PART II

SELECTION OF OPTIMUM ROUTE

Chapter IV

FORMULATION OF ROUTE ALTERNATIVES

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FORMULATION OF ROUTE ALTERNATIVES

4-1 GENERAL CONCEPT

The following three main aims, which would be attained by the construction of all-weather road in the Project Area, are to be taken into consideration in formulating route alternatives.

a) New agricultural land development

b) Reduction of transportation cost for the present agricultural products

c) Improvement of local communications

For the first aim, new agricultural land development, the route is to be selected to pass the center of the potential area aiming at the ribbon development along the road. The historical studies on the effects of roads on agricultural development suggest that the adjacent area to a good road within 5 kilometers has high intensity of land use, which is more than twice as high as the distant area at 15 kilometers. Therefore, a band area along the road of 10 kilometers width is assumed as the influence area of the proposed road on the agricultural land development (hereinafter referred to as the influence area) in this study. The route is so to be selected to include potential land within the band as much as possible.

For the second aim, reduction of transportation cost for the present agricultural products, the route is to be selected to meet the present transportation requirement. Major part of the agricultural products in the Project Area are transported to Bangkok or Tha Rua via Route 21. However, due to the lack of all-weather road, the access to the Route 21 becomes very difficult in rainy season, and the trucks have to travel a hard way on a muddy road or to go a long way round in order to drive on better road. High transportation cost is forced in such conditions and this reflects to the low farmgate prices. Accordingly, the route is so selected as to provide an easier access to trunk routes including the Route 21.

For the third aim, improvement of local communications, the route is to be selected to connect the existing communities or villages as much as possible. The communication with the villages along the Route 21 constitutes the major part of communications between the Project Area and the outside areas. Therefore, the easier access to the Route 21 is an important factor. Beside the above, land communications within the Project Area is also important, considering the fact that some villages become isolated when all the roads to and from the village are submerged in rainy season.

4-2 ROUTE ALTERNATIVES

Based on the topographic maps, aerial photographs, land capability maps, land use maps and other information collected in the field reconnaissance, three route alternatives, Route Alternative-I, -II and -III, were selected for the study. In formulating these alternatives, due consideration was paid to attain all of three aims discussed in the above section as much as possible. Their alignments are illustrated in Figure 4-1.

a) Route Alternative-I

This route was selected paying much attention to the maximum utilization of the existing road alignment. The route runs in north-south direction in flat terrain about five kilometers east

of the Pasak River. After diverging from the National Highway Route 205 at Tha Maduk, it runs north and reaches Phetchabun via Rang Yoi, Si Thep, Wichian Buri, Nong Daeng, Na Khao Do, Rawing, Tham Nam Bang and Nam Ron (1). Out of the total length of 157.4 kilometers, the route includes only 10 kilometers new construction for the section between Na Khao Do and Rawing.

b) Route Alternative-II

This route was selected putting much emphasis on the aim of agricultural land exploitation. The route also runs in north-south direction and some sections are common to those of Route Alternative-I. In the southern part of the Project Area, it runs on the hillside potential area, east of the existing road, with new road construction between Rang Yoi and Sap Bon via Nam Ron (2). In the central and northern areas, two shortcut routes are planned for the section between Sap Bon and Noen Sadao and that between Khok Charoen and Yang Lat. The whole length of this route alternative is 139.3 kilometers among which 82.2 kilometers are new road constructions in total.

c) Route Alternative-III

The Route Alternative-III was selected putting emphasis on the improvement of the present communication system in east-west direction. This alternative is composed of six east-west roads which cross the Pasak River and connect the Project Area with the towns along the Route 21. These towns are Mai Sarika, Wichian Buri (though Wichian Buri is located in the east of the Pasak River, no improvement is required for the section between Wichian Buri and Sam Yaek (2) on the Route 21 because of good road condition), Rahun, Nong Lai, Sam Yaek (1) and Phetchabun. The roads are prolonged to the hillside potential area for the agricultural land development. This route alternative is 110.3 kilometers in total length, and includes new road constructions of 30.8 kilometers in total and many new bridge constructions over the Pasak River and its tributaries.

Figure 4-2 shows the route alternatives superimposed on the map of cultivable land.

The main features of the above three route alternatives are compared in the following table:

Comparison of Route Alternatives

Item	Route Alternative		
	I	II	III
Direction	north-south	north-south	east-west
Length (km)			
Improvement	147.4	57.1	79.5
New construction	10.0	82.2	30.8
Total	157.4	139.3	110.3
Terrain	mainly flat	mainly rolling	flat-rolling
Agricultural Land Development Effect	smaller than that of Alt.-II	large, especially in southern part	limited around the eastern end of the roads
Reduction of Transportation Cost	large	relatively large	large
Local Communication	passes many existing villages within the Project Area	improves local communications in remote area	easy access to the Route 21

4-3 ROAD LINKS

For easy identification in the study, the related routes within the Project Area, together with the Route 21 and the Route 205, are divided into road links with sequence number from the south. Each road link is assumed to have uniform conditions in traffic volume and road surface condition over its length. Road link is used as the basic unit for

traffic forecast, calculation of road users' cost savings and estimation of construction and road maintenance costs.

All road links are listed up in Table 4-1, and their connections shown in Figure 4-3.

The Route Alternatives-I, -II, and -III, formulated in the preceding section, are composed of the following road links, respectively:

Route Alternative-I :	3, 6, 11, 16, 18, 22, 23, 25, 27, 30, 33, 35, 37 and 40
Route Alternative-II :	3, 7, 12, 17, 19, 23, 25, 28, 35, 37 and 40
Route Alternative-III:	8, 10 & 10*, 15 & 15*, 18 & 18*, 20, 27 & 27*, 29, 36 & 36* and 40 & 40*.

(The road link numbers with "*" mark mean the portions to be extended to the east.)

