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THE IMPACT OF ROAD DEVELOPMENT IN THE CENTRAL PLAIN OF THAILAND

by

James Allan Hafner

A dissertation submitted in partial fulfillment
of the requirements for the degree of
Doctor of Philosophy in
The University of Michigan
1970

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ABSTRACT

THE IMPACT OF ROAD DEVELOPMENT IN THE CENTRAL PLAIN OF THAILAND

by

James Allen Hafner

Chairman: L. A. Peter Gosling

This study is an analysis of the differential impact of contemporary road development upon the rural economy, marketing networks, and traditional transport media in the central plain of Thailand. The nature and extent of this impact have been investigated through the use of intensive survey sampling in fourteen spatially stratified and randomly selected districts (amphoe) in the central plain. Structured and informal interviewing of participants in the agricultural, commercial, and transport sectors of the rural economy added a temporal and socio-cultural perspective to the determination of patterns of road development impact.

The impact of contemporary road development in the central plain has been varied in time and space. The realization of benefits resulting from road development and improvement has been conditioned by a variety of economic, social, and environmental variables. High rates of tenancy, limited capital availability, low quality road surfaces, and the existence of more accessible and versatile water transport facilities are

some of the factors which have precluded a wider realization of road development benefits in the wet-paddy areas of the lower central plain. Similar factors have also contributed to a limitation of the effective spatial impact of road development to within 100 kilometers from the Bangkok-Thon Buri Metropolitan area and within five kilometers of the developed road. The apparently greater spatial and developmental impact of road improvements in the drier uplands of the marginal and upper plain emphasized the importance of environmental conditions in facilitating or inhibiting the impact of road development.

The primary effects of road development on the inland water transport industry have been to (1) encourage a greater specialization in route and cargo operations by boats operating on the inland waterway system; (2) to stimulate the construction of larger capacity cargo barges for use in specialized cargo operations, and (3) to displace certain cargo, tow, and passenger vessels from areas/routes where road transport has become increasingly competitive.

The future planning and implementation of road development programs within this region can realize a greater return on such developmental investment by (1) coordinating transport development to make maximum use of existing minimal or low cost water transport systems; (2) recognizing the larger benefits from capital investments in roads in upland as opposed to lowland, wet-paddy areas, and (3) acknowledging the greater advantage in developing all-weather roads instead of loose surface, seasonal roads. Investment in an articulated transport system

as opposed to an arterial system will result in larger economic, social, and developmental benefits and thereby better serve the needs of the country.

PREFACE

The initial conception of this project in 1964-65 as a case study of road development impact within one province (changwat) in Thailand quickly became unrealistic after field research was begun in 1966. The frequently subtle but distinct variations in patterns of economic activity, marketing, and transport utilization among provinces suggested that the investigation of this problem on a larger areal scale would more accurately emphasize the differential impact of road development, and expose the variable combinations of factors influencing and conditioning this impact. The completion of this study is therefore the result of contributions made by many people. It is unfortunately not possible to acknowledge separately the assistance of all those who have contributed to the completion of this thesis. It is hoped, however, that their influence on the author and this thesis will be evident in the following pages and will serve as an acknowledgement of their individual and cumulative advice, criticism, and encouragement.

Field research was carried out in 1966-68 under a grant from the Foreign Area Fellowship Program of the Ford Foundation. I would like to express my gratitude for this support and to those individuals associated with this program who facilitated its administration during the period of field research and writing.

The administration and staff of the Applied Scientific Research Corporation of Thailand were instrumental in contributing to the successful completion of field research and I wish to extend my appreciation for their assistance. I am also grateful for the limited logistic support and help with administration of field questionnaires provided by the personnel associated with the research project of L. A. Peter Gosling, supported by funds from the Geography Branch of the Office of Naval Research.

I would especially like to acknowledge the assistance of several individuals who have offered their encouragement, advice, and guidance over the past several years. Professor Martin Dulgarian, Department of Geography, Miami University (Ohio) is primarily responsible for encouraging me to pursue graduate training in Geography and I am sincerely grateful for his advice and friendship. Associate Professor Aram A. Yengoyan, Department of Anthropology, University of Michigan has shared unhesitatingly of his time, and professional knowledge of research methodology, peasant societies, and rural economic organization in Southeast Asia. I am deeply indebted to him for his assistance in preparing this thesis and for his stimulating personal and professional friendship. Professor Rhoads Murphey, and Assistant Professor James D. Clarkson, Department of Geography and Professor William Gedney, Department of Linguistics, University of Michigan have each patiently read and re-read several drafts of this thesis and made numerous suggestions for its improvement. Finally, and most importantly, I would like to acknowledge the assistance of Associate Professor L. A. Peter Gosling

which has pervaded our personal and professional association for the past ten years. His appreciation and grasp of geographic concept and method and his intuitive understanding of the complexity of contemporary Southeast Asia have had a profound influence on the preparation of this thesis. His constant encouragement and counsel have been a source of great satisfaction for which I am sincerely grateful.

Transliteration

The problem of accurate and convenient transliteration of the Thai language into English has yet to be adequately resolved. A variety of transliteration systems are currently employed in scholarly literature with those being used by linguists the most accurate. The technical and typographical complexity of these systems, however, makes them inappropriate for most general usage. To facilitate clarity and understanding several rules and methods of transliteration for Thai have been adopted.

Personal names, publication titles, and similar words of frequent use will be transcribed according to personal preference and common usage rather than after any specific method of transliteration. Common place names, names of political divisions, and some town names will follow the procedure established by the Royal Institute in the Royal Gazette, No. 84, June 23, 1967. Other less common words, botanical, agricultural, and technical terms will be transcribed according to procedures outlined in Editorial Notice No. 10/2, September 1, 1967, Applied Scientific Research Corporation of Thailand, Bang Khen. This procedure follows closely that of the Royal Institute's "General System of Phonetic Transcription of Thai Characters into Roman," Royal Gazette, 26 March, 1939.

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PART I

INTRODUCTION

CHAPTER I

INTRODUCTION

Research Statement

The importance of transportation in stimulating the process of economic development has been widely documented.[1] Adequate and judicious investment in transportation systems is a central factor in increasing economic growth rates, and encouraging greater economic integration. While the basic economic and locational factors in transport development are reasonably well defined in the more developed Western countries, there is considerably less understanding of these factors in the developing nations. Studies of road development undertaken in these latter nations have continually emphasized the more immediately recognized economic, administrative, and security benefits resulting from this development without a cognitive appreciation of the broader and long-term implications. If development planners are to

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[1] See, for example, Martin Meyerson, "Strategy Planning for Transportation and Economic Development," The Challenge of Development, ed. Richard J. Ward (Chicago: Aldine Publishing Company, 1967), p. 392; Transportation, Vol. V, U.S. Papers Prepared for the U.N. Conference on the Application of Science and Technology for the Benefit of the Less Developed Areas. (Washington, D.C.: Agency for International Development, 1963.)

make maximum use of their normally limited resources, a better understanding of the total and differential impact[1] of road development and the relationship of this development to traditional marketing and transport systems is desirable.

This study is an analysis of the differential impact of contemporary road development upon the rural economy, and traditional marketing systems and trade networks in the central plain of Thailand. Water transportation has long dominated transportation and trade and communications within this region; it was anticipated that a partial displacement of the water transport industry might have occurred. The nature of this displacement was assessed in relation to the functional availability and use of road transport facilities. An assessment of the socio-cultural factors affecting boat operations, ownership, and traffic patterns indicates whether socio-cultural ties to the traditional inland water transport industry have conditioned the impact of road development. Emphasis has also been placed on the impact of road development on intra-regional productivity, cropping patterns, market organization and trade patterns, and the distribution and acceptance of new technology. Variations in spatial and environmental responses of the agricultural, industrial, and commercial sectors of the economy were examined to determine the differential impact of road development within the central plain.

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[1] Differential impact refers to the distinction spatially, temporally, and environmentally in road development impact.

Analysis of the differentials in local and intra-regional impact of road development within the central plain must consider the basic economic, spatial, and sociological ties which exist between the dominant urban areas, the nodal region of the central plain,[1] and the spatial configuration of existing transport networks. The regional and national primacy of the Bangkok-Thon Buri Metropolitan area and its location within the nodal region of the country provide a unique opportunity to analyze the differential spatial and economic implications of contemporary road development. The spatial and geometric configuration of existing land and water transport systems within the central plain and adjoining regions, and the basic environmental disparity between regions of the country, presented conditions under which analysis could be made and inferences drawn regarding the differential environmental impact of road development.[2]

While the decision to invest in roads is often not in question an understanding of the varied implications of road development aside

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[1]The nodal region as a geographic construct may be simply defined as an area characterized by homogeneity in internal structure or functional organization and related to a center (node) by internal circulation. (See D. Whittlesey, "The Regional Concept and the Regional Method," American Geography: Inventory and Prospect, eds. P. E. James and C. F. Jones. [Syracuse, N.Y.: Syracuse University Press, 1954], p. 31.)

[2]Varying statistical and objective field data provide adequate evidence in support of several classical theories of industrial and agricultural location; however, this study was not conceived nor undertaken in an attempt to test the validity of these theories within a Thai context. Notations will be made where existing phenomena or relationships exhibit more than nominal conformity with theory in the hope that future work may be undertaken in these areas.

from their cost-benefit advantages is frequently lacking. An increased knowledge of the nature of road impact will facilitate planning road development programs to enhance their multiple beneficial impact while improving the potential to meet and resolve problems created by road construction. A greater appreciation of the implications of road construction and development will also permit more detailed planning and contribute to a more profitable social and economic return on developmental investment. Ultimately the acquisition of a more comprehensive understanding of the process of road impact and the types of benefits which can be anticipated as a result of road development will contribute immeasurably to more effective and integrated transport development programs.

Regional Economic Inputs

The cultural, economic, and political development of Thailand is focused on the central plain. This region has consistently served as the economic base of the country and the primary source of economic and administrative stability necessary for national development. Although the great disparity in regional economic inputs so characteristic of earlier periods has diminished in the twentieth century, the central plain still maintains a clear superiority. The continued economic predominance of this region is most accurately reflected in the regional distribution of inputs into the Gross Domestic Product (GDP).

Regional value added to the GDP indicates the important contributions of individual sectors of the economy and the proportionate inputs of these sectors regionally. Table 1, Mean Regional Percentage Distribution of Gross Domestic Product, 1961-1966, shows the contribution of various industrial sectors by region. The predominance of the central plain in this distribution is evident. Agriculture, of course, is a primary contributor to the GDP but this input is not homogeneous throughout the country. The central plain is the main rice producing area of the country, but is also the most industrially diversified. Although the data in Table 1 suggest a diversified economy, agriculture is the main source of income generation and therefore has considerable influence on contributions to GDP from other sectors. In the period 1956-1957 crop production dropped by 1.1 billion baht while manufacturing declined from 5.0 to 4.8 billion baht (U.S. $240,384,615 to $230,769,231) during the same period.[1] A large portion of the manufacturing sector is composed of rice milling, which is very sensitive to production levels. Changes in the relative contributions of other sectors of the economy are probably to varying degrees a reflection of this internal economic dependence upon agriculture.

The highly centralized location of manufacturing in the Bangkok-Thon Buri Metropolitan area and within a 150 kilometer zone surrouding

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[1] United States, United States Operations Mission-Thailand, "Regional Economic Development in Thailand as seen through the National Income Accounts," by P. Gajewski (Bangkok: United States Operations Mission-Thailand, July, 1965, p. 2). (Conversion of baht to U.S. dollars has been made at the rate of 20 baht to U.S. $1.00.)

TABLE 1

MEAN REGIONAL PERCENTAGE DISTRIBUTION OF GROSS DOMESTIC PRODUCT OF THAILAND, 1961-66

Industrial origin	Regions			
	North	Northeast	Central	South
Agriculture crops livestock fisheries forestry	22.1	25.5	35.6	16.7
Mining and Quarrying	4.6	1.9	28.4	65.2
Manufacturing	10.5	11.0	70.7	7.8
Construction	13.1	13.5	63.3	10.2
Electricity and Water Supply	19.5	4.9	68.7	6.9
Transportation and Communications	11.7	9.4	69.5	9.5
Wholesale and Retail Trade	15.7	19.3	50.1	14.9
Banking, Insurance and Real Estate	4.6	3.2	87.3	5.0
Ownership of Dwellings	13.9	17.3	50.4	18.3
Public Administration and Defense	13.1	17.1	57.9	11.3
Services	13.9	17.6	54.6	13.9
Gross Domestic Product	16.1	18.4	51.1	14.4

Source: Thailand, Office of the Prime Minister, National Economic Development Board, National Accounts Division, "Pre-publication estimates of National Incomes of Thailand, Part II, Statistical Tables, Regional Gross Domestic Product 1961-1966." Bangkok, January 11, 1968.

these cities is reflected in the GDP figures. More than 60 percent of the non-food value added through the manufacturing sector came from within this 150 kilometer zone. The importance of the Bangkok-Thon Buri Metropolitan area extends beyond the manufacturing sector. In 1964 for example, the metropolitan area accounted for 75 percent of the total value added in transportation-communications; most of this from private vehicles.[1] The current construction boom in the capital city reflects the disproportionate shares of construction, and to a lesser degree banking, insurance, and real estate originating from the central plain. Over 25 percent of mineral production originates from this region, mainly in construction aggregates of sand and stone, as well as salt, which together comprised 80 percent of total production in 1963.

The central plain has over 30 percent of the total population within the country and consequently provides a convenient market for wholesale and retail sales of such items as fertilizer, textiles, wood products, and cement. The predominantly rural population deriving income from agriculture is reflected in contributions from wholesale and retail trade.

These data require little further discussion to clarify the economic importance of the central plain in the Thai economy. Although future development plans must devote considerably more attention to other regions of the country, the central plain will remain the basic economic region. The need for more precise knowledge of the impact

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[1] Ibid., pp. 4-5.

of developmental factors, such as roads, will not only improve understanding of the rural economy but facilitate more profitable emphasis on developmental inputs in other regions.

Research Methodology

The analysis of road development impact and transport systems interaction has been based on intensive survey sampling in a series of spatially stratified, randomly selected survey areas within the central plain. The initial identification of qualified survey areas has been dependent upon the existence of five basic criteria: (1) an interconnected local-interchangwat[1] waterway network; (2) a recently developed road linked to the all-weather National or Provincial highway networks; (3) external accessibility by land and/or water transport for at least six months of the year; (4) surplus agricultural production; and (5) location within or adjacent to the survey area of a primary of secondary market performing some minimal assembly-distribution functions. Points or areas possessing these characteristics were identified and assigned random numbers. Survey areas were then selected based on a table of random numbers.

Sample size posed a somewhat more difficult problem. Preliminary intentions had been to study thirty areas of multi-tambon size which would have provided a total sample of over 9.5 percent of all tambons in the

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[1] Thailand is divided into seventy-one provinces or changwats which constitute the largest administrative divisions of the country.

central plain through which passed segments of the National or Provincial Highway network.[1] Ultimately a sample of less than half this size was used due to operational budget and time limitations. It is felt, however, that the existing sample provides an adequate statistical and qualitative measure upon which generalizations can be based.[2]

The locations of amphoe[3] in which surveys were conducted and the related linear and transport distances of these areas from Bangkok and Thon Buri are shown in Table 2 and Fig. 1.

The districts (amphoe) in which detailed studies were conducted have been categorized based on the presence or absence of certain types of transportation facilities. Road development amphoe are those in which roads have recently been constructed or developed. These districts included eleven of the fourteen amphoe in which intensive survey sampling was conducted.[4] The districts designated as control amphoe were amphoe Bang Yai, Lat Bua Luang, and Chumsaeng. In each of these three districts water transportation was the dominant form of

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[1]The tambon is the smallest administrative unit in the country and is frequently termed a sub-district or commune.

[2]The total number of tambons in which analysis was conducted comprises a 1.8 percent sample of all tambons within the central plain. This number includes over 3.5 percent of all such divisions through which pass segments of the National or Provincial Highway network.

[3]The amphoe or district is an intermediate administrative division between the province (changwat) and tambon (sub-district or commune).

[4]Road development amphoe are amphoe Min Buri, Muang Chachoengsao, Bang Khla, Krathum Baen, Damnoen Saduak, Lam Luk Ka, Nong Sua, Tha Rua, Sam Chuk, Sanphaya, and Khok Samrong.

TABLE 2

ROAD, WATER, RAIL, AND LINEAR DISTANCES OF SURVEY AREAS FROM BANGKOK-THON BURI[a]

Amphoe of Survey	Distance in kilometers			
	Road	Water	Rail	Linear
Bang Yai	-	18	-	11
Min Buri	34	29	-	25
Krathum Baen	35	32	-	28
Lam Luk Ka	37	51	-	32
Lat Bua Luang	-	73	-	48
Nong Sua	56	72	-	50
Muang Chachoengsao	69	66	-	57
Damnoen Saduak	99	69	-	65
Bang Khla	101	99	-	78
Tha Rua	142	122	102	88
Sam Chuk	205	165	-	114
Sanphaya	221	203	-	152
Khok Samrong	204	-	-	156
Chumsaeng	-	351	280	234
Mean distance	109.3	103.9	-	81.1

[a]All measurements taken from amphoe Sam Sen, Bangkok. Road and water distances based on shortest route of most frequent use.

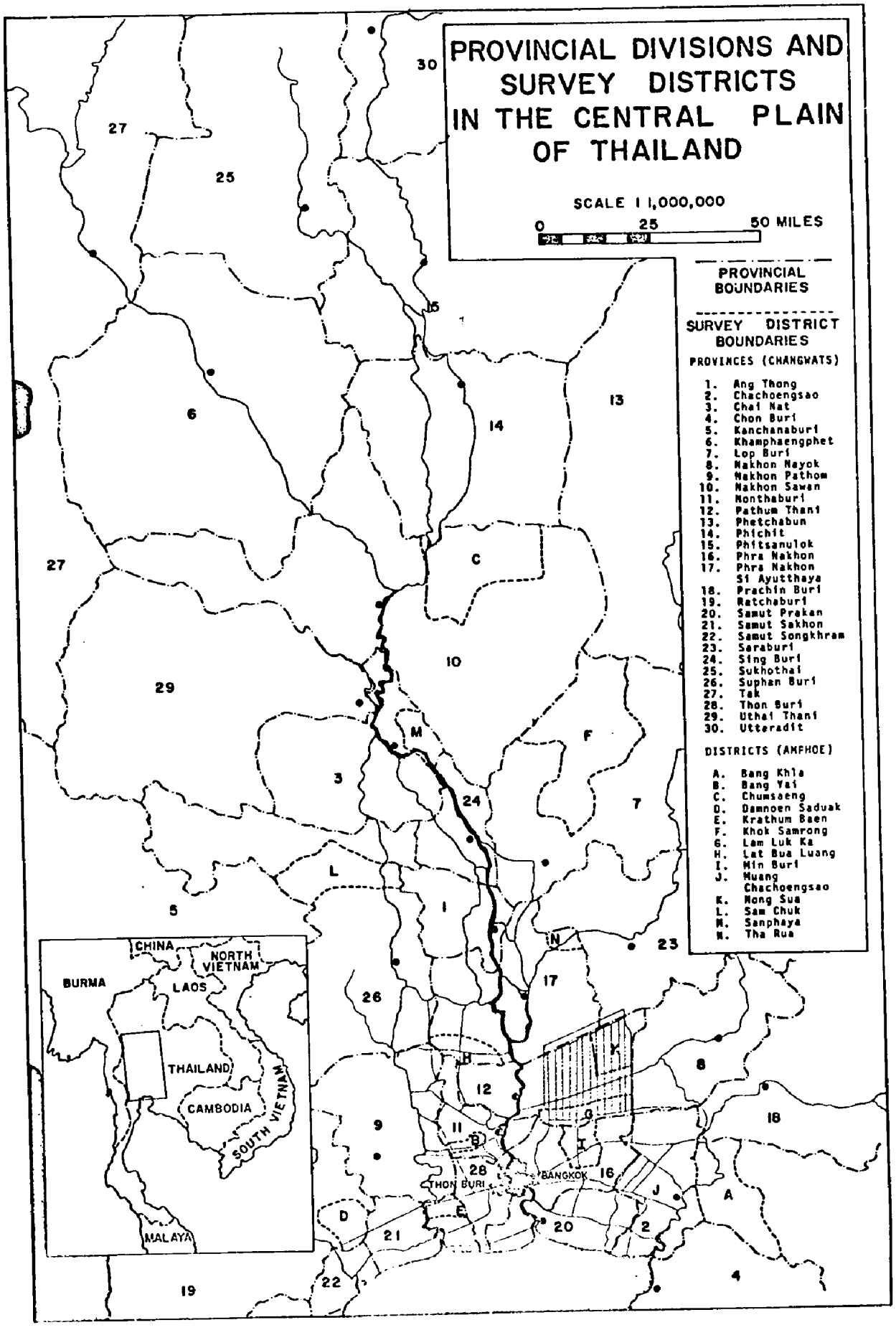
PROVINCIAL DIVISIONS AND SURVEY DISTRICTS IN THE CENTRAL PLAIN OF THAILAND
SCALE 1:1,000,000
0 25 50 MILES
PROVINCIAL BOUNDARIES
SURVEY DISTRICT BOUNDARIES
PROVINCES (CHANGWATS)
1. Ang Thong
2. Chachoengsao
3. Chai Nat
4. Chon Buri
5. Kanchanaburi
6. Khamphaengphet
7. Lop Buri
8. Nakhon Nayok
9. Nakhon Pathom
10. Nakhon Sawan
11. Nonthaburi
12. Pathum Thani
13. Phetchabun
14. Phichit
15. Phitsanulok
16. Phra Nakhon
17. Phra Nakhon Si Ayutthaya
18. Prachin Buri
19. Ratchaburi
20. Samut Prakan
21. Samut Sakhon
22. Samut Songkhram
23. Saraburi
24. Sing Buri
25. Sukhothai
26. Suphan Buri
27. Tak
28. Thon Buri
29. Uthai Thani
30. Utteradit
DISTRICTS (AMPHOE)
A. Bang Khla
B. Bang Yai
C. Chumsaeng
D. Damnoen Saduak
E. Krathum Baen
F. Khok Samrong
G. Lam Luk Ka
H. Lat Bua Luang
I. Min Buri
J. Muang Chachoengsao
K. Nong Sua
L. Sam Chuk
M. Sanphaya
N. Tha Rua
CHINA
NORTH VIETNAM
BURMA
LAOS
THAILAND
CAMBODIA
SOUTH VIETNAM
MALAYA
BANGKOK
THON BURI

Fig. 1

communications and commodity shipment and there were no roads linked to the all-weather National or Provincial highway networks. Amphoe Chumsaeng constituted the one variation in this pattern since it was served by rail and water transportation. The inclusion of these control amphoe provided a method of more precisely identifying the nature of road impact and determining the extent to which the availability of alternate forms of transport may have conditioned the impact of road development. Selection procedures for control amphoe were based on the use of random sampling techniques identical with those used to select road development amphoe.

Physiographically all survey districts except amphoe Khok Samrong and amphoe Chumsaeng are located within the lower central plain where wet-paddy cultivation is the dominant and traditional form of agricultural land use.[1] Each of the districts in the lower plain has multiple direct access to the extensive inland waterway network and except for control districts has a recently constructed or developed road.[2] Amphoe Krathum Buan, Damnoen Saduak, and Bang Khla may be further characterized by the existence of large areas of intensive vegetable and fruit gardening in addition to wet-paddy cultivation. In contrast to these districts amphoe

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[1]The term "paddy" is used here to indicate the unmilled grain as differentiated from rice which is the end product of the milling process.

[2]The central plain as a physiographic region has been divided into two separate parts, the upper plain, and lower plain. The division between these two falls approximately between the cities of Chai Nat and Nakhon Sawan. (See, Robert L. Pendleton, Thailand, Aspects of Landscape and Life [New York: Duell, Sloan and Pearce, 1962], pp. 34-39.)

Khok Samrong and amphoe Chumsaeng are upland rather than lowland areas.[1] Amphoe Khok Samrong has no water transport or irrigation facilities, a predominance of upland crops and dry paddy, and a mixed vegetation cover of scrub and bamboo forest. Similarly, amphoe Chumsaeng is without benefit of extensive irrigation and canal facilities, and is more suited to the cultivation of upland crops than irrigated paddy. These essential physiographic differences between amphoe Khok Samrong, and amphoe Chumsaeng and the remaining survey districts established an environmental differential against which could be measured variations in road development impact under different environmental conditions.[2]

The comprehensive survey sampling conducted in these amphoe included detailed interviewing of farm and non-farm households, merchants, and other residents. The size of multi-tambon areas within amphoe in which comprehensive survey sampling was undertaken was

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[1] The terms upland and lowland are used throughout this study to suggest certain physiographic differences between survey districts. The major distinction made here is not one of elevation but between wet and dry areas and associated cropping patterns, irrigation-communication facilities, and vegetation-soil patterns. Lowlands are those areas characteristic of the irrigated, wet rice flood plain where irrigation-communication canals and inland waterway networks are extensive, soils are primarily poorly drained heavy clays, and vegetation cover is sparse. Uplands in contrast are dry areas of more limited rainfall with an absence of extensive irrigation-communication canal systems, a greater diversity in soils which are less adaptable to wet-paddy cultivation, and more frequent cultivation of non-irrigated upland crops. The transition from lowland to upland areas is never distinct, but rather a gradual change in physiographic and land-use conditions.

[2] A more detailed tabulation of the soil, precipitation, vegetation, and characteristic crop associations in each survey district is contained in Appendix I.

partially determined by the type of sampling techniques employed in field data collection.

Survey sampling within selected amphoe was based on a method of parallel traverse sampling. A series of traverse lines dissecting the road or khlong (canal) at ninety-degree angles and extending for five kilometers on either side of this route were laid out in each amphoe.[1] These lines were spaced at one kilometer intervals along this transport route for a distance of three to five kilometers. The grid defined by these traverse lines was thus divided into units of one square kilometer which facilitated interviewing and field mapping. Interview schedules were taken from rural farm and non-farm households located at one kilometer intervals along these parallel lines up to a distance of five kilometers from the road or khlong.[2] Although these areal units did not conform to "existing" tambon boundaries they did include at least two entire tambon. The size of areal units included in this intensive survey sampling varied from thirty to fifty square kilometers with a mean of 46.5 square kilometers.

In addition to interviews with rural farm and non-farm households within these areas, interview schedules were also completed for mer-

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[1] The Thai word khlong is defined as a waterway or canal and will be used interchangeably with canal throughout this study.

[2] A distance of five kilometers has been assumed in this study to be the optimum spatial parameter of road impact; however, field tests were conducted to determine if there were variations in this distance under different environmental conditions.

chants, home industries, operators of transport facilities, manufacturing and processing establishments, and other relevant economic and social units.

Analysis of local trade networks and transport patterns utilized detailed interviewing and quarterly boat enumerations.[1] The quarterly boat census provided information on traffic patterns, cargo shipment, seasonal variations in type and areas of operations and cargo handled, seasonal-temporal variations in operational units in any one area (waterway), and competition with road transport. These surveys were carried out through a visual tabulation and interview process and covered all important waterways in the central plain.

To supplement these methods of primary data collection a series of interviews and questionnaires were obtained from tambon and amphoe officials. The information obtained from these sources was primarily used to corroborate patterns and activities exposed in the intensive field interviewing. This information was also important in establishing temporal trends in transport utilization, transport availability, and commercial development.

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[1]These quarterly surveys were taken in November, 1966; February, 1967; May, 1967; and August-September, 1967 as part of the Applied Scientific Research Corporation of Thailand-University of Michigan joint investigation of transportation in the central plain of Thailand. (See Thailand, Applied Scientific Research Corporation of Thailand [ASRCT], ASRCT Newsletter, No. 3, November, 1966 [Bang Khen (Thailand): Applied Scientific Research Corporation of Thailand, 1966], p. 3.)

The market census of amphoe and local markets employed a direct enumeration technique. In addition to recording the shop-by-shop changes in market composition over time information on merchandising and consumption patterns was obtained. These census forms were used in each amphoe market and primary markets located within or adjacent to the survey area. Temporal changes in market size and function in relation to changes in availability of transport facilities was an important aspect of these surveys. In areas where the markets were large (exceeding 250 shop units) only a 20 percent sample was taken.[1]

The basic components of the samples obtained in the fourteen amphoe in which surveys were conducted consisted of six interview schedules, and seven separate data enumeration forms. The essential data categories of each of these forms and schedules are listed in Appendix II. Interviews with farmers and gardeners were recorded on one form which included separate sections relevant to the activities of each type of farm operation. The schedule used for merchants also contained separate sections for brokerage-wholesaler activities. Individuals who acted entirely as brokers or dealers in various agricultural or consumer goods were interviewed, using this form, with emphasis being placed on those sections which were relevant to their particular activities. Rice mill

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[1]Reliance upon the cooperation of amphoe officials to complete the market census in certain amphoe resulted in incomplete surveys in several markets. A 20 percent sample of the amphoe Chumsaeng market was taken by the author, and samples of similar size were ultimately required in amphoe Sam Chuk and amphoe Khok Samrong markets. Complete surveys were taken in all other markets.

questionnaires were structured for various sized operations, but no form was employed for other processing and service industries. Interview schedules for transport units (bus, trucks, mixed passenger-cargo vehicles, and boats) were recorded on formal schedules. The variation in boat types and functions necessitated the use of several different forms and some interchangeable sections.

The enumeration forms included the market census, tambon and mu ban household census, agricultural production forms, tambon and amphoe household population census forms, amphoe and municipality market construction, and an enumeration form for recording changes in private and commercial transport facility use over time.[1] These enumeration forms recorded data annually for the period 1947-1967 when available.

Field data collection within the central plain was begun in October, 1966 and continued for eighteen months thru April, 1968. The process of enumeration and completion of interview schedules within individual survey areas was done in pre-scheduled periods of one to three weeks or longer. Efforts were made to live and work in each area during various times of the month and in each major agricultural and climatological period of the year.[2] These pre-scheduled monthly and seasonal interview-

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[1] Each tambon contains several mu ban, or hamlets. The mu ban is the lowest government administrative unit. (See infra, p. 99, n. 1)

[2] This pre-determined field enumeration schedule was only interrupted for a total of six weeks during the quarterly river surveys, and this disruption was minimized by participation in surveys covering areas of sample surveying.

enumeration periods were closely adhered to except during the wet season (June-October) when movement was more restricted. Only ten of the fourteen survey areas were worked in for more than one week during the wet season.

The collection of interview schedules within survey areas was based primarily on the parallel traverse sampling grid discussed previously. Interviews with farmers and gardeners at these pre-determined points facilitated the construction of temporal and spatial impact-development profiles within each area. Endemic variations in settlement patterns, agricultural land-use patterns, and size of agricultural holdings frequently necessitated selection of alternative households for interviewing. These factors are also partially responsible for the intra-regional variations in the total number of agricultural households sampled within survey areas. In certain areas in which tests of the maximum spatial impact of road development were made and marketing networks were more complex, a larger number of households were interviewed.

The distribution of interview schedules within survey areas is shown in Table 3. Interviews with merchants, part-time produce dealers, and wholesalers were not as limited as the table seems to indicate. A considerable amount of informal interviewing, discussion, and inquiry was done in markets, which limited the number of formal interviews required. The extent of sampling conducted among individuals engaged in commercial activities was determined more by the complexity of marketing procedures and channels, merchandising, and local trade networks

TABLE 3

DISTRIBUTION OF INTERVIEW SCHEDULES BY TYPE AND SURVEY AREA OF COLLECTION

Survey Area	Farmer	Merchant	Broker, wholesaler	Rice mill	Other processing, service industry	Trucks	Buses	Boats	Total
Bang Yai	17	7	1	1	2	-	-	5	33
Min Buri	20	3	1	3	4	1	1	10	43
Krathum Baen	17	3	2	1	5	2	1	7	38
Lam Luk Ka	20	3	-	3	1	-	2	8	37
Lat Bua Luang	14	3	-	1	-	-	-	10	28
Nong Sua	8	3	1	3	1	1	2	8	27
Muang	16	3	-	1	-	1	1	8	30
Damnoen Saduak	24	3	2	-	1	3	2	10	45
Bang Khla	17	4	1	1	1	1	2	12	39
Tha Rua	8	4	2	1	8	1	1	20	45
Sam Chuk	6	4	2	2	1	1	-	10	26
Sanphaya	6	3	1	-	1	1	1	8	21
Khok Samrong	12	4	2	1	1	3	1	-	24
Chumsaeng	6	8	2	1	-	1	1	20	39
Total	191	58	17	19	24	15	15	136	471

than by a desire to obtain a specific numerical sample. The number of interview schedules listed under "Other processing..." in the table refers to such varied activities as coconut dessication plants, ice plants, saw mills, maize drying facilities, stone crushing plants, and machinery (engine) repair shops.

In order to provide a quantitative measure of the physical characteristics, including comfort and convenience, of road surfaces and transport conditions in survey areas, a Road Development Index (RDI) was constructed. This index was based on Control Section Profiles and construction-maintenance records of the Highway Department, changwat and amphoe road maintenance records, actual user perceptions of conditions, and field evaluations. The RDI uses a two-component numerical gradation from 0 to 10.8 to record seasonal accessibility, road surface composition, and conditions of transport. Separate combinations of these variables were assigned a two-component numerical value ranging from 0 (no road surface) to 10.8 (all-weather, hard surface road). The division of these numerical components and the characteristics they represent are shown in Table 4.

Combination of the initial and sub-components provided a representative measure of the seasonal and annual changes in transport conditions. The addition of a subscript "f" to certain indices was employed to show roads which were subject to seasonal flooding Although this Index is highly simplified it does provide an accurate measure of each road under construction.

TABLE 4

NUMERICAL AND QUALITATIVE COMPONENT CHARACTERISTICS OF THE ROAD DEVELOPMENT INDEX

Initial Component	Accessibility-Surface Characteristics	Sub-Component	Transport Condition Characteristics
0.0	no road surface	0.00	non-trafficable
1.0	inaccessible, deteriorated road surface	0.20	poor
2.0	dry season, dirt	0.40	medium
3.0	dry season, stone	0.60	fair
4.0	dry season, mixed	0.80	good
5.0	dry season, laterite	0.00f	"f" subject to seasonal flooding
6.0	dry-wet season, dirt		
7.0	dry-wet season, stone		
8.0	dry-wet season, mixed		
9.0	dry-wet season, laterite		
10.0	dry-wet season, asphalt other hard surface		

A more important value of the Index than the representation of specific transport and road surface conditions at a given point in time was in defining periods of transitional road development. This type of development occurred when improvements in road surfaces resulted in an upward reclassification of roads from the seasonal (0-5.8) to all-weather (5.8-10.8) portion of the scale. Any reclassification of road

surfaces from the seasonal to the all-weather portion of the scale are considered transitional road developments. This type of development is particularly important in relation to corresponding changes in economic, social and transport patterns.

PART II

TRANSPORTATION DEVELOPMENT IN THE CENTRAL PLAIN

CHAPTER II

TRADITIONAL TRANSPORTATION SYSTEMS: INLAND WATERWAYS

Throughout the history of Thailand water transportation has been a central factor in the development and coalescing of the kingdom. Early capitals at Chieng Mai and Sukhothai were founded in the valleys and fertile flood plains of the Ping and Yom rivers. As the kingdom grew and expanded its territorial boundaries, the capital was moved further south. The establishment of the capital at Ayutthaya in 1350, and its later transfer to Thon Buri in 1767, both situated on the Chaophraya river, provide recent examples of this historical preference for locations along major river systems. This pattern is a logical response to the availability of fertile soils, and the convenience of water transport for communications, trade, and administrative control.

During the centuries of early Thai political and military expansion, the need for extensive transport and communications routes was limited. In the Ayutthaya period, 1350-1767, the major areas of settlement and economic activity from which the capital derived its support were centered in the upper Chaophraya delta from Ayutthaya to Nakhon Sawan. It was in this area that wet paddy cultivation was most widely

practiced and agriculture most developed. The lower delta from Ayutthaya south to the Gulf of Siam was primarily a lightly settled tidal and fresh water swamp unfit for paddy cultivation. The rice monoculture centered around Ayutthaya was a primary source of support for the economy and flourished on fertile soils and irrigation waters supplied by the Noi, Pasak, and Chaophraya rivers.

The importance of inland waterways and water transport in the early agricultural, commercial, and administrative activities of the kingdom is expressed in the systems of land taxation and inland transit dues (octroi) which existed as early as the Ayutthaya period.[1] In the early eighteenth century paddy lands were classified for taxation purposes according to land quality and availability of water for irrigation. This classification scheme divided paddy lands into two categories: Na Khu-kho, and Na Fang-loi lands. The Na Khu-kho lands were taxed according to the total area of lands owned, while Na Fang-loi lands were taxed only on the area cultivated.[2] This taxation policy reflected the areal distribution and location of paddy lands with respect to the availability and dependability of water for irrigation. The Na Fang-loi lands were dependent mainly upon rain water for irrigation and thus had

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[1] H. G. Quaritch Wales. Ancient Siamese Government and Administration. (London: Bernard Quaritch, Ltd., 1934) p. 209. Wales states that according to the Annals of Ayutthaya the inland transit dues were probably introduced during the reign of King Ekkasorath, A. D. 1605-1610. (Hereinafter referred to as Wales, Ancient Siamese Government.)

[2] Ibid., p. 202.

a less consistent output. In contrast, the Na Khu-kho lands were well watered by both precipitation and their proximity to the Suphan, Noi, Pasak, and Chaophraya rivers which provided them with more consistent and higher yields per unit area. This latter group of paddy lands was located immediately adjacent to the capital at Ayutthaya and within the region watered by the four main rivers of the upper delta. The Na Fang-loi lands were situated further from these sources of irrigation water and were therefore less heavily taxed.

Inland transit dues (octroi) was one form of revenue collection derived from taxation of boats and carts carrying produce within and between monthon.[1] A series of customs houses was established along major waterways and overland routes to exact the tax from passing boats, carts, and mule caravans. Wales states that the amount of this tax was 10 percent of all cargo carried.[2] This taxation program and the network of customs houses provided one of the early forms of control over inland water and land transport.

Although the historical annals of the Kingdom of Siam devote little attention to early works of irrigation and canal construction, there is

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[1] As part of the Siamese governmental reorganization begun in the 1890's, eighteen new administrative divisions termed monthon (circles) were created. Each of these monthon incorporated several of the existing provinces, although provincial boundaries were still maintained. These divisions were finally discarded in 1933. (See, Walter F. Vella, The Impact of the West on Government in Thailand. [Berkeley: University of California Press, 1955] pp. 340-345.)

[2] Wales, Ancient Siamese Government, p. 209.

some evidence that the first major communications canals in the central plain were built during the Ayutthaya period.[1] The increasing development of communications and later irrigation-communications canals is indicated in Table 5 and Figure 2. The canals (khlongs) listed here are only the more major routes in the lower plain, but they form the basic framework for subsequent developments.

The construction of the first major lateral canal extending eastward from Bangkok to the Bang Pakong river is recorded in the Dynastic Chronicles:

> In the reign of King Phraphudthayawdfaa, at the time of the establishment of Bangkok as the capital, canals had been dug within and beyond the city walls, by using manpower requisitioned from the vassal states of Laos and Cambodia. Later in the reign of King Phraphudthaleudlaa, a royal decree commanded that a more direct canal be dug behind the town of Nakhorn Khyankhan, by hiring Chinese labor. Then in the reign of King Phranangklao, a royal decree had directed that two more canals be dug, by hiring Chinese labor: one canal started at Thungsaensaeb District, passed by Bangkhanaag District and emptied into the river north of the town of Nakhorn Khyankhan and south of the mouth of the Samrong Canal. B.E. 2394 (1837).[2]

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[1] เจ้าพระยาวงษานุประพัทร์ ประวัติกระทรวงเกษตราธิการ. พิมพ์ครั้งที่ ๒, (กรุงเทพฯ โรงพิมพ์โสภณพิพรรฒธนากร, พ.ศ. ๒๔๘๔) หน้า ๑๒๖
(Chaophrayawongsanupraphat, History of the Ministry of Agriculture, 2nd ed. [Bangkok: Sophanphiphadthanakan Press, 1941], p. 126).

[2] Chaophraya Thipakorawong, The Dynastic Chronicles, Bangkok Era, the Fourth Reign B.E. 2394-2411 (A.D. 1851-1868). Vol. I, trans. by Chadin (Kanjanavanit) Flood (Tokyo: Centre for East Asian Cultural Studies, 1965), p. 72. Some modifications of the exact transliteration of Thai to English used in this work have been made to simplify presentation here. (Hereinafter referred to as Thipakorawong, Dynastic Chronicles.

TABLE 5

MAJOR CANAL CONSTRUCTION IN THE LOWER CENTRAL PLAIN OF THAILAND FROM A. D. 1450 TO A. D. 1900

Canal	Length in kms.	Excavation begun	Excavation completed
Samrong	26.0	-	1498
Bangkok Yai	-	1522	1522
Bang Kruaj	4.0	1538	1538
Mahachai	25.0	1645	1721
Saen Saeb-Bang Khanak	67.0	1837	1840
Mahasawat	33.5	1858	1860
Phasicharoen	31.0	1865	1866
Damnoen Saduak	42.0	1865	1868
Nakhorn Nuangkhet	21.5	1876	1877
Thawiwattana	17.5	1877	1878
Prawet Burirom	49.1	1878	1880
Naraphirom	22.0	1879	1881
Rangsit	55.0	1890	1896
Phrayabanlue	40.0	1891	1900

Source: Takashi Tomosugi, "Historical Development of Irrigation and Drainage in the Chao Phraya Delta," Water Resource Utilization in Southeast Asia. (Kyoto: Center for Southeast Asian Studies, Kyoto University, 1966), pp. 165-176; J. Homan Van der Heide, General Report on Irrigation and Drainage in the Lower Menam Valley (Bangkok: Ministry of Agriculture, 1903); and เจ้าพระยาวงษานุประพันธ์, ประวัติกระทรวงเกษตราธิการ, ๒๖๕-๒๕๙ (Chaophrayawongsanupraphat, History of the Ministry of Agriculture, pp. 125-158).

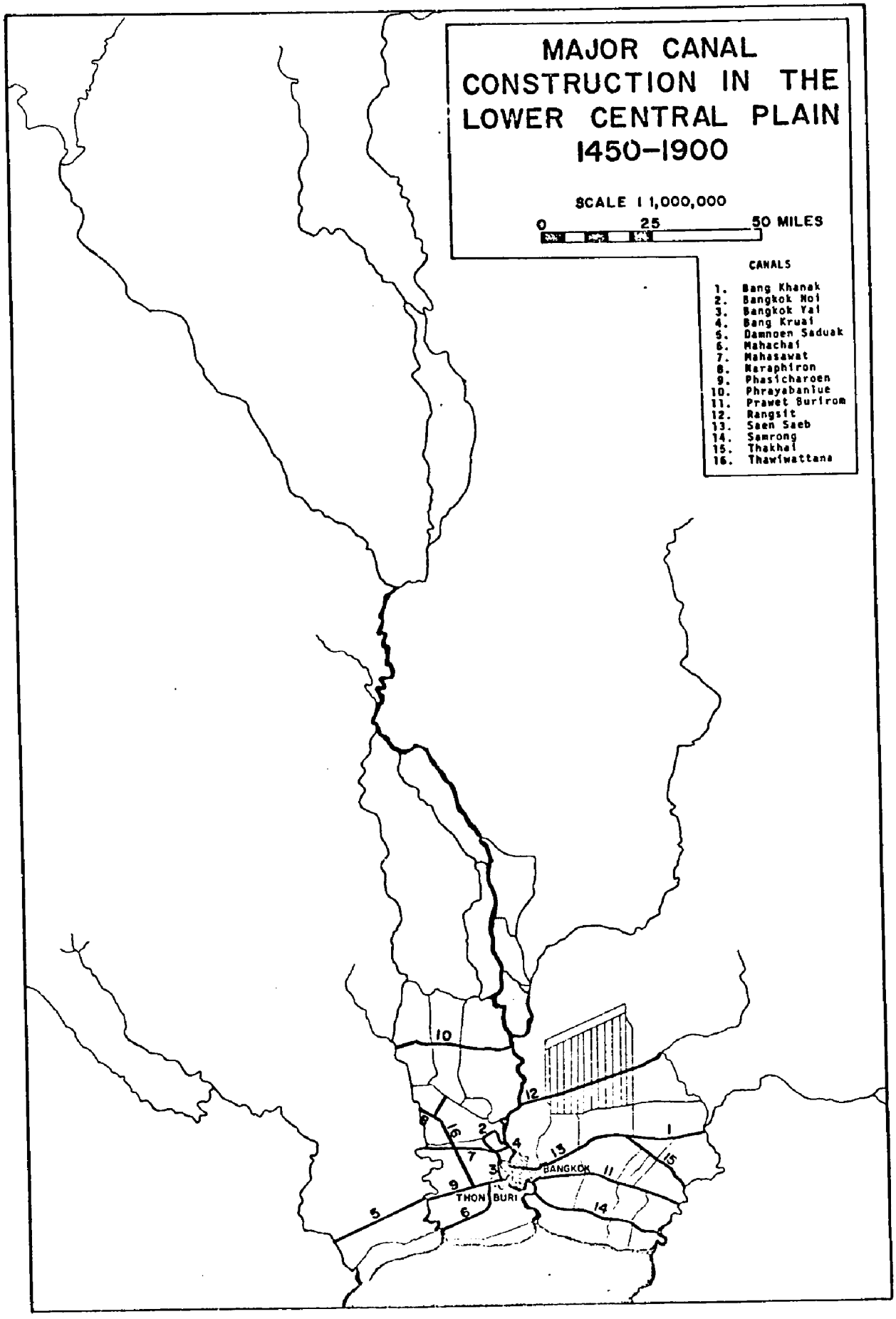
MAJOR CANAL CONSTRUCTION IN THE LOWER CENTRAL PLAIN 1450–1900
SCALE 1 1,000,000
0 25 50 MILES
CANALS
1. Bang Khanak
2. Bangkok Noi
3. Bangkok Yai
4. Bang Kruai
5. Damnoen Saduak
6. Mahachai
7. Mahasawat
8. Naraphiron
9. Phasicharoen
10. Phrayabanlue
11. Prawet Burirom
12. Rangsit
13. Saen Saeb
14. Samrong
15. Thakhai
16. Thawiwattana
BANGKOK
THON BURI

Fig. 2

These two canals extended east from Bangkok and Phrakanong district and joined the Bang Pakong river some eighty to one hundred kilometers east of the capital. Both routes, now identified as khlong Saen Saeb and khlong Dan, were the first artificial waterways excavated connecting the city of Bangkok with the Bang Pakong river to the east. In addition to facilitating transport and communications within this area they also aided shipment of produce to the capital and provided access to the undeveloped agricultural lands lying in this tidal region.[1] Their construction was of little value in encouraging settlement, since tidal inundation and salinity precluded any extensive cultivation of these low agricultural lands.

In B.E. 2400 (1857) efforts were begun to increase communications and produce movement within the area west of the capital by constructing new canals and re-dredging several older ones.

> In that same year, the king commanded Chaophrayarawiwongsamahaakoosaathibbadii and Phrasiisombad to hire Chinese labor to dig a canal which was to extend all the way from the Chaiyaphrygsaamalaa temple to the city of Nakhorn Chaisi, where it would empty into the river near the Sancawsubin Spirit House.
>
> The excavating started on Wednesday, the tenth day of the waning moon in the tenth month. The canal measured 676 sen in length, seven wa in width, and six sawg in depth. The money

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[1] The military and strategic importance of this work may have overshadowed its developmental significance. Chinese rebellions of obscure motivation in Chantaburi in 1824 and against taxation of sugar milling in Chachoengsao in 1848 may have encouraged these canal projects. (See G. William Skinner, Chinese Society in Thailand: An Analytical History [Ithaca: Cornell University Press, 1957] pp. 143-144.)

that financed the construction came partially from the Royal Treasury, partially from the money of a now-deceased elderly lady named Ngen, whose rank was Thaawtheebpha-aakawn, and who was formerly the owner of a market place...

.....

The total cost came to 1101 chang, and 10 tamlung. This included the cost of redigging a portion, 8 sen in length, of the former canal, making the total length of the work 684 sen. The canal was completed, meeting the river, on Thursday, the 13th day of the waning moon in the sixth month, the year of the Monkey, the second year of the decade. The king called it Mahasawad canal.[1]

(B.E. 2409 [1865]) During that year of the Tiger the king commanded Phraphasiisombadbaribun, the opium tax collector for the Crown, to use the money collected as opium tax to defray the cost of digging a canal that was to start from the Bangkok Yai canal at a point by the Paknam Temple, and empty into the river at the city of Nakhorn Chaisi. The canal, when finished, came to 620 sen in length, 7 wa in width, and 5 sawg in depth. The total amount of wages paid for labor in excavating earth and removing stumps came to 1,400 chang. The canal was named Phasicharoen.[2]

These canals provided the two major routes of transport and communications west from Bangkok to the Tachin river and adjacent settlements. Although these canals provided direct water transport with the Tachin river and by following this river north one could reach Suphan Buri, and finally Chai Nat, there was still no direct inland waterway route to the city of Ratchaburi on the Maekhlong river, fifty kilometers

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[1] Thipakorawong, Dynastic Chronicles, Vol. I, pp. 175-176. (Equivalent values for the terms of measure used in the above text are: wa is 2 yards, a sen equals 40 yards, a sawg equals 0.5 yards. The monetary values of chang and tamlung are 8 baht and 4 baht respectively. Eight baht was the equivalent of one £ sterling from 1850 to 1879. (See James C. Ingram, Economic Change in Thailand Since 1850. [Stanford: Stanford University Press, 1955], pp. 243-244.)

[2] Ibid., Vol. III, p. 373.

further west. In B.E. 2411 (1867) the final link in this system of major canals extending west from Bangkok was opened.

> (B.E. 2411 [1867]) On Monday, the fourth day of the waxing moon in the seventh month, the Chief Minister of Military Affairs went personally to officiate at the opening of the newly constructed canal at Bangnokkhwaek District. The digging of this canal was begun around the latter part of the year of the Tiger, the eighth year of the decade. It was excavated from a point by the eastern bank of the Bang Yang river, in the city of Nakhorn Chaisi, and it finally emptied into the Bangnokkhwaek Canal in the city of Ratchaburi. Its length was eight hundred and forty sen, its width six wa, and its depth six sawg. The wages paid for the excavation and removal of stumps were partly paid for by the Chief Minister of Military Affairs, and partly by the king for the use of the public. The Minister paid one thousand chang, while the king paid four hundred chang. The total amount of wages paid was thus one thousand and four hundred chang. The canal was named Damnoen Saduak.[1]

The nature of canal construction in the lower delta of the central plain in the nineteenth century suggests that the majority of these projects were undertaken more for reasons of civil and administrative control, and expediting produce movement to the capital, than to improve irrigation conditions and expand agricultural production. It was not until the final decade of the nineteenth century that external demands for increased rice exports and internal pressures for the expansion of areas under cultivation culminated in the first major irrigation-communication canal project within the central plain.[2]

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[1] Ibid., p. 398.

[2] Further details on canal construction in the central plain are contained in Robert V. Hubbard, "The Canals of the Chao Phraya River Delta" (unpublished M.A. thesis, University of Michigan, 1969).

The Inland Waterway Network: 1890-1966

The first major step in the planned development of the irrigation system was taken in 1889 when the government granted a concession for a period of twenty-five years to a private Thai company, the Siam Canals, Land and Irrigation Company, for the development of a tract of land in the lower plain.[1] This concession provided for the development of 240,000 hectares of land located between the Chaophraya River and the Nakhon Nayok River, and bounded on the south by khlong Saen Saeb (see Fig. 3). The terms of the concession stated that all uncultivated lands extending 800 meters on either side of the excavated canals would be the property of the company.[2] Shortly after the concession was granted, the company began dredging a system of navigation and irrigation canals which by 1905 totalled over 1600 kilometers in length.[3] This system of parallel north-south canals was bisected horizontally by one major drainage canal, khlong Rangsit, which connected the Chaophraya and Nakhon Nayok rivers. This area, later known as the Rangsit concession, or Rangsit area, opened to cultivation an area which had previously been only tidal swamp. Although the original project was a developmental measure, no plans had been made for the periodic flushing of

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[1] Arnold Wright, ed., Twentieth Century Impressions of Siam (London: Lloyd's Greater Britain Publishing Co., Inc., 1908), p. 200.

[2] Ibid.

[3] J. Homan Van der Heide, General Report on Irrigation and Drainage in the Lower Menam Valley (Bangkok Ministry of Agriculture, 1903), p. 26. (Hereinafter referred to as Van der Heide, General Report.)

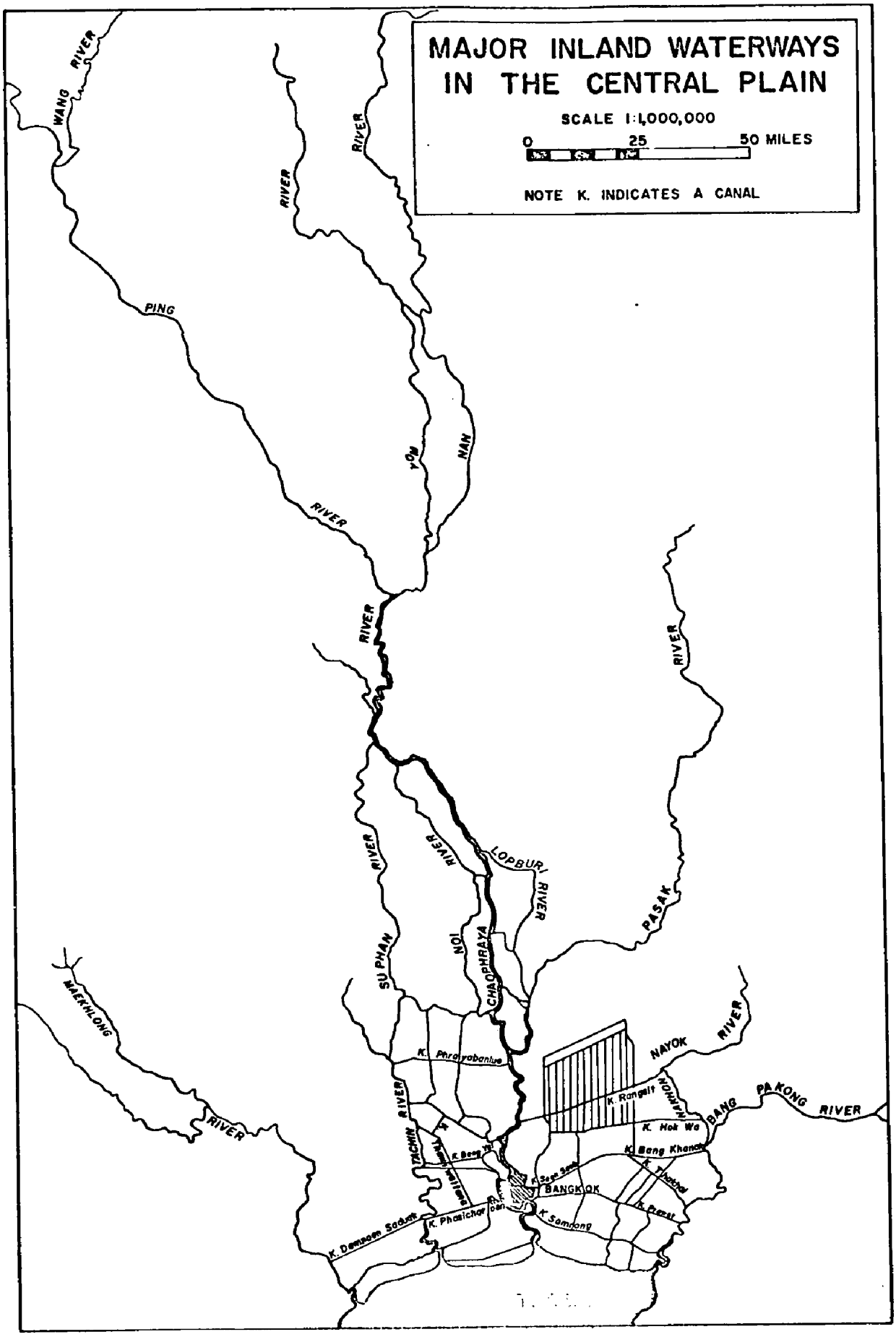
MAJOR INLAND WATERWAYS
IN THE CENTRAL PLAIN
SCALE 1:1,000,000
0 25 50 MILES
NOTE K. INDICATES A CANAL
WANG RIVER
PING RIVER
YOM RIVER
NAN RIVER
LOPBURI RIVER
PASAK RIVER
SU PHAN RIVER
NOI RIVER
CHAOPHRAYA RIVER
MAEKHLONG RIVER
NAYOK RIVER
BANG PAKONG RIVER
BANGKOK
K. Phrayabanlue
K. Rangsit
K. Hok Wa
K. Bang Khanoo
K. Phasicharoen
K. Samsen
K. Damnoen Saduak

Fig. 3

the area with fresh water to reduce accumulations of tidal salt in the soils. Due to the extensive system of absentee landlordism, poor soils, and adverse living conditions, this area soon became characterized by extremely high tenancy rates and poor agricultural production.

