and three rai of mungbeans were planted for 1983-85; in Huai Khilek, 12 rai of peanuts and 2 rai of mulberry were planted during the same period. Rice acreage in trial plots was much greater, but it was the non-rice crops during the dry season that needed to be promoted. Extension workers' lack of experience caused problems with trial plots, as did input shortages.

Demonstration plots. Planned by DOAE staff, demonstration plots are cultivated by local farmers according to DOAE recommendations and inputs. Budgetary delays and insufficient labor to follow complicated crop management practices often resulted in lower than predicted yields. Water shortages and pest problems also caused low yields, as well as damaged crops. While more rai were planted in demonstration plots than in trial plots (56 rai of non-rice crops in Huai Aeng in 1983, 1984, and 1985), there still were insufficient plots to serve a real demonstration role.

Cropping system and double cropping trials. New practices, such as peanut/rice/corn systems, were also introduced into the project for field testing. Cropping system studies were designed to identify crops suitable for the area, with farmer income rather than maximum yields the main criterion for adoption. Double cropping, such as corn and chilies or corn and watermelon, was also tried in the NESSI sites. Farmers were hesitant to adopt these complex systems because they required additional time and labor. The area planted for cropping systems trials was very small, no more than one or two rai per site.

Field days. Staff attempted to hold field days at each site to pass new information to farmers. These gatherings were usually held in conjunction with demonstration or trial plots of a single crop and were often "opened" by the chief of the district or another influential official. Given the staff time required to organize them, and their cost, generally no more than one annual field day was held in each site. Field days reached only a small number of farmers.

Field trips. At project inception, field trips were made quite frequently, but the number of trips has been reduced during the last few years. Generally, the trips were to such areas as Lam Nam Oon or Nam Pong project sites, where dry season crops were being promoted. The four-day field trips normally included about 30 people, most often chaek leaders or other important individuals at the different sites.

Farmer training. Under NESSI, RID and DOAE staff conducted a number of training courses for farmers, zonemen, subdistrict extension staff, farm leaders, and WUA officers. Table 10 details the variety of courses and number of trainees.

Table 10

NESSI Training Course, 1983-1988

Type of Training Course	No. of Annual Participants YEAR					
	1983	1984	1985	1986	1987	1988
Farmer Training		240	240			400[2]
Field Worker			40			
Chaek Leader OFWM[3]						300
O&M Staff Training	11					
Orientation of chaek groups	**					
Chaek Group Leadership Training		66				45
RTG[1] Orientation Workshop		30				
Training of Trainers		5				
Zonemen Training		17				
Subdistrict Ext. Agent, SMS			**	30		
Farmer Marketing Training				210		
Farmer Leader Training				540		
O&M Participation Planning					34	
O&M in Northeast Training					35	

[1] RTG members of the Field Working Group
[2] Farmer training on O&M
[3] OFWM On-farm water management
** Data not available

Monitoring and Evaluation. The team could find no studies concerning the effectiveness of the extension methods. Technology transfer techniques, communications, and media methods used by DOAE staff have not been evaluated in any systematic way, which appears to be a major weakness in the original design. Each wet and dry season, DOAE carried out farm surveys at the sites. Data about increased yields and improved production practices did provide indirect evaluations of the extension activities, but this approach does not clearly define cause-and-effect relationships. At the field working group level, an informal evaluation of agricultural activities was made through presentations and discussions by involved parties, but this approach cannot replace a formal evaluation.

3.3.4 Extension Problems and Assessment

Extension agents identified their main problems as too much routine work, lack of knowledge and experience concerning irrigated agriculture, limited funds, and too large an area of responsibility. RID field staff indicated similar problems: deficiencies in the quantity of required inputs, lack of knowledge and experience, in addition to a shortage of field staff. Both groups placed highest priority on increasing the number of field staff assigned to work locally with their respective agencies.

During the project, many DOAE field extension workers attended no training courses. Of the 12 extension workers interviewed, 5 were trained by KKU staff on area analysis at the seven sites. Following their training, the agents carried out applied agro-ecosystem studies at their sites, although only two had ever received training in irrigated agriculture. In contrast, 8 of 17 RID staff surveyed had attended a training course on system O&M. One RID staff member from each site also attended a course on cooperating with water users groups. Two staff from Huai Aeng attended the irrigated agriculture course, and one from Huai Chorakhe Mak attended the course on project management.

Due to numerous constraints, NESSI's agricultural extension component did not realize many of its goals. A reliance on traditional extension techniques hampered its activities. The few demonstrations and trials held were limited in scope, with their success depending upon factors often outside the extension worker's control. Extension workers who were responsible for promoting dry season cropping suffered from a lack of experience in growing non-rice crops. During NESSI's early years, the private sector was still in a formative stage in the Northeast; thus, it was only marginally involved in extension, usually providing information about market demands rather than playing a technical role[3]. Extension did not provide the leadership role envisioned in the original project design, nor has it responded to the rapidly changing economic climate and the demands thus created.

3.4 Marketing

Increased dry season production and market development were to be major thrusts of the NESSI Project. The following section assesses marketing approaches used by NESSI, describes existing marketing and procurement systems in project areas, and identifies persistent marketing problems that have implications for future development efforts.

3.4.1 NESSI's Design and Approach to Marketing

In the late 1970s, when NESSI was designed, the primary crops sold by farmers in the Applied Study sites were rice (glutinous and nonglutinous), kenaf, cassava, sugarcane, Turkish tobacco, watermelon, peanuts, and various vegetables. Crops such as rice, sugarcane, kenaf, and cassava use the monsoon as a primary source of moisture and are not normally irrigated in the Northeast. Turkish tobacco, peanuts, watermelons, and the various vegetables grown were relatively drought tolerant and could survive on a nominal amount of supplemental irrigation water. Today's high-value cash crops, such as baby corn, tomatoes, supersweet corn, and oil seed crops (with the exception of peanuts), were generally grown only in small areas and primarily for local consumption. Even when grown for home consumption, yields were very poor and, combined with limited secure water supplies and local market opportunities, did not offer strong encouragement for expanding production of the higher-value, irrigated non-rice crops.

Given these circumstances at NESSI's initiation, project staff tried in 1982 to facilitate marketing opportunities and identify crops well suited to the various sites. Consequently, in 1983, 1984, and 1985, DOAE field staff implemented a set of crop tests to identify appropriate irrigated crops (including rice) to recommend. Results were very mixed, with different crops doing well at different locations. Since the crop tests were not replicated, it was impossible to make proper statistical comparisons across the test sites. Mungbeans and sweet corn were the only new crops found to be favorable in the tests.

Unfortunately, the test results were not linked to any marketing criteria, and recommendations for an area's new crops were based only on possible yields—not necessarily a sufficient criterion. For example, based on DOAE staff recommendations, farmers at Huai Aeng planted baby corn. But by the time they harvested the crop, the canning factory that had offered to buy the crop was closed. Farmers were then forced to sell their baby corn as a fresh vegetable on the local market, at a lower price.

NESSI staff approached marketing by first trying to establish demand for crops at local, regional, national, and international levels. They also collected information on price trends and fluctuations. These activities were carried out by relatively junior DOAE staff under the Planning and Special Projects Division. As part of this process, local merchants and related government officers at the sites were interviewed to develop preliminary ideas about market structure, and attempts were made to organize village-level farmer cooperative centers. CTF and DOAE staff also approached BAAC officials at the NESSI sites to ensure credit would be available for dry season crops.

In August 1984, CTF proposed and the project accepted that within each village a marketing unit would be organized to buy and sell on behalf of the people. This organization was to be totally independent of the WUAs. The expatriate marketing specialist spent his last four months of service promoting village co-op marketing centers, but there is no record of this approach being adopted at any NESSI site.

Table 11

Estimated Daily Flow of Vegetables Supplied to Potential NESSI Markets (1984)

Site	Potential Market (tons)	Source of Supplies: Local (tons)	Source of Supplies: Other Markets (tons)	Total
Huai Aeng	Roi Et	8	14	22
	Mahasarakham	6	8	14
	Khon Kaen	11	72	83
Huai Kaeng	Kalasin	6	9	15
	Khon Kaen	11	72	83
Huai Khilek	Mukdahan	5	5	10
	Loeng Nok Tha	-	1	1
Phuttha Utthayan	Amnatcharoen	2	4	6
	Yasothon	2	10	12
	Ubon Ratchathani	11	30	41
Huai Talat	Buri Ram	3[1]	12[1]	15[1]
Huai Chorakhe Mak Lam Chamuak	Pimai	-	4	4
	Nakhon Ratchasima	105	294	399

Source: Special Report on Marketing, The Northeast Small Scale Irrigation Project. Bangkok: Parsons-Team, CTF, September 1985.

[1] Combined for both reservoirs.

Various NESSI marketing studies revealed that most vegetables produced in the sites were sold to local markets in provincial and district towns. Since the volume of vegetables demanded at nearby local markets is limited, NESSI staff examined the two regional wholesale vegetable markets at Nakhon Ratchasima and Khon Kaen. In 1984, the daily volume of vegetable trade at Nakhon Ratchasima wholesale market was approximately 300-550 tons. During the same period, the flow of vegetables through Khon Kaen market was less than 100 tons. Local markets near the NESSI sites draw on these markets and, thus, vegetables from NESSI sites must compete with supplies from the regional markets. Table 11 shows the flow of vegetables into potential local markets as estimated by NESSI staff prior to the 1984 dry season. In terms of location and market access, this table indicates that in 1984, Huai Aeng, Huai Kaeng, Lam Chamuak, and Phuttha Utthayan offered the best opportunity for expanding dry season vegetable production.

3.4.2 Expansion of Processing Plants and Vegetable Markets in Northeast Thailand

Before 1985, there were 47 processing plants in the Northeast. The more important processing industries, in term of production capacity, were tomato paste, baby corn, and shelled groundnuts. During 1985-89, nine new processing plants, including three food canneries, one frozen food company, one tomato paste factory, and four vegetable preserving factories, were established in Roi Et, Yasothon, Khon Kaen, Nong Khai, and Nakhon Ratchasima. During this period, production capacity of baby corn and tomato increased at least 16,000 and 18,000 tons per annum, respectively. In addition, demand for other vegetables as raw materials for freezing and preserving increased more than 15,000 tons a year. In 1990, two large-scale processing plants will be established to produce chili sauce and powder and soybean oil in Ubon Ratchathani and Kalasin (see Table 12).

Table 12

Types and Total Number of Processing Plants by Years in Northeast Thailand

Types of Processing Plants	Before 1985	During 1985-1989	In 1990
Food canneries	4	7[1]	7
Groundnut shelling plants	27	27	27
Frozen food companies	1	2[2]	2
Tomato paste factories	4	5[3]	5
Chili processing plants	2	2	3[5]
Ginger powder factories	1	1	1
Vegetable preserving factories	8	12[4]	12
Mungbean milling plants	1	1	1
Vegetable oil factories	-	-	1[5]
Total	48	57	59

[1] Production capacity of baby corn increased more than 16,000 tons/year, and tomato over 18,000 ton/year.
[2] Capacity increased more than 10,000 tons/year.
[3] Production capacity increased more than 50,000 tons/year.
[4] Production capacity increased more than 15,000 tons/year.
[5] Data are not available.

The number of provincial and regional wholesale markets for fresh vegetables in the Northeast has not changed significantly during the last decade, but the volume of vegetables traded in the markets has increased due to production expansion and population growth. Likewise, the region's structure of provincial wholesalers for oil crops remains largely the same as in the early 1980s, because of difficulties new firms face entering the industry. Growth of the oil seeds market has occurred more from the expansion of existing firms than from new firms entering into the area.

3.4.3 Market Organization in the NESSI Project Areas

In the Northeast, eight different types of facilities provide at least preliminary processing of agricultural products:

- food canneries,
- groundnut shelling plants,
- frozen food companies,
- tomato paste factories,
- chili processing plants,
- ginger powder factories,
- vegetable preserving factories, and
- mungbean milling plants.

Vegetable Processing

In NESSI sites, food canneries and tomato paste factories are the most important in terms of production capacity, capital investment, employment levels, and amount of business with farmers.

The food canneries are of two types: private investment companies and Royal projects. As of early 1989, five privately owned food canning companies were located in or near the cities of Roi Et, Yasothon, Khon Kaen, Nakhon Ratchasima, and Nong Khai. In addition, two Royal project food processing plants are located in Sakon Nakhon and Buri Ram. These seven companies have a total production capacity of over 20,000 tons per year for baby corn and tomatoes. There are also 27 groundnut shelling plants: 2 in Surin, 4 in Ubon Ratchathani, 6 in Si Sa Ket, 1 in Udon Thani, 3 in Kalasin, 11 eleven in Nakhon Ratchasima. The groundnut processing plants in Kalasin are relatively large operations, with a production capacity in excess of 50 tons a day.

Five tomato paste factories are in Nong Khai, and Nakhon Ratchasima has a frozen food company (the only one in the region). All of these plants require tomatoes as a raw material. Operating more than 100 days per annum, the plants can process about 1,700 tons of tomatoes per day. Other fruits and vegetables for freezing are also required, making their volume roughly 2,000 tons of produce per day. Factories in Chum Phae (Khon Kaen province) can process over 10 tons of salted mushrooms daily. Finally, a new processing industry of chili sauce and chili powder will start operation under the Chamber of Commerce in Ubon Ratchathani in 1990. This plant is designed to meet the demand for chili products, which is expected to increase rapidly in the near future. Table F-1 and Figure F-1 show the type, number, location, production capacity, and labor use of these processing plants.

Agribusiness Oil Seed Firms

Privately owned provincial wholesalers are the major agribusiness firms involved in marketing oil crops such as soybeans, groundnuts, and mungbeans. They are found in every province of the region, with the largest concentrations in the major marketing centers in Nakhon Ratchasima, Khon Kaen, Ubon Ratchathani, Surin, Buri Ram, Si Sa Ket, and Yasothon. Through their local sales offices, many wholesalers purchase the crops directly from the farmers. The Department of Agriculture's Centers for Propagation have been another important purchaser of oil seeds. These centers are located in 8 of the 17 Northeast provinces (Roi Et, Kalasin, Khon Kaen, Nakhon Ratchasima, Surin, Ubon Ratchathani, Sakon Nakhon, and Udon Thani). Table F-2 and Figure F-2 give the names and locations of oil wholesalers.

The major entities purchasing oil seed crops from farmers in Huai Aeng, Huai Khilek, and Huai Chorakhe Mak are the Centers for Propagation in Surin, Roi Et and Kalasin. A private agribusiness firm in Nakhon Ratchasima (Bangkok), Charoen Phokaphan Produce, Co., Ltd., is also a large purchaser. Provincial wholesalers, however, account for only a small part of the amount purchased from NESSI farmers.

Marketing Centers for Fresh Vegetables

The Northeast has 31 wholesale vegetable markets, at least one or two in every province. These markets can be classed as either provincial or regional. Regional markets are centers for vegetables from several provinces. From regional markets, vegetable distribution moves to the national market in Bangkok. Chum Phol and Prapa markets in Nakhon Ratchasima are the Northeast's main regional vegetable markets; the rest are provincial markets that distribute vegetables to the regional wholesale market and to the nearby provinces. Table F-3 and Figure F-3 give the names and locations of the fresh vegetable wholesale markets.

Because of their low level of vegetable production and the distance to the markets for their perishable crops, farmers in NESSI areas in Roi Et, Mukdahan, and Buri Ram do not usually sell to wholesale merchants. Field survey data indicate that about 81 percent of vegetables in the Applied Study sites were sold to buyers at wholesale markets and roadside booths. The remainder was sold on-farm to local dealers.

Market Agents for Seeds Production

Two kinds of market agents sell commercial seed for planting: private seed merchants and DOA Centers for Propagation. Most seed merchants are in Khon Kaen, Nakhon Ratchasima, and Sakon Nakhon. Major seed merchants (detailed in Table F-4) deal largely in seeds for corn, tomato, cantaloupe, bottle gourd, watermelon, and other vegetables, and seeds for oil crops. Centers for Propagation usually contract farmers to produce such oil seeds as soybean, groundnut, and mungbean. Seeds produced under contract are used only for breeding and production expansion to the other areas. Generally, propagation centers have a quality/price schedule that encourage farmers to harvest when quality is at its peak.

In addition to seed merchants and the Centers for Propagation, seed companies in Bangkok, Saraburi, and Chiang Mai province have also entered the Northeast to play an important role in the seed market. Additional companies entering the market have stimulated competition in the region. At NESSI project sites of Huai Aeng, Huai Khilek, and Huai Chorakhe Mak, farmers produced tomato seeds under contract solely for merchants from Khon Kaen, and grew soybeans and peanuts for the Centers for Propagation in Surin, Roi Et, and Kalasin.

Procurement Systems in the NESSI Applied Study Sites

In NESSI areas, there are two types of procurement systems for producing and marketing crops: procurement for the spot (current) market and procurement by contracts.

In the spot market, crops are traded for immediate delivery. Most mungbeans grown at the NESSI site in Buri Ram and peanuts produced in Roi Et and Mukdahan are sold on the spot market. Likewise, all mushrooms and vegetables, other than baby corn and tomatoes, from study sites are shipped to the spot wholesale market and local retailers.

Two kinds of contracts are used in the NESSI project areas: the production contract and the marketing or procurement contract.

Production contract. A production contract involves the processing plant in the growing process. The processing plant frequently purchases the crop under cultivation and pays the farmer a "compensation" that includes a payment for his land and labor. The farmer's payment often takes the form of a piece-wage, e.g., 100 baht for three working days. Currently, production contracts predominate in the NESSI project area in Roi Et for baby corn and in Nong Khai for tomatoes.

Marketing or procurement contract. A marketing or procurement contract is an agreement between the seller (farmer) and the buyer (a processing plant or a Center for Propagation) covering details of the product, time and nature of delivery, price, and other aspects of exchange (for example, when payment does not take place at the time of delivery). Marketing contracts are very common for baby corn and tomatoes in Roi Et, tomatoes and soybeans in Mukdahan, and groundnuts in Buri Ram. Figures F-4, F-5, and F-6 show additional details of these procurement systems.

Results from the Applied Study field survey reveal that most farmers in the NESSI sites prefer to sell their produce to the contract market in order to assure reasonable prices. In general, farmers themselves do not select the kinds of crops to sell by contract: the processing plant has to offer an agreement to them. Farmers would like to have marketing contracts for crops they know how to produce, as well as for newly introduced crops.

However, contract markets now exist only for baby corn, tomatoes, soybeans, and groundnuts. Other agricultural products produced in the study sites are marketed mostly through the spot market. Table 13 presents a comparison of prices received in the spot market and under market contracts for selected crops in 1988. From this table, it is apparent that contract prices are consistently slightly higher than spot prices.

Table 13

Farm Prices of Selected Crops on Spot and Contract Markets
NESSI Applied Study Areas, 1988 (baht/kg)

Crops	Contract Market			Spot Market		
	Roi Et	Mukdahan	Buri Ram	Roi Et	Mukdahan	Buri Ram
Baby Corn	2.00			1.80		
Tomatoes	1.30	1.35		1.20	1.20	
Soybeans	7.50	7.00	7.50	7.00	7.00	7.00
Groundnut	8.00		11.00	6.00		8.50
Mungbeans			10.00			8.00

Source: Interviews and Provincial Offices of Commerce

3.4.4 Problems in the Marketing and Procurement System

Field research identified a number of production and marketing problems in the NESSI sites. These problems are not unique to NESSI, but solving them is critical if small to medium reservoirs are to be economically viable in the Northeast. Initially, it was expected that NESSI would be able to solve some of these problems. However, many of them continue to exist, although there has been improvement over time.

Production Problems

Small-scale farms with diversified crops. Little area in the NESSI sites is planted in commercial crops, and there is a tendency for farmers to grow several different non-rice crops, usually in small quantities. As a result, crops are rarely in sufficient supply at the right time to satisfy market requirements. For example, during the dry season of 1988-1989, the area planted with baby corn in Huai Aeng was only 975 rai; its production was less than 1,000 tons. Yet, processing demand for baby corn in the Roi Et markets exceeded the supply over fivefold. In Huai Khilek, the area planted with tomatoes was only 110 rai, producing about 20.4 tons. Fresh tomato processors' demand in Yasothon and Sakon Nakhon, which Huai Khilek supplies, is greater than 11,000 tons a year.

Nonuniformity in the cropping system. Crops grown are still not uniform in variety, planting dates, or time to maturity. This variation affects water use and causes fluctuations in quantity and quality of produce. For example, crop production in Huai Aeng on average varied 20 to 60 percent from one dry season to another. Accordingly, farmers have fewer marketing options, since the wide fluctuations in quantity and harvest timing mean that they cannot transport their produce to the market in volume.

Lack of experience in producing new crops. Local agricultural extension workers and NESSI agriculture staff lack experience in the production of new crops, such as baby corn and tomato. This creates an obstacle to expanded production in the NESSI project areas, even when sufficient water is available.

Marketing Problems

Limited market outlets for farm products. The problem of where to sell their products for reasonable prices is crucial to farmers. At present, sales are mostly limited to nearby processing plants and merchants within an average range of about 100 kilometers. In structural terms, there are many farmers producing one kind of crop and only a few buyers in the market to purchase that crop. Fortunately, even with this situation, a rapidly increasing world market for many of the products farmers can produce in the Northeast keeps prices fairly competitive.

Unspecific marketing contracts. When dealing with processors, farmers tend to enter agreements as individuals, thus sacrificing the leverage they might have if they operated as a group. Marketing contracts signed between individual farmers and processing plants usually lack specific terms concerning the rights and responsibilities of both parties. Contractual terms normally used in NESSI areas, as well as other areas in Thailand, often place farmers at a disadvantage (see Figures F-7 and F-8). Most contracts do not contain penalties for crop damage caused by either party, conditions of payment, payment schedules, and/or schedules for crop delivery. In addition, only two parties sign the contract, the farmer as seller and the processor as buyer. Two plant workers normally witness it, and no one represents the farmer as a friendly witness.

Lack of expertise in marketing. DOAE extension workers and NESSI field staff lack a knowledge of marketing and market structure. Furthermore, WUA and chack group leaders play little or no marketing role and lack experience solving marketing problems that arise. These individuals are more interested in water resource supply and management, which are the focal points for their organizations.

Inefficiencies in market performance. Marketing activities now performed are often inefficient because transportation is arranged by individuals, not by groups; no sorting and grading takes place before the transaction; and no cold storage is provided. Marketing information is not readily disseminated from the important trading centers in the Northeast, and there is an absence of market specialists in the field to advise farmers.

3.4.5 NESSI Marketing Activities

As indicated, NESSI marketing activities were very general and did not address the specific problems faced by farmers in the seven sites. Due to construction delays as a result of the original project's underfunding, the expatriate marketing specialist worked in Thailand before rehabilitation was completed at any of the NESSI sites. Thus, by the time farmers had irrigation and were actually willing to produce enough additional dry season crops to supply expanding market outlets, the marketing specialist had already completed his assignment. As a consequence, just when market development was critically needed, CTF no longer had the technical skills to address market issues. Fortunately, rapid expansion of private food processing facilities in the Northeast, and an explosive demand for non-rice export crops such as baby corn, tomatoes, and sweet corn, has partially overcome these market weaknesses. Much remains to be done, however, to further increase and stabilize agricultural incomes in the NESSI sites.

3.5 Economic Analysis

The Scope of Work calls for reassessing the economic feasibility of a selected subsample of the NESSI sites. One objective of the NESSI Applied Study is to compare the originally estimated 3.41 percent economic rate of return (ERR), from the 1980 Project Paper, with the ERR calculated using data now available. In order to maintain comparability, this analysis uses basically the approach given in the Project Paper; the only change is a substitution of real data in place of the various assumptions.

3.5.1 AIT, USAID, and CTF Economic Analyses

Since the project as originally approved was significantly underfunded, USAID and CTF felt it was necessary to recalculate the 1980 ERRs. This was done for three of the locations in 1983, by both a direct-hire USAID contractor and CTF. Along with the original AIT and Project Paper ERRs, these values are detailed in Table 14. All of the economic calculations used a 12 percent discount factor.

ERRs presented in Table 14 depend upon assumptions related to yield of wet and dry season crops and the area that is cropped during the dry season. Assumptions related to overall project costs are also critical with respect to calculating ERRs.

Table 14

Comparison of AIT, CTF, and USAID Revised ERRs

Site	AIT Feasibility Study	Project Paper 1980[1]	Project Paper, Wet Season Only	CTF Revised 1983	USAID Knapp 1983
Huai Aeng	71	27.79 21.58[2]	21.43	23.10 15.10[3]	27.28 16.92[3]
Huai Kaeng	17	36.02 21.58[2]	14.62	19.70 17.20[3]	
Phuttha Utthayan	26	27.71		24.46 17.30[3]	
Huai Khilek	29	46.85 14.29[2]	10.26		
Huai Chorakhe Mak	11	10.38 7.90[2]			
Huai Talat	23	17.42 9.05[2]			
Huai Lam Chamuak	59	23.55 18.34[2]			

[1] Based on 1978-79 AIT survey data.
[2] Reduced yield of major crops by 20 percent.
[3] Reduced area in dry season crops.

Table 15 presents assumptions used in the various ERR calculations. The differences in the costs assumptions from the original Project Paper and the final costs provided by the Bureau of the Budget (BOB) are striking.

Costs underestimation resulted primarily from AIT's serious misjudgment of the degree of damage in the main canals and the costs of removing the vast amount of accumulated sediment. Of course, as the project was delayed, inflation added an additional burden to the originally estimated costs. Assumptions varied considerably, also, with respect to the area that could be cropped during the wet and dry seasons. For example, the Project Paper assumed 7,800 rai of dry season cropping in Huai Aeng while CTF's revised estimate assumed 15,890 rai. Similarly, for Phuttha Utthayan, the Project Paper planned for 14,000 rai of wet season rice and no dry season crop production, while CTF's revised estimate assumed 22,700 rai of wet season rice and 15,890 rai of dry season cropped area. Providing written documentation of these assumptions helps explain the differences in the ERRs and also facilitates comparison with circumstances that now exist in the different sites.

3.5.2 Bureau of Budget NESSI Economic Analysis

In addition to the ERRs presented in the Project Paper and the revised ERRs developed in 1983, BOB staff developed ERRs for the entire project in 1987, as part of an RTG evaluation. This economic analysis drew on available data, primarily those reported by DOAE, although some assumptions from the original Project Paper were used. Table 15 details the critical assumptions of the Project Paper, USAID, CTF, and BOB economic analyses. Table 16 presents the ERRs calculated by BOB.

BOB found that all of the projects had an economic rate of return greater than 14 percent and, therefore, concluded that all the sites were economically justified. Yield values used by BOB in its study presumably came from data collected in the sites by DOAE staff. However, in some cases it is not readily apparent exactly where all the data, such as total area served in the wet and dry seasons, dry season area in different crops, and yields, were obtained. Assumed yield values for non-rice crops used by BOB in its economic analysis are contained in Table 17. Data used and calculations made in the BOB study are clearly specified, and very detailed tables are provided in the annexes. As a result, the document provides an excellent basis for comparisons.

3.5.3 Applied Study Economic Analysis

Project economic analysis involves a comparison of the future situation "with" the project compared to the situation "without" the project. Not only is it difficult to estimate what production increases will be once a project is completed, it is also difficult to estimate what future yields will be in the absence of the project. As indicated earlier, conditions in Thailand, including agricultural production practices and market opportunities, are changing very rapidly. This means that, even without NESSI, it is very likely that yields for wet season crops would have increased. Since the study team has the gift of hindsight, it is easy to document that rice yields and production in irrigated and non-irrigated areas of the Northeast have increased over the past two decades. In fact, Dr. Ammar Siamwalla[4], a recognized expert on world as well as Thai rice trade, claims that an ever larger percentage of Thailand's exportable surplus rice now comes from the Northeast.

One of the major weaknesses of the previously referenced economic studies is that most of them assumed static yields for the "without" condition and assumed rapid or immediate increase to maximum yields for the "with" situation. In addition, all of the previous economic studies assumed dry season cropped areas that, given the erratic rainfall in the sites, are not possible on an annual basis. The crude method used by AIT to forecast average inflow into the system overestimates the true figure, particularly during the dry years. Similarly, the more sophisticated regression technique used by the CTF also appears to overestimate inflow during the drier years. The engineering section discusses this issue in more detail.

Using actual project data from four of the sites, it is possible to "reestimate" ERRs for those sites. The economic analysis presented here follows the original methodology as closely as possible, to ensure that results presented can be compared to the previous economic analysis. For example, when the benefit/cost (B/C) ratios are calculated, a 12 percent discount rate is used, and the analysis begins with 1982 to ensure comparability.

Table 15

Assumptions Used for Calculating USAID, CTF, and BOB ERRs

Site	Factor Assumed	Project Paper 1980[1]	CTF Revised 1983	USAID Study 1983	BOB Study[3] 1987
Huai Aeng	Wet Area (rai)	19,000	22,700	22,000	20,083
	Dry Area (rai)	7,800	15,890	15,400 2,800[2]	4,762
	With Rice Yld (kg/rai)	530	500	500	470
	w/o Rice Yld (kg/rai)	248	250	250	323
	Costs ('000 B)	36,678,000	84,544,392	93,100,100	90,621,130
Huai Kaeng	Wet Area (rai)	15,000	22,700		10,534
	Dry Area (rai)	10,000	15,890		4,214
	Costs ('000 B)	44,988,000	100,855,000		85,205,331
	With Rice Yld (kg/rai)	454	600		470
	w/o Rice Yld (kg/rai)	238	310		293
Phuttha Utthayan	Wet Area (rai)	14,000	22,700		12,014
	Dry Area (rai)	0	15,890		2,979
	Costs ('000 B)	34,294,000	74,993,000		66,879,407
	With Rice Yld (kg/rai)	506	500		450
	w/o Rice Yld (kg/rai)	257	300		224
Huai Khilek	Wet Area (rai)	9,000			8,632
	Dry Area (rai)	9,000			4,316
	Costs ('000 B)	37,014,000			47,175,412
	With Rice Yld (kg/rai)	490			470
	w/o Rice Yld (kg/rai)	240			277
H.Chorakhe Mak	Wet Area (rai)	14,000			9,065
	Dry Area (rai)	0			3,626
	Costs ('000 B)	26,138,000			57,196,175
	With Rice Yld (kg/rai)	506			635
	w/o Rice Yld (kg/rai)	240			350
Huai Talat	Wet Area (rai)	14,000			15,466
	Dry Area (rai)	6,186			
	Costs ('000 B)	55,602,000			59,743,946
	With Rice Yld (kg/rai)	668			635
	w/o Rice Yld (kg/rai)	339			395
H.Lam Chamuak	Wet Area (rai)	7,000			8,245
	Dry Area (rai)	1,000			3,298
	Costs ('000 B)	29,786,000			51,002,184
	With Rice Yld (kg/rai)	495			635
	w/o Rice Yld (kg/rai)	368			338

[1] Based on 1978-79 AIT survey data.
[2] Assumes 18 percent dry season area cropped.
[3] Based on Bureau of Budget reported data, 1987.

Table 16

ERRs from BOB Economic Analysis

Site	ERR	B/C[1] Ratio	ERR Case 2	B/C Ratio	ERR Case 3	B/C Ratio
Huai Aeng	15.4	1.2:1	13.2	1.1:1	14.0	1.0:1
Huai Kaeng	23.6	2.0:1	20.5	1.7:1	21.7	1.8:1
Phuttha Utthayan	16.9	1.3:1	14.2	1.1:1	15.2	1.2:1
H. Khilek	19.5	1.5:1	16.7	1.3:1	17.8	1.4:1
Chorakhe Mak	15.3	1.2:1	12.9	1.0:1	13.8	1.1:1
Huai Talat	22.4	1.8:1	19.4	1.5:1	20.6	1.6:1
Lam Chamuak	15.4	1.2:1	13.0	1.0:1	13.9	1.1:1
NESSI average	18.5	1.5:1	15.8	1.2:1	16.9	1.3:1

Case 2 Sensitivity analysis assuming construction costs increase 20 percent and benefits decrease 10 percent.
Case 3 Sensitivity analysis assuming benefits decrease 20 percent.
[1] Uses a 13 percent discount rate.

Table 17

Initial and Final Dry Season Crop Yields in NESSI Project Sites Used by BOB for Calculating 1-30 Year Benefits

Site	CROP YIELD (kgs) Sweet Corn[1]	Peanut	Soybeans	Vegetables[2]	Chilis	Mungbeans	Water Melons
Huai Aeng	2,034	202		814			1,800
	4,000	250		1,300			5,500
Huai Kaeng	2,138	185		814			1,800
	4,000	250		1,300			5,500
Huai Khilek	2,688	134		588	162		1,520
	3,300	330		1,300	214		6,000
Chorakhe Mak	3,379	240	124	792		47	
	5,000	310	204	2,500		122	
Phuttha U.	2,688	192		814	106		1,520
	3,300	330		1,300	125		6,000
H. Talat	1,480	246	124	1,480		70	
	5,000	310	204	2,500		122	
Lam Chamuak	733	120	124	1,735		84	
	3,500	240	204	2,500		122	

[1] Ears per rai.
[2] Cucumbers.

Table 18

Factor Values Used for Calculating Applied Study ERRs

Site	Factor Used	Value
Huai Aeng	Wet Area (rai)	21,066
	Dry Area (rai)	3,160 (15%)
	Costs ('000 B)	83,742,683[1]
	After 5 yrs With Rice Yield (kg/rai)	330
	Final With Rice Yield (kg/rai)	480
	Initial w/o Rice Yield (kg/rai)	220
	Final w/o Rice Yield (kg/rai)	320
Huai Khilek	Wet Area (rai)	8,625
	Dry Area (rai)	3,850 (40%)
	Costs ('000 B)	39,632,683[1]
	After 5 yrs With Rice Yield (kg/rai)	340
	Final With Rice Yield (kg/rai)	475
	Initial w/o Rice Yield (kg/rai)	239
	Final w/o Rice Yield (kg/rai)	320
H.Chorakhe Nak	Wet Area (rai)	9,600[2]
	Dry Area (rai)	2,880 (30%)
	Costs ('000 B)	53,129,236[1]
	After 5 yrs With Rice Yield (kg/rai)	450
	Final With Rice Yield (kg/rai)	600
	Initial w/o Rice Yield (kg/rai)	287
	Final w/o Rice Yield (kg/rai)	400
Phuttha Utthayan	Wet Area (rai)	12,014
	Dry Area (rai)	4,806 (20%)
	Costs ('000 B)	66,879,407[3]
	After 5 yrs With Rice Yield (kg/rai)	300
	With Rice Yield (kg/rai)	475
	Initial w/o Rice Yield (kg/rai)	240
	Final w/o Rice Yield (kg/rai)	320

[1] Based on RID costs data.
[2] Assuming completed all on-farm ditches.
[3] Based on Bureau of Budget reported data, 1987.
( ) Best estimate of long-term annual average dry season cropped area as percentage of wet season cropped area.

A comparison of Tables 15 and 18 shows that the assumptions related to area served in the dry season are, in general, much smaller than used in the previous economic studies. This reflects the historical data that clearly indicate initial estimates of dry season cropped area are not sustainable on a year to year basis. In the different sites, assumed area for yearly dry season cropping presented in Table 18 represents the best estimate of "on the average" area that can be cropped. Wet season crop yield assumptions in the two tables are not very different, although the final "without" project yields tend to be higher than those used in the other economic studies. Similarly, it is also important to examine assumptions concerning average yields obtained for non-rice crops; these data are in Table 19.

Table 19

Initial and Final Non-Rice Crop Yields Used in NESSI Applied Study Economic Analysis

Site	CROP YIELD (kgs/rai) Sweet[1] Corn	Peanuts	Soybeans	Vegetables[2]	Chilis	Mung-beans	Water Melons
Huai Aeng							
initial	1,300	180		814			1,000
final	3,000	250		1,150			3,100
H. Khilek							
initial	1,000			588			1,200
final	3,500			975			2,000
Chorakhe Mak							
initial	1,800	180	180			100	1,200
final	3,200	250	240			200	1,800
Phuttha Utthayan							
initial	2,200	180		700			1,400
final	4,000	250		1,150			2,500

[1] Ears per rai.
[2] Usually cucumbers.

Combining data from Tables 18 and 19, economic internal rates of return were calculated for four of the seven NESSI sites. As the previous economic analyses carried out by the different organizations varied in the way farm labor was treated, analysis in Table 20 treats farm labor in two ways. In the first approach, farm labor required in NESSI sites is treated as a production cost; in the second, farm labor opportunities generated are treated as a project benefit. The appropriate approach to use depends upon whether labor in the NESSI sites has sufficient off-farm employment opportunities. If so, the use of this labor in increased agricultural production represents income foregone; if not, the use of this labor represents increased income and therefore is a benefit to farmers in the project area. Given the historical tendency of Northeast farmers to work off-farm during the dry season, this question can easily be argued either way. To minimize debate, and to make the analysis comparable with the previous ERRs, results are presented using both approaches. Tables G-1 through G-4 provide a listing of the 30-year stream of benefits and costs used to calculate the Applied Study ERRs.

From Table 20 it is apparent that two projects, Huai Khilek and Huai Phuttha Utthayan, have ERRs well above 12 percent, while Huai Aeng and Huai Chorakhe Mak have ERRs at or slightly below 12 percent, even considering farm labor as a project benefit. The success of Huai Khilek and Phuttha Utthayan is related to a relatively better dry season water supply in the case of Huai Khilek, and a slightly better dry season water supply combined with a faster adoption rate for dry season cropping in Phuttha Utthayan. Lower ERRs for Chorakhe Mak and Huai Aeng reflect the relative shortage of dry season water in both areas and the delay in completing construction at Chorakhe Mak. The results of the sensitivity analysis show that, for the systems, an increase in dry season cropping of 10 percent[5] of the wet season area and/or a 15 percent decrease in construction costs is required to increase the ERRs to greater than 12 percent.

Table 20
ERRs for NESSI Applied Study
1982 through 2012 (30 Years)

Site	ERR Standard Assumptions	B/C Ratio (12%)	ERR Case 1[1] Assumptions	ERR Case 2[2] Assumptions	ERR Case 3[4] Assumptions
Huai Aeng					
Include labor costs	10.0	0.87:1	11.9	[3]	12.0
Exclude labor costs	12.0	1.03:1	12.4	[3]	15.0
Huai Khilek					
Include labor costs	15.5	1.21:1	17.1	18.8	18.4
Exclude labor costs	17.5	1.35:1	20.3	22.7	21.6
Chorakhe Mak					
Include labor costs	10.5	0.91:1	11.6	13.3	12.9
Exclude labor costs	11.5	0.98:1	13.1	14.7	14.3
Phuttha Utthayan					
Include labor costs	16.5	1.22:1	20.6	26.1	21.4
Exclude labor costs	18.1	1.33:1	24.8	33.7	24.5

[1] Case 1 Assumes increase in dry season area by 5 percent of wet season area, for example, increase Huai Aeng from 15 percent to 20 percent of area.
[2] Case 2 Assumes increase in dry season area by 10 percent of wet season area, for example, increase Huai Khilek from 40 percent to 50 percent of area.
[3] There is not enough secure water to consider case 2 in Huai Aeng.
[4] Case 3 Assumes increased farmer participation and larger chaek size leading to 15 percent reduction in overall construction costs.

3.5.4 Conclusions

Economic analysis, using actual project data for the past five years, indicates that two of the four sites examined by the Applied Study team have an ERR greater than 12 percent, while the other two have ERRs greater than 10 percent. Given NESSI's experimental nature and the difficulties associated with developing projects in "bypassed"[6] areas, NESSI's economic results, while not nearly as high as those originally estimated by AIT, can be considered marginally acceptable. At all sites, overestimation of the secure potential area for planting dry season crops has led to higher expectations than can be realistically achieved. Yet, field data indicate that family incomes in the three Applied Study areas, based on "average dry season" area that can be served, have risen by 20 percent in Huai Aeng and 50 percent in Huai Khilek, and will increase by 40 percent in Chorakhe Mak when all the construction is complete[7].

Even the relatively low income increase at Huai Aeng is slightly misleading, as it was more advanced than the other sites in 1982. Agriculture in the Roi Et region has increased rapidly, lessening the difference between "without" and "with" conditions; the low area that can be cropped in the dry season limits family benefits, however. Income increases in the other areas reflect their ability "on the average" to plant larger dry season areas.

3.6 Engineering Issues

This section assesses significant engineering aspects of NESSI and identifies positive and negative findings related to these issues. The primary engineering issues are those related to design, irrigation command area, dry season water supply forecasting, reservoir sedimentation, water conflict, and construction costs. These issues are addressed in the following section.

3.6.1 Design and Implementation

NESSI engineering design emphasizes water distribution and drainage systems. Design criteria are based primarily on minimizing construction costs and facilitating operation and maintenance activities. Initially, NESSI's design features were similar to

irrigation systems in Thailand, but after revision, chaek size was reduced and additional farm level ditches were introduced.

Main design features and operation procedures assume the following:

- A change from continuous to rotational flow allows the main canal conveyance capacity to be less than system-wide water requirement.
- Increasing the number of main ditches and farm ditches better serves small groups of farmers (10-15 farmers).
- Higher canal density requires a better plan for scheduling rotation irrigation.

Implementation of the NESSI design concept has been successful in developing a good operation and maintenance program. However, project construction costs were quite high due to an increased number of concrete-lined main farm ditches, as well as a large number of unlined ditches. NESSI's most prominent design criteria has been the reduction of chaek service area. The project developed an experimental pilot area of 500 rai in 1982, which, using the Bishop system, had farm ditches that served a relatively large chaek area. Experimental results indicated that farm feeder ditches, which in many cases fed directly from the main canals, served too many farmers to permit effective organization of farmer groups. This, in turn, led to poor water control. Based on an evaluation of the pilot area, a decision was made to modify the NESSI design criteria. A series of lined main ditches were added to feed much-smaller farm ditches. After this modification, chaek service area for each farm ditch was reduced to 100-150 rai. Table 21 details the main project features of the three Applied Study sites.

Table 21

Summary of Selected Project Features of Study Sites

Features	Project Name Huai Aeng	Huai Chorakhe Mak	Huai Khilek
Storage capacity, mcm	17.8 (21.89)	20.91 (21.22)	23.7 (26.98)
Active storage, mcm	17.4	19.58	21.7
Dead Storage, mcm	0.4	1.32	2.0
Lost Storage[1], mcm	4.09	0.31	3.28
Number of years with with no spillage	6	8	7
Lowest storage, mcm	N.A.	1.6	3.0
Year	-	1989	1989
Annual municipal water demand,			
Present, mcm	1.5	3.6	0.07
By year 2009, mcm	3.02	7.2[2]	0.4[2]

( ) Initial storage capacity.
[1] Storage lost due to sedimentation.
[2] Rough estimate.

3.6.2 Reservoir Sedimentation

Due to reservoir sedimentation, two of three study sites, Huai Aeng and Huai Khilek, have much lower storage capacity than when they were initially built. In the past 18 years, Huai Aeng's reservoir has lost storage capacity of 4.09 mcm. If sedimentation continues at this rate, the reservoir dead storage capacity will be severely reduced in a few years, and reservoir dredging activities may have to be undertaken. Major reasons for Huai Aeng reservoir sedimentation are cassava growing in the watershed area and the sandy-soil nature of the watershed. Huai Khilek has lost storage capacity of 3.28 million cubic meters in 16 years. However, its dead storage capacity of 2 mcm is still quite high, and it will not be filled in the next 10 years. Huai Khilek reservoir sedimentation results from the mountainous watershed topography and sandy soils. Cassava and sugarcane production are also a contributing factor.

Huai Kaeng has a reservoir sedimentation problem similar to Huai Khilek and seems to have the most severe sedimentation problem among the seven project sites. Huai Kaeng has lost about 5.7 mcm of storage capacity in 10 years. Huai Kaeng's watershed area is used for cassava production even more than the Huai Khilek area and, therefore, has a more severe sedimentation problem. Even though sedimentation is not yet a significant problem in the other systems, given the relatively small storage in the reservoirs, it is still a concern.