TABLE 4-1

1 of 2

Table 4-1 ROAD LINKS

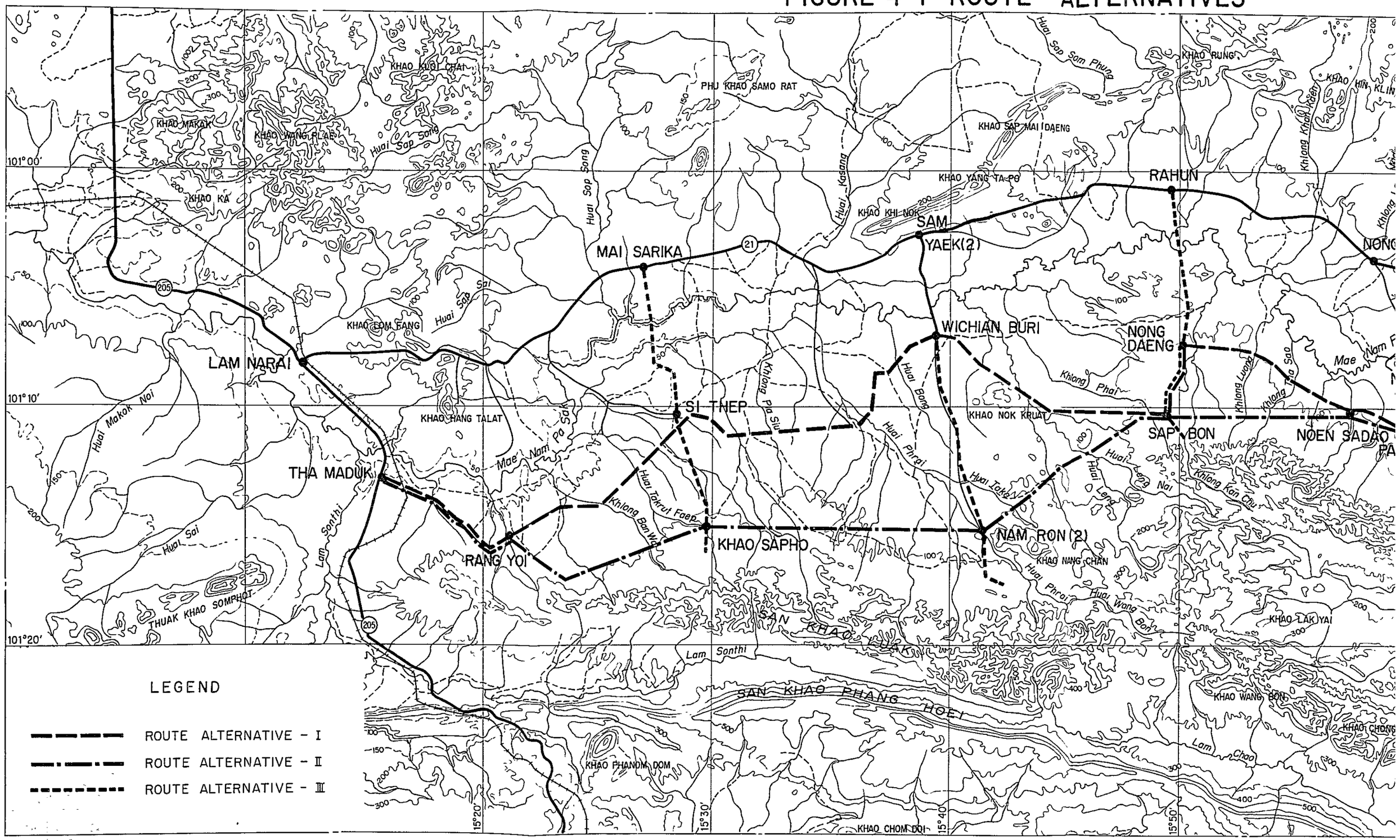
ROAD LINK NO.	FROM	TO	EXIST-ING ROAD	NEW CONSTRUC-TION	REMARKS
1	Lam Narai	Tha Maduk	11.0	-	Route 205, out of project
2	Lam Narai	Din Daeng	20.3	-	Route 21, out of project
3	The Maduk	Rang Yoi	12.5	-	
4	Din Daeng	Mai Sarika	10.0	-	Route 21, out of project
5	Din Daeng	Si Thep	17.0	-	Out of project
6	Rang Yoi	Si Thep	18.0	-	
7	Rang Yoi	Khao Sapho	-	17.0	
8	Mai Sarika	Si Thep	13.2	-	
9	Mai Sarika	Sam Yaek (1)	23.5	-	Route 21, out of project
10&10*	Si Thep	Khao Sapho	-	10.0 (+2.0)	
11	Si Thep	Wichian Buri	24.0	-	
12	Khao Sapho	Nam Ron (2)	-	20.5	
13	Sam Yaek (2)	Wichian Buri	7.9	-	Out of project
14	Sam Yaek (2)	Rahun	21.3	-	Route 21, out of project
15&15*	Wichian Buri	Nam Ron (2)	15.7	(+4.5)	
16	Wichian Buri	Sap Bon	21.0	-	
17	Nam Ron (2)	Sap Bon	3.0	15.0	
18&18*	Nong Daeng	Sap Bon	5.3	(+2.5)	
19	Sap Bon	Noen Sadao	-	14.2	
20	Rahun	Nong Daeng	12.8	-	
21	Rahun	Nong Phai	19.1	-	Route 21, out of project
22	Nong Daeng	Noen Sadao	14.0	-	
23	Noen Sadao	Pak Bot	4.4	-	
24	Nong Phai	Pak Bot	12.5	-	Out of project
25	Pak Bot	Khok Charoen	6.0	-	
26	Nong Phai	Nong Lai	8.0	-	Route 21, out of project
27&27*	Na Khao Do	Khok Charoen	4.5	(+4.3)	
28	Khok Charoen	Yang Lat	-	15.5	
29	Nong Lai	Na Khao Do	9.0	-	
30	Na Khao Do	Rawing	-	10.0	
31	Nong Lai	Komo	14.5	-	Route 21, out of project
32	Komo	Rawing	5.5	-	Out of project
33	Rawing	Yan Lat	6.5	-	