By 1900 it became apparent that unless action was taken to (1) redredge some of the older canals, (2) develop a system of canals and locks to reduce the salinity in the coastal tracts east and west of Bangkok, and (3) provide some system of water control and management to insure more consistent supplies of fresh water, it would be impossible to meet the increasing demands for arable land.

In 1902 the Siamese government decided that it was necessary to develop a major irrigation system and invited J. Homan Van der Heide, a Dutch engineer then working in India, to make a study of the irrigation needs of the central plain. The basis of Van der Heide's proposal, presented after an eight month study of the area, was the construction of a barrage at Chai Nat, some 200 kilometers north of Bangkok, with a system of diversion canals extending southward into the lower delta. This network would be supplemented by dredging (canalization) and control of the Suphan and Noi rivers which ran parallel to the Chaophraya on the west. Although the proposed project was a comprehensive one and would not only have expanded the area under cultivation and stabilized yields, but added a minimum of 892 kilometers of inland waterways to the existing system, it was turned down by the government.[1]

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[1] Based on analysis of textual and graphic materials in Van der Heide's report of 1903 (Van der Heide, General Report). The primary reason for the government's rejection of Van der Heide's plan appears to have been its cost.

During the next eight years the only improvements made on the inland waterway transport and irrigation system were the redredging of some existing canals and the establishment of an Irrigation Department.

At the turn of the century there were 3700 kilometers of major waterways throughout the whole of the lower central plain south of Nakhon Sawan. Although it is unclear what portion of this total number was useable on a year-round basis, it is likely that over 60 percent could be navigated by some type of boat throughout the year. By comparison, the inland land transport network in this same region had no first- or second-class roads outside of municipal areas, and less than 100 kilometers of dirt cart tracks which at best could be used for only limited periods in the dry season. The complete dominance of water transport in trade and communications in the central plain is clearly reflected in the returns of the Royal State Railway for the year 1903/04. Of all rice exported from the country during this year, 97 percent of the total was shipped to Bangkok by water and 93.5 percent of all other exports reached the capital by water.[1] This is especially significant when viewed in relation to an estimate made by Van der Heide of the origins of rice exports by producing regions. He estimated that of the total rice exports of 14 million piculs in 1905/06, no more than 2 percent

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[1] C. A. Carter, ed., The Kingdom of Siam (New York: G. P. Putnam's Sons, 1923), p. 230.

originated outside of the central plain.[1] Ingram further substantiates these conditions in stating that in 1905, "...virtually all exports originated..." from the central plain.[2]

The dominant position of the central plain in the production of export produce, mainly rice, emphasized the need for a comprehensive program to develop irrigation facilities in this region. In 1903 a Canal Department was established in the Ministry of Agriculture but was subsequently shifted along with the Irrigation Department to the Department of Ways and Transportation in 1912. From 1912 to 1914 this department was responsible for both water and land transport in the entire country. In 1914 a new Royal Irrigation Department was established within the Ministry of Land and Agriculture and the Canal Department was transferred to this new department.

In 1915 Sir Thomas Ward submitted to the Siamese government a revised proposal for irrigation development in the central plain. This proposal incorporated much of what Van der Heide had urged twelve years earlier, but suggested that the works be implemented in stages and through separate projects rather than in one integrated project. Out of this proposal developed the first government programs for irrigation and navigation development in the lower central plain.

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[1]Van der Heide, General Report, p. 57. One picul is equivalent to 133.3 lbs.

[2]James C. Ingram, Economic Change in Thailand Since 1850 (Stanford: Stanford University Press, 1955), p. 45. (Hereinafter referred to as Ingram, Economic Change.)

The South Pasak Project, begun in 1915, was the first part of this program. Through the construction of a dam, navigation locks, and regulators along the Pasak River, controlled inundation and flushing of the Rangsit area was made possible. In addition to the head works on the Pasak River, some 450 kilometers of irrigation-communications canals were built before the project was completed in 1924.[1] A related conservation and drainage project in the tidal flats east of Bangkok was begun in 1921. The Chiengrak-Bang Hia Project linked all the irrigation works from the Pasak River south to the Gulf and established a dike and a series of regulators along the coast to control tidal flow. Initiated at the same time was a third major project, designed to canalize 123 kilometers of the Suphan River, and through the construction of regulators and locks utilize the river for irrigation purposes.[2] The most important part of this project for navigation was the dredging of eighty kilometers of the river north of Suphan Buri, previously unnavigable in the dry season. The completion of all the irrigation canals and regulators was not accomplished until 1955. Two additional projects were begun in 1933 and 1941 on the Nakhon Nayok and Maekhlong Rivers

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[1]Ministry of Lands and Agriculture, Royal Irrigation Department. Administration Report of the Royal Irrigation Department for the Period 2457 B.E. - 2468 B.E. (1914/15-1925/26) (Bangkok: Bangkok Times Press, Ltd., February, 1927), pp. 8-41.

[2]Ministry of Lands and Agriculture, Royal Irrigation Department, Project Estimate for Works of Irrigation, Drainage and Navigation to Develop the Plain of Central Siam. Vol. I, Hydraulic Data Collected and Projects Elaborated. (Bangkok: Bangkok Daily Mail, 1915), pp. 32-40.

respectively, but neither was completed until after 1950. The implementation of Van der Heide's suggestion of a barrage located on the Chaophraya river at Chai Nat and distribution canals to link these works with those completed or under construction in the lower delta was scheduled for 1940, but was postponed due to the war.

It was not until 1952 that the Chaophraya dam, a major aspect of the Chaophraya Irrigation Project, was begun. Construction of the dam was completed in 1957 including the excavation of two major distribution canals: the west distributary canal in the Suphan tract of 142 kilometers; and the Chai Nat-Pasak canal, from amphoe Manorom to the Pasak River, of 132 kilometers. Other aspects of this direct gravity irrigation scheme were completed shortly after the dam in 1957.

In the last ten years increasing emphasis has been placed on dam construction, river training, and improving irrigation facilities in the upper plain north of Nakhon Sawan.[1] Although only limited excavation of new canals has been undertaken, an extensive program of dredging existing rivers and canals and improving navigation on the inland waterway system is being followed. The entire inland waterway network in the central plain is estimated to include over 10,000 kilometers of annually or seasonally navigable canals and rivers, making it an important part of the overall transport system in this region.

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[1]The Phumibol dam on the Ping Rive in changwat Tak was completed in 1964, and construction is in progress on the Wachiralongkon dam in amphoe Tha Muang, changwat Kanchanaburi. Several proposals have also been advanced to construct a dam on the Nan River north of changwat Phichit.

CHAPTER III

THE DEVELOPMENT OF LAND TRANSPORT SYSTEMS: 1890-1966

The existence of an extensive inland waterway system functionally compatible with the physical and agricultural environment of the central plain historically precluded the development of alternative forms of land transport. Road and rail systems were of primary importance only for distribution and shipment of agricultural and consumer commodities outside of this region. Existing land transportation systems acted as communication and distributary mechanisms within external regions and provided links between these regions and the capital through the inland waterway system.

Construction of a rail system in Thailand was officially initiated in 1891 with the construction of a rail line connecting Bangkok with changwat Nakhon Ratchasima in the northeast. Operations were inaugurated in 1896 on the first segment of this route to Ayutthaya, and were followed in 1900 with traffic to Korat (Nakhon Ratchasima), and in 1919 to Chieng Mai in the north. In this early period of rail development three private rail lines were constructed and operations proceeded in conjunction with official lines. The first private rail line was operated

by the Paknam Railway Co., Ltd., and began services over twenty-two kilometers of track between Samut Prakan and Hua Lampong station in Bangkok in 1893.[1] On May 17, 1905 the Maekhlong Railway Company was granted permission to begin rail services between khlong Sarn and Mahachai, changwat Samut Sakhon, southwest of Thon Buri. An additional thirty-three kilometers of track between amphoe Muang Samut Sakhon, and the Maekhlong River at changwat Samut Songkhram was authorized in 1909.[2] These private rail lines were allowed to operate under contracts which would expire in 1936 and 1945 respectively, at which time the rail lines became the property of the Royal State Railway of Thailand.

From 1891 until 1917 the Railway Department was divided into two divisions: the Northern Division controlling development and operations east of the Chaophraya River, and the Southern Division supervising the area west of the Chaophraya River. In 1917 these two divisions were consolidated within one department, the Royal Siamese Railways Department. The track systems of these two divisions remained unconnected, however, since the gauge of the Southern Division track was 1.0 meters, Northern Division track was 1.435 meters, and there was no bridge spanning the Chaophraya River to connect these two track systems.[3]

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[1] Thailand, Royal State Railways of Siam. Royal State Railways of Siam, Fiftieth Anniversary 1897-1947 (Bangkok: R.S.R. Printing Office, 1947), pp. 5-7. (Hereinafter referred to as Royal State Railways, Fiftieth Anniversary.)

[2] Ibid.

[3] The 1.0 meter gauge on the Southern Division track was equivalent to that used in Malaya, Singapore, Burma, and Indo-China at this time.

Standardization of track gauge to a uniform 1.0 meter width was completed on the Northern Division track in 1920, and the opening of the Rama IV bridge across the Chaophraya River in Bangkok on January 1, 1926 connected these two rail systems.[1]

By mid-June of 1932 rail lines had been constructed linking Bangkok with Padang Besar on the Thai-Malay border; eastward to Chachoengsao and Aranyaprathet on the Thai Khmer border; to Korat and changwat Ubol in the northeast; and changwat Chieng Mai in the north. The total length of existing track at that time was 2,996 kilometers serving every region of the country.[2] In the years following the revolution of June 24, 1932, previously planned track expansion programs and improvements were implemented and in 1940 total track had increased to 3,130 kilometers.[3] Extensive bombing of rail yards and equipment during World War II did considerable damage and the extent of this disruption in terms of value was estimated in 1946 to have been 522,662,000 baht.[4] Repairs and replacement of damaged equipment were the primary activities of the State Railway in the post-war period. Some additional segments of new track were laid between 1955 and 1966, increasing the length of the pre-war network by 12.2 percent (see Fig. 4). Developments within the last fifteen years have been centered on modernization and rebuilding old yards, replacing wood-burning steam locomotives with new diesel units, and improving roadbeds and rail weights to accommodate heavier ton-axle loads.

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[1]Royal State Railways, Fiftieth Anniversary, p. 9.

[2]Ibid.

[3]Ingram, Economic Change, p. 48.

[4]Royal State Railways, Fiftieth Anniversary, p. 12.

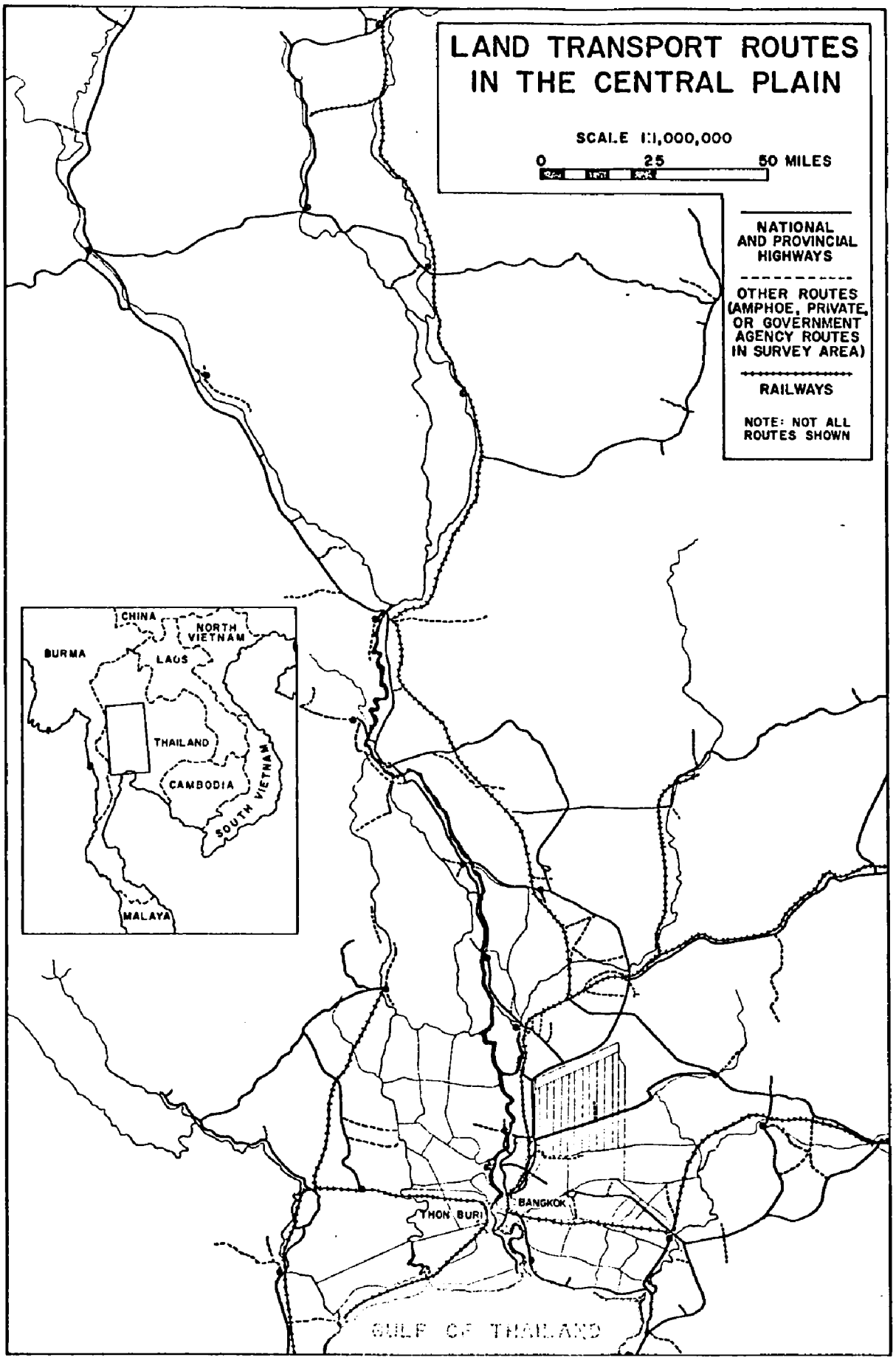
LAND TRANSPORT ROUTES
IN THE CENTRAL PLAIN
SCALE 1:1,000,000
0 25 50 MILES
NATIONAL AND PROVINCIAL HIGHWAYS
OTHER ROUTES (AMPHOE, PRIVATE, OR GOVERNMENT AGENCY ROUTES IN SURVEY AREA)
RAILWAYS
NOTE: NOT ALL ROUTES SHOWN
CHINA
NORTH VIETNAM
BURMA
LAOS
THAILAND
CAMBODIA
SOUTH VIETNAM
MALAYA
THON BURI
BANGKOK
GULF OF THAILAND

Fig. 4

The development of the railway system in Thailand, particularly in the central plain, was never conceived as a stimulant to the expansion of the agricultural production which took place between 1860 and 1940.[1] The expansion of irrigation and communications canal networks within the central plain during the first thirty years of the twentieth century adequately served the transport and communication needs of this region. The extension of rail lines into the north and northeast, however, did effectively stimulate agricultural production and facilitated commodity shipment to Bangkok from these areas. In 1905 over 200,000 piculs of rice were sent by rail from Korat to Bangkok (see supra, pp. 37-38 and n. 1, p. 38) and between 1925 and 1935 rail shipments of paddy and rice from the north and northeast increased from 2.35 million piculs to 5.9 million piculs.[2] This volume of paddy and rice shipment in 1935 accounted for over 25 percent of the total export shipments in that year. Rail shipments of paddy and rice declined in the immediate post-war period due to poor harvests, and an absence of rail cars. From 1950 to 1957 rail cargo traffic volumes increased at an annual rate of 11 percent. Slight declines in cargo volumes occurred from 1958 through 1960 and were in part due to rapidly improving road transport conditions, and increased utilization of truck transport. In

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[1] See Virginia Thompson, Thailand, the New Siam (New York: The MacMillan Co., 1941), pp. 498-506, and W.A. Graham, Siam, Vol. II (London: De La More Press, 1924), pp. 141-153.

[2] Ingram, Economic Change, p. 47.

the early 1960's volumes again increased but gains were very modest and only in the shipment of LCL (less than car load) lots.[1] Competition from trucks and buses has noticeably reduced LCL rail shipments, particularly on short and medium hauls. Passenger traffic is becoming more subject to competition from road transport on medium and short hauls and even on certain long haul routes as well since buses have a definite cargo capability which is free of charge to passengers as long as individual volumes do not exceed 60-80 kilograms (132-176 lbs.). Declines in rail passenger volumes may become more common as road networks and bus services improve. These trends may be more pronounced in the central plain, where similar services are provided by road and water transport and back-haul activity of the LCL-type commodities is increasingly handled by truck shipment.

The same combination of political and economic factors which stimulated rail construction at the turn of the century acted against similar developments of road networks in the central plain. The existence of a dual purpose navigation and irrigation network and related engineering and cost obstacles to road construction mitigated against investments in roads in this region. It was not until the mid-1930's that changes in political and economic conditions generated efforts to develop the road

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[1] Dorothy Clark, and Angelo Giarratana, "Transportation Systems in Thailand" (McLean, Va.: Research Analysis Corporation, 1964), p. 47.

network.[1] The relatively recent growth of a National and Provincial road system in Thailand can best be visualized by analysis of three factors: (1) the development of the administrative highway structure; (2) increases in vehicle registrations; and (3) expansion of the National and Provincial highway systems.

No central administrative structure concerned with highway development existed in Thailand prior to 1910. Unpaved cart tracks, bridle paths, or dirt-surfaced municipal roads were under the jurisdiction of local or provincial officials, or in Bangkok controlled by the Department of Public Works. The existing road system at this time within the central plain was less than fifty kilometers in length, most of which was dirt tracks. The first step in establishing the administrative framework responsible for road planning and construction was made in 1912 when the Department of Ways was created within the Ministry of Communications. Attached to this Department was the Division of Waterways which formerly was under the jurisdiction of

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[1] A governmental policy of "direct" returns on capital investments seems to have prevailed prior to 1932. An expansion of the role of government and attitudes toward capital investment under the constitutional regime was one factor in increased interest in road development. A second factor was Thai concern with French investments in transport facilities in Laos and Cambodia during the 1930's. Thai economic influence in Laos had been strong and Lao trade was traditionally channeled through Bangkok. French investments in roads linking Laos with Ben Thuy (near Vinh), Hanoi, and Phnom Penh would have reduced this profitable trade. Finally, the rise of militaristic-nationalism and a pan-Thai movement in the late 1930's focused increasing attention on ethnic and historic ties between northeastern Thai (Tai) and Tai speaking peoples in Laos. Primary attention was given to military roads in many regions during this period.

the Ministry of Lands and Agriculture. This new department was then responsible for both highway and water transportation. In 1914 a Road Commission was established to formulate policy and a program for highways. With the Thai entrance into World War I and a growing shortage of engineers, the Department of Ways was transferred to the Department of Royal State Railways in 1917. The prevailing attitude at this time toward highway construction in the central plain is contained in a statement from the Annual Report of the Department of Ways, 1918:

> The greater portion of highways in the Central Division are in the east and northeast. The physical nature of soils and topography necessitates the maintaining of only cart tracks in the Central Division until such time as a suitable system of roads and fund expenditure can be decided upon.[1]

The clayey soils, frequent inundation, and high construction and maintenance costs for even a rudimentary road system within the central plain were beyond the physical and economic capability of the Department at this time.

The decennial distribution of road kilometerage by geographic region in Thailand from 1918 to 1967 is shown for the National and Provincial highways in Tables 6 and 7. In 1918 the Central Plain had

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[1]Siam, Department of Royal State Railways, Department of Ways, First Annual Report, B.E. 2461 (1918) (Bangkok: R.S.R. Printing Office, 1919), p. 12. Administratively the Department of Ways divided the country into three Divisions: Northern, Central, and Southern. The Central Division included all of the central plain, the northeast, and the three coastal provinces southeast of Bangkok.

TABLE 6

KILOMETERS OF NATIONAL HIGHWAYS BY GEOGRAPHIC REGION OF THAILAND, 1918 to 1967[a]

Year	North	Northeast	Central	South	Southeast	Total
1918	358	1987	78	1065	112	3600
1928	507	35	423	1078	112	2055
1938	781	1196	1337	1410	..[b]	4724
1948	2202	3456	2332	2997	642	11629
1958	2535	4614	3503	2989	477	14118
1967	1657	4373	3955	2212	784	13111

[a]Calculated from: Siam, Department of Ways, Annual Reports of the Department of Ways, 2460-2470 (1918/19--1927/28) (Bangkok: R.S.R. Printing Office); Thailand, Department of Highways, Annual Reports of the Royal Highway Department, B.E. 2475-2500, B.E. 2508/09. (Bangkok: Department of Highways); and United States, United States Operations Mission-Thailand, Capitol Projects Division, "Highway Kilometerage for Control Sections of Thailand Highway Divisions and Districts," (Bangkok: United States Operations Mission-Thailand, February, 1968). Marked changes in regional highway kilometerage between decennial periods are often due to administrative shifts of roads between national, provincial, and local jurisdiction.

[b]Data for 1938 for the southeast region were not available. This region consists of changwats Cholburi, Rayong, and Chantaburi.

TABLE 7

KILOMETERS OF PROVINCIAL (CHANGWAT) HIGHWAYS BY GEOGRAPHIC REGION OF THAILAND, 1918 to 1967[a]

Year	North	Northeast	Central	South	Southeast	Total
1918[b]	..	..	..	..	..	..
1928	51	815	54	17	..	937
1938	391	589	645	478	62	2165
1948	1444	2721	1179	660	233	6237
1958	..	..	..	..	..	..
1967	1676	2784	2778	1969	614	9821

[a]Calculated from: Ibid.

[b]Data not available for 1918, 1928 for the Southeast, and 1958 for all regions.

only seventy kilometers of roads, all of which were classed as cart tracks.[1] By comparison, the Southern region had over 1,000 kilometers of National Highways of which 69 percent were of Class I, II, or III. In 1921 the highways under control of the Department of Ways were divided into State and Provincial roads in preparation for the transfer of administrative control of provincial roads to the Department. The first official tabulation of provincial road statistics in 1922 indicates that only thirty-one kilometers of provincial highways existed within the central plain. During the 1920's the most noticeable progress in developing a road system within this region was the initiation of construction on three routes: twenty-two kilometers of road between Nakhon Pathom and amphoe Ban Pong, changwat Ratchaburi; ninety-one kilometers of road between amphoe Ban Pong and changwat Petchaburi; and continuation of construction began in 1918 on a fifty-one kilometer highway from amphoe Ban Pong to Kanchanaburi.[2] In 1928 surveys were made in preparation for conversion of a 112 kilometer cart track between amphoe Taphan Hin, changwat Phichit, and Petchabun to a Class III highway.[3] By 1929 there were still less than sixty kilometers of surfaced municipal roads within the central plain.

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[1]The Department of Ways classified roads by road surface as either Class I, II, or III. Class I roads were surface treated with asphalt painting, Class II roads were of water-bound macadam, and Class III road surfaces were water-bound macadam of laterite.

[2]Thailand, Department of Ways, 10th Annual Report of the Department of Ways, B.E. 2470 (1927/28), pp. 1, 5, 44.

[3]Ibid., p. 1.

A growing awareness of the need for roads and for a more comprehensive highway program began in the 1930's (see supra, n. 1, p. 47). In 1933 the Department of Ways became the Civil Engineering Division of the Ministry of Interior, and in 1934 it was renamed the Division of Highways within the Department of Public Works, Ministry of Interior. The country as a whole had the beginnings of a small highway network, with the most extensive systems in the northeast and south, but the central plain still remained almost without inter-regional roadways. Bangkok is referred to in 1936 as being "isolated with respect to vehicle traffic," and the country as "virtually a roadless land" with transport of people and commodities done by river and canal.[1] Existing road construction policy was to build roads as feeders to rail lines and major waterways rather than to penetrate areas where they would serve to stimulate agricultural production and facilitate commodity shipment. In 1936 the first 5-Year Highway Construction Program was formulated. The primary goals of this plan were (1) to connect provincial centers not served by rail or water transport; (2) to penetrate areas of potential agricultural and mineral development; and (3) to construct three radial routes extending from Bangkok. A total of 2,125 kilometers[2] of roads

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[1] Katrine R. C. Greene. Transportation, Part II of An Economic Survey of the Pacific Area. (New York: International Secretariat, Institute of Pacific Relations, 1941), pp. 53-54. (Hereinafter referred to as Greene, Transportation.)

[2] การรวบรวมรายละเอียดของทางหลวงแผ่นดินในประเทศไทย กรมทางหลวงแผ่นดิน กระทรวงพัฒนาการแห่งชาติ พ.ศ. ๒๕๐๖ หน้า ค
(Thailand, Ministry of National Development, Department of Highways, "A Compilation of Details of National Highways in Thailand B.E. 2506 (1963)," [Bangkok: Ministry of National Development, 1963], p. ii.)

were to be constructed, 1,520 of which were completed by 1939; two of the three radial routes from Bangkok were opened in 1937.[1] Existing highway kilometerage in the central plain in 1940 exceeded 3,000 kilometers of both National and Provincial roads, although most of the routes under construction were in the east and northeast. While completion of this original plan was interrupted by World War II, development of a highway system was becoming a recognized need, and administrative changes transforming the Division of Highways into the Royal Highway Department under the Ministry of Communications were made in 1941. A second, more energetic, highway development plan was proposed in 1941 covering ten years to 1952, but was not implemented due to the war.

From 1950 through 1963 there were at least four separate highway development programs proposed which included the construction and improvement of 11,200 kilometers of highways.[2] Three major road construction programs begun in 1955 expanded and improved road transport facilities within the central plain: construction of the Friendship Highway connecting Korat and Saraburi over 148 kilometers of Class I road; the building of the East-West Highway covering 130 kilometers between Phitsanulok and Lomsak; and a program of bridge replacement. By 1958

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[1] Greene, Transportation, p. 54.

[2] การรวมรวมรายละเอียดของทางหลวงแผ่นดินในประเทศไทย พ.ศ. ๒๕๐๖ กรมทางหลวงแผ่นดิน หน้า ค
(Department of Highways, "A Compilation of Details of National Highways in Thailand B.E. 2506 [1963]," p. ii.)

the National Highway system in the central plain had increased by 1158 kilometers or 50 percent over the post-war years of 1947/48. An accurate breakdown of these highways by class is not available, but probably less than 25 percent of the total network was of the first three classes.

In response to increasing vehicle registrations, growing traffic volumes over many routes, and a need for greater centralization in highway planning and development, the Royal Highway Department was renamed the Department of Highways and transferred to the newly established Ministry of National Development in 1963. Plans were immediately laid for a surfacing program to asphalt all primary highways within five years.[1] Late in 1963 the Provincial Highway Department of the Ministry of Interior was placed under the control of the Highway Department, consolidating for the first time within one department all resources and facilities concerned with national and provincial highway planning and development. By 1965 over 16 percent of the total highway system in the central plain was of Class I, II, or III, and in 1967 the total length of National and Provincial highways exceeded 6733 kilometers (see Fig. 4).

A final criterion of the growth of road networks and the developing capability of road transport functionally and regionally is vehicle registrations. Limitations on available statistics for the period since 1950

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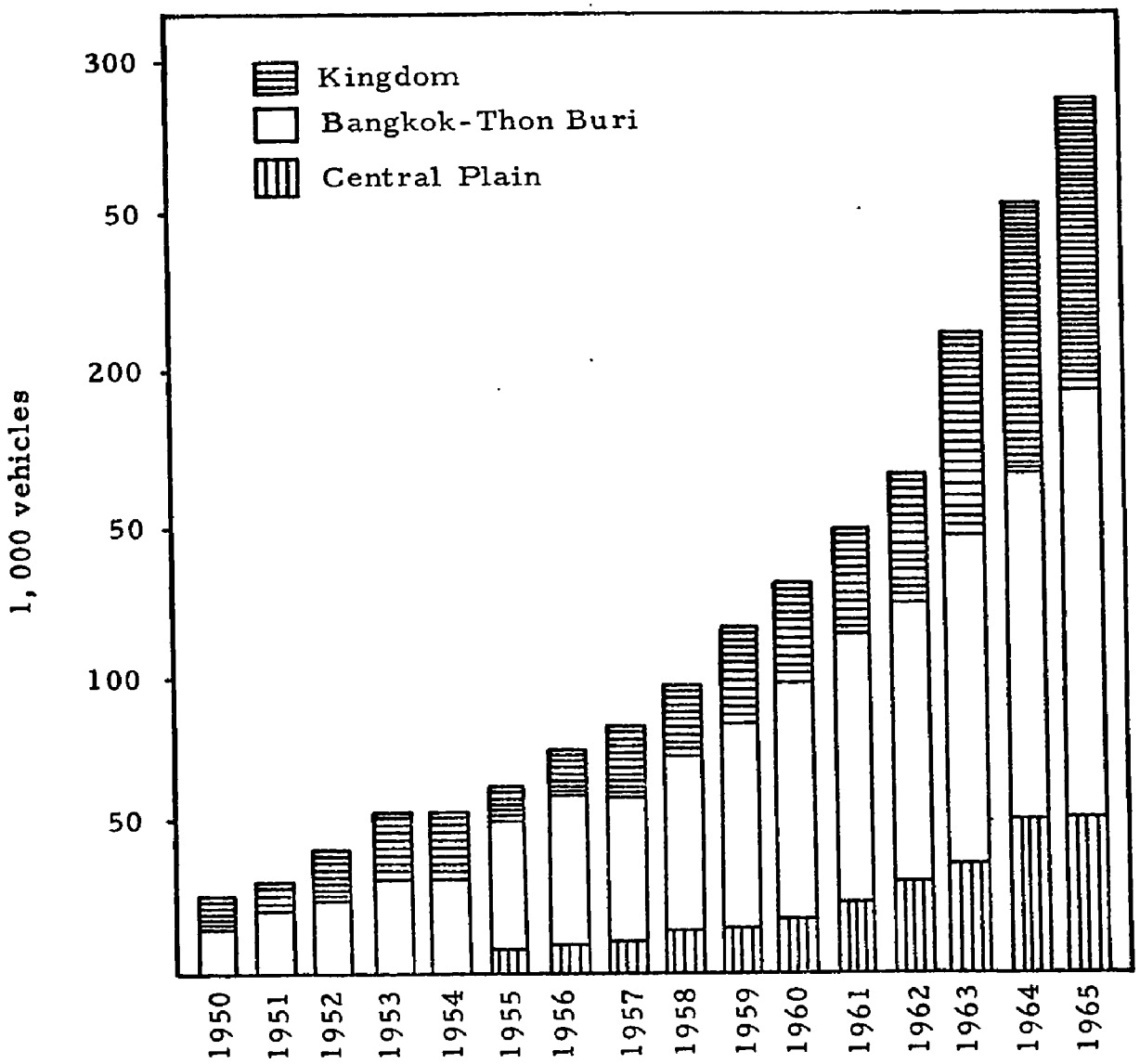
[1]In 1962 the Royal Highway Department adopted a set of minimum design standards for highways. The characteristics of road surfaces by class were: Class I - cement, concrete or plant mix bituminous; Class II - penetration macadam; Class III - double surface treatment; Class IV - single surface treatment; and Class V - laterite or dirt palliative.

prohibit analysis of detailed regional growth in vehicle registrations and composition historically, although gross registrations by vehicle type is available annually since 1908.

Between 1920 and 1940 annual registrations of trucks increased at a rate of 70 percent while cars and buses increased at more modest rates of 13.8 percent and 8.3 percent respectively. The greater Bangkok-Thon Buri metropolitan area has consistently contained the largest single concentration of registered vehicles in the country. In this pre-war period the metropolitan area accounted for 20-30 percent of all registered vehicles in the country. Beginning in 1945 a growing trend toward increasing this concentration occurred, and continued through the 1950's. Registration statistics since 1960 indicate a reversal of this trend with greater equalization of vehicle distribution throughout the country. Motor vehicle registrations in Thailand from 1950 to 1965 are shown in Fig. 5 for Bangkok-Thon Buri, the central plain, and the whole country. Total vehicle registrations during this period increased by over 74 percent per annum.[1] The growing distribution of vehicles outside of the Bangkok-Thon Buri metropolitan area is most apparent beginning in 1962-1963. Rapid improvements and expansion of the road network in the 1950's and early 1960's has contributed greatly to this trend. Regional growth during this period has been most marked outside of the central plain, although registered vehicles in the central plain increased significantly

[1] Total vehicle registrations between 1950 and 1965 increased by 1114 percent, or an annual increase of 74.3 percent.

Fig. 5 - Motor Vehicle Registrations for Bangkok-Thon Buri, the Central Plain, and Thailand, 1950-1965.



Source: Registration Division, Police Department, Bangkok (unpublished records).

from 1960 to 1964. The construction of strategic security and feeder roads in the north and northeast have accounted for much of the growth in these regions.

Temporal changes in unit composition of vehicle registrations provide a more descriptive indication of regional road network expansion, and improvements in the functional capabilities of road transport. Variations in the regional distribution of vehicles by type, particularly trucks, buses, and motorcycles, for the period 1950 to 1965 are shown in Fig. 6 . Classes of vehicles include both private and public units. Truck registrations as a percentage of total registered vehicles have declined by over 33 percent since 1950, and passenger cars have declined by 42 percent. These declines are directly related to the 530 percent growth in motorcycle registrations during this period. The motorcycle, especially in Southeast Asia, functions as both passenger and cargo vehicle. It frequently provides the only form of motorized land transport operable in many areas and is particularly useful in areas where road surfaces are poor and accessibility by larger vehicles is limited. The increasing registrations of motorcycles outside of the central plain may in part reflect the functional adaptability of these vehicles and the large number of loose surface feeder and security roads being constructed in these regions.

The registration of buses within the central plain and Bangkok-Thon Buri has grown rapidly since 1955 when over 75 percent of all buses were found outside of this region. Road resurfacing programs, construction of new all-weather routes, and the rapid economic and population growth occurring in the Metropolitan area have contributed to this growth. The Transport Co., Ltd., a government owned bus company

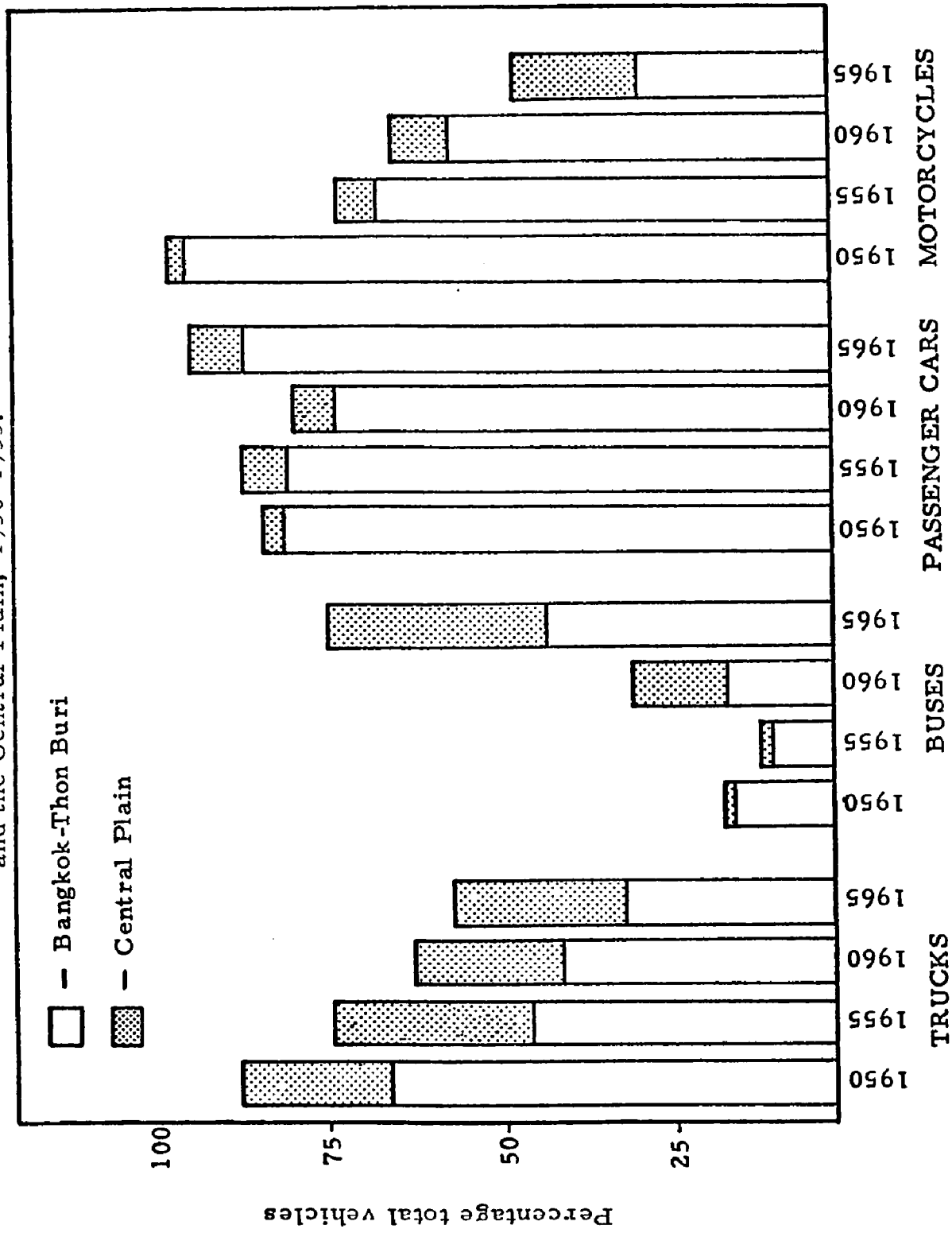


Fig. 6 -- Percentage Distribution of Registered Trucks, Buses, Passenger Cars, and Motorcycles in Bangkok, Thon Buri, and the Central Plain, 1950-1955.

with offices in Bangkok and Thon Buri, provides extensive bus service throughout the country. The establishment of the company in 1959 and subsequent expansion programs in services and facilities have swelled registrations in the Bangkok-Thon Buri Metropolitan area.[1] In 1965 over 75 percent of all registered buses were located in the Central Plain, including Bangkok and Thon Buri. Passenger car registrations have remained relatively stable over this 15 year period, although 1965 data suggest that units registered in Bangkok and Thon Buri may be increasing proportionately faster than in the Central Plain or other regions.

Truck registrations have undergone a general increase within the central plain while declining in the Metropolitan area. In addition to expansion and improvement in road networks in the central plain, the rapid material buildup by American military forces since 1960 has undoubtedly been responsible for some of this growth. Both public and private trucks are used to carry military and aviation fuels, consumer goods, military supplies, and personal effects between ports at Sattahip, Utapao, and Bangkok and numerous military installations north and northeast of Bangkok. Recent increases in maize production have also generated considerable demand for truck transport. Operators of private

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[1] In 1959 the Transport Co., Ltd. incorporated the inter-urban bus operations of the Express Transportation Organization (ETO), a second government-owned transport service. Bus services are now conducted over sixty separate routes in the country by Company owned and privately leased buses. ETO also conducts urban bus services in Bangkok and Thon Buri over seven routes, using 284 buses.

trucks often carry maize in harvest season and then shift to military cargoes which offer regular work during the remaining months of the year. Accompanying the growth in truck registrations has been a functional change in truck capacities. Increasing numbers of new trucks are made from imported Japanese Isuzu chasses and locally fabricated bodies which increase the axles from two to three and expand cargo capacities to 15-20 tons. While expanded cargo capacities are a response to improving road conditions, their excessive axle loads cause rapid deterioration in road surfaces.

The post-war expansion of the Thai highway system in both areal and functional capacity is reflected in these changes in numbers and types of vehicles. Improvements in the road network have stimulated greater use of trucks, buses, and motorcycles within the central plain and other regions of the country. Contemporary distributions and trends in vehicle registrations can be expected to continue in the future paralleling demands generated by growth in the agricultural and industrial sectors of the economy.

PART III

THE IMPACT OF CONTEMPORARY ROAD DEVELOPMENT ON THE RURAL ECONOMY

CHAPTER IV

THE AGRICULTURAL ECONOMY

The agricultural sector of the rural economy has many components which are variously dependent upon and responsive to transport facilities and conditions. The importance of transportation in facilitating agricultural development and the extent to which various environmental, spatial, and economic conditions influence the impact of transport development on the agricultural economy are explored in the following pages. This developmental-response relationship is examined in terms of agricultural land use patterns, land tenure, land values, technology, income levels, and farm consumption patterns.

Agricultural Land Use

Patterns of agricultural land use within the central plain have traditionally been dominated by wet paddy cultivation. The basic clay soils and availability of adequate if often erratic water supplies have combined to make this region one of the most extensive rice plains in the world. The dominance of a rice monoculture in this region has only begun to show signs of diversification within the last fifteen years.

The relatively recent trend toward crop diversification has been widely manifested in the central plain by the rapid increase in areas planted to corn. Most permanent intra-regional changes in land use occurring within the last fifteen years have involved expansion of the area devoted to corn cultivation.[1] The areas under cultivation to wet paddy have remained relatively constant over this same period.[2] Within the central plain almost all of the increase in area devoted to corn cultivation has taken place in transitional uplands and uplands bordering the plain on the east, northeast, and north. Figure 7 indicates the spatial distribution of agricultural lands in non-paddy crops by thirty kilometer zones from the Bangkok-Thon Buri Metropolitan area. The increase in mean percentages of agricultural lands in non-paddy crops after 150 kilometers reflects these changing environmental conditions. The lower rainfall, absence of adequate irrigation facilities, more suitable soils, and improvements in transport facilities have all contributed to the increased cultivation of corn in these areas. The changwats in which the

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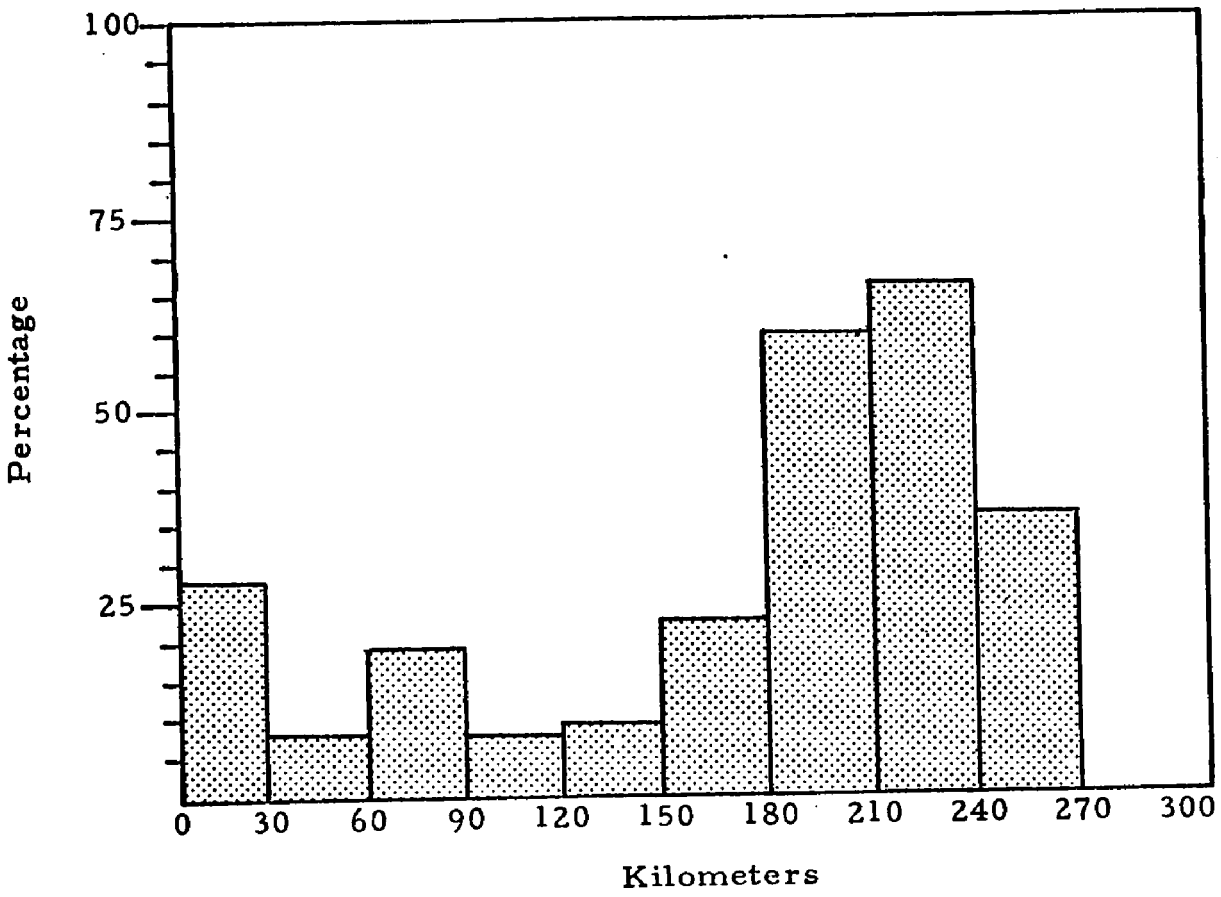
[1]The recent expansion of corn production discussed here refers primarily to the corn grown for export shipment using the recently introduced Guatemalan seed named Tequisate Golden Flint. Cultivation of the local corn variety, Pakchong dent, has undergone no apparent improvement in varieties planted or area cultivated.

[2]Total area planted to paddy in the central plain increased from 16,746,000 rai in 1950/51 to 20,422,000 rai in 1966/67. During the same period area devoted to corn production increased from 100,000 rai to 3,377,000 rai. (One rai equals 0.4 acres.)

Fig. 7 -- Mean Percentage of Agricultural and in Non-paddy Crops for Selected Amphoe in the Central Plain by 30 Kilometer Zones from Bangkok and Thon Buri.



Calculated from: Thailand, Office of the Prime Minister, National Statistical Office, Census of Agriculture 1963, Changwat Series (Bangkok: National Statistical Office, 1964); and Thailand, Ministry of Agriculture, Department of Agriculture, unpublished statistics of crop production by amphoe for 1962 and 1964.

greatest concentrations of corn production are found are Sara Buri, Lop Buri, Nakhon Sawan, Petchabun, Phichit, Phitsanulok, and Sukhothai.[1]

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[1]Chaiyong Chuchart, Gordon R. Sitton, and Arkhom Soothipan, "Production and Marketing Problems Affecting the Expansion of Corn Growing in Thailand," Kasetsart Economic Report No. 8, Department of Agricultural Economics, Faculty of Economics and Cooperative Science (Bangkok: Kasetsart University, 1962), p. 4. (Hereinafter referred to as Chuchart, Sitton, and Soothipan, "Production and Marketing.")

Road development may be important in facilitating investment in changes in agricultural land use in a variety of ways. The existence of a road and the availability of transport facilities is by itself, however, not usually a sufficient inducement for farmers to invest in this type of agricultural development. For road development to act as a precipitant for changes in agricultural land use the farmer or local entrepreneur must be able to realize some cost savings or increased income resulting from this improvement in transport facilities. The ways in which roads can facilitate these savings are through the realization of higher market prices due to more rapid shipment, reduced transport costs, savings in handling and transhipment fees, and increased yields and incomes related to improved distribution of technological inputs. The existence of a cheap, convenient, and extensive water transport system increases the marginal cost and convenience advantages which must be provided by road transport relative to those of water transport. The decision, therefore, of whether to convert existing holdings to more profitable forms of land use must consider in addition to other factors the relative cost and convenience advantages of each type of transport.

Changes in agricultural land use patterns following road development have taken two distinct forms. Permanent changes generally involved some physical alteration of fields to accommodate garden holdings, piggeries, poultry farms, and other forms of non-paddy land use. The extent of these field alterations, cropping patterns, tenure conditions, and cultivator commitments to large, long-term capital and labor inputs

were indicative of the permanency of this type of change. In contrast, temporary changes in land use also involved physical alterations of fields, but tenure conditions, cropping patterns, and scale of economic inputs were definitely of a lower and more short term nature. Temporary changes in land use consistently took the form of conversion of paddy fields by tenant operators to vegetable and melon gardens. These holdings were leased and operated for short periods of one to five years after which the fields were returned to wet-paddy cultivation. While temporary changes in agricultural land use occurred more frequently, those of a permanent nature involved considerably larger areas. The percentage changes in agricultural land use shown in Table 8 indicate that only two amphoe, Krathum Baen and Khok Samrong, experienced significant levels of change. The remaining amphoe had either very small percentage changes of around 1.0 percent or no change at all. Permanent changes in land use must be considered more beneficial and desirable in terms of agricultural development and diversification. Only in transitional upland areas does road development appear to be an important factor in this process.

Road development in the central plain has had little overall influence on agricultural land use. However there are indications that the impact of road development on agricultural land use does vary spatially and with changes in environmental conditions. Percentage changes in agricultural land use following road development in amphoe located in the wet-paddy environment of the lower plain exhibited no

TABLE 8

CHANGES IN AGRICULTURAL LAND USE AND ROAD TRANSPORT CONDITIONS IN SELECTED AMPHOE IN THE CENTRAL PLAIN

	Percentage change in agricultural land use, 1953-1968 (% of all holdings)	Type of crop change	Year of Initial Change	Mean year of change	Year (Period) of Transitional Road Development
Bang Yai	..	fruit, vegetable	1958	1961	..
Min Buri	0.2	piggeries, poultry	1958	1963	1957
Krathum Baen	6.9	fruit, vegetables	1960	1964	1955
Lam Luk Ka	1.0	"	1964	1965	1963
Lat Bua Luang	1.1	"	1961	1964	..
Nong Sua	0.2	"	1966	1966	..
Muang Chachoengsao	..	"	1957	1963	1957
Damnoen Saduak	0.0	"	..	..	1960
Bang Khla	0.3	"	1957	1961	1957
Tha Rua	0.0	..	..	..	1963
Sam Chuk	..	sugar cane	1958	1958	..
Sanphaya	0.0	..	..	..	1964
Khok Samrong	12.5	maize, bean sorghum	1957	1961	1961-1963
Chumsaeng	1.1	maize, vegetables	1953	1961	..

consistent pattern. The most diversification in land use in this area, particularly within sixty kilometers of the Bangkok-Thon Buri Metropolitan area, involved temporary changes in land use in which road improvements were of only marginal importance.

Temporary changes in land use occurred most often in amphoe located within approximately sixty kilometers of Bangkok and Thon Buri. With the exception of amphoe Krathum Baen, the areal extent of these changes was small. More importantly, all changes in agricultural land use within this zone, excluding the permanent developments in amphoe Krathum Baen and Min Buri, can be directly related to a system of migrant gardening which exists throughout the lower central plain. This system flourishes in areas of high tenancy and requires intermittent rotation to new fields since prolonged use of one holding under current cropping practices produces rapid declines in yields.[1] The development of fruit and vegetable gardens in these amphoe have been almost exclusively initiated by non-resident gardeners and produce brokers, most of whom are of Chinese descent or have ties with the Chinese economic community. Possessing adequate knowledge of garden cropping techniques, access to capital and credit sources through formal or informal kin and economic ties, and prior experience with marketing procedures greatly enhanced their ability to invest in this type of agricultural activity. Thai

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[1] The primary crops grown on these garden holdings include watermelon (Citrullus vulgaris), sweet potato (Ipomoea batatas), white potato (Solanum tuberosum), cucumber (Cucumis sativas), beans (Vigna inguiculata), chili (Capiscum annum and Capiscum frutescens), kale (Cruciferae), pepper (Piper nigrum) and pumpkins and gourds (Cucurbita maxima).

wet-paddy farmers resident in these same areas were either unable financially and technologically or unwilling to make similar investments. The fact that road development had recently taken place in these areas was a consideration in almost all decisions to invest in garden cultivation, although not necessarily a prerequisite for such investments. The relationship of initial development of market gardens and periods of transitional road development are shown in Table 8 (see supra, p. 22-23). In several cases initial changes in land use occurred simultaneously with road development, although in others considerable time lags occurred. The absence of complete data, the insignificant levels of change, and several large temporal gaps between road development and initial conversion of fields suggests that this type of transport improvement has had only a marginal influence on diversification of agricultural land use patterns.