3.6.3 Command Irrigation Area

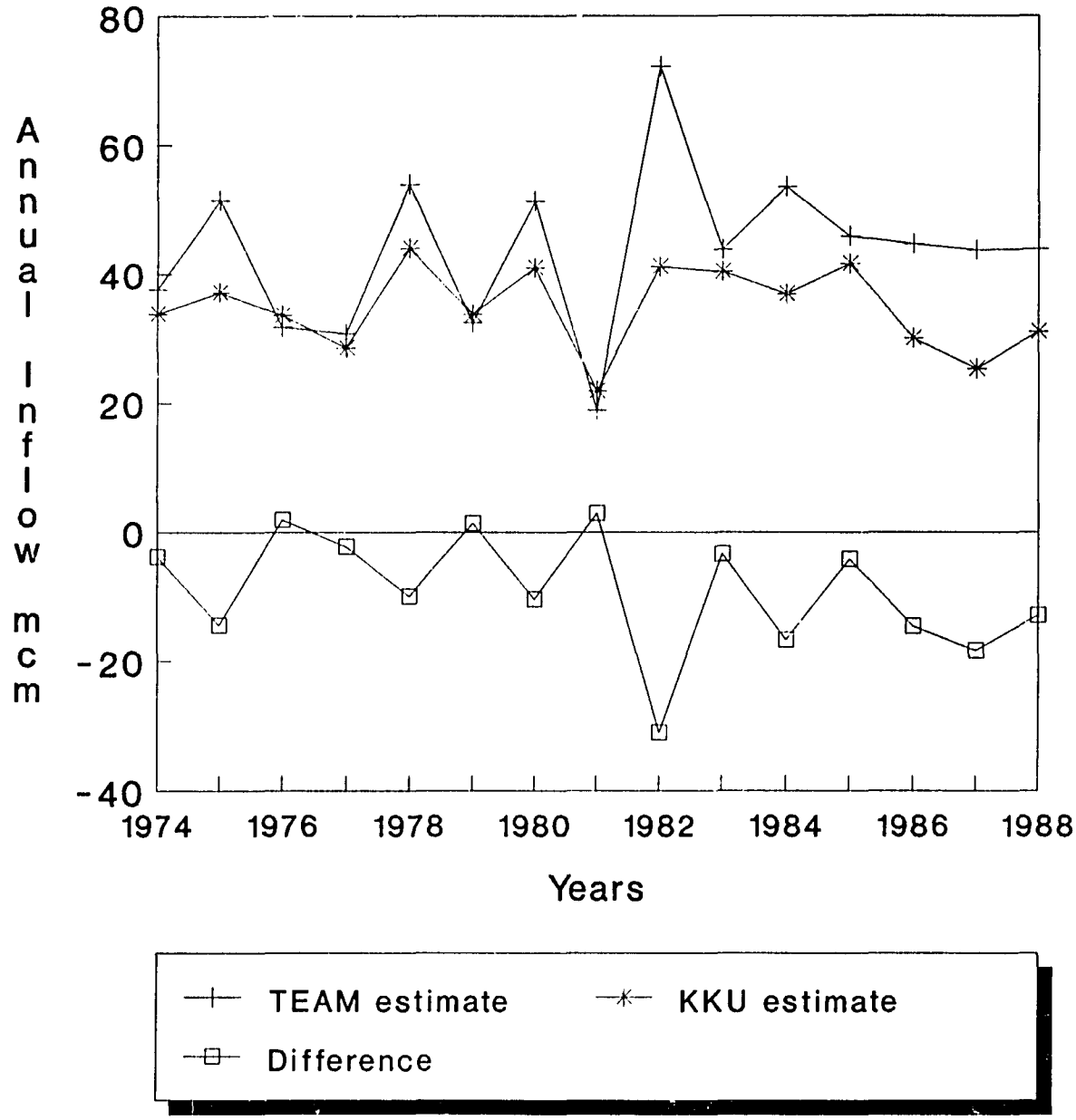
Huai Aeng has the largest command irrigation area, 21,066 rai. Compared to its active storage capacity of 17.4 mcm, the command irrigation area is quite large, given its water supply. Moreover, with an additional daily water withdrawal of 4,000 cubic meters for the Pra Phutta Yod Fah army camp, the available irrigation potential is further reduced. Other NESSI sites have more-realistic command irrigation areas, although the city of Buri Ram's domestic use of the available water supply at Huai Chorakhe Mak reduces the potential area that can be served at that site. However, in all cases it is clear that the available service area for dry season cropping is directly related to the previous wet season rainfall. Because of limited storage capacity and erratic rainfall, it will be very difficult to plant 100 percent of the available area during the dry season. In the three study sites, reservoirs in the dry season can serve, on average, 15 percent of the wet season area for Huai Aeng, 40 percent of the wet season area for Huai Khilek, and 30 percent of the wet season area for Huai Chorakhe Mak.

3.6.4 Water Availability

Techniques used to forecast secure available water supply tend to overestimate inflows into NESSI reservoirs. As a result, there has been an overly optimistic estimation of irrigation potential. Three methods were employed in estimating inflow into the NESSI projects reservoirs. AIT used a crude runoff coefficient approach to estimate inflows, assuming inflow to be 20-25 percent of effective monthly rainfall. Resource Engineering Consulting Co. (REC) used a water balance equation to estimate inflows based on measured outflows. TEAM Consulting Engineers Co., Ltd. used a regression equation approach to estimate reservoir inflows. TEAM's approach, which has been used by CTF to develop recommendations for dry season operation, developed lagged, linear regression equations to predict runoff (inflow) as a function of rainfall. These equations were based on nearby watersheds that had adequate rainfall-runoff data. Unfortunately, there are few watersheds with adequate data in the Northeast. Thus, the available watersheds were not necessarily representative of the NESSI sites (Tables 22 and H-1).

Although linear regression techniques usually provide a good estimation for average conditions, they do not provide accurate estimates if extreme values are the norm. REC's approach is much better, as it predicts extremes with more accuracy. However, the water balance approach requires that outflow data be available. Given the importance of accurately estimating low-flow extremes in medium-size reservoirs, an approach that overestimates low flows, such as the linear regression model, should not be used for forecasting inflows. With the Northeast's erratic rainfall, any system used to forecast available water must be one that does not minimize the importance of extreme values, particularly low extremes.

Severe drought in 1985-88 caused extremely dry conditions for Lam Chamuak and Huai Chorakhe Mak reservoirs. Although it is impossible to predict, this critical drought period may again occur. Therefore, it is suggested that inflow estimation study be based on physical hydrologic modeling and that irrigation potential studies be carried out taking into consideration the 1985-88 drought period. Figure 7 illustrates different inflow estimates obtained using a physical hydrologic model compared to a linear regression model.



KKU hydrologic inflow model compared to TEAM regression inflow model.

Figure 7

Estimated Annual Inflow
Huai Aeng, Roi Et Province

Table 22

Important Characteristics of NESSI Watersheds and Selected Watersheds Used for Regression Analysis

NESSI Subproject and Corresponding Selected Watershed	Characteristics		
	Watershed Area (km^2)	Annual Rainfall, (mm)	Major Type of Land Use in Watershed Area
Huai Aeng, Roi-Et	147.50	1,118.4	Cassava
Lam Chi Long, Chaiyaphum	265.00	1,028.3	Forest
Huai Khilek, Mukdahan	80.60	1,480.6	Sugar cane, forest
Huai Bang E, Mukdahan	702.00	1,529.0	Forest
Huai Chorakhe Mak, Buri Ram	96.25	1,294.0	Paddy

3.6.5 Conflicting Water Demands

All three NESSI sites studied experience both municipal and irrigation water demands. It is expected also that several other medium-scale irrigation projects in the Northeast are in a similar condition. Huai Chorakhe Mak is in the worst situation, since it is expected to provide 3.6 mcm of water annually for the city of Buri Ram's domestic consumption. As Buri Ram grows, in part from tourism promotion, the domestic water demand will likely double within 20 years. Moreover, the Provincial Water Works Authority (PWWA) for Buri Ram, the organization responsible for providing the municipal water supply, currently pays nothing for the water, which it sells at a profit (1988 net return was stated as 10,000,000 baht). In contrast, farmers in Huai Chorakhe Mak are asked to contribute free labor for O&M. In the near future, water users there will also be asked to pay WUA membership and seasonal O&M fees. Table 23 compares the projected return from water for municipal and irrigation use.

Table 23

Comparison of Municipal Water Revenues and Potential Net Returns from Dry Season Agricultural Use

NESSI Site	Annual Supply (mcm)	Municipal Revenue[1] (million baht)	Dry Season Agriculture	
			Irrigated Area[2] (rai)	Net Return[3] (million baht)
Huai Aeng	1.5	7.5	1,500	2.07
Huai Chorakhe Mak	3.6	18.0	3,600	3.98
Huai Khilek	6.07	0.2	70	.11

[1] Assumed treated water net revenue of 5 baht m^3.
[2] Assumed net water consumption of 1,000 m^3/rai/season.
[3] Based on average net returns for all dry season crops at three sites.

As expected, municipal water provides higher returns, but these returns accrue to the PWWA rather than RID. Consequently, there is no contribution toward O&M from water used for municipal purposes.

In addition to domestic and industrial demands, there are also competing agricultural demands. As can be seen in Figure 8 (and in Appendix H), there has been a rapid increase in small weirs and diversion structures in the watershed above the NESSI sites. These structures are restricting inflow, and during dry years such as this year in Nakhon Ratchasima, are capturing all the flow in the stream.

RID is currently studying alternatives to solve the long-term water shortage problem for Huai Chorakhe Mak and address the water problems for Buri Ram. The department is considering the following:

1. Building a pumping station to pump water from the Lam Plaimat stream at a rate of 4 cms during the wet season to fill the Huai Chorakhe Mak reservoir. This intrabasin water transfer scheme is economically feasible if PWWA is willing to pay the investment and operation costs. Prior to undertaking this alternative, a natural resource management scheme that considers both upstream and downstream water demand from the Lam Plaimat must be undertaken, to ensure there are no conflicts over water rights.

2. Raising the dam in order to increase the reservoir storage height by 0.5 meter, thus increasing reservoir storage capacity by about 5 mcm. This alternative will inundate one square kilometer of land.

3. Digging a connecting channel between Huai Talat reservoir and Huai Chorakhe Mak reservoir. The retention level of Huai Talat reservoir is 0.729 meter higher than that of the Huai Chorakhe Mak reservoir. Historically, the water level in the Huai Talat reservoir is generally higher than in Huai Chorakhe Mak's reservoir. From 1964 to 1988, the lowest annual maximum water level was at elevation 161.7 meters msl for Huai Talat reservoir. This level is just 0.5 meter below the maximum retention level of the Huai Chorakhe Mak reservoir. The total storage capacity of both reservoirs is 40.67 million cubic meters, and the total catchment area of both reservoirs is 249.25 square kilometers. Huai Talat's storage level also has less variation than that of Huai Chorakhe Mak. Therefore, this third alternative is a feasible alternative to consider in more detail for relieving the water supply problems of the city of Buri Ram.

3.6.6 Construction

Construction activities were delayed for Huai Khilek, Huai Talat, Huai Chorakhe Mak, and Lam Chamuak due to underestimated construction costs during the design of NESSI. Of the three NESSI sites with completed construction, only Huai Kaeng's construction quality is poor, due to its sandy soil, steep rolling terrain, and poor engineering supervision. Huai Aeng and Phuttha Utthayan construction quality appears to be satisfactory. Huai Khilek and Huai Talat were recently completed and that construction quality is also satisfactory. Lam Chamuak and Huai Chorakhe Mak are nearly completed, and so far the construction quality is satisfactory. Table 24, which summarizes construction costs of the main components for all NESSI sites, reveals the following:

1. Construction of the distribution system and on-farm system accounted for about 60 percent and 35 percent of the total costs, respectively. If these two cost items can be reduced, the economic viability of the project will be much more attractive.

2. Drainage system construction costs are much reduced from original designs, from about 23 million to 4.8 million baht. Use of the natural drainage system, which was recommended by the project field director during the early stages of the project, makes this cost reduction possible.

Overall, NESSI's construction costs are rather high due to a comprehensive distribution and on-farm system. With this type cost structure, the NESSI model will not be easily spread to other areas on a large scale due to limited government budget and the model's relatively high per-unit costs.

3.6.7 Operation and Maintenance Program

The NESSI concept of small irrigated chacks at the farm ditch level that serve a limited number of farmers (10-15) requires irrigated water to be delivered on a rotational basis. Rotation scheduling at the NESSI sites includes the entire distribution system hierarchy, from main canal to farm ditch. Except for farm ditch rotation scheduling, the RID

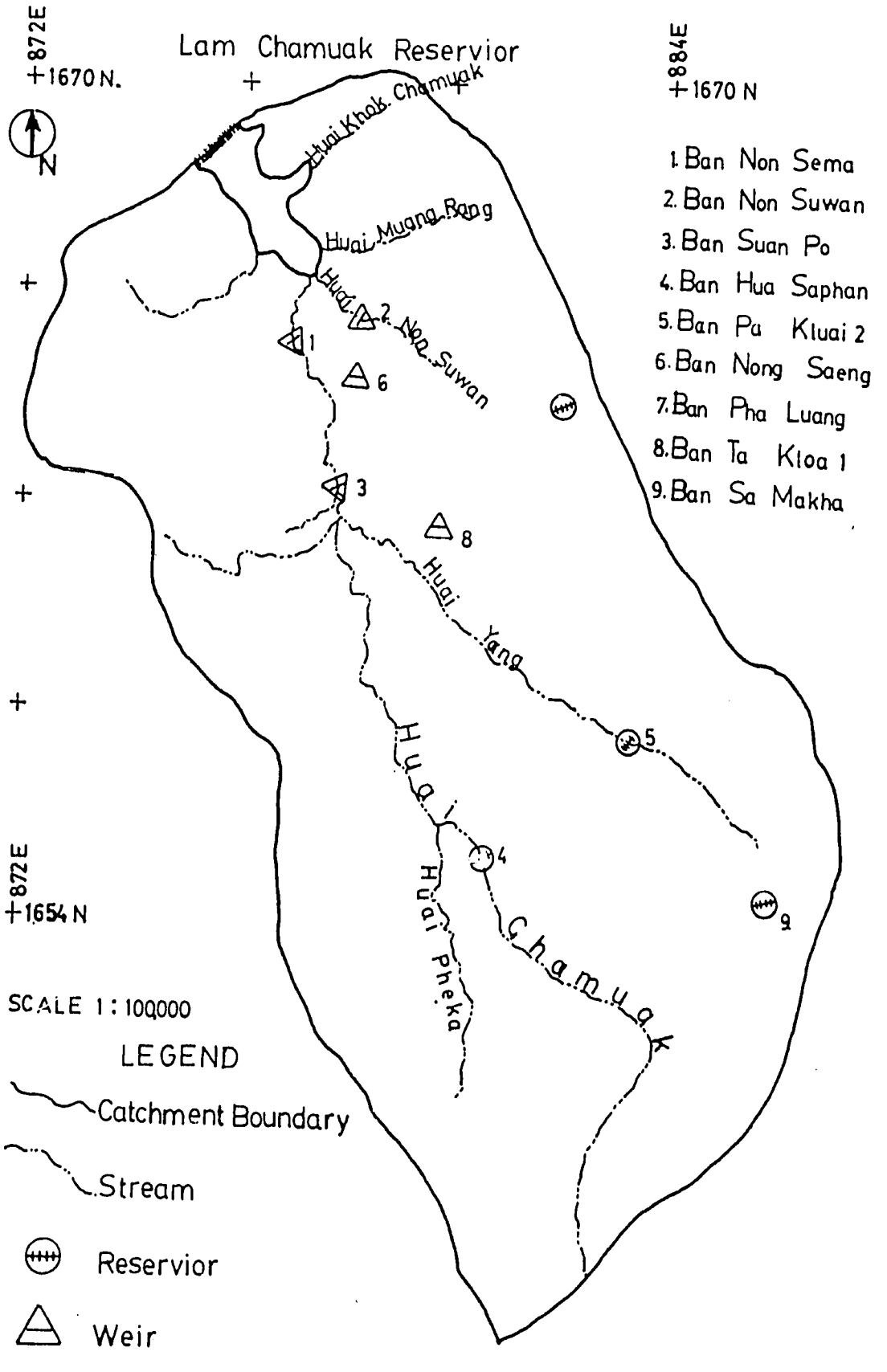


Figure 8

Location of Major Small Weirs and Reservoirs in Lam Chamuak Catchment Area, Nakhom Ratchasima, 1987

Table 24

NESSI Subproject Construction Cost[1] (1982-1989)

Subproject	Line Item Cost (baht)				
	Dam Improvement	Distribution System	Drainage System	On Farm System	Total
Huai Aeng	799,278	40,943,588	3,417,705	37,898,980	83,059,511
Huai Kaeng	788,152	55,354,291	432,994	19,659,982	76,235,419
Phuttha Utthayan	957,600	30,452,374	957,600	26,778,131	59,145,705
Huai Khilek	-	23,956,530	-	13,014,344	36,970,874
Huai Talat	152,998	40,352,770	-	11,881,137	52,386,905
Chorakhe Nak[2]	5,040,249	33,293,106	-	13,966,482	52,299,837
Lam Chamuak[3]	153,000	26,053,878	-	17,363,566	43,570,444
Total	7,891,277	250,406,537	4,808,299	140,562,622	403,668,735
% of total cost	1.955	62.033	1.191	34.821	100

[1] Excluding office building, farmer training center, access road, and construction preparation.
[2] Construction will be completed in July 1989.
[3] Under construction.

O&M unit chief and zonemen are responsible for operating the system. Because of the expanded requirements of operating a rotation system, rotation has caused an increase in their tasks. Therefore, the area under each O&M unit chief has been reduced to about 6,250 rai. O&M unit chiefs and zonemen at NESSI sites have attended a number of procedural training courses to help them cope with their tasks of delivering irrigation water, and coordinating O&M involvement of chaek groups and water users associations.

3.6.8 Engineering Conclusions

NESSI has demonstrated that an irrigation system with small chaeks works well in medium-scale reservoirs in Northeast Thailand. However, due to the large number of lined canals and unlined farm ditches, the NESSI approach has proven to be relatively expensive. AIT and CTF forecasting techniques to predict firm supply of dry season water have consistently overestimated actual availability. As a result, the irrigation command area is too large for the normal water supply; 50 percent or more of the irrigation facilities cannot be used each dry season.

Sediment inflow into NESSI reservoirs is a problem at some locations and, if not restricted, will soon reduce the active storage at a number of sites. Competing demands for municipal and industrial water also serve to reduce the water supply actually available for farmer use. In the future, as the Northeast economy continues to grow, competition for water supplies will become even more problematic.

Notes–Chapter 3

1. James R. Chamberlain, "The Northeast Small Scale Irrigation Project: A Management Review." Prepared for USAID/Thailand, Office of Agriculture. March 1985.

2. In some cases chacks were as large as 700 rai.

3. Adams Tobacco's innovative extension program all over the Northeast promoting Turkish tobacco is an exception to this statement.

4. Personal conversation held on May 22, 1989 at TDRI in Bangkok.

5. Dry season cropping at this level is not possible on a sustainable basis for Huai Aeng due to a shortage of water.

6. Bypassed areas are those that economic development has missed due to such factors as poor transportation access, occupation by a minority group, presence of diseases like malaria, limited natural resources including poor or erratic water supply, and distance from the sea or the more settled areas of a country.

7. This assumes chack groups will be formed in every chack, continuing efforts will be made to strengthen the WUA and help the farmers with their transition to more commercial agriculture, and "normal" rainfall will occur soon.

4

RECOMMENDATIONS

This chapter provides a set of recommendations for the future development of medium-scale reservoirs in Northeast Thailand. The recommendations are based primarily on findings from the NESSI Applied Study. Drawing upon other on-going water resource development activities in the Northeast, the recommendations also attempt to synthesize these experiences and provide a comprehensive approach that the RTG can follow over the next decade. The ultimate goal, of course, reaches beyond merely developing the water resources, to encompass improving the income of a significant portion of the Northeast's agricultural population, who are at present the lowest income group in the country.

4.1 Institutions

Successful exploitation of medium-scale reservoirs in the Northeast requires not only technical development of irrigation structures, but also a proper institutional structure to encourage interagency cooperation. NESSI provided a relatively complicated institutional structure; this section recommends a simpler model.

Project Coordination

In retrospect, the management structure proposed for NESSI was far too complex and overdesigned. Yet, given Thailand's irrigation climate in 1978-80, when large irrigation systems dominated and few advocated investing either in small-scale irrigation or in the Northeast, it probably made sense to propose a system that had many built-in checks. However, as indicated in Chapter Three, only two coordinating bodies, the Project Coordinating Subcommittee and the field working group, played a major role in the project. Ironically, neither was part of the original design.

Based on NESSI experience, additional medium-scale projects in the Northeast should have a relatively lean organizational framework featuring the field working group as a major element. This group should be formed very early and should continue to function even after the project (as a formal entity) is completed. Of course, as the WUA becomes stronger over time, the role of the field working group will have to reflect the WUA's growing strength. Figure 9 details the recommended organization. Note that the Coordinating Subcommittee contains only directly concerned line agencies. Both groups include representatives of the private joint committees (PJCs) at the national and provincial level, to ensure private-sector knowledge of the project.

4.2 Water Users

NESSI has successfully created a functioning structure of water users groups at the project sites, and has provided opportunities for them to participate in system O&M and planning for dry season cropping. The project has also improved water group access to RTG officers. During its relatively brief period of strengthening water users groups, NESSI has made tangible gains in reaching these shorter-term water management goals of improved O&M, but it is still too early to conclude that the revitalized WUAs and the newly-created chack groups are sustainable.

Sustainability of water users groups depends upon a mixed set of organizational factors, only some of which relate directly to water management:

- an understanding of the rules and regulations of the chack group, preferably growing out of consensus among the farmers over time;

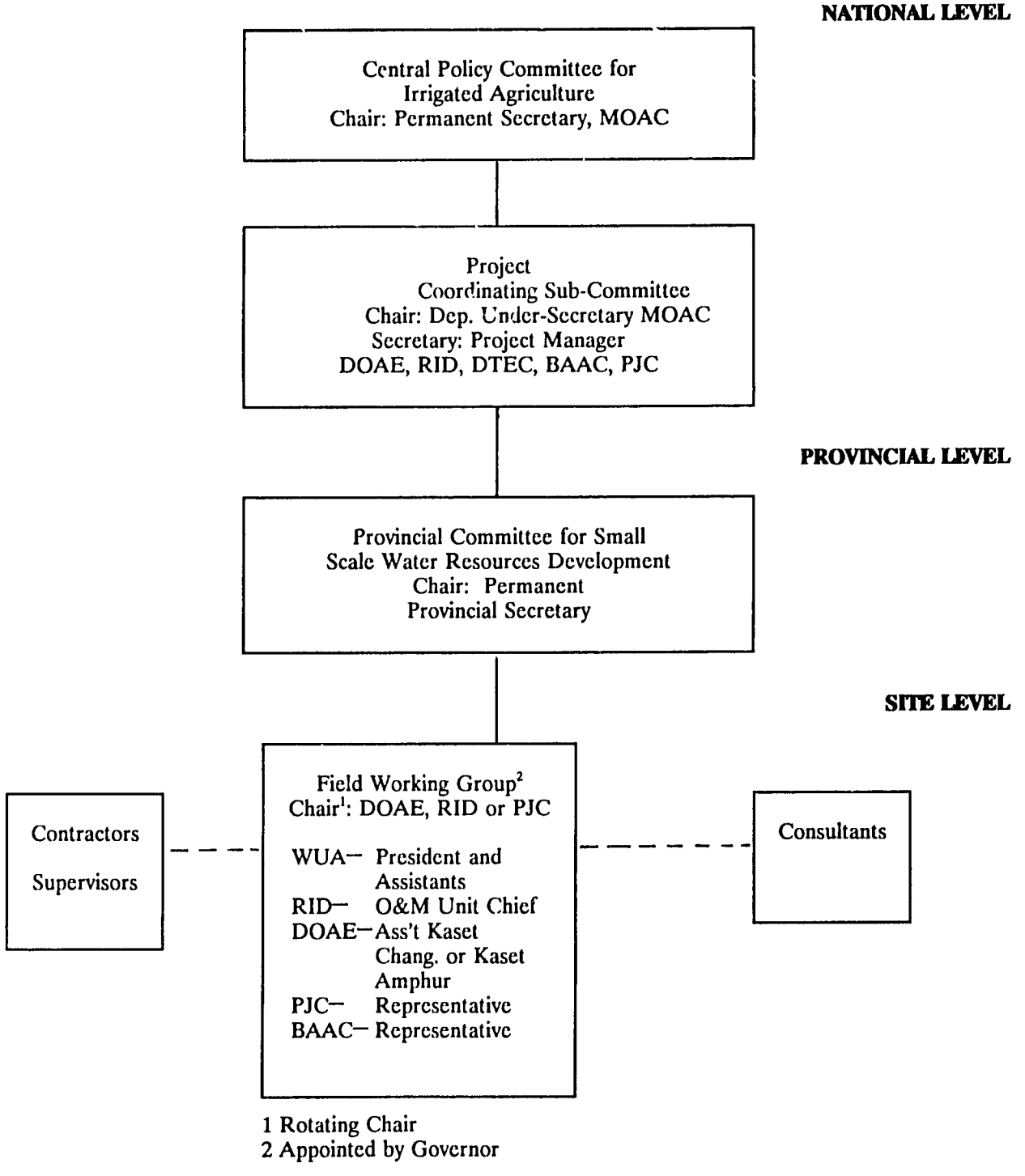


Figure 9

Phase II: Medium-scale irrigation Project
Recommended Organization Diagram

- strong but accountable group leadership;
- preparedness and willingness to accept increased responsibilities for system O&M;
- a substantive role in decision-making about water allocations and scheduling above the farm ditch;
- an ability by both group members and government officers to be forward-thinking, not seeing group formation as an end in itself but as a means to increased production and income; and
- appropriate technologies for turning system O&M benefits into increased agricultural income.

Effective technology transfer and marketing initiatives, as the means to attain the longer-term goals of improved agricultural production and increased income for farmers, have been far more difficult for NESSI to implement. NESSI's first phase legitimized a role for water users in system O&M; Phase II must move beyond water management by using the new chaek groups and revitalized WUAs as a means to generate higher agricultural incomes. Recommendations presented here will not be easily implemented; they may require both increased funding and adoption of new operating procedures by sometimes entrenched bureaucracies. However, at least two potential rewards offset these difficulties: an improved standard of living for Northeast farmers, and a reduction in the costs of rehabilitation construction and O&M due to increased farmer contributions.

Recommendations

1. Keep RID as the primary RTG agency in water user organizing and strengthening, since improved water management is the basis for successful group action. Within RID, responsibility for organizing water users would best lie within the On-Farm Water Development Branch, under the O&M Division. This branch is already responsible for assisting and monitoring WUAs and chaek groups throughout Thailand. To strengthen its capability to organize water users, the branch will need to obtain technical assistance from a senior, field-experienced social scientist who can work with the staff to establish procedural guidelines for organizing farmers and integrating production-oriented activities into the approach.

2. Adopt at the highest levels of the RTG the concept of farmer involvement at all stages of irrigation development, from site design through O&M, and institutionalize the concept as the Standard Operating Procedure at all RID levels. Savings in construction and O&M costs will more than cover the cost of recruiting a relatively small number of contract staff to work with water users. Specific actions for each stage should include the following recommendations:

Design

- Recruit ICOs (both B.Sc. Agriculture and B.A. Sociology/Education) as contract RID employees.
- Deploy two ICOs per zoneman; pair Agriculture and Sociology Education graduates.
- Establish a 4-6 month lead time for organizing chaek groups.
- Explain the RID plan in detail and reach agreement on right-of-way and property compensation.
- Arrange visits for chaek leaders to other sites.
- Have farmers review, discuss, and offer suggestions for changes in preliminary design.

Construction

- Explain construction schedule and update farmers regularly.
- Have water users help RID lay out ditches and locate field outlets.
- Recruit local farmers as skilled and unskilled labor for construction.
- Make certain farmers understand final design prior to construction.
- Organize O&M training for chaek group leaders.
- Have farmers monitor construction and feedback information through the ICOs.

Operation and Maintenance

- At sites with existing WUAs, reactivate and provide management skills training.
- In sites without WUAs, have chaek leaders enroll members and collect membership fee.
- Expand responsibilities of water users through chaek and main ditch leaders in allocating and scheduling water with zonemen.
- Have zonemen gradually take over ICO responsibility of working with water users.
- Keep ICOs in sites rehabilitated earlier under different programs.

3. Lack of monitoring of the farmer training program has made it difficult to assess Phase I training efforts. In Phase I, training focused on chaek group leaders and WUA officers; other water users at the sites did not directly participate. In Phase II, the training approach must become more participatory. WUAs and water users should be involved in program planning, rather than taking part as passive participants.

   These suggestions should be incorporated into the training design:

- A Training Task Force for the Northeast should be created in the On-Farm Water Development Branch in Bangkok, which will oversee training programs for ICOs and zonemen. This training function should be gradually absorbed into RID's Division of Training.
- ICOs should determine specific, goal-oriented training needs of WUA officers and chaek group leaders/members, and give feedback to the Training Task Force through the on-site Field Working Group.
- Initially, the Training Task Force will need to design training programs based on needs identified by ICOs, Field Working Groups, WUAs, and water users. To ensure a sense of involvement, the Field Working Group should approve training course formats in advance.
- As training progresses and training programs are given and modified, the Training Task Force should develop standardized training modules for use in future sites.
- Training should emphasize learning by doing, most often in a field situation. Material ought to cite real experiences of farmers and work toward resolving actual field problems. Contract marketing will be an important area for training in Phase II.
- Monitoring and follow-up visits should be made to determine if the training was used and to serve as a feedback mechanism. ICOs ought to monitor the success of training programs and convey findings to the Field Working Groups for transmittal to the Training Task Force.

4. Even if Phase II medium-scale water development activities are based on these recommendations, monitoring of Phase II implementation will still be required. The recommended monitoring system is based on the Standard Operating Procedure discussed above. In Phase II, on-site monitoring of rehabilitation, farmer organizing, and system operation must emphasize cost-effectiveness, minimized staff time, timely feedback, and maximum farmer participation. Since farmers are the most important beneficiary group, water users should conduct the monitoring themselves and channel their findings through the WUA to the Field Working Group. (See Appendix E for further elaboration of this monitoring concept.)

5. Phase II development of medium-scale irrigation in the Northeast will require greater participation from the private sector than was found in Phase I. (Estimates suggest that in the next 10 years, approximately 80 percent of the Northeast's dry season produce will be produced under contract.) WUAs, marketing activities, and processing agents will be crucial to the success of extending the focus of water group organizing beyond water management alone, to include increasing production and incomes for group members. Contract marketing will require greater pre-planning coordination between farmers and buyers, to better match supply with demand.

   Prior to each dry season, the WUA and zoneman should determine how much water will be available in the reservoir and project the rai of dry season crops that can safely be irrigated with this amount of water. Farmers who grow dry season crops will form Farmer Production and Marketing Groups, informal

interest groups composed of the farmers at a site who grow the same crop. WUAs must ensure that FPMGs do not overcommit themselves in contracts with buyers and promise to cultivate more land than the available water can supply. The WUA role in projecting land for dry cropping and ensuring that available water supplies are not over committed ties marketing to the WUA's more traditional water management responsibilities.

4.3 Crop Production

Recommendations for crop production require consideration of other factors: market demands for crops, conservation of soil fertility, sustainability of soil fertility, sustainability of soil resources, and quality of products. Processing plants are rapidly establishing a presence in the Northeast and, consequently, demand for non-rice crops is increasing rapidly. Processing plants require a regular supply of quality crop products, but at present, plants in the region have difficulty meeting their supply requirements. Farmers should change to producing crops that can be grown on contract to meet the plants' requirements.

Erosion and depletion of soil nutrients are major problems of Northeast soils. Nitrogen-fixing crops like peanuts, soybeans, and mungbeans can be used to improve soil fertility. Such cropping patterns as intercropping of cassava and peanuts are recommended both to reduce soil erosion, particularly in the upland crop areas above the medium-scale reservoirs, and to help maintain soil fertility.

4.3.1 Crop Recommendations for Applied Study Sites

Huai Aeng

Rice is the main wet season crop, both in irrigated and nonirrigated areas. The most widely used variety is RD6. Cassava is the main upland crop. Dry season crops include a second rice crop, peanuts, watermelons, glutinous and sweet corn, and vegetables. Vegetables include chili peppers, gourds, yard-long beans, and eggplant. Dry season rice is not recommended because it requires so much water. Farmers' incomes can be increased from both wet and dry season crops. It is recommended that other field crops replace cassava in the upland areas, since sediment inflow into the reservoir is a major problem. Peanuts and baby corn have potential, since they have a high market demand. Farmers already have experience growing peanuts in the dry season, and peanut growing has an indirect benefit of increasing soil fertility. Crops recommended for the dry season depend on market demand and, therefore, will vary with market prices. Recommended crops include peanuts, baby corn, sweet corn, vegetable soybeans, tomatoes (fruit and seed), mushrooms, and such vegetables as yard-long beans, cucumbers, and chilis. All of these crops are suitable for processing and export. Price will depend upon quality, which can be improved if farmers at the site use irrigation properly.

Huai Khilek

During the wet season, cassava, sugar cane, and peanuts are the main upland crops, while rice occupies the lowland areas. The only recommendation for crop intensification at this site is to grow more peanuts by intercropping them with cassava in the upper fields. Again, this recommendation is made to reduce sediment inflow into the reservoir and to improve soil fertility. Overall rice production can be improved by shifting more area into improved nonglutinous rice varieties. Dry season crops are sweet corn, chilis, yard-long beans, cucumbers, eggplant, and some cabbage and pumpkin: all are required by processing plants. Recommended crops for promotion include tomatoes, baby corn, soybeans, and peanuts, which are mainly for processing and export.

Huai Chorakhe Mak

Under rainfed conditions, rice is the main wet season crop. Rice is also the main wet season crop in the irrigated areas. Glutinous corn is the main crop grown in upland areas. Upper paddy or upland areas should be diversified to grow baby corn and peanuts. A possible way to increase cropping intensity is to grow peanuts in upland areas and vegetables close to water sources. Dry season crops are peanuts, mungbeans, soybeans, sesame, and such vegetables as cucumber, garlic, and shallots. Recommended crops for the dry season are the same as those for Huai Aeng.

4.3.2 Crop Production Considerations

Farmers in all three sites are continuing to experiment with different crops and different cropping practices. As additional farmers grow crops under contract, processing plants will advise concerning the required technology. Over the next few years, however, there will be quite a variation in yields and quality, but over time, experience with new crops and availability of better varieties will reduce yield variation. Training and improved technology transfer methods—both private and public—and the formation of FPMGs should help farmers become more proficient in producing processing and fresh market crops.

4.4 Extension

NESSI's extension activities were premised on the assumption that farmers had almost no access to technical knowledge and secure markets for non-rice crops. Marketing and production data presented in Chapter Three clearly indicate that the situation in the Northeast today is far different from the late 1970s, when NESSI was designed. Under these new circumstances, approaches used to help increase farmer incomes need to be rethought.

4.4.1 Increasing Production in Irrigated Areas

Increasing labor costs in the central and northern regions of Thailand constrain the country's ability to meet the world market's rapidly growing demand for such export crops as canned/fresh baby and sweet corn, processed tomatoes, and the more-exotic bamboo shoots, mushrooms, Chinese radishes, and tropical fruits. Under these circumstances, if irrigation water is available, the semitropical climate of the Northeast is actually much better suited than elsewhere in Thailand for producing a number of non-rice crops. As a result, interest has shifted to the region's production areas that have good supplies of dry season irrigation water.

NESSI project sites, as well as Lam Nam Oon, Nam Pong, and Lam Pao, are already starting to reflect the benefits of this new interest. Processing capacity already built in the Northeast, combined with that planned or already under construction, guarantees that the Northeast's rapid expansion in non-rice crop production will continue, at least in the near future. Field-level technical knowledge to feed this growth is presently being refined by farmers in the irrigated areas. Yield fluctuations and quality-control problems, along with a certain amount of frustration on the part of the newer growers, are an inevitable by-product of rapid expansion. Similarly, RID officials are having to learn how to operate irrigation systems to produce non-rice crops. Erratic rainfall leading to widely varying water supplies in the reservoirs complicates the process, as it is difficult for all parties to plan from year to year.

4.4.2 Technology Transfer

Changing from rainfed subsistence crops to commercial crops in both wet and dry seasons has brought Northeast farmers much closer to private-sector processing and marketing organizations. These initial contacts have brought certain problems, but more and more farmers are starting to look to firms like Adams Tobacco, Universe Foods, NACO, and Charoen Phokap and for market guidance and technology. Farmers now realize that market demands dictate both the type of product and the time of its harvest. This, information is available only from commercial firms; thus, DOAE field staff at the subdistrict and district level are ' nding their traditional, pure technology-transfer oles being reduced.

The study team believes that this phenomenon will continue and that it works to the benefit of the farmers, the private-sector firms, and DOAE. However, DOAE must now find a new role in the intensively irrigated areas where the private sector is active. In the future, it is recommended that subdistrict agricultural officers provide liaison between processing firms and marketing organizations and farmers, preferably through FPMGs and WUAs. In the early stages, while Northeast farmers are still naive about legal contracts, DOAE should develop a standard contract (see Appendix F). DOAE should also organize a campaign to inform farmers about the concept of market contracting and promote the standard contract. In some cases, DOAE personnel may also need to play a mediator role when problems arise between farmers and private firms.

In contrast to the model of the flow of technology and information represented in the Project Paper (Figure 10), the study team believes a new model for future medium-scale irrigation projects in the Northeast is required. Figure 11, in which the private-sector role in policy, technology transfer, and marketing is much more dominant, captures the direction of Northeast agricultural development during the 1990s.

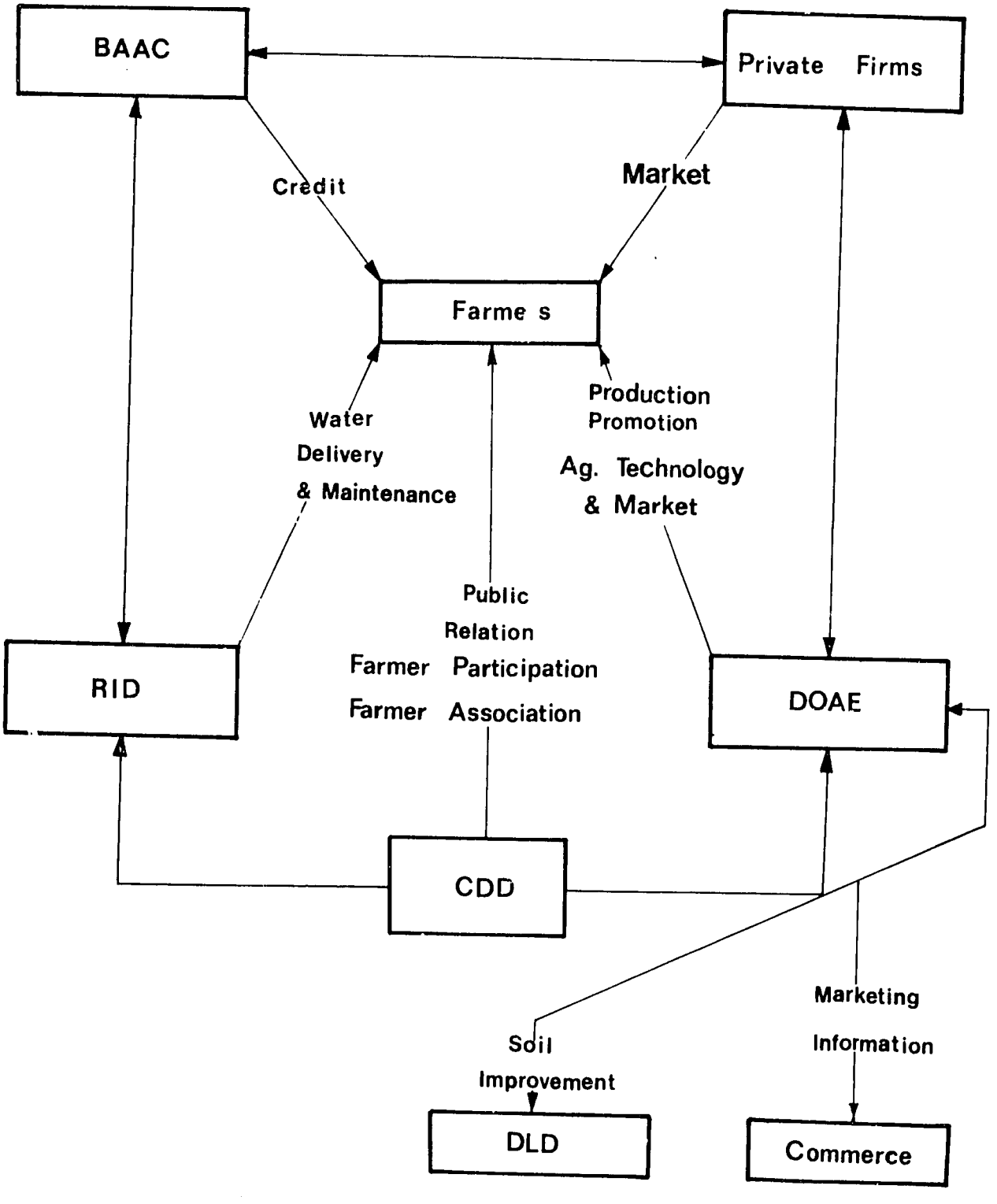


Figure 10

Project Development Concept

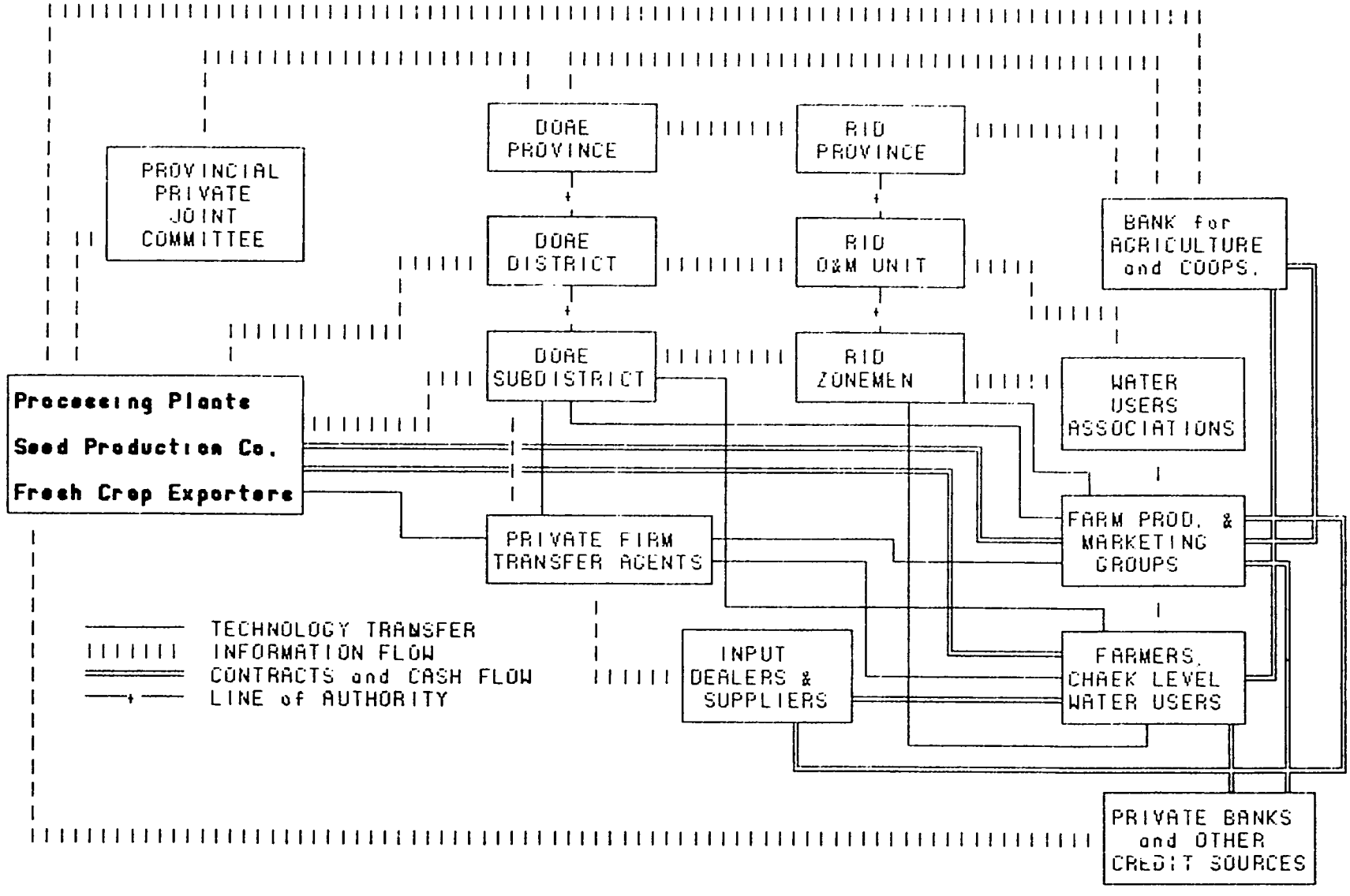


Figure 11

Technology Transfer and Information Flow for
Intensively Cropped Areas Served by Medium-Scale Reservoirs

4.5 Marketing

Although marketing initiatives under NESSI have been limited in the project sites, these efforts do give some direction for future development. The next phase should emphasize crop recommendations based on existing and predicted market conditions, approaches to improve existing procurement systems, improved and simplified market contracts, and market training programs for WUA leaders and DOAE and RID staff.

4.5.1 Recommended Crops and their Markets

Vegetables and oil seed crops for processing are strongly recommended for the NESSI project areas, because regional and international demand for these crops continues to be very strong. Recommended crops include baby corn, tomatoes, soybeans, peanuts, and mungbeans. These crops should be grown under marketing contracts with food processing plants or wholesale dealers. In particular, it is recommended that baby corn be produced to supply processing plants in the Northeast and fresh markets in Bangkok. Demand for baby corn has increased by more than 120 percent per annum since 1983. For example, one Bangkok exporter demands a minimum of 50 tons of baby corn per week, and is willing to provide cold storage facilities at the farm level if farmers in a location can meet the demand.

Mushrooms, chilies, peppers, and yard-long beans are recommended for sale to spot markets. Tables F-5 through F-7 give recommended vegetable varieties for Huai Aeng, Huai Khilek, and Chorakhe Mak for sale to wholesalers, processing plants, and roadside markets. Size of the market represented by the information in Table F-1 suggests that the three NESSI sites studied have access to large and expanding markets. Table 25 lists the most important national and provincial markets for the various recommended Northeast crops.

4.5.2 Improvement of the Marketing Contract

Farmers commonly enter into disadvantageous marketing contracts with processing plants and middlemen. For example, most contracts have no penalty clause when processing plants do not uphold their contractual terms. The following recommendations are suggested for improving the production and marketing aspects of contract farming in medium-scale irrigation locations. These recommendations include specific suggestions for more-equitable contracts.

Production Aspects

1. Local RID officers, in cooperation with agricultural extension agents, decide which crops will be grown, and where.
   a. Farmers determine their production plans and inform the WUA.
   b. WUA and zonemen synthesize the plans into a viable pattern for each site.
   c. RID officials, WUAs, and FPMGs jointly determine the dates to plant crops and supply water to the different chaeks.