Table 4-1 ROAD LINKS (cont'd)

ROAD LINK NO.	FROM	TO	EXISTI-ING ROAD	NEW CONSTRUC-TION	REMARKS
34	Komo	Sam Yaek (1)	11.5	-	Route 21, out of project
35	Yang Lat	Tham Nam Bang	8.5	-	
36&36*	Sam Yaek (1)	Tham Nam Bang	8.0	(+4.5)	
37	Tham Nam Bang	Nam Ron (1)	11.7	-	
38	Sam Yaek (1)	Phetchabun	24.0	-	Route 21, out of project
39	Nam Ron (1)	Wang Khong	4.5	-	Out of project
40&40*	Nam Ron (1)	Phetchabun	11.0	(+3.0)	
41	Wang Khong	Phetchabun	12.0	-	Out of project

Note: The road link numbers with "*" mark mean the roads to be extended to the east in case of the Route Alternative - III and figures in parentheses show their length of extension.

FIGURE 4-1 ROUTE ALTERNATIVES



ROUTE ALTERNATIVES

ROUTE ALTERNATIVES

FIGURE 4 - 1

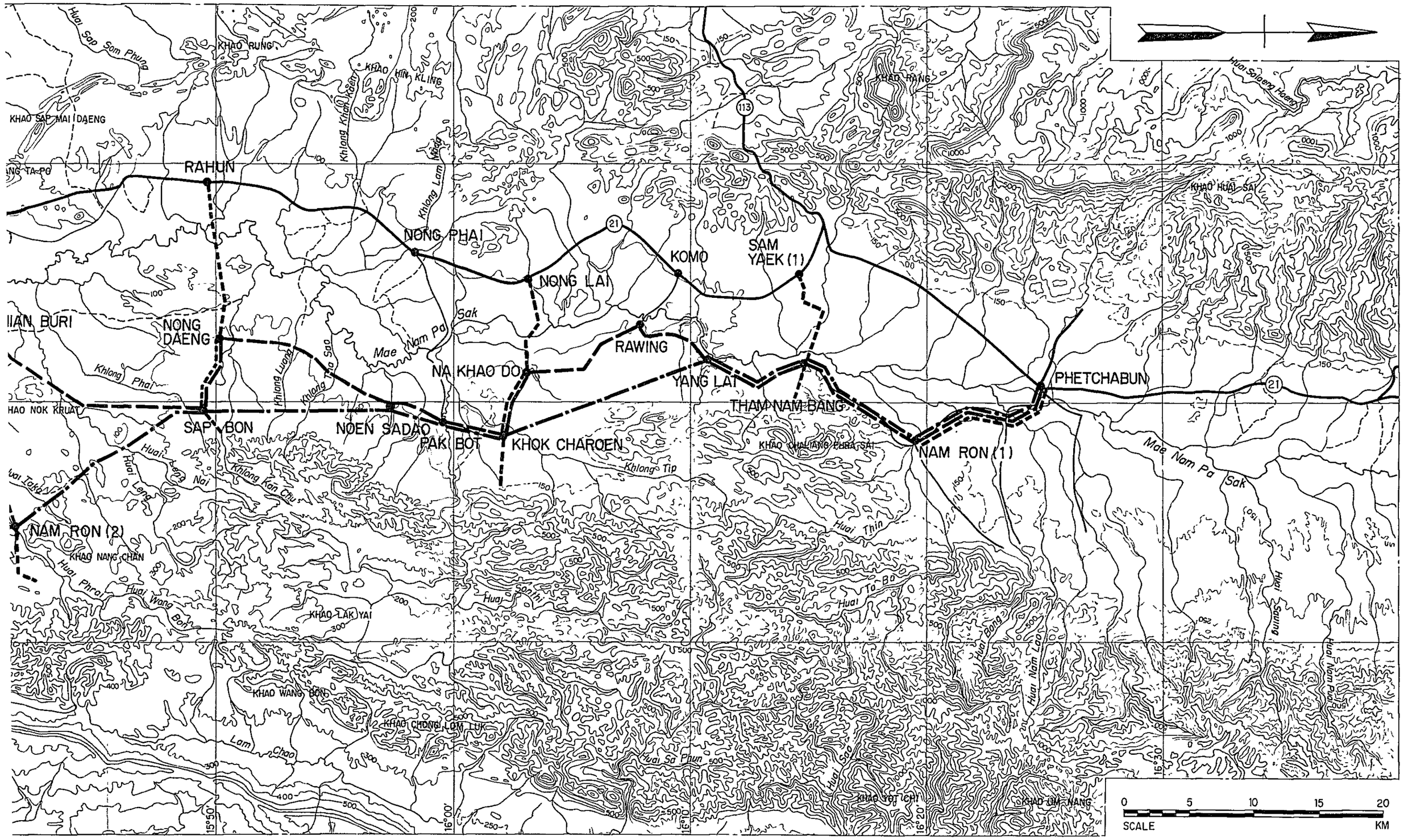
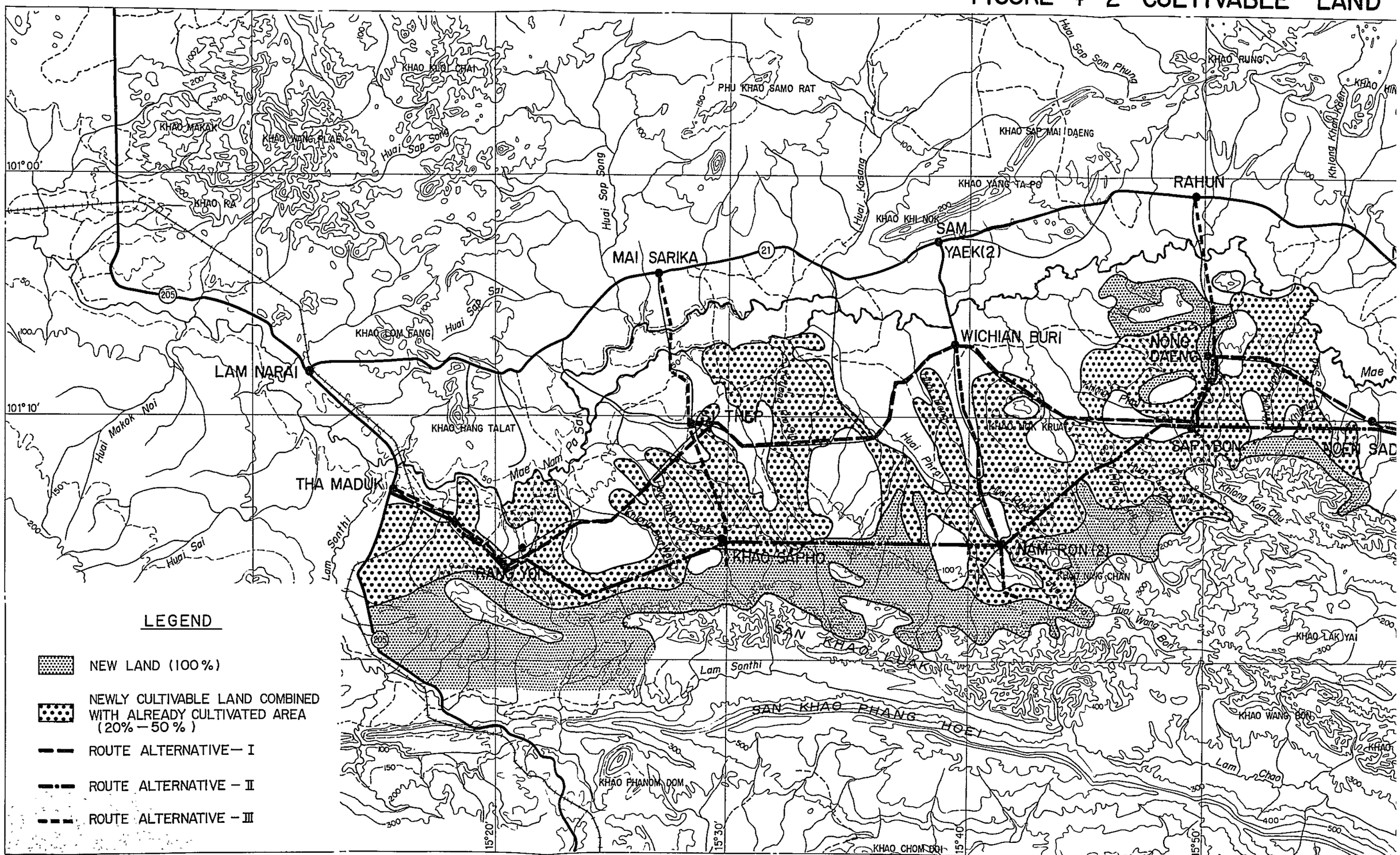
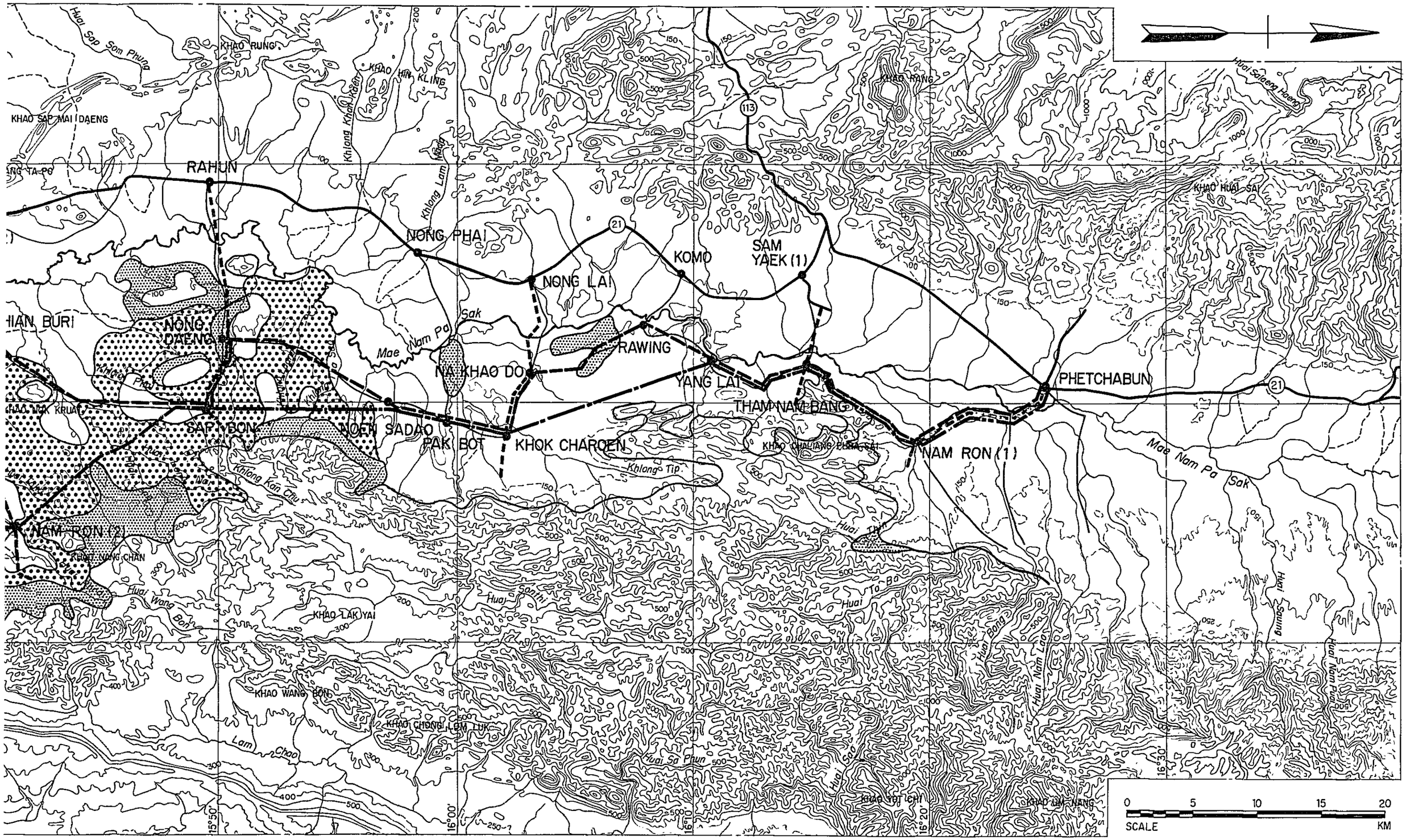
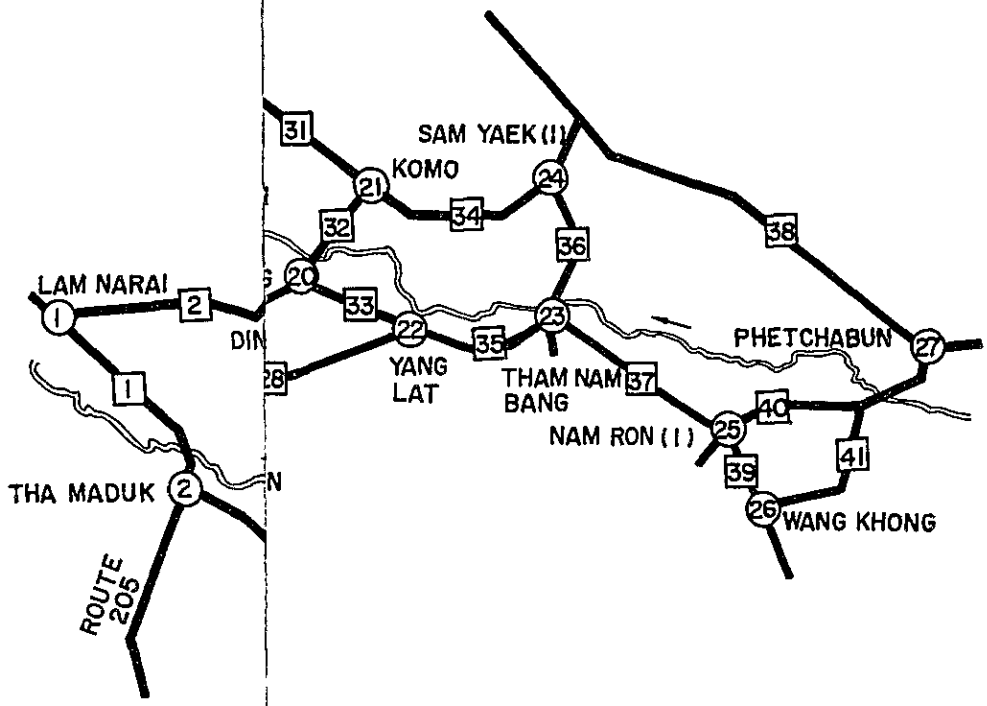