In amphoe Lat Bua Luang, not served by any road transport facilities, percentage changes in agricultural land use were of the same general magnitude as two road development areas and greater than six others. This amphoe has been a pivotal center for migrant gardening activities in recent years.[1] The most recent period of extensive cultivation by migrant gardeners occurred from 1961-1965. The absence of

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[1]Migrational vectors for migrant gardeners appear to originate from the southwestern edge of the central plain and extend to the north and east to amphoe Lat Bua Luang where they diverge to the east and south in changwat Pathumthani. Lat Bua Luang appears to be the northern perimeter of these movements in the area west of the Chaophraya River. To the east of the Chaophraya River, where road facilities are more developed, this type of cultivation extends into changwat Saraburi.

road transport facilities in no way appeared to inhibit the production and marketing of garden crops since water transport was easily accessible and maximum travel times to market of eight to ten hours did not jeopardize the realization of optimum market prices. In amphoe Lam Luk Ka, where the percentage change in land use was only 1.0 percent, Chinese market gardeners began cultivating watermelon and several types of squash and gourds in 1964, one year after improvements in road conditions took place. These gardeners consistently avoided the use of road transport to ship their produce preferring the slower and often more expensive water transport. The poor condition of the road and its limited utility even in the dry season caused frequent damage to produce shipped by truck and resulted in lower market prices and a loss of income. By 1968 only one resident Thai paddy farmer had converted some of his lands to garden holdings and poor road conditions, unreliable transport services, high shipment costs, and lack of investment capital or credit were indicated as primary reasons for the absence of similar investments by other wet-paddy farmers.

While road surfaces and transport conditions were recognized considerations in decisions to change land use in this area, several other economic, technological, and spatial factors appear to have been of equal or greater importance. These factors include: (1) the availability of capital resources; (2) technical knowledge and experience in cultivating market garden crops; (3) knowledge of and contacts with the principle sources of credit and capital for investment in market garden-

ing; (4) the high capital and labor inputs required to convert wet-paddy fields to more profitable forms of land use; (5) distance from major urban markets in Bangkok and Thon Buri; (6) availability of alternative forms of transportation; and (7) environmental conditions. The primacy of any one factor or set of factors varies with distance and environmental conditions. However, credit and capital availability seemed to be an essential pre-requisite in every amphoe studied.

The only instance of permanent changes in agricultural land use in the lower central plain occurred in amphoe Krathum Baen. While considerable expansion of areas devoted to non-paddy crops has occurred since 1960, five years after transitional road development took place, this diversification is primarily the result of (1) the continued development of existing patterns of non-paddy crop cultivation; (2) increasing land values precipitated by recent relocation of small industries from Bangkok and Thon Buri; and, (3) indigenous soil, irrigation, and hydrologic conditions more conducive to diversified farming than wet-paddy cultivation. Recent improvements in local and inter-changwat roads connecting this amphoe with Thon Buri have encouraged more diversification and development of garden cultivation. Much of this recent development has involved expansion of existing holdings by local gardeners with capital and credit incentives from produce dealers and wholesalers based in the fresh produce markets in Thon Buri and Bangkok.

The importance of road development in encouraging investments in diversification of agricultural land use has increased with distance from major urban market centers, and changes in environmental conditions. In transitional uplands, where waterway route densities are low, irrigation facilities are limited, rainfall and soil conditions are more conducive to cultivation of upland crops, and a greater variety in cropping alternatives exists, the improvement of road conditions facilitates the decision to diversify and expand agricultural cultivation patterns. Low land values and field conversion costs, relative to those in the wet paddy environment near Bangkok, enable farmers to grow maize, sorghum and beans which are increasingly in demand for export markets.[1] These commodities do not require rapid field to market shipment and do not depreciate greatly in value over time.

In amphoe Khok Samrong, located in a transitional upland area, scattered dry and wet rice cultivation interspersed with bamboo and scrub forest was the major form of agricultural land use as recently as 1958. A rapid expansion in maize cultivation began in 1957 and was continued, although at a slower rate, in 1968. The improvement of road transport conditions from 1961 to 1963 corresponds closely with the mean year of change in agricultural land use shown in Table 8.

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[1]Field conversion costs, exclusive of seedlings and seed, in the lower central plain range from 500 baht (U.S. $25.00) to 1,000 baht (U.S. $50.00) per rai with a mean of 800 baht (U.S. $40.00) per rai, while in Khok Samrong this cost is only 50 baht (U.S. $2.50) per rai.

These changes in land use were not initiated by local residents, but by immigrant farmers from adjoining amphoe and changwats (see infra, p. 214, Table 25). The strength of correlation between the expansion in maize cultivation and road development is supported by interviews with immigrant maize cultivators in this amphoe. The entire sample of farm households interviewed indicated that the availability of land and increased accessibility resulting from road development were important considerations in their decision to invest in maize cultivation. Road development under these conditions appears to be of considerably more importance in influencing decisions to invest in diversification of agricultural land use than in the more restrictive wet-paddy environment of the lower plain.[1]

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[1]In a recently completed econometric analysis of corn and kenaf supply response in Thailand several hypotheses were advanced to explain the shift in geographic concentration and expansion of corn production from the northeast to seven changwats in the central plain. This relocation of the primary center of corn cultivation was related to: (1) highway improvements resulting in reductions in marginal transport costs to Bangkok; (2) improved malarial control measures resulting in a lowering of the malarial death rate and opening of upland areas for cultivation; and (3) variations in soil characteristics. Unfortunately, the importance of road development in this change has been inadequately emphasized since only one road, the Friendship Highway from Saraburi to Korat, was considered. In reality several rather extensive construction and road improvement projects were in progress in these changwats prior to and during the years when the expansion of corn cultivation took place. Recent field investigations also indicated that these road improvements were important considerations in the increased cultivation and marketing of corn. (Jere R. Behrman, "The Adoption of New Products and of New Factors in Response to Market Incentives in Peasant Agriculture: An

Road development impact studies conducted in transitional uplands in Thailand and Sabah allude to the importance of environmental differences in conditioning the impact of road development.[1] In general these studies suggest that road development had more extensive influence on land use patterns and agricultural diversification in transitional uplands and uplands than in lowland wet-paddy environments. However, data from this study and related research in Thailand and Southeast Asia are not yet sufficiently comprehensive or comparative to allow more than presentation of partially substantiated hypotheses about this relationship.

The spatial distribution of farm units reporting changes in agricultural land use after road development took place provides one indication

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Econometric Investigation of Thai Corn and Kenaf Supply Responses in the Postwar Period," Discussion Paper No. 45, Department of Economics, University of Pennsylvania [Philadelphia: Wharton School of Finance and Commerce, February, 1967], pp. 7-12.)

[1]See, Great Britain, Ministry of Transport, Department of Scientific and Industrial Research, Road Research Laboratory, "The Relationship Between Road Building and Economic and Social Development in Sabah," by R.S.P. Bonney, III Pts., (Crowthorne Berks [Great Britain]: Road Research Laboratory, February, 1964) (hereinafter referred to as Great Britain, "Road Building in Sabah"); Nit Jittasatra, "Economic Effects of Village Roads in Northeast Thailand," (Bangkok: Southeast Asian Treaty Organization Graduate School of Engineering, 1967) (hereinafter referred to as Jittasatra, "Village Roads");Tasana Patanapanich, "Economic Effects of the East-West Highway," unpublished Master's thesis No. 62 (Bangkok: Southeast Asian Treaty Organization Graduate School of Engineering, 1964) (hereinafter referred to as Patanapanich, "East-West Highway"); and J.H. Jones, "Economic Benefits from Development Roads in Thailand," Technical Note No. 15 (Bangkok: Southeast Asian Treaty Organization Graduate School of Engineering, April 15, 1964) (hereinafter referred to as Jones, "Development Roads").

of the degree to which the influence of road development extends spatially from the developed route. Variations in these distributional patterns between amphoe also suggest ways in which the alignment and configuration of alternative transport routes may condition the impact of road development. The percentage distribution of farm units reporting changes in land use by distance of farm unit from the road or khlong is shown in Table 9. Among all farm units reporting changes in land use 65.6 percent were located adjacent to transport routes and over 87 percent within the first kilometer from these routes. This number includes both road development amphoe and those not served by road transport facilities. If this latter group of control amphoe are excluded, then, 60.7 percent of all farm units reporting changes in land use in road development areas are located adjacent to the road and 85.7 percent within one kilometer. The slight difference between these two sets of figures indicates the small number of changes in land use occurring in non-road development areas. The high concentration of farm units reporting changes in agricultural land use located along transport routes indicates the limited influence of road development spatially on land use patterns. The greater density of the waterway network in the lower plain provides convenient social and commercial access to interior farm units. The simple physical and cost difficulties related to utilization of developed roads by interior farm families for both social and commercial purposes has minimized the advantages of road development spatially. In contrast, the potentially lower transport, labor, and

TABLE 9

SPATIAL DISTRIBUTION OF FARM UNITS SURVEYED REPORTING CHANGES IN AGRICULTURAL LAND USE

Amphoe	% of Units Reporting				
	Road/khlong site	1 km	2 km	3 km	4 km
Bang Yai	100.0	..	..	..	..
Min Buri	75.0	25.0	..	..	..
Krathum Baen	50.0	35.7	14.3	..	..
Lam Luk Ka	91.0	9.0	..	..	..
Lat Bua Luang	100.0	..	..	..	..
Nong Sua	100.0	..	..	..	..
Muang Chachoengsao	100.0	..	..	..	..
Damnoen Saduak	..	100.0	..	..	..
Bang Khla	..	..	100.0	..	..
Tha Rua	..	..	..	..	..
Sam Chuk	100.0	..	..	..	..
Sanphaya	..	..	..	..	..
Khok Samrong	23.1	38.5	23.1	15.4	..
Chumsaeng	100.0	..	..	..	..
Mean all amphoe	65.6	21.9	9.4	3.1	..

convenience costs located adjacent to roads is primarily responsible for the pattern shown in Table 9.[1] The importance of existing alternative transport routes in minimizing the influence of road development spatially is emphasized by the distributional pattern in Table 9 for amphoe Khok Samrong. The absence of alternative water transport routes in

[1]The configuration of existing land holdings can also be a factor in this pattern. The dissection of individual holdings by a road produces conditions under which each holding may become separately operated and ultimately through the conversion of each holding to non-paddy land use double the impact of road improvements.

this amphoe and the relative ease of movement perpendicularly from the road have resulted in a more equal distribution of farm units reporting changes in land use.

The configuration and alignment of existing canal networks may facilitate or condition the spatial influence of road development. In three amphoe in the lower plain, Damnoen Saduak, Krathum Baen, and Bang Khla the interior canal system, exclusive of major through-routes, is well developed with many small, but annually navigable canals. In these amphoe there is more disparity in the spatial distribution of farm units reporting changes in land use than in amphoe with less extensive internal canal systems. These variations in distributional patterns suggest that where internal movement is relatively unrestricted and a point or points of contact with external road transport links exist, the spatial influence of road development may be much greater. In comparison, the spatial variations in distribution of farm units reporting changes in land use are much smaller in amphoe where major waterway networks are more geometric and lineated with few auxiliary canals.

The importance of contemporary road development in encouraging changes in agricultural land use must be considered in terms of numerous economic, technological, spatial, and environmental factors. No consistent determination of the variable impact of this type of transport development can be reached unless these factors are considered. Available evidence indicates that the influence of road development in stimulating changes in agricultural land use and diversification in cropping

patterns is more limited in lowland wet-paddy agricultural environments than in transitional upland and upland conditions. More beneficial and desirable permanent changes in land use are more closely associated with road improvements in upland environments than in the more restrictive wet-paddy environments of the lower central plain. The extensive inland waterway system in the lower central plain will continue to minimize the importance of road development for agricultural diversification until such time as the road transport network and facilities can provide functional and cost services more competitive with those of the inland waterway transport system.

Land Tenure

One of the characteristics of the agricultural economy of the central plain has been high levels of tenancy relative to other regions of the country. Full and mixed tenures are particularly common in the lower plain. Traditionally high levels of absentee landlordism, inadequate and unstable irrigation facilities, lack of tenant farmer security, and low farm incomes are a few of the factors associated with these high tenancy areas. The recent rapid growth of the Bangkok-Thon Buri Metropolitan area and related increases in land values and demand have reinforced an already inequitable land tenure system in the lower plain.

Land tenure in this region can be conveniently divided into three categories: full ownership; mixed tenures; and full tenancy. Mixed tenures are those in which the operator owns some of the land he culti-

vates and rents the remainder. The categories of tenure used in the 1963 Agricultural Census of Thailand were: owner, cash-renter; crop-renter; and other, but ambiguity in this classification limits its usefulness.[1]

A clear spatial pattern of tenure distribution by type is evident in the central plain. Figure 8 shows the mean tenure distribution by type of tenure for amphoe surveyed by distance from Bangkok and Thon Buri.[2] The definite upward trend in full ownership of holdings as distance from Bangkok and Thon Buri increases, and corresponding declines in land devoted to non-paddy crops and potential output value of agricultural holdings are consistent with predicted patterns based on rent theory.[3] The high levels of full tenancy within ninety kilometers of the Metropolitan area are related to the concentration of non-paddy crop cultivation to the north and west of Bangkok-Thon Buri and the

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[1]The Census definition of cash and crop-renter tenures indicated that all holdings in these categories were rented, but rent was paid in either cash or kind. Other tenures in addition to including squatting, homesteading, and land used rent free, also included holdings on which land was rented on a mixed cash and in-kind basis. The difficulty in trying to arrive at some estimate of total holdings under full tenancy is evident. The Census distribution for these tenure categories in the central plain was: owner-76.6 percent; cash and crop-renter-13.26 percent; and other-12.9 percent.

[2]The occurrence of types of tenures other than those shown in Figure were so small that they constituted an insignificant percentage of the total number of holdings sampled.

[3]The concept of Economic Rent and concentric zonation of agricultural land use around centers of consumption are explored in detail by Michael Chisholm, Rural Settlement and Land Use, An Essay in Location (London: Hutchinson and Co. (Publishers) Ltd., 1962); W. Isard, Location

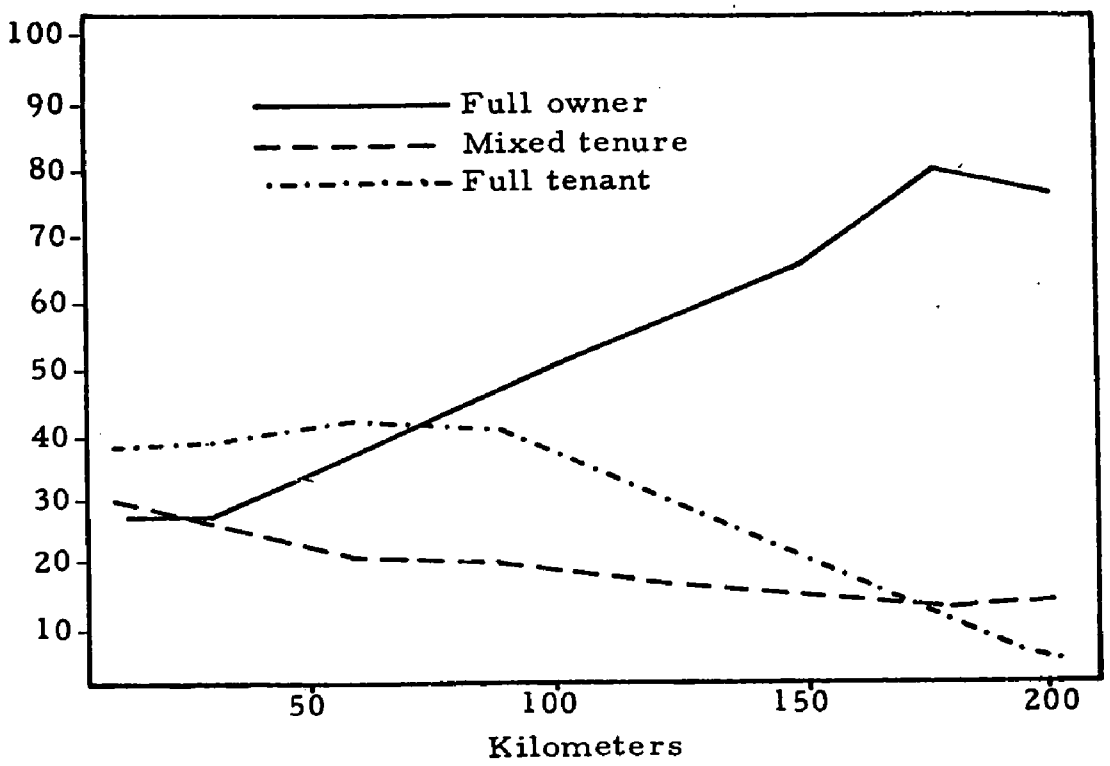

Fig. 8 -- Percentage Distribution of Tenure Categories in Selected Amphoe by Distance from Bangkok and Thon Buri

high frequency of absentee landlordism. From the percentage distribution of tenure categories within survey amphoe shown in Table 10 it is also apparent that the spatial extension of full tenancy is primarily due to the tenure patterns in amphoe Damnoen Saduak and Tha Rua.[1] Although the data from amphoe Tha Rua do tend to distort the spatial

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and Space Economy (New York: John Wiley & Sons, Inc. 1956); and August Losch, The Economies of Location, trans. by W.H. Woglom with the assistance of W.F. Stolper (New Haven: Yale University Press, 1954).

[1] Data for amphoe Tha Ruaare partially drawn from the area of the urban municipality in Tambon Tha Rua where the amphoe offices, market, railroad station and several commercial establishments are located. Many of these non-agricultural holdings are rented, particularly those in the fresh produce and general goods markets.

TABLE 10

DISTRIBUTION OF LAND TENURE CATEGORIES
IN SURVEY AMPHOE, 1966-1968

Amphoe of Survey	Tenure Categories (Percent of total)		
	Full Owner	Mixed Tenures	Full Tenancy
Bang Yai	35.3	35.3	29.4
Min Buri	33.3	21.4	45.3
Krathum Baen	20.6	31.0	44.0
Lam Luk Ka	27.1	7.1	65.8
Lat Bua Luang	50.0	28.6	21.4
Nong Sua	5.2	22.2	72.6
Muang Chachoengsao	..	..	..
Damnoen Saduak	44.4	0.0	55.6
Bang Khla	60.0	28.0	12.0
Tha Rua	30.4	13.1	56.5
Sam Chuk	..	..	..
Sanphaya	58.4	30.0	11.6
Khok Samrong	99.2	0.8	0.0
Chumsaeng	76.2	16.7	7.1

pattern of full tenancy the overall pattern is indicative of (1) the areal extent of high value, low bulk agricultural production under intensive land-use conditions, and (2) a definite westward distortion of production zones resulting from extensive agricultural production of fruit and vegetable crops in this area. The definite decline in mixed tenures spatially from Bangkok and Thon Buri reflects this lower demand for land and a decrease in the frequency of absentee landlordism.

The differential distribution of tenure categories in surveyed amphoe is an important factor in understanding spatial variations in land-use and the extent to which road development influences this pattern. In six of the fourteen survey amphoe full tenancy is the dominant type of land tenure. The spatial distribution of these areas is confined to a zone of ninety kilometers from the Bangkok-Thon Buri Metropolitan area. The two control areas, amphoe Bang Yai and amphoe Lat Bua Luang, are among the three amphoe having the lowest percentage of all tenures in full tenancy. By comparison, 60 percent of all road development areas within this zone have higher percentages of land in full tenancy than in any other category. This in itself is not of particular significance unless viewed in conjunction with existing land-use patterns and recent changes in land-use within these areas. Only two of the eight road development areas located within ninety kilometers of Bangkok and Thon Buri exhibited any noticeable change in land utilization following periods of road development. The temporary changes in land-use in amphoe Lam Luk Ka were almost entirely composed of migrant market gardening activities,

while those in amphoe Krathum Baen involved a permanent conversion of paddy and sugar cane fields by local residents. The differences in road development indices between Krathum Baen and Lam Luk Ka, 10.8 and 8.4_f respectively, may indicate that roads have had a differential impact due to variations in the nature of land-use change and quality of road surfaces. The significance of road development for land tenure patterns appears to be related to the quality of existing and improved road surfaces, distance from Bangkok and Thon Buri, and the types of change in agricultural land-use which occur within these areas of development.

The normally intense utilization of land around urban areas is often characterized by high tenancy rates. These conditions reflect the existence of absentee landlordism and intensive competition for land. The disproportionately higher tenancy rates in road development areas which might be anticipated, however, were not consistently present. Aside from existing transport conditions the variation in this pattern can be related to certain ecological and cultural factors.

The high levels of full tenancy in amphoe Nong Sua (see supra, p. 80, Table 10) are not due to any significant increase in market gardening, but are the result of historical land development programs. The construction of the Rangsit Irrigation system in the 1890's opened this area to extensive wet-paddy cultivation and resulted in most of the land being purchased by absentee landlords in Bangkok. Aside from previous difficulties in providing adequate and reliable irrigation facilities for

this area contemporary absentee landlords exhibit no interest in investing in land improvements nor do tenancy conditions encourage the tenant to do so. Only within the last year have the first indications of changes in agricultural land-use become evident. Non-resident landlords are usually not capable of assessing the extent of local land demand and consequently are unable to determine the potential income which might result from leasing or conversion of their paddy holdings to more profitable forms of use.[1] The existence of similar conditions in amphoe Min Buri is further complicated by attitudes of the resident Thai Moslem population. A significant number of Thai Moslem households are located within the road development area and residents engage primarily in wet-paddy farming and operation of small, local rice mills. Interviews with residents of these households frequently revealed a reluctance toward leasing holdings, particularly fields adjacent to the road, which might be utilized for purposes other than wet-paddy cultivation. Although studies of a nearby community indicate no apparent hostility between resident ethnic or religious groups, the attitudes of many Moslem households towards leasing agricultural holdings whether in response to increased demand for land following road development or out of concern

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[1]Resident landlords usually acknowledge the advantages of converting paddy fields to more profitable fruit and vegetable cultivation. They prefer to lease their fields to gardeners since they enjoy several benefits: (1) rent per rai is three to five times that gained from paddy field rental; (2) direct improvement in soil quality through the nutrient exchanges from fruit and vegetable crops and fertilizer inputs of the gardener; (3) initially high paddy yields per unit area once the fields have been converted back to wet-paddy, especially following melon; and (4) improved marketing contacts with external produce dealers and wholesalers.

that leased lands would be used more profitably by Chinese market gardeners were generally negative.[1] Unfortunately, limitations on interview depth and structure preclude any analysis of the broader implications of this situation.

The large percentage of holdings under full tenancy in amphoe Damnoen Saduak is a reflection of historical settlement patterns, the dominance of gardening by Chinese, and the pivotal location of this amphoe in terms of migrant market gardening in the lower plain. In amphoe Khok Samrong almost 100 percent of all holdings are owned and operated by resident farmers. This fact reflects the very low demand for land in this area and the unlimited supply because of the recent opening of the area for cultivation.

Under the existing patterns of varying intensity of land utilization and demand within the central plain, road development exerts little impact on land tenure. The impact of road development on agricultural land-use and tenure patterns appears to be confined to a distance of ninety kilometers from the major market centers in Bangkok and Thon Buri. The extent to which improved road transport facilities influence land tenure conditions within this zone is dependent upon (1) local cropping patterns, (2) distance from major market centers, (3) potentially

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[1]See Herbert P. Phillips, Thai Peasant Personality. The Patterning of Interpersonal Behavior in the Village of Bang Chan (Berkeley: University of California Press, 1965); Kamol Odd Janlekha, A Study of the Economy of a Rice Growing Village in Central Thailand (Bangkok: Ministry of Agriculture, 1957).

higher incomes through better market prices and savings in transport and handling costs, (4) the financial and technological ability of farmers for self-improvement, and (5) the continued existence of historical and cultural factors which inhibit changes in land use and tenure patterns. Ultimately, however, the most crucial factor must be the ability of cultivators to breach the rigid tenure system through economic and technological improvements in his status.

Rural Land Values

Land value is one of the most responsive factors in the rural agricultural economy to alterations in local transport conditions. The dynamic response of land values to changes in transport conditions is in part a reflection of improvements in accessibility and increased economic potential of holdings. A second component of land value is location which is most often interpreted in terms of social convenience and prestige. Evaluation of land holdings and the relative weighting of both social and economic components of land value by land owners, investors, and tenants is an important relationship in understanding the impact of road development.

The basic social component of agricultural lands is represented by the houselot or farmstead. The physical condition of the farm lot, buildings, and garden plot, and the inherent advantages of having the h ouselot located on the farm and adjacent to major transport routes are important aspects of thc social component of land values. The economic

component of land value is generally considered in terms of the capitalized inputs of production (investment) and the potential output value (return) of the land. Aside from agricultural economic value the land may also have potential industrial and commercial value of a much higher magnitude than any derived from agricultural inputs. These two basic components may and often do respond differently in evaluation to changes in local transport conditions.

Evaluation of the real and potential value of rural agricultural lands may be obtained in two different ways. The tax assessed value is legally ascertained every three years although in reality this is seldom done. The infrequency of land assessment leads to an inaccurate tax structure which does not represent actual value. Normally the tax assessed value is 30 to 50 percent lower than the actual market value. Market price is therefore a much more accurate measure of real land values. Market values are more representative of the functional and locational aspects of individual parcels of land than are tax assessed values and are therefore considered to be a more accurate measure of real land value.

The Thai farmer is normally quite capable of making accurate evaluations of the social and prestige aspects of field location as opposed to the economic value of agricultural holdings. He is aware, for example, of the social and prestige advantages of having the house-lot and gardens located on or adjoining his agricultural holdings. Similarly, the size and condition of buildings, gardens, and other structures,

access to inter-district transport routes and routes frequented by local vendors and tradesmen, the relationship of his holdings to neighboring houses, the local village, and Buddhist wat (temple) are all evaluated accordingly. The attributing of higher values to houselots and gardens than to paddy fields even though they may be contiguous is due to the importance of these social and cultural factors.

Lowlands which are subject to flooding in the wet weason or are improperly drained during dry weather are given a lower value than holdings with better physical characteristics. Bamboo forest and scrub land is considered as undeveloped land until there is an indication that improvements will be made or actual improvements are made. Lower values are given to land if drainage patterns and accessibility are disrupted through road development. On numerous occasions it was observed that paddy farmers would put a higher value on one of two apparently identical holdings. Their valuation was based on assessment of such factors as the tenants ethnic group or reputation. The implicit relationship here is one of recognizing not land potential, but superior technological ability. For example Chinese farmers have the reputation of being expert gardeners. Where basic physical potential of the fields was equal, the potentially superior physical and economic inputs of the Chinese gardener were considered to provide greater economic output and thus increase the value of the land. All of these real and intangible factors are inherent in the following assessments of market values of agricultural land.

Change in land values related to improvements or deterioration in transport conditions frequently antedated actual periods of change.[1] This response to impending changes is usually the result of speculation, occasionally based on access to privileged information. The latter is more true in relation to highway development plans entailing the use of large tracts of land. Increases in land values following road development are particularly high in areas of severe agricultural and commercial marketing competition.

The frequency of antedated changes in land values related to road development can be seen in the graphs in Appendix IV, for each amphoe studied. In six of the twelve study amphoe land values began to increase prior to or commensurate with periods of road development. In two cases, amphoe Lam Luk Ka and amphoe Nong Sua, a definite time lag occurred between road development and initial changes in land values. In both cases poor road conditions and the prevalence of absentee landlordism may have contributed to this lag. A somewhat shorter lag in response occurred in four other areas, all within sixty kilometers of Bangkok and Thon Buri. Although no apparent spatial pattern is evident

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[1]Both Jittasatra and Patanapanich report significant changes in land values antedating road development in their studies of the Khon Khaen-Yang Talad Feeder road and the East West Highway respectively. In both areas completely new roads were being built in transitional uplands and uplands. Patanapanich also notes that significant increases in land values occurred commencing with the inauguration of the highway. (see, Patanapanich, "East-West Highway," and Nit Jittasatra, "Economic Effects of the Khon Kaen-Yang Talad Feeder Road in Northeast Thailand," unpublished Master's thesis No. 164, Southeast Asian Treaty Organization Graduate School ofEngineering, Bangkok, 1967 [Hereinafter referred to as Jittasatra, "Khon Kaen-Yang Talad"].)

here these areas do fall within a zone of high tenancy and absentee landlordism where changes in land-use may have come more slowly.

The correlation between percentage increase in land values and changes in road conditions is quite marked. The trends in land values and road development indices clearly suggest a cause and effect relationship. This is demonstrated in the differential increase in land values in relation to changes in the road development index. The data in Figure 9 show the relative rates of increase in land values superimposed on the road development index. In every case, with one exception, the percentage increase in land values is greater when transitional changes in road transport conditions occurred (see supra p.22). The average percentage increase in land values of all road development areas during periods of transitional road development was 433 percent, while the average increase for these same areas during periods of non-transitional development was only ninety-one percent. By comparison the mean percentage increase in land values in the control areas over similar time periods was only ninety-seven percent.[1] An indication of the differential impact of road development on land values in wet-rice agricultural environments and upland areas can be seen by comparing these values with those obtained by Jittasatra and Patanapanich. Along the Khon Kaen-Yang Talad feeder road Jittasatra found that the range of increases in land values between pre- and post road development

[1]Percentage increases in land values for control sites were: Lat Bua Luang, 80.8 percent for the period 1961 to 1967, and 114 percent in Bang Yai for the period 1959 to 1967.

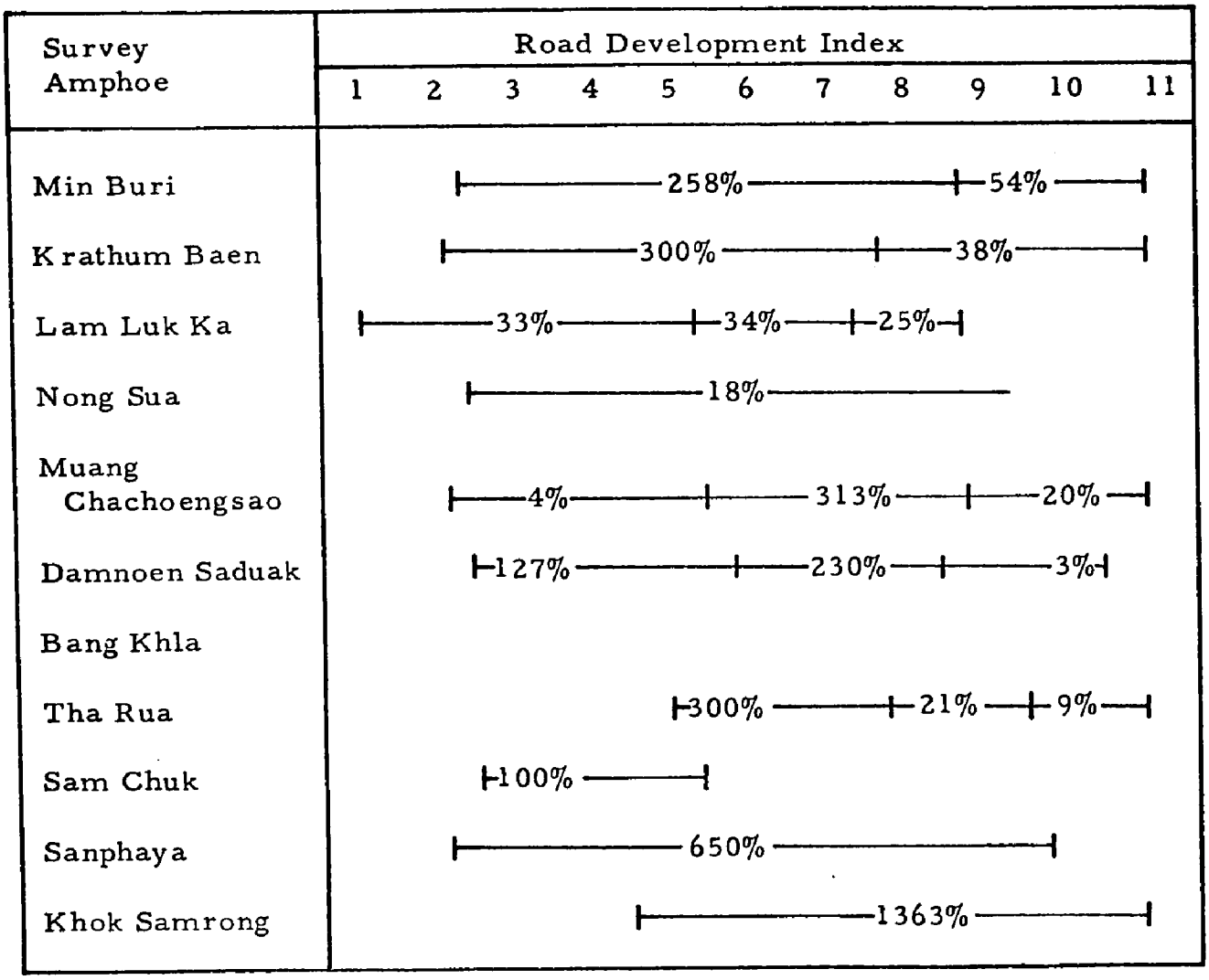

Fig. 9 -- Mean Percentage Increase in Roadside Land Values in Relation to Changes in the Road Development Index.

periods was 300-1200 percent.[1] Increases in agricultural land value ranged from 300-600 percent with a median of 400 percent, while the range for residential lands was from 300-1200 percent with a median of 500 percent.[2] Patanapanich found similar differentials along the East-West Highway; overall range of 75-5300 percent, residential lands from

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[1] Jittasatra, "Khon Kaen-Yang Talad," pp. 68-69.

[2] Ibid.

160-600 percent, and agricultural lands from 75-400 percent with a median of 350 percent.[1] The high percentage increase in land values in amphoe Khok Samrong, 1363 percent, accompanying a transitional change in the road development index is similar to what has been reported by Jittasatra and Patanapanich. The nature of land value differentials in this transitional upland area on the northeastern edge of the central plain is again indicative of differential responses to road development in different environmental zones.

Several conclusions are immediately evident from a comparison of these three sets of data. Road development in upland areas where cultivation is more extensive than intensive, land pressure is low, and transport facilities are limited induces a greater increase in land values between pre- and post-road development periods than in lowland wet-rice cultivating areas. When improvement in road transport within the central plain does not produce a sufficient reduction in production and transport costs to present a more favorable alternative to existing water transport, the impact of this improvement on land values will be limited. The impact of road development on land values is relative to its real and potential ability to reduce production and marketing costs within the highly competitive and intensive system of land utilization in the central plain. Any development of roads in upland areas contributes to a reduction in production and marketing costs because no alternative

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[1]Patanapanich, "East-West Highway," p. 51.

means of transport exists. The data in Figure 9 strongly suggest that road development exerts an optimum influence on reducing production and marketing costs and increasing land values when it improves transport conditions from seasonal to all-weather. The greater percentage increases in land values within amphoe where transitional road development has occurred underscores this relationship. The smaller increases in land values occurring near the right side of the continuum suggest that additions of asphalt, asphaltic concrete, macadam, and other all-weather surfaces to roads do not result in as large increases in value as occur from transitional road development.[1] These smaller increases are also probably due to the antedated increase in land values resulting from the assumed improvement in road surfaces.

The differential spatial impact of road development upon land values within survey amphoe is characterized by a marked decrease in value within the first kilometer from the road. The cross-sectional profiles of land values in survey amphoe are contained in Appendix IV. The percentage change in values spatially from the developed road at one kilometer intervals is shown in Table 11. A percentage decrease in land values of 30 percent or more within the first kilometer from

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[1]The relationship between road surface and land values, and agricultural development in general is not confined to Thailand alone. The correlation between transitional improvements in roads from dirt surfaces to some all-weather surface and levels of agricultural development has been demonstrated in studies conducted in Sabah and the Philippines. (See Great Britain, "Road Building in Sabah," Pt. I; and Fabian A. Tiongson, "Improved Merchandising of Selected Farm Products in the Philippines," (unpublished Ph. D. dissertation, Cornell University, 1962).

TABLE 11

MEAN PERCENTAGE CHANGE IN LAND VALUES SPATIALLY FROM TRANSPORT ROUTES IN SURVEY AMPHOE

Survey Amphoe	Distance from transport route in kilometers			
	1	2	3	4
Bang Yai	- 9%	-60%	..	..
Min Buri	-63	-54	-17	..
Krathum Baen	-85	+33	-33	..
Lam Luk Ka	-64	- 7	-29	..
Lat Bua Luang	-30	-17	..	..
Nong Sua	..	-66	..	..
Muang Chachoengsao	-34	-51	-42	..
Damnoen Saduak	-76	+40	+30	+10
Bang Khla	-73	-10	-17	..
Tha Rua	-70	-23	-13	..
Sam Chuk	-62	..	..	+20
Sanphaya	-78	-10	-11	..
Khok Samrong	- 4	- 4	..	..
Chumsaeng	+250	-80	-17	..

the road occurred in all but four areas. Two of these four amphoe were control areas and were located within sixty kilometers of Bangkok and Thon Buri. The absence of any measurable change in land values in the first kilometer in amphoe Nong Sua is due to the rectangular configuration of fields extending laterally between vertical khlongs and demarcation of field boundaries after one and one-half kilometers from the road. The noticeably lower percentage changes in land values within this first kilometer in the two control areas is an indication of the important influence roads have on land values. The very small decrease in

land values in amphoe Khok Samrong reflects the greater overall mobility in transitional uplands and variable drainage rates which tend to minimize the spatial differential in land values.[1] In Chumsaeng the increase of 250 percent in land values within the first kilometer from the transport route is related to the existence of a rail line which parallels the river at a distance of approximately one kilometer. Land bordering the rail line has been officially designated as 1st class land which carries a higher assessed and market value than more distant holdings.

The maximum spatial extent of road development influence on land values is variable, but rather consistently falls within a distance of four kilometers from the road.[2] The general absence of any percentage changes in land values between three and four kilometers from the transport route would suggest that a distance of four kilometers is the normal spatial extent of road development impact on land values. The notable

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[1]Land located east of the road is higher in elevation than most holdings found on the west andis less subject to seasonal flooding and poor drainage. These conditions produce occasionally higher market values of 20-50 baht (U.S. $1.00-2.50) per rai over the fields located to the west of the road, however this cost differential is minimal on holdings located over two kilometers east of the road.

[2]No effective spatial parameter of road development impact has been determined. Jones and Orr have utilized a distance of four kilometers in their study of village roads in northeastern Thailand while Bonney acknowledges the decreasing facility of roads with distance but finds no obvious break in response patterns spatially. (John H. Jones and Jerry A. Orr, "Exploratory Study of Economic Effects of Selected Village Roads in Northeast Thailand," Technical Note No. 25 [Bangkok: Southeast Asian Treaty Organization Graduate School of Engineering, June 20, 1966] p. 4 [Hereinafter referred to as Jones and Orr, "Exploratory Study"] and Great Britain, "Road Building in Sabah," III pt., p. 5).

exceptions to this pattern in amphoe Krathum Baen, amphoe Damnoen Saduak, and amphoe Sam Chuk result from the influence of alternative transport routes, variations and disruptions in drainage patterns, and the existence of irrigation canals. In each amphoe individual or multiple combinations of these factors have sufficiently improved the value of agricultural holdings to produce a corresponding increase in land values.

The existence of alternative transport routes juxtaposed to or parallel with developed roads has a varied influence on the pattern of land values evolving with road development. Because of the rather complex transport network in the lower Chaophraya River delta it is common to find a high degree of interconnectivity between road and water transport systems and numerous parallel route segments. Under these conditions when the distance between parallel routes is under one kilometer, uniform changes in land values occur in the area between the two routes. The land value profiles for amphoe Sam Chuk, Nong Sua, and Muang Chachoengsao in Appendix IV provide several examples of this uniformity in land values. Another aspect of the juxtaposition of land and water transport routes is the frequent increase in land values along the side of the secondary route closest to the road. This occurs more often in areas where the two transport routes are separated by more than one kilometer. Increasing land values under these conditions vary in relation to the size and function of the secondary route, existence of other alternative transport routes near the secondary route,

local land-use patterns, location and size of the nearest market, and a wide range of socio-cultural factors. A considerable differential in land values on opposite sides of canals may exist if transport, marketing, and general factors of production are concentrated along only one side of the canal.

Almost every road in the central plain is paralleled by a small canal of seemingly marginal value. Usually these canals are the result of excavation to raise the level of the road bed. They are frequently dry or so shallow during low water periods that they are unnavigable. These small canals hold an important position in the physical and economic mechanism which influences land values. The development of roads often imposes severe restrictions on the farmer in terms of the natural irrigation and drainage system related to the annual flooding of the central plain. Road development often produces an artificial barrier to the natural flow of irrigation and drainage waters. Unless corrective steps are taken the farmers' fields will receive too much water or too little and will drain too quickly or slowly. The result is often a marked decrease in productivity and a lowering of land values. These conditions occurred in amphoe Min Buri, Muang Chachoengsao, Nong Sua, and Chumsaeng. The most widespread damage occurred in amphoe Chumsaeng where a local intra-amphoe road was built several years ago. The limited access, dry season road was built sufficiently high above existing paddy fields to act as dike during flood season and flooded out several annual crops. Land values dropped and several families moved to fields located further from the road.

The physical roadbed is normally raised above surrounding fields. Aside from the disruption of natural irrigation and drainage mechanisms it can also cause problems for marketing and local transport patterns. Obstructions in paddy field canals caused by road development have produced hardship for the farmer in the collection and transport of his grain for milling or sale. Highway Department regulations often prohibit farmers from cleaning and maintaining the navigability of small canals paralleling roads and thereby insuring their rapid siltation. Once these canals have become too shallow for small local boats or barges the farmer is often unable to selectively ship his grain to market or to a rice mill for milling. In areas where the majority of paddy collection and shipment is done by boat this has had a considerable impact on local trade and marketing patterns, and indirectly been reflected in a reduction in the social component of agricultural land value.

The impact of road development upon agricultural land values is variable and reflects the interrelationship of spatial, economic, social, and environmental variables. The effect of road development in the central plain has resulted in (1) a consistently large percentage change in land values occurring within the first kilometer from the road, (2) a stabilization of minimum land values at approximately four kilometers from the road, (3) the greatest increase in land values during periods of transitional road development, (4) an apparent environmental differential in the influence of road development on land values, and (5) an

evident difference in the influence of land and water transport routes on land values.

Agricultural Technology

The Thai farmers' acceptance and utilization of various "modern" factors of agricultural production is conditioned by a variety of cultural, social, economic, and even psychological variables. The absence of adequate financial resources, educational background, technical ability, a distributional system, and psychological problems in adopting new techniques or equipment condition the acceptance or rejection of most modern agricultural technology. Apart from the complex problems of isolating and understanding the factors which inhibit the acceptance of new technology are the vectors through which these new methods become introduced and available to the farmer. In most cases these vectors are directly responsive to changes in the speed and capacity of transport systems.

Agricultural improvement in central Thailand has been accomplished in several ways. The rural merchant-broker provides the primary source of information about new or improved methods of production. The government does provide some educational and informational services to farmers, but has been relatively ineffective in reaching the majority of farm operators.[1] Commercial producers and distributors of machinery,

[1]In 1968 the Ministry of Agriculture announced the formation of a new division within the Ministry devoted primarily to agricultural extension work. Prior to the establishment of this new division the authority

seed, fertilizers and insecticides also engage in limited programs of education aimed at improving the techniques of the farmer while increasing the sales of their products. In terms of contact and dissemination of information the rural merchant-broker and inter-personal relations between producers and their kinsmen are the two most effective mechanisms. The principal disadvantage of these two channels of information dissemination is often the lack of required technical and practical knowledge.

Based on a sample of 191 agricultural households and eighty-three merchants, brokers, and produce dealers in the central plain, Table 12 shows sources of acquired or suggested knowledge about the use of chemical fertilizer and insecticides.

Information obtained from government officials was primarily restricted to officials at the amphoe level and below. This group also includes the puyai ban who is a locally elected official and the villagers' most direct contact with the government.[1] The puyai ban is in most areas an important vector for dissemination of information at the mu ban level. Cooperative organizations include both official and ad-hoc groups formed by local residents.

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and activities of agencies concerned with extension work had been ineffective. (A recent survey of Asian agriculture indicates that the inadequacy of educational and informational processes in many nations has been a hindrance to agricultural development and adoption of new technology. P.K. Mukherjee, "Role of Rural Institutions in Asian Agricultural Development," in Asian Development Bank, Asian Agricultural Survey [Seattle: University of Washington Press, 1969], pp. 601-634.)

[1]The puyai ban is the locally elected headman for a hamlet which is the lowest government administrative unit.

TABLE 12

SOURCES OF INFORMATION ABOUT CHEMICAL FERTILIZER AND INSECTICIDE USE ON SELECTED FARMS

Source of Information	Chemical Fertilizer (% reporting)	Insecticide (% reporting)
Radio Broadcasts	2.7	2.4
Printed advertising and directions in the product	26.1	27.1
Demonstrations by commercial firms	4.7	1.1
Friends, neighbors, kinsmen	32.2	25.8
Merchants, produce dealers, rice millers	17.5	12.9
Government officials	6.0	18.8
Co-operative organizations	2.0	8.2
Other	8.8	3.7

It is initially apparent from the table that the groups or individuals with whom the farmer has the most consistent economic and social relations are also the ones responsible for almost 50 percent of his knowledge about chemical fertilizers and over 39 percent of his information about insecticides. This pattern is not unusual considering the normally close economic and social bonds which exist between the farmer and local merchants, produce dealers, and rice-millers. The traditionally strong debt-credit relationship between the farmer and the local merchant make this group a logical source for information about

new techniques and for the actual inputs themselves. The broker or merchant is continually aware of the economic advantages for him in inputs designed to improve production. The rural broker-merchant is normally aware of a range of commercially prepared fertilizers and insecticides and has direct contact with sales agents and distribution outlets locally and in Bangkok.

The rather frequent statement that new fertilizers or insecticides were first tried in response to advertising and enclosures in the product is somewhat misleading. This source of information would suggest that the farmer had some prior knowledge of the product and that its method of application was obtained from the enclosed brochure or instructions. It is more likely that the original source of information came from friends, relatives or merchants who suggested that fertilizer or insecticides should be used. In very few instances were pamphlets or commercial advertising brochures observed in rural areas.

The radio, newspaper advertising, and government officials accounted for only a small percentage of the total. This is a reflection of the lack of any comprehensive government program and a general absence of locally generated initiative. In the past five years there has been, however, a somewhat more active interest by amphoe officials, kamnan, and puyai ban in disseminating insecticides, fertilizers, and information about their proper use.[1] This is particularly reflected by the increasing

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[1]The kamnan is a supervisory official for a tambon which contains an average of ten villages. (Discussions of the psychological, economic, and social problems related to dissemination and adoption of new technology

percentage of farmers reporting government officials as the source of this type of information. In many amphoe the government provides insecticides to the farmer free of charge on a trial basis and occasionally during years of heavy insect attack the amphoe will make insecticides available to farmers without obligation.[1] The purchase and resale of bulk lots of fertilizer by local farmers co-operatives is a common function of these groups. In amphoe Min Buri, Bang Yai, Bang Khla, Sanphaya, Lat Bua Luang, and Damnoen Saduak amphoe officials have been active in the distribution of information and limited quantities of fertilizers and insecticides.

The vectors for introduction of innovative technology to the farmer showed no clear spatial patterns within the central plain. The use of field demonstrations of fertilizers by commercial firms was apparently limited to a distance of approximately one hundred kilometers from Bangkok and Thon Buri. One facet of this pattern is of some importance in assessing the impact of road development on the rural economy. A definite difference exists between the number of reported sources of information about new techniques between road development areas and control

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in Southeast Asia are contained in Vu Quoc Thuc, ed. Social Research and Problems of Rural Development in South-East Asia [Paris: UNESCO, 1963]).

[1]Farmers in amphoe Sanphaya indicated that in recent years when pests became prevalent the amphoe and changwat officials provided them with free quantities of insecticide. In amphoe Min Buri the local officials distribute sample bags of fertilizer and insecticide and additional supplies were available at the amphoe office. Bulk lots of fertilizer were purchased by officials in amphoe Thanyaburi, changwat Pathum Thani and distributed at cost to interested farmers, a practice becoming increasingly common in the central plain.

areas. Road development areas had some thirty percent more sources of innovative inputs than did control areas. The main methods of information dissemination within control areas were those associated with word-of-mouth transmission of information among friends and kinsmen. No farmer reported local officials distributing information or insecticides and fertilizer in either control area. The range of contacts among the merchant, produce dealer, and broker community was also significantly smaller than in road development areas. These patterns suggest that inadequate internal and external communications serve to limit the introduction of new technology. The high costs of fertilizers, particularly when internal distribution systems are undeveloped and the anticipated high yields are not realized, discourage their adoption.

Road development and the utilization of agricultural technology.

The availability and ultimate adoption by farmers of various new factors of production has been greatly accelerated by the improvement of road transport conditions. Although the informational process is particularly important in acquainting the farmer with these products and their value, the inadequacy of distributional systems and transport facilities has often limited or retarded their adoption. The availability and distribution of commercially prepared chemical fertilizer is an appropriate example of the importance of transportation in the introduction of new agricultural techniques.

The importation of commercially prepared chemical fertilizer into Thailand has shown a considerable increase within the last fifteen years. In 1950 the total fertilizer imports amounted to 9,354 metric tons, less than twelve percent of the total imports of 1964. The mean annual percentage increase in fertilizer imports over this period has been 23.4 percent. This rapid growth in fertilizer imports is evident in Figure 10. Commercial fertilizer imports are handled completely by private concerns, the three largest of which are Bara-Windsor Co., Ltd., Yip-in-Tsoi and Co. Ltd., and U.S. Summit Co. Ltd. The Bara-Windsor Co. Ltd. is the largest in terms of both volume imported and amount distributed.[1] Most fertilizer imports are stored in godowns in Bangkok until distributed to up-country dealers. Import taxes, storage charges, and transport costs are relatively high and much of these costs are passed on to the farmer.

The high price which the farmer pays is partially the result of farmer preference and product identification. The 100 kilogram paper bags of imported fertilizer are discarded and the product transferred to jute bags with polyethylene liners before it is distributed to dealers and agents throughout the country. There are two reasons for this procedure: (1) farmers prefer to buy fertilizer in jute bags since they can then use these bags to sack their paddy after harvest, and (2) this rebagging process

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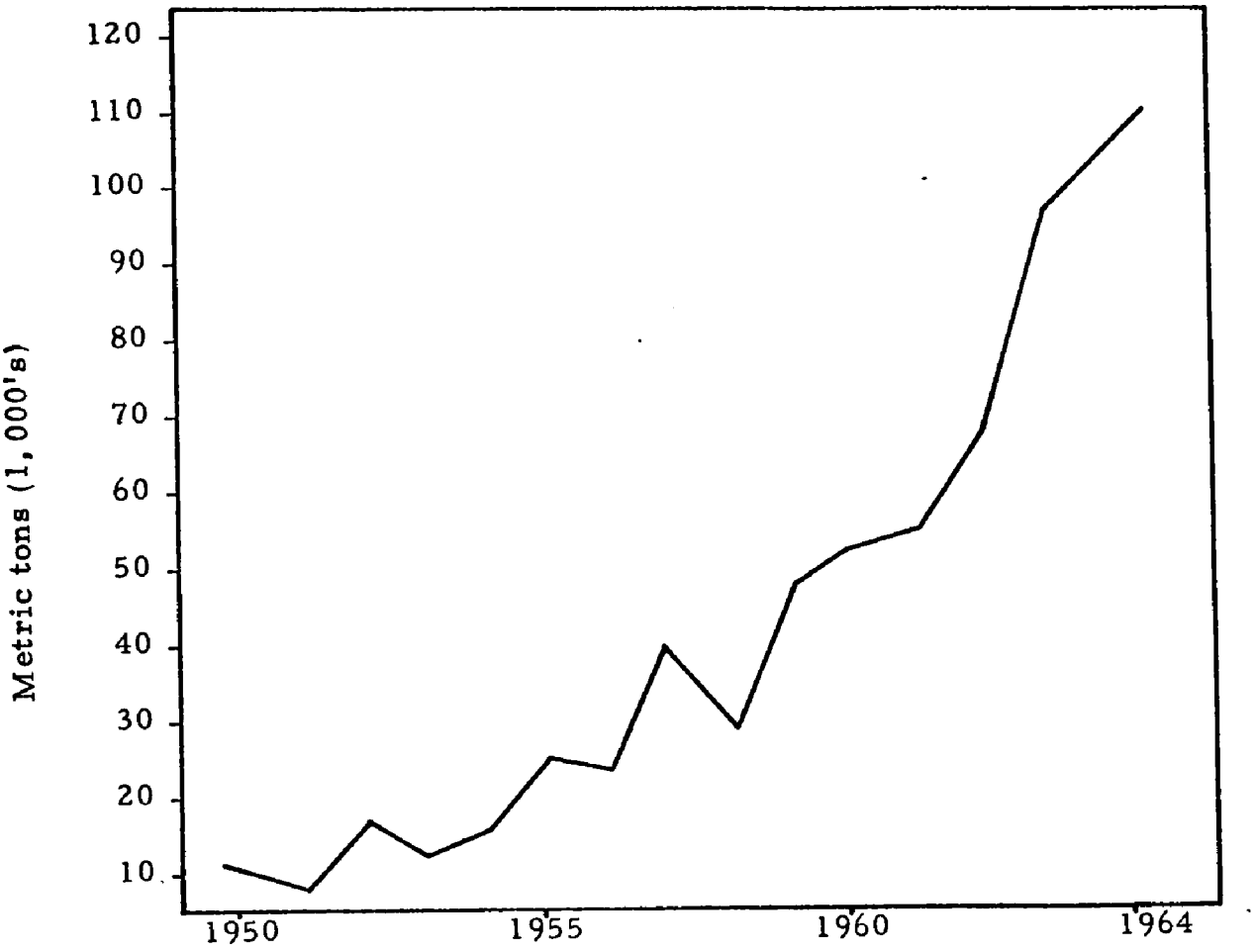
[1]U.S., USOM/AID-Thailand, "A Report on the Thailand Fertilizer Situation and Potential," by B.J. Bond, T.J. Kelso, and R.O. Woodward. (Bangkok: AID-Thailand, 1966) p. 44.(Hereinafter referred to as USOM/AID-Thailand, "Fertilizer Situation.")

Fig. 10 --Thailand: Total Fertilizer Imports by Year, 1950-1964 (metric tons)[a]



[a]Calculated from: U.S., USOM/AID-Thailand, "A Report on the Thailand Fertilizer Situation and Potential," by B. J. Bond, T. J. Kelso, and R. O. Woodward, (Bangkok: AID-Thailand, 1966) p. 133.

is done to encourage product identification through a brand name. The local distributors of fertilizer essentially sell the same product and therefore rebagging the fertilizer in their own bags under different names allows them to sell it at substantially different prices. This cost is approximately 180 baht (US $9.00) per ton, including the jute bags,

polyethylene liners and labor. This additional cost is then added to the variable market prices which farmers must pay, raising the import price by about 18 baht (US $0.90) per 100 kilogram sack.[1]

The distribution system for fertilizer is characterized by a definite division between importer-distributer and the local dealer. Once the fertilizer has been distributed to local dealers the only link which exists between the two is the credit bond which ties the dealer to the distributor. The absence of any consistent credit ratings among dealers is a strong deterrent to the expansion of fertilizer marketing.[2] The average rural fertilizer dealer is normally a small merchant, produce dealer, or even farmer who operates a multi-faceted retail and wholesale business. Aside from retail and wholesale dealings in fertilizer he may lend money, operate as a broker for agricultural produce, consumer goods, local whiskey, cigarettes, and other products. These local dealers usually buy fertilizer on credit and use land deeds, bank notes, or his personal reputation and credit standing as collateral. Since these rural merchants are also the primary source of credit, daily consumer goods, and outlets for farm produce they enjoy a favorable position. Although most dealers lack storage facilities for fertilizer and some delays in delivery may occur they normally deal in small enough volumes so that these conditions do not cause serious problems.