Table 25

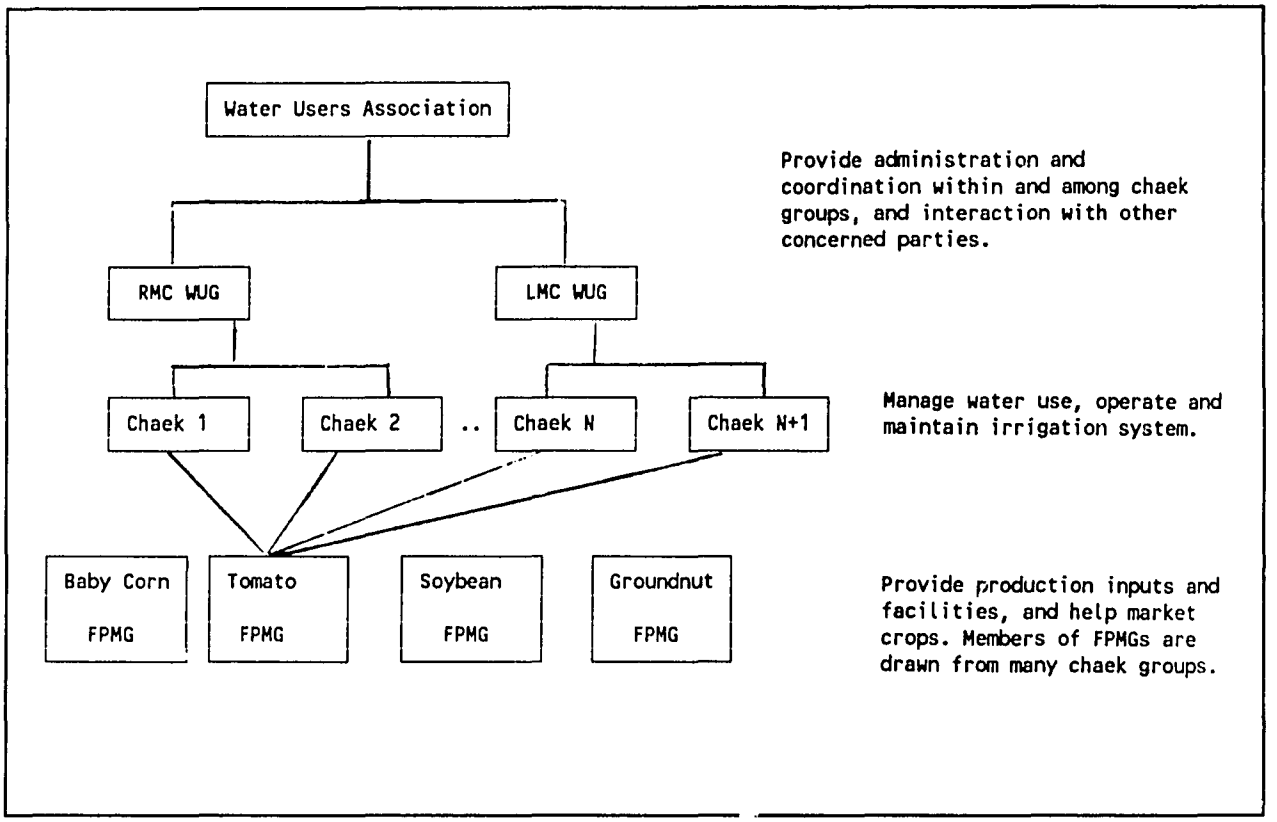
Important Markets for Recommended Northeast Crops

Crop	Provincial and National Markets
Baby corn	Roi Et, Yasothon Khon Kaen, Sakhon Nakhon Bangkok
Tomatoes	Roi Et, Yasothon Khon Kaen, Sakhon Nakhon
Soybeans	Kalasin, Nakhon Ratchasima Ubon Ratchathani, Sakhon Nakhon Bangkok
Mungbeans	Khon Kaen (Chum Phae)[1] Nakhon Ratchasima, Buri Ram Kanchanaburi, Bangkok

[1] Most important mungbean market in Northeast Thailand

2. Farmer Production and Marketing Groups stay actively involved.

   a. Production and Marketing Groups would play the following roles within the existing structure of WUAs:



   b. FPMGS, informally organized around a particular crop during the dry season, are represented by an elected group chairmen. Chairmen of the FPMGs sign contracts with processing plants and contact concerned parties for assistance. Membership and status of FPMGs will likely change each season as farmers decide to vary the crops they grow.

   c. The optimal size of each FPMG depends upon the area planted to the crop and the market demand.

Marketing Aspects

1. Have WUA, Field Working Group, and DOAE staff arrange meetings between FPMGs and processing plants or middlemen. The following commitments are suggested:

   a. Processing plants/middlemen fix the quantity required of a particular crop at a guaranteed price, with an agreed-upon date for delivery.

b. FPMG chairmen, having already determined group members' interest and level of commitment, make an agreement with the processing plants (or middlemen) to fill some or all of the production quota. They then discuss the terms with the FPMG members and agree upon a quota for each farmer. At this point, marketing contracts are prepared and signed.

2. Inputs and assistance provided by processing plants should include the following facilities and services:

   a. furnishing seed,

   b. providing credit or suggesting sources for production credit,

   c. accepting delivery of crops, and

   d. recommending production practices.

The Marketing Contract

1. Contracts should include the following provisions:

   a. quality of the crop and a fixed-price set by processing plants/middlemen;

   b. detailed area planted by the farmer under the contract;

   c. cultural practices recommended or required, including amount and type of fertilizer and chemicals to be applied;

   d. harvesting schedule;

   e. determination of grade and nature of product, and schedule for delivery;

   f. responsibility for damages caused by either party, e.g., nondelivery of crops on time;

   g. date of contract expiration; and

   h. conditions and payment schedule for each crop transaction (see Figures F-8, F-9, and F-10).

4.5.3 Improving Procurement Systems

Procurement systems can be improved by changing the direction of commodity flows from provincial to national markets.

Processed Vegetables

In the Northeast, farmers generally have limited market outlet options, and often sell their baby corn to nearby processing plants. In the future, procurement for baby corn, tomatoes, soybeans, and peanuts should move to exporting channels. Exporters or wholesalers need to provide cold storage facilities at the local level for baby corn purchase by Bangkok wholesalers and/or exporters. In addition, post-harvest activities such as sorting, grading, packing, etc., must be performed in order to expand the market boundary from farms in the NESSI sites to processing plants further away (see Figures F-11 through F-14 and Tables F-8 through F-10). Table F-1 gives names and addresses of major processors.

Oil Seeds

The procurement system for such oil seeds as soybeans, peanuts, and mungbeans can be improved by having farmers deal with the provincial markets, rather than depending only upon the Centers for Propagation and local assemblers (see Figure F-15). However, this will put a greater burden on the farmers to carry out predelivery activities such as grading, transportation, and collecting and disseminating market intelligence. Table F-2 lists names and addresses of provincial wholesalers dealing in oil seeds.

Fresh Vegetables

Northeast provinces can produce many different kinds of vegetables, which are sold to wholesale markets within the province and in other provinces of the region (Figure F-16). At present, produce from the study sites is shipped too far (Figures F-17 through F-20). In general, the distance from farm to wholesale market should not exceed 150 km. for green leafy vegetables and fruits, and 200 km. for root vegetables. FPMGs should handle delivery of fresh vegetables. Before selling, the groups will need to sort, grade, and pack the produce properly for shipping. Tables F-5, F-6, and F-7 give recommended vegetables for the NESSI project sites. Table F-3 lists addresses of provincial wholesale markets in the Northeast.

4.5.4 Encouraging Private Firms to Contact Farmers

Recently, RTG established a national policy of forming Private Joint Committees in every province to connect private-sector firms and public-sector government agencies. PJCs are to develop provincial economies, assist with production and marketing schemes, and solve problems in agriculture, industry, and services at the provincial level. So far PJCs have been established only in the large provinces that are trading centers and/or main producing areas of economic crops, e.g., provinces in East Thailand, an economic zone for fruits. To date, PJCs in the Northeast have been established in Ubol, Udorn, Khon Kaen, and Nakhon Ratchasima. Ubol is the only NESSI site with a PJC.

In order to focus on the marketing problems and improve/develop procurement systems in the NESSI areas, PJCs should be formed by senior provincial government officers and private-sector businessmen in all NESSI provinces. To convey the importance of the PJC, the governor should initially chair the committee. Once PJCs are formed and functioning, the chairmanship of the PJC should be rotated, given the numerous tasks of provincial governors. Committee members include private firms, representatives from private-sector groups such as provincial chambers of commerce, and officials from provincial offices of agricultural extension, commerce, industry, and communication. Figure 12 illustrates the composition of a typical PJC at the provincial level.

The head of the Provincial Office of Agricultural Extension should be a member of the PJC and play an important role in linking private entrepreneurs to WUAs in the NESSI project areas. Through the PJC, the extension director will learn about crops demanded by private firms. His office and staff can then carry this information to WUAs. In turn, WUAs will be expected to convey the information to water users groups and farmer production and marketing groups.

4.6 Engineering

NESSI experience, particularly at Huai Aeng, indicates that the design criteria for the farm ditch service area of 100-150 rai is workable and effective for O&M activities. The experience has been based upon farmer participation during the postconstruction stage only.

4.6.1 Design, Construction Costs, and Other Demands

The study team believes that if farmers are involved during preconstruction, a workable and effective service area for each farm ditch may increase to 200-250 rai. This translates into about a 5 percent reduction in construction costs, as shown in Table 26. Furthermore, if farmers can be motivated to participate during the construction period, costs can be reduced even further. Assume, for example, that farmers contribute free labor for farm ditch construction and sodding as shown in Table 27. Using the basic NESSI technical design, with increased water user participation, construction costs can be reduced by approximately 15 percent.

Both rehabilitation and new development projects, particularly in the Northeast, must take into account other water demands (such as for domestic and industrial use), annual rainfall, physical characteristics of the catchment area, and land use in order to get realistic estimations of water availability and irrigation command area in both wet and dry seasons. In particular, it is important that any new reservoir construction consider present and potential demands for domestic and industrial water. For example, in the three reservoirs studied by the team, none of the original documents planned for domestic use, yet all three systems now provide free water to other users. But farmers are being asked to pay O&M fees and provide labor. The study team strongly recommends that a mechanism be developed for ensuring that other large water consumers, such as the city of Buri Ram, pay for part of the capital development cost and accept their share of O&M costs.

4.6.2 Reservoir Inflow Estimation

Inflow forecasting techniques originally used to design the NESSI Project tended to overestimate firm inflow. Therefore, the team recommends that future inflow estimations be based upon a hydrologic model that is better suited to take into account land use and physical characteristics of specific watersheds. A hydrologic model employed in RID's Chi Basin Water Management Improvement Project, based on the SCS small watershed rainfall-runoff model, can be applied to any medium-scale irrigation project. Appendix H shows examples of inflow estimation using these methods.

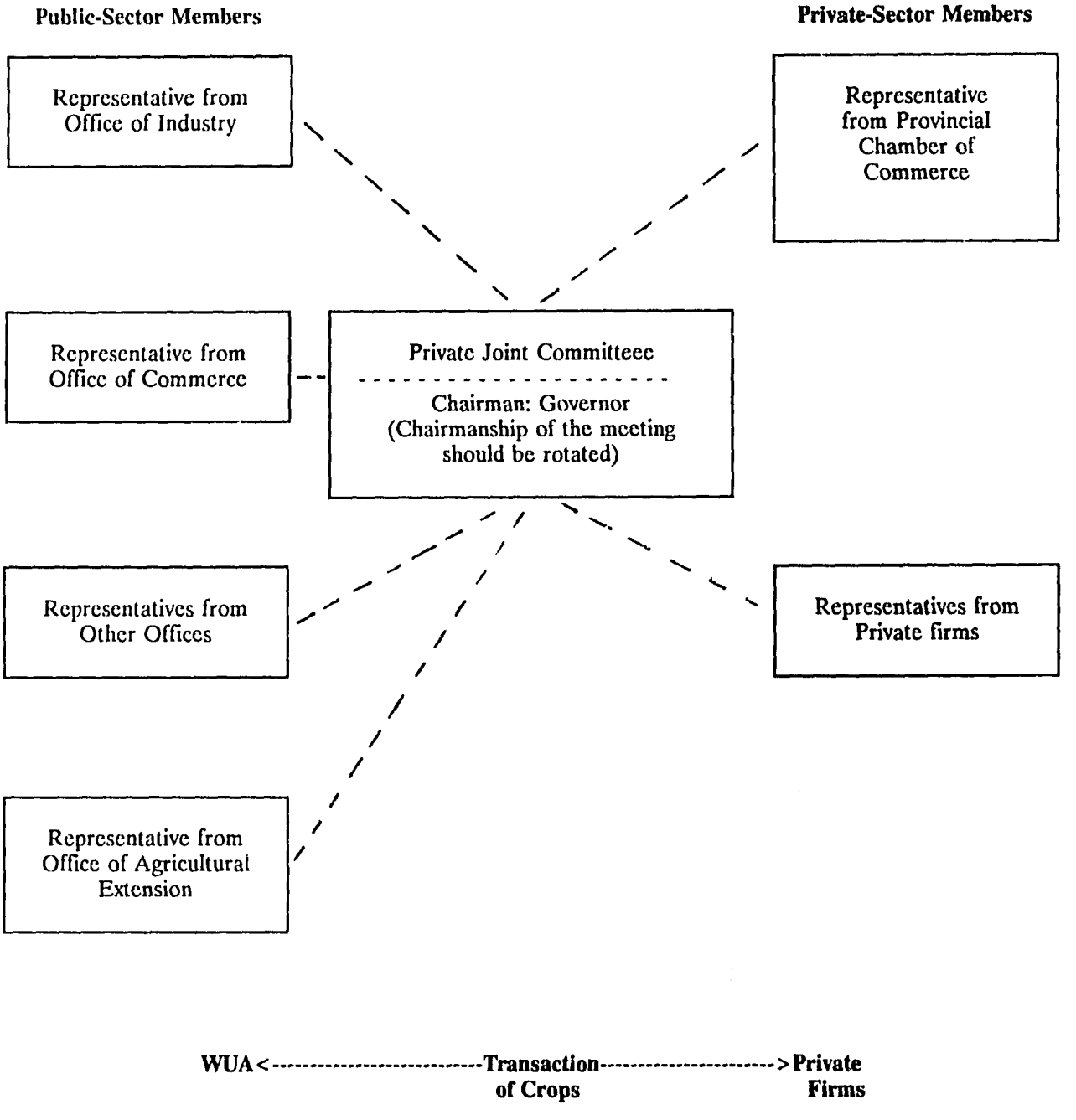


Figure 12

Composition of Private Joint Committee at Provincial Level

Table 26

Construction Cost Comparison for Three Design Criteria[1] for Huai Aeng.

	Cost, x 10^3 B		
	RID Criteria[2]	CTF Criteria[2]	Proposed Criteria
Dam improvement	2,670	2,671	2,671
Main canals	9,445	9,445	9,445
Main ditches	7,516	17,216	13,336[3]
Drainage system	113	761	761
Structures (main systems)	4,093	4,784	4,784
Access roads	15,382	12,270	12,270
Sublateral canals	4,231	17,092	17,092
On-farm system	40,082	23,854	23,854[4]
Total	84,554	88,093	84,213

Note: [1]Criteria Service area, rai
Original up to 400
NESSI 100-150
Proposed 200-250

[2] From NESSI Final Report of Consultant Task Force, Vol. 11, September 1985.

[3] Estimated using linear cost reduction between the NESSI criteria and original criteria.

[4] Assume that cost reduction of fewer farm ditches is offset by higher costs for additional farm ditch conveyance capacity and length.

Table 27

Analysis of Construction Cost Reduction Generated from Farmer Participation at Huai Chorakhe Mak

Item	Unit	Quantity	Unit price (B)	Total (B)
Construction of farm ditches Type, TN-1	m	57,290	85	4,869,650
Construction of Farm ditches, Type, TN-2	m	21,430	95	2,035,850
Sodding of main ditches	m^2	41,490	6	248,940
Sodding of main canal	m^2	234,342	6	1,406,502
Total				8,560,492
Total project construction cost				53,129,235
Fifty percent farmer labor contribution				4,280,240
Percentage of farmer contribution				8.056
Sixty five percent farmer labor contribution				5,564,320
Percentage of farmer participation contribution				10.470

4.6.3 Basin Water Management Study

Given the vast amount of uncoordinated water resource development over the past 20 years, as well as work underway in the "Greening of the Northeast" Program, it is strongly recommended that a basin-wide water management study be carried out prior to deciding to develop any new reservoirs in Northeastern subwatershed basins. All small-scale irrigation projects in the catchment area must be included in the study so that realistic irrigation potential of the medium-scale irrigation project can be assessed. In Lam Chamuak, for example, 19 small weirs have been developed in the watershed above the reservoir in the past six years. This partially explains why Lam Chamuak reservoir is having trouble filling. Without more coordination of water resource development in the Northeast, this problem will become even more acute in the near future.

In addition, reservoir sedimentation continues to be a major problem in several NESSI subprojects. It is suggested that any further expansion of the NESSI concept to other Northeast reservoir sites incorporate a sedimentation survey program into the rehabilitation plan and include watershed conservation measures in any rehabilitation or new development programs. At sites where cassava is extensively grown in upland areas above the reservoir, programs to promote intercropping with peanuts and mungbeans should be made an integral part of the development program. Otherwise, many medium-scale reservoirs will fill with sediment before providing enough benefits to justify development.

4.6.4 Dry Season Cropping Area

With the erratic rainfall and intensive development that has occurred in the subwatershed basins throughout most of the Northeast, inflows into reservoirs are extremely variable. This means that it will be impossible to produce dry season crops on all of the service area every year. In fact, based on historical records and hydrologic models, it is estimated that "on the average" dry season cropping will be 15 percent of the total service area in Huai Aeng, 40 percent in Huai Khilek, and 30 percent in Huai Chorakhe Mak. These percentages must be recognized as averages: for example, Huai Khilek had over 4,000 rai of dry season crops in 1987/88, and about 1,000 rai in the dry season of 1988/89. Therefore, the dry season cropping intensity dropped from 50 percent to 12 percent in one year.

With this type of variation, RID and the WUAs will have to work very hard to accurately determine the available water supply. Equity problems associated with allocating limited water supplies in drier years will place severe strain on both RID staff and WUA leadership. RID and the WUAs need to develop guidelines to plan for the shortages that are expected to occur regularly, and formulate an equitable method of rotating dry season service area.

5

SUMMARY AND IMPLICATIONS

NESSI was conceived and initiated during a turbulent period in Thailand's history. Since NESSI's conception in the late 1970s, Thailand has undergone dramatic economic and democratic changes and, at present, is one of the strongest economies in Asia. Lessons learned from activities carried out during this period, including those learned from NESSI, are valuable not only for Thailand, as it rehabilitates additional medium-scale irrigation systems, but also for other countries in the region that struggle to address poverty in lower-income areas.

5.1 Summary

NESSI faced a number of challenges in the early years: budgetary, staffing, institutional, and organizational. Due to delays caused by underfunding, the expatriate consulting firm had basically completed its contract before NESSI was at a point to use many of the skills available. As a result, the local contractor, TEAM Engineering, carried the weight of the responsibility and deserves credit for much of the project's success. Thailand is fortunate to have capable local engineering contractors and will certainly want to draw on them in the future.

Sites developed under NESSI are at a stage where economic opportunities for farmers are very high. In order to maximize economic benefits from improved irrigation water availability, stronger chaek groups and WUAs must exist, and RID must continue to work closely with these groups to encourage and support them. In addition, it is critical that farmers work closely with private-sector firms to establish an equitable contracting system benefitting both parties. Prior to expansion of the private sector in the Northeast, market opportunities were very limited. Now that these opportunities exist, all efforts must be made to link producers and farmers in a productive chain.

Strengthening chaek groups and developing an expanded role for WUAs will take a significant effort from RID. This is a new role, which requires that RID enhance the capabilities of its On-Farm Water Management Branch. However, if RID is ever to benefit from increased farmer contributions for O&M, the agency must make a commitment to increasing its own capacity to train and work with water users groups.

Under the present "Greening of the Northeast" program, there is a tremendous amount of development activity, much of it focused on water resources. This activity follows two decades of various water resource development projects organized through RID, Land Development Department, Community Development Department, Accelerated Land Development Department, Land Settlements Department, KKU, the Army, National Energy Authority, PWWA, and a multitude of other agencies. While a large number of projects have been completed that provide benefits to the population, the projects have been carried out in a relatively uncoordinated way. As a result, competition for water resources in the Northeast is increasing. Before the Northeast has a bad enough drought year to lead to a crisis, it is necessary to study present conditions in the different subbasins and determine the exact water balance in each system. Otherwise, as is becoming apparent, new projects will simply take water from older irrigation systems, causing their benefits to decline. Soon, competition with industry and tourism for the limited water supplies will be the most serious problem farmers face.

5.2 Implications

Thailand's development experience provides a model for other countries in the region. Certainly, Laos, Cambodia, and Vietnam all look to Thailand as an

economic model they would like to emulate. Indonesia, Malaysia, and the Philippines are also interested in the "Thailand model," particularly its balanced growth between agricultural and industrial exports. Thai businessmen are already involved in agricultural and tourist-related activities throughout Southeast Asia. With its strong economic base, Thailand will continue as a regional development resource for the next two decades.

The secret of Thailand's success has been the RTG's willingness to let the private sector do what it does best. This policy has meant that the RTG does not hesitate to withdraw from public service areas when the private sector demonstrates that it can perform the service better, and at less cost to the government. Thailand has allowed the private sector to provide such services as air travel, toll roads, lower and higher education, agricultural inputs, agricultural marketing, and exports. It has also encouraged the private sector to provide more traditional public services: seed development, agricultural research and extension, express mail service, power generation, and even water resource development. The private provision of public services brings the forces of competition into areas of monopoly. In Thailand, it has been demonstrated repeatedly that these forces lead to better services at a lower price.

With respect to NESSI, it is clear that the emergence of private-sector processing plants has ensured that farmers can benefit from their labor. When NESSI reservoirs were first constructed in the 1960s, farmers had water but no outlet for their products. Given their limited economic incentives, farmers did not use the water. Today, by contrast, at every Northeast location where dry season water is available, farmers are eager to produce crops and private processing plants want to buy them. When local farmers are not interested, farmers from other parts of the Northeast will rent their land. Due to RTG encouragement of private-sector investment, massive past investments in water resource development are paying very high returns for farmers in Northeast Thailand and for the country as a whole.

APPENDICES

A

SCOPE OF WORK

I. Project Objectives

The Northeast Small-Scale Irrigation Project (NESSI) is a pilot project which seeks, through a diversified program of construction and institutional support, to increase agricultural incomes in Thailand's most deprived region. The project is being implemented on seven sites dispersed throughout the Northeast Region. These sites are the potential command areas of existing small reservoirs (called "tanks" locally). Roughly 4600 households are being served by NESSI on the seven sites.

Project activities have included:

- the improvement of deteriorated embankments;
- the rehabilitation, extension, and improvement of main canal systems;
- the design and construction of effective on-farm distribution systems;
- the organization of water user associations to encourage farmer participation in operation and maintenance;
- the development of training programs for farmers and RTG personnel;
- the coordination of participating local government agencies; and
- marketing initiatives in the agro-industrial sector.

As a pilot project, NESSI is expected to be the first experimental phase of a longer-term initiative of the Royal Irrigation Department. A somewhat modified NESSI approach will eventually be extended to nearly one hundred additional sites in the Northeast.

II. Purpose of the Applied Study

The Northeast Small-Scale Irrigation Project is regarded by the RTG as Phase I in the development of irrigation systems in the region. Phase II will expand upon the NESSI experience both by continuing activities in the original sites that were not completed during the project's life and by developing new sites. In any case, there are certain to be changes in approach in all sites in the Northeast during the second phase. NESSI contained a significant construction component, through which main canals were rehabilitated and main ditches and farm ditches were constructed. Phase II is likely to deemphasize construction, by restricting the scope of this activity to the main canals, and will focus on sustaining farmer organizations, operation and maintenance, and marketing linkages.

This applied study of NESSI will serve both to describe and assess NESSI and to set the direction for the next phase. Specifically, it has the following major purposes:

- to describe and assess NESSI, both in terms of individual elements and as an integrated package;
- to identify those elements of NESSI (and other irrigation development efforts in the region such as the Lam Nam Oon Integrated Rural Development Project) which ought to be transferred to other potential sites;
- to establish guidelines for potential activities, presently at only a formative stage in NESSI, such as marketing; and
- to provide recommendations concerning the modification and institutionalization of NESSI elements suitable for the further development of the seven NESSI sites and for transfer to other sites in the region.

An objective of the NESSI Project was the development of an implementation approach which would provide a replicable model for the rehabilitation of other sites in the Northeast. Following on that objective, an early purpose of this applied study was the delineation of a "NESSI model" for such replication, based on actual project experience. However, during the life of the project, activities focused heavily on construction. There has been initial progress made on coordinating local government offices, organizing water user associations, and encouraging farmer participation in operation and maintenance, but there have been few marketing initiatives. Therefore, the definition of a NESSI model based on actual project implementation is not yet possible.

In summary, the study team will be responsible for assessing project activities as they stand and suggesting to the RTG the most effective ways in which Phase II might be conducted, in terms of both goals and steps to reach those goals.

III. Background

The 1978 Report on "Water for the Northeast" prepared by the Asian Institute of Technology for the Royal Thai Government's Water Resources Sub-committee points out that the farmers of the Northeast are plagued by unreliable seasonal rainfall and that this is one of the main reasons that the Northeast has the lowest crop yields per area of any region in Thailand. Most rainfall is lost to the farmers as it quickly percolates through the sandy soils. In the dry season water is scarce. Despite these problems, the report concludes that much of the demand for basic household water requirements could be met through existing water resources and that the first priority for water resource development in the Northeast should be the better distribution of available resources through improvements to existing systems.

There is considerable potential for increasing crop yields in the Northeast that is not being realized due, at least in part, to poor utilization of available water resources. Estimates vary depending on source, but it appears that less than 20% of the Northeast's irrigable area from existing water resources of about 650,000 hectares is actually being irrigated in the wet season, and less than 5% in the dry season.

One of the important resources for irrigation in the Northeast is the more than 200 small to medium-sized tanks in the region. RID estimates that these tanks, ranging in size from about 1 million cubic meters to over 20 million cubic meters, command an irrigable area of over 175,000 hectares. However, since most of these tanks have incomplete or deteriorated irrigation systems that are being inefficiently utilized, only a fraction of their potential is being realized.

There are numerous problems in improving the crop production and incomes of farmers within the command areas of these tanks. Many existing tanks and their delivery systems require some design modifications and/or considerable rehabilitation as well as extension of their canal systems in order to maximize their water delivery and utilization potential. Construction and/or improvement of the on-farm structures (ditches and dikes) is especially needed in many cases, and construction of related infrastructure such as operation and maintenance roads and farm-to-market roads can also be important.

Besides the capital improvement needed to existing tank systems, there are many other constraints that must be overcome before the water available from improved tank systems can be properly utilized to improve agricultural yields. Maintenance of existing systems has been poor and irrigation water, even when available, is generally not well managed within the system. Cropping patterns and cultural practices do not maximize returns and cropping intensities are well below the potential. Farmer access to agricultural inputs such as quality extension services, low-cost credit, unadulterated fertilizer, pesticides, seeds, etc. has been generally inadequate. Marketing problems are also important constraints and farmers need assurance of dependable market access and attractive prices before they will invest their money and labor to improve yields.

The NESSI Project sought to establish a sustainable system for increasing the agricultural productivity and income of more than 30,000 rural poor within the potential command areas of seven existing small to medium sized tanks in the Northeast of Thailand. The strategy of the project was to address the major identified constraints to improve productivity in the Northeast Region through a package of consultant assistance, demonstrations, training and construction that would provide:

- basic infrastructure for reliable delivery of water to farmer's fields;
- improved arrangement for key RTG agricultural service organizations to deliver their services to farmers;

- adequate procedures to help link up farmers to necessary agricultural inputs and markets;
- a strengthened farmer organization structure for managing and maintaining on-farm water delivery; and
- a system of training that would motivate farmers to properly utilize inputs to increase yields and market their crops.

The NESSI Project was expected to yield an implementation approach which would provide a replicable model for rehabilitation of about 100 of the remaining small-medium tanks in the Northeast which have sufficient storage capacity to warrant development. It should be pointed out that the seven tanks selected for the NESSI Project were seven of the ten largest tanks in the Northeast in terms of storage capacity. In fact, the NESSI Project tanks have storage capacities in the range of 15-35 million cubic meters, whereas of the remaining tanks, about 45 have capacities of 3-5 million cubic meters and about 100 have capacities of only 1-3 million cubic meters.

IV. Study Approach

The applied study will be conducted under the guidance of the team leader who will have the responsibility for coordinating the work of all study team members, ensuring the quality of the written report, and presenting results of the study at the NESSI Workshop to be held in mid-October 1989. The team leader will be in-country for 2 1/2 months during the study period and an additional 2 weeks to finalize the report and prepare the presentation for the workshop.

Since the team leader will be in-country for only two months of the three month study period, a deputy team leader who is a Thai professional will be selected and will coordinate the study team's efforts during the absence of the team leader.

Given the limited amount of time and resources, it will be impossible to study each of the seven NESSI sites. Thus three sites are recommended, based on size and approach, which should capture all of the elements envisioned in the NESSI objectives. These sites are Huai Aeng at Roi Et, Huai Khilek at Mukdahan and Lam Chamuak at Nakhon Ratchasima.

Detailed arrangements and organization of the study team will be the responsibility of the Team Leader, but a suggested work schedule is outlined here as a preliminary guide:

Month One

The Study Team members will assemble in Bangkok for a two-day Team Planning Meeting, to be led by a Thailand-based facilitator. The meeting will serve to acquaint all members with the objectives of the study, determine individual responsibilities, and clarify technical and administrative problems. The team will review all documents, including project reports, AIT and other feasibility studies, and RTG evaluations related to NESSI and other relevant development efforts in the Northeast. These documents ought to be assembled by USAID prior to the arrival of the team.

The team, with USAID and RID assistance, will select no more than three of the seven NESSI sites for intensive study. In addition, the team members will visit the Lam Nam Oon Integrated Rural Development Project to identify marketing initiatives and water user group/operation and maintenance activities which might be incorporated into Phase II for medium scale systems development. During this period, the team will visit the sites selected for intensive examination and interview NESSI staff, RTG officials, and farmers. They will jointly determine areas for further investigation which will be followed through during the coming month.

By the conclusion of Month One, the American team member who will participate only during this period will provide a final report to the Team Leader, according to an already agreed to focus. Those team members who will be actively involved during month two will agree on their activities during that period.

Month Two

The three Thai members of the team will participate in the study half-time. Their responsibilities will likely fall into three categories: review and summary translation of Thai documents which will form part of the basis of the final report; review of notes, determination of additional interviews, and preliminary drafting of sections of the final report; and field visits to the selected sites to supplement previous trips. The members will work under the supervision of the Deputy Team Leader.

Month Three

Gathering of the team, including the Team Leader and the three Thai members. The team will make field visits as required, brief USAID and RID on its conclusions and anticipated guidelines for further development activities, and prepare the final report. The team will prepare and submit the final draft report in the form given below which discusses the presentation of results.

Month Four

USAID will review the report and request modifications, as required. The Team Leader and Deputy Team Leader will make any reasonable changes. Their activities, however, will focus on a presentation of the report's findings and recommendations to the NESSI Policy Workshop, which will formally close the project. Their presentation will take one-half to one full day, as agreed to with USAID personnel.

V. Study Team Composition and Level of Effort

The study team will be composed of two American and three Thai specialists:

Agricultural Economist/Team Leader (American)
Irrigation Engineer (American or Thai)
Social Scientist (Thai)
Agricultural Extension Specialist (American or Thai)
Marketing Specialist (American or Thai)

Only one of the three latter positions will be filled by an American. The choice will depend upon the qualifications and availability of candidates, although it is likely that the pivotal position of Marketing Specialist will be filled by an American citizen.

A Thai member of the team will be selected as Deputy Team Leader and will provide continuity to the assignment during the period the full team is not in place.

The following chart indicates the projected level of effort of the team members:

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Position              / Month 1 /  Month 2 / Month 3 /  Month 4 /

Ag. Economist (TL)    ============           ==========  ========

Engineer (Deputy TL)  ============ --------- ==========  ========

Social Scientist      ============ --------- ==========

Ag. Extension Spec.   ============ --------- ==========

Marketing Specialist  ============

=====  full-time effort

-----  half-time effort
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This chart is meant to be indicative of anticipated levels of effort based on assumptions that the Deputy Team Leader is an engineer and that an American is identified for the marketing position. The second American team member will participate for one person-month.

VI. Team Member Responsibilities

Agricultural Economist/Team Leader. The responsibilities of the agricultural economist/team leader will include the overall supervision of the study team and the final report. The team leader will organize and coordinate the work schedules of the other team members and determine activities for Thai team members during Month Two. The team leader will also regularly review team progress and directions with USAID and RID to ensure compatibility of objectives, and will review and edit, as required, all preliminary and final drafts of the study report to ensure internal consistency and that the report fulfills its goals. With the deputy team leader, the team leader will prepare an oral presentation, with appropriate visuals, for the NESSI Policy Workshop.

The agricultural economist will assess the economic feasibility of the NESSI model. Assumptions on which the project was built will be tested. For example, the Project Paper drafted in 1980 estimated an ERR of 31.41 percent based on a variety of assumptions about cost and benefit streams associated with project activities. Recognizing that not all pieces of the originally envisioned project fell into place as planned, the agricultural economist should utilize such data as has been generated over the eight years since the project was authorized and reestimate the ERR. The objective would be to reach an overall judgement on whether the NESSI project concept warrants continued investment by the RTG. A part of reaching this judgement would be to determine modifications in project concept that would improve the ERR. In undertaking this task the agricultural economist would work closely with other specialists on the team.

The agricultural economist should evaluate the implications for economic and financial feasibility of the NESSI model of the RID decision to only construct and rehabilitate main channels, leaving construction and improvement of minor channels and water courses to the farmers. Specifically, a financial analysis of investment in irrigation ditches and recurrent expenditures in maintaining them by the farm unit(s) will be undertaken by the agricultural economist. This work should be undertaken in close consultation with other members of the team.

Irrigation Engineer. The responsibilities of the irrigation engineer will be to review the operations and maintenance programs in the three NESSI sites selected and, in cooperation with the social scientist, identify and define the approaches to O&M which appear to be successful. The engineer should also review the development of main canals, farm ditches and on-farm water distribution systems at the three sites, to describe the design and construction approach used and identify problems which have constrained successful completion of any of the elements. The engineer should work with the social scientist to develop an approach for involving farmers in the design and construction process and recommend how this approach might be applied to the smaller remaining undeveloped tanks in the Northeast. Since current RID thinking implies that no farm ditches would be constructed by RID in these remaining smaller project areas, the engineer should work with the social scientist to develop a recommended approach for mobilization of farmers to construct such facilities.

Social Scientist. As the organization of water user associations will become an increasingly important aspect of irrigation development in the Northeast, the Social Scientist will be responsible for reviewing and assessing NESSI progress in this area. The social scientist will draw upon Thai experiences in organizing such groups, through a careful review of all documentation and personal involvement in research and implementation. Many of the farmers in the sites have no previous experience with irrigation or are relative newcomers to the area. Working with this diverse population, NESSI has organized a formal structure for farmer involvement with chaeks and hierarchical levels of leadership, closely tied to the physical plan of the system. The social scientist will examine the effectiveness of this participatory approach and its suitability for operation and maintenance and other irrigation activities. Based on extended periods in the selected sites, interviewing farmers and farmer leaders, the Social Scientist will also provide recommendations for Phase II activities. The Social Scientist is expected to work particularly closely with the Agricultural Extension Specialist and the Marketing Specialist.

Agricultural Extension Specialist. The principal responsibility of the Agricultural Extension Specialist will be to work with RTG extension specialists at the three sites selected to describe how dry season irrigated crops can best be introduced to the farmer. Most farmers in the command areas now serviced by the systems have little or no experience with irrigated crops during the dry season and a well planned extension program is needed to ensure that farmers fully understand both the options available and the cultural practices required.

The Extension Specialist should also work with the Marketing Specialist to develop a recommended extension program which would introduce farmers to crops with highest market potential and assist them in developing such potential. Approaches should be recommended both for the seven existing NESSI sites and also for the remaining smaller sites with development potential in the Northeast. The approaches may or may not be similar in these two cases. In either case, the objective will be to stimulate farmer responsiveness to market requirements.

Marketing Specialist. The creation of marketing linkages between farmers and transporters or factories in the area was a goal of the NESSI Project. It is also certain to be a significant Phase II objective. The Marketing Specialist will closely examine the experiences of the Lam Nam Oon IRD Project in marketing and assess their suitability for medium scale sites. The existence and availability of markets for dry season crops is still uncertain. The Marketing Specialist will canvas the area and determine various strategies which might be employed by both farmers and transporters/factory owners for establishing either formal or informal linkages. The focus here will be on the creation of sustainable ties between the two sectors to ensure a reliable source of and market for farmer produce. The specialist will be expected to determine the nature of those ties and requirements (credit, for example) to maintain them. Close collaboration between the Marketing and Agricultural Extension Specialists is required.

VII. Presentation of Results

Results of the study will be presented in two formats, a formal written report and an oral presentation to the NESSI workshop.

a. **Written Report**—should contain the following sections:

Basic Project Identification Data Sheet

Executive Summary: Three pages, single spaced.

Body of the Report: The report should include, (1) a discussion of the purpose of the study; (2) the economic, social and political context of the NESSI project and replicable sites; (3) team composition and study methods (one-two pages); (4) an assessment of the NESSI project including a description of the NESSI "model" and the strengths and weaknesses of each element; (5) recommended approaches to extend the positive aspects of lessons learned in the NESSI project to other sites in the Northeast; (6) recommendations for strengthening uncompleted elements of the NESSI project such as market development; and (7) a summary of other findings of the study and overall conclusions. The body of the report should consist of no more than 40-50 pages, with more detailed information regarding methodological or technical aspects of the study placed in appendices.

Appendices should include:

- scope of work of the study;
- bibliography of the study and documents consulted;
- persons interviewed and sites visited;
- other information as noted above.

b. Oral Presentation—should be prepared with quality visuals highlighting findings of the study. The presentation should include:

- study team composition;
- study objectives;
- brief discussion of the approach;
- summary of the findings of the assessment of NESSI;
- recommendations for strengthening the marketing component of NESSI; and
- recommendations for extension of NESSI concepts to other sites in the region.

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C

INDIVIDUALS AND ORGANIZATIONS CONTACTED

Name	Position	Department/Organization
USAID/Thailand		
Douglas Clark	Director	O/TR
David Delgado	Director	O/ANR
Kamol Chantanumate	Program Officer	O/TR
Peter Thormann	Economist	O/Programs
RID		
Leck Jindasanguan	Deputy Director General	
Nukool Thongtawee	Formerly Director	O&M
Sakulwat Chantarobol	Director	O&M
Viraa Vongsaengnak	Chief, Foreign Aid Cooperation Branch	O&M
Pradit Prombut	Chief, Ditch and Dike Project II	Khon Kaen
Suchat Hanchanachaikul	Office Engineer, Ditch and Dike Project II	Khon Kaen
Sombat Suksuvan	Chief, Water Use Promotion Unit, Ditch and Dike Project II	Khon Kaen
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Huai Kaeng

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Huai Aeng

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Tongdaeng Wilitchai	Controller	Huai Aeng WUA
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Wichai Kittisriworaphan	Chief of Fruit Tree Section, Muang District Agricultural Office	DOAE
Damrong Wonglert	Vice Chairman	Huai Aeng WUA
Marong Wongsiri	O&M Engineer, Zone 1, Roi Et	RID
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Wichai Khamsaiua	Registrar	Huai Aeng WUA
Worarat Parwal Patamakul	Project Engineer	RID
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Pakdee Poribal	Research Assistant, FPIP Project	KU
Somsak Samgwibutra	ICO supervisor, FPIP Project	DOAE
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Kittipong Tongwisoong	Agricultural Officer	DOAE
Cherdchai Karnsamniang	ICO	RID
Supol Chipaworn	Agricultural Officer	DOAE
Manas Kirduboon	Irrigation Engineer	RID
Wandee Prapasarang	Water Master	RID
Porntep Anontachai	Water Delivery Work Chief	RID

Phutha Utthayan

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Prateep Loonachit	Canal Keeper	RID
Tipwipa Sopakaew	Agricultural Officer	DOAE
Amporn Sokham	Agricultural Worker	DOAE
Chan Butsao	Canal Keeper	RID

Huai Talat and Chorakhe Mak

Winai Padoongcharoen	Civil Engineer	RID
Prasong Pinyosap	O&M Engineer, Buriram	RID
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Yaowalak Tangchanyadhyum	Agricultural Officer	DOAE
Prapat Polsiam	Agricultural Worker	DOAE
Tawee Chaichana	Construction Technician	RID
Suchin Meesantat	Civil Engineer	RID

Lam Chamuak

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Chakrit Oonsamai	ICO	RID
Banchong Saenpinit	Water Master	RID
Thitipong Plaengngern	Irrigation Engineer	RID
Duangporn Satnok	ICO	RID
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Ubol Phannguleum	Research Assistant, FPIP Project	KU

Lam Nam Oon

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Chootinat Maliwan	Personnel Officer	RID
Sansonthi Boonyothayan	Field Coordination	ALRO

Nikhom Kamsoi Land Settlement

Khanchai Sathian	Superintendent	DPW

Other Organizations

Apichart Anukularmpha	Managing Director	A&R Consultants
Israel E. Navor	Agricultural Operations Division	World Bank
Dhira Phantumvanit	Director, Natural Resources and Environment Program	TDRI
Kevin Smith	Project Advisor	Thai-NZ SWDP

Part II. Individuals Interviewed for Data on Marketing

Name	Position	Department/Organization
1. Food Processing Plants		
Pornsak Viniyompong	Chairman	Universe Food Co.,Ltd, Roi Et
Charnnarong Reonchaichatuporn	General Manager/ Committee	Boonsiri Canned Foods Co.,Ltd, Yasothon
Paiboon Nititawan	Executive Director	Northeast Agriculture Company, Ltd, Limited, Nong Khai
Vichacharn Boonsamboon	Administration Manager	Northeast Agriculture Company, Ltd,
Somsak Phloypanitcharoen	Plant Manager	Royal Project Food Products, Sakon Nakhon
Sakchai Aoonjittikul	Plant Manager	Srichiengmai Agriculture Industry Ltd, Part., Nong Khai
Montree Kongtrakoontian	General Manager	1. Charoen Phokaphan Agricultural Industry Co.,Ltd, Bangkok 2. Bangkok Seed Industry, Co., Ltd, Bangkok 3. Charoen Phokaphan Engineering Co.,Ltd, Bangkok 4. Charaen Phokaphan Produces, Co.,Ltd, Bangkok
Sitthisak Sothikulanun	Plant Manager	E-Sun Foods Industry Co., Ltd, Khon Kaen
Arthit Metdamrong	Manager	TAS Co., Ltd, Nakhon Phanom
Preecha Phunchasri	Owner/Manger	PSH Part., Ltd, Nonthaburi
Charuk Phoramanon	Manager	Asian Best Canned Food Products Co., Ltd, Samut Sakhon
Thavatchai	Owner	Kwang Eal Lung Part., Ltd, Bangkok
Wirukchai Lerchaphatanaphon	Export Manager	Royal Foods Co., Ltd, Bangkok
Phairot Lonutkaphong	Chief, Division of Raw Material Purchases	Malee Samphran Co., Ltd, Nakhon Phatom
Somsak Thainoi	Purchases Manager	Thep Phadung Co., Ltd, Nakhon Phanom

Name	Position	Department/Organization
2. Exporters of Vegetables and Fruits		
Nareerut Sae Tae	Manager	AI Trading Co., Ltd, Bangkok
Wunchai Lertphangdee	Owner/Manager	International Fruits (Bangkok) Co., Ltd, Nonthaburi
Tavat Lavapaoraya	Consultant	International Fruits Co., Ltd.
Pornthima Sithabut	Manager	Eastern Foods Co., Ltd, Bangkok
Rutchaneeporn Kanokvanich	Owner/Manager	Phisitthichai International Co., Ltd, Bangkok
Nuanchun Maethithamphongvanit	Manager	I.V. Phong Part., Ltd, Bangkok
Vinich	Manager	C.P. Intertrade Co., Ltd, Bangkok
Nakorn Sangnin	Agricultural Products Manager	Asoke International Co., Ltd, Bangkok
Kui Huat	Owner	Kui Huat Store, in Market Organization, Bangkok
3. Other Agribusiness Firms and Banks		
Sukkasem Chitsing	General Manager	Pacific Seeds Co., Ltd, Saraburi
Khai Arkamut	Chief, Agricultural Credit Division	Bank for Agriculture & Agricultural Cooperatives, Roi Et Branch
Sommanat Suwanmena	General Manager	Bank for Agriculture & Agricultural Cooperatives, Bangkok Branch
	Manager	Bangkok Bank Roi Et Branch

4. Other Individuals

Government Officials at Provincial Offices of Commerce (POC)
Provincial Offices of Industry (POI)
Provincial Offices of Agricultural Extension (POA)

There are 17 provinces in the Northeast. Each of them has one POC, one POI, and one POA. In the Study, 17 government officials at POC, 17 at POI, and 17 at POA were interviewed about marketing and processing situations. Among the officials are Phanich Changwat (leader of POC)/ Assistant of Phanich Changwat/Economist at POC, Utsahakam Changwat (leader of POI)/Assistant of Utsahakam Changwat at POI, and Kaset Changwat (leader of POA)/Technical Assistant of Kaset Changwat at POA.