FIGURE 4-2 CULTIVABLE LAND



GURE 4-2 CULTIVABLE LAND





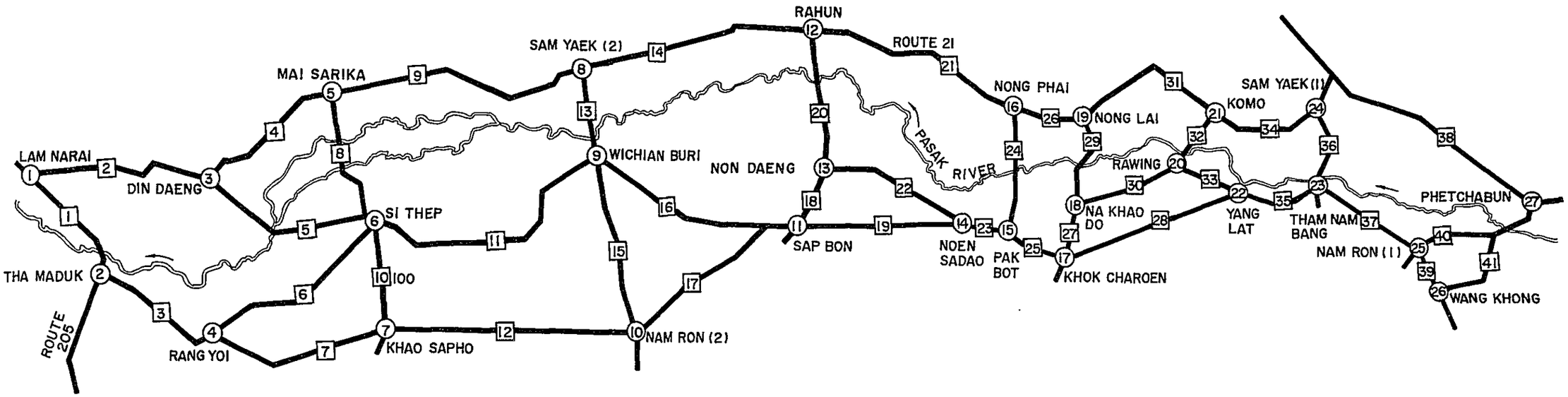
SECTION		LENGTH (km)	REMARKS
FROM	TO		
Nong Daeng	Noen Sadao	14.0	
Noen Sadao	Pak Bot	4.4	
Nong Phai	Pak Bot	12.5	
Pak Bot	Khok Charoen	6.0	
Nong Phai	Nong Lai	8.0	Route 21
Na Khao Do	Khok Charoen	4.5	
Khok Charoen	Yang Lat	15.5	New road
Nong Lai	Na Khao Do	9.0	
Na Khao Do	Rawing	10.0	New road
Nong Lai	Komo	14.5	Route 21
Komo	Rawing	5.5	
Rawing	Yan Lat	6.5	
Komo	Sam Yaek (1)	11.5	Route 21
Yang Lat	Tham Nam Bang	8.5	
Sam Yaek (1)	Tham Nam Bang	8.0	
Tham Nam Bang	Nam Ron (1)	11.7	
Sam Yaek (1)	Phetchabun	24.0	Route 21
Nam Ron (1)	Wang Khong	4.5	
Nam Ron (1)	Phetchabun	11.0	
Wang Khong	Phetchabun	12.0	