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[1] Ibid., p. 47.

[2] Ibid., pp. 50-52.

The percentage utilization of chemical fertilizer, insecticide, and selected types of farm equipment on sampled farm holdings is shown in Table 13. With the exception of two amphoe the use of chemical fertilizer is quite high among all farmers interviewed. The data do suggest, however, that there is a definite decline in chemical fertilizer use spatially from Bangkok and Thon Buri (see infra pp. 117-8, and Fig. 11, p.119). The application of organic manures: bat guano, duck droppings, and animal dung, is not reflected in the table. These types of fertilizers are used widley in amphoe Bang Khla, Krathum Baen, and Damnoen Saduak where there are extensive fruit and vegetable gardens.[1] Qualitative data based on field observations indicate that the use of this type of fertilizer increased considerably following improvements in road conditions. These transport improvements have facilitated increases in both amounts of organic manures handled by local dealers and the volume of organic manure being shipped by truck.[2]

A determination of the degree of correlation between the use of chemical fertilizers and changes in road transport conditions is difficult. The absence of adequate data indicating the extent of internal distribution

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[1]The 1963 Agricultural Census indicates that the use of "Other Fertilizers," presumably organic manures, in the provinces in which these districts are located is significantly greater than the 12.5 percent mean for the whole central plain. The Census does include a separate category for chemical and soil dressing.

[2]Organic fertilizer dealers in amphoe Damnoen Saduak, Bang Khla, and Muang Chachoengsao stated that the availability of organic fertilizers had increased considerably in recent years due to improved road transport. The dealer in amphoe Damnoen Saduak indicated that the volume handled and his storage space had both increased and that earlier shipments by boat were being replaced by direct truck shipment from dealers in Bangkok and as far away as changwat Nakhon Sawan.

TABLE 13

UTILIZATION OF CHEMICAL FERTILIZER, INSECTICIDE, AND SELECTED FARM MACHINERY ON AGRICULTURAL HOLDINGS IN SURVEY AMPHOE, 1967-1968[a]

Survey Amphoe	Percentage of sampled holdings				
	Chemical Fertilizer	Insecticide	Gasoline Water Pumps	Hang-yao Water Pump[b]	Tractor
Bang Yai	100.0	88.0	82.3	35.2	..
Min Buri	78.9	15.7	35.3	17.6	..
Krathum Baen	76.5	64.7	64.7	11.8	..
Lam Luk Ka	100.0	38.8	71.4	19.0	4.8
Lat Bua Luang	71.0	61.4	35.7	38.6	..
Nong Sua	100.0	12.5	50.0	12.5	..
Muang Chachoengsao	85.7	35.7	73.3	46.6	..
Damnoen Saduak	95.6	70.8	75.0	16.6	..
Bang Khla	82.0	47.0	11.8	35.3	..
Tha Rua	75.0	66.0	33.3	..	..
Sam Chuk	100.0	33.0	50.0	..	..
Sanphaya	75.0	75.0	..	..	..
Khok Samrong	16.6	50.0	..	..	25.0
Chumsaeng	16.6	100.0	16.0	33.0	..
Mean: Central Plain[c]	12.7	..	24.0		14.2

[a]Utilization of machinery refers to ownership of these items.

[b]The Hang-yao pump is a dual purpose boat engine and irrigation pump. The normal six foot propeller shaft enables it to serve as a boat engine for small boats and attachment of a siphon tube converts it to an irrigation pump.

[c]Thailand, Office of the Prime Minister, National Statistical Office, Census of Agriculture, 1963, Central Region (Bangkok: National Statistical Office, 1964), pp. 36-37.

[d]The Agricultural Census has no separate categories for different types of pumps, consequently the central plain mean includes both types of pumps.

and use of chemical fertilizers over time precludes any statement of statistical correlation between these two variables. Field interviews, evaluations, and limited quantitative data do suggest, however, that improvements in road conditions is an important factor in the increased use of chemical fertilizers on sampled holdings. The mean percentage increase in holdings using chemical fertilizer during the two years following road improvements was 15.5 percent.[1] Only 6.7 percent of the sampled holdings began to use chemical fertilizer in the two years prior to road development. By comparison, the mean percentage increase in holdings using chemical fertilizer for any consecutive two year period in control areas was only 9.8 percent, and no two year period exceeded 15.5 percent. Annual percentage increases in individual survey amphoe varied considerably depending upon the type of local road surface, distance from the central fertilizer distribution point in Bangkok, extent of existing fertilizer use, and agricultural land-use patterns.[2] Annual changes in import volumes of chemical fertilizer and expansion of the distribution system must also be considered as important factors, although their precise significance must await a more detailed study of

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[1]The mean percentage increase in holdings using chemical fertilizer in road development areas during the first four years after development took place was 31.4 percent and rose to 42.4 percent within the first six years.

[2]Increases in the number of farm holdings using chemical fertilizer following road development in amphoe Krathum Baen, and Damnoen Saduak were lower than in other road development areas. In addition to high pre-road development levels of chemical fertilizer use the alkaline nature of soils in these areas reportedly require the application of over 80 percent of all yearly imports of ammonium sulphate.

fertilizer marketing. While these figures present only a superficial analysis of fertilizer use and road development they do indicate that improved transport facilities are important in encouraging a wider adoption of chemical fertilizers.

The increase in number of farm holdings reporting the adoption of insecticides was more variable among survey amphoe than the use of chemical fertilizers Farmers in several amphoe reported a decline in their use of insecticides over the period under study. The areas where insecticides are most widely used correspond approximately to the areas in which there is extensive cultivation of fruit and vegetable crops. In most of these areas, however, insecticides were used on an average of over 30 percent of the holdings prior to road development. For example, over 64 percent of the farm holdings in amphoe Damnoen Saduak indicated that they tried or were using insecticides prior to improvements in transport conditions. There was also no apparent difference in the rate of adoption of insecticide between road development and control areas during the period under consideration. While field observations and interviews indicate that improvements in road conditions have made insecticides increasingly available in rural markets, local farmers have not seemed to utilize them at any appreciably faster rate. The increased availability of insecticides in rural markets has not been accompanied by any apparent increase in the farmers' understanding of the types and uses of different insecticides. This has occasionally culminated in the improper application of insecticides or use of

the wrong variety of insecticide resulting in crop damage, yield decline, or no abatement in insect damage to crops. These conditions are limited for the most part to wet-paddy farmers, since most gardeners are familiar with insecticide application. Wet-paddy farmers have consequently related poor yields or insect damage not to natural causes, but to the application of insecticides. Government dissemination of advice on insecticide use still appears to be inadequate, although some improvements in this service at a local level have been made in recent years. Even though improvements in transport conditions have made insecticides and fertilizers more readily available to the farmer the lack of adequate information about their use has not enabled the full impact of improved distribution to be felt.

Road development has had a less measurable impact on the distribution and use of various types of agricultural machinery. Probably the most common piece of agricultural machinery found on holdings in the central plain is the gasoline powered water pump. Originally designed as an outboard engine for boats it has been modified in recent years to serve as both engine and irrigation pump. The percentage of farm holdings sampled which own these pumps is shown in Table The gasoline powered hang-yao pump obtains its name from the long propeller shaft which is used to propel boats.[1] This dual purpose engine

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[1] The hang-yao type engine, including the propeller shaft, was reportedly developed in Chachoengsao province. Prior to 1955 or 1956 most such engines used wooden shafts to which a metal propeller was attached. Metal shafts and the increased use of foreign engines apparently began in this province around 1957. (See infra, n. 1, p. 153)

has been in use for over ten years, but its adaption for irrigation purposes is a relatively recent development. The gasoline powered water pump is used primarily for irrigation since it has a larger capacity and more horsepower than the hang-yao engine. Both types of units are found throughout the central plain, although the gasoline water pump is more widely used in the irrigation of fruit and vegetable gardens. This fact accounts for the greater frequency of this type of unit in those amphoe in which vegetable gardening is an established form of land-use. The water pump is somewhat older than the hang-yao engine in terms of utilization as an irrigation device. This pump is also frequently attached by a belt to the rahat (dragon bone pump or water ladder) for irrigating paddy fields.

Both types of units were in use prior to the development of many of the roads under study here, but the development of these transport routes has facilitated the distribution and utilization of both types of engines. The increased availability of this unit in new markets created by road development is shown in Table 14. This pump became available in markets in road development areas at the same time or immediately after periods of road development. The two exceptions to this pattern are amphoe Damnoen Saduak and Sam Chuk. Traditional cultivation of garden crops and fruits in the former amphoe resulted in local distribution and use of this pump prior to transport development. In amphoe Sam Chuk the initial encouragement for local distribution and use of water pumps came from the sugar mill which was built in this amphoe

TABLE 14

LOCAL AVAILABILITY AND PURCHASING PATTERNS
FOR GASOLINE POWERED WATER PUMPS
IN SURVEY AMPHOE

Survey Amphoe	Year First Available	Period of Transitional Road Development	Purchase location of locally owned units (% of total)		
			local market	other[a] markets	Bangkok & Thon Buri
Bang Yai	1960	..	14.3	21.4	64.3
Min Buri	1961	1954-1957	..	33.3	66.7
Krathum Baen	1956	1954-1955	..	..	100.0
Lam Luk Ka	1962	1962-1963	13.3	13.3	73.4
Lat Bua Luang	1962	..	40.0	40.0	20.0
Nong Sua[b]	1964	1957-1958	..	25.0	75.0
Muang Chachoengsao[c]	1964	1954-1957	..	50.0	50.0
Damnoen Saduak	1952	1959-1960	88.2	..	11.8
Bang Khla	..	1956-1957	..	..	100.0
Tha Rua	1963	1962-1963	..	..	100.0
Sam Chuk[d]	1959	..	66.0	33.0	..
Sanphaya	..	1963-1964	..	..	..
Khok Samrong	..	1962-1963	..	..	..
Chumsaeng	1963	..	100.0	..	..

[a]Other markets include those located outside of the survey amphoe or in other changwats, except in the case of amphoe Muang Chachoengsao, amphoe Nong Sua.

[b]The market surveyed in amphoe Nong Sua is not located within the amphoe, but is directly south at the junction of Khlong 10 and Khlong Rangsit. There are no primary or secondary markets in this amphoe, and the one along khlong Rangsit is the functional market for residents of this amphoe.

[c]The market surveyed is located along Khlong Thakai (Thakai market) and is not the primary amphoe market, which is synonymous with the provincial market.

[d]No transitional road development had occurred by June, 1968.

in 1957, three years before the road was built. Three markets still do not sell this piece of equipment even though road development occurred over four years ago. While road development has evidently played some part in introducing this type of pump into local markets it has not done so at a price which is competitive with provincial markets or markets in Bangkok and Thon Buri. An average of 55 percent of all pumps now in use on sampled farm holdings were purchased in Bangkok and Thon Buri and an additional 18 percent were obtained in markets in other amphoe or changwats. Farmers consistently reported that local prices for this pump were too high and many of the units offered for sale were not new but used. They also recognized that they had a much larger selection at lower prices in other markets, particularly in Bangkok and Thon Buri, and that no inconvenience in making this longer trip was involved.

It is not surprising that a similar pattern exists for the local availability of long-tailed engines. In this instance, however, the purchase sources of locally owned pumps were approximately equal. The introduction of the hang-yao engine into local markets was accomplished during or following periods of road development as seen in Table 15. Over 36 percent of the units owned were purchased in Bangkok and Thon Buri, 33 percent in other markets, and 31 percent in local markets. The greater equality in the distribution of purchase locations for hang-yao engines is related to its dual function for irrigation and boat propulsion and the predominance of water transportation and irrigated

TABLE 15

LOCAL AVAILABILITY AND PURCHASING PATTERNS FOR LONG-TAILED (HANG-YAO) TYPE ENGINES IN SURVEY AMPHOE

Survey Amphoe	Year first available	Period of Transitional Road Development	Purchase location of locally owned units (% of total)		
			local markets	other[a] markets	Bangkok & Thon Buri
Bang Yai	..	..	..	33.3	66.7
Min Buri	1962	1954-1957	33.3	33.3	33.3
Krathum Baen	1956	1954-1955	50.0	..	50.0
Lam Luk Ka	1965	1962-1963	25.0	25.0	50.0
Lat Bua Luang	1964	..	50.0	50.0	..
Nong Sua[b]	..	1957-1958	..	..	100.0
Muang Chachoengsao[c]	..	1954-1957	..	71.4	28.6
Damnoen Saduak	1963	1959-1960	50.0	50.0	..
Bang Khla	..	1956-1957	..	66.7	33.3
Tha Rua	1962	1962-1963	..	..	..
Sam Chuk[d]	..	..	..	..	..
Sanphaya	..	1963-1964	..	..	..
Khok Samrong	..	1962-1963	..	..	..
Chumsaeng	1962	..	100.0	..	..

[a]Other markets include those located outside of the survey amphoe or in other changwats, except in the case of amphoe Muang Chachoengsao and amphoe Nong Sua.

[b]The market surveyed in amphoe Nong Sua is not located within the amphoe, but is directly south at the junction of Khlong 10 and Khlong Rangsit. There are no primary or secondary markets in this amphoe and the one along Khlong Rangsit is the functional market for residents of this amphoe.

[c]The market surveyed is located along Khlong Thakhai (Thakhai market) and is not the primary amphoe market, which is synonimous with the provincial market.

[d]No transitional road development had occurred by June, 1968.

wet-paddy cultivation in the central plain.[1] This type of pump is probably the most widely utilized piece of machinery in the lower central plain.

The tractor, while limited in its utility in wet-paddy areas, is well suited to the drier conditions in the transitional uplands in which amphoe Khok Samrong is located. The increased availability and use of the tractor in this amphoe since 1960 is related to a greater demand for better transport facilities stimulated by the expansion in corn production and improvement of transport conditions. The demand for more rapid and extensive plowing and field clearing accompanying the expansion in corn production and a consequent need for faster and more versatile means of shipment has resulted in increased availability and ownership of tractors. The water buffalo and kwien (ox-cart) were used almost exclusively for these activities until the early 1960's even though commercial corn production began to expand as early as 1957. It was not until transitional road development occurred in 1962-1963 that local tractor sales and service agencies were opened and ownership of tractors in the amphoe began to increase.[2] While road development has been an important factor in this pattern it cannot be considered independently of the expansion in commercial corn production.

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[1]The spatial decline in ownership of hang-yao type engines from Bangkok and Thon Buri closely corresponds to a similar decline in the density of the inland waterway network. Analysis based on only major inter-changwat canals and rivers indicates that the density of this network in route kilometers per square kilometer of area at fifty kilometers from Bangkok and Thon Buri is 0.26, and declines to 0.08 at 100 kilometers; 0.02 at 150 kilometers; and 0.01 at 200 kilometers.

[2]Three tractor sales agencies are located in the amphoe Khok Samrong market. Diethelm-Stein Co. Ltd., the first to be established in 1962 has

The importance of road development in stimulating farmers and local entrepreneurs to adopt new technology and methods of production is variable. Its most extensive impact appears to be in areas where no alternative transport facilities are available. While improved transport facilities can make these techniques and materials more readily available to the farmer they frequently do so at costs above what local farmers can or will pay. The improvement of the communications process which makes these techniques available and relevant to the farmers' needs is equally important. The capacity of improved transport facilities to stimulate this process is limited and unless corresponding improvements in information dissemination are made the introduction of these new techniques will find only limited markets.

Spatial aspects of technology adoption.

The distribution patterns for utilization of the five factors in Table 13 showed no significant spatial relationship within the central plain, except for chemical fertilizer. The differential percentage utilization of chemical fertilizer on holdings in the central plain is due to several factors.

Calculations by the major fertilizer importers indicate that from 50 to 60 percent of all imported fertilizer is used within a radius of

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sold only sixteen units while Massey Ferguson, opened in 1963, has sold over 80 units and Ford another 25 since 1965.

100 kilometers from Bangkok and 75 to 80 percent within 250 kilometers.[1] The accuracy of these calculations and the importance of distance in the distribution of fertilizer is emphasized by the utilization of chemical fertilizer in survey amphoe. A correlation coefficient ("r") of -.71 was obtained for the relationship of percentage utilization of chemical fertilizer in survey amphoe and distance from Bangkok and Thon Buri. The slope of the regression line and the equation for that line are shown in Figure 11. Although the size of n is small at only 14 the correlation is significant at the ±0.05 percent level. The apparent spatial parameters of chemical fertilizer use in the central plain can in part be related to the distributional system for this commodity, cost and convenience of existing transport systems, and varying requirements of fertilizer use in agricultural activities. The distributional system for fertilizer is restricted by the lack of dealers and regional distribution points, and the division between importer-distributor and local agents. The limited extent of secondary and feeder road systems, especially in the lower plain, also acts as a restraint on fertilizer distribution. A majority of the chemical fertilizer now used within the central plain is shipped from importer-distributor to local agents by truck. The inland waterway system is seldom used for the initial intra-regional distribution, although it is the primary method of shipment between local agents and farm-lots of fields. This pattern may be partially

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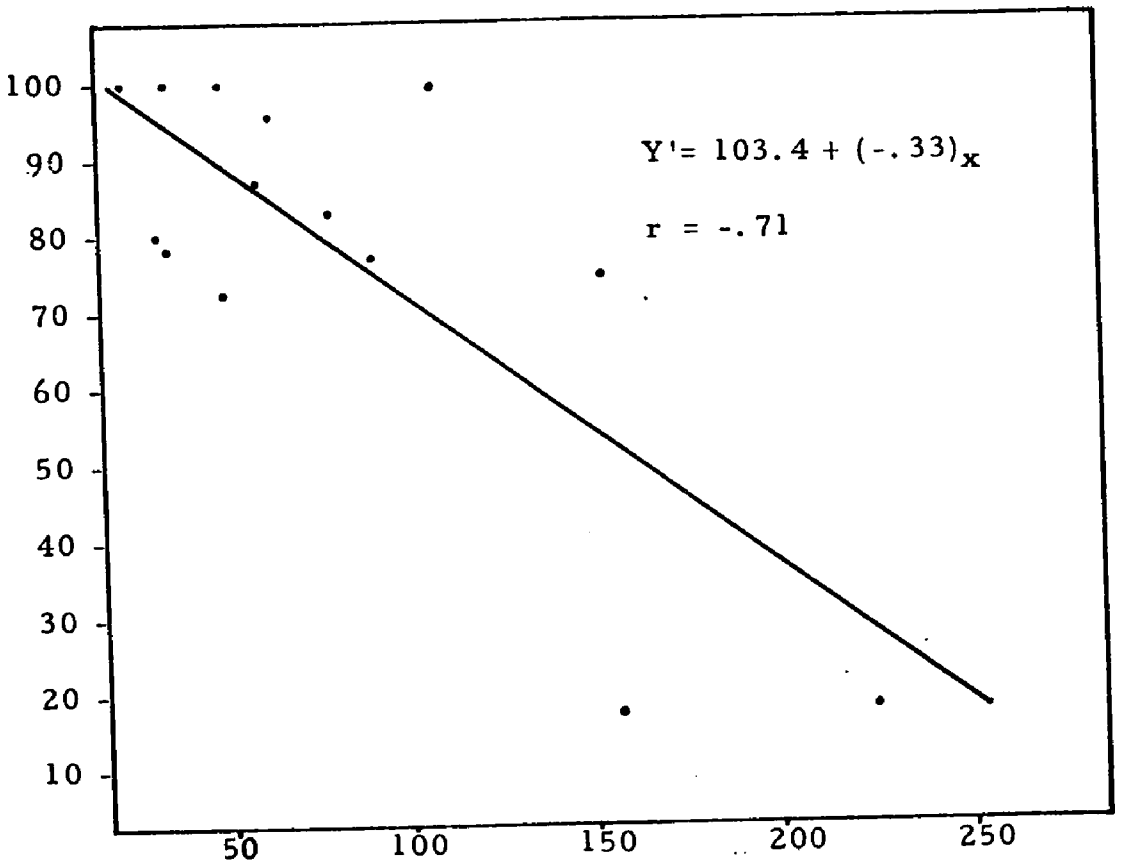
[1] USOM/AID-Thailand, "Fertilizer Situation," p. 48.

Fig. 11 -- Percentage of Agricultural Holdings Using Chemical Fertilizer and Distance From Bangkok and Thon Buri.



due to the longer shipment time by water transport, inadequate planning of the distributional process, and insufficient stocks of chemical fertilizers. Differences in agricultural land-use, soil types, precipitation and irrigation facilities, and physical relief are also important factors. Changes in these variables are initially evident in the transitional uplands such as exist in amphoe Khok Samrong and become more pronounced with increased distance from Bangkok. Chemical fertilizer is generally in less demand in these areas due to declining intensity in cultivation, changes in cropping patterns, and soils which have been less

heavily worked and are more suitable for upland crops than wet-paddy. It is therefore not coincidental that the point at which these changes become increasingly apparent closely corresponds to the division between the upper and lower plains, some 200 kilometers from Bangkok, and the boundary of the 250 kilometer zone within which over 75 to 80 percent of chemical fertilizers are used.

The utilization of gasoline motors, water pumps, hang-yao engines, insecticides and other types of inputs on farm holdings showed no significant spatial patterns which could be corroborated statistically. Correlation coefficients obtained from analyzing utilization and distance were not significant at a $\pm$.0.05 percent level. The small number of sample areas may be partly responsible for the absence of any significant correlations. There is some reason to believe, however, that with a larger sample some indications of correlation between the use of these factors and distance from Bangkok and Thon Buri would occur.

Rural Income

For the vast majority of Thai farmers the main source of income is that derived from the cultivation and sale of paddy. While other forms of temporary and seasonal employment contribute varying amounts to their annual income none is as important as the cash obtained from the sale of paddy. The simplicity of income earning patterns among rural farm households is modified by the number of secondary sources of income which are related directly or indirectly to agricultural activities.

Wage labor is one of the most common secondary sources of income among rural farm households. Wage labor often involves employment on agricultural holdings within close proximity to the residence of the laborer. Remuneration is generally in cash, payment being based on either time worked or tasks performed. While wage labor is predominantly a secondary source of income there are indications that close to large urban areas some wet-paddy farmers are endeavoring to replace rice cultivation with wage labor as their primary source of income while still maintaining their agricultural holdings. The existence of this trend was particularly evident in amphoe located close to Bangkok and Thon Buri. In these amphoe the younger members of rural households are resisting family and social traditions tied to paddy cultivation and seeking various forms of wage employment in the cities. Such individuals will often commute between these rural districts and their jobs or, if the distance is too great, move permanently to the city. The absence of younger household members and even heads of households during the slack periods of agricultural activity is becoming increasingly common. The proportion of the total seasonal migrant labor force in the central plain, which is composed of these individuals, is somewhat unclear.[1]

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[1] Phillips refers to similar seasonal wage labor patterns among residents of Bang Chan; "it is common practice in Bang Chan now for a husband to be away for four or five months at a time earning money in Bangkok, or during the dry season on a vegetable farm, returning home to visit his wife and children whenever opportunity permits, with or without funds." (Herbert P. Phillips, Thai Peasant Personality: The Patterning of Interpersonal Behavior in the Village of Bang Chan [Berkeley: University of California Press, 1965], p. 25.)

The rapid growth of the construction industry in Thailand and the accelerating rate of public and private construction in Bangkok and Thon Buri is drawing large numbers of the younger generation from rural areas to these cities as both full and part-time laborers. Skilled and semi-skilled tradesmen in many of the rural communities studied indicated that there was an increasing demand for their skills outside of their local community. The amount of income they earn from these activities varies greatly, but often will equal or exceed their annual income from paddy cultivation. Some of the more frequently reported secondary occupations of residents in survey amphoe are shown in Table 16.

The wide range in incomes from secondary occupations as indicated in Table 16 reflects variations in skills, demand for labor, and the intensity to which individuals devote themselves to these secondary occupations. The vast majority of these activities are pursued only seasonally after paddy harvest and during periods of low labor demand in farm operations. It was not uncommon, however, to find paddy farmers employed full-time as laborers or passenger boat operators with maintenance of their paddy holdings being entrusted to wives or other family members. These situations were primarily found where the size of holdings was small and family labor was available to maintain paddy fields.

Several additional secondary sources of income among agricultural households involve the vending of fresh produce, prepared foods, and daily consumer items by boat along local waterways and operation of local water passenger transport services. The operation of the common long-

TABLE 16

SELECTED SECONDARY OCCUPATIONS OF SAMPLE FARM RESIDENTS[a]

Occupation	Frequence of Activity	Area of Employment	Income per day[b]
Paddy field laborer	part-time	rural	20 baht (US $1.00)
Garden laborer	part-time	rural	25-30 baht (US $1.25 to $1.50)
Construction laborer	part-time	urban	20-35 baht (US $1.00 to $1.75)
Fresh produce vendor	part-time	rural	30-100 baht (US $1.50 to $5.00)
Fishing	part-time	rural	2-3 baht (US $0.10 to $0.15)
Passenger boat operator	part-time	rural	45 baht (US $2.25)
Carpenter	part-time	urban	80-100 baht (US $4.00 to $5.00)
Tailor	part-time	urban	35 baht (US $1.75)

[a]These secondary occupations represent those most frequently noted by members of rural households sampled in all survey amphoe. The income (wages) listed for each activity represents only the wage received by the individual engaged in this activity. Wages reported for the same activity varied among amphoe, with laborers skill, and type of tasks performed.

[b]The median gross annual income of all paddy farmers surveyed was 12,600 baht (US $630.00). One baht equals US $0.05.

tailed boat as a passenger ferry is convenient for many farmers and requires little investment since most farmers own both boat and engine. Seasonal passenger boat operations are most frequently associated with areas in which (1) alternative forms of land transport are unavailable, or not competitive, (2) existing ad-hoc passenger boat "groups" do not offer services along minor khlongs;[1] and (3) the secondary or minor khlong system is well developed. This type of part-time activity was common among many farmers in amphoe Lam Luk Ka, Nong Sua, Bang Yai, Lat Bua Luang, Damnoen Saduak, and to a lesser extent in amphoe Muang Chachoengsao. In most instances farmers either join existing ad-hoc passenger boat groups during the periods in which they are active or work individually along the many minor canals ferrying people to major waterways or local markets. One farmer in amphoe Nong Sua operated along only a four kilometer route making two or three trips per day with a gross daily income of 40 to 60 baht (U. S. $2.00 to $3.00). In amphoe Sanphaya the few farmers engaged in part-time passenger boat operations are those who live along the Chaophraya River. They work as both passenger and cargo ferries between the amphoe market, the Chaophraya Dam, and a smaller market located on the river's east bank. These seasonal passenger boat operators often provide an important service to

[1] Ad hoc passenger boat groups are primarily informal, cooperative systems which evenly distribute passenger traffic among all boat operators. There is no formal organization and usually little or no fee is required of participating operators. They regularize passenger and route distribution through rotational operations among boat operators.

local residents due to the frequent impassability of secondary and local roads.

The vending and hawking of fresh produce, prepared foods, and daily consumer goods is another common source of supplementary income for rural households. Both men and women engage in this type of activity, although women are more frequently seen vending these goods in local markets and along the smaller canals. Fresh produce sold in this manner is normally obtained from the family garden plot and is either surplus to home consumption or a quantity specifically planted for this purpose. Individuals engaged in this type of activity will often go to the local market early in the morning and then sell any remaining produce later in the day along the route back to their houses. The income gained from this type of activity is obviously quite varied, but daily earnings as high as 100 baht (US $5.00) are not uncommon. Incomes of this magnitude were usually made by those individuals who annually plant a certain portion of their garden holdings to produce for sale.

A final source of supplemental income is that which is contributed by friends and relatives in the form of remitted income. The context in which this income is given and the form which it takes vary considerably. While direct remittance of cash from relatives is the most common form, food, clothing, transportation expenses, and even school tuitions have been indicated as forms of remitted income. Due to the highly personal nature of this form of income it is difficult to obtain detailed

accounts of actual amounts of remittance, location and activities of remitters, and temporal consistency in remittance patterns. These difficulties are particularly great among certain ethnic minorities in Thailand. The process of remitting income among the Chinese population of Thailand seems to be quite common, although in very few instances was it possible to obtain detailed information about the process of remittance.

Remitted income was reported by farm households in eight of the fourteen survey amphoe in the central plain. The percentage of households which indicated receiving this type of income out of the total number of households surveyed is shown in Table 17. In no survey amphoe did a farm household indicate remitting funds in any form to other non-resident members of the family except in the case of educational assistance. The areas in the table are listed in order of increasing distance from the Bangkok-Thon Buri Metropolitan area. The rather wide range of responses indicate that the total number of households receiving income in this manner may be larger than was indicated by the sample. The sensitive nature of investigations required to obtain quantitative responses from informants may have discouraged individuals from reporting conditions accurately.

With the exception of amphoe Khok Samrong, all cases of remitted income were reported to have occurred within approximately 100 kilometers of Bangkok and Thon Buri. Aside from the apparent spatial pattern and occasional references to the increased frequency of remittances

TABLE 17

PERCENTAGE OF HOUSEHOLDS IN SURVEY AREAS RECEIVING REMITTED INCOME, 1966-1968

Survey Area	Percentage of Households Sampled Receiving Remitted Income
Bang Yai	..
Min Buri	5
Krathum Baen	12
Lam Luk Ka	5
Lat Bua Luang	15
Nong Sua	..
Muang Chachoengsao	20
Damnoen Saduak	5
Bang Khla	29
Tha Rua	..
Sam Chuk	..
Sanphaya	..
Khok Samrong	9
Chumsaeng	..

in post-road development periods existing data are insufficient to provide an understanding of the relation of remitted income to road development.

Road development and income change.

The relationship between road development and changes in annual income of agricultural households is at best vague. The investigation of income levels in non-Western societies is in itself a difficult task and is further complicated when attempts are made to ascertain quantitative changes in incomes which can be related to the development of transport facilities. Since the majority of Thai farmers keep no accounts of their receipts and expenditures it was necessary to rely primarily on oral enquiries and supporting statements from individuals associated with local economic and agricultural conditions.[1] Although farmers do not keep accounts they can recognize and relate changes in local transport and economic conditions to their own economic position. The relationship between improvements in transport facilities and production and marketing costs, product demand, price structure, and profit margins is sufficiently pronounced to generate definite recognition among farmers of how these improvements affect their income.

The impact of road development on rural farm earnings has resulted in a general increase in gross annual income. Respondents in 85 percent of the amphoe surveyed indicated that their gross annual income had increased since improvements in transport conditions

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[1] A report on an economic survey of rice farmers in Nakhon Pathom Province conducted in 1955-56 indicates that farmers were unable to keep accounts of receipts and expenditures. This was primarily due to a lack of interest in this procedure and an inability to recognize the benefits of keeping records. (Thailand, Ministry of Agriculture, Office of the Under-Secretary, Agricultural Economics Division, Agricultural Research and Farm Survey Division, "Report on Economic Survey of Rice Farmers in Nakhon Pathom Province During the 1955-56 Rice Season," Bangkok, 1959, p. III.)

were made. The primary source of this increase was from farm activities. These same farmers qualified this increase in income by noting that although gross annual income had risen following road development there had also been a corresponding increase in their expenditures and costs so that real income had not changed significantly.

There was, however, an important differential in the number of households reporting increased incomes between road development and control areas. Figure 12 shows the percentage of reporting households which indicated an increase, decrease, or no change in their income in road development and control amphoe. Over 63 percent of the agricultural households reporting in road development amphoe indicated that their earnings had increased since improvements in road transport facilities had taken place, while only 25 percent of these in control areas experienced an increase in their incomes. Conversely, less than 2 percent of the households interviewed in road development areas reported declines in their incomes while the earnings of over 37 percent of the households reporting in control areas had declined. The evident differential between road and control areas emphasizes the significance of this type of transport development for the income levels of agricultural households. Among the road development amphoe only one, amphoe Damnoen Saduak, had some farmers who indicated that their incomes had declined over the period under study.[1] The holdings of these

[1] These farmers accounted for less than five percent of the total number of households reporting in amphoe Damnoen Saduak.

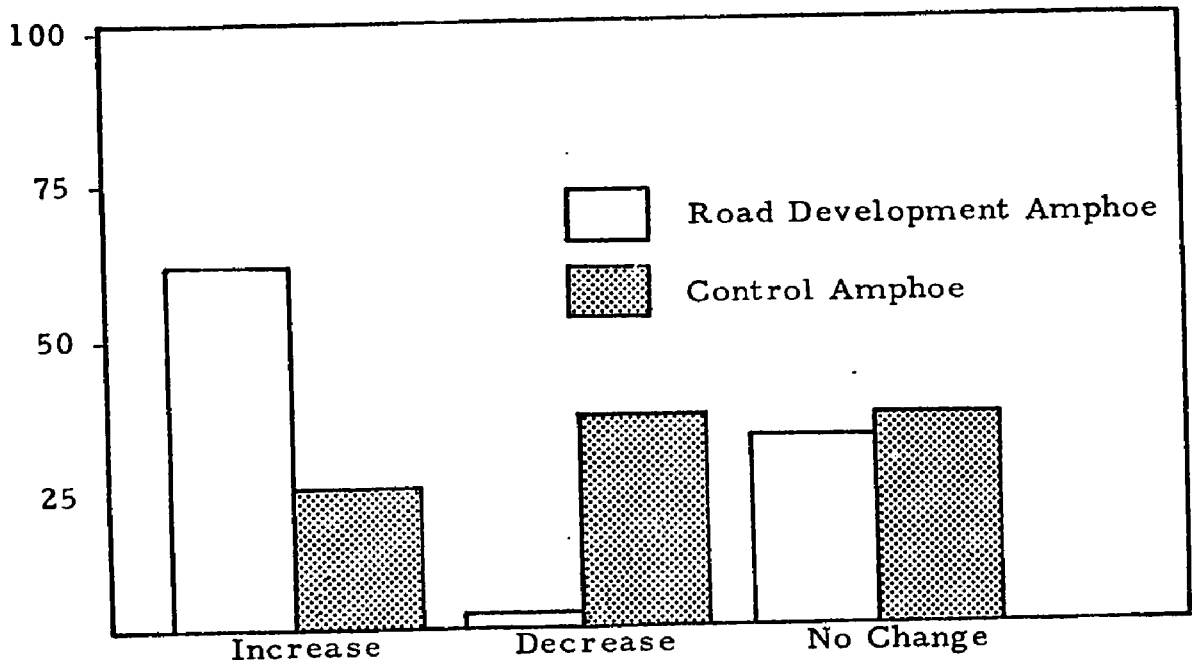

Fig. 12 -- Percentage of Reporting Households Indicating Changes in Gross Annual Income in Road Development and Control Amphoe, 1957-1967

farmers were devoted to cash garden crops, primarily chili, and were located no further than one kilometer from the road. Their decline in earnings was attributed to a decrease in yields resulting from deposits of laterite road dust on the flowering buds of the chili plants.

Farmers acknowledged a wide range of economic and hydrologic variables which through direct or indirect relationship to road development were associated with changes in their incomes. Among the most frequently cited factors were (1) farm produce prices, (2) produce demand, (3) production costs, (4) fluctuations in yields related to irrigation conditions, (5) productivity, (6) lower transport costs, and (7) increased convenience in which was implied reduced shipment, handling, and marketing costs. The relating of changes in income to irrigation conditions and yield fluctuations was a rather unique situation which had

produced both increases and declines in earnings. For example, in amphoe Chumsaeng the construction of a local, loose surface, dry season road through an area of wet-paddy fields produced an imbalance in the natural irrigation-drainage system. Inadvertently an insufficient number of drainage culverts were installed under the roadbed which resulted in uncontrolled flooding, slow drainage, considerable local crop damage, and a loss of income. The construction and development of roads in amphoe Sanphaya, Sam Chuk, and Nong Sua increased and improved local irrigation facilities and resulted in better water control, higher yields, and increased farm earnings. In the first two amphoe the excavation of canals paralleling developed roads initially served as a source of roadbed material and later augmented existing irrigation facilities. This added irrigation capacity allowed farmers to expand wet-paddy production and increased yields per unit area. In amphoe Nong Sua road development improved the ability of the existing canal dike to control flood waters and stabilize the natural flooding and drainage conditions.

Among the factors more directly related to road development and income change were those associated with production, transport, and marketing of farm produce. Although increased productivity is considered to be one direct benefit of road development in upland areas in the north and northeast its importance in all but two survey areas was negligible.[1] The existence of numerous economic restraints, unavailability

[1] Jittasatra and Jones report the occurrence of increased production after road development in their studies in the north and northeast

of land, and insufficient knowledge of double-cropping and cash gardening techniques appear to have minimized any potential for the expansion of production generated by road development. Aside from the rapid expansion of corn production in amphoe Khok Samrong only gardeners in amphoe Krathum Baen indicated an expansion in agricultural production following road development. A reduction in production costs was reported by farmers in four amphoe. Significantly, each of these amphoe were areas in which large amounts of land were devoted to gardening and cash crop production. Incomes were increased through cost reductions in machinery, fertilizer, and other inputs although profit margins were not necessarily greater. For many of the wet-paddy farmers, however, the adoption of new factors of production meant an increase in production costs and a lowering of profit margins since expected yield increases did not materialize. This increase in production costs was partially offset by higher prices for farm produce related to improved contact with buyers and external markets, and generally lower transport and marketing costs.

Reductions in transport costs were recognized in only two areas as being important factors in increased farm earnings while demand for farm produce was cited in almost every amphoe. It was impossible to

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and Bonney records similar results in his study in Sabah. (Jittasatra, "Khon Kaen-Yang Talad," pp. 15-37; Jones, "Development Roads, pp. 12-16; and R.S.P. Bonney, "Road Building and Economic Development in Sabah," Development Digest, 4 (2), July, 1966, p. 31.)

determine whether demand differed between road and control areas on an individual crop basis and whether demand was a function of improved transport and marketing conditions or just a reflection of changes in the overall market demand for agricultural produce.

From the preceding discussion it is evident that while incomes have increased more consistently in road development than control areas the variables affecting this change in earnings vary considerably. Certain gaps in field investigation have unfortunately made it possible to indicate only that earnings of farm households have increased more consistently in road than control areas and that a wide range of factors are important in facilitating this difference in incomes.

Spatial aspects of income differentials.

Patterns of spatial differentials in income and income per rai of land cultivated are similar to the spatial relationships which exist between land values and distance. Spatial differentials within individual road development areas can be related to distance more consistently than on a regional level.

Spatial profiles of gross annual farm income within survey areas consistently showed a pattern of decreasing income as distance from transport routes increase. Certain deviations from this normative profile occurred in several areas but the general pattern was one of decreasing incomes. The median gross annual farm income spatially from transport routes for all survey amphoe is shown in Figure 13. Incomes

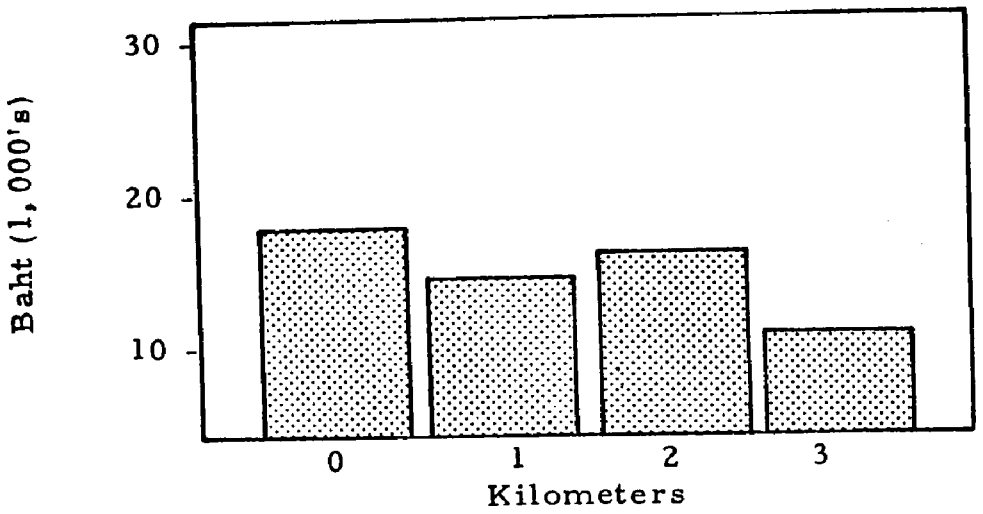

Fig. 13 -- Median Gross Annual Farm Income Spatially From Transport Routes for All Survey Amphoe, 1966-67.

for farm households located along the transport routes are considerably above those of households situated further from these transport routes. The slight rise in gross annual income at a distance of two kilometers may quite possibly be the result of larger holdings found at this distance. Initial road construction in some amphoe fragmented many holdings along the construction route into smaller sized parcels. Portions of these holdings were often sold off after road development, thus contributing to a general trend toward smaller holding size along transport routes.[1] The higher incomes of farms along the roads and canals may

[1]The fragmentation of farm holdings as a result of road development was often commented upon by farmers in amphoe Min Buri, and amphoe Muang Chachoengsao. They suggested that the reduction in size of larger holdings had varying effects. Land owners gained from the transport route, land values increased, and smaller plots were more easily sold, but physical disruption of existing drainage patterns and rapid sedimentation of smaller canals along the road retarded production and transport of crops.

be attributed to a variety of factors, the most important of which are: (1) lower transport costs, (2) higher produce prices for farms along the road or canal and lower prices with increasing distances, particularly where buyer transport is used to collect produce, (3) increased production of low bulk, high value agricultural produce, livestock and fowl, and (4) real and potential economic and social values attributed to houselots and farmsteads with access to transport arteries. A decided increase in land-use intensity is implicit in the third factor and is directly related to differentials in income per rai of land cultivated.

Spatial differentials in mean gross annual income per rai of land cultivated are shown for all survey amphoe in Figure 14. The graph shows these spatial profiles for road development and control areas separately. The difference between the two areas is especially great for holdings adjacent to the transport route and up to one kilometer from these routes. The greater income per rai of land cultivated at two kilometers than at one kilometer or even the khlong in control areas may again reflect the larger size of holdings at this distance.[1] One additional reason for the larger size of these holdings may be related to the general configuration and distribution of the minor waterway network within survey areas. Main khlongs are often bisected at numerous points

[1] The spatial differential in farm size based on samples taken in the field also support this pattern. The median farm sizes for all areas at one kilometer intervals from transport routes are: 21 rai along transport routes, 26 rai, 31 rai, and 24 rai respectively.

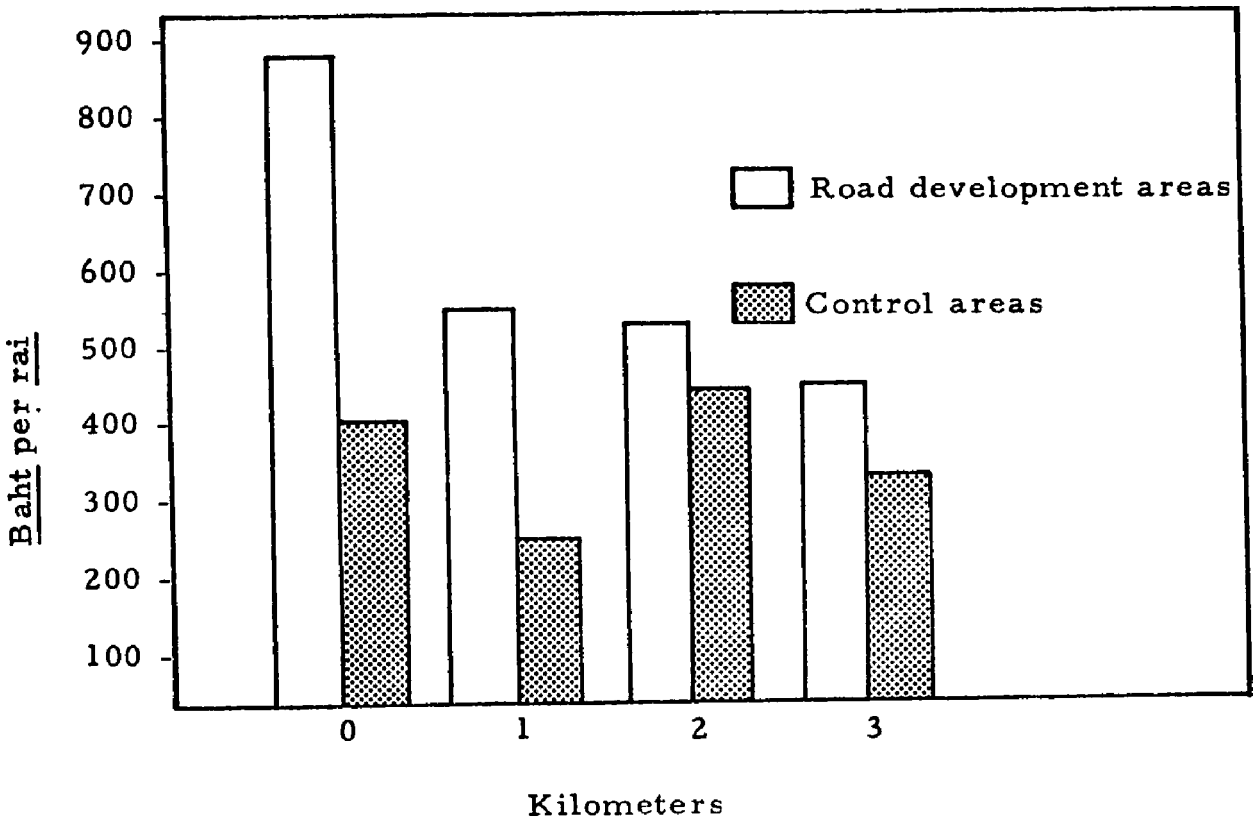

Fig. 14 - Mean Gross Annual Income Per Rai Cultivated Spatially from Transport Routes

by many small seasonally navigable canals which may not extend laterally away from the main khlong for more than one or two kilometers. These minor waterways may in effect have served as field boundaries up to the point at which they become indistinct from surrounding wet-paddy fields, thus further reducing field sizes close to transport arteries.

Although farm holdings may be larger further from transport routes and therefore contribute to larger annual incomes per farm, the income per unit area cultivated is considerably higher along transport routes. The greater intensity of cultivation and higher frequency of cultivation of low bulk, high value crops on farms located adjacent to

roads results in larger incomes per rai than on holdings further from the road.

Intraregional income differentials.

The distribution of median farm incomes for all survey amphoe spatially from Bangkok and Thon Buri shows no strong relationship with distance. The correlation coefficient for median gross annual incomes of farmers in survey amphoe and distance of the survey amphoe from Bangkok and Thon Buri is shown in Fig. 15. Individual points represent the median income of sampled agricultural households within survey amphoe and not incomes of individual farmers. The negative relationship between distance and incomes represented by the slope of the regression line suggests that income decreases as distance from the Metropolitan area increases. The correlation coefficient ("r"), however, is -.42 and is not significant at a level of ± 0.05. The smallness of the sample size may have contributed to the absence of any strong correlation between farm incomes and distance from Bangkok and Thon Buri. A correlation coefficient of r=-.31 was obtained for mean gross annual farm income per rai of land cultivated and distance from Bangkok and Thon Buri. Although the regression line shown in Fig. 16 is negative the coefficient of correlation is not significant at a level of ± 0.05.

If farm incomes were directly related to linear and transport distance of farm sites from Bangkok and Thon Buri, then improvements in road transport conditions might conceivably have influenced farm income

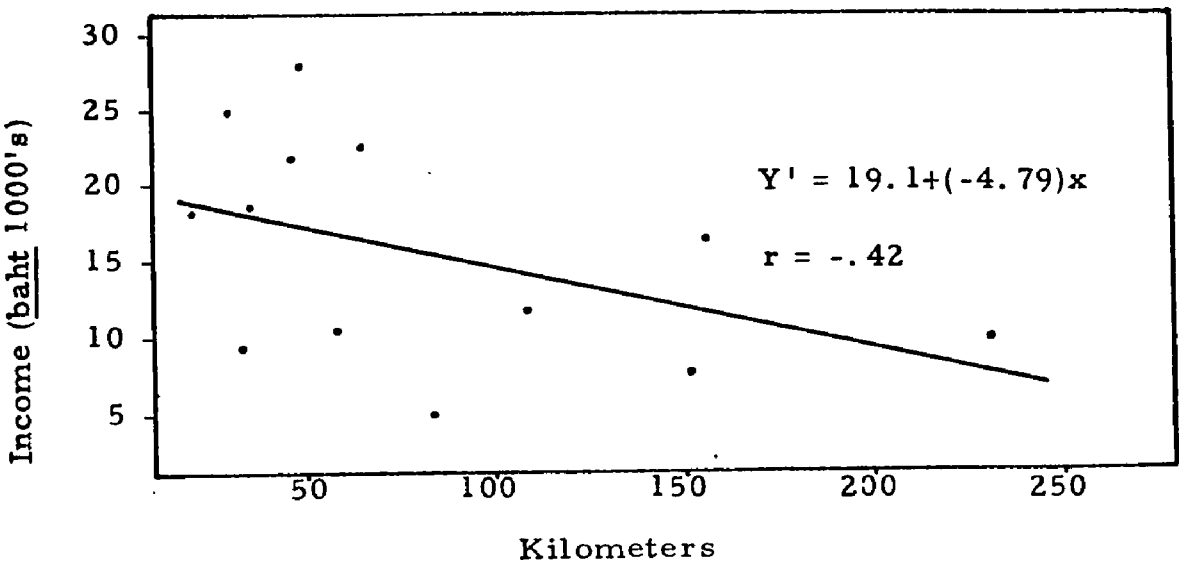

Fig. 15 --Median Gross Annual Farm Income in Survey Amphoe and Distance From Bangkok and Thon Buri

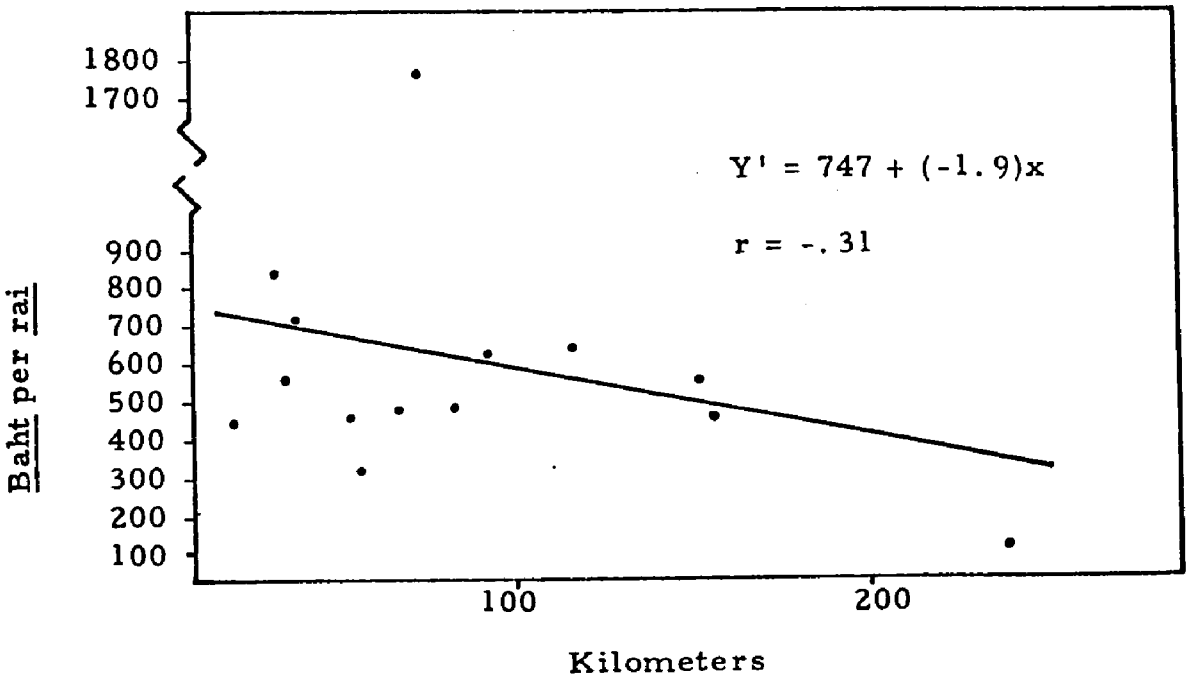

Fig. 16 -- Mean Gross Annual Income Per Rai of Land Cultivated in Survey Amphoe and Distance From Bangkok and Thon Buri

spatially. The absence of any apparent relationship between higher farm earnings close to the capital and lower ones further away suggests that road development through improved transport conditions, lower costs, and higher produce prices is not a major factor in spatial variations in incomes within the region. The importance of road improvements in generating conditions conducive to higher farm incomes is primarily confined to the advantages this development affords holdings which can directly utilize these transport routes. These farm units are primarily those located within the first one or two kilometers from the road. The existence of a well developed inland waterway system may condition the spatial impact of road development on farm earnings in the lower central plain where the waterway system is most extensive. The relative ability of road development to increase farm incomes may be more significant spatially within separate road development areas as these areas are located further from Bangkok and Thon Buri and the marginal advantages of water transportation decrease.

Consumption patterns.

The temporal pattern of purchases of luxury goods by rural households in relation to changes in transport conditions is more illustrative of the influence of road development on income levels than are changes in gross annual income.[1] The increased ability of rural residents to purchase

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[1] Those items considered as luxury goods are radios, bicycles, television sets, sewing machines, electric fans, electric irons, electric generators, ice boxes, and automobiles.

this type of commodity reflects both a change in their real income and improvements in merchandising-distribution systems related to road developments.

Within the fourteen amphoe surveyed, radios constituted over 75.4 percent of all luxury goods owned by rural households. The majority of these units were battery powered, locally produced sets although the ownership of imported Japanese AC-DC battery units was increasing. Bicycles were the next most commonly owned luxury item (12.8 percent), followed by television sets (5.2 percent), sewing machines (2.9 percent), and fans, irons, generators, ice boxes, and automobiles with 0.5 percent.[1] Not every household owned one of these items, although 63 percent of all sampled households did own at least one radio. In several cases where production of garden crops was the primary economic activity of the household each of these items was found to be owned by that family unit. Bicycle ownership among rural households indicated a relationship between units owned and operational conditions. Over 68 percent of all bicycles were found among households located in the upper plain where annual inundation was minimal, canal systems were limited, and these vehicles could be used year-round.

Time and location of purchase for these luxury goods was closely related to periods of road development and the spatial distribution of

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[1] Television sets owned by sampled households were either of Japanese or Dutch origin and used batteries or AC-DC current. Sewing machines were powered primarily by a foot treadle although a few were electrically operated.

consumers from Bangkok and Thon Buri. Over 60.2 percent of all luxury goods owned by sampled households had been purchased since local road development took place. The total annual volume of luxury goods purchased by households in road and control areas in relation to the mean year of transitional road development is shown in Fig.17.