D

DESCRIPTION OF THE RESEARCH SITES

1. Huai Aeng, Roi Et and Mahasarakam Provinces
2. Huai Khilek, Mukdahan Province
3. Huai Chorakhe Mak, Buri Ram Province

TABLES

FIGURES

D

DESCRIPTION OF THE RESEARCH SITES

1. Huai Aeng, Roi Et and Mahasarakam Provinces

Huai Aeng irrigation scheme is about 22 km from the city of Roi Et. The system is located in Mahasarakam and Roi Et provinces and commands an area of 21,066 rai. The reservoir was started in 1962 and completed in 1965. Average farm size in the area is 15 rai and there are slightly less than 2,000 families in the service area.

1.1 Rainfall

Rainfall in the Huai Aeng area is influenced mainly by the southwest monsoon and depressions from the South China Sea. Rainfall normally starts in April and ends in late October or November. Maximum rainfall is in September with an average of 253 mm. Average annual precipitation is 1070.5 mm.

The range of mean monthly temperature is rather narrow, from a minimum mean monthly temperature of 23.3 c in December to 29.7 C in May. Mean annual temperature is 27.18 C. Mean monthly rainfall, temperature, relative humidity and evaporation at Roi Et is illustrated in Table D-1. Monthly rainfall and temperature at Huai Aeng is given in Figure D-1.

1.2 Soils

Soils of the Huai Aeng project are classified as Roi Et, Ubol, Korat and Sithon series. Roi Et series covers an area of 14,000 rai. It has developed from old alluvium. The soils are very deep, poorly drained and have moderate permeability and slow surface runoff. Surface soils are brown to strong brown sandy loam. Reaction of both surface and subsoils are strongly acid (pH 5.0). Ubol series is similar to Roi Et and suitable for rice production in an area of 3,500 rai.

Korat series is also derived from old alluvium. They are very deep, moderately well drained soils. Permeability is moderate and runoff is medium to slow. Surface soils are dark reddish brown, brown and light brown sandy loam. Reaction of surface and subsoils is strongly acid (pH 5.0). This series is suitable for field crops and covers an area of about 4,000 rai. Sithon series covers an areas of about 500 rai. It is loamy clay or clay and poorly drained. The soil are suitable for rice in the rainy season and for field crops in the dry season.

1.3 Cropping patterns

Most land areas of the project are level to flat land. In the rainy season, farmers normally grow rice in the lowland and field crops in the upland areas especially cassava. With the availability of irrigation water, farmers can start their rice crop earlier in the season, i.e., in late June or July. RD 6 is the most popular rice variety and is widely grown in the area. Cassava is grown only in the upland areas on Korat soils.

The main aim of irrigation water is not for a second rice crop since it requires too much water. Due to damage of their rice crop in the rainy season by flooding, farmers are frequently allowed to grow rice in the dry season. The second rice crop was first grown in 1983 for 200 rai and the area increased up to 400 rai in 1985. RD 23 variety has been used to replace RD 7 and RD9 since it is more tolerant to rice blast disease. Fertilizer (16-20-0) is applied at the rate of 30 kg/rai. Furadan 3 G. at the rate 2.6 kg/rai is used to control stem borer. Under this type of cultural practices, the average yield is about 450 kg/rai.

Table D-1

Mean Monthly Rainfall Temperature, Relative Humidity and Evaporation at Roi Et (Period 1955-1968)

Month	Mean Monthly Precipitation (mm)	Mean Monthly Temperature C	Mean Monthly Relative Humidity %	Mean Monthly 2/ Evaporation (mm)
Jan	1.8	23.5	63	155
Feb	12.4	25.9	62	154
Mar	36.5	28.7	60	191
Apr	86.4	30.2	63	187
May	190.8	29.7	72	167
Jun	188.8	28.9	75	153
Jul	196.1	28.5	76	153
Aug	251.6	28.0	80	131
Sep	324.4	27.5	82	117
Oct	95.0	26.8	76	153
Nov	9.3	25.2	70	151
Dec	0.2	23.3	66	151
Total	1,411.3	326.2		1,863
Average		27.18	70	

1/ The Soils of the Kingdom of Thailand by F.R. Moormand and S. Rojanasoon-thorn
2/ Period 1961-1968.

Field crops grown in the dry season are watermelon, glutinous corn and vegetables. Watermelon was introduced into the project area about 10 years ago. Although it is a high return crop, it also requires high production inputs and skill. Watermelon needs good land preparation and intensive care. Farmers normally grow watermelon on raised beds with a hill size of 40x40x40 cm. They are usually fertilized with both farm manure and chemicals. Normal spacing is 120x110 cm. The most widely grown variety is Sugar Baby. Watermelons have many pests such as beetles, leaf minors and leaf rollers which requires regular insecticide sprayings. The crop will mature in about 70-75 days and yield about 2,000-2,500 melons per rai.

Glutinous corn is normally planted in double rows with 30x30 cm spacing on one meter raised beds. Farm manure mixed with 15-15-15 fertilizer is used at the beginning when seeded. The crop is normally top-dressed with 15-15-15 fertilizer at the rate of 50 kg/rai. Harvesting can be done in 70 days. The average yield is about 6,000 ears/rai and the price is 0.6-0.7 baht/ear.

Peanuts are also planted in the project area on 50 cm beds with 30x30 cm spacing. Tainan 9 variety is used and planted 2 seeds per hill. Furadan is normally applied before seeding to control subterranian ants. The crop can be harvested at 120 days and average yield is about 80 kg/rai which is rather low for peanuts in the Northeast. Cropping patterns for Huai Aeng are illustrated in Figure D-2.

2. Huai Khilek, Mukdahan Province

Huai Khilek irrigation scheme is located in the Amphur center of Nikom Kham Soi, approximately 27 km from the city of Mukdahan. Construction on the reservoir started in 1964 and was completed in 1965. The system commands an area of 8,625 rai and serves 611 families. Average farm size is approximately 20 rai.

2.1 Rainfall

The project site is located in the Mekong Basin where rainfall is generally above average for the Northeast. From the 15-year record, annual rainfall

at the project site is 1531 mm. The rainy season lasts from April to November and has a bimodal type of distribution with the first peak in April to June and the second in July to October. Monthly rainfall for Huai Khilek Project site is detailed in Figure D-3.

Average temperature at the project site is 26.6 c. Minimum temperature, which normally occurs in December is about 22.5 c and the maximum temperature in April is 29.9 c.

2.2 Soils

The project site contains rolling land and is made up of several soil series used for rice, field crops and fruit tree production. The major soil series in the project boundary include Chiang Rai, Nakorn Prathom, Roi Et, Renu, Warin, Tartphanom and Sanpaya.

Soils suitable for rice production are Chiang Rai, Nakhon Prathom, Roi Et, Renu, Sanpaya and Sithon series. These soil series are developed from old alluvium. The soils are very deep, poorly drained and have moderate permeability and slow or medium runoff. Surface soils are dark gray or gray silty clay loam or light reddish brown silt loam. Reaction ranges from strongly acid (pH 5.0) to neutral (pH 7.0). Subsoils reaction ranges from very strongly acid (pH4.0) to alkaline (pH 8.0).

Soils suitable for field crop production are series of Sanpaya, Sanpatong, Satuk and Warin. There soils are derived from recent and old alluvium. They are very deep, moderately to well drained with moderate permeability and have medium to rapid runoff. Surface soils range from pinkish gray and light reddish brown silt loam, to dark brown loam. Reaction ranges from neutral to strongly acid.

Fruit trees will grow well in soil series of Satuk, Tartphanom and Warin. They are derived from old alluvium and are very deep, well drained with moderate permeability and medium to rapid runoff. Surface soils are brown to dark brown loam. Reaction ranges from medium acid to neutral.

2.3 Cropping patterns

In the rainy season, main rain crop of the lowland areas is rice. Upland areas are usually devoted to field crops such as sugar cane, corn, peanut, cassava, kenaf and sesame. The proportion of production areas in rice to field crops is about 60:40. For example, in 1985 the planted area for rice was 4,677 rai while for field crops was 2,985 rai. The most important field crop in 1985 was sugar cane. Also, 1985 vegetable area was 227 rai.

Rice varieties grown in the rainy season are glutinous types and improved varieties such as RD6, RD8, and Sanpatong, early maturing varieties. Popular varieties planted in the higher terrace areas are Pong-Anew and Plakeng. The average yield for the whole project areas is 200-350 kg/rai. Only small land areas are used to produce non-glutinous rice. Sugar cane is also an important field crop produced in the area to sell to the sugar mill located in Kham Soi Land Settlement. Variety F-141 "Pinda," provided by the sugar mill, is grown in their area. Land preparation is done by hired tractor at the cost of 450 baht per rai,which include two plowings and creation of a raised planting bed of 50 cm width. Fertilizer, 15-15-15, at the rate of 25 kg/rai is used. Harvesting starts from December; 1985 planted area was about 1,637 rai,with average yields in the range of 5-10 tons/rai.

Dry season crop production is practiced in limited areas. Vegetables are the major crops farmers grow. These include yard-long bean, chili, eggplant and cucumber. About 33 percent of total cropped area in the dry season is planted to vegetables. Area planted to vegetables is detailed in Table. Yard-long bean is grown after rice, on raised beds of 120 cm width with a drainage ditch of 30 cm. A spacing of 50x70 cm is used. Organic manure is first applied, followed by chemical fertilizer (13-13-21) at a rate of 50 kg/rai. The crop needs insecticide sprayed every two weeks. Harvesting can be done after about 50-60 days.

Chilies are grown widely in this area. A spacing of 120x120 cm is used. Normally, seedlings are transplanted in hills of 30x30 cm. After germination, the stand is thinned to only two plants per hill. Farm manure along with chemical fertilizer is applied. Harvesting starts at 4 months and lasts for 6 months. Average yield is one ton per rai, but this requires a monthly top-dressing with 13-13-21 fertilizer. Peanuts were introduced to the project site in 1983 and the production area increased rapidly. In some areas, RD rice varieties are grown in the dry season under irrigation with yield of 500 kg/rai. Crop calendars for the project area are given in Figure D-4.

Table D-2
Production Areas of Dry Season Crops at
Huai Khilek 1983-1986 (rai)

Crop	Crop Year 1983	1984	1985	1986
Vegetables	485	692	707	542
- Yard long bean	118	120	118	95
- Chili	75	88	107	57
- Eggplant	106	101	108	42
- Cucumber	110	102	95	96
- Others (eg. pumpkin, cabbage)	76	281	279	252
Peanut	12	92	102	1
Rice	27	50	50	-
Total	524	834	859	543

Source: Amphur Nikom Kham Soi Agricultural Office, 1986

3. Huai Chorakhe Mak, Buri Ram Province

The Huai Chorakhe Mak reservoir is located in Muang district about 12 km from Buri Ram city. The project was started in 1962 and completed in 1963. Project rehabilitation started in 1985 and is expected to be completed in 1989. Total irrigation area after completion will be 9,600 rai. Average farm size is around 12 rai.

3.1 Rainfall

As in the other parts of the Northeast, rainfall normally starts in April and increase gradually until September or October. Highest rainfall in October is influenced by the Northeast Monsoon. Rainfall will decrease abruptly in late October and completely stop at the end of October or early November. There is normally a dry spell for three weeks or one month in June or July. The twenty-year average annual rainfall at Buriram is 1,230 mm which is the average annual rainfall of the Northeast region.

Average annual temperature at the site is 27° C. Mean monthly values are relatively uniform throughout the year. The mean temperature is highest in April and lowest in December. Mean maximum values are 34° C and 15.9° C in April and January, respectively. Figure D-5 illustrates monthly rainfall at Huai Chorakhe Mak.

3.2 Soils

Soils on both sides of the main canal are different. Soils in the right main canal (RMC) are clay or loamy clay since they developed from volcanic rock from the nearby Khao Kradong. They are fertile due to the accumulation of silt washed away from the sloped hill. Soils on the light main canal (LMC) are sandy or loamy sand with rolling topography.

DLD's soil survey indicated that the project site contains more than 38 soil groups. The main soil series include:

Nakhon Phanom (31.57%)---Nakhon Phanom series have developed from old alluvium on low terrace. The soils are very deep, poorly drained and have slow permeability and run off. Ground water is deeper than 1-5 m in the dry season. Surface soils (0-15 cm) are brown or reddish brown sandy loam, or silt loam or silty clay loam. Reaction of the soil is strongly to slightly acid (pH 5.6-6.5). Reaction of the subsoils is strongly acid (pH 4.5-5.0). These soils are used for paddy fields.

Buriram (11.87%)---Buriram series derived from volcanic rock on the lower part of lava flow. They are very deep, poorly drained soils. Permeability and runoff are slow. Surface soils (0-20 cm) are black and dark gray silty clay loam or clay. Reaction of the soil is strongly acid to slightly acid (pH 5.5 - 6.5).

Reaction of subsurface and subsoils is mildly alkaline (pH 6.5 - 8.0). They are used for rice production.

Renu (11.12%)---Renu series also developed from old alluvium. The soils are deep, poorly drained and have moderate permeability and slow runoff. Surface soils (0-20 cm) are pinkish gray or light reddish brown or reddish brown sandy loam or loam or silt loam or silty clay loam. Reaction of the soil is strongly to slightly acid (pH 5.0 - 6.5). Subsurface and subsoils have reaction ranging from very strongly to strongly acid (pH 4.5 - 5.0). These soils are used for rice cultivation.

Khao Yoi (9.94 %)---Khao Yoi series have developed from old alluvium. They are deep,poorly drained soils. Permeability is moderate and runoff is slow. Ground water is deeper than 1-5 m in the dry season. Surface soils (0-15 cm) are light reddish brown or reddish brown sandy loam or loam. Reaction of the soil is very strongly acid to slightly acid (pH 4.5 - 6.5). Subsurface and subsoils have reaction of medium acid to mildly alkaline (pH 6.0-8.0). These soils are transplanted to rice.

3.3 Cropping patterns

Based on land suitability, land in the project areas can be classified into paddy field and upland crop areas. Land suitable for paddy is about 14,967 rai or 80% of the area.

Before construction of the tank irrigation systems, farmers grew crops under rainfed conditions. Most of the areas both in the lowland and upper paddy fields (higher terrace) are transplanted to rice. Lowland paddy fields near the river (Huai Chorakhe Mak) are normally flooded and fail to produce a good rice crop. Besides rice, only glutinous corn is grown in the small areas of upland during the rainy season. In the dry season, farmers grow vegetables, using a supply of water from nearby hand-dug wells or from Huai Chorakhe Mak. Only glutinous corn and cucumber are normally grown during the dry season.

Even with the availability of water in the irrigation systems, rice is still the main crop occupied most of the areas in the rainy season. Small portions of upland areas are grown to glutinous corn. In the dry season only small portions of irrigated land are under cultivation. About 650-850 rai are under cultivation of glutinous corn, peanut, soybean, mungbean, sesame and vegetables such as cucumber, garlic and shallot. Vegetables are grown primarily for family consumption. Off-farm employment is attractive to farmers in the dry season, since the project site is close to town.

Rice varieties normally grown are Khao Dokmali 105, Khao Tahang and RD 6 (glutinous). Fertilizer 16-20-0 is normally applied to rice at the rate of 25-40 kg/rai. Mungbeans are grown in the paddy fields after rice in the dry season. Standard land preparation is practiced after burning of rice stubble. Flood irrigation is needed to wet the soil before broad casting of seed. Fertilizer 16-20-0 at the rate of 25-40 kg/rai is applied to mungbean.

For peanuts, field burning and flood irrigation are practiced before land preparation is start. Seedbeds are prepared in the form of ditch and dikes pattern. Dikes are about 60-80 cm wide, and ditch are spaced every 25 cm. A glutinous corn variety is used and is grown in hills spaced at 30 cm width. About 6-8 seeds per hill are planted, which leave 3-4 healthy seedlings per hill. Fertilizer, 15-15-15 is usually top-dressed at the rate of 15 kg/rai. Harvest is usually in about 65 days. Average yield is approximately 5000-7000 ears/rai which will earn 4,000-5,000 baht. Cropping patterns in non-irrigated and irrigated areas of Huai Chorakhe Mak are presented in Figures D-6 and D-7, respectively.

Figure D–1 Monthly Rainfall and Temperature (1974–1981)
Huai Aeng Project

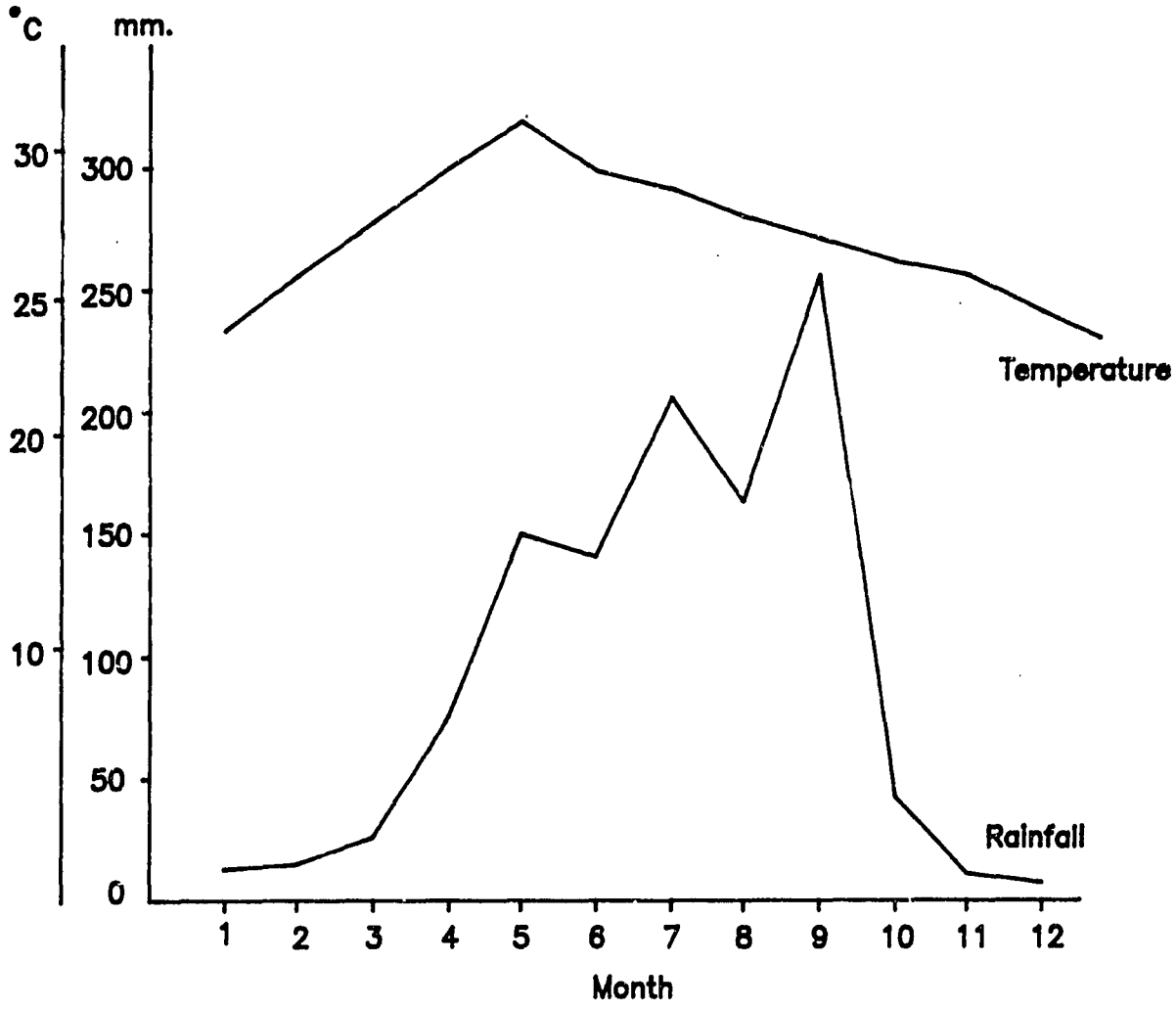
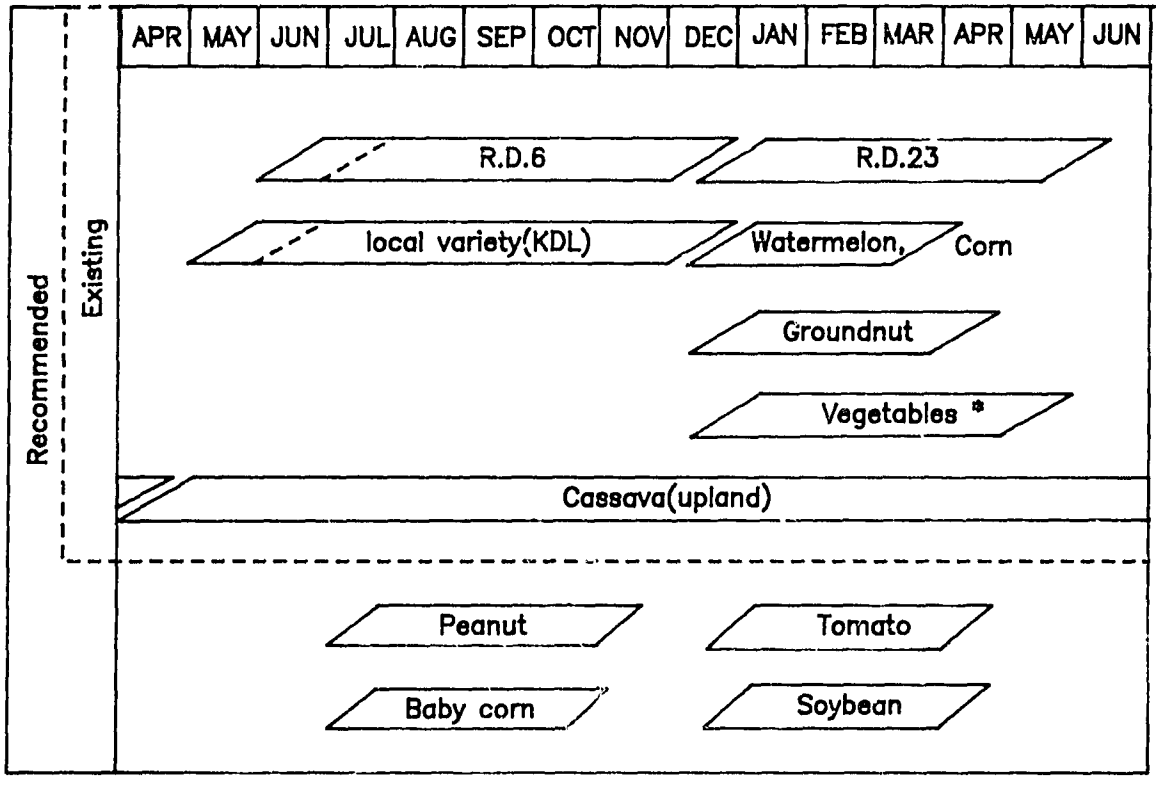


Figure D–2 Cropping Patterns for Huai Aeng Project



* Vegetable = Chili,White gourd,Green gourd
Cucumber,Yard long bean,Egg plant

Figure D–3 Monthly Rainfall, Huai Khilek Project (1984–1986)

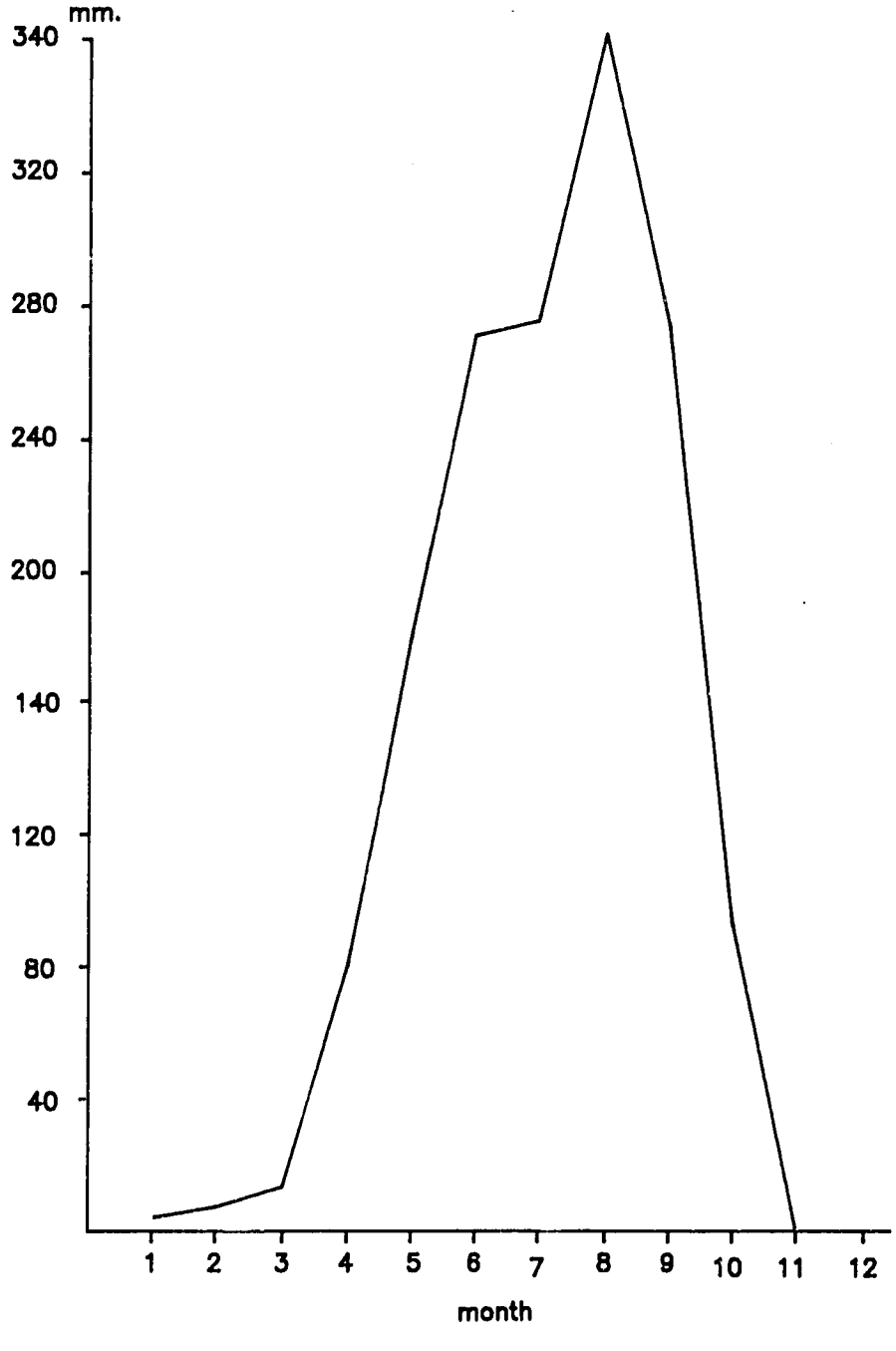


Figure D–4 Cropping Patterns in Irrigated Area (Huai Khilek Project)

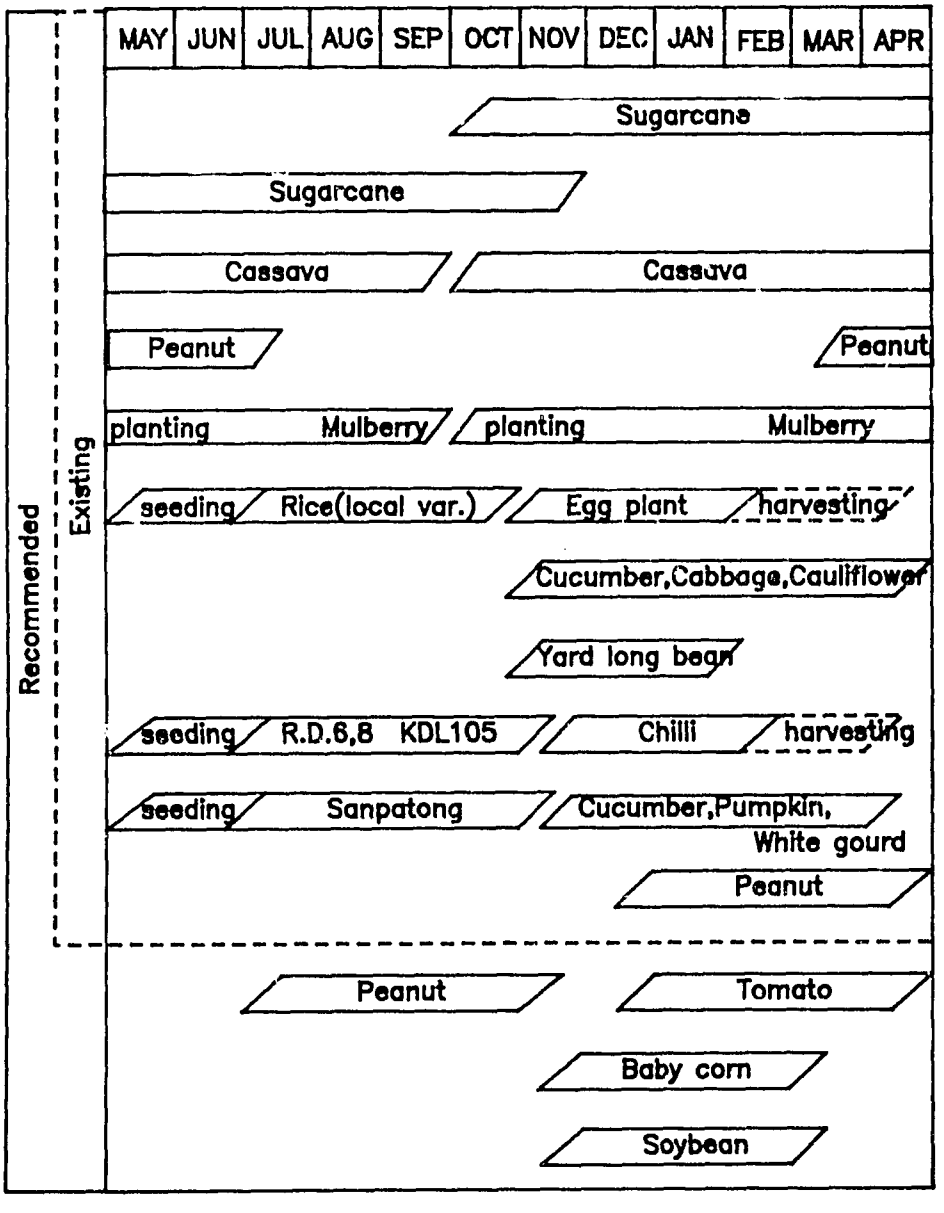


Figure D–5 Monthly Rainfall and Temperature (Huai Chorakhe Mak Project)

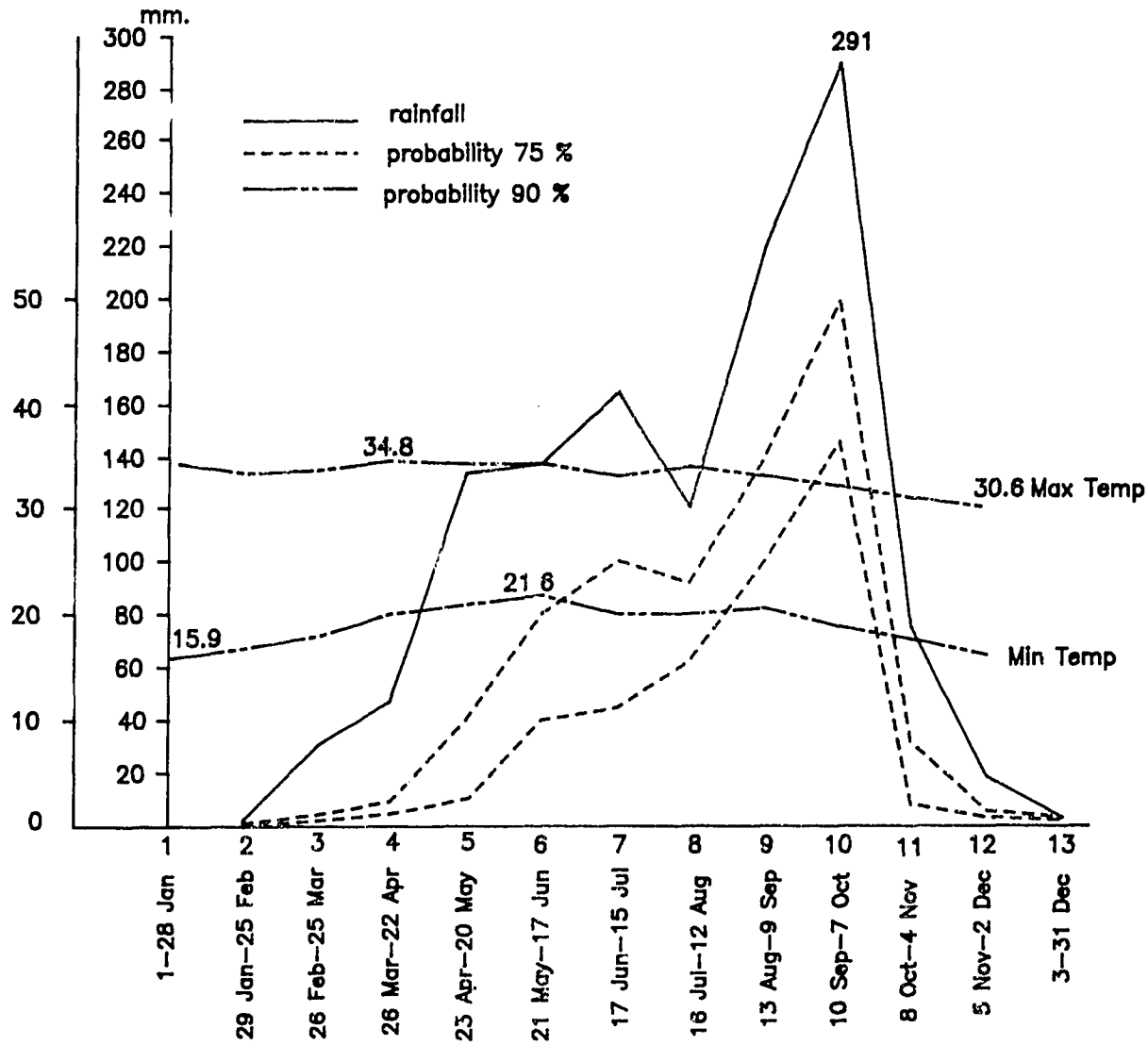


Figure D-6 Cropping Patterns in Non-irrigated Area (Huai Chorakhe Mak Project)

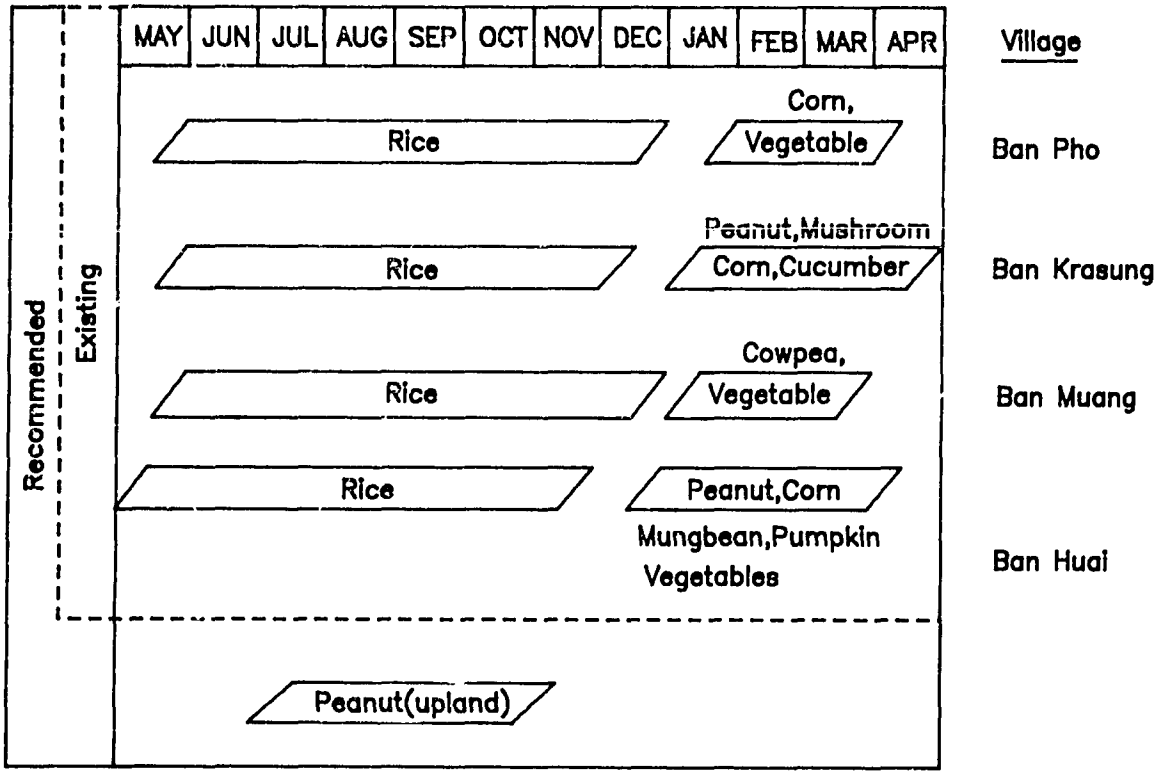
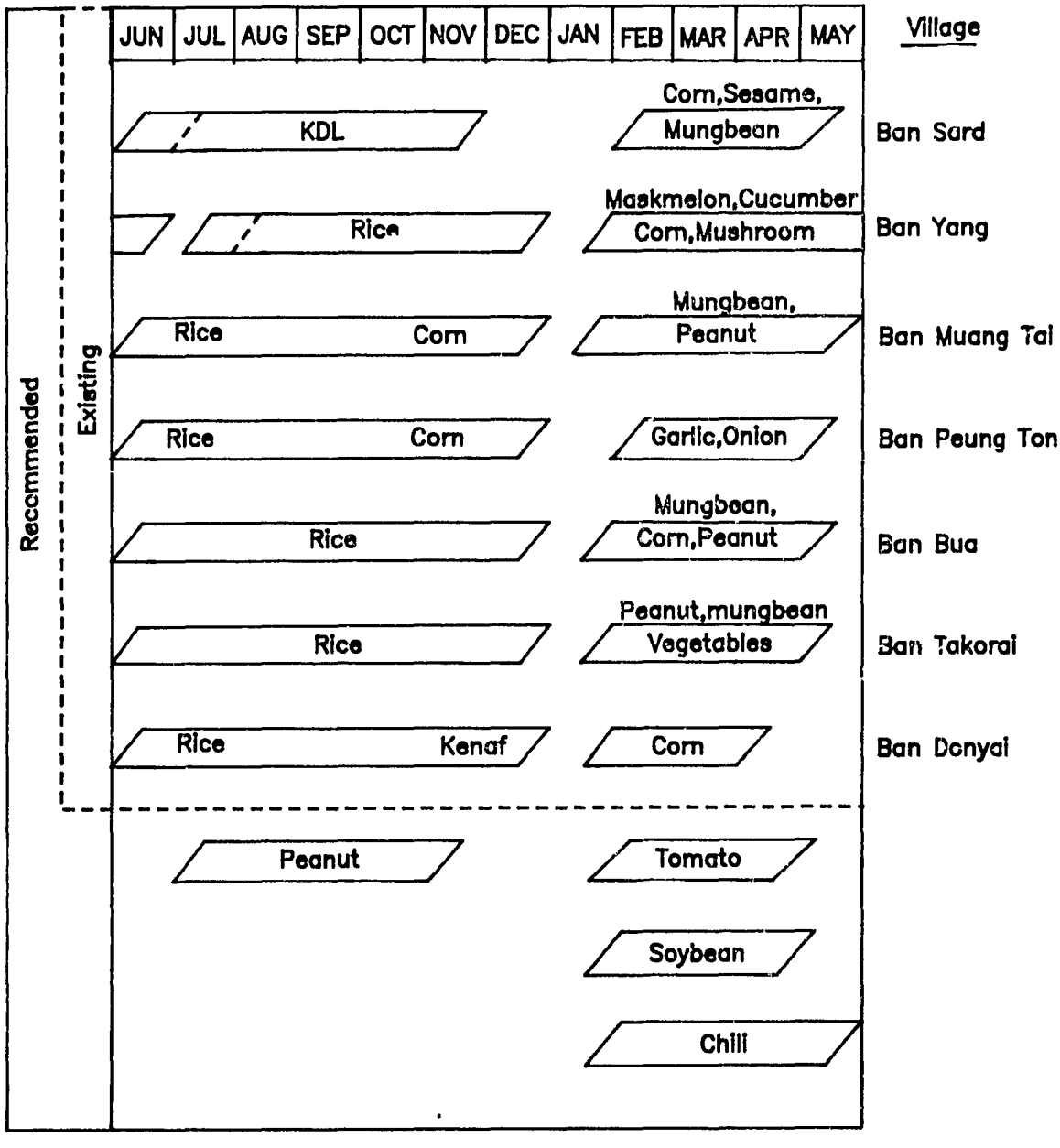


Figure D-7 Cropping Patterns in Irrigated Area (Huai Chorakhe Mak Project)



E

WATER USERS

Chaek Group Agreement for Water Use and Maintenance

Water Users Association Rules and Regulations

Selection Criteria for the Best Performing Farmer Institution in Irrigation

Guidelines for Monitoring Site Rehabilitation and O&M Stages

- Preliminary Monitoring Form for the Construction Phase
- Preliminary Monitoring Form for the Operation and Maintenance Phase in the Wet Season
- Preliminary Monitoring Form for the Operation and Maintenance Phase in the Dry Season

E

WATER USERS

CHAEK GROUP AGREEMENT FOR WATER USE AND MAINTENANCE

Chaek Group No.

Main Ditch No.

Canal: LMC or RMC

1. Members will receive water on a schedule that the chaek group leader or assistant chaek group leader determines.

2. Any person stealing water will be fined ___ baht.

3. Any member who obstructs the watercourse at the main canal or the farm ditch or damages the irrigation structure will be fined ___ baht and that person must remove the obstruction or be fined _ baht.

4. All members must participate in cleaning and repairing the farm ditch, main canal, and irrigation structures as the chaek group leader and the assistant chaek leader schedule. If not, he the member must send a substitute, of an age no less than ___ years. If not, the member will be fined ___ a day.

5. If the chaek group leader and his assistant violate the rules and regulations, they will be fined ___ times the amount paid by the other members.

6. Any member who destroys and damages an irrigation structure and illegally opens and closes the gate will be fined ___ baht.

7. The chaek group leader and the assistant leader are responsible for judging the culpability of those charges with violating these rules and regulations and for determining the fine. The fines will be used for cleaning and repairing the farm ditch, main canal and irrigation structures and for any other use for the benefit of the members.

Agreement made: date/month/year

Signatures of members:

WATER USERS ASSOCIATION RULES AND REGULATIONS

1. Name of the WUA:

2. Number of members:

3. The Policing Committee consists of some chaek group leaders or all main ditch group leaders. The committee is responsible for inspecting activities along the canals and ditches to determine that activities are consistent with approved schedules and plans.

4. The Administrative Committee is composed of the WUA president, his assistant and secretary, specialists in agriculture, irrigation, credit, marketing, and auditor, and chaek group members or chaek group leaders, not exceeding a total of 15 persons. The president and his committee are responsible for implementing the project as proposed, in line with the regulations governing implementation.

5. Objectives:

   a. cooperate with the RID officers in water allocation;

   b. maintain on-farm system (farm and main ditches);

   c. cooperate with RTG officials who are providing services and disseminating knowledge on O&M, technologies for agricultural production, and credit;

   d. providing, loaning, renting, and selling agricultural inputs to WUA members; and

   e. contact markets for WUA members to assist them in selling their crops.

6. Sources of Income:

   a. Memberships fees

      Members of the WUA pay a one-time membership fee of ___baht. The chaek leader is responsible for fee collection and gives to the cash to the WUA president. The fee is to be used in a revolving fund for WUA.

   b. Fines

      The chaek group leader is responsible for collecting fines within __ days. The fines are to be used for maintenance of the chaek (_%), maintenance of the main ditch (_%), maintenance of the main canal (_%), WUA activities (_%), and for the development of cooperation with RTG, and for religious and social affairs (_%).

c. O&M fees

Wet season cropping	___ baht/rai
Dry season cropping	___ baht/rai
Fish pond	___ baht/rai
Duck raising	___ baht
Other	___ baht

Members must pay wet season O&M fees before the end of January and dry season O&M before the end of April. The chaek group leader collects the O&M fees for the WUA president or auditor.

d. Agricultural inputs

Members who participate in demonstration and trial plots and are provided seeds, fertilizer, pesticide, and other agricultural inputs must return these inputs in kind or in cash equivalent to the WUA president or WUA administrative committee through their chaek group leaders.

The selection of farmers to participate in demonstration and trial plots is made jointly by the administrative committee and the sub-district agricultural extension worker. Farmers must sign a contact with the WUA, agreeing to pay back the WUA for the inputs.

Payback rates: cash/kind

Seeds	___
Fertilizer	___
Pesticide	___
Other	___

The WUA administrative committee and the agricultural extension worker determine how the repayments are to be used for such purposes as funeral rites, production, fishing, and donations.

7. Terms of office:

Chaek group leader	___ years
Main ditch group leader	___ years
Main canal group leader	___ years
President	___ years

8. Financial control

a. All WUA income will be deposited at BAAC or a commercial bank.

b. Balance sheets are to be kept.

c. Chaek group leaders are to give WUA income they collect to the WUA president or auditor within seven days.

d. Any requests for WUA funds by chaek group leaders or members of the administrative committee are to be made at least 15 in advance so the WUA president or auditor can withdraw the money.

e. The WUA president and auditor must present a financial report to the monthly field working group.

f. The field working group has the right to review and invoice the accounts of the WUA if there is a problem.

SELECTION CRITERIA FOR THE BEST PERFORMING FARMER INSTITUTION IN IRRIGATION

The Ministry of Agriculture and Cooperative has established a policy to select the best performing farmer institution in a number of fields, including irrigation. The award will be presented by the King on the Royal Ploughing Day (eg. 5 May 1989), which demonstrates the Ministry's support for farmer organizations in irrigation.