LE

□ : LI

○ : NO

Figure 4-3 ROAD LINKS



LEGEND

□ : LINK NUMBER

○ : NODE NUMBER

ROAD LINK NO.	SECTION FROM	SECTION TO	LENGTH (km)	REMARKS
1	Lam Narai	Tha Maduk	11.0	Route 205
2	Lam Narai	Din Daeng	20.3	Route 21
3	The Maduk	Rang Yoi	12.5	
4	Din Daeng	Mai Sarika	10.0	Route 21
5	Din Daeng	Si Thep	17.0	
6	Rang Yoi	Si Thep	18.0	
7	Rang Yoi	Khao Sapho	17.0	New road
8	Mai Sarika	Si Thep	13.2	
9	Mai Sarika	Sam Yaek (1)	23.5	Route 21
10	Si Thep	Khao Sapho	10.0	New road
11	Si Thep	Wichian Buri	24.0	
12	Khao Sapho	Nam Ron (2)	20.5	New road
13	Sam Yaek (2)	Wichian Buri	7.9	
14	Sam Yaek (2)	Rahun	21.3	Route 21
15	Wichian Buri	Nam Ron (2)	15.7	
16	Wichian Buri	Sap Bon	21.0	
17	Nam Ron (2)	Sap Bon	3.0	
18	Nong Daeng	Sap Bon	5.3	
19	Sap Bon	Noen Sadao	14.2	New road
20	Rahun	Nong Daeng	12.8	
21	Rahun	Nong Phai	19.1	Route 21

ROAD LINK NO.	SECTION FROM	SECTION TO	LENGTH (km)	REMARKS
22	Nong Daeng	Noen Sadao	14.0	
23	Noen Sadao	Pak Bot	4.4	
24	Nong Phai	Pak Bot	12.5	
25	Pak Bot	Khok Charoen	6.0	
26	Nong Phai	Nong Lai	8.0	Route 21
27	Na Khao Do	Khok Charoen	4.5	
28	Khok Charoen	Yang Lat	15.5	New road
29	Nong Lai	Na Khao Do	9.0	
30	Na Khao Do	Rawing	10.0	New road
31	Nong Lai	Komo	14.5	Route 21
32	Komo	Rawing	5.5	
33	Rawing	Yan Lat	6.5	
34	Komo	Sam Yaek (1)	11.5	Route 21
35	Yang Lat	Tham Nam Bang	8.5	
36	Sam Yaek (1)	Tham Nam Bang	8.0	
37	Tham Nam Bang	Nam Ron (1)	11.7	
38	Sam Yaek (1)	Phetchabun	24.0	Route 21
39	Nam Ron (1)	Wang Khong	4.5	
40	Nam Ron (1)	Phetchabun	11.0	
41	Wang Khong	Phetchabun	12.0	

Chapter V

PROSPECTS OF AGRICULTURAL DEVELOPMENT

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PROSPECTS OF AGRICULTURAL DEVELOPMENT

5-1 GENERAL

The effects of the proposed road on the agricultural development will be multiple. They are classified as follows:

1) Effects on Prices

- improvement of bargaining position of the farmers caused by reduction of transportation costs, saving of handling charges, shortening of travelling time for crop assembling

2) Effects on Production Increase

a) By Intensive Land Use

- augmentation of new land development accelerated by the road improvement
- increase of areas of double cropping accelerated by the road improvement

b) By Increase of Crop Yield

- intensive use of fertilizers and agro-chemicals which become easier to be applied by farmers owing to the enhancement of agricultural extension services and reduction of prices of these agricultural inputs accelerated by the road improvement

- accelerated conversion from conventional variety to new variety with higher yield, especially for maize. This is also owed to the enhancement of agricultural extension services and improvement of rural communication

5-2 INFLUENCE AREA

Studies on the impacts of Route 21 and Route 12 suggest that the high intensity of land use extends over adjacent areas to good roads within 5 kilometers on an average. As the same condition will be applicable in the project area, the influence area of the proposed road was presumed as the band areas with 10 kilometers width along each route alternative.