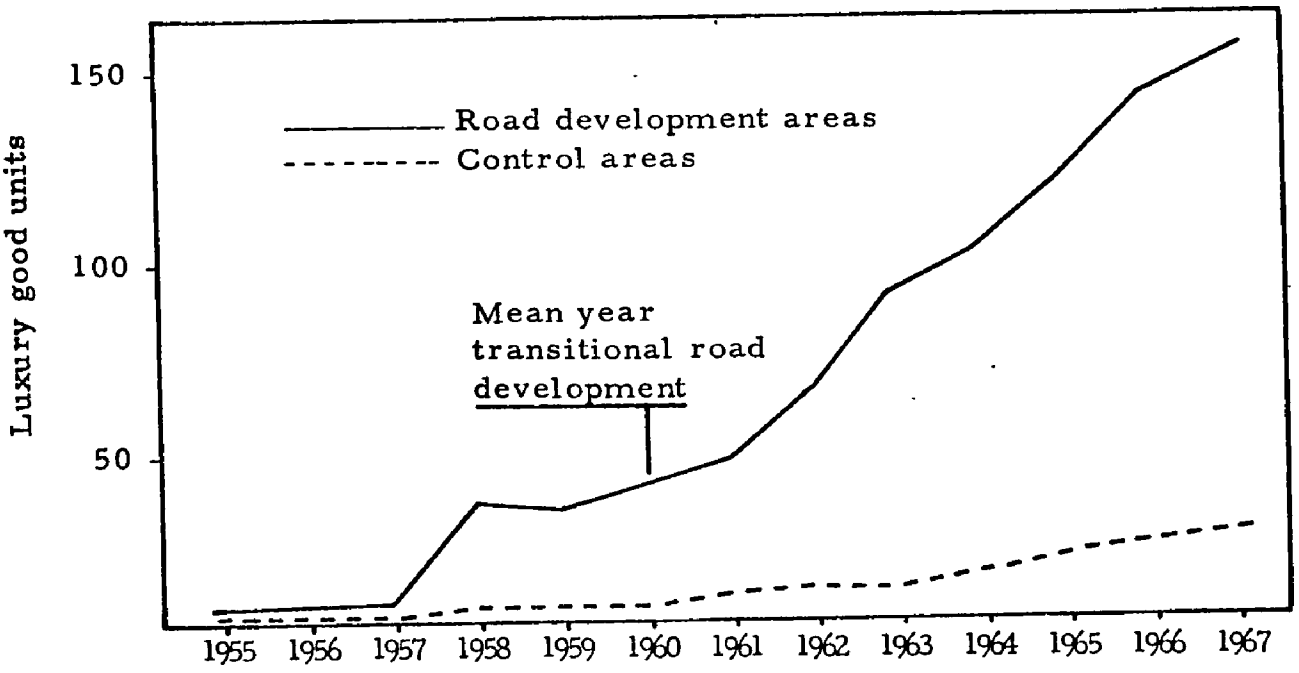

Fig. 17 --Luxury Good Purchases by Households in Road and Control Areas, 1955-67.

The consumption of luxury goods in road development areas has increased at a considerably greater rate than in control areas, although the levels of ownership of these items were approximately equal in 1957. Since control areas were the only ones in which farmers consistently indicated no change or a decrease in their earnings the rapid increase in luxury good purchases in road areas can in part be considered a response to road development.

While the evident rise in luxury good ownership in road areas beginning in 1957, and again in 1961, suggests a concurrent increase in real income in these areas, the relationship is more complex. Improved merchandising techniques, better distributional systems, increased imports and production of luxury goods, and an overall increase in availability of consumer goods following road improvements are all factors contributing to this pattern.

Purchasing patterns for luxury items in road development areas and distance of the consumer from Bangkok and Thon Buri exhibit a strong negative correlation. The number of luxury goods purchased in the Bangkok-Thon Buri Metropolitan area decreases proportionately with the distance of the consumer from these urban areas. Conversely, the number of luxury goods purchased in local or regional markets increases with distance from Bangkok and Thon Buri. The correlation between the percentage of total luxury goods purchases made in Bangkok and Thon Buri and the distance of the consumer from these cities is shown in Fig. 18.

The correlation coefficient of $r = -.79$ is significant at a ± 0.05 level reflecting the decreasing frequency of luxury good purchases in Bangkok and Thon Buri with increasing distance of the consumer from these markets. Consistently higher market prices in local markets, limited variety of luxury goods, and absence of adequate service and repair facilities are important factors in this pattern. While improvements in road transport conditions have widened the variety of luxury goods available to local consumers, these same improvements have also resulted in considerable

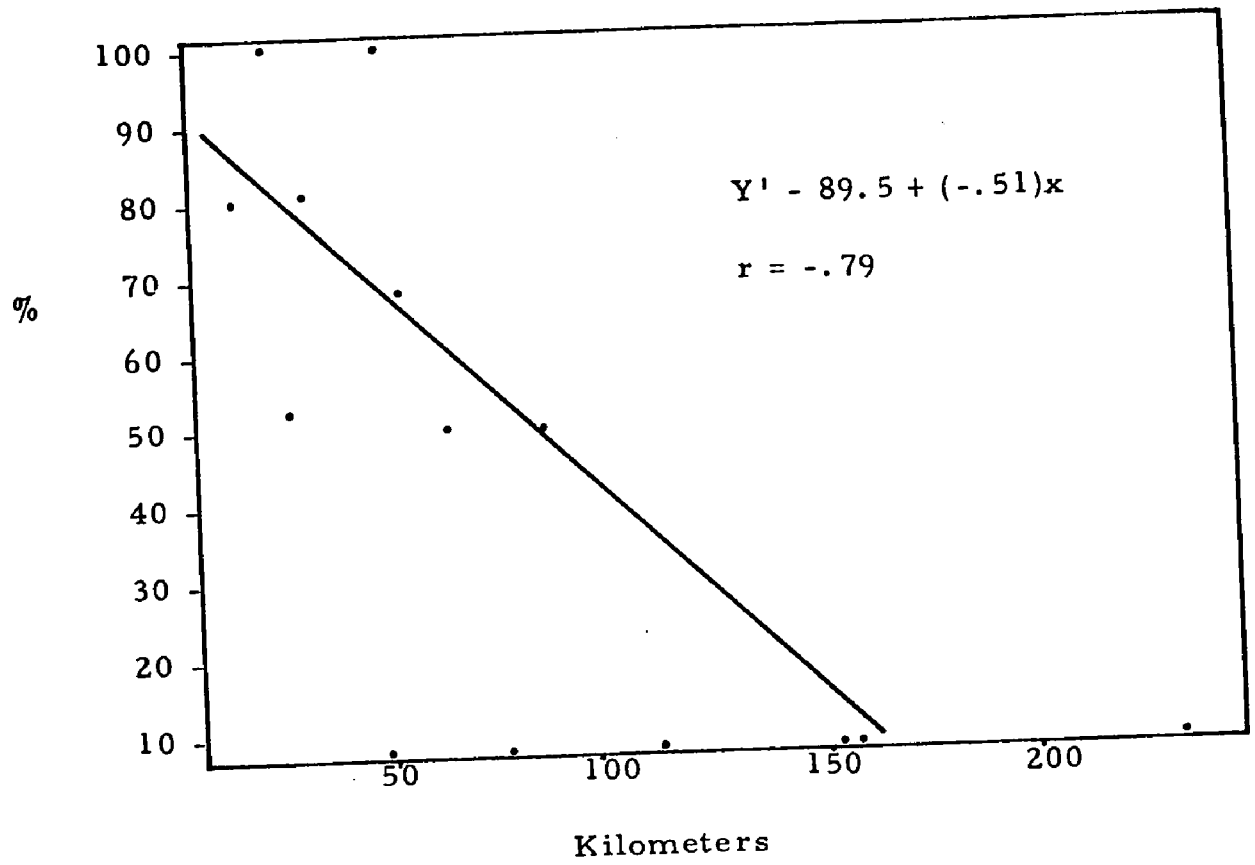

Fig. 18 -- Percentage of Total Luxury Good Purchases Made in Bangkok and Thon Buri and Distance of Consumer in Survey Amphoe From These Markets.

price inequalities with the larger urban markets. Those rural families enjoying increased earnings following road development most often exercise rational purchasing behavior by making luxury good purchases outside of local markets where unit prices are lower, and variety and quality of goods better.

CHAPTER V

THE INDUSTRIAL AND MANUFACTURING SECTOR

Industry in the Thai economy is primarily controlled by the private sector. Although many of the large-scale manufacturing units engaged in cement, timber, tobacco, and similar types of production are government controlled or subsidized, the bulk of industry is in the private sector and individually owned.[1] Fixed capital formation in manufacturing from the private sector during the period 1959-1965 was thirteen times greater than in the public sector.[2] The current economic development plan has consequently placed considerable emphasis on stimulating industrial growth and investment in the private sector of the economy. This emphasis is in marked contrast to the First Six-Year National Economic Development Plan begun in 1961, which included a detailed industrial development plan for only state-owned enterprises. While

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[1] A detailed statistical analysis of industrial ownership by category of ownership is contained in: Thailand, Office of the Prime Minister, National Statistical Office, "Report of the 1964 Industrial Census," 3 vol., Bangkok, n. d.

[2] Thailand, Ministry of Industry, "Industrial Development and Investment in Thailand, 1966," Bangkok, November 9, 1966, p. 1. Capital formation figures for this period were: private sector manufacturing 18,534 million baht; and public sector manufacturing 1,415 million baht.

numerous legislative acts and investment plans have been formulated to encourage investment in industry, these plans for the most part have emphasized promotion of large-scale industry.[1] A great percentage of these promoted industries are located within the Bangkok-Thon Buri Metropolitan area, and consist of heavy industry supported by large amounts of foreign capital, and local assembly and processing firms. The dominance of Bangkok and Thon Buri as centers for industry of all types is comparable with the regional concentration of industrial and manufacturing units located within the central plain. The most recently available statistics showing regional distribution of industries is provided by Silcock. Figures available from this source are for the year 1963 and indicate that the central plain, including the Bangkok-Thon Buri Metropolitan area contained slightly less than 50 percent of all factories within the country. In this region the Metropolitan area had 9,495 units and the central plain the remaining 5,096 factories.[2] Silcock estimates that of the total factories located within the central plain some 13,500 are small industry.[3] Aside from the concentration of light manufacturing in or near urban areas, the bulk of industrial units within the central plain are small, resource based, manufacturing-processing plants or

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[1]Various industrial promotion acts have been established dating back to 1954. The most recent one was established in 1962.

[2]T. H. Silcock, ed., Thailand, Social and Economic Studies in Development (Canberra: Australian National University Press, 1967, p. 276.

[3]Ibid., p. 275.

cottage industries with little or no machinery and only a few employees.[1] It is essentially this type of industry which is most immediately affected by local improvements in road transport facilities.

Traditionally the small cottage industry and manufacturing plants distributed throughout the central plain were almost exclusively located along waterways. This site feature was the most logical locational decision with reference to existing raw materials, labor supplies, and markets. The great bulk of these resource based industries were locally market oriented or directed at intra-regional distribution of products. With the major exception of paddy production the rural industrial economy was oriented toward processing of local agricultural produce and raw materials for domestic consumption rather than export. Overall road development has done little to change the basic functional pattern of domestic oriented processing and service industries in the central plain.

The resource orientation of most industries has been a major factor inhibiting any increase in producing units, particularly of those factories directly dependent upon and related to agricultural production. The static nature of consumer demand for many types of agricultural commodities has not encouraged any significant increase in producing units, but rather increases in individual unit output. The cate-

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[1] A concise analytical discussion of the industrial structure of the Thai economy, the functional composition of industry, and concentrations of industrial activity is presented in Robert J. Muscat, Development Strategy in Thailand, A Study of Economic Growth (New York: Frederick A. Praeger, Publishers, 1966), pp. 176-251.

gorical distribution of agricultural and non-agricultural related industries within survey amphoe is shown in Table 18 for the period 1950 to 1967. The range of industries shown in this table is based on changwat registration figures and provides an accurate sampling of the types of industry found within the central plain, excluding Bangkok and Thon Buri. With the exception of those industries numbered 1, 8, 18, and 20, the rest have shown only small numerical increases since 1950. Many of those showing an increase within the last ten years are processing and light manufacturing industries not dependent upon local markets, and located spatially within fifty to sixty kilometers of the Bangkok and Thon Buri Metropolitan area (numbers 4, 5, 6, 10, 11, 12, 16 and 19). Only three of the twenty-one industries registered within the study amphoe can be considered service industries: boat building and repair; engine repair; and foundry or metal turning shops. These units are directly related to improvements in transport facilities and the increased utilization of mechanized farm equipment and engines. Cottage industries involving such activities as brick making, mat making, fabrication of wicker materials, knife making, metal smolting and casting, palm sugar processing, and the processing of various wood products are normally too small to be registered under existing procedures. They nevertheless employ considerable numbers of people on a full and part-time basis and are important sources of secondary income for many individuals. What limited data are available regarding cottage industries does suggest that their operations are highly seasonal and sub-

TABLE 18

NUMBER AND TYPE OF ANNUALLY REGISTERED INDUSTRIES LOCATED IN SURVEY AMPHOE, 1950-1967

Industry[b]	Registered units by year																	
	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967
1. Rice mills	9	11	12	12	12	15	16	21	22	25	31	31	46	47	47	50	51	51
2. Saw mills	4	4	4	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
3. Ice plants	2	2	2	2	2	3	4	4	4	4	4	4	4	4	4	4	4	4
4. Printing plant	..	..	..	..	..	..	..	..	..	..	1	1	1	1	1	1	1	1
5. Vegetable oil pressing mill	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1
6. Cloth dyeing plant	..	..	..	..	..	..	..	..	..	..	..	..	..	1	1	1	1	1
7. Foundry or metal turning shop	1	1	1	1	2	3	3	3	3	3	4	4	4	4	4	4	4	4
8. Engine repair shop	3	3	3	3	4	5	6	8	9	11	16	17	21	22	24	24	24	24
9. Sugar factory	..	..	..	..	..	2	2	2	2	2	2	2	2	2	2	2	2	2
10. Rubber products	..	..	..	..	..	..	..	..	..	..	..	3	3	3	3	3	3	3
11. Lac-shellac factory	..	..	..	..	..	..	..	..	..	..	1	1	1	1	1	1	1	1
12. Mechanized, edible flour mill	..	..	..	..	..	..	..	..	..	..	1	1	1	1	1	1	1	1
13. Mechanized abbatoir	..	..	..	..	1	1	1	1	1	1	1	1	1	1	2	2	2	2
14. Mechanized, food from flour mill	..	1	1	2	4	4	4	4	4	4	5	6	6	6	6	6	6	6
15. Mechanized soft drink factory	..	..	..	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
16. Cloth factory	..	..	..	..	..	..	..	..	..	..	..	..	..	..	2	2	2	2
17. Hide curing factory	..	..	..	..	..	..	..	1	1	1	1	1	1	1	1	1	1	1
18. Mechanized stone-grinding-crushing factory	..	..	..	..	..	..	..	..	..	2	3	6	6	7	9	10	11	12
19. Galvanized metal	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1
20. Boat building-repair	5	5	5	5	5	5	7	7	8	9	9	9	9	11	11	11	17	17
21. Sedge mat factory	..	..	..	..	..	..	2	2	2	2	2	2	5	5	5	5	5	5
TOTAL	24	27	28	32	37	43	50	58	61	67	85	91	116	121	127	132	140	143

Source: Unpublished changwat statistics.

[a]Data for amphoe Min Buri is excluded from the table.

[b]Large increase in rice mills from 1961 to 1962 due to variations in time series data.

sidiary to basic employment in agriculture. Several examples will illustrate this pattern. In amphoe Lam Luk Ka there were thirty to forty households engaged part-time in the production of takraw, woven rattan balls used in a traditional Thai ball game. All of these families were primarily engaged in wet-paddy cultivation and takraw production as a home industry was a secondary source of income pursued only during periods of slack agricultural activity. Along many of the smaller canals north of Bangkok in changwats Pathum Thani, Nontha Buri, Ayutthaya, Ang Thong, Sing Buri, Lop Buri, and Chai Nat small brick yards produce fired bricks from locally available raw materials. Farm families utilizing rice straw, clay, and paddy husk make these bricks during the dry season when agricultural activities are limited and either market them locally or sell in bulk lots to wholesale brick dealers.

Industrial Growth and Road Development

The functional activities of industries located within the central plain are primarily confined to processing and manufacturing. Almost 50 percent of the industries listed in Table 18 can be considered processing industries and an additional 28 percent as manufacturing. The remaining 22 percent are a functional mixture of processing-manufacturing and service industries. The impact of road development upon industrial growth, defined in terms ofthe increase in registered units, has been varied. Industrial growth rates ranged from zero to 240 percent under varying road development conditions and actual numerical

increases have frequently been small. The highest average annual rates of growth in the amphoe under study have occurred during periods of non-transitional road development. The comparative growth rates for all road and control amphoe over the period under study, and for road development amphoe separately during transitional and non-transitional periods are shown in Figure 19. Industrial growth rates were consistently higher in road development areas over the period 1950 to 1967 than within control areas.[1] This might tend to indicate that road development and improved road transport facilities are more effective in stimulating industrial growth than existing water transport facilities.

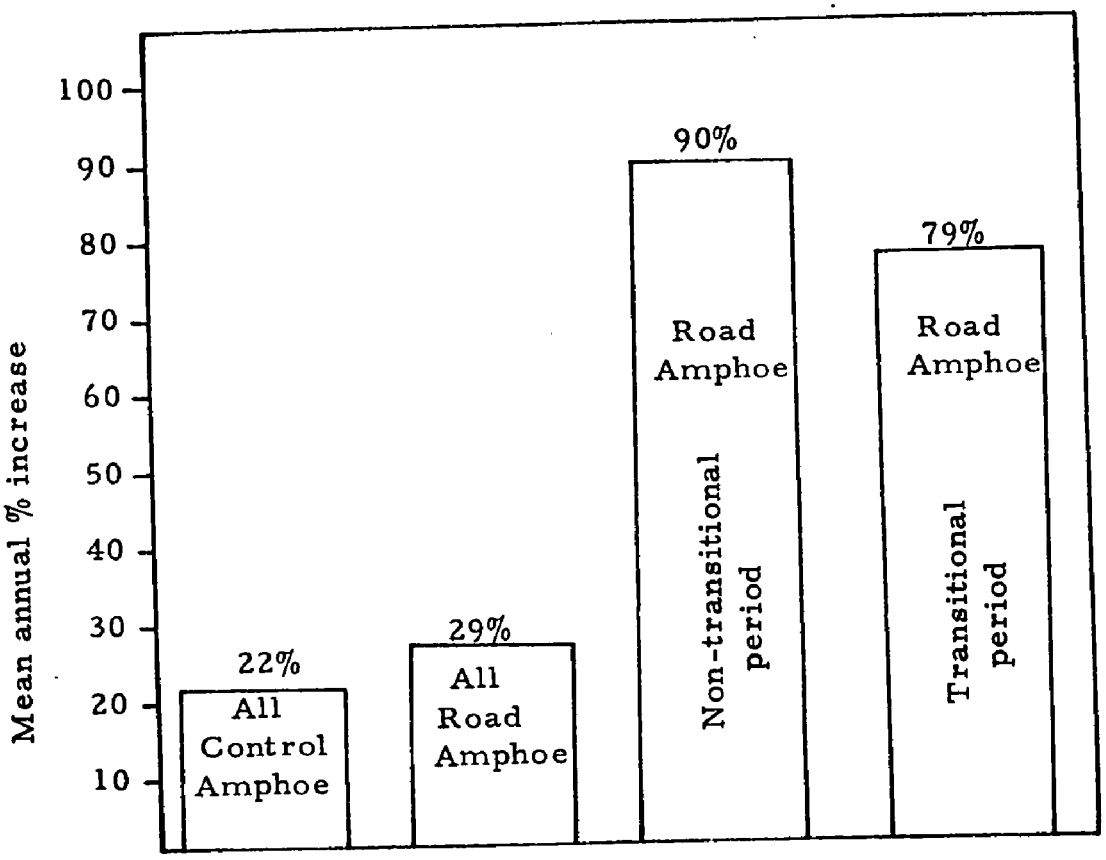

Fig. 19 -- Annual Industrial Growth Rates for Survey Amphoe During Different Road Development Periods.

[1] Individual Industrial Growth Profiles for survey amphoe are located in Appendix V.

The mean annual rate of industrial growth in all road amphoe during the years covered by non-transitional road development was ninety percent, while during the periods of transitional road development the mean annual rate of growth was only 79 percent. The greater growth during the former period suggests several things about he composite nature of industrial establishments and the possible negative impact of road development on industrial growth. The improvements in road surfaces from seasonal to all-weather, year-round conditions may encourage entrepreneurs to utilize the improved transport conditions and access to distribution systems by expanding production rather than building new factories.[1] This type of motivation may be especially relevant under conditions in which the bulk of local industry is directly dependent upon agriculture for its raw materials. Over 50 percent of all industries operating in survey amphoe were engaged in the processing of agricultural produce or manufacturing of products derived from agricultural materials. The limited marketing hinterlands of many of the rural industries are further reduced when transport conditions are improved. Local food processing and manufacturing industries often experienced a reduction in local demand for their products once consumer mobility increased through improved transport conditions.

Three notable exceptions to the pattern of lower rates of industrial growth following improvements in transport conditions occurred. In

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[1]Unfortunately, industrial output data for individual units were not available to corroborate this point.

amphoe Krathum Baen, thirty-five kilometers west of Bangkok by road, industrial growth during transitional road development was 230 percent. The closeness of this amphoe to Thon Buri and Bangkok and the predominance of manufacturing among the newly registered industries partially explains this growth. Improved road conditions, availability of land for factory construction, and lower operating costs motivated many of these units to locate in this area. Over 16 percent of all registered industries in survey amphoe (excluding rice mills, saw mills, and ice plants) were located in this amphoe.[1] Only one, or 7 percent of the total, is dependent upon local resources. Two of these industries, a cloth dyeing plant and the pre-cast pipe factory, were relocated from Bangkok. The rubber products plants, towel and clothing plants, and the lac-shellac factory all import raw materials and ship finished products to Bangkok by truck for distribution. In amphoe Damnoen Saduak, sixty-five kilometers further west, a similarly high percentage increase in industrial units has occurred during the transitional period of road development. The composition of this 238 percent increase is limited to boat and vehicle engine repair shops; and thirteen boat building yards. The boat builders are for the most part engaged in the construction of the hang-yao type passenger boat used in short-haul passenger traffic

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[1]Newly registered factories included a printing plant; dyeing factory, three rubber products plants, lac-shellac factory, two towel and clothing plants, a pre-cast pipe factory, and five sedge mat factories.

along khlong Damoen Saduak.[1] The engine repair shops reflect the increased use of motorized passenger craft and the expansion of locally based commercial bus and truck services. The only processing or manufacturing plant, a coconut dessicating factory, was established along the road in 1965. The two primary factors influencing the decision to locate the plant here were stated by the manager to be (1) the availability of surplus coconuts in the amphoe, and (2) the access to and convenience of road transportation. This plant is export oriented, supported with Thai capital and Japanese machinery, and uses its own trucks to ship the coir fibre to Bangkok. The only other area where any significant increase in registered industrial units occurred was in amphoe Tha Rua, also relatively close to Bangkok. Over 81 percent cent of the industries registered during the period of transitional road development were engaged in the crushing, grading, and shipment of stone and gravel. The first of these plants was built in 1955 and in 1967 there were a total of eight units in operation, seven having been built since 1959. Four factors appear to have been responsible for the increase in these plants: (1) the prohibition from operating stone crushing plants within the municipal area in amphoe Muang Sara Buri, (2) the

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[1] The hang-yao type passenger boat so-called because of the use of long-shafted outboard motors is a light (less than one ton gross), shallow draft (.4-.6 meters) passenger boat used for local and medium long haul passenger and/or cargo operations. These boats range in length from a few meters to over eleven meters and are often fitted with powerful (11-20 horsepower) marine diesel engines. They are usually constructed of light plywood and seat two people abreast.

improvement in road transport conditions enabling the use of ten-wheeled trucks to carry the quarried stone, (3) the availability of cheap barge transport on a year-round basis in amphoe Tha Rua, and (4) proximity to the stone quarries at Khao-khao and Khao-leo, eighteen kilometers north of amphoe Tha Rua. The quarried stone is crushed and sold locally to individual barge operators and buyers or shipped by barge to areas outside of the amphoe. In each of these three amphoe the development of road transport conditions has been a major factor in the increase in industrial units.

The absence of any significant spatial pattern in the rates of industrial growth within the central plain reflects the marginal capacity of road development to stimulate industrial growth and the predominance of resource oriented industries in this region.[1] It is not surprising, therefore, that rice mills constituted over 36 percent of all the industrial units registered in the survey amphoe. The largest numbers of industrial establishments and the greatest diversity in types of industries were found in amphoe located close to Bangkok and Thon Buri. Over 34 percent of all the registered industrial units engaged in the manufacturing or processing of products of non-agricultural origin were found

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[1] While there is little reason to believe that industrial growth might be more rapid in upland areas following road development than in lowland, wet-rice areas, particularly in light of the spatial and functional character of the Thai industrial sector, a USOM study in Chieng Rai province reported that "Private investment in light industry and transportation services has been stimulated by the Chieng Rai security road...". (United States, United States Operations Mission-Thailand, Research Division. "A Cost-Benefit Study of Roads in North and Northeast Thailand," Bangkok, August 31, 1966, p. 2.)

within a radius of thirty kilometers of these urban areas, and all such units were located within 100 kilometers. If the stone crushing plants at amphoe Tha Rua are omitted from this category, then over 64 percent of all industrial units producing products of non-agricultural origin were located within thirty kilometers of Bangkok and Thon Buri.

In road development amphoe the trend toward locating new industry along roadways is apparently more pronounced than in the past. However, this is dependent upon the type of industry. Rice mills have, in general, preferred locations along waterways, which are more convenient for the collection and shipment of paddy and rice. In several cases rice mills which mill paddy for export rather than local consumption have built access roads to the developed road. In amphoe Khok Samrong one mill was completely relocated from a site four kilometers east of the developed road to a point along the road. Although no quantitative data are available, except for survey amphoe, it would appear that considerably less than 50 percent of the existing mills have or use trucks for paddy collection or rice shipment. From the total sample of rice mills taken, 41 percent were located along waterways, 9 percent along roads, and 50 percent had access to both road and water transport. This proportionate distribution is probably incorrect in terms of the entire central plain where canal located mills probably constitute over 60 percent of the total. However, many mills now give priority to road transport. One example is the Sahamit Rice Mill located on the Tachin River in amphoe Krathum Baen. Up until 1958 this mill had

used its own barges and tow boats to ship rice to Bangkok, but since the road was improved the mill has begun to rent trucks locally for shipment of rice by road. The comparative speed of road over water transport was instrumental in causing this change in method of shipment.[1]

While access to road transport is increasingly desired for some new manufacturing and processing plants the availability of waterways for transport and operational needs is also an important consideration. Sawmills and ice factories of course require sites along waterways for convenience of production. Several operators of cloth printing and dyeing plants located along roads stated that access to water for dyeing and waste discharge was also an important consideration. Two of the industries most directly related to water transportation, boat builders and engine repair shops, are consistently found with access to a waterway. The stone crushing plants in amphoe Tha Rua are located so as to have access to road transport for receipt of the quarried stone and water transport for shipment of gravel.

The preceding discussion has attempted to assess the effect of road development upon industrial growth. Industrial growth rates in all survey amphoe were consistently low, with only three exceptions. While the improvement of road surfaces and transport facilities does not appear to have had any measurable effect on industrial growth except within very limited distances from Bangkok and Thon Buri, it continues to be an im-

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[1] The speed with which rice can be delivered to Bangkok is often instrumental in enabling the miller or shipper to obtain an optimum price in the Bangkok market during short and infrequent periods of price fluctuation.

portant consideration in location of new industries. Within the limits defined by available data and the absence of output figures it is only possible to conclude that road development considered independently of other variables is not an important factor in industrial growth. [1]

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[1] Among the range of factors often proposed as inhibiting industrial growth in Thailand the following ones present the general magnitude of the problem: (1) high costs of land in the major market and trade centers, especially Bangkok, (2) high costs of electric power in urban areas and the frequent limitations on its availability, (3) inadequacy of the transport system, (4) lack of skilled labor, (5) vague zoning regulations in Bangkok, and (5) various organizational and financial limitations.

CHAPTER VI

RURAL ECONOMIC ORGANIZATION

The characteristics of the rural economy of Thailand and its organizational structure are not dissimilar from other market oriented peasant economies in developing countries. The generally small-scale of producing units, technological simplicity, limited capital availability, and the existence of a monitized, market exchange system are all characteristic of this type of economic system. In the course of the economic development process numerous changes in the rural economy are expected and in fact programmed as part of the drive to increase the economic growth rate. Developmental investment in the transport system, as one aspect of the expanding infrastructure, can produce various changes in the operations and organizational structure of the rural economy. The following pages investigate the impact of transport development on two important facets of rural economic organization; market size and available services, and marketing patterns. This discussion includes an analysis of the growth in available services and functional units (shops) in market centers, and changes in the position of these market centers within the hierarchy of central places.

Although no studies have been conducted in Thailand concerning the ordering of central places, extent of market trading areas, and consumer behavior patterns it would appear that the basic tenets of classical central place theory are applicable to conditions in Thailand.[1] It is also conceivable that the application of the spatial ordering of places described by Skinner in his article on China may be relevant within certain limits for Thailand.[2] In order to facilitate a clearer analysis of the impact of transportation development on market size and functions a simple five order hierarchy of market places was proposed. These individual levels have been termed social, minor, standard, intermediate, and central markets in ascending order of complexity.[3] The three lower levels of this hierarchy are supported

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[1]The exposition of this theoretical concept is found in C. Baskin, The Central Places of Southern Germany, (Englewood Cliffs: Prentice Hall, Inc., 1966) which is a translation of the original statement of central place theory made by Walter Christaller in 1933; and A. Losch, The Economics of Location, trans. by W. H. Woglom and W. F. Stolper, (New Haven: Yale University Press, 1954).

[2]G. W. Skinner, "Marketing and Social Structure in Rural China, Part I," The Journal of Asian Studies, XXIV (November, 1964), pp. 6-8.

[3]The social market is characterized by the absence of any marketing functions for agricultural produce, a small number (less than fifteen) of retail shops, very limited retail functions, and most importantly, as a center for social contact and interaction. The minor market usually has a service area of multi-tambon size, and marketing activities for agricultural produce are on a horizontal rather than vertical level. The standard markets are synonymous with the district (amphoe) capitals and a broad range of trade, marketing, and consumer services are available. These markets also serve as primary processing, collection, and distribution centers for agricultural produce which is inserted into the vertical marketing network. Administrative functions associated with the district capital are important characteristics of market places at this level.

by field observations and quantitative data, but the intermediate and central markets which appear to be logical extensions of the hierarchy in Thailand are based entirely on field observation and the existence of administrative, commercial, and trade activities associated with certain political units. Whether this categorization of market places within a central place hierarchy would withstand a more rigorous examination along traditional central place lines is relatively unimportant since its primary purpose here is to facilitate the investigation of the influence of transportation development on market size and functions.

Market Growth and Road Development

Of rural institutions, the market is probably one of the most responsive to improvements in local transport facilities and conditions. Improvements in road surfaces, establishment of bus services and commercial truck shipment, and even increases in waterway passenger transport services are reflected in changes in market size and functions. Changes in market size often occurred simultaneously with road development and frequently antedated this development. A closer examination of market growth rates through time and under varying road conditions will provide some insight in the relationship between road development and market growth. [1]

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[1]Market growth rates as used here are simply the percentage increase in operating shop units within any market over a one year period.

Average annual rates of market growth for all markets in survey amphoe during the period from 1945 to 1967 showed considerable variation. Since many of the newer markets, particularly those in amphoe Bang Yai, Lat Bua Luang, and Damnoen Saduak, have only become established within the last fifteen years it was difficult to obtain comparative time series data. The fact that the time period under consideration overlaps the immediate post World War II years was also influential in producing variations in growth rates. Utilizing the mean annual growth rate for markets in road development areas during various stages of transport development did produce however, some rather clear patterns. These mean annual growth rates for the three main periods of road development are shown in Figure 20 for all road development amphoe. It is immediately evident that the most rapid growth occurred during periods of transitional road development. The figure of 16.7 per cent is significantly greater than growth rates in either the pre- or post-road development periods. The differential rates of market growth between the pre- and post-road development periods can be explained primarily by the rapid growth in one market. In amphoe Damnoen Saduak a new market established in 1955 grew at a rate of 40 per cent per year in the pre-road development period.[1]

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[1] This high rate of growth should not be misinterpreted, particularly during this formative period, since even small annual increments of one or two new shops would result in marked percentage increases in the growth rate.

Soon after this market opened it became the amphoe terminal for inter-changwat bus services and shops opened rapidly over a four year period, although there were only thirteen shops here in 1967. If the growth rate of this one market is excluded from calculations of the mean for the pre-road development period the mean then becomes 6.1 percent per year, comparable to the post-road development period.

Unfortunately, the differential in market growth rates between road amphoe and control amphoe is not accurately recorded in the

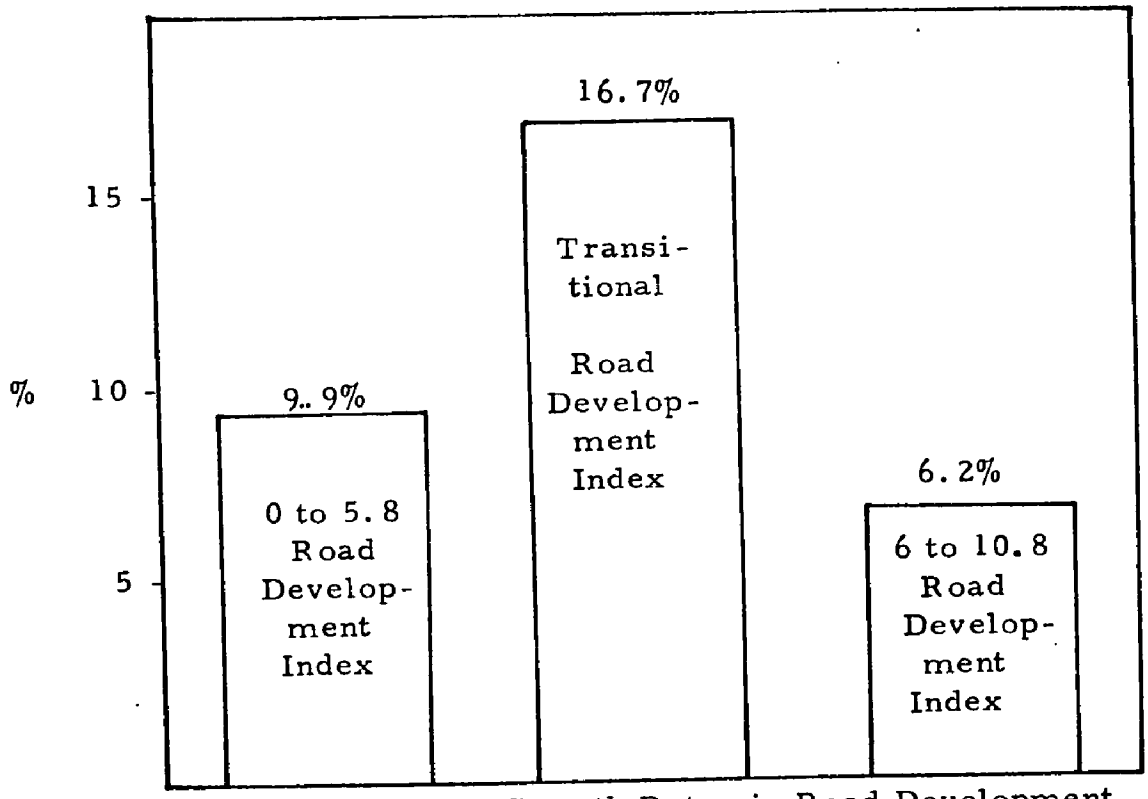

Fig. 20 -- Mean Annual Market Growth Rates in Road Development Amphoe During Road Development Periods.[1]

[1]Market census data for amphoe Sam Chuk and Khok Samrong were not available and are therefore not included in this graph.

available data. Since there were no comparative periods of transport development in control amphoe it was necessary to rely on the mean annual growth rate for the entire period of the survey. In amphoe Bang Yai from 1949 to 1967 the market grew at a rate of almost 90 per cent per year while in amphoe Lat Bua Luang over the same period market growth never exceeded 11 per cent per year. Several factors appear to have been important in the growth of the Bang Yai market and may help to qualify its very high rate of growth and also to emphasize the differential in market growth rate between road and control amphoe.

From 1949 to 1955, there was only one shop in the Bang Yai market, located at the junction of khlongs Thawiwattana and Bang Yai. In 1955 khlong Thawiwattana was dredged by the Royal Irrigation Department. This increase in khlong depth improved local transport conditions and enabled wet-paddy farmers to begin double-cropping. Subsequently, the market almost doubled in size each year. The fact that the market did not grow at all in this early period substantiates to a limited extent the differential in market growth rates between road and control amphoe. The situation in amphoe Lat Bua Luang does support this argument. On the other hand, the rapid growth in the market after 1955 suggests that stimulants to market growth other than improvements in transportation facilities were of some importance.

Since market census data were not available in amphoe Khok Samrong a survey of shop building construction was used as an indi-

cator of the relationship of road development to market growth. Between 1959 and 1967 a total of fifteen new shop buildings were built housing sixty-eight new shop units. Over 92 per cent of these shop units were constructed during the period of transitional road development. This number of new shop units constituted almost one-third of all functional shop units in the market as of December, 1967. While this construction of new shops added significantly to the size of the market it was still within the range of growth experienced by other markets in upland environments. Increases in the number of commercial shop units in markets in Lomksak, Phitsanulok, Maha Sarakham, and Kalasin over periods of seven years in which road development occurred averaged 17.7 per cent per year with a range of 12 to 20 per cent.[1] This mean annual growth rate in markets located in upland environments corresponds closely to the 16.7 per cent rate of growth for all markets in road survey amphoe. On the basis of these figures and the similarity in survey techniques it is possible to conclude that environmental

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[1]Jones and Orr reported in a study of twenty-five villages, located in six provinces along Accelerated Rural Development roads (ARD), that a net gain of 20 per cent in one year in commercial shops occurred in these northeastern villages. (Jones and Orr, "Exploratory Study" p. 5). Patanapanich in his study of the East-West Highway from 1957 to 1963 shows that the annual percentage increase in shop units in the provincial capitals of Lomsak and Phitsanulok were 12 and 20 per cent respectively (Patanapanich, "East-West Highway," pp. 44-46). Similar rates of commercial growth were recorded for markets along the Khon Kaen-Yang Talad feeder road by Jittasatra. (Jittasatra, "Khon Kaen-Yang Talad", pp. 55-61)

conditions in Thailand have not been significant factors in determining the rate of market growth related to transportation development.

While it is apparent that improvements in transport conditions from seasonal to all-weather show a marked correlation with increases in market size, it has not been possible to determine if further upgrading of all-weather roads from a loose to hard surface (asphalt, macadam, asphaltic-concrete) contributes to sustained or increased market growth. In 50 per cent of the amphoe in which post-development improvements in all-weather roads to some hard surface were made a sustained or slightly increased rate of market growth resulted. The smallness of these increases suggests however, that transitional improvements in roads from seasonal to all-weather is of more immediate and long-term significance than any subsequent addition of hard top road surfaces.

The Market Hierarchy: Expansion in services and functional units

One of the most ubiquitous characteristics of the rural market place in Southeast Asia is the prevalence of the small, invariably one-roomed, multi-purpose shop. These shops offer a small but varied selection of consumer goods, fresh produce, luxury items, and hardware and seldom appear to deal in any one particular good or service. The apparent absence of a more widespread specialization in retail or wholesale activities is partially the result of an abundance of part-time, small-scale traders and vendors. The wet-paddy farmer

who sells prepared foods or fresh produce during the months between harvest and planting or the farm wife who retails surplus garden produce locally, both contribute to a mechanism which limits the development of specialized retail and wholesale establishments in rural markets. These part-time traders are not motivated by any strong need to obtain high profit margins in their infrequent dealings and therefore are more easily able to bear risks. The specialized trader who deals in fresh produce or luxury goods however, can't afford to deal in such small volumes or sell below a certain profit margin. These innumerable part-time traders then, act as an informal control mechanism on the development of large numbers of specialized commercial establishments.

The marketing services for agricultural produce and the retailing of consumer goods in the central plain are handled by a large number of small-scale retail merchants and specialized crop dealers and wholesalers. With the improvement of local transport facilities in the central plain an evident change in the number of shop units and services available in markets has occurred. These changes in available services and shops (functional units) can be directly related to the type and quality of improvements in transport facilities and the levels at which individual markets are located in the hierarchy of market places.

If the number of functional units and available services in each survey market are plotted for any particular year a very definite pattern emerges. Individual markets form distinct clusters which

exhibit considerable conformity to the previously stated levels of market places. Figure 21 shows the positions of each market surveyed for the pre- and post-road development periods. Individual markets have been numbered in relation to the data in Table 19. In the pre-road period two distinct clusters of standard and minor markets are evident with one cluster of emerging incipient minor markets. Reference to Table 19 will indicate that the markets at amphoe San Chuk and Khok Samrong have been excluded from the pre-road period due to the inavailability of data and that the newly emerging social markets at amphoe Bang Yai and Damnoen Saduak are too small to be recorded. In the post-road development period the same clusters of standard and minor markets exist, but there has been a change in the level in the hierarchy for several markets and one market has experienced almost no growth.

The standard markets as a group have remained unchanged in terms of their ranking in the hierarchy. Their positions before and after transport development reflect only a slight reordering within the standard market level with amphoe Min Buri undergoing the most noticeable change. Although amphoe Chumsaeng has no external road connections it is a major collection point along the northern rail line and a district capital which contributes to its size. Recent evidence of inter-regional migration, expanded cultivation of maize, and differences in environmental conditions contribute to its growing market

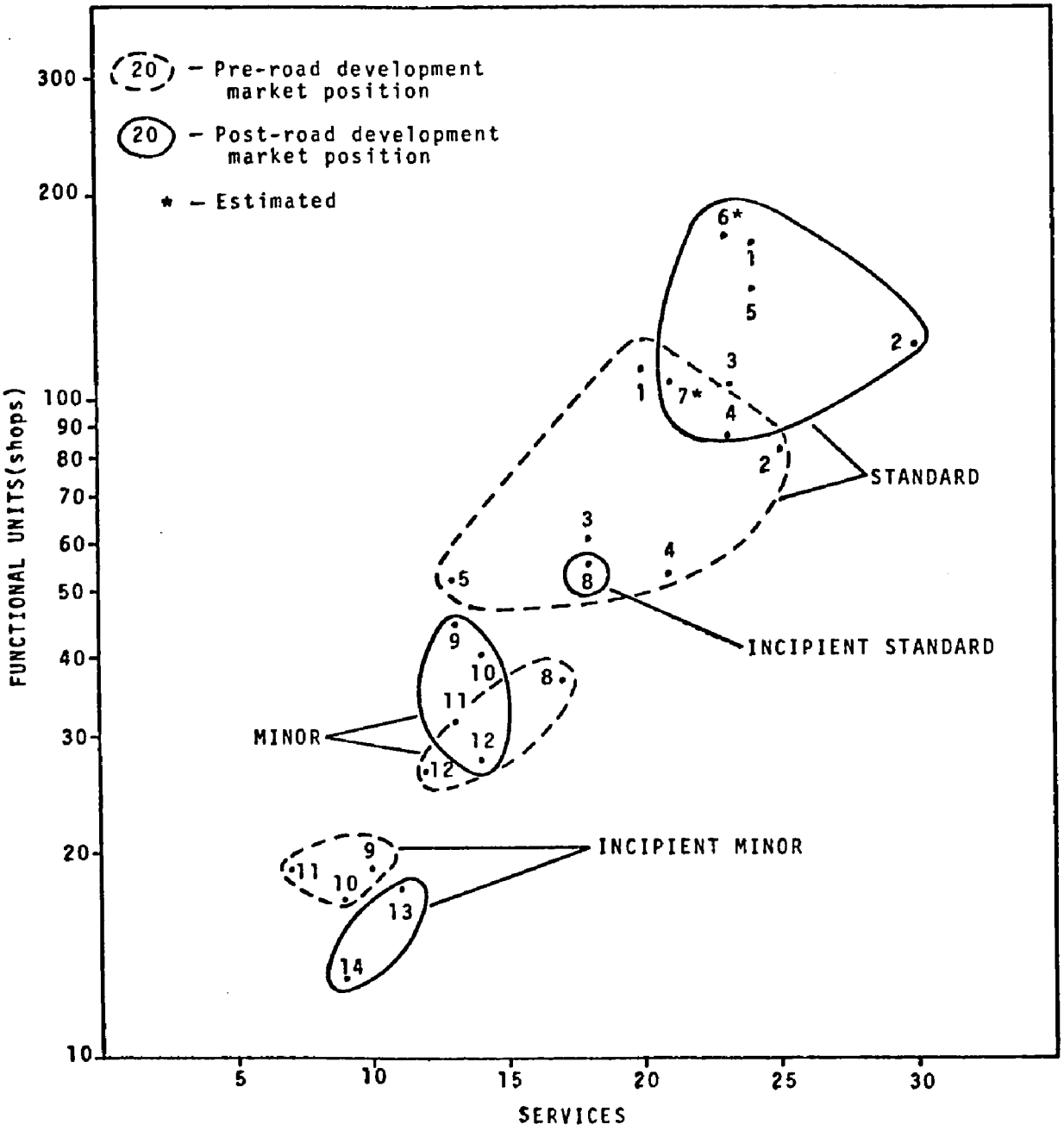

Fig. 21 -- Relationship of Market Services to Functional Units and Market Levels in the Pre-road and Post-road Development Periods for Survey Amphoe.

TABLE 19

FUNCTIONAL-UNIT/SERVICE RATIOS AND MARKET LEVELS IN PRE- AND POST-ROAD DEVELOPMENT PERIODS

Market	Pre-road development period				Post-road development period			
	Services (s)	Functional units (f)	Ratio of f : s	Level in market hierarchy	Services (s)	Functional units (f)	Ratio of f : s	Level in market hierarchy
1. Chumsaeng	20	109	5.5:1	standard	24	171	7.1:1	standard
2. Tha Rua	25	84	3.4:1	standard	30	120	4.0:1	standard
3. Bang Khla	18	61	3.4:1	standard	23	103	4.5:1	standard
4. Krathum Baen	21	54	2.6:1	standard	23	87	3.8:1	standard
5. Min Buri	13	53	4.1:1	standard	24	145	6.0:1	standard
6. Khok Samrong[a]	..	..	..	standard[e]	23[e]	174[e]	7.6:1[e]	standard[e]
7. Sam Chuk[a]	..	..	..	standard[e]	22[e]	107[e]	4.8:1[e]	standard[e]
8. Sanphaya	17	37	2.8:1	minor	18	56	3.1:1	incipient standard
9. Lat Bua Luang[b]	10	19	1.9:1	incipient minor	13	45	3.5:1	minor
10. Muang Chachoengsao[c]	9	17	1.9:1	incipient minor	14	41	2.7:1	minor
11. Nong Sua[d]	7	19	2.7:1	incipient minor	13	32	2.4:1	minor
12. Lam Luk Ka	12	27	2.3:1	minor	14	27	1.9:1	minor
13. Bang Yai[b]	4	4	1.0:1	social	11	18	1.6:1	incipient minor
14. Damnoen Saduak	3	3	1.0:1	social	9	13	1.4:1	incipient minor

[a] Data not available for pre- and post-road periods.

[b] Census period designated for these control amphoe were 1957 for the pre-road period and 1967 for the post-road period.

[c] Market of survey located on khlong Thakhai (Thakhai market) not the primary market at amphoe Muang.

[d] Market of survey located at junction of khlong 10 and khlong Rangsit. Although located outside the amphoe this is the primary market for amphoe Nong Sua. (Vertical canals in Rangsit are numbered consecutively from west to east beginning with No. 1.)

[e] estimated

and large service area.[1] Even with the limited data that are available there are strong indications that the standard market at amphoe Khok Samrong has grown appreciably. The elevation of its position within the standard market level between the pre- and post-road development periods is probably comparable with or in excess of the expansion experienced by the amphoe Min Buri market.[2] The improvement of transport facilities has been an important factor in this development.

The emergence of the new incipient standard market at amphoe Sanphaya is indicative of one way in which transport development has affected markets. The service area of this market has been restricted for many years by the larger intermediate market at amphoe Muang Chai Nat and the commercial and occupational complex centered on the Chaophraya Dam. A large number of residents in amphoe Sanphaya are actually employees at the dam and in the past have often found it more convenient to conduct their marketing activities at amphoe Muang Chai Nat due to its accessibility and proximity to their place of work. The construction of the all-weather road connecting this amphoe with the dam, amphoe Muang Chainat, and provincial capitals to the south

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[1]See E. C. Chapman and A. Allen, "Internal Migration in Thailand," Paper presented to the ANZAAS Conference, Hobart, Tasmania, August, 1965; and supra, n.1, p. 72.

[2]The Min Buri market had a sustained growth rate of over 11 per cent per year during the transitional and post-road development periods which was the highest among all standard markets.

has done much to increase the size of the market.[1] Much of this increase in functional units can be related to the improved accessibility of the market to residents who are employed at the dam and the increasing use of the amphoe as a dormitory settlement for dam employees (see infra, p. 217). On the other hand, this development of transport facilities has drawn many potential consumers to more distant markets resulting in the very small increase in available services shown in Figure 21 and Table 19. There is some reason to believe that these factors, among others, may continue to prevent future development of the market to the standard market level.

Among the minor markets those in amphoe Lat Bua Luang, Muang Chachoengsao, and Nong Sua have moved up from positions as incipient minor markets in the pre-road development period. The market at amphoe Lam Luk Ka has actually declined in importance although its position as a minor market remained unchanged after road development. The poor quality of the new road and its highly seasonal utility have negated any benefit it might have contributed to market growth. The service area of this market has also been increasingly dominated by a rapidly growing market at Saphan Mai, Don Muang, amphoe Bang Khen, just to the southwest. It is doubtful whether road development in this case would have had any beneficial impact on the market at amphoe Lam Luk Ka since its services have been eclipsed by the Saphan Mai

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[1] The amphoe Sanphaya market had the highest rate of growth in transitional road development period (10.8 per cent/year) of the pre-road minor markets

market which is more easily and conveniently reached by water transport.[1] The major exception to minor or incipient minor market growth stimulated in part by transport development was in amphoe Lat Bua Luang. During the period under study the number of services increased by only three in this market, while the number of functional units expanded by two and one-half times. This entire change in the market is primarily related to modifications in agricultural cropping patterns and immigration of market gardeners. The conversion of large areas of wet paddy to market gardens by migrant gardeners in the early 1960's stimulated an increased local demand for consumer goods, clothing, basic services, hardware, and agricultural supplies. As soil fertility declined after one to three years many of the migrant gardeners moved elsewhere leaving behind a newly built block of concrete shops unoccupied. The importance of this loss of consumers to the local retail market is reflected in the increasing numbers of merchants who have begun to hawk their wares by boat outside of the market since they are unable to retail them among the reduced population of consumers. The impact of road development on the minor market at amphoe Nong Sua, especially in terms of the proportionate

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[1]The Saphan Mai market has grown significantly since 1960. Much of this growth is a response to the increasing buildup of Thai military personnel and their dependants who live and work nearby. This market has become the primary retail and service center for the military and civilian population who staff the nearby Don Muang military and commercial airfields, Thai Air Force Academy, and similar installations.

growth of services to functional units, is significant and will be discussed in the following pages.

The establishment of the two social markets in the pre-road development period and their subsequent development into incipient minor markets emphasizes the importance of road and water transport in stimulating market growth. The relationship of market growth to transport development in these markets has already been mentioned (supra, p. 161-163). The development of the amphoe Bang Yai market is indicative of conditions under which improvements in local waterways can contribute to the growth of local markets.

The increase in functional units in markets has been accompanied by varying changes in the number of available services. The numerical increases in services and changes in the functional unit-service ratio for separate markets are shown in Table 19. Standard markets as a group have exhibited a much higher percentage change in the functional unit-service ratio between the pre- and post-road development periods than have minor markets. This represents a more disproportionate increase in functional units than services. Among minor markets this percentage change has been significantly lower suggesting a more equitable increase in services during periods of road development. The mean percentage increases in this ratio between the pre- and post-road development periods for standard, minor, and social markets are shown in Figure 22. The implication of these differences is that the improvement of transport facilities serving minor and incipient minor

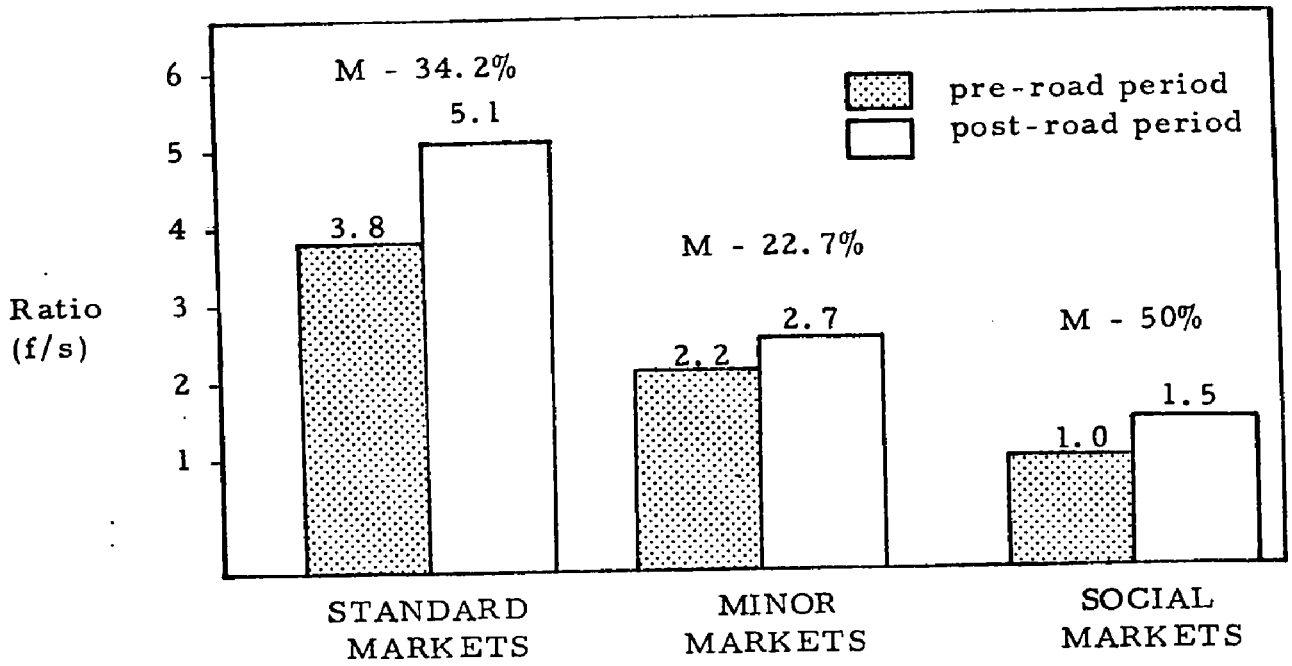

Fig. 22 -- Mean Functional Unit-Service Ratios and Percentage Increase in Ratios by Market Class During the Pre- and Post-road Development Periods

markets may contribute to a more rapid expansion of available services than has occurred among standard markets. This pattern reflects not only the developing nature of minor markets and their comparatively smaller size, but their expanding service areas and transitional position between standard markets. The 50 percent change in the functional unit-service ratio in social markets is misleading since these markets are so small that even minimal increases in shops or available services result in a large percentage change in the ratio. Nevertheless, initially rapid expansion of the number of functional units after transport development may not be unusual considering the improved accessibility and wider service area resulting from this development.