1. Objectives

to promote farmers participation in developing irrigated agriculture;

to promote group participation in O&M for the greatest benefits; and

to promote efficient and economical water use.

The goal of the award is the encouragement of farmer institutional self-reliance and the coordination of these farmer institutions with both the government and the private sector in increasing yields within the irrigation project area.

2. Qualifications of the Farmer Institutions for Eligibility for Selection

2.1 Farmer institutions in irrigation are of two types:

water user associations and water user cooperatives [the latter are in the Land Consolidation Project] that are registered and are legal entities and

water use administrative groups that are federated to implement activities.

The federated organizations have an administrative committee selected from water users. The administrative committee members should consist of the group chairman, secretary, registrar, and auditor. This administrative committee is to strengthen efficiency in water management and the maintenance of irrigation structures. It leads to strong farmer institutions, which can be registered as legal bodies in the future.

2.2 Project Size

For WUAs and water user cooperatives, the project size is as stated in the rules and regulations governing their establishment and implementation.

For the medium scale project, the administrative group must cover the entire area of at least one zone, or a minimum of 5,000 rai.

For the large scale project, the administrative group must cover at least one zone or a minimum of 5,000 rai.

2.3 Group Size

The number of farmers in a group must not be less than 50 families.

2.4 Criteria to be Considered

Administrative groups, WUAs, and water user cooperatives are eligible for consideration if:

they have ongoing activities that are useful for all members, has the best performance of making use of water to increase yields, and can be used as an example for others;

they are established and registered at least for two years to the day the regional subcommittee meets for selection; and

they have received an award in irrigation at the national level or have not received an award for at least 5 years.

3. Criteria for Selection

3.1 Initiative (20 Points)

having other activities related to the promotion of water use;

initiating systematic efforts, such as meeting for planning before the cropping season, preparing the water use schedule, and coordinating with government agencies or other farmer groups;

initiating the development and selection of new technology; and

developing or modifying expensive or local resources and technology to the best benefit.

3.2 Cooperation among Members (20 points)

abide by the rules and regulations;

select a strong leader;

committee members know their responsibilities;

committee members devote themselves to the group, association, or cooperative;

members cooperate with one another;

members have the right attitude and think primarily of benefits to the group rather than to themselves; and

members are strongly united.

3.3 O&M Activities (20 points)

members cooperate best in the maintenance of the delivery system;

members determine a maintenance plan;

members determine criteria for mobilizing labor, material, and money for maintenance; and

members request technical assistance from the project and follow the recommendations.

3.4 Production and Local Development Activities (20 points)

the group or WUA has good or satisfactory yields;

members seek to improve both the efficiency and quality of production;

members modify production to be consistent with the situation;

members transfer useful technology to other farmers; and

members cooperate with other farmers for local development and for the benefit of the group.

3.5 Self-reliance (20 points)

members mainly use the group's funds;

members undertake activities that assist other members;

members seek assistance from other members, rather than going to others;

when they received outside support, the members use the resources for the benefit of the group; and members set guidelines to strengthen self-reliance and to activities.

4. Means of Selection

4.1 The Selection Committee

The selection committee at the ministry level is in charge of determining the method and criteria for selection. At the department level, the RID appoints the selection committee to select the best administrative unit, WUA, or water users cooperative in the whole country. The selection committee then sends the report to the committee at the ministry, through the DOAE, level for final consideration.

4.2 Procedures for Selection

1. The selection committees at the ministry and department levels are appointed and the criteria are set. The regional selection committee selects one group, WUA, water user cooperative and proposes it to committee at the department level.

2. The department appoints a working group to visit institutions which are competing for the award.

3. The selection committee at the department level selects the best candidate and reports its recommendation to the committee at the ministry level.

4. The selection committee at the ministry level makes the final selection of the group to be awarded by the King.

4.3 Schedule for Deliberations

15 December-15 January	Regional committee review
16 January - 15 February	Working group visits
16 February-29 February	Department committee selects
15 March	RID reports to ministry
15 April	Final decision by ministry

GUIDELINES FOR MONITORING SITE REHABILITATION AND O&M STAGES

Farmers will be trained by ICOs to complete simple monitoring forms which are based on the actual steps of the Standard Operating Procedure. A different form is prepared for each of the three stages. Suggested models appear in Appendix E, listing in sequence all of the anticipated actions and requirements from group formation through O&M. Rather than offer here a complex and rigid mechanism for the transfer of the findings up the system, ICOs ought to work with the chack groups, WUAs, and field working groups to determine a simple, implementable procedure. The procedure ought to include how the information is transmitted from chack group leaders to the administrative committee in a useable form. This monitoring ought to become part of the field working group's monthly agenda. Findings, problems, and actions taken are then regularly conveyed to the On-Farm Water Development Branch in RID and other line agencies for modifying the approach and implementation activities and schedule, as needed.

By using the farmers to monitor the work:

- No extraordinary hiring of staff is required and little additional funding ought to be necessary, since the On-Farm Water Development Branch is already responsible for monitoring O&M efforts.
- The monitoring system reinforces the Standard Operating Procedure, since farmers are actively involved with an assigned, continuing responsibility.
- Water users are aware of the entire sequence of the work at each stage.
- Water users gain a practical understanding of their rights and responsibilities and can measure performance against expectation.
- The system emphasizes the accountability of RTG staff and construction teams and requires their frequent interaction with water users.
- Accurate feedback can be channeled regularly to the field working group through the WUA and problems can be quickly identified.
- Responsible officials at the national and provincial levels will be able to track and assess project implementation and make necessary adjustments as an ongoing process.

PRELIMINARY MONITORING FORM FOR THE PRE-CONSTRUCTION/DESIGN STAGE

Activity	Completed	Date	Remarks
1. First meeting with ICO			
2. Monitoring discussed			
3. Site design introduced			
4. Chack group leader chosen			
5. Monitoring plan approved by chack group			
6. Initial discussion about rules and regulations			
7. Agreement on rules and regulations			
8. Agreement on right-of-way reimbursement			
9. Field visits to other sites			
10. Review preliminary design			
11. Suggestions made to RID regarding design			
12. Discussions with RID about design and modifications			
13. Consultations on training needs			
14. Training program discussed			
15. Monitoring forms transmitted to WUA or reviewed with ICO			
16. WUA initial meeting, fee collection, and follow-up			
17. Discussions about dry season farming and income potential			

PRELIMINARY MONITORING FORM FOR THE CONSTRUCTION PHASE

Activity	Completed	Date	Remarks
1. Construction schedule introduced			
2. Interim for schedule update agreed to			
3. Informed about RID visit to stake farm ditch			
4. Contributed stakes			
5. Assisted with laying stakes			
6. Farmers approached for labor			
7. Farmers recruited for hired labor or for contribution			
8. Final design shown and chack group discussion			
9. Consensus reached between chack group and RID			
10. Final revised design presented			
11. Field trip			
12. Training provided			
13. Feedback to ICO/zoneman on construction			
14. Resulting construction changes			
15. Dry season crop techniques			
16. Initial market contacts with private sector technicians			
17. Initial FMPGs discussed or formed			

PRELIMINARY MONITORING FORM FOR THE OPERATION AND MAINTENANCE PHASE IN THE WET SEASON

Activity	Completed	Date	Remarks
1. RID meeting on maintenance plan			
2. Labor contributed for maintenance in			
- farm ditch			
- main ditch			
- main canal			
3. RID meeting on water delivery in			
- farm ditch			
- main ditch			
- main canal			
4. Water delivery and rotation schedule discussed and agreed			
5. Determining and regulating water allocations in			
- farm ditch			
- main ditch			
- main canal			
6. O&M and other fees collected			
7. Survey by RID and WUA of interest in dry season			
8. Training for dry season			
9. Rules violations			
10. Rules enforcement			

PRELIMINARY MONITORING FORM FOR THE OPERATION AND MAINTENANCE PHASE IN THE DRY SEASON

Activity	Completed	Date	Remarks
1. Maintenance plan meeting			
2. Labor contributed for maintenance in - farm ditch - main ditch - main canal			
3. Meeting on water delivery in - farm ditch - main ditch - main canal			
4. Water delivery and rotation schedule discussed and agreed			
5. Determining and regulating water allocations in - farm ditch - main ditch - main canal			
6. Informed of dry season water supply			
7. Formation of FPMGs			
8. Training in contract marketing			
9. O&M and other fees collected			
10. Contact with markets - extension worker, factory technician			
11. Contracts signed			
12. Rules violations			
13. Rules enforcement			
14. WUA activities			

F

MARKETING

A Marketing Contract Currently Used in Roi Et

Suggested Model for a Marketing Contract

TABLES

FIGURES

A MARKETING CONTRACT CURRENTLY USED IN ROI ET

Agreement to whom it may concern for participating in baby corn production:

This agreement is made on the.....day of (month), between farmer name (Mr., Ms.) ....., age..... years, Address No....., Mu ....., Tambon ....., Amphoe ....., Changwat ..... and Universe Foods Co., Ltd., address No.92 Tambon Nua Muang, Amphoe Muang, Changwat Roi Et, Tel. (043) 511831, by Mr. ..... as representative of the Company. Both parties are willing to operate the program under the following conditions:

1. The company agrees to

1.1 provide technician staff to advise new cropping techniques of baby corn to the farmer throughout the planting period without any service charges,

1.2 provide good quality of production inputs to sell to the attended farmer at fair prices,

1.3 purchase peeled baby corn from the attended farmer at the price of .....baht/kg. The peeled baby corn must meet the company's established standards as follows:

1.3 1 perfect ears of baby corn
1.3.2 length of ear not over 9 cm.
1.3.3 the shortest ear not less than 4 cm.
1.3.4 diameter of the biggest size not over 1.5 cm.
1.3.5 diameter of the smallest size not less than 10 cm.
1.3.6 ears fresh, not sitting in the water before sales at all
1.3.7 kernels are straight

1.4 purchase unpeeled baby corn at the price of .....
baht/kg. in the event the farmer sells unpeeled produce.

2. The attended farmer agrees to

2.1 plant baby corn on ..... rai,

2.2 look after the crops strictly as suggested by the company's technical staff,

2.3 join the program willingly and pay additional expenses based on the company's advice, and

2.4 join hands in work and solve problems together with the company.

3. Both parties agree that

3.1 In case of damage due to natural forces, war, politics, or other uncontrollable situations which cause a bad harvest, each party will be responsible for himself and no penalty can be claimed by either

3.2 This agreement is valid immediately at the date of adding both parties' signature.

3.3 This agreement has two copies, each retaining one.

Farmer's signature .....
( )

Company representative's signature .....
( )

Witness' signature .....
( )

SUGGESTED MODEL FOR A MARKETING CONTRACT

This agreement is made on the ..... day of (month), year, between the Farmer Production and Marketing Croup (FPMG) in Mu ....., Tambon ....., Amphoe ....., Changwat ..... and food processing plant/middleman (name), in (address).

Both parties are willing to operate the program together under the following conditions.

1. The plant agrees to

1.1 provide technician staff to closely advise on cropping method and to help solve problems of production to the FPMG through the planting period without any service charges,

1.2 provide seeds and other production inputs (if necessary) for sale on credit to the members of FPMG at prices not over the current local market prices, and

1.3 determine a schedule (including dates) for planting practices with the FPMG (see attached schedule)

1.4 provide vehicles without service charges to collect produces from the members of FPMG at agreed to delivery places on farm on the on the following fixed dates:

Date of Delivery	Name of Delivery Places	Approximate Amount*(tons/kgs.)
.....	.....	.....
.....	.....	.....
.....	.....	.....
.....	.....	.....
.....	.....	.....
.....	.....	.....
.....	.....	.....

* may be vary 10% from this amount

1.5 purchase different grades of produces from the members of FPMG at the following guaranteed prices:

Grade of Produces	Farm Prices (baht/kg.)
A	.....
B	.....
...	.....

Grading by the farmer will be inspected and approved by a representative of buyer and a representative of the FPMG on purchase day. The quality and standard of each grade are established as follows :

Grade	Description of quality and standard
A	.....
B	.....
...	.....

1.6 payment is made for produces to individual members/farmers.

2. The chairman of FPMG on behalf of the members agrees to

2.1 Plan a production schedule as mentioned in 1.3 with the cooperation of the plant (or middleman) and is willingly to follow and operate the scheduled activities strictly,

2.2 harvest and sell all produce to the processing plant (or middlemen) in the agreed to amount and on time as mentioned in 1.4, and at the prices fixed in 1.5 depending on the quality produced,

2.3 purchase production inputs from the plant/middleman when the prices are not higher than the local market prices, and

2.4 work closely with the plant/middleman to solve production problems.

3. Both parties agree that

3.1 in case of damage due to natural forces, war, politics or other uncontrollable situations which cause bad harvests, affecting quality and quantity, each party will be responsible and no penalty will be claimed each other.

3.2 in case of damage caused by either the processing plant/middleman or the member of FPMG, a compensation can be requested from that party. Causes of damage and percentage of compensation are established as follows:

Percent of Causes of Damage	Compensation based on the the Value of Produces Damaged
Date of delivery to buyer delayed	.....
Buyer does not make payment on time	.....
Farmer does not harvest crops on time	.....

Farmer does not sell agreed
to amount (as in 1.4) .....

Others (specify)..... .....

3.3 Members of FPMG will share the risk equally if any damages occur.

3.4 The agreement is valid immediately at the signing of both parties and the witnesses and expires on (day/month/year).

3.5 The agreement has two copies, each party retaining one.

Signature of FPMG chairman	.....(Seller)	.....(Date)
Signature of processing plant/ middleman's representative	.....(Buyer)	.....(Date)
Signature of extension worker or NESSI Project officer	.....(Witness)	.....(Date)
Signature of commercial bank's representative	.....(Witness)	.....(Date)

Table F-1

Type, Number, Location and Production Capacity of Processing Plants in the Northeast, 1989

Province	Name of Processing Plant	Production Capacity	Address
Roi-Et	1)*Universe Food Co., Ltd.	- Baby Corn 40 tons/day - Tomato 25-30 tons/day - Super sweet corn 13 tons/day - Others e.g. mushroom, bamboo shoots, bean sprout, longan, papaya, mango, banana water chestnut, etc. - Total capacity 1,250 boxes per day including Baby corn 40% Tomato 30% Others 30% (Workers over 800 persons, female workers mostly)	92 Mu10, Tambol Nua Muang, Amphoe Muang Roi-Et. Tel (043) 511149, 511831, 512533
	broker of E-Sun Food Industry Co., in Chem Phae, Khon Kaen	- Baby corn - Tomato - Others (See E-Sun Food Industry in Khon Kaen)	Amphoe Muang Roi-Et
Buri-Ram	Royal Project Food Products'	- Baby Corn - Tomato (Production capacity Sai is almost the same as Royal Project in Sakon Nakhon)	Tambol Non Din Dang, Amphoe Lahan
Surin	1) Chong Siri Phanich	Groundnut shelling 58.4 tons/yr., male worker 7 persons.	1/2 Mu 4, Tambol Chom Phra, Amphol Chom Phra
	2) Wattan Phunphol Surin, Part.Ltd.	Groundnut shelling 60 tons/yr., male worker 42 persons	176,178,180 Paktama rd., Amphoe Muang surin
	3) Charoen Chai (salted Chinese radish)	Chinese radish 100 tons/yr., male worker 14 persons & female 10 persons.	118 Mu 3, Tambol Chaliang
Ubon	1) Khow Tiam Huad Ratchathani	Groundnut shelling 4,800 bags/yr., machine 14.3 horse-power, cash capital 0.81 million baht.	135 Soi Ooplisarn, Ooplisarn rd., Amphoe Muang Ubon.

Table F-1 (Continued)

Province	Name of Processing Plant	Production Capacity	Address
	2) Siew Siang	Groundnut shelling 26 tons/yr., machine 4 horse-power	2/25 Soi Lung Chalerm Wattana, Phalo Chai rd., Amphoe Muang Ubon
	3) Hua Num Warin	Groundnut shelling 1,400 bays/yr., machine 16 horse-power	Mu 1, Tambol Thut, Amphoe Warin Chamrab
	4) Nathee Thong	Groundnut shelling 6,000 bags/yr., machine 12 horse-power	449/1 Kunthaluk rd., Tambol Warin, Amphoe Warin Chamrab
	5) *Chili Processing Plant (Chamber of Canmera in Ubon Ratchathani)	Chili powder & Dried chili (Hua Rua variety)	Ban Nong Manow, Tambol Rham Yai, Amphoe Muang Ubon.
Yasothon	Boon Siri Food Cannery, Co.,Ltd*	- Baby corn 5,100 tons/yr. - Tomato 1,000 tons/yr. - Bamboo shoot 204 tons/yr. - Mushroom 240 tons/yr. - Mango 1,400 tons/yr. - Papaya 250 tons/yr. - Water melon 700 tons/yr. machine 2,160 horse-power, male worker 15 persons, female 160 persons.	109 Mu 7, Aroon Prasert rd., Tambol Thad Tong, Amphoe Muang Yasothon.
Si Sa Ket	1) T. Saeng Thai	Groundnut shelling 50 tons/mo., male worker 5 persons.	393 Mu6, Tambol Ponkha, Amphoe Muang Si Sa Ket
	2) Lui Seng Lee Chun	Groundnut shelling 10 tons/mo., male worker 2 persons.	317 Mus, Tambol Nong Krok, Amphoe Muang Si Sa Ket
	3) Tai Tiang	Groundnut shelling 300 tons/mo., male worker 7 persons.	987/26 Khukhun rd., Tambol Muang Tai, Amphoe Muang Si Sa Ket.

Table F-1 (Continued)

Province	Name of Processing Plant	Production Capacity	Address
Si Sa Ket	4) Sri Veera	Groundnut shelling 10 tons/mo., male worker 7 persons.	69 Sumrong Kiat Khunharn, Mu6, Tambol Buk Dong, Amphoe Khun Rarn
	5) Saha Kit	Groundnut shelling 87.5 tons/mo.	Mu 5, Sumrong Kial Khunharn, Tambol Si, Amphoe Khenharn
	6) Thai Charoen	Groundnut shelling 10 tons/mo., male worker 7 persons.	89 Mu 5, Tambol Nong Ya Lad, Amphoe Kunthaluk
	7) Saha Siam Farm	preserved ginger and short cucumber 10 tons per month, male worker 15 persons	149 Mu 5, Tambol Si, Amphoe Khumharn
Udon Thani	1) Wachiraphon Industry	Ginger power 4/tons/mo., male workers 9 persons	95-95/1 Wattana rd., Tambol Mak Khang Amphoe Muang Udon
	2) Saeng Chai Factory	Chili sauce 6,000 bottles/mo., male water 7 persons	237/11 Adulyadet rd., Tambol Mak Khang, Amphoe Muang Udon
	3) Mr.Ming Daowon	Groundnut powder 1.5 tons/mo.	53/5 Chamnusorn rd., Tambol Mak Khang, Amphoe Muang Udon
Nong Khai (Note : Plants 1,2,4 also produce canned baby corn and canned mushroom	1)*Sri Chiang Mai Agricultural Industry	- Tomato paste 280 tons/day (operating 100 days/ yr., in Dec.-Apr.) - Baby corn (Operating in May) Worker 68 persons	99/1 Soi 8, Mu4, Sri Chiang Mai-Sung Kom rd., Tambol Phan Phrao, Amphoe Sri Chiang Mai

Table F-1 (Continued)

Province	Name of Processing Plant	Production Capacity	Address
	2)*Thai Sun food products	Tomato paste 600-700 tons/day rd.,	26 Sri Ming Muang Mu 13 Tambol Phan Phrao, Amphoe
Sri Chiang Mai	3)*Kaset E-Sun (NACO)	Tomato paste 500 tons/day	147 Mu 2, Tambol Sang, Amphoe Seka
	4)*Agricultural Industry Nong Khai	Tomato paste 50 tons/day, worker 30 persons	3 Mitthaphab rd., Mu 3, Tambol Kong Nang. Amphoe Tabo
	5)*Luk Chai Trading, Sri Chiang Mai Phan Phrao, Amphoe	Tomato paste 180 tons/ day, worker 20 persons.	31 Mu 13, Ming Muang rd., Tambol
Sri Chiang Mai	6)*Sri Charoen Farm	Baby corn, Bamboo	Amphoe Tabo
Kalasin	1)*Thai Carter Peanuts (Exporter) (makes contract with farmers who have planted area of groundnut more than 200 rai)	Groundnut shelling 50 tons/day	142/2 Theenanon rd., Amphoe Muang Kalasin
	2) Kaset Thai	Groundnut shelling	Amphoe Muang
	3) Mr.Prasit	1,000 tons/yr.	Amphoe Kommalasai
	4)*Vegetable Oil Processing Plant (Will operate in 1990)	Soybean, Groundnut	Amphoe Kommalasoi
Sakon Nakhon	Royal Project Food Products*	- Baby corn 5 tons/day (operating 2 months/ yr.) - Tomato 1100 tons/day (operating from Jan. to April, 100 days) - Bamboo shoot 40 ton/yr. - Mushroom worker 400 persons including female 70%	Tambol Tao Ngoy, King Amphoe Tao Ngoy

Table F-1 (Continued)

Province	Name of Processing Plant	Production Capacity	Address
Nakhon	1)*P.C.Food Industry, Ratchasima Co.,Ltd.	- Canned vegetables 1,960 tons/yr. - Canned fruit 50 tons/ yr.(Cash capital 12.3 million baht, worker 245 persons)	117 Mu 18, Mitthaphab rd., Tambol Pak Chong, Amphoe Pak Chong
	2)*Mr.Krai Lerk	- Baby corn&vegetables, frozen, 100 tons/yr. - Mango 400 tons/yr. (Cash capital 25.2 million baht, worker 122 persons)	942/1 Mu 1, Mitthaphab rd., Tambol Pak Chong, Amphoe Pak Chong
	3)*E-Sun Food Industry (Branch of processing plant in Chum Phae, Khon Kaen)	- Frozen bamboo shoot, tomato, vegetable soybean, & other fruit vegetables. (Cold storage facilities can keep produces 2,000 tons, purchase every season)	Korat-Pak Thong Chai rd.
	4) Song Chee	Groundnut shelling (male worker 6, female 2)	Mu 1, Si Kiew Chaiyaphum rd., Tambol Si Kiew Amphoe Si Kiew
	5) Lao Meng Huat	Groundnut shelling (male worker 2 persons)	Mu 1, Chumka rd., Tambol Si Kiew, Amphoe Si Kiew.
	6) Yun Yong	Groundnut shelling (male worker 6 persons)	Mu 7, Mitthaphab rd., Tambol Si Kiew, Amphoe Si Kiew
	7) Thawee Phol	Groundnut shelling (male worker 4 persons)	Mu 1, Si Kiew-Dan Khuntod rd., Tambol Si Kiew, Amphoe Si Kiew
	8) Thai Soon Lee	Groundnut shelling (male worker 4 persons)	Mu 1, Suk Bantard rd., Tambol Si Kiew, Amphoe Si Kiew
	9) Mr.Soonthorn	Groundnut shelling (male worker 5 persons)	Mu 16, Suk Bantard rd., Tambol Si Kiew, Amphoe Si Kiew,

Table F-1 (Continued)

Province	Name of Processing Plant	Production Capacity	Address
	10) Tang Song Huat	Groundnut shelling (male worker 3 persons)	Mu 1, Suk Bantard, rd., Amphoe Si Kiew
	11) Wikrom	Groundnut shelling (male worker 2 persons, female,2)	151 Mu 8, Tambol Si Kiew, Amphoe Si Kiew
	12) Throng Phanich	Groundnut shelling (worker 12 persons)	254/Mu 3, Mitthaphab rd., Tambol Pak Chong, Amphoe Pak Chong
	13) Sahaphun Agricultural Industry (Thailand)	Groundnut shelling (Worker 8 persons)	97 Mu 8, Mitthaphab rd., Tambol Kok Kuad, Amphoe Muang
	14) Chat Chai Industry	Groundnut powder 63 tons/yr. - Chili 19 tons/yr. - Chili power 6 tons/ yr. (Female worker 3, male, 3)	58,59,60 Mu 19, Nakhon Ratchasima Chok Chai rd. Tambol Hua Thab, Amphoe Muang
	15)*Charoen Phokaphan (E-Sun)	Soybean Cake, corn cake, etc. (Cash capital 597 million baht, male worker 30 persons, female 20)	86 Mu 6, Mitthaphab rd., Tambol Kok Kuad, Amphoe Muang
	16)*Betagro (North)	Bean powder, corn powder, etc. (Cash capital 10 million baht, male worker 16 persons,	196 Mu 4, Thana Ruch rd., Tambol Moo Si, Amphoe Pak Chong
Khon Kaen (Note : Mushrooms are exported from Chum Phae about 10 tons per day)	1) Prayoon Trading 2)*E-Sun Food Industry (Has branches in Udon Thani, Roi-Et, Maha Sarakham)	- Bamboo shoot - Mungbean milling 10 tons/mo. - Baby corn 20 ton/day (all the year round) - Tomato - Mushroom - Okra - Vegetable soybean - male worker 57 persons)	Mu 3, Tambol Chaiso, Amphoe Chum Phae Amphoe Chem Phae Tel 31221-212131 - Asparagus

Table F-1 (Continued)

Province	Name of Processing Plant	Production Capacity	Address
	3)*Mr.Sombat	Mushroom, salted 3-4 tons/day	Opposite Savings Bank, Amphoe Chum Phae
	4)*Sino thai	Mushroom, salted 3-4 tons/day	Amphoe Chum Phae
	5) Khon Kaen Lublae Food Cannery, Co.,Ltd.	Tomato paste (Registered Capital 11.3 million baht)	Kilometer 25, Mitthaphab Rd. Tambol Muang Kao, Amphoe Muang
	6) Chun Seng Biscuits	Groundnut 7.1 tons/mo. (male worker 8 persons)	141/1-2 Pracha Samrun rd., Tambol Nai Muang, Amphoe Muang
Chaiyaphum	Siam Castor-Bean Oil	Castor Bean	Muang Chaiyaphum
Kanchanaburi	Bean Noodle Factories	Mungbean for Making bean noodle	Ta Rua, Kanchanaburi

Note : * indicates more important plants than the others in terms of volume of products, and opportunity to deal with farmers in the NESSI Project areas.

Table F-2 Wholesalers for soybean, groundnut, mungbean and other upland crops in the Northeast, 1989

2.1 ร้านค้าทรงซื้อถั่วต่าง ๆ และพืชไร่อื่นๆ

จังหวัด	ชื่อร้าน	ชนิดผลิตผลที่รับซื้อ	ที่อยู่
นครราชสีมา (และ กทม.)	บ.เจริญโภคภัณฑ์โปรดิวส์ จำกัด	ถั่วเหลือง	- อ.เมืองนครราชสีมา - 36 ซอยเย็นจิตร ก.จันทน์ อ.ยานนาวา กรุงเทพมหานคร โทร.2111561-3
อุบลราชธานี	1)นายอำเภออำนาจเจริญ	ถั่วเหลือง	อำเภออำนาจเจริญ
	2)ศูนย์ขยายพันธุ์พืช 10	ถั่วลิสง, ถั่วเหลือง	อ.เมืองอุบลราชธานี
	3)อดมดำพืช	ถั่วต่าง ๆ และพืชไร่ทุกชนิด	147 ถ.ชยางกูร ต.ขามใหญ่ อ.เมืองอุบลฯ
	* ศูนย์กลางรับซื้อถั่วและผลิตผลเกษตรอื่น ๆ ของจังหวัดอุบลฯ อยู่ที่ กิ่ง อ.อำนาจเจริญ		
	อ.เดชอุดม		
	อ.น้ำยืน		
	อ.เมืองอุบลฯ		
	อ.วารินชำราบ		
สุรินทร์	1)ศูนย์ขยายพันธุ์พืช 16	ถั่วลิสง	อ.ประสาท
	2)ร้านสุรินทร์พัฒนา	ถั่วลิสง	ถนนทางไป อ.ท่าตูม, อ.เมืองสุรินทร์
	3)รัตนะ	ถั่วลิสง	ถนนทางไป อ.ประสาท, อ.เมืองสุรินทร์
	4)เชียงยาว	ถั่วลิสง	ถนนทางไป อ.กระสัง, อ.เมืองสุรินทร์
	5)ร้านค้าต่าง ๆ ในอำเภอจอมพระ	ถั่วและพืชไร่	อ.จอมพระ
ยโสธร	ทรัพย์อุดม	ถั่วเหลือง	อ.เลิงนกทา
	ศูนย์กลางซื้อขายพืชผลเกษตรที่สำคัญของจังหวัดยโสธร		
	คือ - เขตเทศบาลเมืองยโสธร	(สำคัญที่สุด)	
	- เขตสุขาภิบาล อ.กุดชุม	(สำคัญอันดับรอง)	
	- เขตสุขาภิบาลเลิงนกทา	(อำเภอที่ใหญ่ที่สุดของการติดต่อค้าขายกับมุกดาหารและอุบล)	

Table F-2 (Continued)

จังหวัด	ชื่อร้าน	ชนิดผลิตผลที่รับซื้อ	ที่อยู่
มุกดาหาร	1)องไพบูลย์	กวาวเครือ	อ.นิคมคำสร้อย
	*2)มุกดาหารอุตสาหกรรม(ใหญ่ที่สุด)	กวาวแดง	113 ถ.มุกดาหาร-คำชะอี อ.เมืองมุกดาหาร
	*3)สมบูรณ์พืชผล	กวาวแดง/กวาวเครือ	820/60 ถ.ยุทธพัฒนา อ.เมือง
	4)จันลง	กวาวแดง/กวาวเครือ	5 ถ.ชยางกูร อ.เมือง
	5)ตงงวนเส็ง	กวาวต่างๆ	814/30 ถ.ยุทธพัฒนา อ.เมือง
บุรีรัมย์	1)พ่อค้าในตลาดลำปรายมาศ (มากกว่า 10 ร้าน)	กวาวแดง,กวาวเครือ	อ.ลำปรายมาศ
	2)พ่อค้าในอำเภอนางรอง (มากกว่า 20 ร้าน)	กวาวต่าง ๆ และพืชไร่	อ.นางรอง
	3)พ่อค้าในอำเภอหนองกี่ (ประมาณ 10 ร้าน)	กวาวต่าง ๆ และพืชไร่	อ.หนองกี่
	4)พ่อค้าในอำเภอละหานทราย (ประมาณ 10 ร้าน)	กวาวต่าง ๆ และพืชไร่	อ.ละหานทราย
	5)พ่อค้าในอำเภอเมือง (ประมาณ 10 ร้าน)	กวาวต่าง ๆ และพืชไร่	อ.เมือง
	6)พ่อค้าในอำเภอบ้านกรวด (ประมาณ 5 ร้าน)	กวาวต่าง ๆ และพืชไร่	อ.บ้านกรวด
	7)พ่อค้าในอำเภอกระสัง	กวาวต่าง ๆ และพืชไร่	อ.กระสัง
	หมายเหตุ : สำหรับร้านค้าที่สำคัญมีดังต่อไปนี้		
บุรีรัมย์(ต่อ)	เรืองกิจพืชผล	กวาวแดง,กวาวเครือ	อ.ลำปรายมาศ โทร.661471
	สงวนพืชผล	กวาวแดง,กวาวเครือ	อ.ลำปรายมาศ โทร.661382
	แสงชัยพืชผล	กวาวแดง,กวาวเครือ	อ.นางรอง
	เจริญชัยพืชผล	กวาวแดง,กวาวเครือ	132-133 ถ.โชคชัยเดชอุดม อ.เมือง โทร.612680
	บริษัทพาณิชย์	กวาวแดง,กวาวเครือ	22/20 ถ.หลักเมือง อ.เมืองฯ โทร.611693, 612477
	โรงอัดปอมันไทยดำรงค์	กวาวแดง,กวาวเครือ	300/1 หมู่ 15 ถ.บุรีรัมย์-สตึก อ.เมือง โทร.611609

Table F-2 (Continued)

จังหวัด	ชื่อร้าน	ชนิดผลิตผลทรบซื้อ	ที่อยู่
	สินธัพน์	กวลิสง,กวเขียว	ถนนบรรมย-พุทธไธสง อ.เมืองฯ
	เตมสหธพชผล	กวลิสง,กวเขียว	255 ม.17 ถ.นางรอง-ประคำ อ.นางรอง โทร.631416
	จงเจริญ	กวลิสง,กวเขียว	31/2 หม่ 2 ถ.ประดิษฐบานะ อ.นางรอง โทร.631109
ศรีสะเกษ	1)สินทวีการเกษตร	กวตางๆและพชไรอนๆ	129 หม่ 7 ต.ขยอาญา ต.กาแพง อ.อทมพรพิ
	2)ไทเส็ง	กวตางๆและพชไรอนๆ	35/1 ต.เพียรพจนกิจ ต.กาแพง อ.อทมพรพิ
	3)สยามธัญญะ	กวตางๆและพชไรอนๆ	1490/4 ต.ขนธ ต.เมองโต อ.เมองฯ
	4)จงเจริญพาณชย	กวตางๆและพชไรอนๆ	หม่ 5 ถ.ขนธ ต.เมองโต อ.เมองฯ
	5)หงษสมบตขนส่ง	กวตางๆและพชไรอนๆ	525 ถ.ศรีสะเกษ-ขนธ ต.หนองครก อ.เมือง
	6)เจริญผลธัญกิจ	กวตางๆและพชไรอนๆ	073/1 ม.1 ต.น้ำอม อ.กันทรลักษ์
	7)สินประดิษฐ	กวตางๆและพชไรอนๆ	90 ม.6 ต.คร อ.กันทรารมย์
	8)อภิญญา-วิภาวดี	หนอไมฝรง (ทนจดทะเบยน 5 ล้านบาท)	1240/2 ถ.วจตรนคว อ.เมองศรีสะเกษ
	9)เกษตรกรเมองศรี	หนอไมฝรง (ทนจดทะเบยน 3 ล้านบาท)	76 ม.8 บานโนนแดง ต.ศรีสะเกษอทมพร ต.หญาปลอง อ.เมองศรีสะเกษ
	10)ศนยรบซอหอมใหญ่, กระเทยม ของจงหวดศรีสะเกษ	หอมใหญ่,กระเทยม	อ.กันทรลักษ์
อดรธานี	อดรเรองสนไทย (ใหญ่สดในอดร)	กวและพชไรตางๆ	ต.ศรีสย ข้างรร.หมากแข้ง อ.เมืองอดรธานี
	รานคาตางๆในอำเภอนากลาง	กวและพชไรตาง	อ.นากลาง,อ.บางบัวลำภ, อ.กดจับ
	อ.หนองบัวลำภ, อำเภอกดจับ		
มหาสารคาม	เจแดง	กวเหลอง	อ.เมองมหาสารคาม
สกลนคร	*1)โชคพลผล	กวและพชไรตางๆ	ก.รฐพฒนา อ.เมองสกลนคร
	*2)บรพาพชผล	กวและพชไรตางๆ	อ.สวางแดนดิน
	3)บ.สินคาสย	กวและพชไรตางๆ	อ.สวางแดนดิน
	*4)แสงวบลย์	กวและพชไรตางๆ	ตลาดนวลมณ อ.เมองสกลนคร
	5)พงษสกล	กวและพชไรตางๆ	ก.รฐพฒนา อ.เมองสกลนคร
	6)ไทยวฒนาพชผล	กวและพชไรตางๆ	ตรงข้ามสนง.ไฟฟ้าจังหวด, ก.สยเกษม
	7)อ.รวมชย	กวและพชไรตางๆ	ก.รฐพฒนา, อ.เมองสกลนคร
	8)ผลแสงไทย	กวและพชไรตางๆ	อ.พงโคน
	9)รานสินพฒนา	กวและพชไรตางๆ	อ.พงโคน
	10)ศนยขยายพนธพช	กวลิสง	อ.พงโคน

Table F-2 (Continued)

จังหวัด	ชื่อร้าน	ชนิดผลิตผลที่รับซื้อ	ที่อยู่
นครพนม	เคซาพาณิชย์	กาแฟและพืชไร่ต่างๆ	306 ต.นิคโย อ.หนองญาติ อ.เมือง
	รวมเครื่องกล	กาแฟและพืชไร่ต่างๆ	6 หมู่ 4 ต.นิคโย ต.หนองญาติ อ.เมือง
	เกงพาณิชย์	กาแฟและพืชไร่ต่างๆ	481 ถ.อภิบาลบัญชา ต.ในเมือง อ.เมือง
	สายฝน	กาแฟและพืชไร่ต่างๆ	63-73 ถ.นิคโย ต.ในเมือง อ.เมือง
	พงศกร	กาแฟและพืชไร่ต่างๆ	703 ถ.โพนแก้ว ต.ในเมือง อ.เมือง
	วิทยาพืชผล	กาแฟและพืชไร่ต่างๆ	766/8 ถ.นิคโย ต.ในเมือง อ.เมือง
ร้อยเอ็ด	1)รายอเซ่ง	กาแฟต่างๆและพืชไร่	6 หมู่ 11 ถ.ร้อยเอ็ด-กาฬสินธุ์ อ.เมืองร้อยเอ็ด
	2)ร้านไทยแซ่	กาแฟและพืชไร่ต่างๆ	36/2 ถ.ปทุมนนท์ อ.เมืองร้อยเอ็ด
ชัยภูมิ	1)สหแสงหิรัญ	พืชไร่ต่างๆ	อ.หนองบัวแดง
	2)วานรการเกษม	พืชไร่ต่างๆ	ถ.ชัยภูมิ-หนองบัวแดง อ.เมืองชัยภูมิ
	3)อภัยพืชผล	พืชไร่ต่างๆ	ถ.ชัยภูมิ-หนองบัวแดง อ.เมืองชัยภูมิ
	4)แสงหิรัญอมปอรตเอกปอรต	พืชไร่ต่างๆ	ถ.ชัยภูมิ-หนองบัวแดง อ.เมืองชัยภูมิ
	5)อาลง	พืชไร่ต่างๆ	ถ.ชัยภูมิ-หนองบัวแดง อ.เมืองชัยภูมิ
	6)อ.สิรอง	พืชไร่ต่างๆ	ถ.ชัยภูมิ-หนองบัวแดง อ.เมืองชัยภูมิ

Table F-2 (Continued)

2.2 ร้านค้าที่รับซื้อถั่วและพืชไร่ต่างๆในจังหวัดเลย

ชื่อผู้ประกอบการ	ที่อยู่ (เลขที่, ถนน, ตำบล, อำเภอ,)
1)สมบัติ จำปานิล	59 หมู่ 9 ต.กกดู่ อำเภอเมืองเลย
2)เยาวลักษณะ	15 หมู่ 6 ต.ชัยพฤกษ์ อ.เมืองเลย
3)ยงยุทธ	46/9 ถ.ร่วมใจ ต.กุดป่อง อ.เมืองเลย
4)ราช่างค์	1/20 ถ.พิพัฒนมงคล ต.กุดป่อง อ.เมืองเลย
5)เกษตรเมืองเลย	70 หมู่ 4 ต.ศรีสองรัก อ.เมืองเลย
6)สุพรชัย	116 หมู่ 1 ต.น้ำสวย อ.เมืองเลย
7)หนูนิตา	62 หมู่ 8 ต.นาโป่ง อ.เมืองเลย
8)สาย	118 หมู่ 4 ต.นาอ้อ อ.เมืองเลย
9)พรหมพาณิชย์	18 หมู่ 7 ต.น้ำสวย อ.เมืองเลย
10)ตาวกูล	57 หมู่ 12 ต.นาดินดำ อ.เมืองเลย
11)ตาวัน	59 หมู่ 8 ต.นาดินดำ อ.เมืองเลย
12)ฉลาด	37 หมู่ 3 ต.นาอ้อ อ.เมืองเลย
13)อริยแอนด์ที่อิมปอร์ตเอ็กปอร์ต	17/15 ต.นกแก้ว ต.กุดป่อง อ.เมืองเลย
14)ต้นศักดิ์ท่าลี่	135/1 หมู่ 2 ถ.ราษฎร์บำรุง ต.ท่าลี่ อ.ท่าลี่
15)ราช่าเกษม	ถ.ร่วมใจ ตรงข้ามสถานีขนส่งจังหวัดเลย
16)ร้านจงนภา	ทางออกสามแยกนาร่วน กิ่งอ.นาร่วน
17)บ.ฟ้ายอาคเนย์ จำกัด	ต.สายเชียงคาน อ.เมืองเลย
18)สิทธิสมบูรณ์	ต.สายเชียงคาน อ.เมืองเลย
19)ฟ้ายอีสาน	ต.สายเชียงคาน อ.เมืองเลย
20)ฟ้ายเมืองเลย	ต.สายเชียงคาน อ.เมืองเลย
21)ธัญญาวันพืชผล	ต.สายเชียงคาน อ.เมืองเลย
22)อมรวัฒนา	ต.สายเชียงคาน อ.เมืองเลย

Table F-2 (Continued)

2.3 ร้านค้าที่รับซื้อถั่วเหลือง, ถั่วเขียวและถั่วลิสงในจังหวัดขอนแก่น

ชื่อผู้ประกอบการ	ที่อยู่ (เลขที่, ถนน, ตำบล, อำเภอ,)
*1.ประยูรพืชผล	267 ถ.บูรณะเจริญ อ.ชุมแพ โทร.311043
2.ป้องไผ่	108 ถ.บูรณะเจริญ อ.ชุมแพ โทร.311195
3.ชุมแพไทยสงวน	308 ถ.ชุมแพ-ภูเขียว อ.ชุมแพ โทร.311414
4.อ.พืชผล	225 ถ.ชุมแพ-สีชมพู อ.ชุมแพ
5.สงวนชัยพืชผล	ถ.มิลิวัลย์ อ.ชุมแพ โทร.311084
6.สหะพืชผล	141 ถ.มะลิวัลย์ อ.ชุมแพ โทร.316258
7.ซินไล่ฮะ	198 ถ.มะลิวัลย์ อ.ชุมแพ โทร.311384
8.วัฒนาพืชผล	276 ถ.มะลิวัลย์ อ.ชุมแพ โทร.311988
9.ค.เจริญพืชผล	306 ถ.ชุมแพอุตร อ.ชุมแพ
10.พูลสิน	ท่าพระ อ.เมือง จ.ขอนแก่น 221536
11.เตี่ยงเส็ง	ถ.ประชาสโมสร อ.เมือง
12.หลิงเส็ง	ถ.ประชาสโมสร อ.เมือง โทร.236658
13.นำเซ่งฮวด	ถ.มะลิวัลย์ อ.เมือง โทร.236215
14.โรงสีมีชัย	อ.ชุมแพ
15.จินดาวัฒนา	อ.ชุมแพ
16.ไทยสงวน	อ.ชุมแพ

หมายเหตุ : ตลาดชุมแพเป็นตลาดรับซื้อถั่วเขียวที่สำคัญของภาคตะวันออกเฉียงเหนือ

Table F-2 (Continued)

2.4 ร้านค้าที่รับซื้อข้าวโพดและพืชไร่ชนิดต่างๆในจังหวัดนครราชสีมา

อำเภอ	ชื่อผู้ประกอบการ	ที่อยู่ (เลขที่, ถนน, ตำบล)
ปากช่อง	1)ห.เซ่งสาด	154 หมู่ 1 ต.หนองสาหร่าย
	2)ยิ้งตั๊กกี่	155 หมู่ 1 ต.หนองสาหร่าย
	3)ทิพทิศักดิ์พืชผล	490 หมู่ 1 ต.หนองสาหร่าย
	4)ต้าวงสิน	142 หมู่ 1 ถ.นิคม ต.หนองสาหร่าย
	5)เรืองโรจน์พานิช	ต.หนองสาหร่าย
	6)นายวิเชียร เลียวพรเศรษฐ	173 ต.หนองสาหร่าย
	7)ตงพานิช	172 ต.หนองสาหร่าย
	8)อ.พานิช	170 ต.หนองสาหร่าย
	9)จิงเจริญ	159 ถ.จันทึก ต.หนองสาหร่าย
	10)เจริญไทยค้าข้าว	161 ถ.จันทึก ต.หนองสาหร่าย
	11)ช.ยิ่งไชยชัย	357-358 ถ.จันทึก ต.หนองสาหร่าย
	12)พงษ์ศักดิ์พานิช	189 ต.หนองสาหร่าย
	13)มาลีพืชผล	362 ต.หนองสาหร่าย
	14)มีชัย	351 ต.หนองสาหร่าย
	15)ผลเกียรติการค้า	343 ต.หนองสาหร่าย
	16)ช.ประเสริฐไชยชัย	344 ต.หนองสาหร่าย
	17)มงคลพืชผล	130 ถ.นิคม ต.หนองสาหร่าย
	18)ส.เสริมสิง	315 ถ.นิคม ต.หนองสาหร่าย
	19)ทวีทรัพย์	138 ถ.นิคม ต.หนองสาหร่าย
	20)เรืองโรจน์อุตสาหกรรม	370 หมู่ 1 ถ.นิคม ต.หนองสาหร่าย
	21)ปากช่องพืชผล	40/1 หมู่ 7 ถ.นิคม ต.หนองสาหร่าย
ด่านขุนทด	22)ตั้งย่งง้วน	ด่านขุนทด-บ้านเก่า
	23)แสงชัยพืชผล	503/1-4 ถ.สีคิ้ว-ชัยภูมิ ต.ด่านขุนทด
	24)นาชัย	276 ถ.สีคิ้ว-ชัยภูมิ ต.ด่านขุนทด
	25)นิคม	100/7 ถ.เลิศประดอง ต.ด่านขุนทด
	26)พูลสวัสดิ์	454-455 ถ.สีคิ้ว-ชัยภูมิ ต.ด่านขุนทด
	27)ลิมเจริญ	148 หมู่ 11 ถ.สีคิ้ว-ชัยภูมิ ต.ด่านขุนทด
	28)พ.พืชผล	466 ถ.สีคิ้ว-ชัยภูมิ ต.ด่านขุนทด
	29)ฟ้ามุ่ย	102 ถ.เลิศประดอง ต.ด่านขุนทด
	30)นายจรูญ หงษ์เวียงจันทร์	59 ถ.ด่านฯ ต.ด่านขุนทด
	31)พัวหลี่เส็ง	155 ถ.สีคิ้ว-ชัยภูมิ ต.ด่านขุนทด
	32)อ.พานิช	20-21 ถ.สีคิ้ว-ชัยภูมิ ต.ด่านขุนทด

Table F-2 (Continued)

2.5 ร้านค้าที่รับซื้อพืชเศรษฐกิจในจังหวัดนครราชสีมา

อำเภอ	ชื่อผู้ประกอบการ	ที่อยู่ (เลขที่, ถนน, ตำบล)
ปากช่อง	1)ก.พาณิชย์	158 ถ.มิตรภาพ ต.ปากช่อง
	2)จึงนำชัย	96-97 ถ.มิตรภาพ ต.ปากช่อง
	3)แสงกิจ	335-336 ถ.มิตรภาพ ต.ปากช่อง
	4)นายไพรัตน์ โลว์กูลประกิจ	1596-1597 ถ.คุรุ ต.ปากช่อง
	5)มิตรเสนา	116-117 ถ.มิตรภาพ ต.ปากช่อง
	6)โกดังแสงรัตน์	139 ถ.มิตรภาพ ต.ปากช่อง
	7)โกดังหน่ำเฮง	220 ถ.มิตรภาพ ต.ปากช่อง
	8)เพื่อนการเกษตร	3/5 หมู่ 1 ถ.มิตรภาพ ต.ปากช่อง
	9)อุดมชัย	336-337 ถ.มิตรภาพ ต.ปากช่อง
ครบุรี	10)สยามพืชไร่	515-518 ต.บ้านใหม่
	11)ไทยเพิ่มพูน	210 ต.บ้านใหม่
	12)อุดมโชค	519-591 ต.บ้านใหม่
	13)ส.เจริญเกษตร	765 ต.บ้านใหม่
	14)ครเกษตร	278-279 ต.บ้านใหม่
	15)ทวีศักดิ์พืชผล	395-397 ถ.สุขาภิบาล ต.บ้านใหม่
	16)ลิ้มไท้เฮง	288-289 ต.บ้านใหม่
	17)เป็งเส็ง	201-203 ต.บ้านใหม่
	18)เฮงเจริญพืชผล	127 ถ.บ้านโคกกรวด ต.เฉลียง
	19)อุดมผล	503 ต.บ้านใหม่
	20)จุรีชัยพืชผล	568 ต.รอบเมือง ต.โพธิ์กลาง
เสิงสาง	21)สัจพงษ์พืชผล	351 ถ.โคกน้อย-โนนสูง ต.เสิงสาง
	22)ธีรพงษ์ชพืผล	65 ต.สระตะเคียน
	23)แสงชัยพืชผล	29 ต.สระตะเคียน
	24)เอื้องพรพืชผล	203 ถ.เสิงสาง-ประคำ ต.กุดโบสถ์
	25)พิริยะพงศ์	314 ถ.ครบุรี-เสิงสาง ต.เสิงสาง
	26)เชียงยงพานิช	1 ถ.ครบุรี-เสิงสาง ต.เสิงสาง
	27)จ.เจริญพืชผล	282 ถ.ครบุรี-เสิงสาง ต.เสิงสาง
	28)พัฒนา	323 ถ.รุ่งเรือง ต.เสิงสาง

Table F-3
Locations and Names of Vegetable Wholesale Markets in the Northeast, 1989

Province	Amphoe (District)	Name of Market
Roi Et	Muang	Hai Sok Municipality Market
Mukdahan	Nikom Kham Soi	Nikom Kham Soi Market
Yasothon	Muang	1) Municipality Market
		2) Krom Thanaruk Market
	Lung Nok Tha	3) Lung Nok Tha Market
Ubon Ratchathani	Muang	1) Municipality Market
	Warin Chumrab	2) Warin Chumrab Market
	Amnat Charoen	3) Amnat Charoen Market
Buri Ram	Prakon Chai	1) Prakon Chai Market
	Muang	2) Municipality Market (biggest)
	Ban Guad	3) Nikom Ban Guad Market
Surin	Muang	Municipality Market
Si Sa Ket	Muang	1) Municipality Market (biggest)
		2) Trading Center Market
Udon Thani	Muang	1) Thai E-Sun Market
	Muang	2) Udon Muang Thong Market
Nong Khai	Muang	1) Po Chai Market
	Muang	2) Chai Porn Market
Kalasin	Muang	1) Market for Farmers
	Muang	2) Municipality Market I
Maha Sarakam	Muang	Municipality Market
Sakon Nakhon	Muang	T.Karnka Market
Nakhon Phanom	Muang	Ekachon Market
Khon Kaen	Muang	1) Bang Lumphu Market
		2) Bo Bae Market
		3) Municipality Market
Nakhon Ratchasima	Muang	1) Chum Phol Market[1]
	Muang	2) Prapa Market[1]
	Pak Chong	3) Pak Chong
Loei	Muang	Municipality Market
Chaiyaphum	(No.wholesale market)	Wung Saphung Market

[1] Regional market.