The present land use in the influence area of each route alternative was estimated, based on the available land use map, aerial photographs and the field survey information, as follows:

Present Land Use in Influence Area

(1,000 rai)

	Alt.-I	Alt.-II	Alt.-III
Maize Field*	327	280	218
Paddy Field*	189	110	136
Non-cultivated	143	348	108

* including planted area for second crops

Out of non-cultivated areas, the potential land for future agricultural development was selected taking into consideration their land capabilities and forests to be reserved. The land capabilities especially for upland crops and paddy were judged in preliminary evaluation of the soils, topography, climate, availability of water, etc. The acreage of the newly cultivable lands, suitable for maize and paddy, in each influence area was estimated as below:

Newly Cultivable Area (1978)

	(rai)
Alternative-I	130
Alternative-II	321
Alternative-III	87

Judging from the land capability analysis and considering the lower initial investment cost, it is anticipated that maize will be the main crop to be cultivated in the newly cultivable land, sharing 80 to 100 percent, differing by Amphoe of the area. Most of the remaining area will be covered by paddy and beans will be planted as second crops of maize and paddy. Cotton is not recommendable from the viewpoint of difficulties in farm management and handling as well as the climate condition. Other minor crops such as sorgham, groundnuts, sesame, vegetables and fruits will be planted partly, but their production amount will be still small due to the limitation of marketability. Thus, major crops to be considered in the influence area were decided to be maize, paddy and beans.

5-3 MAJOR ELEMENTS OF DEVELOPMENT EFFECTS

5-3-1 Effects on Farmgate Price

The proposed project will bring about the improvement of transportation and handling systems for crops, which affects the alteration of price mechanism. Farmgate prices of products will be raised up by the reduction of transportation costs, savings of unnecessary handling charges and avoidance of long trips for assembling and the consequent deterioration of crop quality. In other words, those improvement will raise up the real value of products.

The field survey information shows that farmgate prices of maize along the Route 21 are higher by more than 10 Bahts per 100 kilograms than those of remote places in the Project Area. The difference in the prices is derived mainly from the difference in transportation costs. The field survey also found that the difference between transportation costs for

maize on bad conditioned roads and those on good roads was in average of 10 Bahts per 100 kilograms within an average distance of 10 kilometers. As maize is harvested in rainy season, the proposed all-weather road will contribute to eliminate those differences in costs and prices, i.e. about 10 Bahts per 100 kilograms of farmgate prices of maize.

The almost same effect as maize will be attained for beans, although the shipping times of beans are not only in rainy season but also in dry season. As unit amount of shipment of beans is small comparing with maize, unit costs of handling and transportation are rather expensive, and consequently annual average savings of costs will be similar to the case of maize.

For paddy, savings of around 10 Bahts per 100 kilograms will affect the farmgate price. As rice is shipped mostly in dry season, the savings of transportation costs due to the all-weather road will not be considerable. However, savings of village middlemen's charge will be attained owing to the improvement of road networks. With project, local rice mills will be set up in each rice production area nearer to farmers. It enables farmers to bring their products directly to millers, saving village middlemen's charges. Survey data shows that local middlemen's expenses for marketing of rice amount at around 8 percent of retail price of rice. As retail price of rice in 1978 is around 400 Bahts per 100 kilograms, i.e. 260 Bahts in term of paddy, the local middlemen's expense including transportation costs, sacking costs as well as middlemen's own charges are estimated at about 20 Bahts per 100 kilograms. About half of this expenses is estimated as actual savings of costs to be unnecessary in case of eliminating local middlemen.

5-3-2 Increase of Production Area

1) Development of New Land

Under the situation without good road, the opening of new land can proceed only with slow speed. Instead, improvement of road network accelerates the speed of the opening of new land. In the case of the Route 21, the cultivated lands doubled in first 10 years after the completion of the new Route 21. Since presently available new lands to be cultivated remain less than before, increase rate of total

cultivable area in the Project Area can not be similar to the case of the Route 21. However, it would be forecasted that all of the newly cultivable land in the influence area would be converted to the crop field within 15 years after the completion of the road.

Furthermore, speed of opening of new land will be rapid in the former period after the road completion. It was estimated that three fourth of the new land would be opened to cultivated land at 7th year. On the other hand, the situation without project may enable to open only half of new land within 15 years. Difference of new lands opened in situation with project and without project reflects the increment of production attributable to the Project.

2) Acceleration of Double Cropping

At present, in the area without all-weather road, the intensity of second cropping is relatively low especially for maize field, mainly because of delay of harvesting of the first crop due to the worst road condition flooded in the shipping time. The proposed all-weather road will enable early and timely harvesting of maize and consequently accelerate the expansion of double cropping. It was forecasted that 10 to 28 percent, differing by alternative, of increase of second cropping of beans would be seen by the full development year.

5-3-3 Increase of Crop Yield

1) Introduction of New Variety for Maize

The authorities concerned of the Thai Government is now promoting to introduce a new variety of maize, "Hybrid Suwan I" of average yield of 400 kilograms per rai, instead of the conventional variety, Guatemala and local variety of average yield of 320 kilograms per rai. Improvement of land communication by the proposed road will enhance the agricultural extension services and improve the local communication to extend information on new farming practice as well as on new variety. Conversion from conventional variety to new variety will be accelerated as a consequent of the road improvement.

The share of Hybrid Suwan I, 20 percent at present, will be raised up to 80 percent at the full development year. Thus, the average yield of maize will be increased from 344 kilograms per rai, 30 percent of Suwan and 70 percent of conventional variety in 1983, to 384 kilograms per rai.

2) Improvement of Farming Practice

Enhancement of agricultural extension services and reduction of transportation cost will enable farmers to adopt more sophisticated agricultural inputs such as fertilizer, insecticide and pesticide. Intensive use of fertilizer will increase the average yield of rice from 350 to 370 kilograms per rai at full development year. The average yield of beans will also be raised up from 135 to 140 kilograms per rai owing to the input of agro-chemicals and to the more intensive farming of beans as second crops.