The only market in which services grew more rapidly than functional units during the period of road development is located at the junction of khlong 10 and Khlong Rangsit and serves amphoe Nong Sua. The functional unit-service ratio declined from the pre-road development period by 0.3 even though the number of functional units increased by thirteen. This disproportionate growth in services is related to the surfacing of the Rangsit road (National Highway No. 305) with asphalt to a point just east of the market and its central location halfway between the standard market at amphoe Ongkharak, changwat Nakhon Nayok and Rangsit market along National Highway No. 1 to the west. The khlong 10 market has also become a central distribution center for consumer goods and certain staple items such as charcoal for much of the eastern half of the Rangsit Irrigation Project area. This new function as a distribution center is a response to the disruption of normal waterway shipment patterns by the closing of a regulator across khlong Rangsit during low water periods and improved road shipment conditions.

The development of roads in the central plain has served as an important stimulant to the growth of markets, particularly where these improvements have resulted in annual rather than season accessibility to the market. The quality of developed road surface has also been influential in contributing to continued growth or stagnation and contraction in market services and functional units. To suggest however, that road development per se is the primary or only stimulant to this

growth would be incorrect since other factors such as rapid increases in population, changes in consumer demand, and even development of waterways have been important as well.

Traditional Marketing Patterns

The process of trade and marketing of agricultural produce within the central plain has traditionally been controlled by the entrepreneurial and economically dominant ethnic Chinese minority. Chinese control of the trade in rice, various fresh produce, pepper, sugar products, and other commodities dates at least to the early ninteenth century, and possibly earlier.[1] The Thai farmer has exercised little or no control over the sale and disposition of his crops. The reasons for his circumscribed role in the marketing process are varied but include a general apathy on the part of Thai males toward commercial activities, the absence of any effective price intelligence system, and the frequent financial instability of the farmer which restricts his withholding power. These among other factors have resulted in the sale of most of the farmer's annual crop immediately following harvest. The withholding of rice and paddy some months after its harvest or processing to be sold later in the year when prices rise is a more common practice among rice millers and dealers than farmers. The

[1]Wales indicates that the practice of tax farming (bhasi), a modified form of the general tax (akara) established during the Ayutthaya period, became very prevalent during the third reign (1824 - 1851) of the Bangkok Dynasty, and was controlled by ethnic Chinese. (Wales, Ancient Siamese, pp. 198 - 225)

absence of adequate storage facilities on most farms and the frequently large debts incurred prior to harvest limit the ability of the farmer to withhold his crops and thus obtain an optimum price.

The purchase of paddy from farmers following harvest is normally handled by several types of individuals. A large number of persons engaged in buying and reselling paddy do so only on a seasonal basis. For greater simplicity in identifying the types of dealers handling paddy and rice this part-time dealer has been termed a local paddy dealer. This group of merchants involves those handling paddy and rice on a part-time basis in local markets while engaging in some other form of full-time commercial activity such as operating a general store, grocery, or similar enterprise.[1] Almost all local markets have dealers of this type. A second type of individual engaged in the rice trade is the merchant-broker who may handle paddy in addition to other commodities. The merchant-broker normally operates as both

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[1]Uthid Narksawad indicates that from a sample of 257 rice traders taken in 1957, 61 per cent were engaged in commercial activities in addition to rice and paddy trading. The most common ancillary activity was grocery shop operator with 59.24 per cent followed by fabric business with 14.01 per cent.
ประเทศไทย, กระทรวงเกษตร กองเศรษฐกิจการเกษตร ภาระหนี้สินของชาวนาและการค้าข้าวในภาคกลาง ประเทศไทย พ.ศ. ๒๕๐๐-๒๕๐๑ โดยอุทิศ นาคสัมฤทธิ์. กรุงเทพฯ พ.ศ. ๒๕๐๑ หน้า ๑๕๙
(Thailand, Ministry of Agriculture, Division of Agricultural Economics, A Study of Rice Farmers' Indebtedness and Paddy Marketing in the Central Plain of Thailand, 1957-1958, By Uthid Narksawad. Bangkok, 1958., p. 158 [Hereinafter referred to as Narksawad, Rice Farmers' Indebtedness])

a local dealer and wholesaler, shipping rice and paddy to the larger provincial markets and Bangkok for resale to exporters. The merchant-broker may also occasionally act as a middleman or agent for a large exporter. The third major dealer in agricultural produce including rice and paddy is the wholesale-broker who operates from one of the major provincial markets or in Bangkok and Thon Buri. When the wholesale-broker purchases paddy and rice he normally does so from local dealers, merchant-brokers, or rice mills and seldom from farmers. This grain is then resold to exporters or to merchants for retail sales to the consumer. In addition to these merchants the rice miller is often a dealer in paddy and rice, buying directly from farmers as well as local dealers and merchant-brokers. Cooperative societies, landlords, and even barge and "store boat" operators actively engage in the buying and selling of rice and paddy.[1] The types of individuals engaged in the wholesale and retail marketing of paddy are seemingly endless, but those described above are the main elements in the trade.

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[1]The store boat is a small barge (20-50 tons gross) which is fitted with shelves and storage compartments for canned goods, dried foods, condiments, and other food staples and luxury goods. These boats are most often operated by ethnic Chinese merchants who provide retail services in consumer goods to individual households and small shop operators. In addition they often act as wholesale distributors to larger stores and serve as middlemen in the marketing of paddy and rice. The operations of these store boats are primarily confined to areas only accessible by water transport.

The consummation of actual paddy sales between the farmer and paddy buyer normally takes place at the farmers house-lot or field when the buyer comes to collect the grain. The actual agreement for sale may have been completed some months before harvest and the collection of the grain does not necessarily imply that a transfer of cash takes place. Paddy to be kept for home consumption is usually set aside prior to collection of the bulk of the crop so that it may be taken to local rice mills for milling at a later date. The collection and transport of paddy in the central plain has traditionally involved the use of the chala, maad, and sampan style local boats and small cargo barges.[1] These boats are either owned by the local paddy dealer or rice mill or have been rented from local owners. The loading and handling of the paddy are done by the full-time laborers of the paddy dealer or rice miller or by temporary laborers hired by the day or volume of paddy they handle.[2] Rice mills and paddy dealers often hire

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[1]The maad, chala, and sampan are small boats which are characteristically used in local and medium haul produce shipment and trade activities. The maad and chala boats differ in style and construction from the sampan in that they are of the lug maad (dugout) style of boats cut from one piece of wood. The chala boat has no gunnels and is usually of very shallow draft and lacks the squared bow and stern platforms for poling and punting found on the sampan and maad. Each of these boats ranges in length from approximately five to twelve meters and has a cargo capacity of from 0.1 to 2.5 tons gross.

[2]Wages for temporary laborers used in paddy collection varied from amphoe to amphoe during the 1966-1967 harvest season. Some representative wage scales for this type of work were: 10 baht per laborer for each kwien (1,000 kilograms) handled or one-half days work; 10-15 baht per man per day plus 3 baht for food, and 17 baht per man per day plus food.

temporary labor to assist in the collection of paddy when large amounts must be moved and their full-time employees are already busy. Many of the small scale paddy dealers often do not have a complement of full-time laborers and will therefore hire local people besides using unpaid family members to assist in paddy collection.

The use of small produce boats and barges to collect paddy for transport to rice mills and dealer storage areas is a common practice in the central plain. The rental of boats for this purpose is not widespread but rates for hang-yao type boats based on volume carried were as high as 0.50 baht per tang (11 kilograms) and small barges and maad type boats with larger capacities normally rented for ten to twenty baht per day. Small barges with capacities of less than two tons gross, and maad, sampan, and chala boats were the only types consistently used for paddy collection by rice millers and paddy dealers. The type of boat and cargo capacity varied depending upon the amount of paddy to be collected, distance from the mill or godown to the farm lot, and condition of the khlongs which were traveled. Prior to the advent of the long-shafted outboard engine boats were poled over these shorter distances or a sweep oar was used.

Once the paddy has been collected and transported to the dealers' storage area or rice mill it may be immediately resold for export, stored for milling later, or processed into rice locally. The small-scale paddy dealer often does not have facilities for storage of large

volumes of grain and there is consequently a more rapid turnover in his paddy after collection than might occur among rice millers. In many cases paddy dealers indicated that agreements for external shipment of paddy had been made prior to the actual harvest and collection of the grain from farmers. Paddy which has been milled into rice may be resold to local merchants for retailing to consumers, sold to external paddy dealers or wholesalers for redistribution and export, or retained by local dealers for sale later in the year. Paddy which is processed by the rice mill may come directly from farmers, local paddy dealers, or even external dealers. The sources of paddy processed by rice mills interviewed in survey amphoe and the disposition of miller owned rice is shown in Table 20.

TABLE 20. SOURCES AND DISPOSITION OF PADDY AND RICE BY RICE MILL CAPACITY IN SURVEY AMPHOE[a]

	Maximum daily (24hr.) milling capacity in kwien		
	0-5 kwien	6-10 kwien	11 kwien and over
Paddy Source			
Farmers	95%	83%	43%
Paddy dealer	5	17	57
Rice Disposition			
Locally[b]	100	51	37
External	..	49	63

[a]Based on interviews with twenty-two rice mills

[b]Included in rice disposed of locally is that volume of rice owned by farmers and milled locally for their own consumption.

Rice mills with capacities of five kwien or less usually mill paddy only for local farmers home consumption, keeping the husk and bran as payment for their services. This pattern is reflected in the table where 100 per cent of paddy handled by small mills is disposed of locally. As mill capacities increase the percentage of paddy obtained from local farmers decreases and supplies from dealers increase. The larger capacity mills from six to ten kwien and above normally handle smaller amounts of paddy for local farmers' use and larger volumes are miller owned and distributed outside of the local area.

This variation in milling function related to mill capacity has on occasion been modified by fluctuations in rice harvests and amounts of available paddy. In 1966-1967 several mills with capacities of over six kwien reported processing paddy primarily for local farm use and only small volumes for redistribution outside of the immediate location of the mill. This change in milling function is also a cumulative process reflecting competition from other mills, changes in land use which diminish local supplies of paddy, and the trend toward greater decentralization of rice mills outside of the Bangkok-Thon Buri Metropolitan area.

Rice mills as processing and distributional agents in the marketing system frequently have large storage areas within or adjacent to the mill. The storage capacities of rice mills and other types of granaries for the entire country by region for 1956 are shown in Table 21. Uthid Narksawad observed that over 71 per cent of all

TABLE 21

NUMBER AND CAPACITY OF PADDY BARNS AND WAREHOUSES BY SIZE CATEGORY FOR REGIONS OF THAILAND, B. E. 2499(1956)

Storage Capacity	Region			
	Central	Northeast	North	South
10-50 kwien[a]				
Number	21,743	2,233	2,499	102
Capacity	438,216	42,897	34,685	2,463
51-100 kwien				
Number	1,369	251	36	22
Capacity	105,971	21,491	3,230	1,940
100 kwien over				
Number	1,198	435	79	48
Capacity	545,948	247,487	69,247	20,343
Total				
Number	24,310	2,919	2,614	172
Capacity	1,090,135	311,875	107,162	24,746

Source: Narksawad, Rice Farmers' Indebtedness, Table 78, p. 218

[a]One kwien equals 1,000 kilograms

storage barns and warehouses were located in the central plain.[1] No differentiation was made however, between paddy barns owned by farms,

[1]Narksawad, Rice Farmers' Indebtedness, p. 211

rice mill storage facilities, paddy dealer godowns or other storage barns. The average capacity of these various facilities in the central plain is forty-five kwien as compared with an average of 107 kwien for storage units in the northeast. From a limited sample of twenty-two rice mills interviewed in the central plain from 1966 to 1968 it was apparent that storage capacities at rice mills vary greatly depending upon milling capacity and milling function. The largest potential storage capacity among those mills interviewed was 1500 kwien in a rice mill located in changwat Pathum Thani. Millers conveyed the general impression that they seldom utilize their maximum storage capacity. In one instance a miller indicated that he had never used more than 60 per cent of his 900 kwien storage capacity and he normally fills only 5 to 30 per cent of this total. The small local mills with milling capacities of from less than one kwien to around five kwien normally have no storage areas.

The marketing process for maize produced for export is quite similar to that for rice. With the exception of the processing stage involving the rice mill, the participants and patterns of marketing are essentially the same. The environmental differences between the wet-paddy producing regions of the central plain and the uplands surrounding the plain where corn is grown do necessitate the use of different modes of transport. Local collection and shipment of corn from farmer to buyers' storage area have traditionally been conducted by kwien (ox-cart), or by small trucks and tractors. The rapid expansion of land

cultivated in corn in recent years has resulted in an increase in the activities of large commercial corn exporters within these producing regions. These firms deal directly with agents distributed throughout the corn producing areas and also with the large numbers of local merchants and brokers who buy small lots of corn, sorghum, and pulses from local farmers.

Storage facilities for drying shelled corn within the producing area are very limited. Most commercial corn exporters maintain large storage areas and godowns within the terminal market where they store corn, kenaf, jute, cotton and various other produce. In 1959 a survey of twenty-one firms exporting corn revealed that nineteen of the twenty-one had storage facilities for their produce.[1] The total storage capacity of facilities owned by these ninteen firms was 153,700 tons with a mean of 8,090 tons.[2] These firms stored corn as well as a wide range of other upland crops in their godowns.[3] The absence of upcountry silos and bins in the past damaged the corn trade to some degree since shipments, even though sacked, were often left in the open and moisture content upon arrival in Bangkok was frequently unacceptable for export.

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[1]Somsri Lelanuja, "Economic Survey of Business Firms that Exported Corn from Thailand in 1959," Kasetsart University Economic Report No. 21, Faculty of Economic and Cooperative Science, (Bangkok: Kasetsart University, October, 1963) p. 22.

[2]Ibid, p. 23, Table 8, "The Capacity and Use Made of Owned Storage by Firms Exporting Corn"

[3]Stored crops included castor beans, cassava flour, chili, timber, kapok, sticklac, cotton, rice, jute, sesame, salt, sago, and corn.

Local and intra-regional marketing patterns for fresh produce utilize a much wider portion of the total marketing system than either maize or paddy. Individual participants in marketing fresh produce perform functions, however, which are essentially comparable to those of their counterparts engaged in marketing paddy, rice, and maize. The major participants in the marketing of fresh produce are the local merchant-broker, wholesale-broker, exporter, and the functional framework of the local, provincial, and regional fresh produce markets. In addition to these elements there exists a rather extensive network of small-scale, mobile produce vendors cum dealers who operate from boats along the inland waterways at both local and intra-regional levels. Dealers in fresh produce at all levels in the marketing hierarchy are active in trading a much wider variety of produce than is the paddy dealer or maize merchant. The limitations on available volumes and marginal income derived from handling only one or two crops necessitates a more diversified range in produce handled.

Fresh garden produce, vegetables, and fruits which are not grown on a scale sufficient to allow them to be sold in bulk lots to produce dealers are usually retailed in local markets or hawked by boat along local canals. Whether sold in bulk lots or vended along canals, water transport has been the primary mode of transportation in the marketing of this type of produce. Local retail sales are usually accomplished through the use of small single or double occupant

sampan, ii-pae, chala, or maad type boats.[1] Marketing of fresh produce in bulk lots is more conveniently handled by larger sampan, maad, chala boats, and smaller capacity cargo barges.

The physical location of fresh produce sales varies more than with the bulk grain commodities. While sales of fresh produce are more commonly consummated at the farmer or gardeners' houselot where the buyer may collect the produce, producer shipment of this type of crop to the buyers' shop is also a common practice. The transport of bulk lots of fresh produce to external provincial markets or to markets in Bangkok and Thon Buri is an equally common practice. The perishability and delicate nature of many of these crops necessitates their shipment in some form of container. Many crops such as mango, papaya, oranges, and watermelon require special care in handling and shipment. Baskets woven from rattan or bamboo varying in capacity from twenty to 100 kilograms are frequently used to pack fragile produce. Mangoes are often packed in heavy wooden boxes holding about fifty kilograms and labelled with the brokers' name and address so that damage to the fruit will be minimized. Bananas and pineapples constitute the only major exception to this system of containerization. These fruits are usually packed in bulk lots, bananas by the "hand" rather than on stems, and covered with palm branches and straw.

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[1] The ii-pae style boat is one of the smaller, single occupant boats commonly used for local communications and trade activities. (see Supra p. 179, n. 1)

The perishability and frail nature of fresh produce preclude the existence of any important types of storage facilities in either local or terminal markets. Certain types of more durable garden crops such as chilies, peppers, onion, garlic, ginger, and coconuts have been observed being stored in local markets. The storage of these crops is primarily a temporary measure while the local dealer awaits orders, some change in market price, or available transport. Coconuts were the only garden crop which was observed being stored for periods longer than thirty days, and in most cases they were being held pending shipment to local coconut dessication plants.

Road Development and Local Marketing Patterns

Road improvements and associated increases in the availability and use of road transport have resulted in several important changes in the marketing process within the central plain. The most important of these modifications include (1) the increased use of trucks for local collection and export shipment of agricultural produce, (2) a greater refinement or simplicity in the marketing channels for vegetable and fruit crops, (3) a decline in volume of locally marketed fresh produce, and (4) the attenuation of local trade networks. These changes have not been consistent with distance from Bangkok and Thon Buri or type of crop marketed. The marketing of corn and fresh produce have exhibited the most evident changes in marketing procedures with an almost uniform trend toward more direct producer - external wholesale-broker contacts.

The patterns of local disposal of paddy and rice and the export shipment of this grain outside of the producing area have undergone almost no change. Traditional practices of selling paddy to local dealers and rice mills still remain the most common pattern.[1] Improvements in road transport conditions have had little influence on this process. Local marketing patterns for selected crops during the pre- and post-road development periods for a sample of 191 farmers are shown in Table 22. The percentage distribution of sales to various buyers by crop indicate that proportion of the total sample which reported sales to a particular type of buyer. The most important modification in paddy marketing practices has been in the type of transport used for shipment of paddy and rice. An increase of 11.9 per cent in the number of cases in which trucks were used in local paddy collection after road developed was reported with corresponding declines of 5.9 per cent and 5.5 per cent in the use of boats and kwien respectively. Of the twenty-two rice mills interviewed, eleven had access to both road and water transport and all eleven had begun to use trucks for external shipment of rice after road development had taken place. Paddy was still more frequently shipped by boat than truck when external

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[1]Uthid Narksawad reported that in the 1956/57 paddy harvest season in the central plain 72.6 per cent of the paddy sold was to "local tradesmen" and "doorstep buyers". These two categories correspond to local paddy dealers and external paddy dealers as used in this study. An additional 10 per cent was sold to local rice mills and 1.94 per cent was sold to land owners. These figures agree with considerable accuracy with those shown in Table 22 for the year 1966/67. (see Narksawad, Rice Farmers' Indebtedness. pp. 164-166)

TABLE 22

MARKETING PATTERNS FOR SELECTED AGRICULTURAL PRODUCE IN PRE- AND POST-ROAD DEVELOPMENT PERIODS BY TYPE OF BUYER AND LOCATION (PERCENTAGE REPORTING)

Crop / Buyer	Paddy		Maize[a]		Vegetables[b]		Fruit[c]	
	1966-67	Pre-road Period	1966-67	Pre-road Period	1966-67	Pre-road Period	1966-67	Pre-road Period
Local paddy dealer	74.0	73.0	..	..	..	..	..	..
Local rice mill	18.0	19.0	..	..	..	..	..	..
External paddy dealer	8.0	8.0	..	..	..	..	..	..
Local merchant-broker	..	..	73.7	..	40.0	52.4	32.7	32.1
Wholesale-broker	..	..	5.3	..	1.7	2.4	3.6	7.1
External merchant-broker	..	..	21.0	..	33.3	23.8	36.4	25.0
Local retail	..	..	..	..	5.0	..	7.4	7.1
Sugar mill	..	..	..	..	..	..	3.6	3.6
Other[d]	1.0	1.0	..	..	..	..	..	..

[a]Refers primarily to the yellow-flint Guatamalan hybrid corn grown for export. Local varieties of maize (pak chong) grown for retailing and consumption are included under the heading Vegetables.

[b]Includes common leguminous, root, spice, and herbacious plants.

[c]Fruits included here are banana, mango, pineapple, watermelon, papaya, coconut, and other indigenous tropical fruits.

[d]The category "Other" includes landlords, itinerant peddlers, and store boat operators.

shipment was involved even though the ultimate destinations of both commodities were the same. Over 45 per cent of the mills with both road and water access used trucks to collect paddy from farmers, although four of this number were located in areas where there were no water transport facilities or available facilities were physically distant from paddy producing areas.[1] All but one of these mills were located in the upper plain where the limited extent of the waterway network restricts its utility for local shipment of paddy from farm to rice mill.

Modifications in the marketing channels for corn planted for export are less distinct due to recent expansion in the area under cultivation. In amphoe Khok Samrong, the only area studied in which corn production was a major form of land-use, over 73 per cent of all farmers interviewed sold their corn to local merchant-brokers. An additional 21 per cent disposed of corn through external merchant-brokers. A study of corn production and marketing in seven changwats conducted in 1959-1960 indicated that in amphoe Khok Samrong and Chai Badan, changwat Lop Buri 52 per cent of the farmers sold corn to local and external merchants while 42 per cent sold to creditors.[2]

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[1] These rice mills were located in amphoe Sam Chuk, Khok Samrong, and Chumsaeng. The absence of adequate canal networks in these areas has necessitated the use of kwien or "jeeps" (four-wheel drive trucks with cargo capacities of less than five tons gross) for the collection of paddy from farmers.

[2] Chuchart, Sitton, and Soothipan, "Production and Marketing", pp. 39-40. The sample in this study included twenty-two farmers in amphoe Khok Samrong and eighteen in amphoe Chai Badan.

The high percentage of farmers selling to creditors during this early period of corn production reflects the initial needs of growers to obtain financial and/or material credit in order to establish their farms. These figures are ambiguous however, since both external and local merchants are and were reported to be creditors.[1] Interviews with twelve corn growers in amphoe Khok Samrong in 1967 indicated that 94.7 per cent sold corn to the same local or external merchant-broker each year due to debt obligations. If sales to "local merchants" and "merchants from other areas" as reported in the Kasetsart study can be assumed to be sales to creditors, which they most probably are, then field interviews conducted in 1967 suggest that there has been no change in local marketing patterns among corn growers. In 1959 a sample taken of twenty-one firms exporting corn revealed that thirteen purchased corn in changwat Lop Buri in addition to one or more of six changwats in the upper central plain.[2] On the average these exporters bought only 14.15 per cent of their corn from producers. The largest source of corn was local and external "middlemen" from whom they obtained 61.45 per cent of their corn.[3] If, in the absence of a more

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[1] Ibid, p. 39.

[2] Somsri Lelanuja, "Economic Survey of Business Firms that Exported Corn from Thailand in 1959," Kasetsart Economic Report No. 21, Department of Agricultural Economics (Faculty of Economics and Cooperative Science, Kasetsart University [Bangkok], October, 1963) pp. 19-21.

[3] Ibid, pp. 20-21.

concise description of the activities of "middlemen", they are in part merchants and creditors of farmers growing corn, then the debt status of these farmers may not have changed sufficiently to allow them to break existing marketing obligations. As long as debt bonds between producer and local merchant-brokers continue to limit marketing of agricultural produce to these individuals it is unlikely that corn growers can begin to take advantage of any new marketing channels resulting from road development.[1]

The only important change in the marketing process for corn has involved a shift in the method of transportation used to collect and export corn. Trucks and tractors have replaced the kwien as the primary mode of shipment in 46 per cent of the cases where kwien were previously used to carry corn from farm-lot to the merchant-brokers shop or storage area. The kwien is still used to a limited extent to carry sacked corn to transhipment points along the highway. The rapid growth in tractor ownership and their use for plowing and hauling grain may soon provide a superior functional replacement for the kwien.

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[1]In 1966/67 the Calabrian (Thailand) Co., Ltd., established several corn drying facilities and storage silos in amphoe Tha Rua and amphoe Khok Samrong. These facilities were intended to provide production inputs (insecticide, fertilizer, seed), training programs, and agricultural credit for corn growers while engaging in the purchase and marketing of corn. The economic failure of this enterprise in 1968 is an appropriate commentary on the controlling forces and status of the marketing system for corn. The control of the marketing process by ethnic Chinese "middlemen", merchant-brokers, and exporters through economic means must certainly be one primary reason for the failure of this commercial enterprise.

The collection, handling, and marketing process for fruit and vegetable crops had exhibited the most modification due to improvements in road transport conditions. Raod development has encouraged a greater degree of simplicity in marketing patterns for fresh produce, reduced the volume of these crops marketed locally within the production area, and facilitated the external shipment by truck of many crops previously sent by boat.[1] Indications of this increased simplicity in marketing channels is shown in Table 22 by the decline in local retail sales and sales to merchant-brokers following road development. The disposal of vegetable crops through local merchant-brokers declined by over 12 percent in the post-road development period. This reduction was accompanied by similar declines in sales of fruits and vegetables to wholesale-brokers and in retail sales with local markets. Offsetting these patterns were increases of over 10 percent in the sales of these crops to external merchant-brokers, and a more modest increase of 5 percent in producer marketing of vegetables in external markets. These modifications in the traditionally more complex marketing process can be directly related to improved road conditions, greater

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[1]From the entire sample of 191 crop growers, 13.6 percent switched to different methods of transport after road development. The most consistent change in method of transport was from boat to truck. Of the 13.6 percent total, 9.94 percent were growers of fruit and vegetables who changed from boat to truck. An additional 2.09 percent were wet-paddy farmers who changed from boat to truck, and 1.57 percent were wet-paddy farmers who changed from kwien to truck.

speed and convenience of truck shipment, and an increased accessibility to road transport.

The process of complete or partial subsidization of gardeners by external produce wholesalers and brokers has been greatly expanded in amphoe Krathum Baen and Lam Luk Ka following road development. This same practice also occurred to a more limited extent in amphoe Damnoen Saduak. The resulting marketing links which have developed have tended to by-pass the older established channels between farmer and local merchant or merchant-broker. In amphoe Lam Luk Ka and Krathum Baen this change has been facilitated through the increased activities of merchant-brokers from the large produce markets at Mahanak and Pak Khlong Talad in Bangkok and Thon Buri. The improvement of road transport conditions and an increased ability to use trucks for produce shipment were important considerations among merchant-brokers working in these areas. The extent to which these direct marketing links have been established is also related to (1) availability of land suitable for conversion to gardens, (2) existence of high tenancy rates, and (3) the degree to which existing garden operations are financially solvent. Tenancy and availability of land have been important factors in both amphoe Lam Luk Ka and Krathum Baen while financial stability seems to have been more important in amphoe Damnoen Saduak.

Improvements in road transport conditions, in addition to encouraging more simplified marketing channels, have altered traditional

methods of shipment of fresh produce. The use of boats for the shipment of fresh produce has declined with a larger relative decline among shippers (merchants, wholesalers, brokers) of fruits than among those transporting vegetables. A decline of over 5.8 per cent in the number of cases where vegetables were shipped by boat was reported while a 16.7 per cent decline occurred in the shipment of fruits (Supra, p.194, n. 1). An increase of 16.7 per cent in the use of trucks for local collection and external shipment of fruits and 7.9 per cent for vegetables accounted for the declines in boat usage. The larger shift to truck shipment for fruits was due in some cases to greater market demand, speed advantages providing opportunities to obtain higher market prices, perishability, and greater convenience.

Declines in the volume of produce marketed through local retail and wholesale channels is related to the more uniform attenuation in local trade networks following road development. Improvements in road transport conditions and increases in the availability of truck and bus services, particularly in areas where they are cost competitive with water transport, has enabled many farmers to market commercially grown or surplus garden produce outside of local markets (Supra, Table 22). These conditions are especially prevalent in amphoe Damnoen Saduak, Lam Luk Ka, Muang Chachoengsao, and Bang Khla.[1]

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[1]Recent deterioration in road surfaces in amphoe Lam Luk Ka has forced wet-paddy farmers to reduce their sales of surplus garden produce in external markets. Rough road surfaces have produced intransit damage to produce which has lowered its market value.

Fresh produce is shipped with increasing frequency to nearby provincial markets or directly to the larger markets in Bangkok and Thon Buri. This increase in the external marketing of fresh produce has diminished the volume of these crops sold through local markets, thereby limiting their availability relative to pre-road development periods.

Local trade networks in several areas have experienced marked reductions in the numbers and types of units involved. Local traders in amphoe Min Buri have decreased by over 50 per cent from the mid 1950's. This decrease has occured primarily in boat vendors selling fresh produce. Similar patterns have occurred in amphoe Muang Chachoengsao, Nong Sua, and Bang Khla.[1] The increased convenience and speed provided by road transport has encouraged many local merchants to order consumer goods, manufactured items, and fresh produce from sales agents and dealers who deliver regularly by truck or bus. In the past merchants obtained many of these commodities from transient store boats. The expansion of merchandising capabilities through mobile truck shipment and the use of sales agents has reduced the sales volumes and numbers of operational store boats. The number of these merchants operating along waterways between Bangkok, Chachoengsao, and Prachin Buri has declined from seven in 1956 to four in 1967.

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[1]In 1966/67 no local traders of fresh produce were active in amphoe Sanphaya, although four or five had existed in the early 1960's.

Interviews with operators of two of the remaining store boats indicated that they intended to stop operations in the near future. The main reason for the reduction in their operations has been declining sales volumes in those markets where improved road transport facilities have opened the market to supply and shipment by truck. [1]

Even the most stable aspects of local trade networks have been influenced by road development. The vending of charcoal is a common scene along waterways in the central plain. Local vendors of this fuel, particularly in amphoe Min Buri, Nong Sua, Lam Luk Ka, and Muang Chachoengsao complained of declines in the number of local and external charcoal vendors in recent years. The improvement of road conditions in these amphoe as well as in charcoal producing regions has enabled local dealers to maintain larger stocks of charcoal, order on a more regular basis, and obtain this fuel from producers much further away by truck delivery. [2] The ability of these local dealers to keep larger stocks or obtain quick delivery when their stock runs low has discouraged many external boat operators who in the past acted as

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[1] The operation of store boats is often transferred from generation to generation. The operators of store boats which were interviewed were the fourth and fifth generations engaged in this type of trade along the same route. (see Supra, p. 178, n. 1)

[2] The traditional sources of charcoal for consumers in the central plain have been in changwat Suphan Buri, Chai Nat, Nakhon Sawan, and Prachin Buri. Korat has become increasingly important as a source of this fuel staple in recent years due to improved road transport conditions.

ancillary dealers from continuing in this activity. The number of such ancillary dealers in charcoal in amphoe Min Buri has dropped from about twenty-five in 1957 to less than fifteen in 1967.

The seasonal activity of local trade as a function of the agricultural cycle has been somewhat less affected by road development, although there is increasing evidence from farmers and local merchants that even this type of trade activity may be declining. It is doubtful however if the trade in daily food staples, coffee and soft drinks, and assorted seasonal luxury items will undergo any great decline until these items can be economically and conveniently supplied to rural residents by road shipment.

PART IV

ROAD DEVELOPMENT IMPACT ON DEMOGRAPHIC PATTERNS AND TRADITIONAL TRANSPORT MEDIA

CHAPTER VII

SETTLEMENT PATTERNS AND DEMOGRAPHIC CHANGE

The construction of penetration and development roads in upland areas of sparse settlement and pioneering land conditions has frequently been accompanied by marked changes in population and settlement patterns.[1] The impact of this type of transport development often involves immigration motivated by the improved access to agricultural land, the development of strip and cluster settlement patterns along the road, and even emigration of some residents. In contrast to this pattern has been the very limited impact of road development on population growth and settlement patterns in the central plain of Thailand. The implications of this limited response to road development are explored in the following discussion of settlement patterns, population growth, and variations in the rate and composition of migration in survey districts.

Settlement Patterns

Settlement patterns within the central plain have traditionally been of three types: strip, clustered, and dispersed. Strip or linear settle-

[1] See, for example, H. P. White, "Communications and Transport," Agriculture and Land Use in Ghana, ed. J. Brian Wills (London: Oxford University Press, 1962), p. 173; and Rex M. Whitton, "Planning a Road Program," Development Research Digest, Vol II, No. 1 (July, 1963).

ment is best typified by the linear array of houselots along the levees of canals and rivers throughout the lower central plain. This type of settlement pattern is most commonly found in the lower delta or "inner plain" where wet paddy cultivation is the dominant form of agricultural land use.[1] The linear riverine settlement pattern reflects the importance of the inland waterway system in transport, trade, irrigation, and a variety of activities of daily importance to the Thai peasant. Cluster settlements, occasionally termed communal settlements, are more often found on the margins of the plain and in upland areas than in the wet lowlands of the central plain. This cluster settlement is a common pattern in amphoe Tha Rua, Khok Samrong, Sam Chuk, and Chumsaeng. Dispersed settlement is most often associated with the intensely cultivated market gardening areas adjacent to Bangkok and Thon Buri and in the coastal areas to the south and west of these cities. These three different settlement patterns reflect differing economic, physical, and transport conditions which are important determinants of intraregional variations in settlement types.

The impact of road development on settlement patterns has been limited in extent and areas of occurrence. Aside from the recent development of strip settlement along National Highway No. 1 in amphoe

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[1]Sternstein uses the term "inner plain" to differentiate between the core wet paddy cultivating area south of changwat Chai Nat along the Chaophraya River and the transitional uplands surrounding this zone. ("Settlement Patterns in Thailand," Journal of Tropical Geography, Vol. 21 [December, 1965] p. 30.)

Khok Samrong the changes in settlement patterns in other districts have been limited. In some road development amphoe such as amphoe Tha Rua, and amphoe Sam Chuk there are indications of modest shifts from cluster settlement to strip settlement along developed roads.

The primary sources of strip settlement occurring along developed roads were (1) relocated households from within tambon(s) adjacent to the road, and (2) immigrant households from other amphoe or changwats.[1] The distribution of households constituting strip settlements along developed roads by administrative unit of origin is shown in Table 23.

TABLE 23

COMPOSITION OF ROADSIDE SETTLEMENT IN SURVEY DISTRICTS BY ADMINISTRATIVE UNIT OF ORIGIN

Survey Districts	Total Households Sampled	Household origin as % of total sample		
		Relocated[a] Households	Immigrant[b] Households	Existing[c] Households
Min Buri	12	8.3	41.7	50.0
Krathum Baen	7	28.6	14.3	57.1
Lam Luk Ka	10	..	60.0	40.0
Nong Sua	6	..	16.6	83.0
Muang Chachoengsao	12	25.0	33.0	42.0
Khok Samrong	8	..	100.0	..

[a]Relocated from within tambon(s) adjacent to the road.

[b]Other amphoe or changwats.

[c]Existing at or prior to time of road development.

[1]The household as the unit of analysis in this and subsequent discussions of population growth and migration is considered as a physical structure whose basic social component is the nuclear family.

Although these data are of limited significance they do suggest the general magnitude of changes in settlement patterns and the extent of road impact on traditional settlement patterns. The physical relocation of established households from canal to road sites within road development amphoe occurred in only three survey districts. In each of these districts the relocation of households was justified by the increased economic, social, and convenience advantages of residing along the road. In most cases no new purchase of land was involved in the relocation of these households. The fact that signficant numbers of existing households have been relocated along the roads from within the survey district suggests that in these amphoe the improvement of road transport facilities has had a measurable impact on settlement patterns. The absence of larger numbers of relocated households in these areas of strip settlement along the road, particularly in amphoe Lam Luk Ka and Nong Sua, suggests that strong economic and social ties to waterway located residence, the absence of available land, and excessive relocation costs among other factors may have precluded a more extensive shift to roadside residence.[1]

The large numbers of immigrant households found along developed roads attests to the economic and convenience advantages offered by

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[1]The absence of more comprehensive data precludes any analysis of relocated households in relation to the total number of existing households along developed roads. If such data were available it would probably indicate that the magnitude of shifts in relocated households in amphoe Min Buri and Muang Chachoengsao was greater than shown in Table 23.

roadside residence. To each of these immigrant households the access to road transport was of significant benefit for the shipment of garden produce, poultry, eggs, swine, and upland crops. In amphoe Khok Samrong existing strip settlement was entirely accounted for by immigrant households. This pattern is related to the recent changes in land use in this amphoe and will be discussed in greater detail in the following pages.

The fact that many of the daily social and economic activities of the Thai farmer are oriented towards and dependent upon water transport may be the most important factor in understanding these limited changes in settlement patterns. While road development may offer a cheaper, faster, and more convenient mode of produce shipment and communication for some individuals these values are not yet sufficiently important to enough of the people residing in the area through which these roads pass to warrant relocating their households to points along the road. The transitive nature of most roads in the central plain, where well developed water transport facilities more easily and adequately serve daily needs, may greatly inhibit any change in settlement patterns due to road development.

Road Development and Demographic Change

There is no consistent correlation between road development and population growth within the central plain. Although certain marked increases in population growth rates in some districts may reflect the importance of road development, a uniform causal relationship between

the two is not evident.

Population statistics which reflect changes in age and sex ratios, in and out migration, and rates of natural population increase at the tambon and amphoe level are at best poor. Quite frequently gross population figures for minor political divisions are not available. These conditions have necessitated the use of rather limited analytical techniques supported by several critical assumptions. The high population growth rates recorded in several survey districts would suggest initially that road development is positively correlated with rates of population growth. This is not the case. While increased birth rates are one aspect of population growth and may be a partial cause of this growth it is unlikely that birth rates of sufficient magnitude could have occurred to account for the large rates of population growth recorded in some districts. Similarly, although more plausible, rapid declines in mortality could have affected population growth rates.[1] Declining mortality rates can be attributed to improved medical services and increased effectiveness of malarial control and suppression measures which have reduced deaths

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[1]Halvor Gille and Thip Chalothorn state that based on the 1960 Population Census the birth rate is estimated at "around 45 per 1,000" and that "it may be assumed that the birth rate has remained fairly constant in recent decades." Mortality, on the other hand, has been rapidly declining and has probably dropped lower than the level of 13 per 1,000 reported in 1960. ("The Demographic Outlook of Thailand and Some Implications," revised version of a paper presented to the National Seminar on the Population of Thailand, Bangkok, 27-29 March, 1963, p. 3 [Mimeographed]. Hereinafter referred to as Gille and Chalothorn, "Demographic Outlook")

caused by this disease.[1] In none of the survey districts was data available which would indicate the importance of these variables to population growth rates. Migration is a third factor in population growth. Available migrational data suggest that in some districts this has been a contributing factor to changes in population growth rates. These data, however, are limited to immigration statistics by household, and no measure of emigration is available.

Any appreciation of the relationship between intraregional differentials in population growth and road development must be prefaced by some comments about the rates of population growth in certain critical areal units. The most important of these units include the road development and control amphoe, the central plain, and the Bangkok-Thon Buri Metropolitan area. For purposes of comparison the period from 1960 to 1967 has been used due to congruity of available statistics. These years cover the post-road development period for seven of the eleven road development amphoe. The estimated annual rates of population growth for all road development amphoe, control amphoe, and the central plain for the period from 1960 to 1967 are shown in Figure 23. The average rate of population growth for the central plain during this period was 3.3 per-

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[1]See J.C. Caldwell, "The Demographic Structure," Thailand, Social and Economic Studies in Development ed. T.H. Silcock (Singapore: Donald Moore Press, Limited, 1967) pp. 39-40; William J. Siffin, The Thai Bureaucracy: Institutional Change and Development (Honolulu: East-West Center Press, 1966) pp. 208-211; and Lee M. Howard, et al., "Report of an Assessment of the National Malaria Eradication Project in Thailand," (Bangkok: Agency for International Development, USOM/Thailand, 1964) pp. 4-7.

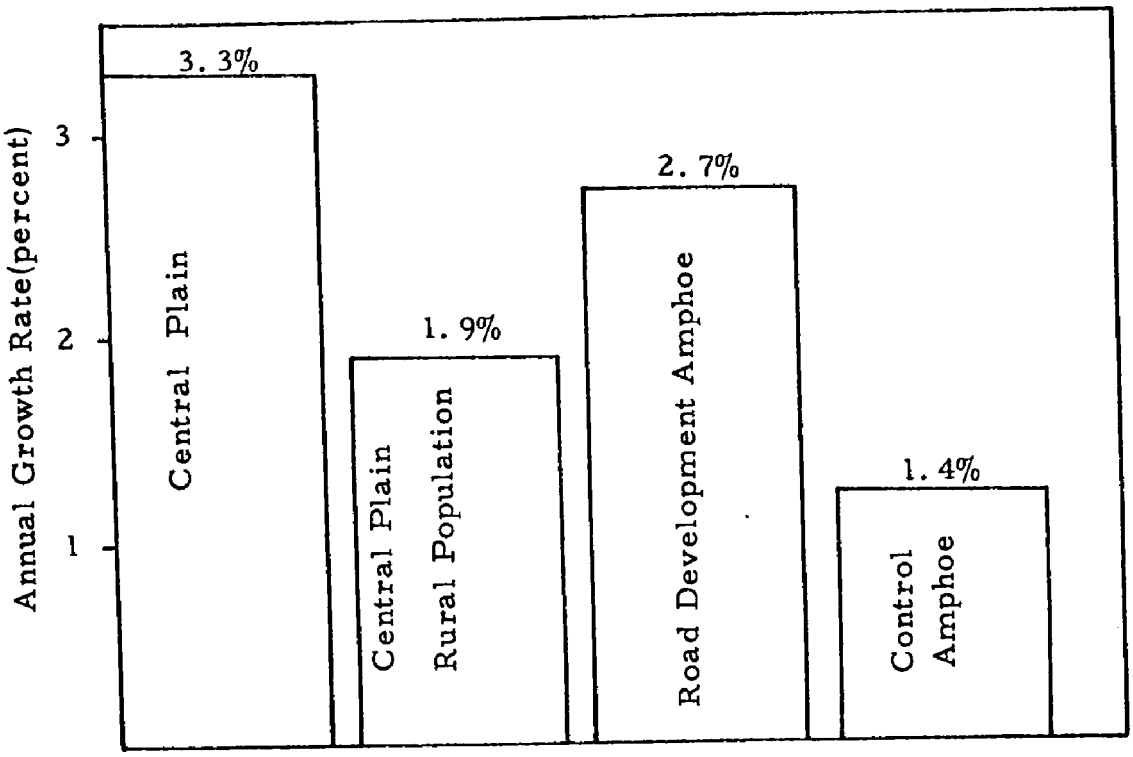

Fig. 23. -- Comparative Population Growth Rates, 1960-1967

cent per year. This figure includes increases from all sources. The rate for the whole country during this same period was 3.2 percent. Included in the annual population growth rate for the central plain is the increase in urban population for the Bangkok-Thon Buri Metropolitan area. Population within this urban area has grown at a rate of 8.4 percent annually since 1960 and has been projected to reach a total of 8.6 million by 1980.[1] Since the vast majority of the population within the central plain is rural and would be most immediately affected by road development a separate rate of growth for the rural population would be more comparative with survey districts than would a figure including both rural and urban populations. The rate of population growth for the

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[1]Gille and Chalothorn, "Demographic Outlook," p. 13.

rural population of the central plain for the period 1960 to 1967 is 1.9 percent per year.

A comparison of the population growth rate for road development districts with that for the rural population of the central plain indicates that these survey districts have grown at a rate of 0.8 percent faster than the rural population. If birth rates within road development districts have been constant then declining mortality and immigation have accounted for the differential rate of population growth between these two units. While dramatic changes in mortality rates may have resulted from increased effectiveness of malaria control and improved medical services, it is unclear if such developments have occurred differentially in these areas.

Control districts experienced a considerably lower annual rate of population growth than either the central plain or road development amphoe. The rate of 1.4 percent does not, however, include all control districts and is therefore of limited accuracy.

Considering the limited amount of available data it is not possible to attribute any significance to road development as an independent factor in population growth. The very restricted capacity of road development to encourage population growth in the lowland areas of the central plain is further emphasized by the insignificant difference in population growth rates in survey districts between the pre-and post-road development periods. Population growth rates for road development districts in the pre- and post-road development periods are shown in Table 24. The

TABLE 24

ANNUAL POPULATION GROWTH RATES FOR ROAD DEVELOPMENT DISTRICTS IN THE PRE- AND POST-ROAD DEVELOPMENT PERIODS

Survey Districts	Pre-road Period (%)	Post-road Period (%)	Population Growth Rate 1960 to 1967 (%)
Bang Khla	3.0	1.6	1.6
Damnoen Saduak	..	2.1	2.1
Khok Samrong	..	3.8	3.8
Krathum Baen	..	1.5	1.4
Lam Luk Ka	3.3	2.3	2.3
Min Buri	2.1	5.9	7.4
Nong Sua[a]	..	2.8	2.8
Sanphaya	1.6	0.9	1.2
Tha Rua	2.1	2.1	2.3

[a]Includes the entire amphoe. Growth rates for other survey districts are based on data for the tambon(s) which are included in the survey area.

mean growth rate for road development amphoe in the lowland areas of the central plain is 2.4 percent in both the pre- and post-road development periods. Even if amphoe Khok Samrong is included in these calculations the mean population growth rate for road development districts in the post-road development period is only 0.2 percent higher than in the pre-road development period. This insignificant difference in growth rates between the two periods reaffirms the general lack of significance of road development as an isolated factor in population growth.[1]

[1]Emigration must be acknowledged as an important factor in population growth rates in the central plain; however, available data are not sufficiently refined to enable determination of the extent of emigration from specific road development areas (see infra, p. 212 n.2).

Data limitations also preclude more extensive analysis of the impact of road development on population growth under differing environmental conditions. The rapid growth of population in amphoe Khok Samrong suggests that road development may have a greater impact on population growth in upland than lowland areas, although the limited data from this study and those of Patanapanich, Jittasatra, and others in Thailand are not conclusive.

Road Development and Migrational Patterns

A critical and comprehensive discussion of population migration and its relationship to road development is restricted by the lack of accurate time series data on the magnitude and composition of emigration, and migrant occupational and residency information. The absence of this data limits the extent to which migration can be conclusively related to road development and population growth.[1]

The patterns of migration for immigrant households in survey districts take several forms. The most frequent movements of households between administrative divisions involved: intertambon movement within amphoe; interamphoe migration within changwats; interchangwat movement within the central plain; and interregional movement within the country. Of these four migration patterns for immigrant households interchangwat movements accounted for 39.9 percent of all such

[1]The data upon which the following analysis and discussion are based is composed of records of village headmen (puyai ban), tambon headmen (kamnan), and field observations and interviews.

movements in survey districts. Intertambon movements are next in frequency with 33.1 percent, followed by interamphoe movements with 23.8 percent, and interregional migrations with 3.1 percent. Immigrant households in survey districts which originated from outside of the central plain included households from the northeast, southeast, south, and several from outside of the country.[1] The total number of immigrant households recorded in all survey districts during the period from 1953 to 1967 amounted to 343 out of a total of 2120 existing households in 1967. The distribution of the immigrant households by survey district of residence, period of migration, and administrative division of prior residence is contained in Table 25. The rate of net migration is an important factor in determining what types of demographic change have occurred following road development. Since data on out-migration at the tambon and amphoe levels are not available it has not been possible to determine rates of net migration for these smaller administrative divisions.[2]

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[1]Extra-national origins of emigrant households were confined to Communist China and Hong Kong.

[2]Several studies have been made of internal migration in Thailand based on the birthplace-residency data contained in the 1960 Population Census. Although none of these studies treats the subject at the amphoe level they do provide some important insights into interregional and intraregional migration patterns which have some bearing on the survey districts considered here.

The most recent of these studies by Ronald C.Y. Ng indicates that from 1955 to 1960 only two of the provinces in which study districts are located experienced a gain by net internal movements of population. Changwat Phra Nakhon had a gain of 1-3 percent and changwat Lop Buri had a gain of over 3 percent. All the other provinces of survey district location experienced losses of from 0-3 percent or more. The major destination of out-migrants from these provinces which lost population

A closer examination of the data in Table 25 indicates several important features of the magnitude and distribution of immigration in survey districts. There has been no consistent conformity between increases and/or decreases in numbers of immigrant households and periods of major road improvement. Three amphoe, Khok Samrong, Sanphaya, and Lat Bua Luang account for over 75 percent of the immigrant households involved in interchangwat movements. In amphoe Khok Samrong the magnitude and intervals of immigration coincide closely with the expansion of corn production and improvements in road transport facilities. In the control district of amphoe Lat Bua Luang a smaller yet significant number of households have immigrated to work as gardeners. The absence of road transport facilities in this control district underscores the variable significance of road development as a stimulant to

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was Bangkok and Thon Buri, except in the northern section of the lower plain where out-migrants from changwat Chai Nat and Nakhon Sawan moved into the less densely settled provinces further north. Over 10 percent of the out-migrants from these provinces which lost population in the central plain were destined for Bangkok and Thon Buri. In changwat Lop Buri the most significant flow of immigrants came from changwats Ang Thong, Sing Buri, Sara Buri, and Ayutthaya.

The main patterns of migration during this five year period were characterized by intraregional flows from the lower plain to Bangkok and Thon Buri, from the northern tier of provinces in the lower plain to the upper plain, and movements from the northeast to the upper plain. The net loss of population in the provinces in the lower plain to Bangkok and Thon Buri may in part explain the variable population growth rates in some survey districts. Certainly the large volume of in-migrants in amphoe Khok Samrong shown in Table 25 is substantiated by Ng's study. The data in Table 25 may also indicate that these main intraregional migrant streams are still important features of the pattern of internal migration. ("Recent Internal Population Movement in Thailand," Annals, Association of American Geographers, Vol. 59, No. 4 [December, 1969], pp. 710-730. Hereinafter referred to as Ng, "Recent Population Movement.")

TABLE 25

DISTRIBUTION OF IN-MIGRANT HOUSEHOLDS WITHIN SURVEY AMPHOE BY PERIOD OF MIGRATION AND PRIOR RESIDENCE, 1953 TO 1967

	Total Households	Total Immigrant Households	1 % Total Households Residing 1-5 Years	Origin				2 % Total Households Residing 6-10 Years	Origin				3 % Total Households Residing 11-15 Years	Origin			
				Tambon	Amphoe	Changwat	Regional		Tambon	Amphoe	Changwat	Regional		Tambon	Amphoe	Changwat	Regional
Bang Yai[a]	--	--	--	-	-	-	-	--	-	-	-	-	--	-	-	-	-
Min Buri	776	38	0.77	5	1	-	-	2.06	11	4	1	-	2.06	11	2	2	1
Krathum Baen	78	4	2.56	1	-	1	-	1.28	1	-	-	-	1.28	-	-	1	-
Lam Luk Ka	211	26	4.73	2	2	6	-	5.21	5	1	4	1	2.36	2	1	2	-
Lat Bua Yuang	76	59	69.73	3	12	38	-	7.89	-	-	6	-	0.0	-	-	-	-
Nong Sua	383	20	2.34	4	2	3	-	1.30	2	1	2		1.56	3	3	-	-
Muang Chachoengsao[a]	--	--	--	-	-	-	-	--	-	-	-	-	--	-	-	-	-
Damnoen Saduak[b]	--	20	--	8	-	8	-	--	-	-	3	1	--	-	-	-	-
Bang Khla	145	32	10.34	13	2	0	-	8.27	10	1	1	-	3.44	5	-	-	-
Tha Rua	115	3	0.0	-	-	-	-	0.86	1	-	-	-	1.73	2	-	-	-
Sam Chuk[a]	--	--	--	-	-	-	-	--	-	-	-	-	--	3	2	9	-
Sanphaya	162	32	4.93	5	1	2	1	5.55	2	1	6	-	8.64	3	2	9	-
Khok Samrong	132	99	20.45	6	3	16	2	21.21	4	3	20	1	33.33	1	33	10	-
Chumsaeng	42	11	11.90	3	-	-	2	7.14	2	-	1	-	7.14	-	-	-	3
Totals	2120	343	--	50	23	74	5	--	38	11	44	4	--	27	42	24	4

[a]Data not available.

[b]Data from field interviews.

population growth. The dominant pattern in most other survey districts was one of intertambon movements except for amphoe Lam Luk Ka and amphoe Damnoen Saduak.

Variations in population growth rates among survey amphoe can partially be explained through analysis of the intensity and occupational composition of immigrant households and their relationship to road development. The high population growth rate in amphoe Min Buri in the post-road development period may be a response to intertambon household movements as a latent impact of road development. The occupational structure of the immigrant households is dominated by farmers and wage laborers as shown in Table 26. The growth of the Min Buri market and the establishment of small manufacturing plants along the highway to amphoe Bang Khen, changwat Phra Nakhon are responsible for the occupational activities of some immigrant households. The fragmentation of land holdings through road construction has probably also been responsible for the number of immigrant farm households shown in Table 26 and Columns 2 and 3, Table 25.

The immigration in amphoe Lam Luk Ka of displaced farmers from expanding residential areas in Bangkok and wage laborers employed at the military-commercial air field complex north of Bangkok in the pre-road development period contributed to the higher population growth during this period. The subsequent decline in the population growth rate in this amphoe does not reflect any significant reduction in the rate of immigration but rather a change in the type of immigrant household as a response to

TABLE 26

OCCUPATIONAL COMPOSITION OF EMIGRANT HOUSEHOLDS BY SURVEY DISTRICT AND OCCUPATIONAL CATEGORY[a]

Survey District	Gardener	Farmer	Wage Laborer	Merchant	Government Officials[b]
Bang Yai	..	..	..	..	..
Min Buri	2	20	11	4	1
Krathum Baen	..	3	..	..	..
Lam Luk Ka	..	17	8	..	..
Lat Bua Luang	10	46	3	..	..
Nong Sua	4	13	2	..	1
Damnoen Saduak	17	..	..	1	2
Muang Chachoengsao	..	..	..	..	..
Bang Khla	26	6	..	..	..
Tha Rua	..	3	..	..	..
Sam Chuk	..	..	..	..	..
Sanphaya	1	6	..	9	16
Khok Samrong	..	99	..	..	..
Chumsaeng	1	10	..	..	..
Total	61	223	24	14	20
Percentage total emigrant households	17.8	65.0	7.0	4.1	6.1

[a]Occupation listed is for head of household.