Table F-4

Selected Seed Merchants Dealing with Farmers in the Northeast, 1989

Province	Name of Dealer	Types of Seed Purchased	Address
Khon Kaen	Adam Enterprises	Tomato, corn, etc.	Amphoe Ban Phai (Near Ban Phai Bus Station)
Nakon Ratchasima	Khakye Co., Ltd	Soybean, oil seeds, corn, etc.	Amphoe Pak Chong
Chiang Mai	Phion Kaset Co., Ltd	Water melon, other vegetable seeds	Amphoe Muang
Bangkok	Universe Seed Co.,Ltd.	Tomato, water melon, eggplant, cantaloupe, mungbean, etc.	Ratchada Phiset Chong Nonsee, Yannawa, Bangkok Tel. 2495857
Sakon Nakhon	Agro-Seed Co.,Ltd.	Tomato, Cantaloupe, hybrid-water melon, etc.	Amphoe Phan Khon
(Khon Kaen)	Seen Seed Co., Ltd (Taiwan)	Tomato, water melon, eggplant, cantaloupe, etc.	This company purchases seeds from farmers in Amphoe Nong Rua
(Sakon Nakhon)	1) Adam Enterprises 2. Hort-Thai Co.,Ltd. 3. Up-John Co.,Ltd. 4. Known You Seed (Thailand) Co.Ltd 5. Kaset Sakon 6. Product-Marketing Management Group 7. Trimit Kaset Co.	Tomato,baby corn, watermelon, Cantaloupes asparagus	These companies purchased seeds from farmers in the Lam Nam Oon Irrigation Proj. area. They are also exporters & have branches to collect seeds in Amphoe Phan Khon, Sakon Nakhon

Table F-5 Recommended Crops to Produce and their Expected Markets
Huai Aang, Roi Et province.

Types of Farm	Recommended Crops	Expected Markets
Processing Plant Crops		
	- baby corn, tomato[1] (fruit), mushroom	Processing plants in Roi Et, Yasothon, Khon Kaen (Chum Phae, via broker)
	- super sweet corn	Processing plant in Roi Et
	- tomato (seed)	Seed companies in Khon Kaen, Saraburi, Sakon Nakhon, Bangkok.
	- white okra, vegetable soybean[1]	Khon Kaen (Chum Phae, via broker; processing plant)
	- chili (Hua Rua variety)	Ubon Ratchathani (processing plant)
Fresh Market Crops		
	- baby corn (fresh)	Bangkok (exporters/wholesalers)
	- water melon,ginger, bitter gourd, lettuce,white gourd, Chinese radish, garden pea, cabbage.	Roi Et vegetable wholesale market.
	- mushroom, chili, ginger, angled loofah, bitter gourd, chinese radish, garden pea, short cucumber, lettuce, pumpkin, leaf mustard, Chinese cabbage, white gourd, multiplier onion, edible rape, yard long bean, Chinese kale, kang kong.	Vegetable wholesale markets in Yasothon, Kalasin, Mahasarakham, Khon Kaen
	- sweet corn, chili, pepper, short cucumber	Local roadside booths, village assemblers/retailers,
Home Garden Crops		
	long cucumber, multiplier onion, yard long bean, eggplant.	Weekend markets, family consumption.

[1] Crops transacted by marketing contract.

Table F-5 **Recommended Crops to Produce and their Expected Markets Huai Aeng, Roi Et province.**

Types of Farm	Recommended Crops	Expected Markets
Processing Plant Crops		
	- baby corn, tomato[1] (fruit), mushroom	Processing plants in Roi Et, Yasothon, Khon Kaen (Chum Phae, via broker)
	- super sweet corn	Processing plant in Roi Et
	- tomato (seed)	Seed companies in Khon Kaen, Saraburi, Sakon Nakhon, Bangkok.
	- white okra, vegetable soybean[1]	Khon Kaen (Chum Phae, via broker; processing plant)
	- chili (Hua Rua variety)	Ubon Ratchathani (processing plant)
Fresh Market Crops		
	- baby corn (fresh)	Bangkok (exporters/wholesalers)
	- water melon,ginger, bitter gourd, lettuce,white gourd, Chinese radish, garden pea, cabbage.	Roi Et vegetable wholesale market.
	- mushroom, chili, ginger, angled loofah, bitter gourd, chinese radish, garden pea, short cucumber, lettuce, pumpkin, leaf mustard, Chinese cabbage, white gourd, multiplier onion, edible rape, yard long bean, Chinese kale, kang kong.	Vegetable wholesale markets in Yasothon, Kalasin, Mahasarakham, Khon Kaen
	- sweet corn, chili, pepper, short cucumber	Local roadside booths, village assemblers/retailers,
Home Garden Crops		
	long cucumber, multiplier onion, yard long bean, eggplant.	Weekend markets, family consumption.

[1] Crops transacted by marketing contract.

Table F-6 Recommended Crops to Produce and their Expected Markets
Huai Khilek, Mukdahan province.

Types of Farm	Recommended Crops	Expected Markets
Processing Plant Crops		
	tomato[1], baby corn[1], mushroom	Processing plants in Roi Et, Yasothon & Royal Project in Sakon Nakhon
	soybean[1]	Kalasin (oil processing plant), Yasothon & Mukdahan (wholesalers) Bangkok (C.P., via Nakhon Ratchasima branch) Ubon Ratchathani & Sakon Nakhon (Centers for Propagation),
	groundnut[1]	Kalasin (processing plant, Carter Peanuts Co.) wholesalers in Nakhon Phanom, Mukdahan, Khon Kaen, Nakhon Ratchasima, Yasothon, and Centers for Propagation in Sakon Nakhon, Ubon Ratchathani
Fresh Market Crops		
	chili (Hua Rua variety) long cucumber, yard long bean, short cucumber, Chinese cabbage, pumpkin, chili, angled loofah, lettuce, edible rape, white gourd, ginger, bitter gourd, leaf mustard, Chinese kale, multiplier onion, Chinese radish, garden pea, cabbage, morning glory.	Ubon Ratchathani (processing plant) Vegetable wholesale markets in Mukdahan, Nakhon Phanom, Sakhon Nakhon, Kaiasin, Roi Et, Yasothon, Ubon Ratchathani (Amnatcharoen, Muang)
Home Garden Crops		
	sweet corn, chili, eggplant, short cucumber, pumpkin, angled loofah, multiplier onion, yard long bean, pepper	local roadside booths, village assemblers/retailers weekend markets, family consumption

[1] Crops transacted by marketing contract

Table F-7 Recommended Crops to Produce and their Expected Markets
Huai Chorakhe Mak (& Huai Talat), Buri Ram province.

Types of Farm	Recommended Crops	Expected Markets
Processing Plant Crops		
	groundnut[1]	Centers for Propagation in Surin, Ubon Ratchathani & wholesalers in Buri Ram, Si Sa Ket, Nakhon Ratchasima (Pak Chong, Si Kiew), Khon Kaen
	mungbean	wholesalers in Khon Kaen (Chum phae), Buri Ram, Nakhon Ratchasima, Bangkok, and processing plants in Kanchanaburi
	soybean[1]	Bangkok (C.P., via Nakhon Ratchasima branch), Ubon Ratchathani^T*^T (Center for Propagation), Buri Ram (Wholesalers), Khon Kaen (Wholesalers)
	tomato[1], baby corn[1]	Buri Ram (Royal Project)
	chili	Bangkok & other nearby provinces (processing plants of noodle)
	tomato,vegetable soybean & other fruit vegetables	Nakhon Ratchasima (Frozen vegetable company)
Fresh Market Crops		
	multiplier onion, ginger, garden pea,bitter gourd, lettuce, edible rape, white gourd, Chinese cabbage, angled loofah, yard long bean, short cucumber, chili, Chinese radish, leaf mustard, Chinese kale, kang kong, pumpkin, white gourd, mushroom, cabbage, cauliflower,	Vegetable wholesale market in Buri Ram, Nakhon Ratchasima, Surin
Home Garden Crops		
	chili,eggplant,angled loofah,coriander,multiplier onion, cucumber, yard long bean, pumpkin, pepper	Local roadside booths, village assemblers/ retailers, weekend markets, family consumption

[1] Crops transacted by marketing contract.

Table F-8

Distance Among Roi Et and Other Provinces

From (Province/ District)	To Province/District	Distance (Km.)
Roi Et/Muang	Bangkok	509
	Kalasin/Muang(a)	83
	Kalasin/Muang(b)	46
	Yasothon/Lung Nok Ta	127
	Surin/Muang	166
	Ubon Ratchathani/Muang	170
	Maha Sarakham/Muang	40
	Buri Ram/Muang	144
	Si Sa Ket/Muang	173
	Khon Kaen/Ban Phai	110
	Khon Kaen/Muang	124
	Khon Kaen/Chum Phae	244
	Nakhon Ratchasima/Muang	312
	Nakhon Ratchasima/Pak Chong	398
	Sakon Nakhon/Muang	166
	Nong Khai/Sri Chiang Mai	326
	Udon Thani/Muang	272
	Loei/Muang	333
	Chaiyaphum/Muang	250
	Nakhon Phanom/Muang	260
	Mukdahan/Muang	146

Table F-9

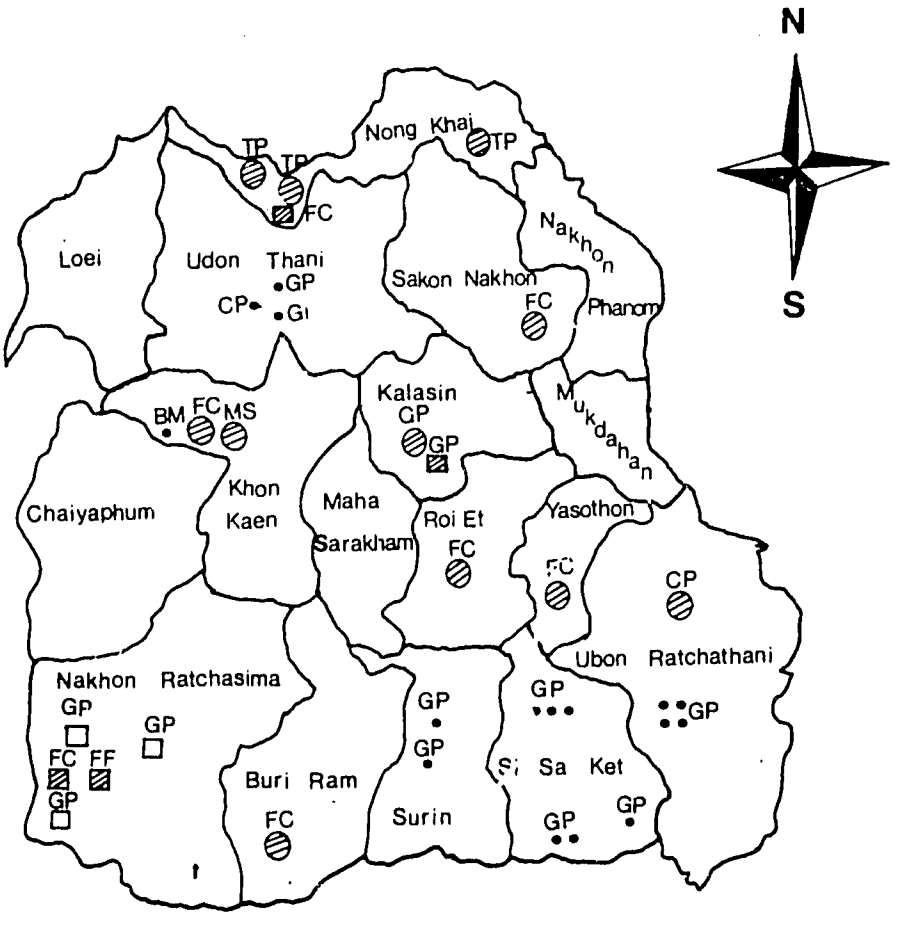
Distance Among Mukdahan and Other Provinces

From (Province/ District)	To Province/District	Distance (Km.)
Mukdahan/Muang	Bangkok	668
	Mukdahan/Nikom Kum Soy	27
	Nakhon Phanom/Muang	105
	Ubon Ratchathani/Muang	165
	Ubon Ratchathani/Amnat Charoen	95
	Ubon Ratchathani/Dech Udom	208
	Ubon Ratchathani/Num Yurn	275
	Kalasin/Muang	155
	Nong Khai/Muang	325
	Roi Et/Muang	146
	Yasothon/Muang	145
	Sakon Nakhon/Muang	115
	Maha Sarakham	186
	Khon Kaen/Muang	239
	Khon Kaen/Chum Phae	359
	Nakhon Ratchasina/Muang	370
	Nakhon Ratchasima/Pak Chong	456
	Si Sa Ket/Muang	230
	Surin/Muang	312
	Buri Ram/Muang	290
	Udon Thani/Muang	275
	Loei/Muang	439
	Chaiyaphum/Muang	365

Table F-10

Distance among Buri Ram and Other Provinces

From (Province/ District)	To Province/District	Distance (Km.)
Buri Ram/Muang	Bangkok	411
	Buri Ram/Lum Paimat	35
	Buri Ram/Nang Rong	55
	Buri Ram/Lahan Sai	92
	Buri Ram/Nong Kee	83
	Buri Ram/Ban Kruad	64
	Nakhon Ratchasima/Muang	155
	Nakhon Ratchasima/Pak Chong	240
	Maha Sarakham/Muang	148
	Roi Et/Muang	144
	Khon Kaen/Muang	180
	Khon Kaen/Muang	300
	Surin/Muang	110
	Si Sa Ket/Muang	211
	Ubon Ratchathani/Muang	271
	Yasothon/Muang	200
	Kalasin/Muang	190
	Mukdahan/Muang	290
	Sakon Nakhon/Muang	310
	Nakhon Phanom/Muang	305
	Udon Thani/Muang	297
	Nong Khai/Muang	350
	Loei/Muang	389
	Chaiyaphum/Muang	275



CAPACITY SYMBOLS:

- capacity over 6,000 tons/yr.
- capacity less than 6,000 tans/yr., actually about 2,000 - 3,000 tons/yr.
- capacity less than 500 tons/yr.
- capacity data is not available.

INDUSTRY SYMBOLS:

FC = Food cannery

GP = Groundnut paste

FF = Frozen food industry

CP = Chilli processing plant

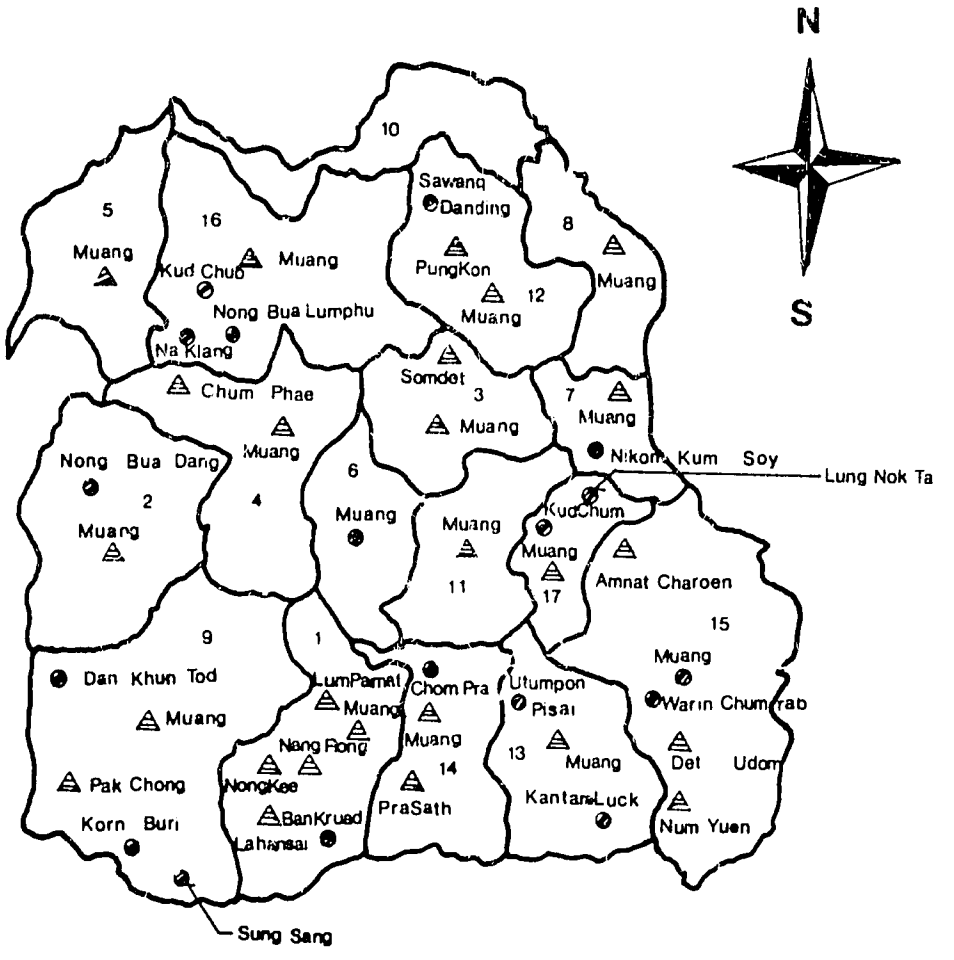
TP = Tomato past industry

GI = Ginger powder industry

BM = Bamboo shoot and mungbean processing plant

MS = Mushroom salted industry

Figure F-1 Location and Capacity of Processing Plants in the Northeast of Thailand



Market Symbols :

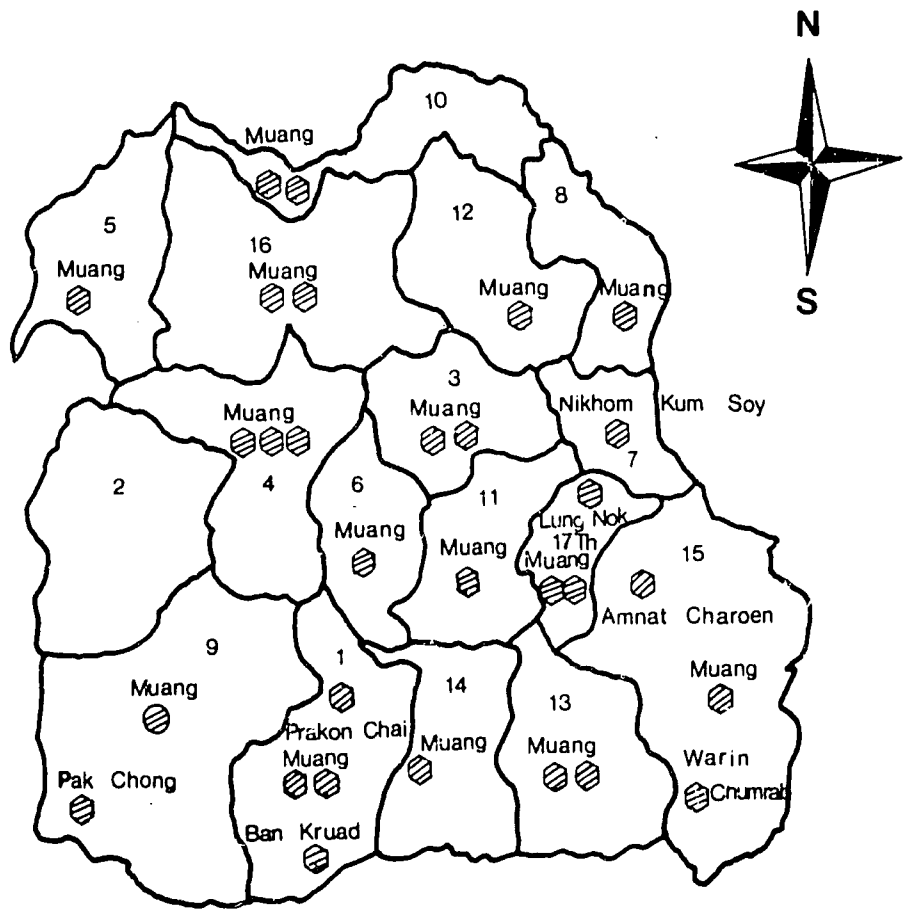
▲ major markets in each province

● minor markets in each province

PROVINCE SYMBOLS :

1 Buri Ram
2 Chaiyaphum
3 Kalasin
4 Khon Kaen
5 Loei
6 Maha Sarakham
7 Mukdahan
8 Nakhon Phanom
9 Nakhon Ratchasima
10 Nong Khai
11 Roi Et
12 Sakon Nakhon
13 Si Sa Ket
14 Surin
15 Ubon Ratchathani
16 Udon Thani
17 Yasothon

Figure F-2 Sites of Markets for Oil Crops and Upland Food Crops in the Northeast of Thailand.



MARKET SYMBOLS :

- Region wholesale market
- Provincial wholesale market

PROVINCE SYMBOLS :

1. Buri Ram
2. Chaiyaphum
3. Kalasin
4. Khon Kaen
5. Loei
6. Maha Sarakham
7. Mukdahan
8. Nakhon Phanom
9. Nakhon Ratchasima
10. Nong Khai
11. Roi Et
12. Sakhon Nakhon
13. Si Sa Ket
14. Surin
15. Ubon Ratchathani
16. Udon Thani
17. Yasothon

Figure F-3 Regional and Provincial Wholesale Markets of Vegetable in the Northeast of Thailand, 1989

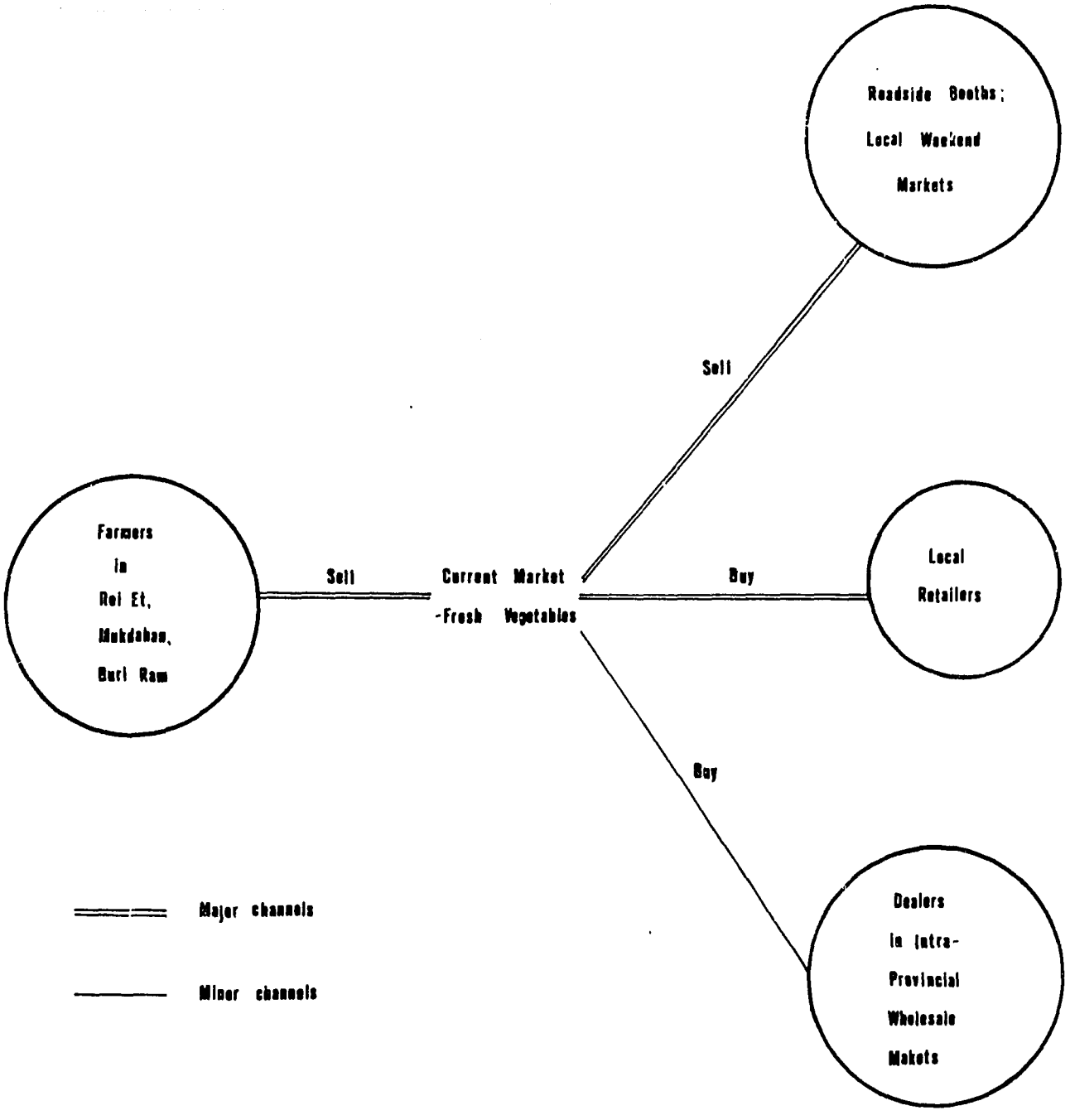


Figure F-4 Existing Procurement Systems for Fresh Vegetables in the NESSI Applied Study Area, 1989

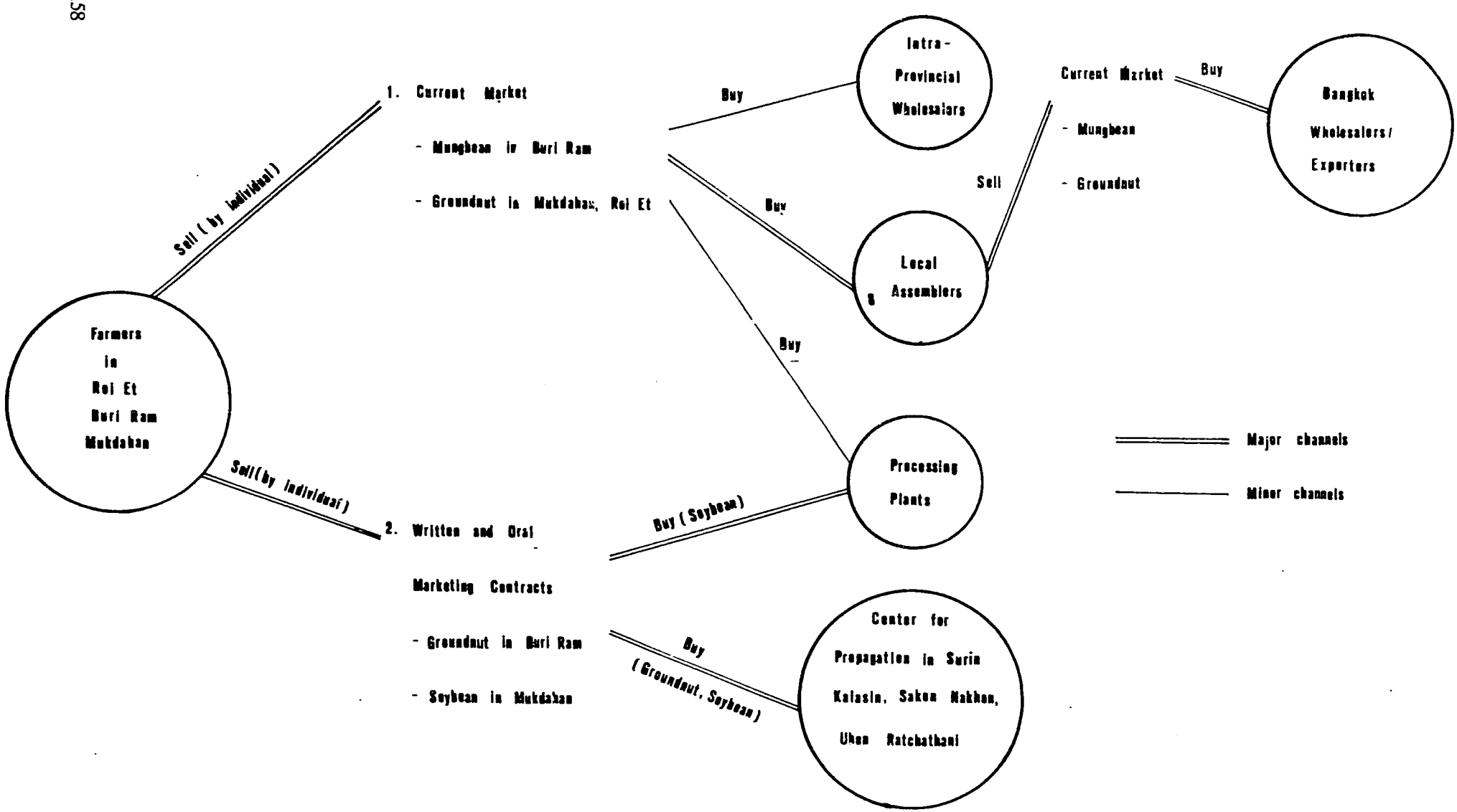


Figure F-5 Existing Procurement Systems for Oil Crops in the NESSI Applied Study Area, 1988

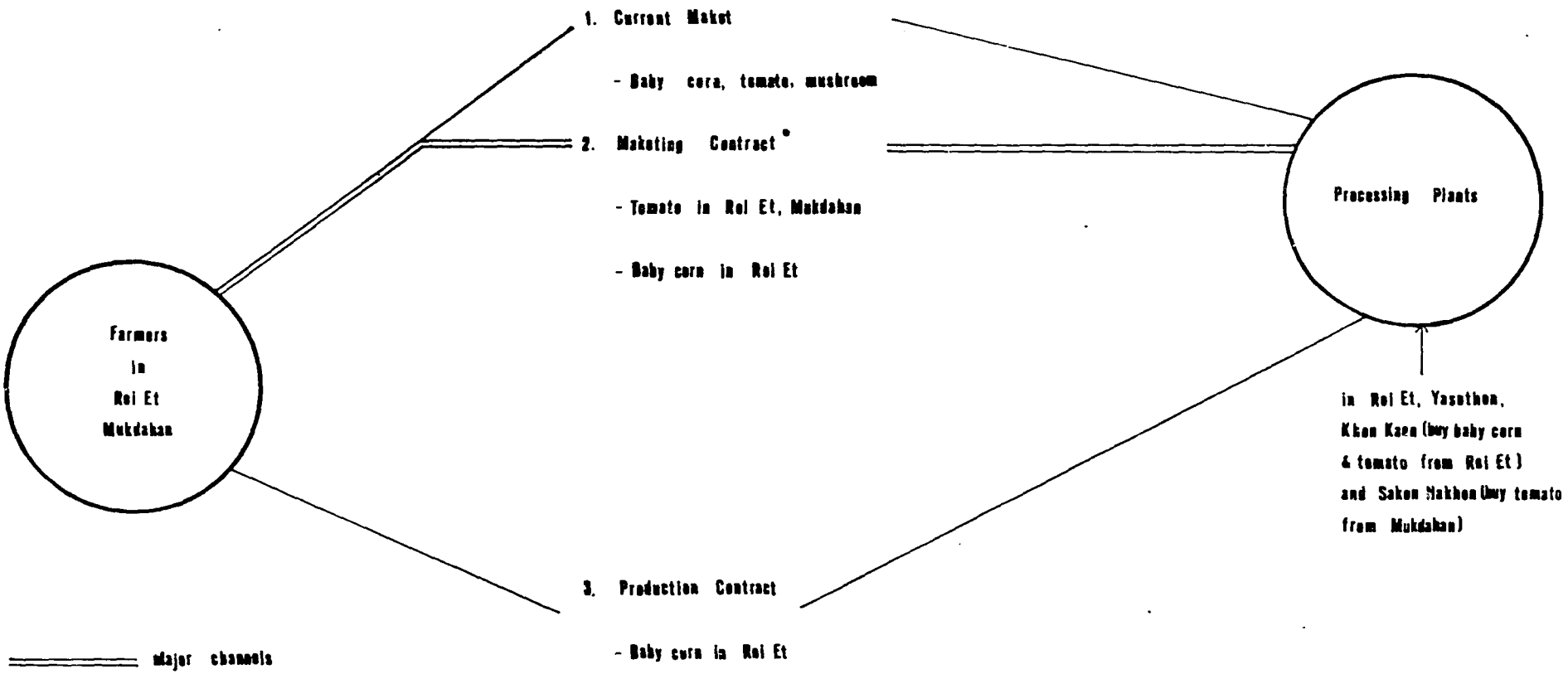


Figure F-6 Existing Procurement Systems for Processing Vegetables in the NESSI Applied Study Area, 1989

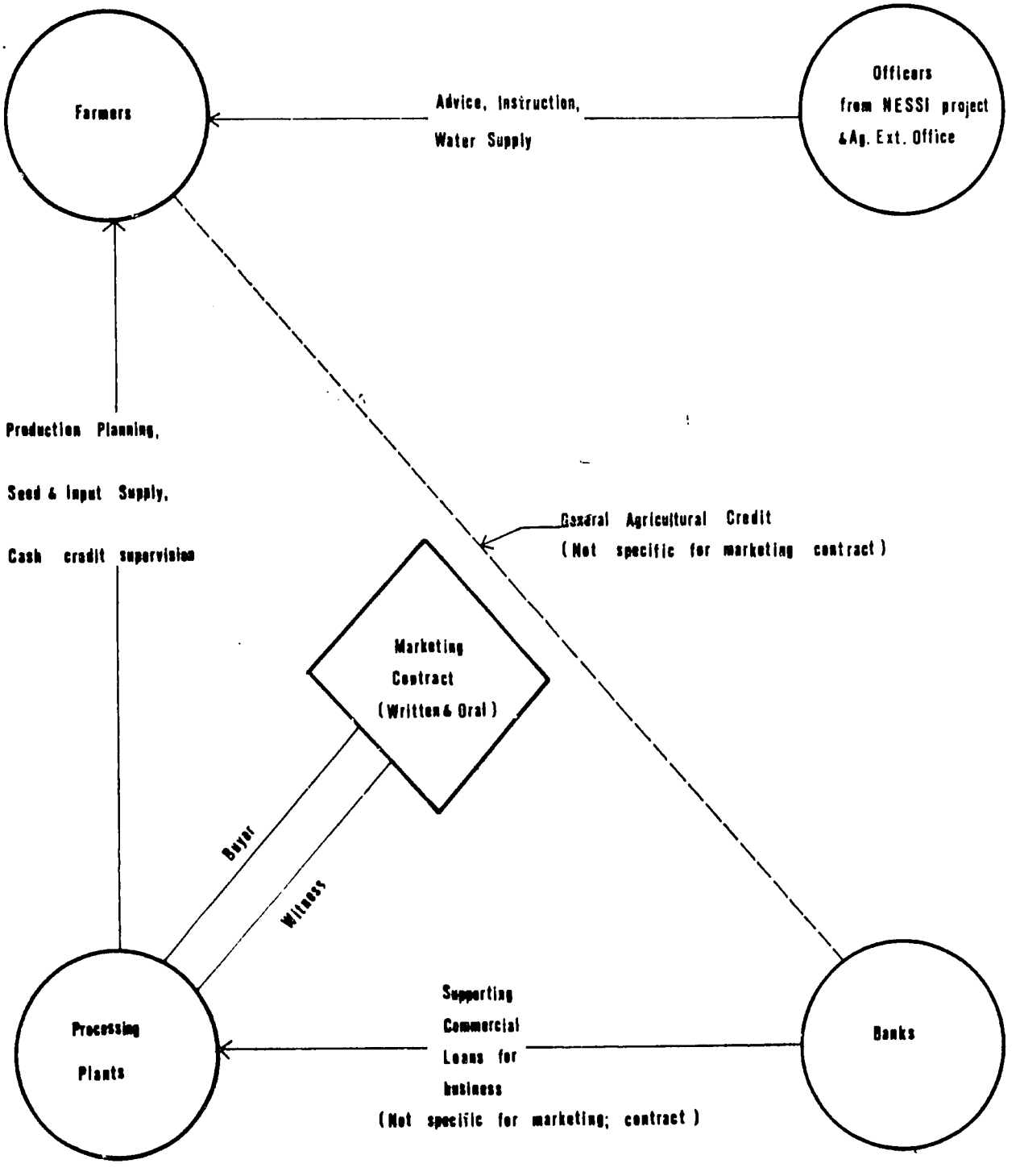


Figure F-7 Existing Pattern and Practice of Contract Farming in the NESSI Applied Study Area, 1988

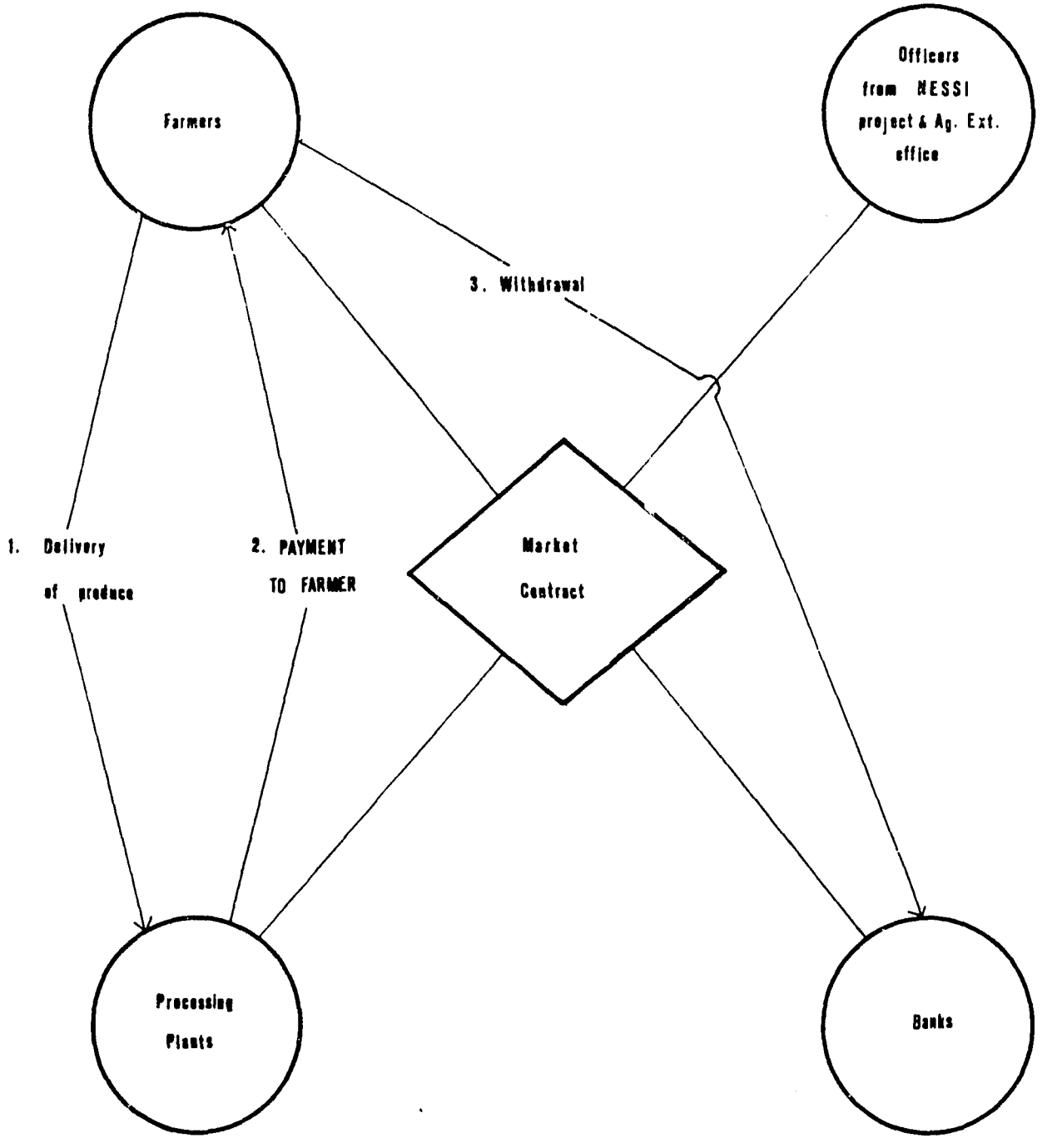


Figure F - 8 Existing Pattern and Practice of Contract : Delivery and Payment in the NESSI Applied Study Area, 1988