5-4 ESTIMATION OF AGRICULTURAL BENEFIT

5-4-1 General Concept

The main agricultural benefit attributable to the Project is the net added value of production which is derived from the various effects mentioned in the preceding section. Main elements which produce the net added value consist of increment of unit value of crops and increment of quantity of production of crops. Net value added should be obtained after deducting necessary costs for opening new land and for increasing crop yield and costs of production inputs. Balance after deducting the net value added without project from that in a situation with project is to be net incremental value of production attributable to the Project.

While the benefit to the national economy is to be estimated with input and output valued under the concept of opportunity cost, the benefit to the farmer is estimated with actual market prices. For economic evaluation of the Project, the former is to be considered to judge the economic viability of the Project to the national economy.

5-4-2 Conditions for Estimation of Benefit

1) Cropping Area

Cropping areas in the influence area are estimated in consideration of the following assumptions:

a) Development Speed

The full development year was set at 15th year after completion of the road. However, in case of without project only 50 percent of newly cultivable area will be opened at 15th year, while 100 percent will be opened with project. In the with project situation, 75 percent of the full development target will be attained by 7th year, while development speed in the without project situation will be linear to the 15th year.

b) Allocation of Cropping Area

Area allocation by crop at full development year was decided under the following conditions:

- Share of maize field in the newly cultivated area will be 80 to 100 percent differing by Amphoe.
- In the existing area, 5 percent of maize area will be converted to paddy field, except 10 percent in Amphoe Nong Phai in case of Alternative-II.
- Second crop area of beans will become about 32 percent at full development year with project.

Thus, cropping areas by each route alternative by major crops in the future both with and without project were estimated. They are summarized below.

Cropping Area

(1,000 rai)

	1983		1989		1997	
	$\bar{W}$	W	$\bar{W}$	W	$\bar{W}$	W
Alternative-I						
Maize	327	327	341	383	359	407
Rice	189	189	200	216	213	220
Beans	142	142	155	182	173	192
Alternative-II						
Maize	318	318	365	495	423	559
Rice	120	120	136	148	151	152
Beans	111	111	139	202	171	229
Alternative-III						
Maize	224	224	234	262	245	278
Rice	143	143	150	160	159	162
Beans	107	107	116	136	129	143

$\bar{W}$: without the project
W : with the project

2) Crop Yield

As discussed in section 5-3-3, crop yield will be raised up owing to the improvement of agricultural inputs or introduction of high yielding variety, which will be accelerated by the Project. Unit crop yields were estimated as follows:

Average Unit Yields

(kg/rai)

	With Project		Without Project	
	1st Year	Full Dev. (15th Year)	1st Year	15th Year
Maize	344*	384**	344*	384**
Rice	350	370	350	350
Beans	135	140	135	135

* Guatemala : Suwan I = 70 : 30
** Guatemala : Suwan I = 20 : 80

3) Farmgate Price

For economic evaluation, unit prices of crops are to reflect the real value of products from the viewpoint of national economy. As export prices, FOB prices of maize, rice and beans, reflect mostly the real value of products to the national economy, the real value of farmgate prices can be estimated at net value of FOB prices after deducting marketing and processing costs and transfer items from FOB prices. Base prices for estimation of unit value to be used in economic evaluation were decided referring to the past trend of FOB prices and IBRD's forecast of world prices. Farmgate prices with project were estimated by adding 100 Bahts per ton to the prices in case of without project in consideration of the price effects of the Project discussed in Section 5-3-1. Unit prices in 1978 constant price were estimated as follows:

Average Farmgate Prices

(Baht/ton)

	With Project	Without Project
Maize	1,800	1,700
Paddy	2,300	2,200
Beans	5,600	5,500

4) Production Cost

Production costs required to attain certain yield of crops are estimated as follows:

Average Production Costs

(Baht/rai)

	With Project		Without Project	
	1st Year	15th Year	1st Year	15th Year
Maize*	449	464	449	464
Paddy	485	520	485	485
Beans	540	550	540	540

* average of Guatemala and Suwan I

Breakdown of the costs are provided in Appendix 3.

5) Land Preparation Cost

To convert new lands to farm land a certain amount of initial investment is required for clearing of forest. As no sophisticated work is necessary for preparation of upland crop field, costs for opening of new land is relatively small. It was estimated that the average cost for land preparation of new land, weighted by shares of maize field and paddy field, was 400 Bahts per rai. In estimation of this average cost, some consideration was paid for values of by-products such as timber and charcoal which might be produced during the clearing works.

5-4-3 Agricultural Benefit

1) Benefit to the National Economy

Increment of net added value estimated under the conditions given in 5-4-2 is the agricultural benefit, from the viewpoint of national economy, attributable to the Project. Formulae to calculate the increment of net added value for each year are as follows:

Increment of Net Added Value = Net Added Value with Project
- Net Added Value without Project

Net Added Value = Net Value of Production - Land Preparation Cost

Net Value of Production (NPV) = (GVP - PC) x CA

where, GVP: Gross Value of Production per rai
= Unit crop yield per rai x Unit farmgate price per ton

PC : Production cost per rai

CA : Cropping area in rai

Increments of net added values of each alternative were estimated as follows:

Increment of Net Added Value

(Million Baht)

	Route Alternative		
	I	II	III
1983	15.7	7.3	11.3
1989	51.8	75.8	36.0
1997	46.6	72.1	32.6

2) Benefit to the Farmers

The improvement of road network will contribute to raise up the farmers' income. Savings of transportation costs and handling costs will directly reflect the raising up of selling prices of farmers. Development of farming practice owing to the improvement of land communication will bring about the increase of crop production. Annual farm incomes of typical farms with 25 rai will be changed as follows:

Annual Farm Incomes of Typical Farms

(Baht)

	1978	1997	
		With Project	Without Project
Maize Farm	4,159	7,098	5,629
Rice Farm	5,935	7,291	5,935

Details are given in Appendix 3.