[b]Includes local district officials, teachers, other full time employees of various governmental agencies.

road development. Immigrant households in the post-road development period consisted entirely of migrant gardeners. Many of these newly established households were not registered with local officials and would therefore not have been tabulated in the tambon and amphoe population figures. The failure of migrant gardening households to report for registration with local officials also occurred in amphoe Lat Bua Luang. The

absence of a high population growth rate in contradistinction to evidence of significant immigration within the past five years in this amphoe suggests that a similar lack of household registration has occurred.[1]

The consistent decline in immigrant households in amphoe Sanphaya since 1953 is reflected in the declining population growth rate. Early immigrant households were predominantly employees of the Royal Irrigation Department engaged in the construction and maintenance of the Chaophraya Dam (see Table 26). With the completion of this facility a certain number of these people were reported to have left the amphoe, although the more significant stream of out-migrants reported by Ng (supra, p. 212, n. 2) for this province may be more directly responsible for the decline in population. Road development has stimulated only small increases in numbers of immigrant households, many of which have involved only local moves from other tambon in the amphoe.

The absence of adequate data for amphoe Damnoen Saduak limits the extent to which migration can be related to population growth and road development. What appears to be a modest volume of interchangwat immigration (see Table 25, Column 1) originating from changwats Samut Sakhon and Samut Songkhram suggests that there may be a cyclical movement of migrant gardeners around the periphery of the Bangkok-Thon Buri

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[1] Although this pattern might imply some ethnic bias on the part of the interviewer the discussions with migrant gardening households revealed that they in fact did avoid registering with local officials for reasons they declined to mention.

Metropolitan area.[1] It is doubtful if this recent immigration is a response to road development since land is at a premium in this district.

The large increase in immigrant households in amphoe Bang Khla is almost entirely confined to intertambon movement within the amphoe, and as such would not consitute an additional increment of population. Amphoe and tambon officials and resident farmers indicated that there had been a noticeable emigration from this amphoe in recent years and net migration may have been negative. Reported declines in paddy yields and increased conversion of holdings to gardens by immigrant households has probably contributed to a net migration ratio in this amphoe. Ng's study of internal population movement in the period 1955-1960 indicated that internal mobility in this area was low (supra, p. 212 n.2), 1 percent, and consisted almost entirely of a loss of 1 percent by changwat Chachoengsao and a gain of 1 percent by changwat Chon Buri. Ng suggests that the attraction of Chon Buri is in opportunities in industrial and service employment related to the Sri Racha area.[2] It would seem that the pattern of movement in 1955-1960 may have accelerated through the 1960's due to the rapid expansion in industrial and service employment related to the development of the Utapao and Sattahip military-commercial facilities in changwat Chon Buri.

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[1]Household registration data for three tambon in amphoe Lat Bua Luang showed that from 1962 to 1967, 22 percent of all immigrant households reported their previous residence as amphoe Damnoen Saduak. A similar pattern was noticed in the Rangsit area and amphoe Lam Luk Ka where immigrant households reported their previous residence as amphoe Lat Bua Luang.

[2]Ng, "Recent Population Movement," p. 722.

The variability among survey districts in population growth rates, magnitude and frequency of internal population movements, and occupational composition of immigrant households is characteristic of the inconsistency in impact of road development on demographic patterns. The difficulty of attributing any precise importance to road development as a factor in demographic change without concurrent consideration of other variables is best exemplified in amphoe Lat Bua Luang and Khok Samrong. The availability of agricultural land for conversion to vegetable and melon gardens in amphoe Lat Bua Luang has been a primary factor in the recent high levels of immigration. The absence of roads has in no way inhibited the extent of field conversion or immigration. The fact that fifty-six of the fifty-nine immigrant households recorded since 1957 were either gardeners or farmers attests to the absence of any such restraint. The large volume of immigrant households, exclusive of increases in population growth rates, indicates that gross population has quite probably increased significantly in the past five years. The lack of external road links has not restrained or limited agricultural or demographic change in this amphoe. The situation in amphoe Khok Samrong exemplifies conditions under which road development has been a significant factor in increased population growth and immigration. Large increases in immigrant households in the mid-1950's (see Table 26, Column 3) resulted from the organized resettlement of agriculturalists from an adjoining amphoe, while subsequent volumes of interchangwat immigration corresponded closely to periods of road development. Many

immigrant households had previously cultivated corn in other areas and had moved to amphoe Khok Samrong to expand their activities on the cheaper land made more accessible through road development. The lack of road development would undoubtedly have inhibited or precluded the extensive immigration, population growth, and increased corn production which have occurred.

The rapid growth of population in amphoe Khok Samrong contrasts significantly with the lower magnitude of population growth in road development districts in wet lowlands of the central plain. This differential in road impact on demographic patterns between upland and lowland areas is further substantiated by other studies of upland areas in north and northeast Thailand.[1] While it must be acknowledged that road development in upland areas can encourage both immigration and emigration there seems to be adequate evidence to support the argument that the impact of road development on demographic patterns may be greater in dry upland areas than in the wet lowlands of the central plain.[2]

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[1]Studies conducted in changwats Nakhon Ratchasima, Khon Kaen, Maha Sarakham, Kalasin, Udon Thani, and Nong Khai indicate that road development has been a factor in increased settlement, land development, and population growth in these areas. (U.S., USOM/Thailand, Program Office, "Economic Survey of the Korat-Nongkai Highway Area," Bangkok, November 21, 1960, p. 25; Jittasatra, "Khon Kaen-Yang Talad," pp. 62-65.)

[2]Jittasatra reported that net losses of population occurred in two of the three amphoe he studied. He concluded that in these two districts road development did not have any significant influence on the rate of population growth, although he did acknowledge the influence of road development in the one district with a high population growth rate. (Jittasatra, "Khon Kaen-Yang Talad," pp. 62-65.)

CHAPTER VIII

THE DISPLACEMENT OF TRADITIONAL FORMS OF TRANSPORTATION

In addition to the beneficial impact of road improvement on agricultural activities, marketing, and communications there are also certain disruptive aspects of this type of transport development. The construction and improvement of roads in the central plain has been accompanied by a decline in the availability, utilization, and function of several types of traditional transport media. This displacement involves both land and water transport facilities. The process of displacement has involved only a partial curtailment or restriction in the functions and use of these transport media and not a complete withdrawal from the cultural landscape. The displaced units usually have experienced a contraction in their areas of operations and activities resulting from the introduction of more convenient, economical, and versatile forms of transport. The impact of road development on these traditional transport media has been most extensive among boats engaged in trade and transport on the inland waterway network and on non-motorized land transport units. The partial displacement and relocation of these transport units has occurred at three distinct but interrelated functional and operational levels.

Road development in the central plain has produced distinct changes in the size and capacity of cargo boats engaged in trade and produce shipment on the inland waterway system. Changes in capacity of boats have been accompanied by functional changes among displaced units and a greater simplicity in the spatial parameters of boat operations. The time period during which these changes have occurred has frequently covered many years, particularly for those changes associated with modification in boat capacity and design. The development of new and improved equipment such as more versatile engines and boat designs has frequently acted to accelerate the process of displacement.

There is no lack of data on boats engaged in inland water transport, but existing data are repetitive, inaccurate, and contradictory. The main source of data on water transportation units is the incomplete annual registration figures of the Harbor Department.

The process of displacement and relocation of cargo bases has involved (1) a relative decline in total units accompanied by an increase in the number of larger capacity barges, (2) a loss of cargo to trucks by those boats engaged in intermediate and long-haul operations, (3) an apparent greater displacement of boats engaged in transport of low bulk, high value agricultural produce over short and medium hauls, and (4) an increase in cargo and route specializations among existing cargo barges.

The decline in total numbers of barges and the increase in numbers of large capacity barges can be adequately shown in the annual registration data of the Harbor Department.[1] The available registration data indicate a decline in total units relative to total tonnage. Figure 24 shows the number of registered cargo barges and the total gross tonnage of all registered barges for the years 1945 to 1965. Although the graph does not indicate tonnage by barge size it is possible to assume that since total units have declined at a more rapid rate relative to gross tonnage either (1) the slower decline in gross tonnage indicates newer barges being built are of larger capacity, (2) the barges going out of use are of the smaller capacity resulting in a slower rate of decline in total gross tonnage, or both. One implicit assumption, of course, is that all barges in operation are registered. Harbor Department officials indicate that this is not always true, although the number of unregistered operational barges is not likely to be larger than 5 percent of the total existing barges. A variation of this magnitude would still not significantly change the relationship between the two trend lines. Assuming that these conditions are accurate, then the frequent observations of barge operators and boat builders that many of the newer barges being built are of increasingly

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[1]Harbor Department registrations make no differentiation in barge size based on capacity or tonnage. Cargo barges were categorized based on cargo capacity rather than gross tonnage. Large barges are those with cargo capacities in excess of 90 tons, medium barges have capacities from 50 to 90 tons, and small barges range downward from 50 tons to below 30 tons.

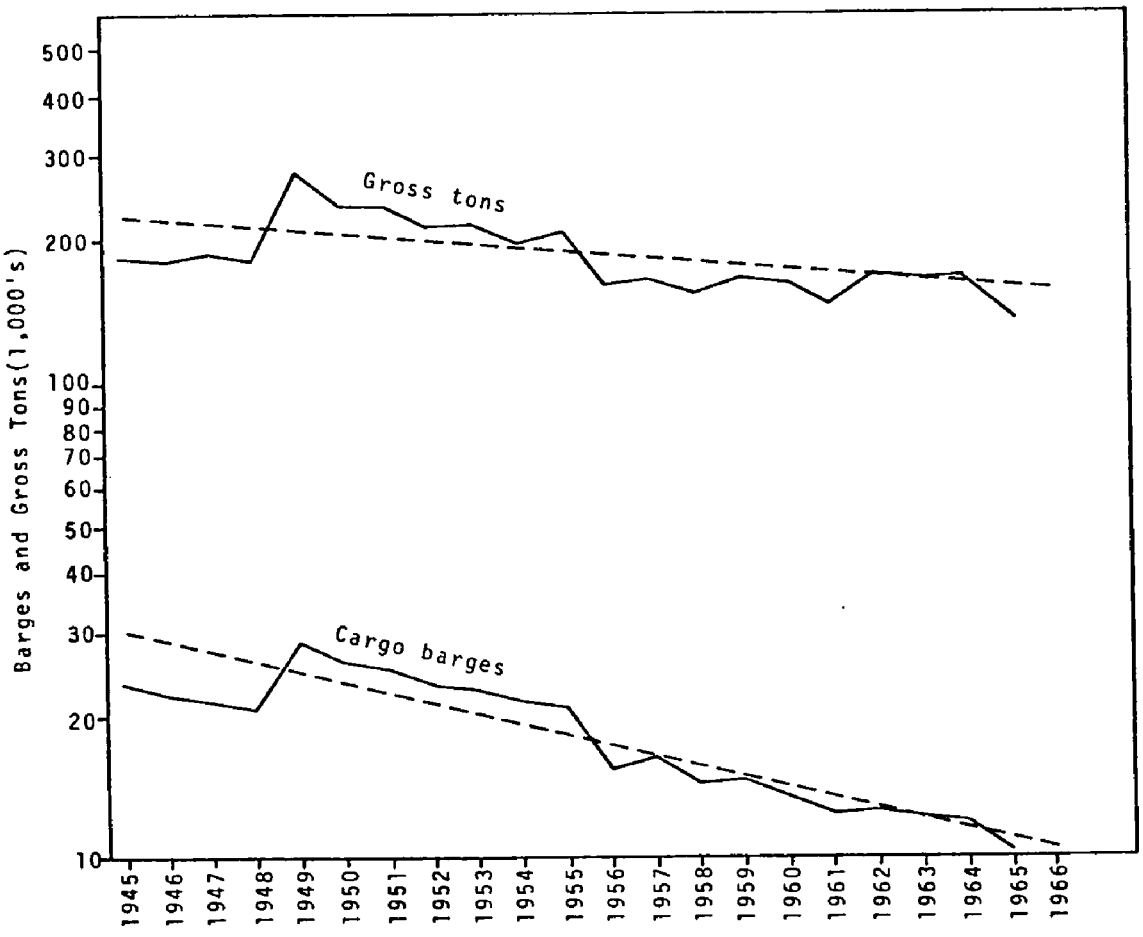

Fig. 24 -- Thailand: Registered Cargo Barges and Capacity in Gross Tonnage, 1945 to 1967.

larger capacity is true. The extent to which road development has displaced the smaller tonnage units and encouraged production of larger capacity barges must await more comprehensive and detailed registration and production statistics.

The apparent trend toward production of larger capacity barges has been accompanied by an increase in the number of barges engaging in specialized cargo and route operations. Many of the newer large capacity barges are involved in this cargo and route specialization. Specialized cargo operations involve the carrying of maize, paddy, stone, cement, and sand from a small number of collection-transshipment points located along the main river systems around the edge of the central plain. Some of the cargo barges which have been displaced from local and short haul operations by truck transport have begun to move into these areas of specialized operations. Amphoe officials in Tha Rua and Chumsaeng indicated that the number of cargo boats in these amphoe had increased significantly in recent years. Amphoe Tha Rua is a major collection and shipment point for corn, stone, gravel, and cement while amphoe Chumsaeng is a transshipment and distribution center for upland crops.[1]

Cargo barges which have undergone a functional displacement resulting from road development have frequently been boats active in short

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[1]Statistics of operational cargo barges from amphoe Chumsaeng officials indicated that locally owned and operated produce boats had increased from four in 1961 to seventeen in 1967. Similar increases were reported by officials in amphoe Tha Rua.

and intermediate haul operations, the transport of low bulk, high value agricultural produce, and consumer goods. An increase in the availability of truck transport facilities has consistently resulted in declines in cargo carried by barges. In amphoe Krathum Baen garden and export crops have traditionally been shipped to Thon Buri and Bangkok by small barges, sampan, and maad type boats (supra, p. 179, n. 1). Local farmers and merchants engaged in marketing of these crops estimated that over 60 percent of all produce now exported from the amphoe was shipped by truck.[1] This change in method of shipment corresponds with the periods when Sethakhit Road, which connects the amphoe with Petchkasem Highway and Thon Buri, was improved and given an asphalt surface. These boats displaced by road shipment were primarily owned and operated by local farmers. Subsequently they have been used only for local delivery of grapes, sugar cane, vegetables, and other garden crops to one of several local transshipment points for reloading to trucks. A similar functional displacement of small produce barges has occurred in amphoe Bang Khla, although not as extensively as in amphoe Krathum Baen. In amphoe Bang Khla there is still a demand for short-haul shipment of fresh produce from farm lots and merchant-broker shops to

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[1] Preliminary indications from a road feasibility study being conducted by the General Engineering Co., Ltd. (Canada) in 1966/67 were that 59 percent of the total volume of export cargo shipped from amphoe Krathum Baen and amphoe Muang Samut Sakhon to Thon Buri was sent by truck. (Interview with Louis Hayashi, Highway Engineer, General Enginnering Co., Ltd. [Canada], September 15, 1967.)

amphoe Muang Chachoengsao where this produce is transshipped to truck. Local amphoe statistics indicate that the number of available for-hire produce boats has declined from a peak of sixteen in 1960 to ten boats in 1967. The loss of cargo and displacement of cargo barges in amphoe Ban Khla has involved both agricultural produce and consumer goods. Several operators of cargo barges in this amphoe indicated that they used to carry local produce to Bangkok and then back-haul a variety of consumer goods, cooking oil, cloth, and other staples. These goods are now almost entirely delivered by truck.

The impact of road development on the availability and use of cargo barges in road development amphoe has been consistent. Only one road development amphoe recorded any significant increase in the number of cargo barges available and/or operated within the amphoe after road development occurred. Official records in amphoe Damnoen Saduak indicated that the number of cargo barges operated within the amphoe had increased from twelve prior to road development to sixty after road development. The number of operational trucks and cargo barges in road development amphoe for the years 1956 to 1967 are shown in Figure 25. The rapid growth in numbers of available trucks is quite evident from the trend line. Cargo barges, however, have remained rather constant in numbers except for the slight increase after 1962-1963. The increase in cargo barge units in amphoe Damnoen Saduak is primarily responsible for this trend. The low quality of the road surface, limited seasonal access due to flooding, and the fragile nature of much of the export produce

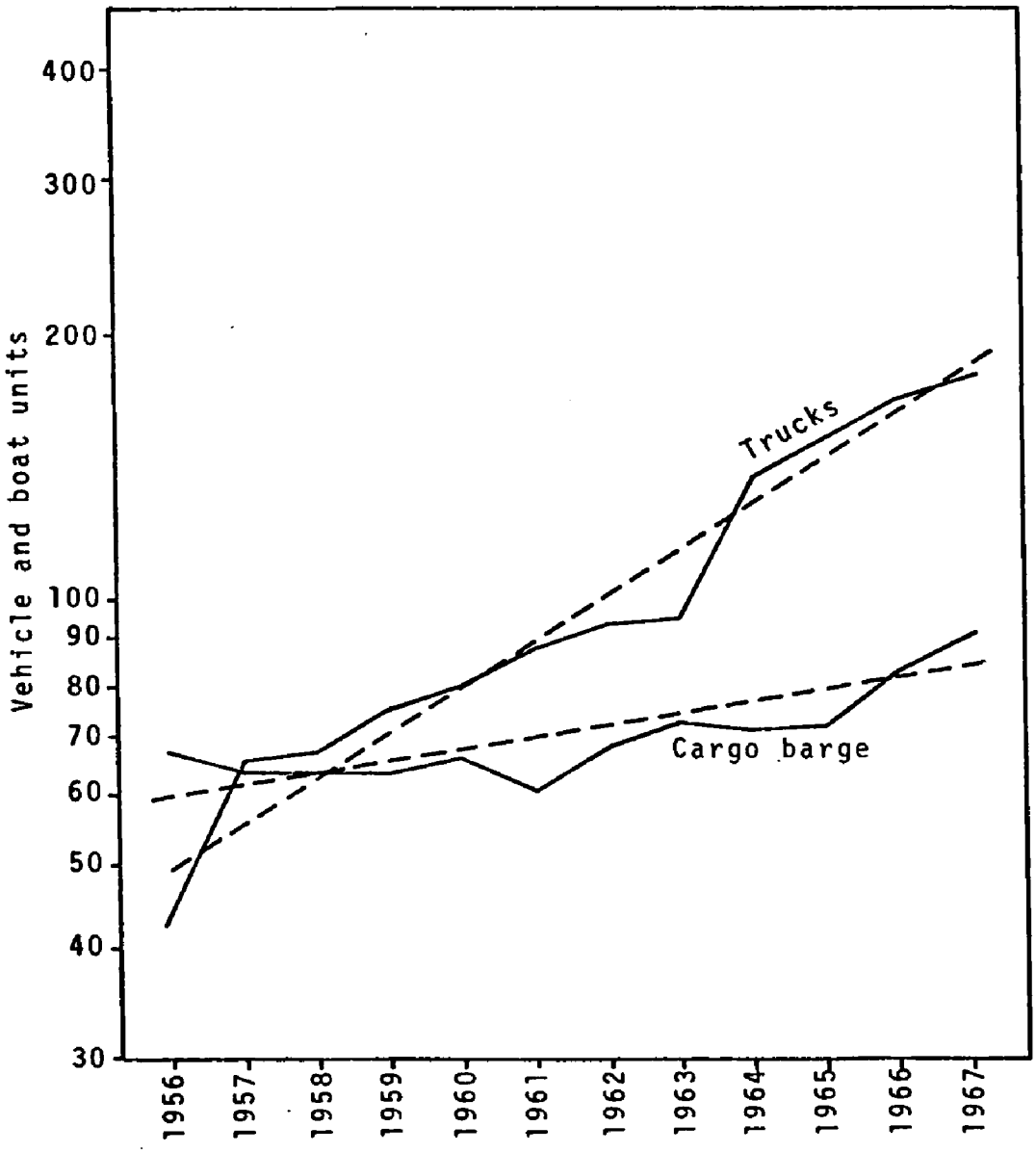

Fig. 25 -- Trucks and Cargo Barges Operating in Road Development Amphoe, 1956 to 1967.

have encouraged many local produce brokers to continue to use water rather than road transport. Small increases in locally available cargo barges have also occurred in several other road development districts and have contributed to the trend for these transport units shown in Figure 25. The extent to which these increases are the result of the relocation of cargo barges displaced from areas of specialized route or cargo activities is still unclear.

A distinct functional displacement of cargo barges has occurred among those boats normally engaged in the shipment of paddy and rice over short and intermediate distances of up to 100 kilometers. Rice mills located further from the large terminal markets than 100 kilometers were reluctant to use trucks for shipment under normal conditions, unless no other form of transport was available. The use of trucks for local collection of paddy was considerably less common, especially in the lower plain where waterway densities are higher. Rice mills located along waterways but with indirect local access to roads made no apparent effort to transship paddy to trucks for export shipment, except when the additional cost of transshipment was outweighed by specific time savings and market price advantages. The functional dislocation by trucks of barges engaged in carrying paddy was generally greater where rice mills and other paddy/rice dealers were located along roads.

Dislocated small barges do not usually relocate in other areas. Relocation of cargo barges to different areas and routes of operations is more likely among the larger capacity boats of fifty tons and above.

Smaller barges can more easily find some employment hauling paddy and similar commodities. One saw mill in amphoe Bang Khla has continued to use several of its smaller capacity barges for local trade and rental rather than continue their uneconomical use in hauling lumber to Bangkok.

The displacement of other types of boats by improvements in road transport facilities has been similar to the displacement of cargo barges. In several areas tow boats have been almost completely displaced by the loss of boat cargoes to road shipment and declining numbers of operational barges. Some of these tow boats have been relocated while others have been stripped and dry-docked. The region in which this situation is most severe is along the main canals extending eastward from Bangkok to the Bang Pakong River. The two tow boat companies usually active in this area have been the Laemthong Transport Co., Ltd., at Pratunam market in Bangkok, and the Prawet Transport Co., Ltd., with headquarters in amphoe Phra Khanong, changwat Phra Nakhon. In 1959 before National Highway No. 304 from Bangkok to amphoe Muang Chachoengsao was developed these companies operated over sixty-two boats. These two companies monopolized tow boat operations within this region and as far east as changwat Prachin Buri. Between 1960 and 1962 barge traffic in this region east of Bangkok underwent a marked decline and by 1968 the two companies owned only ten boats, five of which were actually in operation.[1] Some of the privately owned tow boats formerly leased by

[1]The owners of both of these companies were attempting to sell their remaining boats in 1968 and transfer their financial interests to

these companies had relocated in Thon Buri with the two tow boat companies operating along khlongs Phasicharoen and Damnoen Saduak to changwat Ratchaburi.

Tow boat operations along khlong Rangsit from the Chaophraya River to amphoe Ongkharak, changwat Nakhon Nayok have undergone a similar decline in the scope of their activities. A reduction in the total number of tow boats operating along this route occurred between 1960 and 1965. The completion of the Rangsit Road (National Highway No. 305) along the northern bank of the canal in 1964 and subsequent asphalting of large portions of the laterite surface accelerated the decline in tow boat operations. The total number of operational tow boats dropped from twenty-three in 1960 to three in 1967. Aside from the somewhat more frequent activities of these tow boats in harvest season an average of only five to six barges were in each tow; ten to fifteen lower than in 1960. The Rangsit Tow Boat Co., Ltd., which now operates the three remaining tow boats has sold or relocated all of its other cargo and tow boats. The sale of many of this company's boats enabled the company to establish a passenger bus service which now has a monopoly on passenger traffic along the entire length of the Rangsit road.

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a new company operating along the Chaophraya river. The new company was specializing in towing barges carrying maize, gravel, cement, and sand from changwat Lop Buri, amphoe Tha Rua and Thua Luang in changwat Sara Buri, and Bang Sai in changwat Ayutthaya to Bangkok.

The decline in the number of areas and total routes in which tow boats operate has been precipitated by several factors. Most important has been the development of roads and the subsequent increase in truck transport which has displaced many cargo boats. The reduction in cargo barge operations over short and intermediate haul routes and the increased specialization of boats in particular commodities has made local tow operations increasingly uneconomical. Technological and design improvements in boats and engines have also contributed to a reduced demand for tow boats on minor canals and over short distances. The availability of the low cost hang-yao outboard engine which is adaptable to cargo barges has facilitated this change. The low purchase price and operating costs of this engine and its simplicity of operation and use have made outboard engines increasingly popular with barge operators. It affords the cargo boat operator greater mobility at lower costs and frees him from dependence on tow boats.

Small boats engaged in local, mixed passenger-cargo and commercial passenger operations have been displaced less than cargo boats. However, the large capacity mixed passenger cargo boats have experienced a greater displacement than any other type of boat. Most of the single and double decked passenger-cargo boats are commercially operated by two companies, the Thai Pattana Transport Co., Ltd. and the Suphan Transport Co., Ltd., located at Thapachan, Bangkok.[1] In 1966 the Suphan

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[1]The Suphan Transport Co., Ltd., formerly known as the Suphan Steam Packet Co., has been in operation for at least sixty years. Initial operations at the turn of the century along the Tachin River to the Suphan River were later expanded to include the Chaophraya, Noi, and Maekhlong Rivers. (Arnold Wright ed. and Oliver Breakspear, Twentieth Century Impressions of Siam, London: Lloyd's Greater Britain Publishing Co., Inc., 1931, p. 143.)

Transport Co., Ltd. merged with the Thai Pattana Transport Co., Ltd. buying all its holdings in a bid to establish a monopoly on commercial long haul passenger and passenger-cargo operations by water. Officials of the Thai Pattana Transport Co., Ltd., indicated that both passenger and cargo water transport operations had declined in recent years and by 1966 most of their boats were inactive. The managing director of the Suphan Transport Co., Ltd. reported that in recent years their income derived from cargo operations had declined to less than 10 percent of their total receipts and the consolidation of the two companies was an attempt to increase the percentage of their total operations devoted to cargo shipment.[1] Field interviews with privately owned and operated passenger-cargo boats indicated that a uniform loss of passengers and cargo and a decline in the number of operational boats had occurred throughout the central plain in areas where improved road transport competes with water transportation.

In amphoe Sanphaya locally owned passenger-cargo boats have completely ceased operations. In 1965 a local owner of six boats suspended operations due to the loss of local cargo to trucks and the inability to compete with the rapidly expanding services offered by road transport. After the completion of construction of a laterite road by the Royal Irrigation Department from amphoe Muang Chai Nat to changwat Sing Buri, passing through amphoe Sanphaya, the amount of cargo

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[1]Interview with Pravat Vhudhiporn, Manager, Thai Pattana Transport Company, Ltd., July 10, 1967.

shipped by passenger-cargo boats began to decline. By 1965 all of the rice exports previously shipped to Bangkok by passenger-cargo boats had been transferred to trucks, and the main back-haul cargoes of sugar and kapok were also being sent by truck. The displacement of these boats by truck transport resulted in their eventual sale, and the owners purchased several small Datsun trucks which were converted to buses for local use between amphoe Muang Chai Nat, amphoe Sanphaya, and changwat Sing Buri. Similar cases of truck displacement of passenger-cargo boats were reported in amphoe Bang Khla, Tha Rua, and Krathun Baen. Only in areas without roads has passenger-cargo boat service maintained operations, and limited increases in passenger-cargo boat operations were observed in amphoe Lat Bua Luang and Chumsaeng.

The only area of inland water transport to have increased in operations and functional transport units has been in local passenger operations. Amphoe statistics in nine of the ten amphoe in which data were available showed a significant increase in the number of passenger boats operating in those amphoe. A large number of these boats are of the hang-yao type. These boats use both outboard diesel and gasoline engines and operate primarily over limited distances. Annual registration figures of the Harbor Department for passenger craft also record a marked increase in the total number of boats since the late 1950's. The annual registration figures for all motorized passenger boats and for motorized passenger boats operating in road survey districts during the period from 1953 to 1967 are shown in Figure 26. The variation in the number of this type

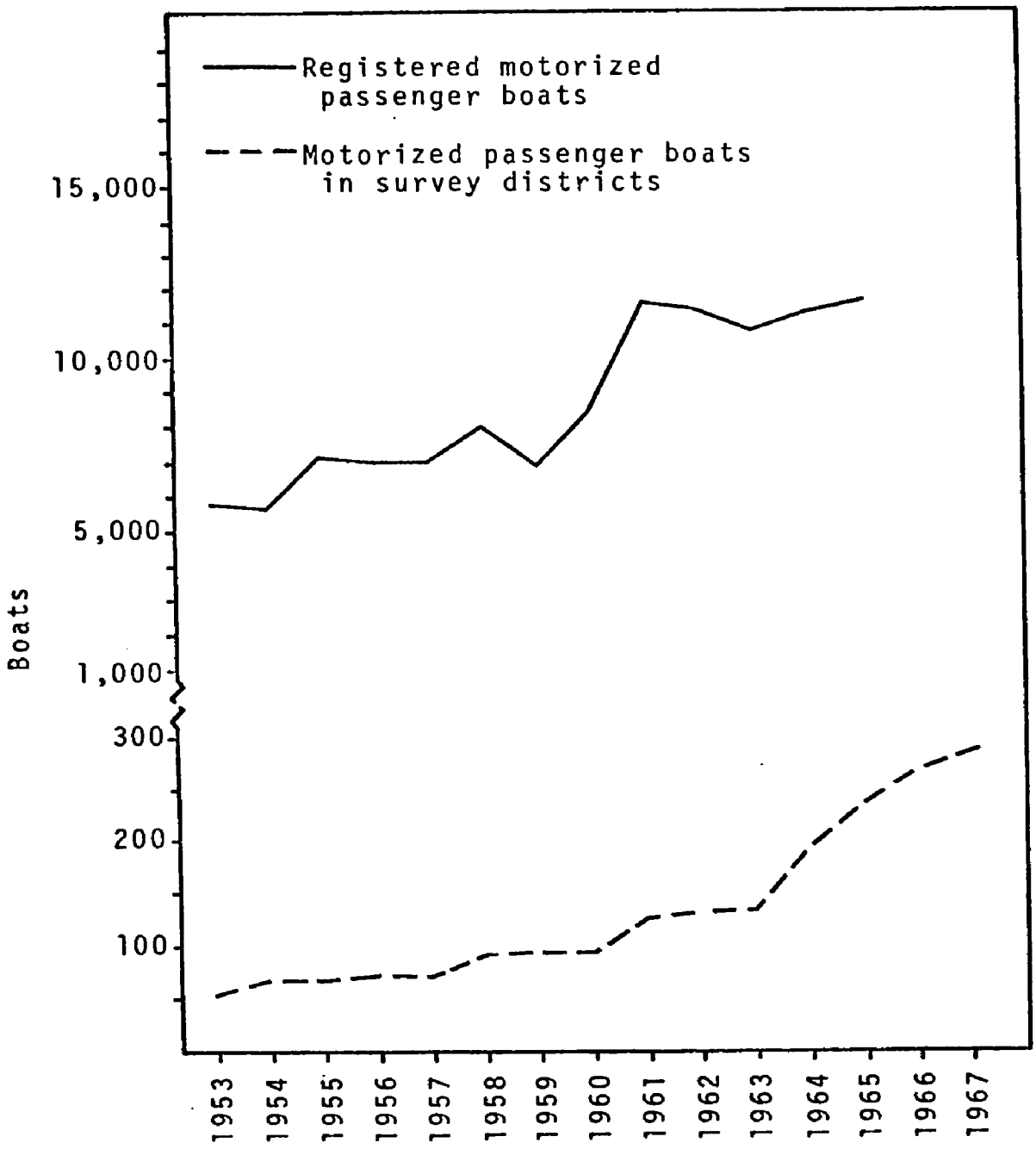

Fig. 26 -- Motorized Passenger Boats Registered in Thailand and Operating in Road Survey Districts, 1953 to 1967.

of boat operating in control districts during the same period has been negligible. The general increase in the use of these passenger craft in road survey districts is consistent with the overall increase in registered passenger boats in the country. However, the implications of the somewhat more noticeable increase in motorized passenger boats in road development amphoe since 1962 are unclear. A certain amount of dislocation of passenger boats by increased interchangwat bus transport where two operated along parallel routes may partially explain this recent increase. Since interchangwat bus services have expanded at a more rapid rate than have local or intrachangwat bus services the recent rise in passenger boats in road development areas may reflect an attempt by boat operators to move into areas where they still maintain some competitive advantage over bus transport.

The impact of road development on traditional forms of land transport has been limited to a partial displacement of the ox cart or kwien. This form of transport is found in those areas of the central plain where it is sufficiently dry for cart operations. The kwien has not been widely used in any portion of the lower plain, but is found along the eastern and western margins of the plain and is frequently used by farmers in the central plain above changwat Chai Nat. Some dislocation of kwien by road development was reported in amphoe Chumsaeng. The primary use of the kwien in this amphoe has been to carry paddy from farms to local rice mills, and occasionally to carry wood and forest products from the mountains. There has been only partial displacement of the kwien because

available roads are often limited to tracks and are more easily negotiated by cart than motor vehicles. Some decline in the use of the kwien was also noticed in amphoe Sanphaya.

An extensive functional and spatial displacement of the kwien has occurred in amphoe Khok Samrong. The kwien was the traditional form of transport and method used to ship produce in this area for many years, but the increased use of trucks and tractors following road development has reduced kwien use to minor importance. While the kwien is still occasionally used to carry maize, sorghum, and other crops from fields to brokers and merchants' shops in Khok Samrong market, its main function has been limited to short-haul shipment of sacked maize from fields to the highway. Once at the road the grain is reloaded to trucks for shipment to Khok Samrong market. The versatility of tractors and their great mobility through brush and scrub vegetation has been an important reason for the decline in kwien use.

The apparent decrease in water transport as a result of improved road transport facilities has been a relative rather than absolute decrease for most of the existing boats operating on the inland waterway system in the central plain.

PART V

CONCLUSION

CHAPTER IX

A SUMMARY AND PROJECTION

The development of roads within the central plain of Thailand has been accompanied by considerable variation in the extent and type of impact on the rural economy. There is great inconsistency in the variety of benefits which can be attributed to road development such as higher farm and market prices for produce, increased production, and changes in land values. The differential in impact of road improvements has been attributed to a combination of economic, spatial, environmental, and sociocultural factors. There is no uniform pattern in developmental impact of roads which suggests that the simple process of road development in itself is not always sufficient reason for change in the form and function of the rural economy. This is particularly true in those parts of the central plain where road and water transport are mutually supportive and/or competitive.

Fundamental to any appreciation of the impact of road improvement in this region is an understanding of the general functional role of the road network. Traditionally the planning and construction of roads in this region prior to 1940 was based on the desire to (1) develop feeder routes to the inland waterway network, (2) provide connecting routes

between major provincial capitals, and (3) link external regions of the country to the central plain and Bangkok through the inland waterway network (see supra, p. 51). The network of roads which resulted from this policy was essentially a system of transitive highways which in effect "passed over" rather than "through" the areas they traversed. These routes were not designed as development roads and therefore the extent of their impact spatially and their capacity to serve as a catalytic agent for change were limited. Although some routes were intended to feed into the waterway network only a few such as National Highways No. 1, 365, and 304 actually did link major water-road transshipment and distribution centers, and even these paralleled major inland waterways (see Fig. 3). Since 1945 with increasing emphasis on road construction the functional character of the highway network has undergone some modification. Nevertheless, the transitive quality of this system is still evident with secondary and local feeder roads providing the few links to local markets and processing-distribution centers. These minor routes are quite often locally built and maintained by religious institutions (wats), private truck and bus companies, or local officials and have lower quality surfaces and less adequate maintenance than Provincial or National highways. Considering the lower trafficability, poor maintenance, and seasonal utility of these routes it is not surprising that the impact resulting from their development has been so variable.

The spatial implications of road development impact in the central plain have several aspects. In this region road development has been

characterized by a decrease in its impact on the rural economy with increasing distance from Bangkok and Thon Buri. The extent of this spatial decrease in realized benefits is reflected in such factors as agricultural land use, land tenure, rates of technology adoption, and consumption patterns. The most consistent realization of benefits from road development was found within a distance of approximately 100 kilometers from Bangkok and Thon Buri, although the impact varies with the influence of other variables.

This relationship between distance and observed impact of road development was more explicitly defined within survey amphoe. Road development had its most extensive impact within the area extending to one kilometer on either side of the road, after which this impact declined with increasing distance. The decreasing facility of road development to influence such variables as farm income, land values, and settlement patterns emphasized the declining impact of road development spatially from this transport route. The maximum linear extent of the impact of roads was limited to a distance of four kilometers from the road. Certain changes in marketing practices, selection of transport, and adoption of technological inputs in both the upper and lower plain emphasized the importance of existing water transport facilities in conditioning the spatial impact of road development. The influence of this factor is greater in the wet lowlands of the lower plain where waterway densities are higher.

The importance of environmental conditions as one factor conditioning the spatial impact of road development was not clearly determined. Limited evidence from this and other research in the country (supra, p. 94 , n. 2) suggests that the spatial impact of road development is greater in dry upland and transitional upland environments than in the wet lowlands of the central plain (supra, p. 14, n. 1). The absence of alternative transport facilities in dry upland areas and the extensive inland waterway system in the lower plain are important factors in this apparent pattern.

An environmental differential in the pattern of road impact is a second feature of road development in the central plain. More significant than any overall differences in gross impact between the dry upland and wet lowland environments has been the variation in types of realized benefits between these two ecological zones. For example, changes in agricultural land use patterns following road improvements in the wet lowlands of the central plain were limited areally and in frequency of occurrence while the opposite pattern was observed in the dry upland areas. The higher costs of field conversion, development inputs, and related production expenses as a reflection of environmental conditions in the wet-paddy lower plain were major factors inhibiting changes in land use in this region. However, in upland areas in both amphoe Khok Samrong and districts investigated in other studies the extent of land use change was greater areally and occurred more rapidly after transport development had taken place. Although it has not been possible to isolate

road development as the catalytic agent of this change, its contribution in facilitating and encouraging such changes in land use in the drier upland areas has been significant. Similarly, the absence of a waterway network in many transitional upland areas, which is in fact an environmental characteristic of the lower plain, has precluded the possibility of alternative transport facilities inhibiting road development impact.

A related aspect of the variable impact of road development under different environmental conditions concerns land development, settlement, and population growth. The improvements in road transport facilities in districts studied in the wet lowlands of the central plain have had very limited influence on these factors. The absence of any significant correlation between road development and settlement, population growth, and land development in this area is due in part to already high population densities, and the lack of land for settlement.[1] In the transitional upland and dry upland environments, the influence of road improvements on settlement, land development, and population growth is more apparent. The lower population densities and frontier land conditions in these areas have provided opportunity for settlement and land ownership not present in the lower plain. Road development has facilitated the settlement and development of land in some of these

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[1] The mean 1960 population density in the nineteen contiguous provinces in the lower plain, excluding changwats Lop Buri and Uthai Thani, was 100.2 persons per square kilometer while the remaining ten provinces in the upper plain had a mean density of 35.5 persons per square kilometer.

areas as the data on household migration and population growth in amphoe Khok Samrong indicate.[1] The ability of road development in upland areas to encourage this type of economic and social change by making previously semi-isolated areas more accessible has also had a negative impact. Net losses in population in some upland areas in which road development has taken place indicate improved communication may encourage greater emigration than immigration.[2] Although the environment acts as an independent variable in relation to the extent of road impact, its significance in this interrelationship must be considered in conjunction with other factors. The environment alone cannot be considered primarily responsible for the variation in developmental impact of road improvements.

Accessibility as a measure of road trafficability, surface characterisitics, and seasonal fluctuation in road utility has been an important variable influencing the impact of road development. Low quality road surfaces of dirt, stone-gravel, and even laterite have frequently limited road benefits by increasing vehicle operating costs, causing damage to transported commodities, and negating potential advantages of convenience and cost that road transport might enjoy over alternative forms of transport. Roads of this type are often poorly maintained which further de-

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[1] See supra, p. 219

[2] Jittasatra states that the two major reasons for emigration were: (1) increased land values due to road development encouraged people to sell their farm lands and settle elsewhere on cheaper land; and (2) out-migration to earn more money. (Jittasatra, "Khon Kaen-Yang Talad," p. 62.)

teriorates their potential, especially in areas where seasonal flooding is common. These conditions were observed in several districts studied in the central plain. Road trafficability and seasonal utility as functions of surface characteristics frequently were responsible for limitations placed on the type and capacity of vehicles, thus restricting the road development potential of these routes. The cumulative effect of these restrictive features of low quality road surfaces has been to limit both the potential and actual development impact of roads. This situation has been more prevalent in the lower plain where seasonal rains and flooding have accelerated the deterioration of road surfaces. In comparison the routes studied which were surfaced with asphaltic concrete, penetration macadam or similar all-weather surfaces provided year-round accessibility, greater convenience, and more competitive transport services. The actual developmental impact of roads of this quality was consistently greater than in districts with loose surface, dry season routes.

The inland waterway network and water transport industry in the central plain is an important factor influencing the developmental impact of road improvements. The availability of water transport has consistently been the one variable which has conditioned the impact of road development in several ways. First, the extensive waterway network in the lower plain has traditionally provided a convenient, easily accessible, and inexpensive means of produce shipment and passenger movement. Road development in its restricted linear and spatial framework

has been unable to provide equivalent advantages in convenience and cost, except in a very limited spatial range. It has only been in districts where all-weather roads have been developed that the advantages of improved convenience, services, and comparable costs have made road transport more competitive with water transport. In these cases there has been a noticeable increase in the use of road transport for both produce and passenger transport. Much of the marketable surplus produce of this region is bulk rice and paddy, mostly still shipped by water. The major utilization of road transport has been in shipping low bulk, high value agricultural produce, consumer goods, and manufactured items. Similar patterns have developed in the selection of passenger transport where all-weather roads have helped to improve passenger comfort and convenience.

Water transport is more reliable annually since there are greater numbers and types of operational units and they are less susceptible to variations in transport conditions. During periods of lowest water levels most local canals and all interchangwat waterways are navigable. This uninterrupted navigability is possible through the use of shallower draft vessels and/or reductions in cargo loads. Many feeder roads, however, become impassible during periods of heavy rain and flooding. The importance of transport system reliability is also reflected in the functional capabilities of transport units. The larger number and greater cargo volumes of waterway vessels provide them with a functional advantage for the collection and shipment of bulk agricultural and mineral commodi-

ties. The increased use of truck transport for the shipment and distribution of some low bulk, high value agricultural produce and consumer goods reflects a current trend toward a division of cargo between road and water transport units. The primary advantages road transport provides in these activities is in speed of shipment and frequency of delivery. A final aspect of the influence of water transport on the developmental impact of road improvements is in the area of transport units. To effectively stimulate changes in transport utilization, marketing patterns, and passenger transport services, road transport costs and services must be comparable with those of water transport. While it is not always necessary for these factors to be competitive the marginal advantages of road transport in convenience and speed should be sufficiently great to enable transport users to realize some savings in cost through reduced handling charges, greater profits from speed of delivery, and convenience which will justify the switch to road transportation. Road transport now only enjoys a cost advantage over water transport for the shipment of agricultural produce within fifty to seventy-five kilometers of Bangkok and Thon Buri.[1] Beyond this distance water transport costs per ton kilometer decline more rapidly than do those of road transport. Road development has been most effective in reducing transport costs and improving its competitive position vis a vis water transport in districts where improved road surfaces are of the all-weather type, and the production of fresh produce for urban markets is a principle feature

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[1] Based on calculations of transport cost per ton kilometer of agricultural produce shipped from survey districts to Bangkok and Thon Buri as recorded on questionnaires and amphoe statistics.

of the agricultural economy. Where both of these conditions exist as in amphoe Damoen Saduak, Krathum Baen, and Bang Khla, there has been an increase in the use of road transport for shipment of this type of agricultural produce. The shipment of bulk agricultural produce such as rice and paddy is still controlled by water transport in most districts where road development has taken place.[1] Under unusual market conditions, however, it is not uncommon for rice millers and paddy dealers to ship these commodities by truck even though an unfavorable differential in transport costs may exist. Road improvements have also been instrumental in improving bus services, which has led to increased local competition and lowering of water transport passenger fares. In some districts where this situation has developed bus fares have remained higher than passenger boat fares, but the increased convenience, speed, and comfort of bus travel has encouraged larger numbers of people to use bus transport.

The full benefit of road development cannot be measured entirely in terms of economic returns. Many rural residents whose incomes are not affected, whose property values remained unchanged, and whose overall standard of living has not improved appreciably still consider road development to be very beneficial and a significant contributor toward elevating the quality of rural life. These social and psychological benefits of feeling in closer contact with surrounding regions, nations,

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[1] The two notable exceptions to this are amphoe Min Buri and Krathum Baen where road development has provided cost advantages over water transport.

and the world; of having easier access to social, economic, and welfare services available in provincial centers and the capital; and of being a member of a greater Thai social and political community are all real benefits which are difficult to measure. The end product of any rural development measure is to improve the welfare and happiness of the people. That roads contribute to this goal in as many non-economic ways as economic ways is beyond doubt. While it is not the aim of this thesis to attempt to measure this "satisficer" role or the non-economic benefits or roads, there is no doubt that they are considerable and must be recognized as a powerful factor supporting road development.

A Projection of Road Impact

Transportation is increasingly acknowledged as one essential for the implementation of development plans and growth in agricultural productivity in developing countries.[1] In view of the extensive and long-term implications of transport system planning and investment in road transportation for economic development in Thailand it is appropriate that some concluding remarks be concerned with the projected impact of future road development within the central plain.[2]

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[1]Arthur T. Mosher has recently re-emphasized the importance of transportation for growth in agricultural productivity, a primary goal of most development plans. ("The Development Problems of Subsistence Farmers, A Preliminary Review," Subsistence Agriculture and Economic Development, ed. Clifton R. Wharton, Jr., [Chicago: Aldine Publishing Company, 1969], p. 9).

[2]Implicit in any projection of road development are certain assumptions about the future stability of agricultural cropping and land use pat-

It is anticipated that those variables which have been important in influencing the developmental impact of road improvements in the past will continue to exert similar influences in the future. Investments in low quality, loose surface roads in this region will not provide sufficient returns in realized benefits and developmental impact to adequately justify their construction. If future investments are in fact made in this type of road they will reinforce the position of water rather than road transportation. Considering the limited efficiency and restricted impact of seasonal roads in the central plain there appears to be no developmental benefit in investing in other than all-weather roads.

Environmental conditions as an independent variable will continue to influence the effectiveness of road development. Aside from the effects of the lowland, wet-paddy environment on problems of road engineering and maintenance, the average farmer or entrepreneur will still be faced with the large capital investments required to convert paddy fields to more profitable forms of land use. However, as road transport networks expand some decline in shipment, production input, and marketing costs can be anticipated. It is conceivable that these reduced costs can provide sufficient stimulus for a greater investment in more intensive forms of land use. If this pattern is accompanied by more effective efforts to acquaint paddy farmers with the advantages of improved transport and

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terns, continued viability of water transportation as a segment of the total transport system, and the continued growth of the urban primate complex of Bangkok and Thon Buri.

lower production input costs it is possible that increased production through higher yields per unit area may result. It is more likely, however, that this aspect of road development may ultimately prove more effective in the drier upland and transitional upland areas where the size and costs of production inputs are lower, roads have a greater spatial zone of influence, and environmental conditions favor more extensive agriculture based on upland crops. In the long run road development may continue to prove a more effective stimulus to rural economic and social development in dry uplands rather than the wet lowlands of the lower central plain.

An increase in the spatial impact of road development, particularly in the lower plain, is anticipated as road network densities increase, road transport services become more competitive in cost and convenience, and the growth of Bangkok and Thon Buri exerts increasing pressure for more intensive use of agricultural lands. Rapid urban growth is already influencing traditional land use patterns in the lower plain and as this growth continues and market demand for various low bulk, high value agricultural and manufactured goods rises the spatial influence of roads as inducements to change land use patterns should increase. In a similar sense the development of all-weather roads will provide more reliable and competitive services and thereby extend the spatial influence of road improvements beyond the limits currently imposed by low quality roads, high transport costs, lack of convenience, and more extensive waterway networks. The ultimate extension of this

influence of road development must also depend upon sufficient cost and convenience advantages and the location of the route with respect to the using population.

The inland waterway transport system has in the past been a principle factor in conditioning the developmental impact of road improvements in the central plain. Contemporary trends toward a greater division of cargo between these two transport systems and greater functional specialization among water transport units should accelerate in the future. Although it is improbable that future road construction will ever provide the coverage now enjoyed by water transportation, the coordinated planning of future road improvements can increase the developmental impact of roads while strengthening the complementary and mutually supporting relationship it has with water transportation. Road transport should also exercise increasing control over the shipment of low bulk, high value agricultural produce, consumer goods, and manufactured items, except at the local level. To gain effective control of local collection and distribution of these items would necessitate construction of a system of roadways extending to each amphoe and many smaller local markets. This is neither economically feasible nor developmentally sound since it would in effect amount to a complete discarding of the already important and efficient water transport system. Road improvements have already led to a significant change in passenger transport patterns and this trend should also continue in the future. While future road improvement will be accompanied by an increase in cargo and passenger tonnage handled,

water transportation should continue to retain its functional advantage in handling bulk cargoes and in local communications and distribution of produce and consumer goods.

The development of road transport facilities in the central plain of Thailand is an essential investment if Thai developmental goals of increased production, agricultural diversification, and economic integration are to be achieved. The nature of this investment must, however, be visualized in terms of the costs and advantages of developing alternative transport facilities and integrating road expansion with available water transport systems. Inefficient use of water transportation will not only diminish the effectiveness of development programs but limit the potential return on investments in road transport systems. Future investment in road transport systems in this region will prove far more beneficial if adequate prior consideration is given to coordinating and integrating the operations of road and water transportation.

APPENDICES

APPENDIX I

PHYSIOGRAPHIC DATA FOR SURVEY AMPHOE

Survey District	Mean Annual Precipitation (mm.)	Basic Soil Type	Crop Associations	Natural Vegetation	Agricultural Land Use Patterns
Bang Yai	1400-1600	humic glei, undeveloped profile	wet paddy, vegetables	none	wet paddy, fruit trees, vegetables
Min Buri	1400-1600	"	"	"	wet paddy
Krathum Baen	1200-1400	"	"	"	wet paddy, fruit trees, vegetables
Lam Luk Ka	1400-1600	"	"	"	wet paddy, vegetables
Lat Bua Luang	1200-1400	"	"	"	"
Nong Sua	1600-2000	humic glei, high acidity	"	"	wet paddy
Muang Chachoengsao	1400-1600	"	"	"	"
Damnoen Saduak	1000-1200	humic glei, undeveloped profile	fruits, vegetables	"	fruit trees, vegetables
Bang Khla	1400-1600	"	wet paddy, fruit, vegetables	"	wet paddy, fruit trees, vegetables
Tha Rua	1200-1400	gray podsol humic glei	paddy, maize	"	wet paddy
Sam Chuk	1000-1200	gray, yellow red podsols	upland crops, wet paddy	"	wet paddy, sugar cane
Sanphaya	1000-1200	gray podsol humic glei	wet paddy upland crops	scrub forest	wet paddy, beans
Khok Samrong	1000-1200	Rendzinas, podsols, lithosols	wet-dry paddy upland crops	"	maize, beans, sorghum, wet paddy
Chumsaeng	1000-1200	alluvial, humic gel	upland crops, wet-dry paddy	"	wet-dry paddy, maize, upland crops

APPENDIX II

QUESTIONNAIRES, INTERVIEW SCHEDULES AND DATA ENUMERATION FORMS

Note: The questionnaires and interview schedules contained in the following pages are not exact duplicates of those used in field data collection, but correspond closely in areas of inquiry and method of questioning. The original forms were written and administered primarily in the Thai language. The informal and loosely structured format of these schedules facilitated their administration and contributed to a more uninhibited exchange of information between informant and interviewer.

Farmer-Gardener Questionnaire

Date_____
Location Key_____
Informant_____
Interviewer_____
Malaria No._____

Mu ban_____
Tambon_____
Amphoe_____
Changwat_____

Land Ownership: Owner-operator

1. No. rai owned_____
2. Purchase date(each parcel) _____
3. Purchase cost (each parcel) _____
4. No. rai leased_____
5. No. tenant households_____
6. Location of leased parcels_____
7. Rent per rai(leased parcels)_____
8. Rent per rai, _____ years ago(leased parcels) _____
9. Rai sold_____
10. Date of sale _____
11. Sale price _____
12. Reason for sale _____

Tenant Operator

13. No. rai rented _____
14. Rent per rai _____
15. Years rented this land _____
16. Location of owner _____
17. Rent per rai _____ years ago _____
18. Rental payment: cash _____
    in-kind_____
    labor _____
    other _____

Hired Operator

19. No. rai worked _____
20. No. years worked this land _____
21. Wages: cash_____
    share produce _____
    share profit_____
    other _____
22. Permanent or temporary operator _____
23. Other hired laborers: temporary _____ wages _____
    permanent _____ wages _____

Field Location and Dimensions(attached map)

Personal Background

23. Years resided in this Mu ban:_____
Tambon:_____

24. Previous residence:
Tambon_____
Amphoe_____
Changwat_____

25. Previous occupation_____
26. Reason(s) for moving here: _____
27. Previous non-farm occupations:
type_____
location_____
years(months)._____
income_____
28. Reason(s) for occupation change: _____
29. Amount and sources of remitted income(detail)_____

Land Values

30. Land value of current holdings at time of settlement:
a) market value_____
b) tax assessed value_____
31. Present land values of holdings worked and/or rented out:
a) market value_____
b) tax assessed value_____
32. Reason(s) for change in land values_____

33. Area(s) of greatest change in land values:
a) khlong_____ c) amphoe town_____
b) road_____ d)market_____

Cropping Patterns

34. Cropping patterns 1965/66, 1966/67, 1967/68(detail)
a) type of crop_____
b) number of rai_____
c) number of plantings_____
d) number of harvests_____
e) yield per rai planted_____
f) income per rai planted per year _____
35. No. years grown each crop:
36. Source of cultivating knowledge for each crop:
37. New crops cultivated next year:
a) crop_____ rai_____ reason for growing_____
38. Local market gardening:
a) Year begun locally_____
b) Reasons for starting_____
c) Origin of initial gardeners_____
d) First crops grown_____

39. Cost(s) of converting paddy to garden:
    a) labor_____
    b) tractor_____
    c) irrigation works_____
    d) other(detail) _____

Marketing

40. Sale/disposition of garden crops grown:
    a) crop_____
    b) sale location_____
    c) buyer_____
41. Sale/disposition of paddy, maize, beans etc.
    a) crop_____
    b) sale location _____
    c) buyer_____
42. Reason(s) for sale of garden crops to same buyer each year:

43. Reason(s) for sale of paddy, maize etc. to same buyer each year:

44. Farmer marketed garden produce:
    a) crop_____
    b) sale location _____
    c) buyer _____
    d) shipping method(cost)_____

45. Sale/disposition of garden crops grown _____ years ago:
    a) crop_____
    b) buyer_____
    c) location_____
    d) shipping method(cost)_____
46. Sale/disposition of paddy, maize, grain crops _____ years ago:
    a) crop_____
    b) buyer_____
    c) location_____
    d) shipping method(cost)_____
47. New markets developed locally:
48. Has demand for your crops changed(detail)_____
49. From whom/how do you learn of current market prices(detail):

Labor

50. Number of full-time laborers hired:
    a) number_____ b)wages_____
    c) origin_____ d) jobs_____
51. Number of part-time laborers hired:
    a) number_____ b) wages_____
    b) origin_____ d) jobs_____

Equipment

52. Boats owned: a) number_____ b) type_____
c) purchase date_____
d) cost_____
e) purchase location_____
53. Farm implements: a) type and number_____
b) purchase date_____
c) cost_____
d) purchase location_____
54. Which items available locally _____ years ago_____
55. Which items available locally now_____

Fertilizer, Insecticide

56. Fertilizer, insecticide, and pesticides used:

Item	Amount	Cost	Purchased	Available

57. Length of time each used:
58. How introduced to the use of each item: (detail)

59. Are these items easier to obtain now than _____ years ago?

Transport

60. Bus services first available locally:
a) year service first begun_____
b) annual/seasonal operations_____
c)type of bus used _____
d) Ownership-operations: local private owner_____
local company_____
external owner/company_____
61. Truck shipment of paddy, maize first available locally_____
62. When did you first use trucks to ship produce:
a) to buyer_____
b) to local market_____
c) to external market_____

63. Which is more convenient / economical for local shipment of produce:
a) boat_____
b) truck_____
c) bus _____
64. Which type of transport is used most often for local shipment of agricultural produce?