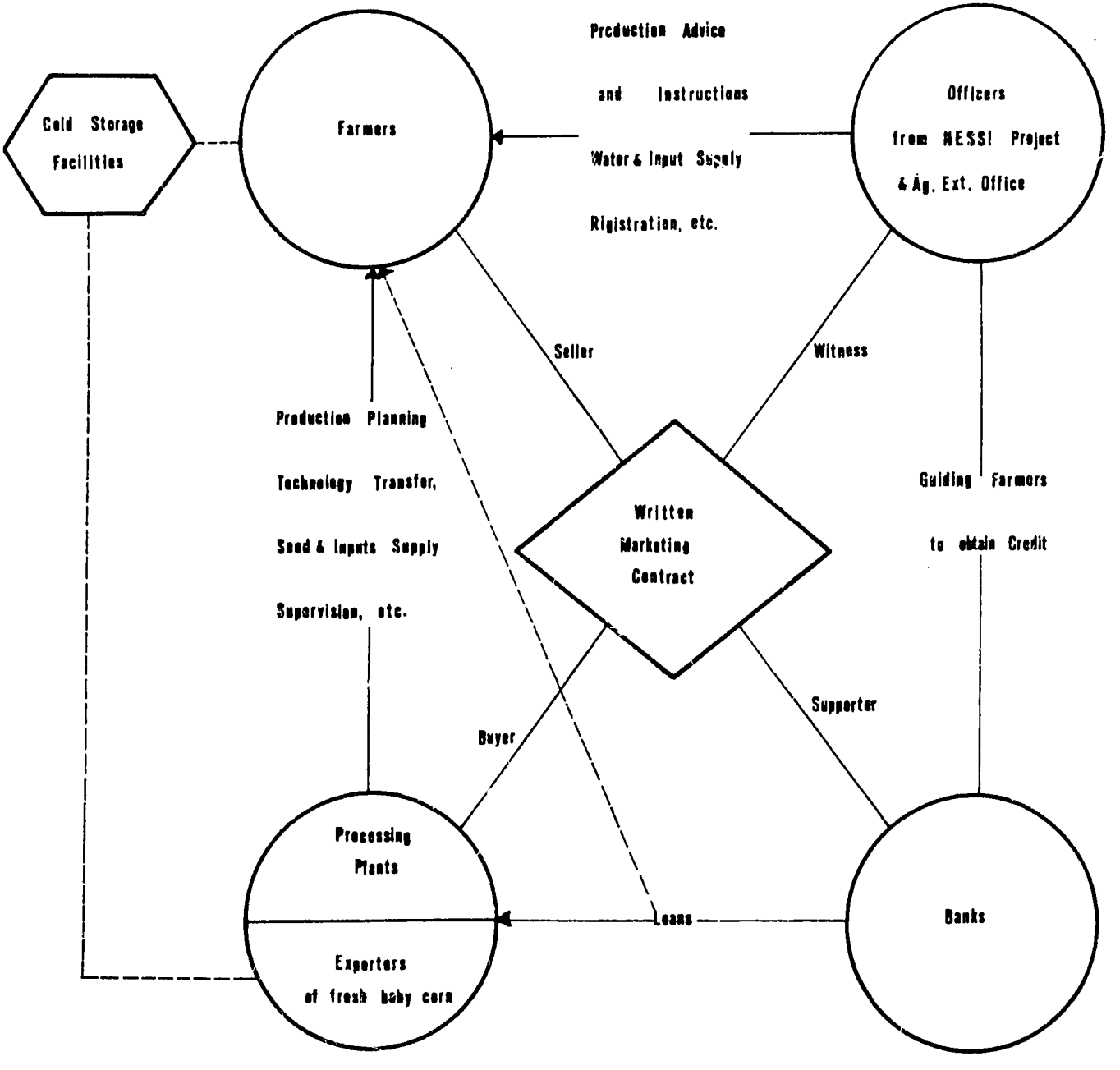


Figure F - 9 Improved Contract Farming Pattern & Practice in the NESSI Applied Study Area, 1989

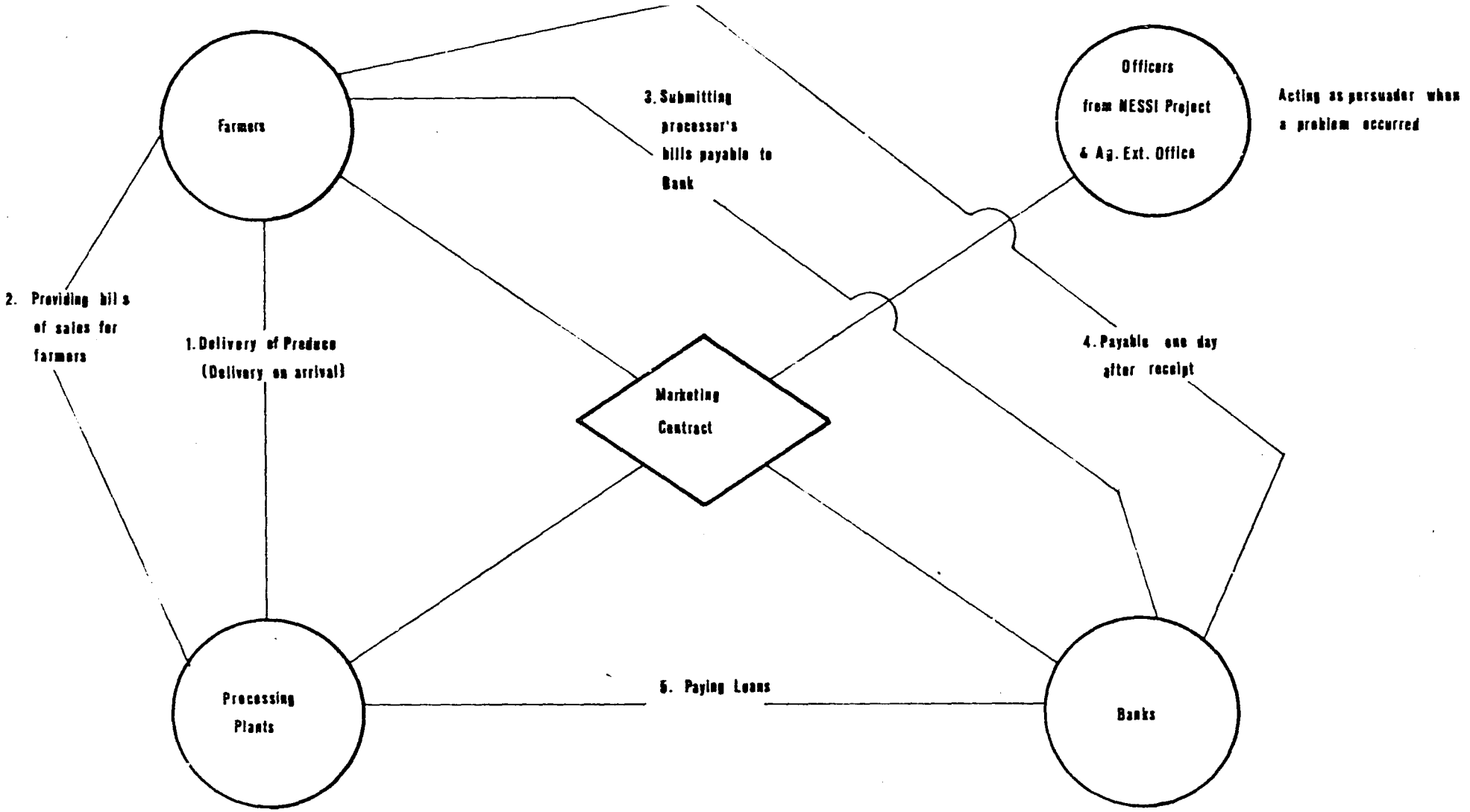


Figure F-10 Improved Contract Farming Pattern and Practice: Delivery and Procedure of Payment

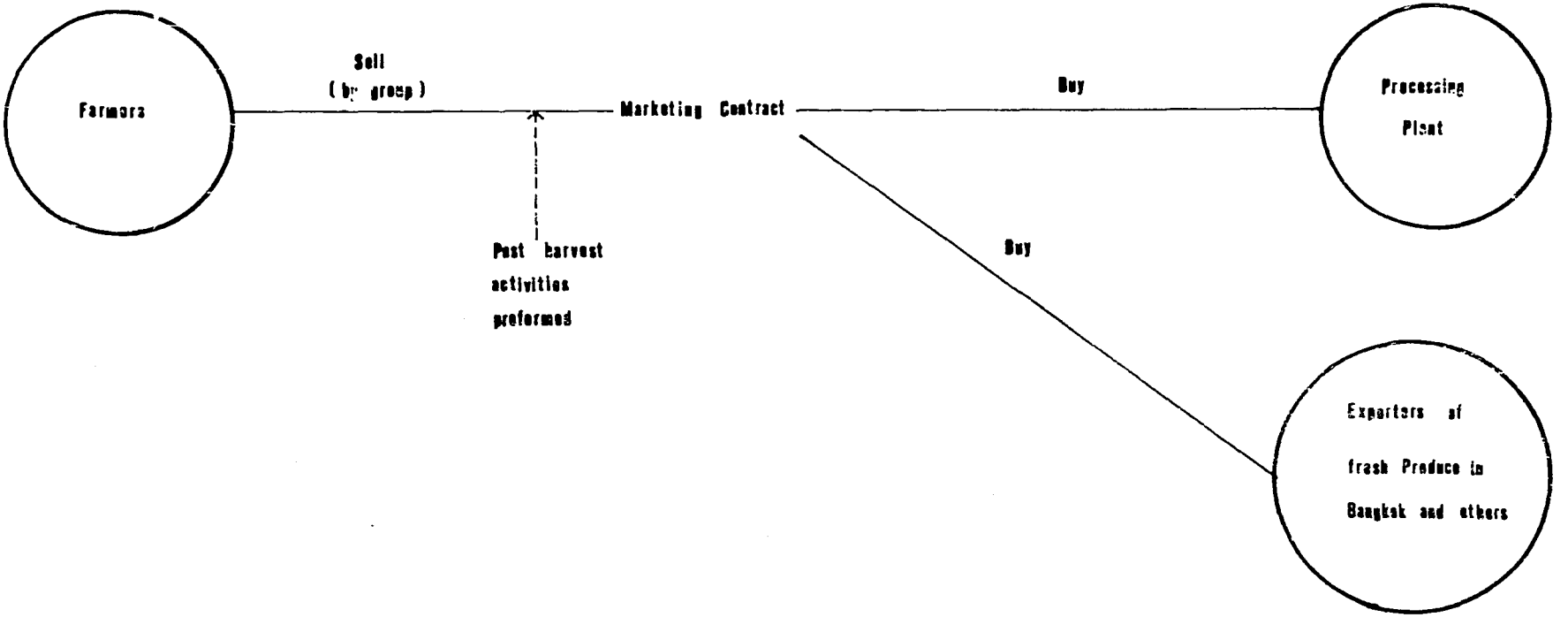


Figure F-11 Improved Procurement Systems for Baby Corn and Tomato

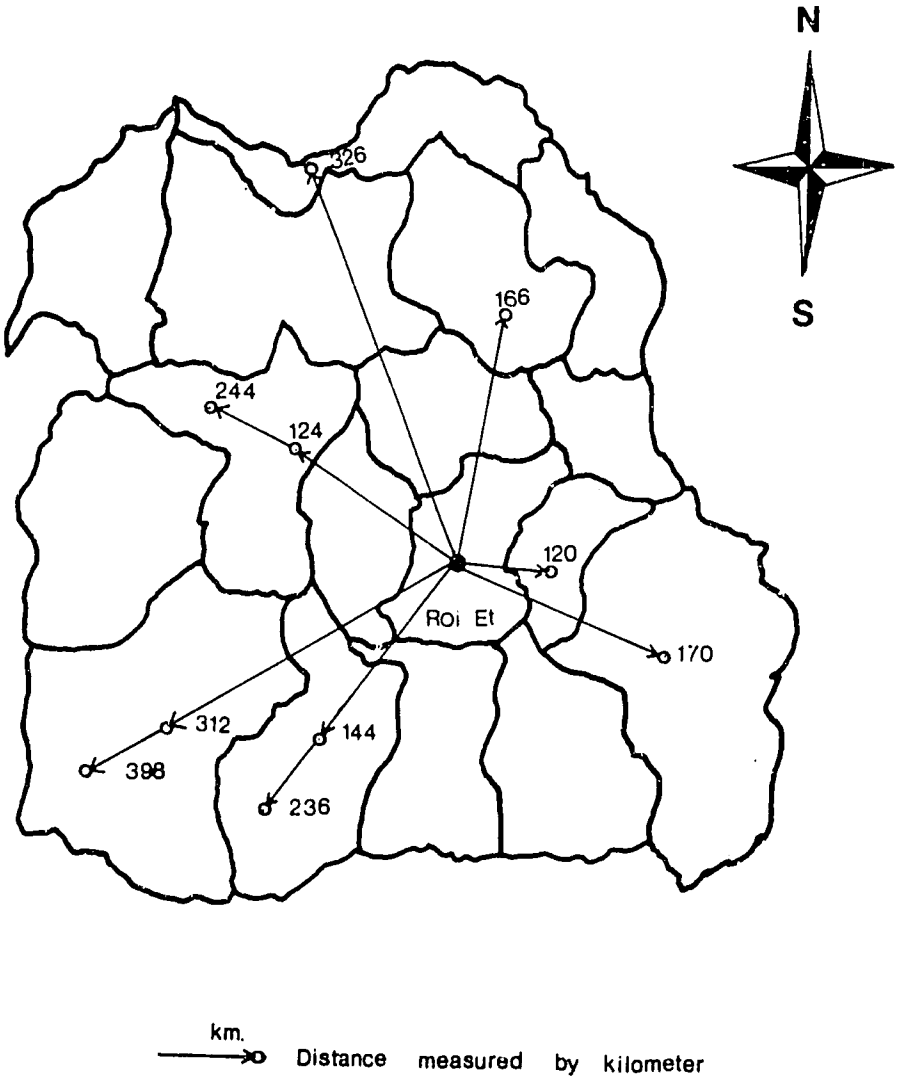


Figure F - 12 Distance for Flow of Selected Processing Vegetables : Huai Aeng Farmers to Processing Plants, 1989.

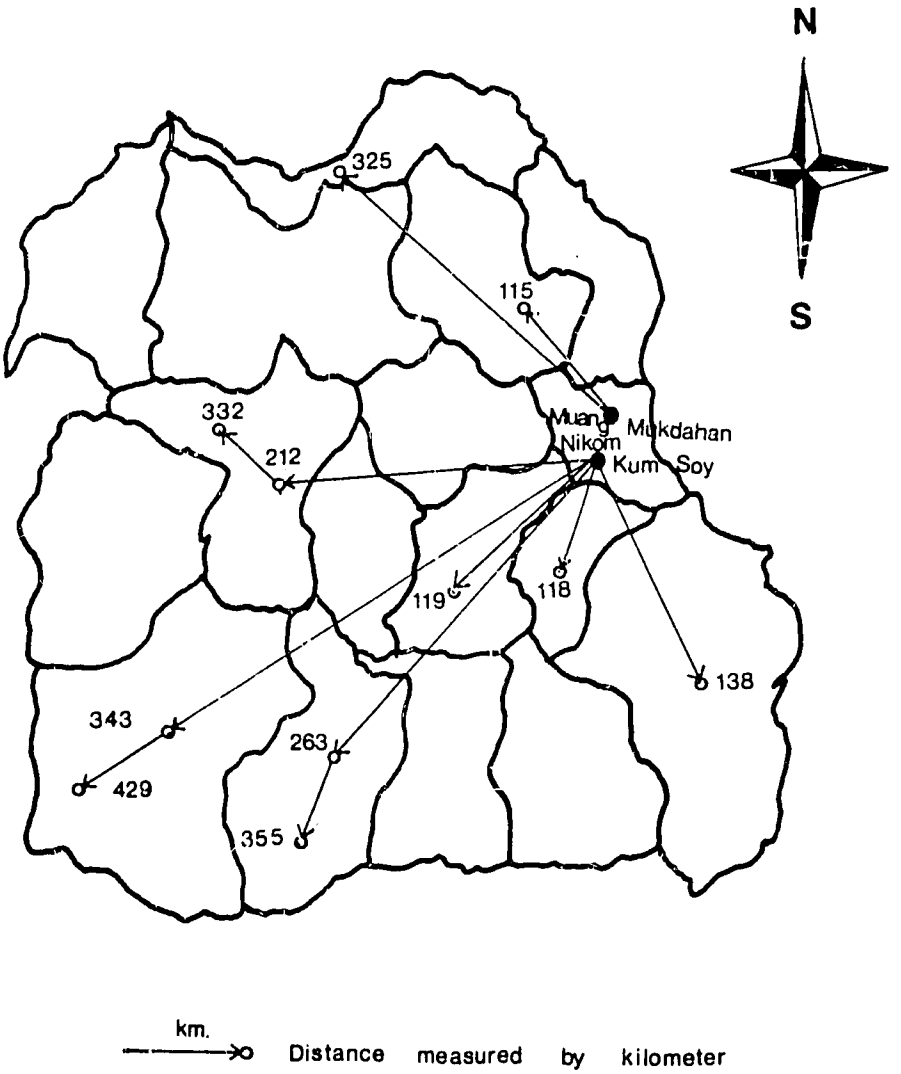


 Figure F-13 Distance for Flow of Selected Processing Vegetables : Huai Khilek Farmers to Processing Plants, 1989

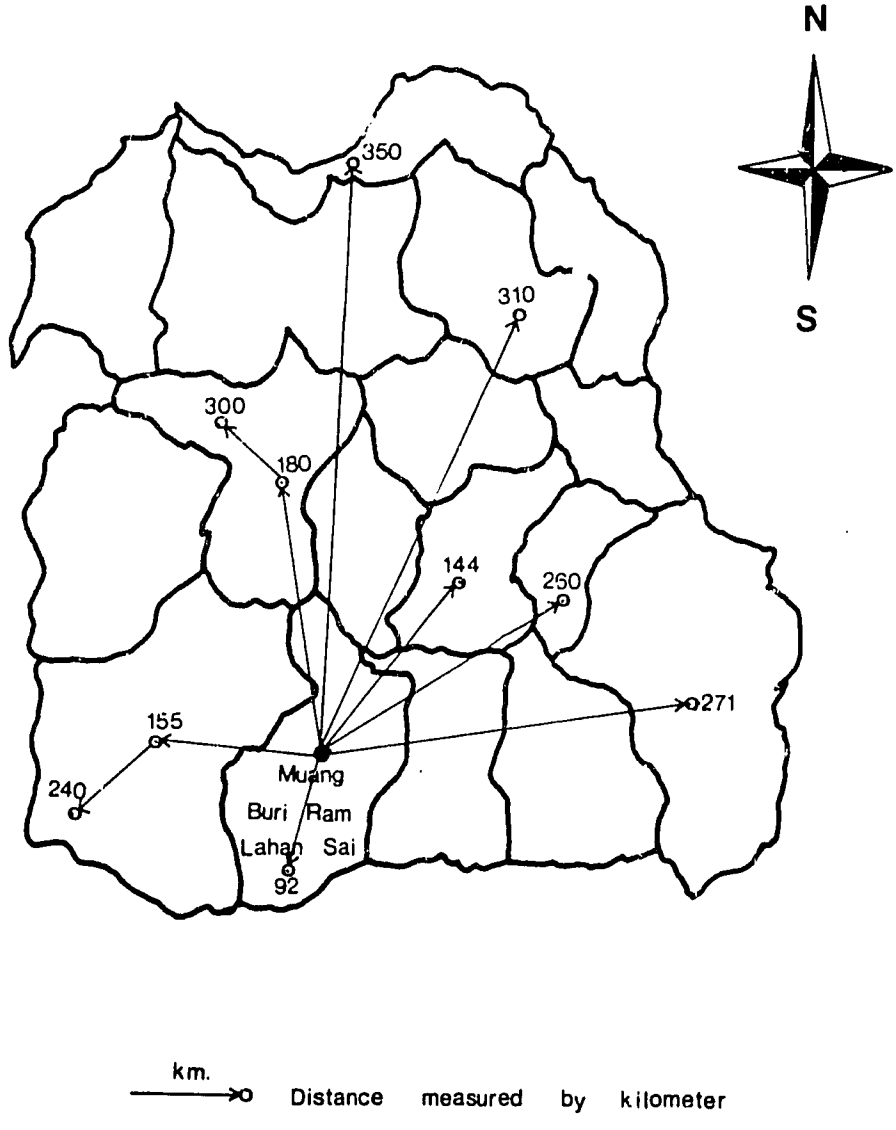
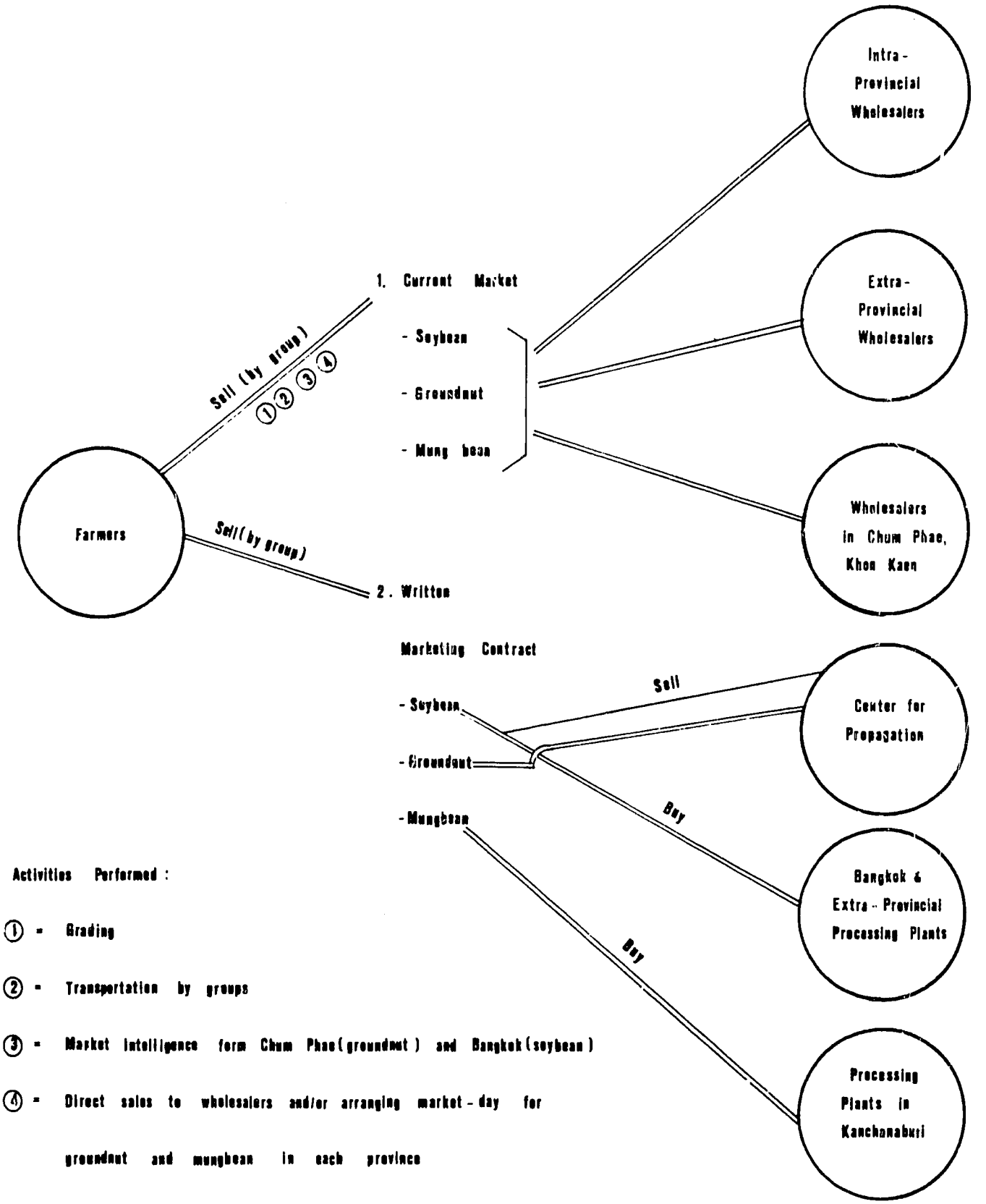


Figure F-14 Distance for Flow of Selected Processing Vegetables: Husi Chorakhe Mak to Processing Plants, 1989



Activities Performed :

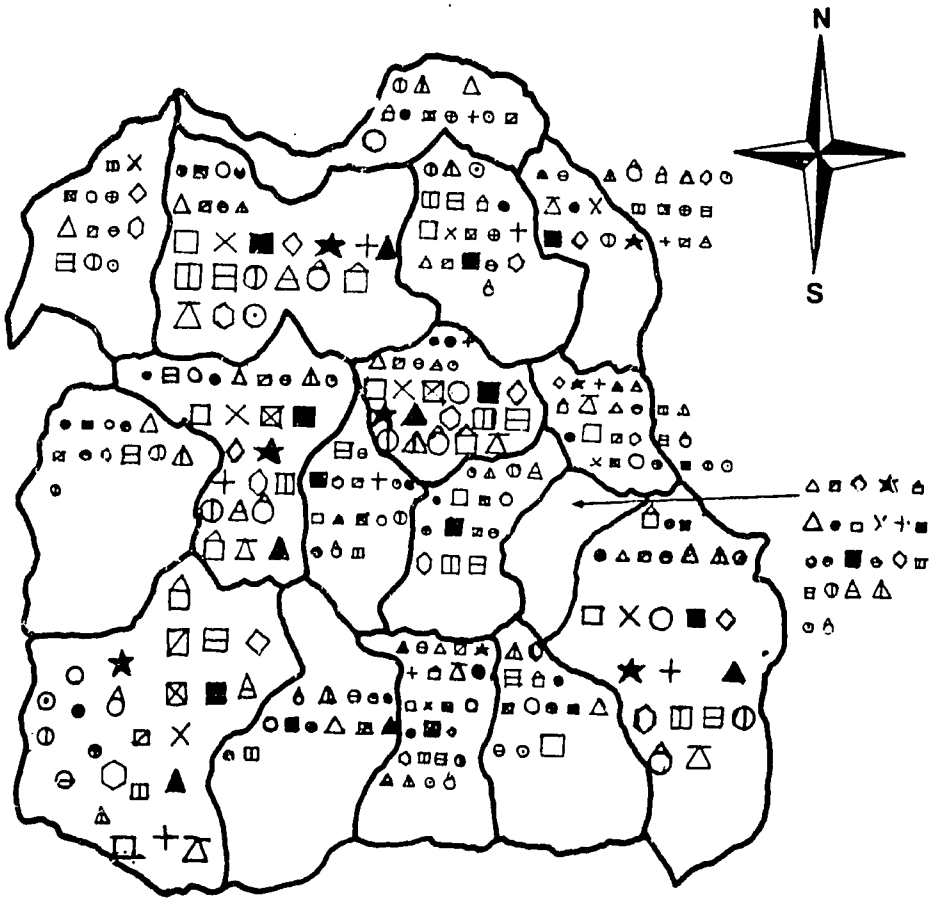
① = Grading

② = Transportation by groups

③ = Market intelligence form Chum Phae (groundnut) and Bangkok (soybean)

④ = Direct sales to wholesalers and/or arranging market-day for groundnut and mungbean in each province

Figure F-15 Improved Procurement Systems for Oil Crops



SYMBOLS:

- Ginger
- Garlic
- Shallot
- Chinese Radish
- Tomato
- Garden Pea
- Cabbage
- Long Cucumber
- Yard Long Bean
- Short Cucumber
- Angled Loofah
- Bitter Gourd
- Chinese Cabbage
- Lettuce
- Leaf Mustard
- Edible Rape
- Chinese Kale
- Kang Kong
- Pumpkin
- White Gourd
- Baby Corn
- Multiplier Onion
- Chilli
- Bird Pepper

Note:

1. Small symbol refers to planted area less than 500 rai
2. Medium symbol refers to planted area between 500 - 1,000 rai
3. Big symbol refers to planted area over 1,000 rai

Figure F - 16 Planted Area for Various Vegetables by Crops, All Provinces in Northeast Thailand, 1989

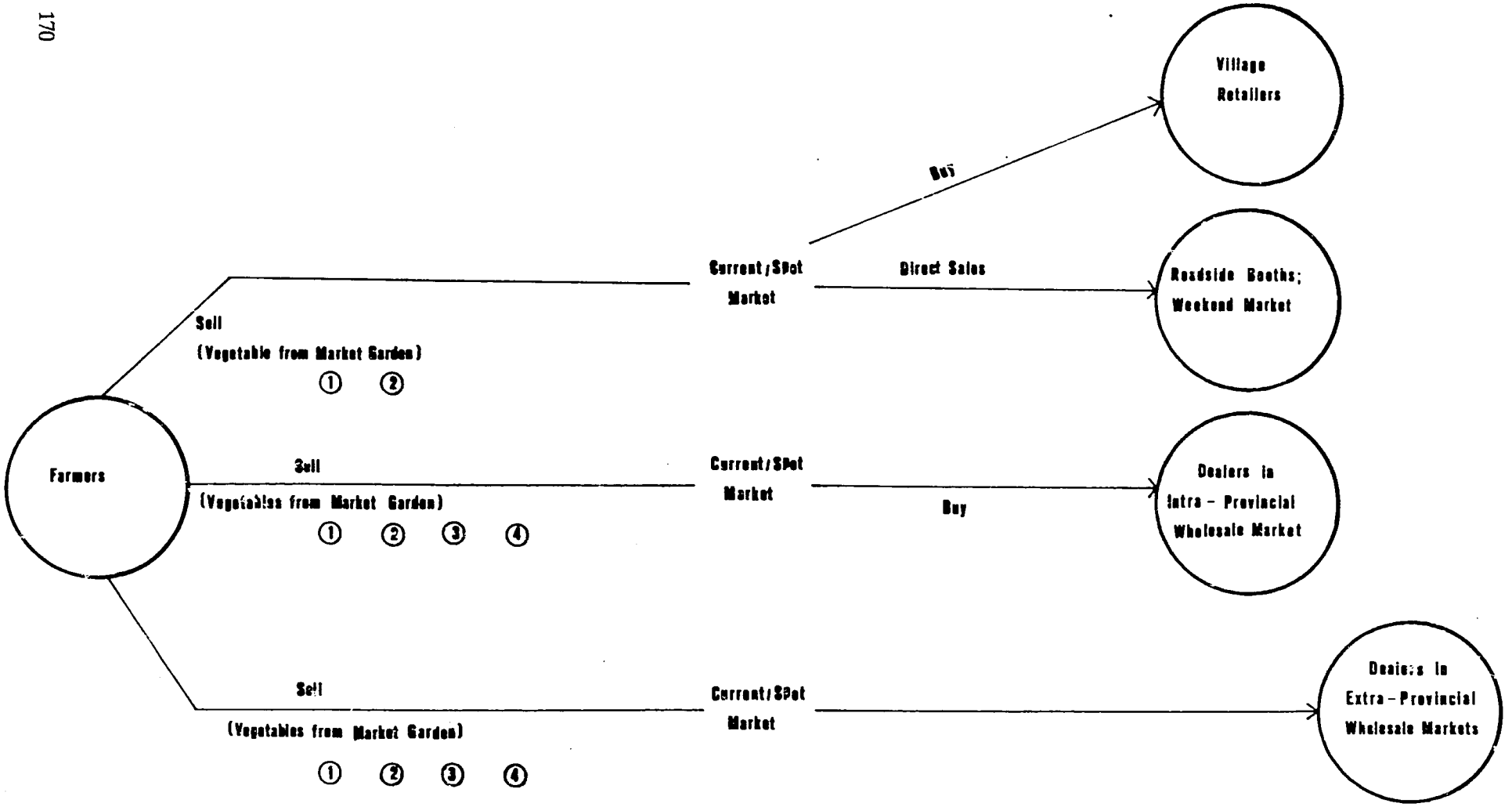


Figure F-17 Improved Procurement Systems for Fresh Vegetables

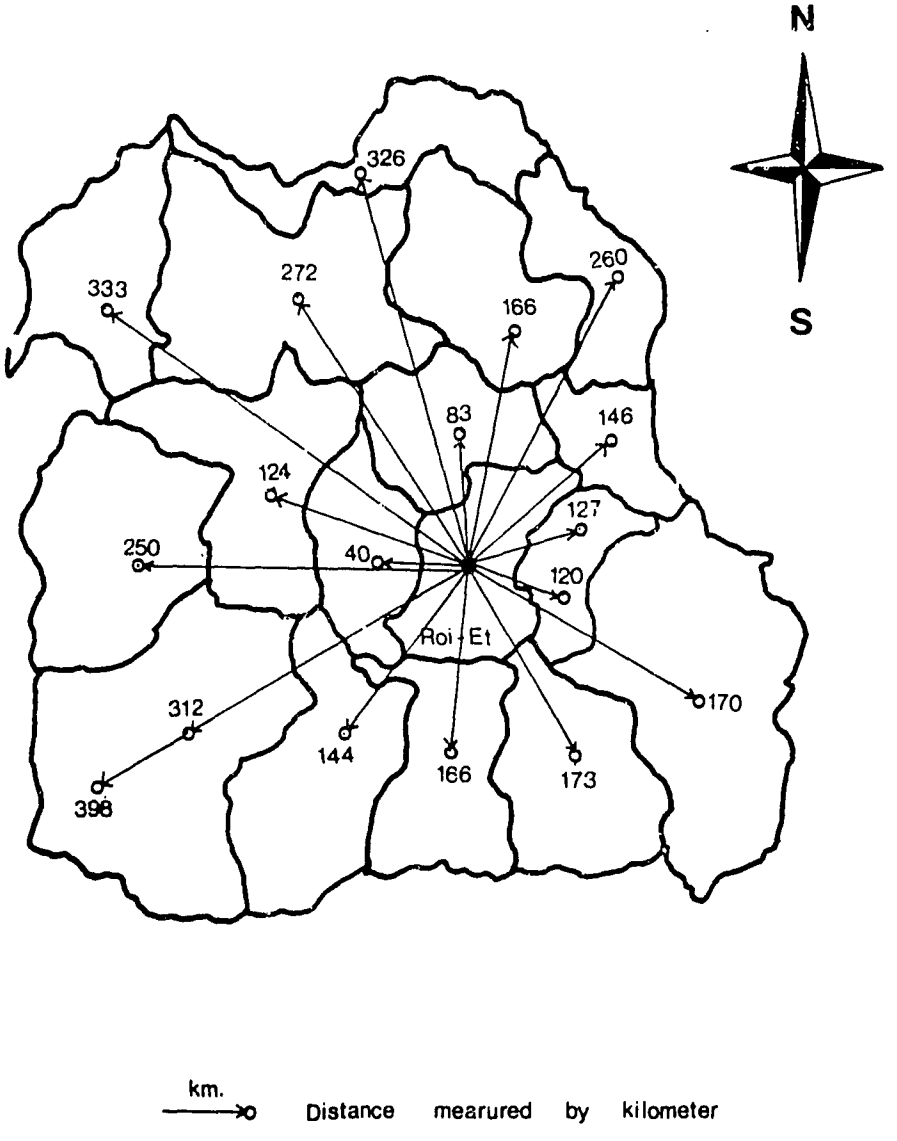


Figure F-18 Distance for Commodity Flow of Fresh Vegetables from Huai Aeng to Regional and Provincial Wholesale Market, 1989

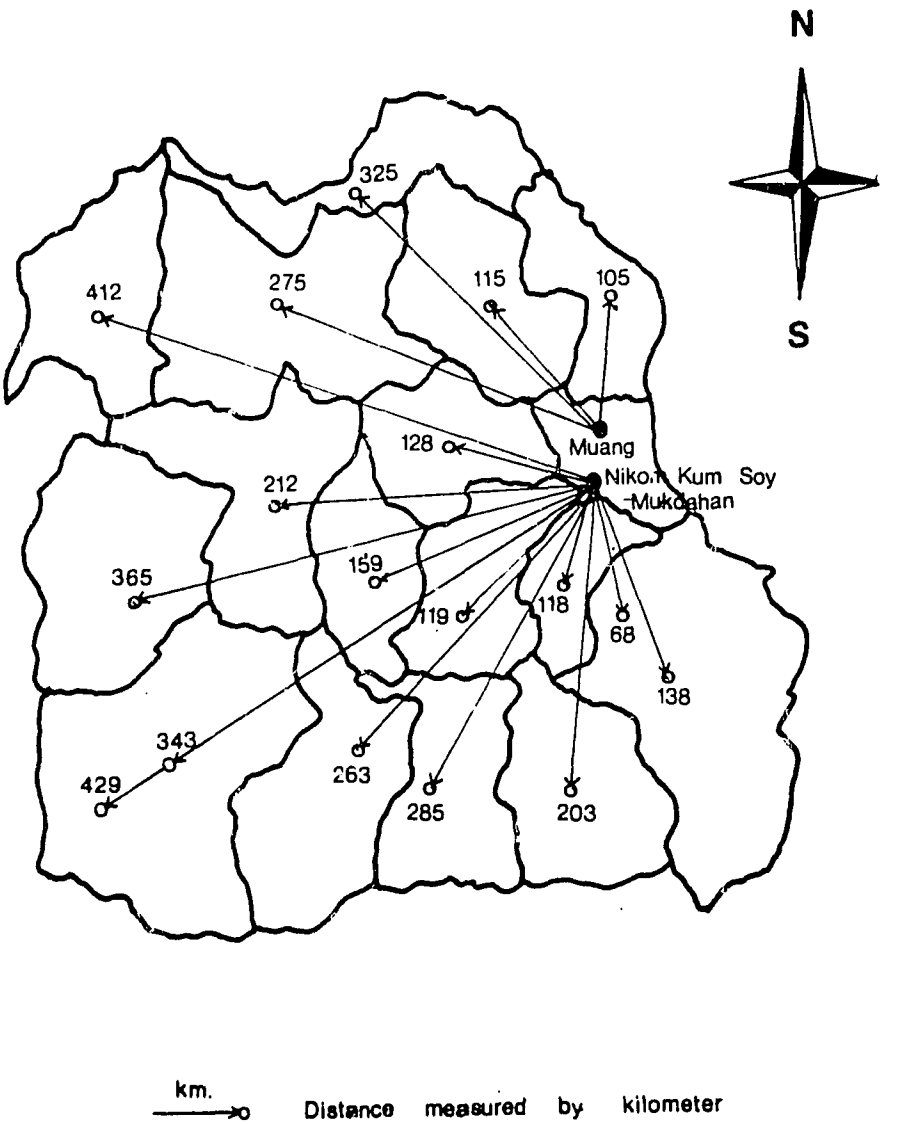


Figure F-19 Distance for Commodity Flow of Fresh Vegetables from Huai Khilek Farmers to Regional and Provincial Wholesale Markets

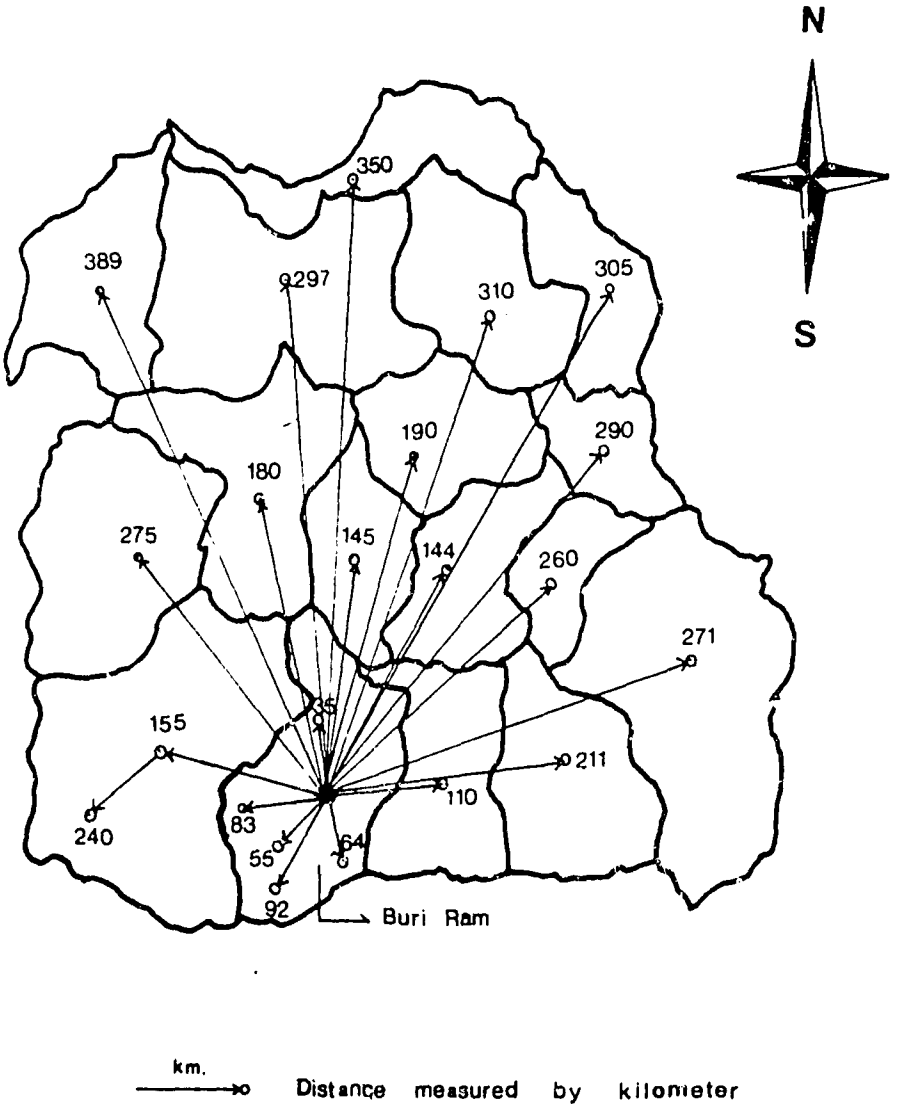


Figure F-20 Distance for Commodity Flow of Fresh Vegetables from Huai Chorakhe Mak to Regional and Provincial Wholesale Market, 1989

G

ECONOMIC ANALYSIS

Table G-1

MUAI AEBG B/C RATIOS

THAI YEAR	YEAR	DISCOUNT RATE (12%)	CONSTRUCTION COSTS	DISCOUNTED CONSTRUCTION	RECURRING COSTS	DISCOUNTED RECURRING COSTS	INCREMENTAL BENEFITS (WET SEASON)	DISCOUNTED DIRECT BENEFIT (WET SEASON)	INCREMENTAL BENEFITS (DRY SEASON)	DISCOUNTED DIRECT BENEFIT (DRY SEASON)	NET BENEFITS	DISCOUNTED NET BENEFITS	DISCOUNTED NET BENEFITS EXCLUDING LABOR COSTS	B/C RATIO
														W/LABOR COSTS
	0													0.869438
2525	1	1.000000	4,355,422	4,355,422	456,000	456,000	(28,000)	(28,000)	(158,712)	(158,712)	(4,998,134)	(4,998,134))	(5,051,144))	
2526	2	0.892857	26,397,199	23,568,928	610,200	544,821	882,000	787,500	292,238	260,927	(25,833,161)	(23,065,322)	(22,769,938)	
2527	3	0.797194	12,809,714	10,211,826	642,260	512,006	2,473,000	1,971,460	2,143,960	1,709,152	(8,835,014)	(7,043,219)	(6,225,513)	
2528	4	0.711780	16,321,682	11,617,451	193,600	137,801	4,300,100	3,060,726	2,902,032	2,065,609	(9,313,150)	(6,628,916)	(5,448,286)	
2529	5	0.635518	24,367,859	15,486,215	459,120	291,779	4,065,900	2,583,953	4,928,370	3,132,068	(15,832,709)	(10,061,973)	(8,755,755)	W/O LABOR COSTS
2530	6	0.567427	490,860	278,527	1,207,460	685,145	5,256,492	2,982,675	3,852,789	2,186,176	7,410,961	4,205,178	5,226,422	
2531	7	0.506631	128,600	65,153	1,115,774	565,286	6,386,100	3,235,397	1,910,118	967,725	7,051,844	3,572,684	4,307,451	1.030347
2532	8	0.452349	0	0	1,369,100	619,311	5,864,215	2,652,673	2,583,236	1,168,525	7,078,351	3,201,887	3,949,982	
2533	9	0.403883	0	0	1,369,100	552,957	5,876,533	2,373,433	2,805,696	1,133,174	7,313,129	2,953,650	3,621,592	
2534	10	0.360610	0	0	1,369,100	493,711	5,995,833	2,162,157	3,134,296	1,130,259	7,761,029	2,798,705	3,413,761	
2535	11	0.321973	0	0	1,369,100	440,814	7,442,661	2,396,338	3,002,648	966,772	9,076,209	2,922,296	3,471,454	
2536	12	0.287476	0	0	1,369,100	393,584	7,442,661	2,139,587	3,002,648	863,190	9,076,209	2,609,193	3,099,512	
2537	13	0.256675	0	0	1,369,100	351,414	6,527,836	1,675,533	3,002,648	770,705	8,161,384	2,094,824	2,532,609	
2538	14	0.229174	0	0	1,369,100	313,762	7,371,220	1,689,293	2,813,968	644,889	8,816,088	2,020,420	2,411,299	
2539	15	0.204620	0	0	1,369,100	280,145	6,924,199	1,416,828	3,022,588	618,481	8,577,687	1,755,165	2,104,164	
2540	16	0.182696	0	0	1,369,100	250,129	7,285,423	1,331,020	3,022,588	552,216	8,938,911	1,633,106	1,944,712	
2541	17	0.163122	0	0	1,369,100	223,330	6,850,858	1,117,523	3,022,588	493,050	8,504,346	1,387,243	1,665,463	
2542	18	0.145644	0	0	1,369,100	199,402	7,800,960	1,136,166	3,415,516	497,451	9,847,376	1,434,215	1,682,626	
2543	19	0.130040	0	0	1,369,100	178,037	7,800,960	1,014,434	3,415,516	444,152	9,847,376	1,280,549	1,502,344	
2544	20	0.116107	0	0	1,369,100	158,962	8,162,184	947,685	3,415,516	396,565	10,208,600	1,185,288	1,383,319	
2545	21	0.103667	0	0	1,369,100	141,930	8,162,184	846,147	3,415,516	354,075	10,208,600	1,058,293	1,235,107	
2546	22	0.092560	0	0	1,369,100	126,723	8,162,184	755,489	3,415,516	316,139	10,208,600	944,904	1,102,774	
2547	23	0.082643	0	0	1,369,100	113,145	8,162,184	674,543	3,632,236	300,177	10,425,320	861,575	1,002,530	
2548	24	0.073788	0	0	1,369,100	101,023	8,884,632	655,579	3,632,236	268,015	11,147,768	822,571	948,424	
2549	25	0.065882	0	0	1,369,100	90,199	8,884,632	585,338	3,632,236	239,299	11,147,768	734,438	846,807	
2550	26	0.058823	0	0	1,369,100	80,535	8,884,632	522,623	3,612,796	212,517	11,128,328	654,605	754,934	
2551	27	0.052521	0	0	1,369,100	71,906	8,884,632	466,628	3,612,796	189,747	11,128,328	584,469	674,048	
2552	28	0.046926	0	0	1,369,100	64,202	8,884,632	416,632	3,612,796	169,417	11,128,328	521,847	601,829	
2553	29	0.041869	0	0	1,369,100	57,323	8,884,632	371,993	3,612,796	151,265	11,128,328	465,935	537,347	
2554	30	0.037383	0	0	1,369,100	51,181	8,884,632	332,137	3,612,796	135,058	11,128,328	416,013	479,774	
			84,871,336	65,583,521	36,173,714	8,546,565	201,360,111	42,273,491	91,321,966	22,178,081	171,637,027	(9,678,514)	2,249,648	

Table G-2

HUAI KHILEK B/C RATIOS

THAI YEAR	YEAR	DISCOUNT RATE (12%)	CONSTRUCTION COSTS	DISCOUNTED CONSTRUCTION	RECURRING COSTS	DISCOUNTED RECURRING COSTS	INCREMENTAL BENEFITS (WET SEASON)	DISCOUNTED DIRECT BENEFIT (WET SEASON)	INCREMENTAL BENEFITS (DRY SEASON)	DISCOUNTED DIRECT BENEFIT (DRY SEASON)	DISCOUNTED NET BENEFITS	DISCOUNTED DIRECT BENEFITS EXCLUDING LABOR	DISCOUNTED NET BENEFITS EXCLUDING LABOR	DIRECT BENEFITS EXCLUDING LABOR	B/C RATIO
	0														
2525	1	1.000000	0	0	220,000	220,000	166,188	166,188	371,424	371,424	317,612	606,772	386,772	786,266	W/LABOR COSTS
2526	2	0.892857	0	0	534,010	476,795	364,578	325,516	273,264	243,986	92,707	623,828	147,033	739,008	1.212381
2527	3	0.797194	450,000	358,737	1,123,361	895,537	351,296	280,051	423,066	337,266	(636,957)	666,427	(587,846)	911,184	
2528	4	0.711780	1,324,049	942,432	1,009,580	718,599	404,572	287,967	546,272	388,826	(984,239)	735,824	(925,207)	1,055,720	
2529	5	0.635518	8,728,446	5,547,055	477,000	303,142	619,655	393,802	1,854,292	1,178,436	(4,277,989)	1,731,807	(4,118,420)	2,494,390	W/O LABOR
2530	6	0.567427	25,554,348	15,067,650	477,000	270,663	1,295,789	735,265	2,992,094	1,697,794	(12,905,253)	2,722,950	(12,615,363)	3,954,358	COSTS
2531	7	0.506631	5,025,840	2,546,247	477,000	241,663	1,813,200	918,624	1,360,003	689,020	(1,180,267)	1,718,165	(1,069,745)	2,105,217	1.349678
2532	8	0.452349	128,600	58,172	477,000	215,771	1,747,950	790,684	4,143,548	1,874,331	2,391,072	3,042,161	2,768,218	5,504,362	
2533	9	0.403883	0	0	477,000	192,652	1,683,263	679,841	4,324,148	1,746,451	2,233,640	2,763,030	2,570,378	5,684,362	
2534	10	0.360610	0	0	477,000	172,011	1,957,369	705,847	4,324,148	1,559,331	2,093,167	2,565,837	2,393,826	5,684,362	
2535	11	0.321973	0	0	477,000	153,581	2,210,756	711,804	4,321,748	1,391,487	1,949,710	2,371,737	2,218,155	5,684,362	
2536	12	0.287476	0	0	477,000	137,126	2,216,531	637,200	4,321,748	1,242,399	1,742,473	2,119,282	1,982,156	5,684,362	
2537	13	0.256675	0	0	477,000	122,434	2,960,438	759,871	4,321,748	1,109,285	1,746,722	2,083,158	1,960,724	5,684,362	
2538	14	0.229174	0	0	477,000	109,316	2,850,600	653,284	4,445,848	1,018,874	1,562,841	1,863,232	1,753,915	5,840,362	
2539	15	0.204620	0	0	477,000	97,604	3,452,194	706,387	4,441,996	908,920	1,517,704	1,785,909	1,688,306	5,840,362	
2540	16	0.182696	0	0	477,000	87,146	3,452,194	630,703	4,441,996	811,536	1,355,093	1,594,562	1,507,416	5,840,362	
2541	17	0.163122	0	0	477,000	77,809	3,452,194	563,128	4,441,996	724,586	1,209,904	1,423,716	1,345,907	5,840,362	
2542	18	0.145644	0	0	477,000	69,472	3,451,116	502,635	4,424,672	644,428	1,077,592	1,268,495	1,199,023	5,840,362	
2543	19	0.130040	0	0	477,000	62,029	3,418,716	444,568	4,784,672	622,197	1,004,736	1,175,186	1,113,157	6,200,362	
2544	20	0.116107	0	0	477,000	55,383	3,418,716	396,936	4,784,672	555,533	897,086	1,049,273	993,890	6,200,362	
2545	21	0.103667	0	0	477,000	49,449	3,408,741	353,373	4,784,672	496,011	799,936	935,817	886,368	6,200,362	
2546	22	0.092560	0	0	477,000	44,151	3,407,663	315,412	4,784,672	442,867	714,128	835,451	791,300	6,200,362	
2547	23	0.082643	0	0	477,000	39,420	3,407,663	281,618	4,784,672	395,417	637,615	745,938	706,518	6,200,362	
2548	24	0.073788	0	0	477,000	35,197	3,407,663	251,444	4,784,672	353,051	569,299	666,016	630,819	6,200,362	
2549	25	0.065882	0	0	477,000	31,426	3,407,663	224,504	4,784,672	315,224	508,302	594,657	563,232	6,200,362	
2550	26	0.058823	0	0	477,000	28,059	3,407,663	200,450	4,779,872	281,168	453,559	530,662	502,603	6,200,362	
2551	27	0.052521	0	0	477,000	25,052	3,407,663	178,973	4,779,872	251,043	404,964	473,805	448,753	6,200,362	
2552	28	0.046894	0	0	477,000	22,368	3,407,663	159,797	4,779,872	224,145	361,575	423,040	400,672	6,200,362	
2553	29	0.041869	0	0	477,000	19,972	3,407,663	142,676	4,779,872	200,130	322,634	377,715	357,743	6,200,362	
2554	30	0.037383	0	0	477,000	17,832	3,407,663	127,390	4,779,872	178,687	288,245	337,245	319,413	6,200,362	
			42,211,283	24,520,324	15,288,951	4,991,658	75,365,015	13,525,933	113,166,075	22,253,854	6,267,810	39,831,696	10,319,714	149,578,470	

Table G-3

CHORAKHE MAK, BURIRAM B/C RATIOS

THAI YEAR	YEAR	DISCOUNT RATE (12%)	CONSTRUCTION COSTS	DISCOUNTED CONSTRUCTION	RECURRING COSTS	DISCOUNTED RECURRING COSTS	INCREMENTAL BENEFITS (WET SEASON)	DISCOUNTED DIRECT BENEFIT (WET SEASON)	DIRECT BENEFITS (DRY SEASON)	DISCOUNTED DIRECT BENEFIT (DRY SEASON)	NET BENEFITS	DISCOUNTED NET BENEFITS	DISCOUNTED DIRECT BENEFITS EXCLUDING LABOR	DISCOUNTED NET BENEFITS EXCLUDING LABOR	DIRECT BENEFITS EXCLUDING LABOR	B/C RATIO
	0															W/LABOR COSTS
2525	1	1.000000	0	0	150,000	150,000	458,700	458,700	(21,239)	(21,239)	287,461	287,461	431,591	281,391	262,150	0.91
2526	2	0.892857	0	0	150,000	133,929	467,500	417,411	(16,313)	(14,565)	301,187	268,917	399,774	265,846	269,506	
2527	3	0.797194	0	0	150,000	119,579	529,070	421,771	86,791	69,189	465,861	371,382	397,434	277,855	364,700	
2528	4	0.711780	0	0	350,000	249,123	741,725	527,945	70,388	50,101	462,113	328,923	443,875	194,752	419,550	
2529	5	0.635518	11,769,583	7,479,783	277,250	176,197	1,212,655	770,664	189,535	120,453	(10,644,643)	(6,764,863)	774,754	(6,881,226)	564,347	W/O LABOR
2530	6	0.567427	15,081,670	8,557,745	415,000	235,482	2,368,705	1,287,324	326,032	184,999	(12,901,933)	(7,320,903)	1,452,106	(7,341,121)	811,678	COSTS
2531	7	0.506631	6,133,166	3,107,253	862,280	436,858	2,571,355	1,302,728	873,815	442,702	(3,550,276)	(1,798,680)	1,776,370	(1,767,740)	1,399,391	0.98
2532	8	0.452349	20,144,816	9,112,492	662,280	299,582	1,991,405	900,810	1,274,264	576,412	(17,541,427)	(7,934,851)	1,572,985	(7,839,088)	1,912,970	
2533	9	0.403883	128,600	51,939	662,280	267,484	3,275,605	1,322,962	2,926,134	1,181,816	5,410,859	2,185,355	2,779,520	2,460,097	3,933,390	
2534	10	0.360610	0	0	662,280	238,825	4,015,700	1,448,102	2,926,134	1,055,193	6,279,554	2,264,470	2,757,615	2,518,790	3,933,390	
2535	11	0.321973	0	0	662,280	213,236	3,099,400	997,924	2,971,134	956,626	5,408,254	1,741,313	2,181,621	1,968,385	3,990,390	
2536	12	0.287476	0	0	662,280	190,390	3,099,400	891,003	2,966,134	852,693	5,403,254	1,553,306	1,946,439	1,756,049	3,990,390	
2537	13	0.256675	0	0	662,280	169,991	3,099,400	795,539	3,206,294	822,976	5,643,414	1,448,524	1,799,535	1,629,544	4,230,550	
2538	14	0.229174	0	0	662,280	151,777	3,099,400	710,302	3,136,294	718,758	5,573,414	1,277,283	1,590,685	1,438,908	4,160,550	
2539	15	0.204620	0	0	662,280	135,516	3,110,000	636,368	3,131,206	640,707	5,578,926	1,141,559	1,421,383	1,285,867	4,160,550	
2540	16	0.182696	0	0	662,280	120,996	2,941,500	537,401	3,131,206	572,060	5,410,426	988,465	1,238,307	1,117,311	4,160,550	
2541	17	0.163122	0	0	662,280	108,032	2,941,500	479,822	3,131,206	510,768	5,410,426	882,558	1,105,631	997,599	4,160,550	
2542	18	0.145644	0	0	662,280	96,457	2,941,500	428,413	3,131,206	456,042	5,410,426	787,998	987,171	890,714	4,160,550	
2543	19	0.130040	0	0	662,280	86,123	2,941,500	382,511	3,137,206	407,961	5,416,426	704,350	882,183	796,060	4,166,550	
2544	20	0.116107	0	0	662,280	76,895	2,941,500	341,528	3,137,206	364,251	5,416,426	628,884	787,663	710,768	4,166,550	
2545	21	0.103667	0	0	662,280	68,656	3,392,750	351,715	3,193,606	331,071	5,924,076	614,130	755,897	687,241	4,166,550	
2546	22	0.092560	0	0	662,280	61,300	3,392,750	314,032	3,193,606	295,599	5,924,076	548,330	674,908	613,608	4,166,550	
2547	23	0.082643	0	0	662,280	54,732	3,384,050	279,666	3,193,606	263,928	5,915,376	488,862	601,878	547,145	4,166,550	
2548	24	0.073788	0	0	662,280	48,868	3,835,300	282,999	3,214,606	237,199	6,387,626	471,330	572,237	523,369	4,187,550	
2549	25	0.065882	0	0	662,280	43,632	3,835,300	252,678	3,214,606	211,785	6,387,626	420,830	510,926	467,294	4,187,550	
2550	26	0.058823	0	0	662,280	38,957	3,835,300	225,605	3,214,606	189,094	6,387,626	375,741	456,184	417,226	4,187,550	
2551	27	0.052521	0	0	662,280	34,783	3,835,300	201,433	3,214,606	168,834	6,387,626	335,483	407,307	372,524	4,187,550	
2552	28	0.046894	0	0	662,280	31,057	4,476,550	209,921	3,214,606	150,744	7,028,876	329,609	393,736	362,681	4,187,550	
2553	29	0.041869	0	0	662,280	27,729	4,476,550	187,430	3,214,606	134,593	7,028,876	294,294	351,551	323,822	4,187,550	
2554	30	0.037383	0	0	662,280	24,758	4,476,550	167,348	3,214,606	120,172	7,028,876	262,762	313,885	289,127	4,187,550	
			53,257,835	28,309,211	17,586,970	4,090,947	86,687,920	17,532,058	71,797,694	12,050,922	87,640,809	(2,817,179)	31,765,154	(635,004)	97,030,752	

Table G-4

PHUTTHA UTTHAYAN B/C RATIOS

THAI YEAR	YEAR	DISCOUNT RATE (12%)	CONSTRUCTION COSTS	DISCOUNTED CONSTRUCTION COSTS	RECURRING COSTS	DISCOUNTED RECURRING COSTS	INCREMENTAL BENEFITS (WET SEASON)	DISCOUNTED DIRECT BENEFIT (WET SEASON)	INCREMENTAL BENEFITS (DRY SEASON)	DISCOUNTED DIRECT BENEFIT (DRY SEASON)	NET BENEFITS	DISCOUNTED NET BENEFITS	DISCOUNTED DIRECT BENEFITS EXCLUDING LABOR	DISCOUNTED NET BENEFITS EXCLUDING LABOR	DIRECT BENEFITS EXCLUDING LABOR	
	0															
2525	1	1.000000	60,421	660,421	200,000	200,000	1,272,291	1,272,291	605,294	605,294	1,017,164	1,017,164	2,007,275	1,146,854	1,144,417	B/C RATIO
2526	2	0.892857	634,192	566,243	430,000	383,929	1,941,471	1,733,456	1,121,639	1,001,464	1,998,918	1,784,748	2,956,786	2,006,614	1,779,562	W/ LABOR COSTS
2527	3	0.797194	817,301	651,547	450,000	358,737	1,941,471	1,547,729	1,114,727	888,654	1,788,897	1,426,098	2,620,056	1,609,771	1,754,560	1.22
2528	4	0.711780	28,667,386	20,404,879	678,234	482,754	3,107,934	2,212,166	3,696,101	2,630,812	(22,541,584)	(16,044,655)	5,340,755	(15,546,878)	4,824,424	
2529	5	0.635518	32,643,285	20,745,398	768,896	488,647	2,934,087	1,864,665	2,267,635	1,441,123	(28,210,459)	(17,928,257)	3,550,571	(17,683,474)	3,210,538	
2530	6	0.567427	2,151,161	1,220,627	887,690	503,699	3,095,469	1,756,452	6,093,076	3,457,375	6,149,693	3,489,501	5,858,968	4,134,643	7,850,494	B/C RATIO
2531	7	0.506631	1,177,061	596,336	768,896	389,547	3,537,080	1,791,995	6,006,033	3,042,843	7,597,156	3,848,956	5,240,404	4,254,521	7,630,329	W/O LABOR
2532	8	0.452349	128,600	58,172	645,000	291,765	3,790,417	1,714,592	5,218,349	2,360,516	8,235,166	3,725,171	4,462,405	4,112,468	6,697,177	COSTS
2533	9	0.403883	0	0	546,200	220,601	3,262,282	1,317,581	4,187,612	1,691,306	6,903,694	2,788,286	3,290,676	3,070,075	5,534,950	1.33
2534	10	0.360610	0	0	546,200	196,965	3,574,646	1,289,053	4,355,012	1,570,461	7,383,458	2,662,549	3,111,112	2,914,146	5,702,350	
2535	11	0.321973	0	0	546,200	175,862	3,336,768	1,074,350	4,342,800	1,398,265	7,133,368	2,296,754	2,697,256	2,521,394	5,702,350	
2536	12	0.287476	0	0	546,200	157,019	4,168,978	1,198,482	4,354,588	1,251,840	7,977,366	2,293,302	2,650,894	2,493,874	5,702,350	
2537	13	0.256675	0	0	546,200	140,196	3,750,891	962,760	4,345,236	1,115,314	7,549,927	1,937,878	2,257,156	2,116,960	5,702,350	
2538	14	0.229174	0	0	546,200	125,175	4,806,081	1,101,430	5,038,336	1,154,657	9,298,217	2,130,911	2,415,981	2,299,806	6,395,450	
2539	15	0.204620	0	0	546,200	111,763	4,431,244	906,720	5,038,336	1,030,943	8,923,380	1,825,900	2,080,427	1,968,664	6,395,450	
2540	16	0.182696	0	0	546,200	99,789	4,431,244	809,572	5,038,336	920,485	8,923,380	1,630,268	1,857,524	1,757,735	6,395,450	
2541	17	0.163122	0	0	546,200	89,097	4,431,244	722,832	4,993,836	814,603	8,878,880	1,448,338	1,651,245	1,562,148	6,395,450	
2542	18	0.145644	0	0	546,200	79,551	5,701,424	830,380	4,947,736	720,610	10,102,960	1,471,439	1,652,606	1,573,055	6,395,450	
2543	19	0.130040	0	0	546,200	71,028	5,701,424	741,411	5,163,736	671,490	10,318,960	1,341,873	1,503,630	1,432,602	6,611,450	
2544	20	0.116107	0	0	546,200	63,418	5,672,590	658,626	5,232,736	607,556	10,359,126	1,202,765	1,347,190	1,283,772	6,680,450	
2545	21	0.103667	0	0	546,200	56,623	5,672,590	588,059	5,232,736	542,461	10,359,126	1,073,897	1,202,848	1,146,225	6,680,450	
2546	22	0.092560	0	0	546,200	50,556	5,672,590	525,053	5,235,736	484,618	10,362,126	959,114	1,074,249	1,023,693	6,683,450	
2547	23	0.082643	0	0	546,200	45,139	5,672,590	468,797	5,235,736	432,694	10,362,126	856,352	959,151	914,012	6,683,450	
2548	24	0.073788	0	0	546,200	40,303	5,672,590	418,569	5,235,736	386,334	10,362,126	764,600	856,385	816,082	6,683,450	
2549	25	0.065882	0	0	546,200	35,985	5,672,590	373,722	5,235,736	344,941	10,362,126	682,679	764,629	728,645	6,683,450	
2550	26	0.058823	0	0	546,200	32,129	5,672,590	333,681	5,235,736	307,983	10,362,126	609,535	682,705	650,576	6,683,450	
2551	27	0.052521	0	0	546,200	28,687	5,672,590	297,929	5,235,736	274,985	10,362,126	544,227	609,558	580,871	6,683,450	
2552	28	0.046894	0	0	546,200	25,613	5,672,590	266,008	5,235,736	245,522	10,362,126	485,917	544,248	518,635	6,683,450	
2553	29	0.041869	0	0	546,200	22,869	5,672,590	237,507	5,235,736	219,216	10,362,126	433,855	485,936	463,067	6,683,450	
2554	30	0.037383	0	0	546,200	20,419	5,672,590	212,060	5,235,736	195,729	10,362,126	387,370	433,871	413,453	6,683,450	
			66,879,407	44,903,622	16,845,116	4,987,864	131,614,938	29,227,928	135,515,514	31,810,095	183,405,929	11,146,536	66,165,497	16,275,010	175,336,500	

H

ENGINEERING

Inflow Generation by Hydrologic Model

FIGURE

TABLES

H

ENGINEERING

The hydrologic model adopted in this study is modified from the Soil Conservation Service (SCS) model for estimating runoff from rainfall. The SCS model has been widely used for a small agricultural watershed with area smaller than 10 square kilometers. The modified SCS model introduces a varying contributive area coefficient for each month to take into account the spatial distribution of rainfall so that the model can be applied for larger watersheds. The model structure is shown in Figure H-1.

The model generates daily runoff from daily rainfall data. Therefore the daily rainfall data to be input must represent the actual rainfall in the catchment area as much as possible. Generally an average rainfall of several rainfall stations covering the whole catchment area should be used. However, since the NESSI project applied study sites lack the rainfall data within the catchment area the rainfall data at the subproject site are used.

Moreover, with very limited outflow data the model calibration is carried out for Huai Aeng with three years data only. After the model calibration the model is used for generating a long record of inflows from available daily rainfall data. Since the model calibration is made with limited data, the model parameters estimated are not a good set yet. Therefore, the generated inflows shown here can be improved further if more data are available.

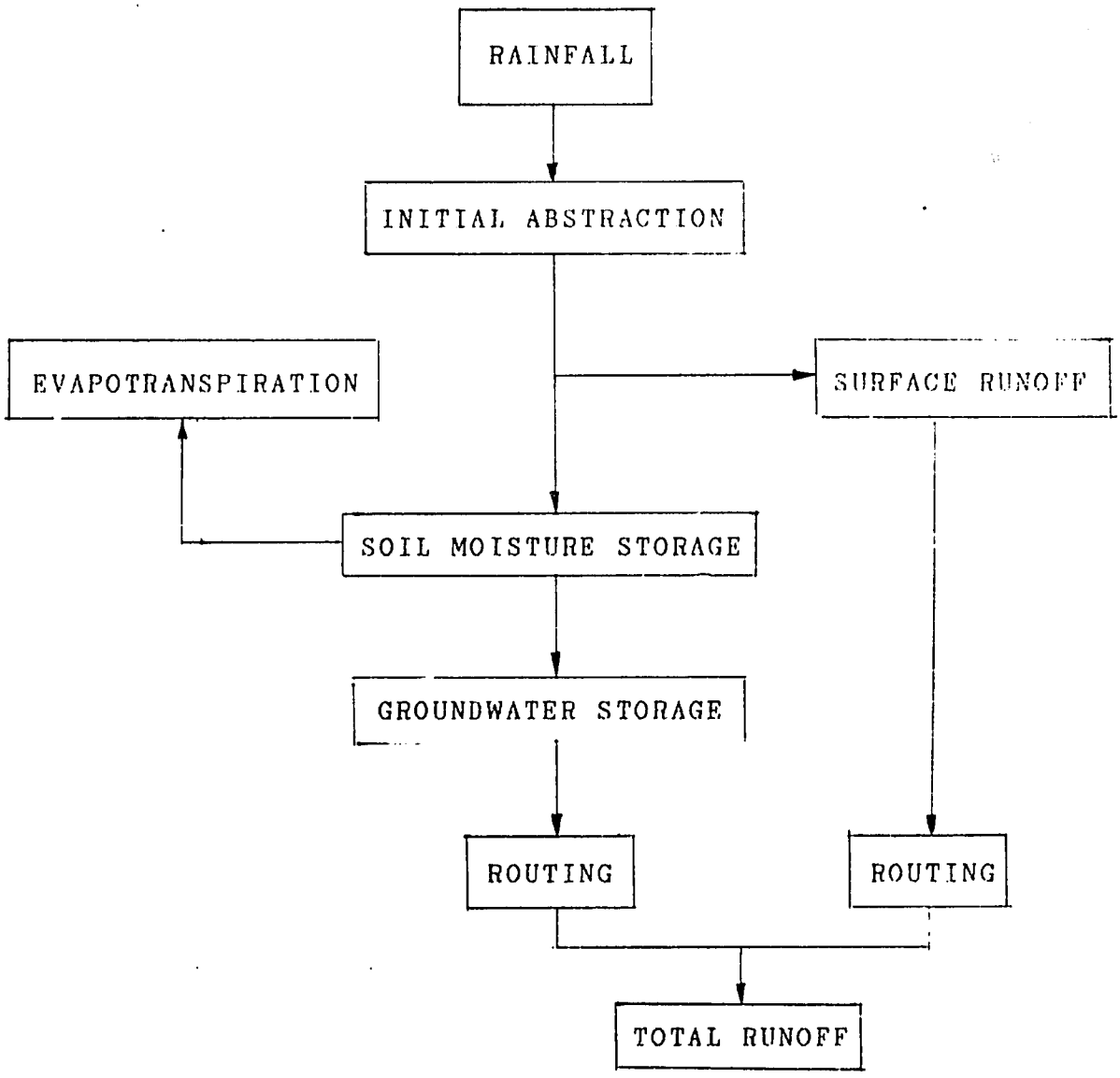


Fig.H - 1 Rainfall-runoff model structure

Table H-1 Comparison of Land Use and Soil Type of Huai Aeng and Lam Chi Long Watershed

Land use	Soil type[1]	Area, km[2]		Area, percent	
		Huai Aeng	Lam Chi Long	Huai Aeng	Lam Chi Long
Wood Forest	A	27.5	147.4	18.7	55.62
	B		74.5		28.11
	C		32.1		12.11
	D				
Agriculture	A	98.1		66.5	
	B	7.7	6.0		2.27
	C				
	D				
Residenc/	A				
bare land	B	6.5		4.4	
	C		5.0		1.89
	D				
Reservoir	A, B, C, D	7.7	0.0	5.2	0.00

Note [1] See "Hydrology," Suppl. A to Sec.4, **Engineering Hand book**, U.S. Department of Agriculture, Soil Conservation Service, 1968.

Average land slope of Huai Aeng = 0.18%

Average land slope of Lam Chi Long = 1.94%

Table H-2 Comparison of Annual Inflow Estimation for Huai Aeng, mcm

Year	Regression Model	Hydrologic Model
1974	37.58	33.75
1975	51.46	37.08
1976	31.70	33.60
1977	30.68	28.47
1978	53.92	43.96
1979	32.39	33.71
1980	51.34	40.91
1981	18.93	21.84
1982	72.06	41.08
1983	43.84	40.38
1984	53.45	36.82
1985	45.81	41.58
1986	36.54	30.00
1987	43.69	25.27
1988	43.86	30.97
Mean	40.71	34.55

Table H-3 Monthly Inflow Generation for Huai Aeng, in mcm.

Year	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	March	Annual
1974	0.01	1.48	2.48	5.28	17.20	3.74	1.83	0.54	0.24	0.004	0.81	0.14	33.75
1975	0.01	1.74	6.02	6.13	6.50	15.42	0.55	0.01	0.28	0.004	0.10	0.16	37.08
1976	0.16	2.50	2.21	6.65	11.78	4.78	4.72	0.73	0.003	0.003	0.002	0.002	33.60
1977	0.68	1.24	1.45	1.87	7.433	15.11	0.92	0.006	0.003	0.002	0.03	0.35	28.47
1978	0.01	0.44	2.32	8.95	4.653	26.44	1.01	0.02	0.004	0.003	0.003	0.10	43.96
1979	0.69	8.32	3.55	1.22	5.57	13.72	0.02	0.01	0.004	0.004	0.07	0.55	33.71
1980	0.02	3.78	7.30	7.10	3.01	18.05	1.24	0.01	0.006	0.005	0.22	0.15	40.91
1981	0.01	0.01	0.59	3.41	6.17	1.44	7.19	0.60	0.004	0.004	0.49	0.37	21.84
1982	0.15	1.68	5.29	2.30	4.79	19.80	6.42	0.47	0.06	0.004	0.002	0.12	41.08
1983	0.16	1.73	9.86	5.91	14.94	4.39	2.56	0.10	0.004	0.003	0.002	0.70	40.38
1984	0.14	1.40	3.31	2.61	12.52	12.45	5.53	0.37	0.003	0.07	0.38	0.62	36.82
1985	0.01	1.44	4.33	4.25	15.23	11.28	4.31	0.73	0.004	0.003	0.002	0.002	41.58
1986	0.07	2.98	5.39	4.40	9.68	4.45	2.50	0.51	0.004	0.003	0.002	0.002	30.00
1987	0.01	0.19	0.01	1.56	5.81	15.75	0.47	1.33	0.004	0.003	0.002	0.13	25.27
1988	0.02	0.20	7.83	3.78	5.39	6.88	4.37	0.004	0.002	0.002	0.001	0.64	30.97
Average	0.14	1.94	4.13	4.36	8.71	11.55	2.91	0.36	0.04	0.01	0.14	0.26	34.55

Table H-4 List of Potential Existing Medium Scale Irrigation Projects

District	Reservoir	Year of capacity (mcm)	Potential construction completion	irrigation area (rai)	Catchment area (km^2)
Chaiyaphum Province					
1. Huai Som Poi	Chatturat	7.65	1962	5,000	96.0
2. Lam Choraka	Muang	10.31	1969	5,000	46.0
3. Ban Phet	Phu Khieo	19.66	1973	8,000	180.0
Sub-total		37.62		18,000	
Kalasin Province					
4. Huai Phung	Na Mon	4.15	1966	8,000	19.0
5. Huai Pha	Na Mon	6.42	1966	13,050	27.0
6. Huai Sathod	Na Mon	11.65	1969	8,000	n.d.
7. Huai Chum Chang	Kuchi Narai	10.87	1973	8,500	n.d.
8. Huai Mano	Khao Wong	5.82	1972	3,186	n.d.
Sub-total		38.91		42,736	
Khon Kaen Province					
9. Huai Toei	Muang	5.33	1964	3,500	28.0
10. Bueng Kaeng Lawa	Ban Phai	37.00	1986	n.d	946.4
Sub-total		42.33		3,500	
Loei Province					
11. Huai Yang	Na Duang	3.71	1966	1,450	25.4
12. Nam Man Weir	Muang	-	1956	5,500	n.d.
Sub-total		3.71		6,950	
Maha Sarakham Province					
13. Huai Chiang Kham	Borabu	5.06	1953	3,200	n.d.
14. Kaeng Loeng Chan	Muang	6.06	1953	6,500	127.7
15. Huai Kho	Na Chuak	31.40	1977	21,000	n.d.
16. Huai Khakhang	Muang	4.12	1957	8,000	72.5
Sub-total		46.64		38,700	
Mukdahan Province					
17. Huai Bok	Khan Cha E	6.3	1983	3,00	n.d.
18. Huai Chanod	Don Luang	18.4	1985	1,800	n.d.
Sub-total		24.7		4,800	
Nakhon Phanom Province					
19. Huai Kan Lueng	Muang	7.4	1968	7,700	n.d.
20. Huai Can	Na Kae	11.09	1969	5,000	n.d.
21. Ban Dong Noi	Na Kae	5.2	1986	4,000	n.d.
Sub-total		23.69		16.700	

		capacity (mcm)	construction completion	irrigation area (rai)	area (km^2)
Nakhon Ratchasima Province					
22. Bueng Kradon	Prathai	7.65	1952	2,900	n.d.
23. Huai Yang	Pak Thong Chai	5.53	1956	3,400	n.d.
24. Huai Ban Yang	Muang	6.51	1968	5,100	n.d.
25. Huai Subpradro	Si Khiu	27.68	1976	12,000	168.0
26. Lam Chieng Krai	Non Thai	21.00	1982	25,000	n.d.
27. Lam Lam Lai	Pak Thong Chai	39.00	1984	15,000	n.d.
28. Huai Takro	Khong	8.52	1986	3,279	n.d.
29. Huai Bong	Chum Puang	11.4	1987	7,500	n.d.
Sub-total		127.29		74,179	
Nong Khai Province					
30. Huai Bang Puan	Tha Bo	10.07	1963	6,000	n.d.
Roi Et Province					
31. Thawatchai	Thawat Buri	3.01	1952	4,700	n.d.
32. Nong Pue	Phanom Pray	4.17	1952	2,000	n.d.
33. Huai Kud Daeng	Chaturaphak Phiman	2.80	1953	4,900	n.d.
34. Huai Laeng (upper)	Chaturaphak Phiman	5.05	1959	4,110	n.d.
35. Huai Jarn Tai	Kaset Wisai	4.95	1968	4,000	n.d.
36. Huai Wang Nong	Nong Phok	13.40	1987	10,760	n.d.
Sub-total		33.38		30,470	
Sakon Nakhon Province					
37. Huai Kan Lueng	Sawang Daen Din	5.90	1967	9,570	n.d.
38. Huai Suang	Ban Muang	6.05	1969	7,700	n.d.
39. Huai Kham	Wanon Niwat	6.0	1963	6,300	n.d.
40. Huai Diak	Muang	4.0	1984	3,000	n.d.
41. Huai Khi Hin	Kud Bak	4.0	1986	3,500	n.d.
42. Huai Huad	Tao Ngoi	17.0	1986	n.d.	n.d.
Sub-total		42.95		30,070	
Si Saket Province					
43. Huai Kla	Muang	3.78	1958	5,300	n.d.
44. Huai Ta Mai	Kantaraluck	38.2	1982	25,000	n.d.
Sub-total		41.98		30,300	

		capacity (mcm)	construction completion	irrigation area (rai)	area (km^2)
Surin Province					
45. Lam Phok	Si Khoraphum	17.7	1961	8,000	n.d.
46. Huai Sawai	Chom Phra	13.56	1977	6,000	n.d.
47. Huai Saneng	Muang	18.54	1978	30,000	n.d.
48. Am Pul	Muang	27.5	1978	4,600	n.d.
49. Huai Dan	Kab Choeng	9.4	1988	8,000	n.d.
Sub-total		86.7		76,600	
Ubon Ratchathani Province					
50. Nong Chang Yai	Muang Samsib	7.68	1953	7,500	n.d.
51. Huai Po	Amnat Charoen	5.39	1956	4,500	n.d.
Sub-total		13.07		12,000	
Udorn Thani Province					
52. Kud Ling Ngo	Muang	5.44	1962	8,800	n.d.
53. Huai Tuan	Ban Dung	13.00	1982	n.d.	n.d.
Sub-total		18.44		8,800	
Grand Total		621.48		399,805	

n.d. = no data

Table H-5 List of Potential New Medium Scale Irrigation Projects

Project	District	Reservoir capacity (mcm)	Construction period	Potential irrigation area (rai)	Catchment area (km^2)
Buriram Province					
1. Lam Chang Han	Lahan Sai	36.00	1986-1990	3,520	n.d.
2. Huai Yang	Nong Khi	17.20	1990-1992	1,920	n.d.
3. Lam Pa Tear	Lahan Sai	25.40	1991-1993	20,880	n.d.
4. Huai Sao (upper)	Korn Buri	19.8	1991-1993	6,500	n.d.
5. O Pring Chanrom	Ban Kruad	8.4	1991-1993	2,900	n.d.
6. Huai Plu	Ban Kruad	6.0	1992-1994	2,400	n.d.
7. Huai Ta Khieo	Ban Kruad	5.0	1992-1994	1,700	n.d.
8. Huai Ta Ko	Ban Kruad	7.7	1992-1994	2,600	n.d.
9. Huai Ka Nang	Kra Sang	40.8	1993-1995	14,000	n.d.
Sub-total		166.3		38,420	
Chaiyaphum Province					
10. Lam Kan Chu	Bamnet Norong	42.6	1990-1993	47,500	n.d.
11. Lam Prong Khun Phet	Nongbua Rawe	82.0	n.d.	25,000	n.d.
12. Huai Sok	Khon Sawan	6.2	n.d.	6,600	14.0
13. Huai Sai	Bamnet Norong	7.1	n.d.	7,400	n.d.
14. Nam Phrom	Phu Khieo	n.d.	1982-1990	60,000	n.d.
Sub-total		38.91		146,500	
Kalasin Province					
15. Nong Yai	Nong Kung Si	4.5	n.d.	6,000	61.6
16. Nong Kham Muang	Kham Muang	3.7	n.d.	3,600	16.0
17. Lam Nong Saen	Nong Kuang Si	8.7	n.d.	9,000	90.1
Sub-total		16.9		18,600	
Khon Kaen Province					
18. Huai Lom Phai	Si Chom Phu	4.4	n.d.	2,200	21.6
19. Huai Sai Nang	Si Chom Phu	5.1	n.d.	5,000	43.2
20. Huai Wha	Ban Fang	3.0	n.d.	3,600	34.0
Sub-total		12.5		10,800	
Loei Province					
21. Huai Phuai	Phu Kradung	16.5	n.d.	31,000	142.7
22. Huai Khong Khao	Phu Kradung	2.2	n.d.	3,000	15.4
23. Huai Nam Man (upper)	Muang	26.5	1986-1990	15,900	n.d.
24. Huai Lin Khwai	Na Duang	12.4	1990-1993	22,800	n.d.
25. Huai Loei (Ka Pro)	Wang Saphung	20.0	n.d.	57,000	n.d.
26. Nam Thop	Wang Saphung	5.54	n.d.	10,000	n.d.
Sub-total		83.14		111,800	

District	Reservoir	Year of capacity (mcm)	Potential construction completion	Catchment irrigation area (rai)	area (km^2)
Maha Sarakham Province					
27. Huai Kut Mek	Borabu	10.0	n.d.	10,000	73.9
28. Huai Khonsak	Kosum Phisai	10.0	1991-1993	5,500	78.7
Sub-total		20.0		15,500	
Mukdahan Province					
29. Kan Tae Yai	Kham Cha-E	3.6	1990-1991	3,600	n.d.
Nakhon Phanom Province					
30. Huai Tuai	Tha U-Then	n.d.	1990-1991	10,150	n.d.
31. Huai Nam Kam	That Phanom	n.d.	n.d.	40,000	n.d.
32. Huai Kra Baou	That Phanom	5.0	n.d.	2,700	n.d.
Sub-total		5.0		52,850	
Nakhon Ratchasima Province					
33. Huai Yang Plalai	Bua Yai	7.60	n.d.	6,000	74.1
34. Lam Phai Mat	Khon Buri	97.30	1986-1990	57,000	n.d.
35. Huai Prasat Yai	Dan Khun Thot	5.50	n.d.	8,000	n.d.
36. Klong Lamlak	Soeng Sang	7.50	1990-1992	2,500	n.d.
37. Huai Pong Roo	Khon Buri	4.68	1991-1993	1,600	n.d.
38. Huai Hoo	Pak Thong Chai	7.10	1991-1993	2,450	n.d.
39. Huai Tap khrua	Pak Thong Chai	11.30	1992-1994	4,000	n.d.
40. Huai Klong Dua	Pak Chong	10.80	1992-1994	3,700	n.d.
41. Huai Wua Tai	Pak Thong Chai	3.10	1992-1994	1,000	n.d.
42. Klong Phai(3)	Pak Thong Chai	4.60	1992-1994	1,000	n.d.
43. Huai Ta Phrom	Pak Thong Chai	7.80	1992-1994	2,700	n.d.
44. Huai Din Dam	Pak Chong	3.40	1993-1995	1,100	n.d.
45. Huai Krok Tae	Pak Chong	5.50	1993-1995	1,900	n.d.
46. Lam Phra Plueng(1)	Pak Thong Chai	8.70	1993-1995	3,000	n.d.
47. Lam Phra Plueng(2)	Pak Thong Chai	60.00	1993-1995	20,000	n.d.
48. Kham Sima (3)	Pak Thong Chai	3.92	1993-1995	1,300	n.d.
49. Klong Boong(1)	Pak Thong Chai	3.70	1993-1995	1,300	n.d.
50. Klong Phai(2)	Pak Thong Chai	4.00	1993-1995	1,400	n.d.
51. Ban Ba E-Taen	Pak Thong Chai	4.70	1993-1995	1,800	n.d.
Sub-total		131.52		44,600	
Nong Khai Province					
52. Huai Ton (upper)	Si Chiang Mai	12.00	1990-1992	12,500	n.d.
53. Huai Sai	Bung Kan	7.65	n.d.	5,000	n.d.
54. Huai He	Bugn Kan	8.20	n.d.	7,000	n.d.
Sub-total		27.85		24,500	

	Project	District	Reservoir capacity (mcm)	Construction period	Potential irrigation area (rai)	Catchment area (km^2)
	Roi Et Province					
55.	Sok Daeng	Phon Thong	4.1	n.d.	2,700	18.0
56.	Huai Dua	Nong Phok	6.6	n.d.	2,300	18.2
57.	Huai Phung Yai	Nong Phok	6.5	n.d.	8,500	
	Sub-total		17.2	n.d.	13,500	
	Sakon Nakhon Province					
58.	Huai Tong	Wanon Niwat	10.0	1986-1990	9,000	n.d.
59.	Huai Lek Piak	Wanon Niwat	7.8	n.d.	8,000	n.d.
	Sub-total		17.8		17,000	
	Si Saket Province					
60.	Huai Sala	Khu Khan	32.0	1984-1989	25,600	n.d.
61.	Huai Samran	Khu Khan	12.35	1990-1992	7,500	n.d.
62.	Huai Ta Pang	Khun Han	20.00	1992-1994	29,000	n.d.
63.	Huai Tik Chu	Khu Khan	38.80	1990-1992	13,000	n.d.
64.	Huai Kanoon	Kantaraluck	9.0	1990-1992	2,700	n.d.
65.	Huai Tha	Khun Han	42.0	1990-1992	25,500	n.d.
66.	Huai Chan	Khun Han	13.0	1991-1993	4,400	n.d.
67.	Huai Dan Eye	Khun Han	12.0	1991-1993	4,500	n.d.
68.	Huai Sang Kot	Khun Han	13.50	1991-1993	4,650	n.d.
69.	Huai Kayung	Kan Taraluck	53.00	1991-1993	18,000	n.d.
70.	Huai O-Talat	Khu Khan	5.00	1991-1993	3,000	n.d.
71.	Huai Ta Baeng	Khun Han	8.00	1991-1993	2,800	n.d.
	Sub-total		258.65		140,650	
	Surin Province					
72.	Huai Tam Nop	Bua Shade	16.0	1985-1989	10,000	n.d.
73.	Ban Charat	Bua Shade	24.50	1989-1990	15,500	n.d.
74.	Huai Ta Thas (System)	Sang Kha	8.60	1956	7,500	n.d.
75.	Huai Lae Ngao	Pra Sart	13.80	n.d.	11,000	n.d.
76.	Huai Khanad Mon	Sang Kha	17.80	1990-1992	11,000	n.d.
77.	Huai Kradon	Si Khoraphum	27.00	1990-1992	9,300	n.d.
78.	Huai Choeng	Sang Kha	10.20	1990-1992	6,500	n.d.
79.	Huai Sen	Sang Kha	11.80	1990-1992	7,500	n.d.
80.	Huai Kam Phok	Sang Kha	10.40	1991-1993	2,500	n.d.
81.	Huai Kam Phok (lower)	Si Khoraphum	10.40	1991-1993	3,000	n.d.
82.	Huai La Loeng Wake	Sang Kha	12.20	1992-1994	7,500	n.d.
83.	Huai Ta chiao	Prasart	10.30	1992-1994	3,500	n.d.
84.	Huai Sarung (upper)	Prasart	10.50	1992-1994	4,300	n.d.
85.	O-Chiao	Prasart	4.00	1992-1994	1,500	n.d.
86.	O-Dye Krahom	Passart	10.20	1992-1994	3,500	n.d.
	Sub-total		197.70		104,100	

	Project	District	Reservoir capacity (mcm)	Construction period	Potential irrigation area (rai)	Catchment area (km^2)
	Ubon Ratchathani Province					
87.	Huai Si Tho	Amnat Charoen	7.00	1990-1991	5,000	n.d.
88.	Huai Sai	Chanuman	6.50	n.d.	10,000	n.d.
89.	Huai Kaeng Mang	Chanuman	9.35	n.d.	7,000	n.d.
90.	Huai Bet (Huai Bon)	Nam Yuen	6.00	1990-1992	7,000	n.d.
41.	Huai Luang	Na Chaluai	12.00	1991-1993	14,000	n.d.
92.	Huai Don	Boon Tharig	7.90	1991-1993	10,000	n.d.
93.	Huai Sa Phong Noi	Boon Tharig	4.00	1991-1993	10,000	n.d.
94.	Huai Din Dam Yai	Boon Tharig	4.40	1992-1994	6,400	n.d.
95.	Huai Duen Ha	Boon Tharig	21.00	1992-1994	37,000	n.d.
96.	Huai Wang Yai	Nam Yuen	9.20	1992-1994	7,500	n.d.
97.	Huai Nam Khieo	Boon tharig	3.25	1993-1995	4,000	n.d.
98.	Huai La Mue	Boon tharig	3.10	1993-1995	9,500	n.d.
99.	Huai Yang	Nan Yuen	5.50	1993-1995	4,500	n.d.
	Sub-total		99.20		131,400	
	Udorn Thani Province					
100.	Huai Mo	Si Boonrueng	3.00	n.d.	2,900	45.20
101.	Huai Dan	Na Klang	6.70	n.d.	6,000	n.d.
102.	Huai Phawang	Na Klang	3.00	n.d.	2,700	38.90
103.	Nam Bong	Non Sang	17.90	n.d.	15,000	n.d.
104.	Huai Sam Phat	Nong Saeng	15.00	1986-1990	20,000	n.d.
105.	Lam Phanchat	Wang Sam Mo	47.00	1990-1994	50,000	445
106.	Huai Yang	Nong Han	4.60	n.d.	4,500	39.1
107.	Huai Phaichanyai	Chai Ya Wan	3.10	n.d.	5,000	45.5
108.	Huai Sai	Nam Som	2.25	1990-1992	3,400	n.d.
	Sub-total		102.55		109,500	
	Yasothon Province					
109.	Huai Sabok	Loeng Noktha	16.80	1986-1990	12,000	n.d.
110.	Huai Ling Chon	Loeng Noktha	12.40	1987-1991	6,400	n.d.
111.	Huai Pong	Loeng Noktha.	14.50	n.d.	12,000	n.d.
	Sub-total		42.90		30,400	
	Grand total		1,340.61		998,220	