65. Which type of transport is most often used for external(long-distance) shipment?

Local Development

66. In what ways has road development influenced your farm operations.

67. How has road development effected local incomes?

68. What changes(increase, decline) in local government activity have occurred since _____ years ago?
    a) new schools_____
    b) school expansion/ repair_____
    c) Public Health: clinics _____
    midwife_____
    hospital_____
    d) Malarial eradication_____
    e) Agricultural extension:
    Fertilizer, insecticide distribution_____
    Cropping, cultivating techniques_____
    Marketing services_____
    Test farms_____
    Other_____
    f) other_____

Consumption Patterns

69. What new luxury items have you purchased recently?
70. Are these items easier to obtain locally than _____ years ago?
71. What new shops have opened recently in the local market?
72. Is there a wider variety of goods available in local markets than _____years ago?
73. Where do you usually go to shop for food staples and clothing?
74. Where did you obtain these items _____years ago?
75. How many times(trips) did you go to the provincial capital this year?(Bangkok-Thon Buri)
76. How many times (trips) did you go to the provincial capital ___ years ago? (Bangkok-Thon Buri)

National-International Awareness

1. What improvements have been made by the changwat Governor in the life of the local people?
2. Do you think the Prime Minister is doing a good job in running the country?
3. Why is there a war in Viet Nam?
4. Do you think Thai soldiers should be sent to help the South Vietnamese?
5. What countries are Thailand's neighbors?

6. Has the President of the United States visited Thailand recently?
7. What is the reason(s) for the trouble in northeast Thailand, and in changwat Nan, Prae, and Tak?

Farm Operations Financed by Brokers

1. Do you work with a broker now?
2. What market does this broker/wholesaler come from?
3. When did you first begin to work with a broker?
4. Do you work with the same broker each year?
5. Did you obtain funds from a broker to establish this farm/garden?
   a) amount_____
   b) terms_____
   c) interest_____
6. What were the costs of converting this land to a garden?
   a) labor_____
   b) tractor_____
   c) irrigation_____
   d) other_____
7. Who paid for this field conversion?
8. How much money/credit do you get from the broker each year?
9. Do you have to resell your produce to the broker?
   a) price paid_____
   b) others sold to_____
10. How long have you been aware of brokers financing farms in this area?
11. Where do most of these brokers come from(market, town)?
12. How does the broker transport your produce?
13. Do you have to buy fertilizer, seed, insecticide from the broker who extends credit for farm operations?
   a) item_____
   b) cost_____
   c) local market cost_____
14. Is transportation included in the cost of these items?
15. If your debt is not repaid each year, must you resell your crops to the broker the following year?
16. How much do you owe the broker now?
17. What other local sources(merchants, friends) of credit do you use:
   a) regularly_____
   b) infrequently_____
18. Which is the most convenient financially?

Rice Mill Questionnaire

Date_____
Location Key_____
Informant_____
Interviewer_____

Mu ban_____
Tambon_____
Amphoe_____
Changwat_____

General

1. Date mill built_____
2. Mill leased, built, purchased, inherited?
   a) date built_____ b) building cost_____
   c) date purchased_____ d) purchase cost_____
   d) lease agreement_____
3. Length of ownership:
4. Reason(s) for locating mill in this tambon:
5. Former occupation:
   a) location_____ b) years_____
6. Reason for change of occupation if No. 5 not miller, mill operator?
7. Other full or part-time occupations now held?
8. Do you belong to any rice millers association for marketing, export?

Local Rice Mill Development

9. Existing mills in this tambon(amphoe) when began working this mill
   a) location_____ b) capacity_____
   c) mill age_____ d) type of operation_____
   e) year closed_____ f) reason for closure_____
10. Reasons for mill closings?
11. Mill construction in this tambon(amphoe) during residence of informant?
    a) location_____ d) type of operation_____
    b) capacity_____
    c) date_____

Personal History

12. Place of birth_____
13. Resident in this tambon(amphoe) _____ years.
14. No. members in household_____
15. Location, activities of non-household members(detail)
16. Ownership/shares of other mills(detail)
17. Previous residence: a) tambon_____
    b) amphoe_____
    c) changwat_____
    d) other_____
18. Reason for moving to this tambon_____

Mill Facilities

19. Average daily output of mill:
    a) paddy harvest season _____
    b) annually _____
    c) Months(weeks) mill works full capacity _____
20. Average daily output of mill when opened?
    a) paddy harvest season _____
    b) annually _____
    c) Months(weeks) mill works full capacity _____
21. Reason(s) for difference between No. 19 and No. 20 _____
22. Type, purchase date, location of milling machinery _____
23. Expansion of mill since opening:
    a) improvements _____
    b) year made _____
    c) cost _____
    d) effect on output
24. Production of par-boiled rice:
    a) year began _____
    b) type of boilers _____
    c) purchase date _____
    d) purchase location of boilers _____
25. Average annual production of par-boiled rice _____
26. Marketing of par-boiled rice:
    a) buyer _____ b) location _____
    c) method of shipment _____
    d) disposition of par-boiled rice(export, redistribution) _____
27. Annual fluctuation in production of par-boiled rice(detail) _____

Transportation

28. Paddy/rice boat ownership:
    a)type and number _____
    b)capacity _____
    c)purchase date _____ d)purchase location _____
    e)cost _____
29. Tow boats owned:
    a) type and number _____
    b) capacity(H. P.) _____
    c) purchase date _____ d) purchase location _____
    e) Cost(s) _____
30. Cargo trucks:
    a) type and number _____
    b) capacity _____
    c) purchase date _____ d) purchase location _____
    e) cost(s) _____
31. Kwien(ox-cart)
    a) type and number _____
    b) capacity _____
    c) purchase date _____ d) purchase location _____
    e) cost(s) _____

Milling-Marketing Operations

32. Source(s) of milled paddy _____years ago.
    a) source_____ b) amount_____ c)location_____
33. How was paddy carried to your mill _____years ago.
    a) type of transport_____
    b) percentage(proportion) of paddy received by type of transport_____
    c) percentage(proportion) of paddy received by mill owned transport_____
34. Milling charges _____ years ago?_____
35. Current milling charges_____
36. Basis for milling charges:
    a) market price_____
    b) milling costs_____
    c) transport costs_____
    d) other_____
37. Do milling rates vary annually?
38. Reason(s) for change in milling charges over time:
39. Sources of milled paddy this year:
    a) source(type of seller)_____
    b) location_____
    c) amount_____
    d) frequency of sale_____
40. How was paddy carried to your mill this year:
    a) type of transport_____
    b) percentage(proportion)of paddy received by type of transport_____
    c) percentage(proportion) of paddy received by mill owned transport_____
41. Reason(s) for change in method of paddy shipment?
42. What percentage of milled paddy will be exported?
43. Has this amount always been milled for export?
44. What percentage of milled paddy sold locally to merchants, rice dealers etc?

Transportation Rates

45. Rental/shipment costs for paddy-rice.
    a) type of transport_____ b) cargo _____
    c) origin_____d) destination_____
    e) transport cost(boat and labor): wet season_____
    dry season_____
    f) rented transport locally owned?
46. What factors are considered in establishing transport rates for paddy collection from the farmer?
47. What are the average costs for each factor ?
48. How important is distance in computing transport rates?

49. What factors determine transport rates for long-haul shipment of paddy and rice?

50. What are long -haul transport rates for paddy?
51. Who establishes local and long-haul transport rates?
52. Why have water and road transport rates changed in the last 10 years)detail)?

53. Have rail transport rates changed?
54. Who arranges for truck shipment of rice/paddy destined for export?
55. In rail shipments of paddy/rice how does ETO effect your transport and handling costs?

56. What are "normal" ETO rail terminus to godown transport rates?

Transport Utilization

57. No. years used owned or rented boats for paddy collection_____
58. No. years used trucks for collection and export shipment of paddy and rice_____
59. Why did you begin to use trucks for this type of shipment?

60. What type of transport is most economical and convenient for local collection of paddy?
61. What type of transport is most economical and convenient for export shipment of paddy and rice.
62. What form of transport is most widely used by local millers for paddy collection and paddy-rice shipment?

Merchant-Broker Questionnaire

Date_____
Informant_____
Interviewer_____

Shop type_____
Shop number_____
Tambon_____
Amphoe_____
Changwat_____

Commercial Background

1. Years owned-operated this business_____
2. Years resided in this town(location)_____
3. :Previous occupation_____ 4. Location
5. Reasons for establishing business in this location:

6. Building-land ownership:
   a) building-land owned_____ purchase date_____
   b) shop owned_____purchase date_____
   c) purchase cost: building(shop)_____
   land_____
7. Building-land lease:
   a) building-shop leased_____ amount_____
   b) land lease_____ amount_____
   c) change in lease in last _____ years_____
8. Land use at this location when informant arrived.
9. Number, location, activities of non-resident family members:
   a) location_____ b) occupation_____
   b) years non-resident_____
   c) remitted income(inc. food, clothing etc.)_____
10. Market size(shops) when informant began business_____
11. Numbers of separate markets operating in this town(amphoe)_____ when informant began business.

Commercial Operations: Consumer Goods

12. Types of merchandise handled when shop opened:
    a) merchandise_____ b) origin_____
    c) supply_____ d) supply frequency_____
    e) method of delivery_____ f) delivery costs_____
13. Primary sources of supply for consumer goods_____
    luxury goods_____
    grocery items_____
14. Types of merchandise handled now:
    a) merchandise_____ b) origin_____
    c) supply_____ d) supply frequency_____
    e) method of delivery_____ f) delivery costs_____
    g) when first sold_____
15. Explain changes of source of supply for goods handled.

16. Reasons for widening / limiting range of merchandise handled_____

Commercial Operations: Fresh Produce

17. Fresh produce sold when informant business opened:
    a) produce_____ b) origin_____
    c) supply_____ d) supply frequency_____
    e) method of delivery_____ f) delivery cost_____
18. Percent(proportion) of fresh produce sold which is obtained locally____
19. Primary sources of fresh produce -food staples :
    a) fresh vegetables_____ b) fresh fruit_____
    c) eggs, chicken_____ d) eggs, duck_____
    e) meat, chicken_____ f) meat, beef_____
    g) meat, pork_____ h) fish_____
    i) noodles_____ j) condiments_____
20. Fresh produce sold now:
    a) produce_____ b) origin_____
    c) supply_____ d) supply frequency_____
    e) method of delivery_____ f) delivery cost_____
    g) year first sold_____

Transportation

21. Produce truck ownership: a) type_____
    b) purchase date_____
    c) cost_____
    d) payment method_____
    e) use_____
    f) annual maintenance cost_____
22. Produce boat ownership: a) type_____
    b) purchase date_____
    c) cost_____
    d) use_____
    e) annual maintenance cost_____
23. Percent(proportion) of local and external produce-merchandise delivered by type of transport.

produce	boat	truck	bus	bicycle	train	other

24. What local merchants , brokers, rice millers have purchased trucks for shipping their own produce/merchandise or for rental?

25. Have improvements in transport facilities had any influence on the types of goods you now handle?

26. If improvements in road(water, rail) transport facilities and services were made would you increase or change the variety of goods you handle?

Markets

27. Markets existing in this area(tambon, amphoe) when informant began business:
    a) market name(s)_____ b) location_____
    c) market size(shops)_____ d) function_____
    e) date opened_____
28. New markets built or opened in last _____years.
    a) market name(s)_____ b) location_____
    c) size(shops)_____ d) function_____
    e) date opened_____
29. Market closures:
    a) market name(s)_____ b) location_____
    c) reason(circumstances) of closure_____
30 Increases in specific shop types(services offerred) noticed by informant.
31. From what tambon-amphoe do people come here to shop for:
    a) food staples_____ b) fresh produce_____
    c) luxury goods_____ d) clothing_____
    e) farm ing needs_____ f) religious items_____
32. What impact has the development of road(water) transport had on the size of this market?

Broker-Wholesale Activity

1. Produce-merchandise handled on wholesale basis:
    a) produce-merchandise_____
    b) origin_____ c) disposition_____
    d) frequency of dealings_____
    e) transport used_____
    f) transport costs_____
    g) first handled these(this) items_____

2. Produce-merchandise handled wholesale when informant began business:
    a) produce-merchandise_____
    b) origin_____ c) disposition_____
    d) frequency of dealings_____
    e) transport used_____
    f) transport costs_____

3. Are wholesale activities conducted with the same people regularly?

4. Do transport rates vary seasonally(detail)?

5. What changes have occurred in your use of transport for shipment of produce and merchandise within last _____ years?

6. Size and capacity of storage facilities.

7. Have your wholesale-brokerage activities been affected by recent improvements in transport facilities and services?

Credit-Lending Activities

8. Do you extend credit/cash to farmers frequently?

9. What are the terms under which credit/cash is extended?

10. What interest is charged on cash and/or credit extension?

11. What are the terms for repayment of cash loaned or credit extended?

12. Does the volume of credit you extend vary seasonally(detail)?

13. Are your credit(lending) activities limited to this amphoe, tambon, other areas(detail).

14. What are the major sources of credit used by local farmers(detail).

Local Development

1. What changes in settlement patterns have occurred in this area in the last _____ years.

2. Has the availability of local and long-distance water(road) transport changed in the past _____ years(detail)

3. What have been the major benefits of road development in this area?

4. Have consumer buying habits changed?

5. What improvements in health, educational, and governmental services have you noticed in this area recently?

Truck Questionnaire

Vehicle class_____
Date_____
Informant_____
Interviewer_____

Vehicle style_____
Tambon_____
Amphoe_____
Changwat_____

Vehicle Specifications

1. Type_____
2. Capacity: cargo_____(tons)
   passengers_____
3. Engine horsepower_____
4. Axels_____
5. Model_____
6. Body style_____
7. Vehicle age_____

Ownership

8. Private ownership
   - 8.1 date of vehicle purchase_____
   - 8.2 place of purchase _____
   - 8.3 cost_____
   - 8.4 method of payment: cash_____
     time_____
     other_____
9. Partnership
   - 9.1 number of partners_____
   - 9.2 location of office/garage_____
   - 9.3 partner occupations_____
   - 9.4 number, type other vehicles owned_____
   - 9.5 division of ownership among partners_____
   - 9.6 division of profit among partners_____
   - 9.7 payment of costs among partners_____
   - 9.8 years in partnership_____
10. Rental-Lease Vehicle
    - 10.1 owner_____ 10.2 location_____
    - 10.3 number, type other vehicles owned-leased_____
    - 10.4 owners other business_____
    - 10.5 rental agreement_____
    - 10.6 rental payment: cash_____
      share profit_____
      % of earnings_____
      other(detail)_____
    - 10.7 years rented from this owner_____
11. Hired Operator
    - 11.1 owner_____ 11.2 location_____
    - 11.3 number, type other vehicles owned-leased_____
    - 11.4 owners other business_____

11.5 wages paid: salary _____
share profit _____
other(detail) _____

11.6 time driving for this owner _____

11.7 time driving cargo truck commercially _____

12. Ownership/Shares in other Vehicles

12.1 type and number _____

12.2 current use _____

13. Operations:

13.1 Free Agent::

a) method of obtaining cargo _____
b) obtain cargo from same person (firm) regularly _____
c) payment of commission for agent(firm) finding cargo ___
d) location(s) of major cargo brokers _____

13.2 Contract:

a) person under contract to _____
b) long or short term contract _____
c) terms of contract _____

14. Initial investment:

14.1 initial cost of vehicle _____
14.2 date and location of purchase _____
14.3 condition of vehicle at purchase(new-used) _____
14.4 vehicle seller _____
14.5 method of payment _____
14.6 present market value of vehicle _____

15. Routine Maintenance

15.1 number of routine maintenance periods monthly/yearly _____
15.2 location maintenance carried out _____
15.3 cost of maintenance: labor _____
parts _____
tires _____
other _____
15.4 time spent in maintenance _____
15.5 work done at each maintenance _____

Operating Expenses

16. average cost/amount gasoline (diesel fuel) used weekly/monthly _____
17. average cost/amount oil used weekly/monthly _____
18. cost and frequency of tire replacement _____
19. vehicle registration fee _____
20. commercial tax _____
21. license fee _____
22. road users fees(cash or materials) _____
23. other expenses(tea money) _____

Operations

1. What amphoe and changwat worked in while driving this vehicle (specify those most frequently worked in)

2. Origin-destination patterns and travel times.

origin	destination	route	travel time: wet season	travel time: dry season

3. What road improvements(construction) have increased/decreased travel times along operational routes?

origin	destination	route: date of dev.	travel time: pre-dev.	travel time: post-dev.

4. What routes do you use most often _____
5. What routes and/or areas worked in now are new within last ___ years?

6. Road passability(x months open)

route	Jan	Feb	Mar	Apr	May	Jn	Jly	Aug	Sp	Oct	No.	De

7. What towns are only accessible by road in dry season?
8. Last round trip details:
   - 8.1 loading point _____
   - 8.2 cargo _____ 8.3 volume _____
   - 8.4 destination _____ 8.5 time/date left _____
   - 8.6 time/date arrived _____ 8.7 route(s) used _____
   - 8.8 cargo recipient _____ 8.9 stops in trip _____
   - 8.10 total trip time _____ 8.11 waiting time _____
   - 8.12 unloading time _____

   - 8.13 loading point _____ 8.14 cargo _____
   - 8.15 loading time _____ 8.16 volume _____
   - 8.17 destination _____ 8.18 time/date left _____
   - 8.19 time/date arrived _____ 8.20 cargo recipient _____
   - 8.21 stops in trip _____ 8.22 route used _____
   - 8.23 total travel time _____ 8.24 unloading time _____

9. Compare road conditions and trafficability with _____ years ago?

Operations: Truck Rates

1. List cargoes carried within the last year.

cargo	origin	destination	cost of transport	seasonal change in rates

2. Which of these cargoes was hauled most frequently?

3. Truck shipment rates from this amphoe to Bangkok and Thon Buri.

cargo	destination	Rate:66-67	Rate:	Determined
paddy				
rice				
maize				
beans				
kenaf				
stone				
sand				
vegetables				
fruit				
coconut				
wood				
charcoal				
consumer gds				
other(detail)				

4. What factors influence the rate charged for each commodity in No. 3.

5. Who usually ships cargo on your truck:
   a) shipper_____ b)location_____
   c) cargo(s)_____ d) destination_____
   e) frequency_____ f) payment method_____

6. What cargo do you now carry that was formerly carried by boat?
   a) cargo_____ b) origin_____
   c) destination_____ d) type boat shipment_____
   e) first carried_____ f) water rate_____

7. Who sets truck shipment rates: shipper_____
   trucker_____
   truck owner_____
   other_____

8. How are shipment rates paid:
   a) in advance_____
   b) cash on delivery_____
   c) deposit in advance, bal. on delivery____
   d) credit_____
   e) other_____

9. What factors have been most important in changing truck shipment rates.

Operations: Labor

1. Do you use a laborer or assistant on your truck?
2. What are his(their) jobs?
3. Frequency of use?
4. Same or different people?
5. Wages_____
6. Who pays these laborers?
7. Are they paid a food and living allowance?

Operations: Specific

1. Number of trips per day/week/month by O-D.

Origin	Destination	Trips	Seasonal Var.

2. Do you carry seasonal(monthly) cargoes?
   a) cargo_____ b) origin_____
   c) destination_____ e) month_____
3. Back-haul activities and rates from Bangkok and Thon Buri.
   a) cargo_____ b) origin_____
   c) destination_____ d) order for shipment_____
   e) rate: wet season_____ dry season_____
   f) recipient_____ g) frequency_____

4. Vehicle used for specialized trade-transport.
   a) commodity_____ b) origin-dest._____
   c) years in trade_____

5. Single route operations of vehicle.
   a) route_____ b) origin-dest. _____

6. Years active in this trade_____
7. Cargo acquisition:
   a) cargo obtained in same place_____
   b) location_____
   c) Adv., disadvantages of this type ops._____

8. Cargo loading: a) loaded by_____
   b) payment for loading_____
   c) amount paid_____
   d) loading time_____
9. Cargo unloading: a) unloaded by_____
   b) payment for unloading_____
   c) amount paid_____
   d) unloading time _____
10. Usually load in one or several places?
11. Usually unload in one or several places?
12. Less than full load trips:
   a) frequency_____
   b) reason(s)_____

Personal

1. Place of birth_____ 2. Present home_____
3. Age_____ 4. Time in this occupation_____
5. Fathers' occupation_____
6. Most recent previous occupation_____
7. Reasons for entering this business_____
8. Other employment possibilities _____
9. Other current occupations _____
10. Other holdings(land, house etc.) _____
11. Previous trucks owned: a) type_____
   b) capacity_____
   c) reason for change_____
12. Is business as good now as _____years ago?
   a) net income per trip/year _____years ago.
   b) net income per trip/year 1966/67(67/68)
13. In what areas have trucks taken cargo from boat shipment?
14. In what areas and cargoes are truck and boat competitive?
15. Major problems in trucking business now_____
16. With more capital, what changes in your business would you make?

17. What is the future of truck transportation?
18. How could truck/road transportation be improved?
19. What is the most important improvement/development in road transport in the last 10-15 years?

Bus Operation Questionnaire

Date_____
Location Key_____
Informant_____
Interviewer_____

Tambon_____
Amphoe_____
Changwat_____

General

1. Years driving this bus_____
2. Time driving buses in this area(amphoe, changwat)_____
3. Other operator activities outside of this area(chronologically)

4. Occupation prior to bus operator _____
   a) location_____
   b) length of time_____
5. Present home _____
6. Other part-time occupations_____
7. Reason(s) for becoming bus operator_____

8. Length of time bus operations existed in this area_____
9. Number of bus('s) or companies now operating in this area_____
10. When did buses first begin regular operations_____

Vehicle Specifications

11. Vehicle type _____
12. Make _____
13. Horsepower_____
14. No. of axels_____
15. Passenger capacity_____
16. Cargo capacity_____
17. Tonnage_____
18. Vehicle age_____

Ownership

19. Private ownership
    a) purchase date_____ b)purchase location_____
    c) seller_____ d)cost_____
    e) method of payment_____
    f) operations:
       contract_____
       agreement_____
       lease_____
       other_____
    g) Other vehicles owned_____
    h) Operational terms_____
20. Partnership:
    a) No. of partners_____
    b) partner occupation(s)_____

c)No. vehicles owned_____ type_____ use_____
d)Division of profit_____
e) Vehicle(s) purchase date and cost_____

21. Lease-rental:
a) leaser:_____ owner location_____ owner occupation___
b) lease terms_____
c) length of lease_____
d) rental cost_____
e) operational agreement_____

22. Hired Operator:
a) owner location and occupation_____
b) other buses rented or owned_____
c) other vehicle operations_____
d) wages:
salary_____
% of profits_____
other_____
e) time worked for this owner_____
f) no. other vehicles operating on same route_____

Operations:Routes

23. Routes currently worked:
a) origin_____ b) destination_____
c) road(s)_____
d) avg. travel time: wet season_____
dry season_____
e) route variations(explain)_____

24. Time operated on this route_____
25. Seasonality of operations_____
26. Date (year) of initial bus operations on this route_____
27. Frequency of route variation_____
28. Are prior arrangements made for route variations_____
29. Seasonal variations in traveled routes_____
a) reason(s)_____
b) impassable routes in bad weather_____

Trip Schedules

30. Total round trips daily_____ wet season_____
dry season_____
other(wat fairs etc.)

31. Layover(stopping) time at origin_____
destination_____

32. Activities during layover(detail)_____

33. Daily trip schedule:
earliest dep._____ origin_____
latest dep._____ origin_____

frequency of intervening trips_____

Road Users Fees

34. Does bus operator/owner make any contributions to the maintenance of the roads used?

35. Does this maintenance fee give you any control over other road users?
36. Are road users fees required of vehicles using this route?
37. Who are these fees paid to?
38. With whom are maintenance/user control agreements made?
    a) amphoe officials_____
    b) private road owners_____
    c) Highway department _____
    d) Royal Irrigation department_____
    e) Wats , _____
    f) other_____

Cargo Operations

39. Under what circumstances do you carry cargo(explain)?

40. Who usually ships cargo on your bus?

41. Do you frequently carry cargo to consumers from local merchants, wholesalers, distributors?

42. What types of cargo do you carry?
    a) cargo_____
    b) origin_____
    c) destination_____
    d) rate: wet season_____
       dry season_____
    e) frequency_____
43. What are standard rates for these different cargoes?
    a) sacked paddy, maize, rice_____
    b) vegetables, fruits in baskets(20, 30, 40, 50kgs)_____
    c) packaged consumer goods_____
    d) machinery, parts_____
    e) bicycles, motorcycles_____
    f) other_____
44. Does this rate apply if the cargo is carried only a short distance, such as less than 10 kilometers?
45. What factors determine cargo rates?
    a) type of produce_____
    b) weight/volume_____
    c) distance_____

d) road conditions_____
e) season _____
f) market price_____
g) shipper_____
i) other_____

46. When did this bus first begin carrying cargo on this route?
47. Have cargo rates changed in the past _____ years?
48. Have cargo volumes or types of cargo carried changed noticeably in the past _____ years?

Passenger Operations

49. Number of passengers normally carried per trip from origin to destination _____
50. Has this number increased or decreased since bus operations first began?
51. What are passenger fares on routes currently traveled?
    a) origin_____ b) destination_____ c) fare_____
52. Have passenger fares changed in the past _____ years(detail)?
53. Has improved bus service along this route reduced the volume of passenger boat traffic (detail)?
54. What influence has road improvement had on your passenger/cargo operations?

Local Transport History

55. When was this road first opened to vehicle traffic?_____
56. What type of surface did it have then_____
57. Was the road useable annually or seasonally when first opened?
58. Were first commercial bus operations locally owned or externally owned?
59. Who was responsible for road maintenance ?

Operational Costs and Income

60. What is your daily, weekly(monthly) average gross income_____
    a) passenger fares_____
    b) cargo fares_____
61. Has this income changed since operations were first begun?
62. What are weekly(monthly) expenses for:
    a) gasoline_____
    b) oil _____
    c) tires_____
    d) routine maintenance _____
    e) special repairs(detail)_____
    f) vehicle registration(yearly)_____
    g) license fee_____
    h) road users fees _____
    i) Tea money _____

63. No. of ticket collectors hired_____
    a) wages_____
    b) food allowance_____
64. Have Transport Company Ltd. reorganization policies of long-haul interchangwat bus services had any influence on your operations?

Transport Improvement

65. What is the major problem in commercial bus passenger operations?
66. What improvements could(should) be made to improve bus passenger services?
67. If you had additional funds, what changes in your operations or occupation would you make(detail)

Mu ban - Tambon Household Census

Mu ban _____
Tambon _____
Amphoe _____
Changwat _____

Puyai ban _____
Kamnan _____
Total households _____
M. S. C. Key _____

1. Name head of household

2. No. years lived in this tambon

3. Current occupation(full and part-time)

4. No. rai(agricultural land) owned

5. No. rai(agricultural land)rented

6. Total rai owned and rented

7. No. rai planted to paddy

8. No. rai planted to garden crops

9. Year entered this tambon

10. Previous residence: mu ban _____
tambon _____
amphoe _____
changwat _____

11. Previous occupation

12. Year left previous residence

13. Reason for leaving former residence

14. Reason for settling in this tambon

Market Census Enumeration

Date _____
Mu ban _____
Tambon _____
Amphoe _____
Changwat _____

Market name(s) _____
_____
Location key _____
Enumerator _____

1. Shop type

2. Primary goods-services sold

3. Year first opened: by present operator _____
by former operator _____

4. Year shop closed: by present operator _____
by former operator _____

5. Reason for shop closure : by present operator _____
by former operator _____

6. Change in shop function: by present operator _____
by former operator _____

7. Addition or deletion of a line or merchandise:

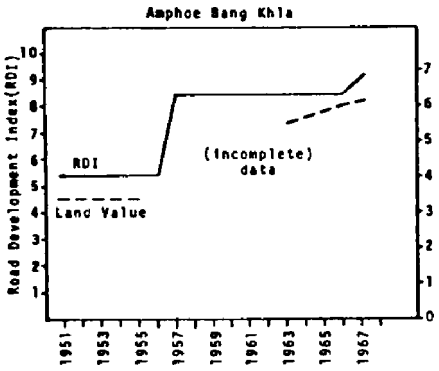
by present operator _____ year _____

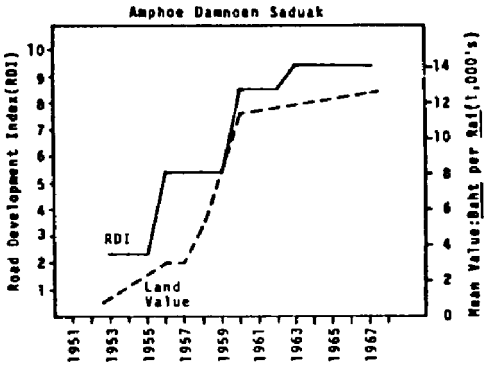
by former operator _____ year _____

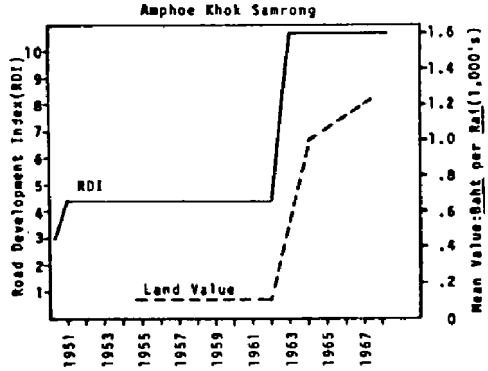
8. Wholesale-brokerage functions(listed)

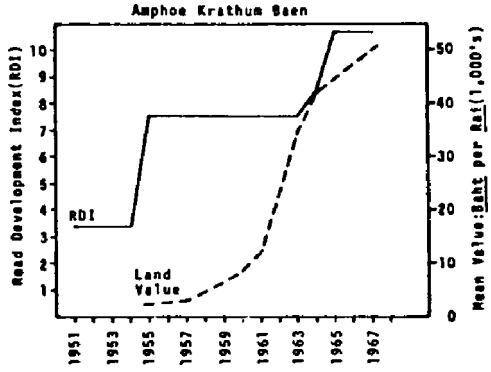
APPENDIX III

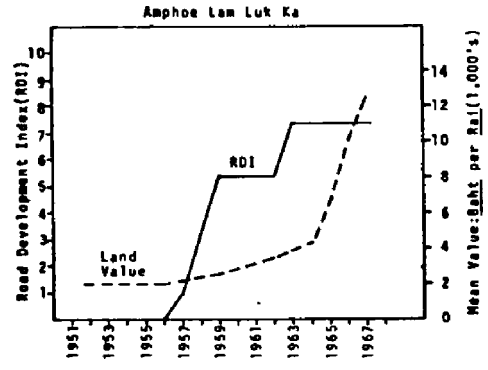
TEMPORAL CHANGES IN ROADSIDE LAND VALUES AND ROAD DEVELOPMENT INDICES (RDI) IN SURVEY AMPHOE

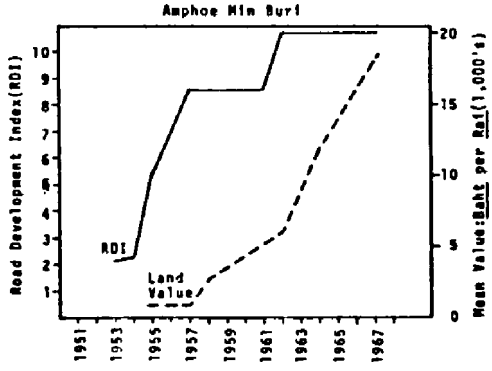

Amphoe Bang Khla
Road Development Index(RDI)
Mean Value:Baht per Rai(1,000's)
RDI
(Incomplete) data
Land Value

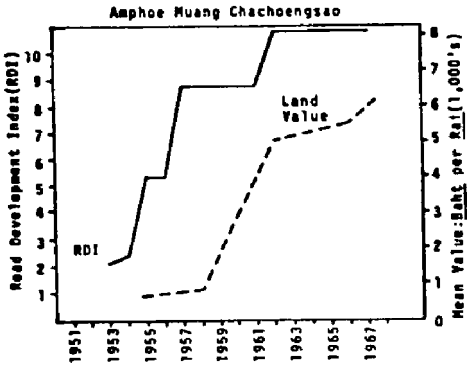

Amphoe Damnoen Saduak
Road Development Index(RDI)
Mean Value:Baht per Rai(1,000's)
RDI
Land Value

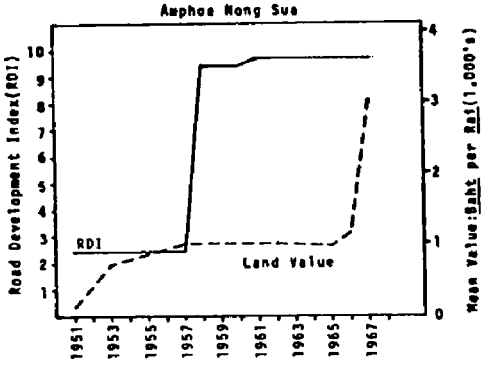

Amphoe Khok Samrong
Road Development Index(RDI)
Mean Value:Baht per Rai(1,000's)
RDI
Land Value

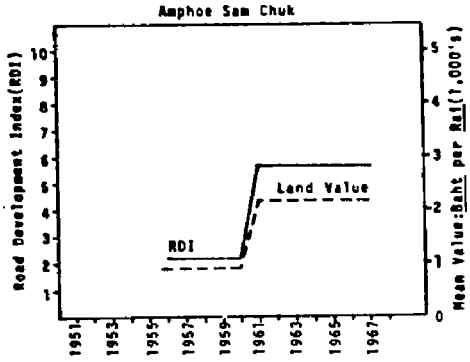

Amphoe Krathum Baen
Road Development Index(RDI)
Mean Value:Baht per Rai(1,000's)
RDI
Land Value

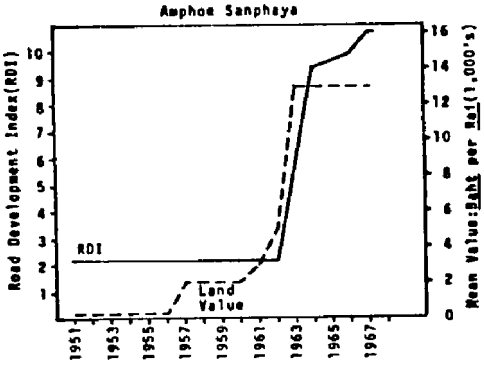

Amphoe Lam Luk Ka
Road Development Index(RDI)
Mean Value:Baht per Rai(1,000's)
RDI
Land Value

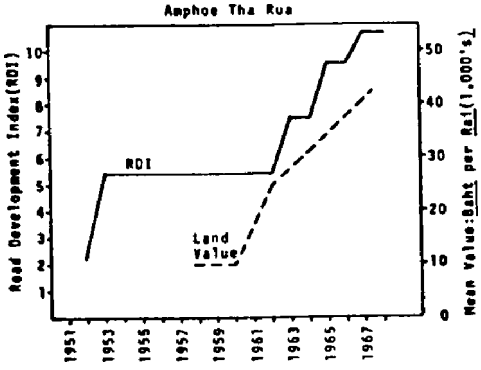

Amphoe Min Buri
Road Development Index(RDI)
Mean Value:Baht per Rai(1,000's)
RDI
Land Value


Amphoe Muang Chachoengsao
Road Development Index(RDI)
Mean Value:Baht per Rai(1,000's)
RDI
Land Value


Amphoe Nong Sua
Road Development Index(RDI)
Mean Value:Baht per Rai(1,000's)
RDI
Land Value

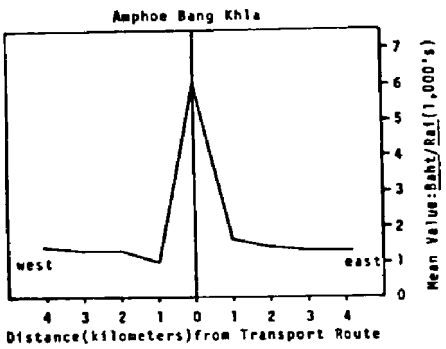

Amphoe Sam Chuk
Road Development Index(RDI)
Mean Value:Baht per Rai(1,000's)
RDI
Land Value

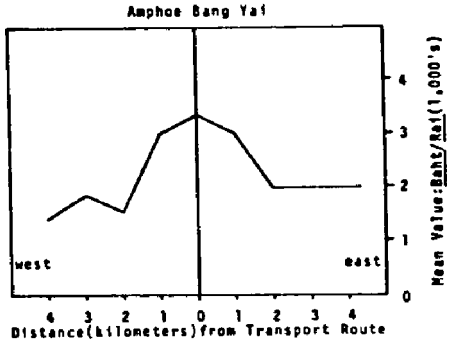

Amphoe Sanphaya
Road Development Index(RDI)
Mean Value:Baht per Rai(1,000's)
RDI
Land Value

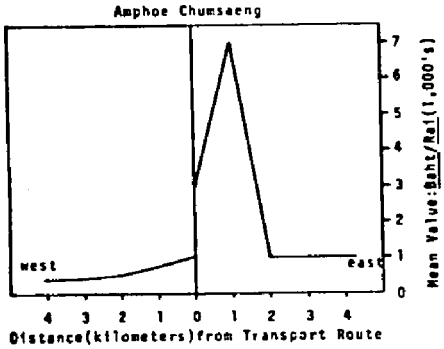

Amphoe Tha Rua
Road Development Index(RDI)
Mean Value:Baht per Rai(1,000's)
RDI
Land Value

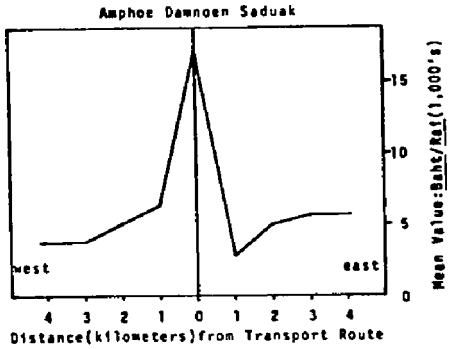
APPENDIX IV

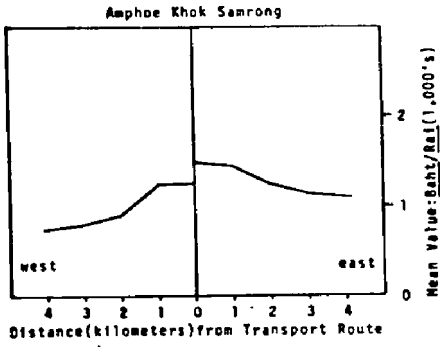
SPATIAL LAND VALUE PROFILE IN SURVEY AREAS

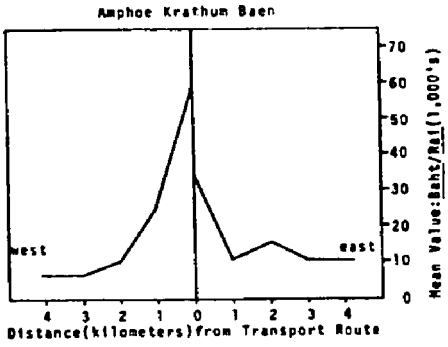

Amphoe Bang Khla
west
east
4 3 2 1 0 1 2 3 4
Distance(kilometers)from Transport Route
Mean Value:Baht/Rai(1,000's)
0 1 2 3 4 5 6 7

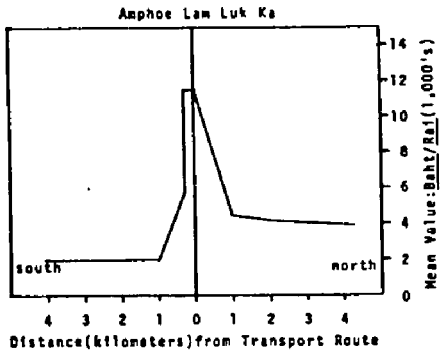

Amphoe Bang Yai
west
east
4 3 2 1 0 1 2 3 4
Distance(kilometers)from Transport Route
Mean Value:Baht/Rai(1,000's)
0 1 2 3 4

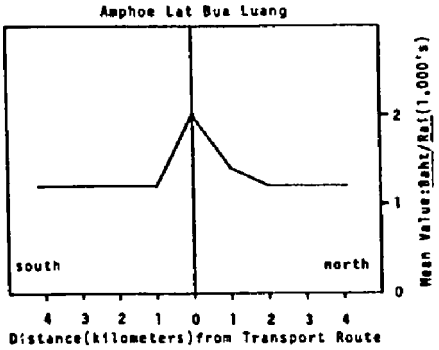

Amphoe Chumsaeng
west
east
4 3 2 1 0 1 2 3 4
Distance(kilometers)from Transport Route
Mean Value:Baht/Rai(1,000's)
0 1 2 3 4 5 6 7

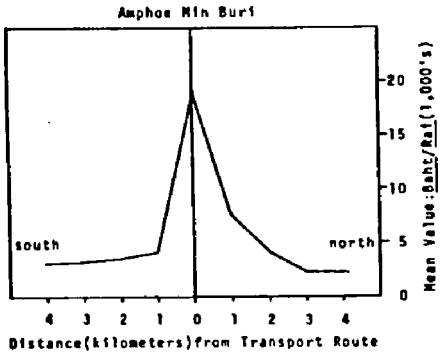

Amphoe Damnoen Saduak
west
east
4 3 2 1 0 1 2 3 4
Distance(kilometers)from Transport Route
Mean Value:Baht/Rai(1,000's)
0 5 10 15

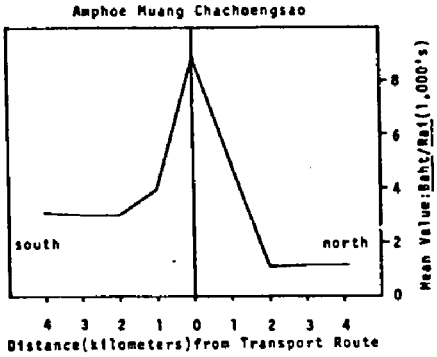

Amphoe Khok Samrong
west
east
4 3 2 1 0 1 2 3 4
Distance(kilometers)from Transport Route
Mean Value:Baht/Rai(1,000's)
0 1 2

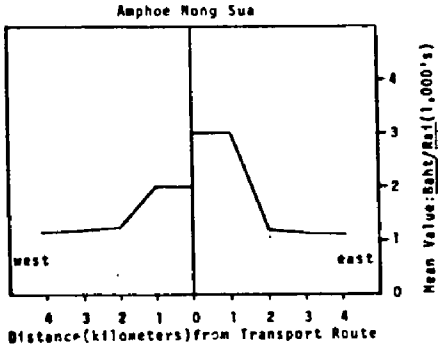

Amphoe Krathum Baen
west
east
4 3 2 1 0 1 2 3 4
Distance(kilometers)from Transport Route
Mean Value:Baht/Rai(1,000's)
0 10 20 30 40 50 60 70

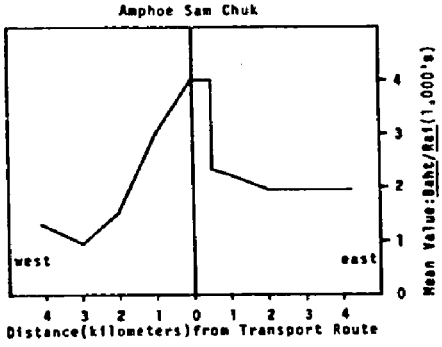

Amphoe Lam Luk Ka
south
north
Distance(kilometers)from Transport Route
Mean Value:Baht/Rai(1,000's)

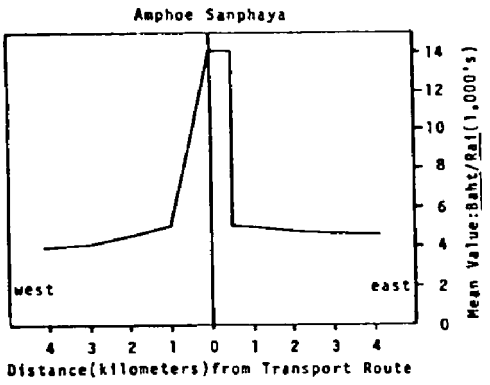

Amphoe Lat Bua Luang
south
north
Distance(kilometers)from Transport Route
Mean Value:Baht/Rai(1,000's)

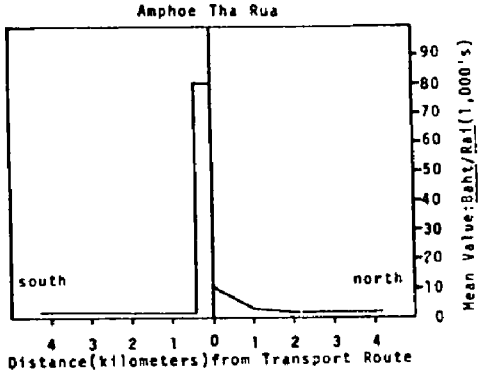

Amphoe Min Buri
south
north
Distance(kilometers)from Transport Route
Mean Value:Baht/Rai(1,000's)


Amphoe Muang Chachoengsao
south
north
Distance(kilometers)from Transport Route
Mean Value:Baht/Rai(1,000's)


Amphoe Nong Sua
west
east
Distance(kilometers)from Transport Route
Mean Value:Baht/Rai(1,000's)

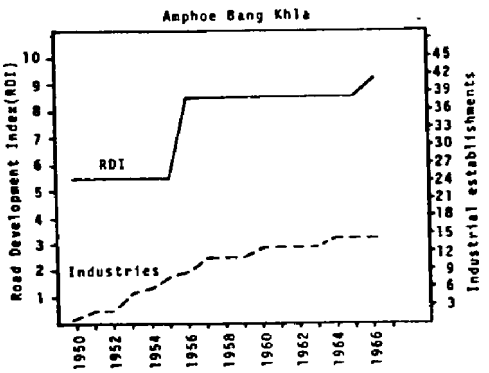

Amphoe Sam Chuk
west
east
Distance(kilometers)from Transport Route
Mean Value:Baht/Rai(1,000's)

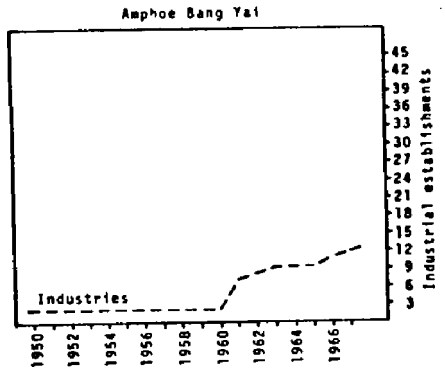

Amphoe Sanphaya
west
east
14
12
10
8
6
4
2
0
4 3 2 1 0 1 2 3 4
Distance(kilometers)from Transport Route
Mean Value:Baht/Rai(1,000's)

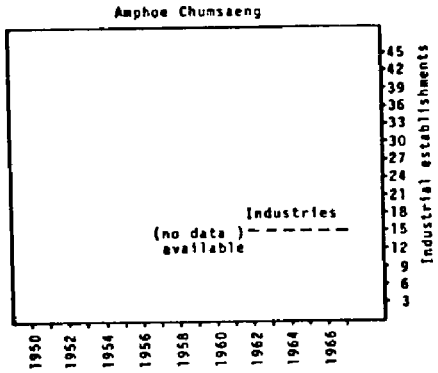

Amphoe Tha Rua
south
north
90
80
70
60
50
40
30
20
10
0
4 3 2 1 0 1 2 3 4
Distance(kilometers)from Transport Route
Mean Value:Baht/Rai(1,000's)

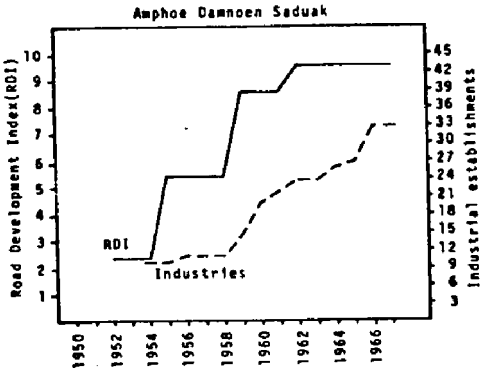
APPENDIX V

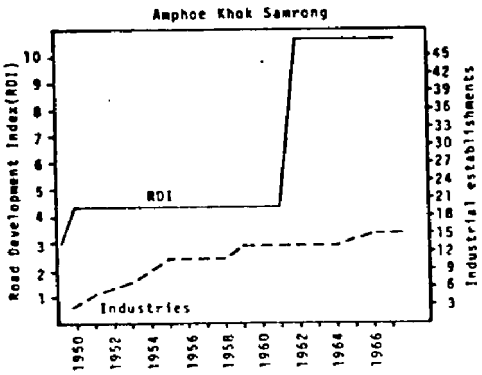
INDUSTRIAL DEVELOPMENT PROFILES AND ROAD DEVELOPMENT INDICES (RDI)


Amphoe Bang Khla
Road Development Index(RDI)
Industrial establishments
RDI
Industries
1950 1952 1954 1956 1958 1960 1962 1964 1966


Amphoe Bang Yai
Industrial establishments
Industries
1950 1952 1954 1956 1958 1960 1962 1964 1966


Amphoe Chumsaeng
Industrial establishments
Industries
(no data) available
1950 1952 1954 1956 1958 1960 1962 1964 1966


Amphoe Damnoen Saduak
Road Development Index(RDI)
Industrial establishments
RDI
Industries
1950 1952 1954 1956 1958 1960 1962 1964 1966


Amphoe Khok Samrong
Road Development Index(RDI)
Industrial establishments
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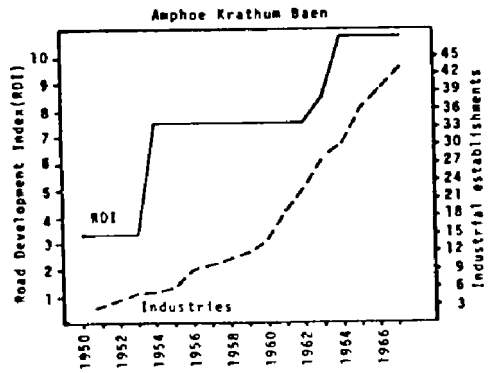
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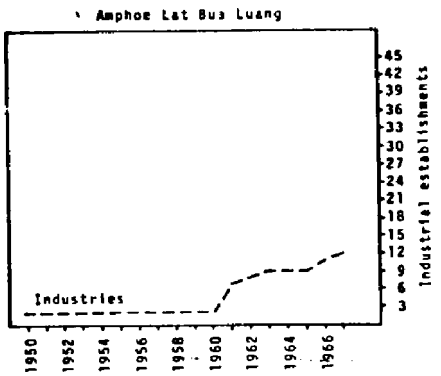
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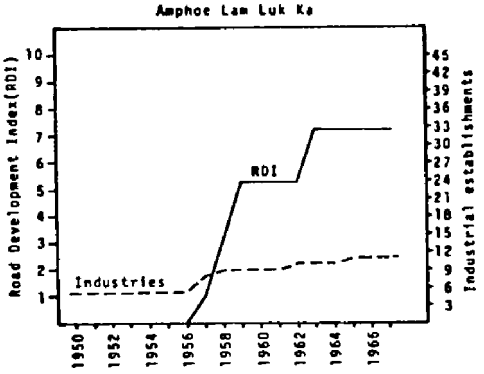
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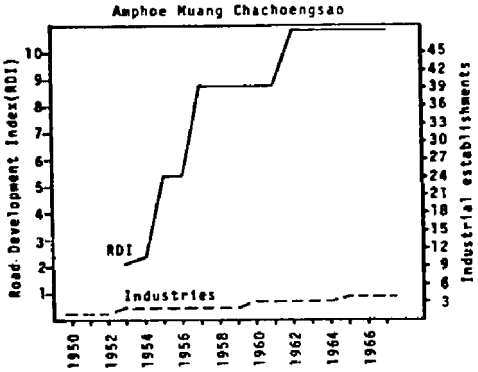
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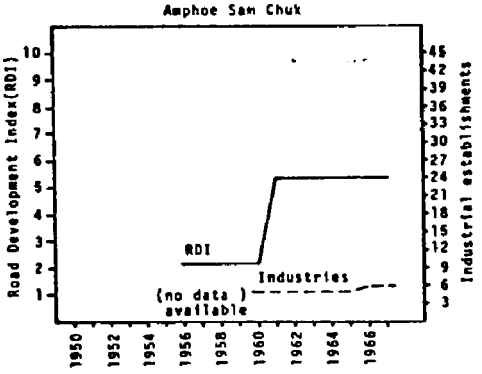
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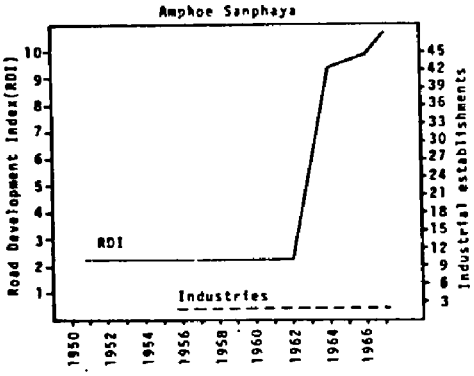
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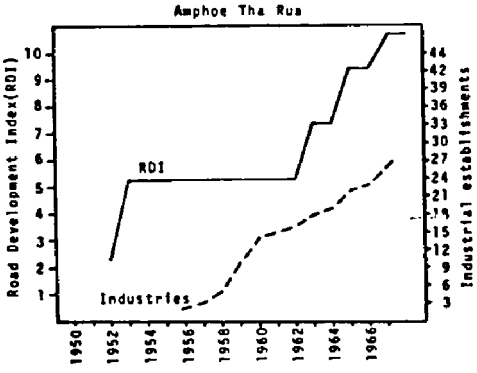
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