# CHAPTER F. PROJECT CONSTRUCTION

## F-1 Introduction

The salient feature of agricultural development project lies in the vastness of the area. To get quick return from a project is to complete construction in short period of time, but will require a great deal of materials, labors and temporary facilities.

The project area is large, however, the Sambor area is a collective of twelve districts, and the districts are all comparatively small, therefore with the completion of construction of each district, the effect of the project will be realized gradually

Since the construction is a consolidation of unit works, such as reclamation and canal construction, etc., the rational construction plan will enable economical facility installations, material and capital investments, and project operation.

Considering the above stated characteristics of this project, the entire construction period of the agricultural development project is set at ten years.

The development plan is established by dividing the project area into twelve districts according to farm management and water utilization.

The construction plan and schedule are worked out by dividing the project area into seventeen districts considering classification and commencement of the construction works(see E-4-2 plan for each district).

The construction period for each construction district is set at two years.

## F-2 Initial Development

Project preference degree from investment consequence is described under para H-4. (Economic Justification and Profitability of the Project.) Examination of the contents of the construction work reveals the fact that the area having a local water resource, such as the Mekong, lakes and tributaries, does not necessarily have to wait the commencement of construction until the completion of the Sambor dam to show the effects of its project.

Saop, Prek Prasap (1), Kratie and Prek Te (R) Districts rely on the Sambor reservoir for water resources, so the construction period should coincide with the completion of the dam construction.

The construction of a demonstration farm is planned at two places, Bos Leav and Chhlong Districts, to carry out investigations and experiments on agricultural technique, and training of the farmers during the first year of operation following the completion of the construction.

The works schedule in other districts is adjusted by taking rough average of an annual quantity of construction amount so that facilities and machinery inputs may be economical considering the internal rate of return and the quantity of construction loads. Construction schedule of each district is given in Fig. IV-28.

## F-3 Future Development

Full benefit of this project will be realized in 11th year after the completion of construction works The project will steadily show its effect with the use of fertilizer, the variety selection and the introduction of new farming technique when the irrigation facilities are completed.

The farmers of this district will be able to better their living standard with the increased production and income, hence encouraging the farmers to promote their productions And at this stage, the farm management will find its way toward improvement of productivity from a mere increase of crop production which is the initial development plan Introduction of high marketable products, large-scale machineries, new irrigation facilities will make it possible to save a labor force in cropping.

In order to realize this, it will become necessary to increase route density of the farm road, to improve the road surface and the drainage system, which will be made possible by the completion of the dam groups of the Mekong Mainstream. In the future, these various facilities installed in this initial development will become the main basic facility to demonstrate a steady effect of the project. Of course the improvements on some facilities will be required, such as enlarging irrigation canals in conjunction with the expansion of the irrigable areas, and some pumps may be eliminated in rising a droughty water level of the mainstream of the Mekong.

The *colmatage* canal which served as soil dressing will be utilized as a flood control and drainage facilities in the future, by constructing a regulating gate at its river mouth, since the flood stage will be lowered.

## F-4 Construction Materials

From the nature of the agricultural development project, the main construction works are reclamation, canal and such earth works, but concrete and steel structures are comparatively few in the entire project. The various nature of the aforementioned factors must be studied for this construction, while the physicochemical nature is made clear by soil analysis.

The soil survey was carried out for the construction materials of the dam and earth canal in order to make a development of the tributaries.

As a result of this survey, the earth materials can be divided into two groups: (1) clayey or loamy type soil, and (2) sandy or silty type soil and either type soil is comparatively of impermeable nature.

In constructing earth canals, water seepage need not be particularly concerned, but special attention should be paid for the flow of soil textures since the textures are so fine. In this case, the side slopes of the canal should be more than 1:2.0, and the flow velocity to be less than 0.5 m/sec. If this is to be used as construction materials for embankment the following precautions should be observed. This material is of high compression with low shear intensity and has the tendency of sliding, so if works are to be done during the low moisture ratio period, complete compaction is necessary because the effect of compaction is great. If the works are to be done during the rainy season, the cross section should be of gentle slope. A vertical drain of the dam should be designed at the downstream side, so that infiltrated water may be drained out.

In reference to the concrete aggregate, a laboratory test was made on the Mekong right bank near the Sambor dam site, and from the result of test it was found that the unweathered original rock was suitable for a concrete aggregate.

## F-5 Construction Problems

The probability of an agricultural development in this project area, and its procedure and method are indicated clearly. In order to expect the maximum effect of the project, the construction should be carried out orderly and economically in compliance with the objections set forth for the project. Since the construction is operated in a wide area, the standardization of mechanical facilities and of technical know-how, and well coordinated construction progress are the most important points for the construction of the project.

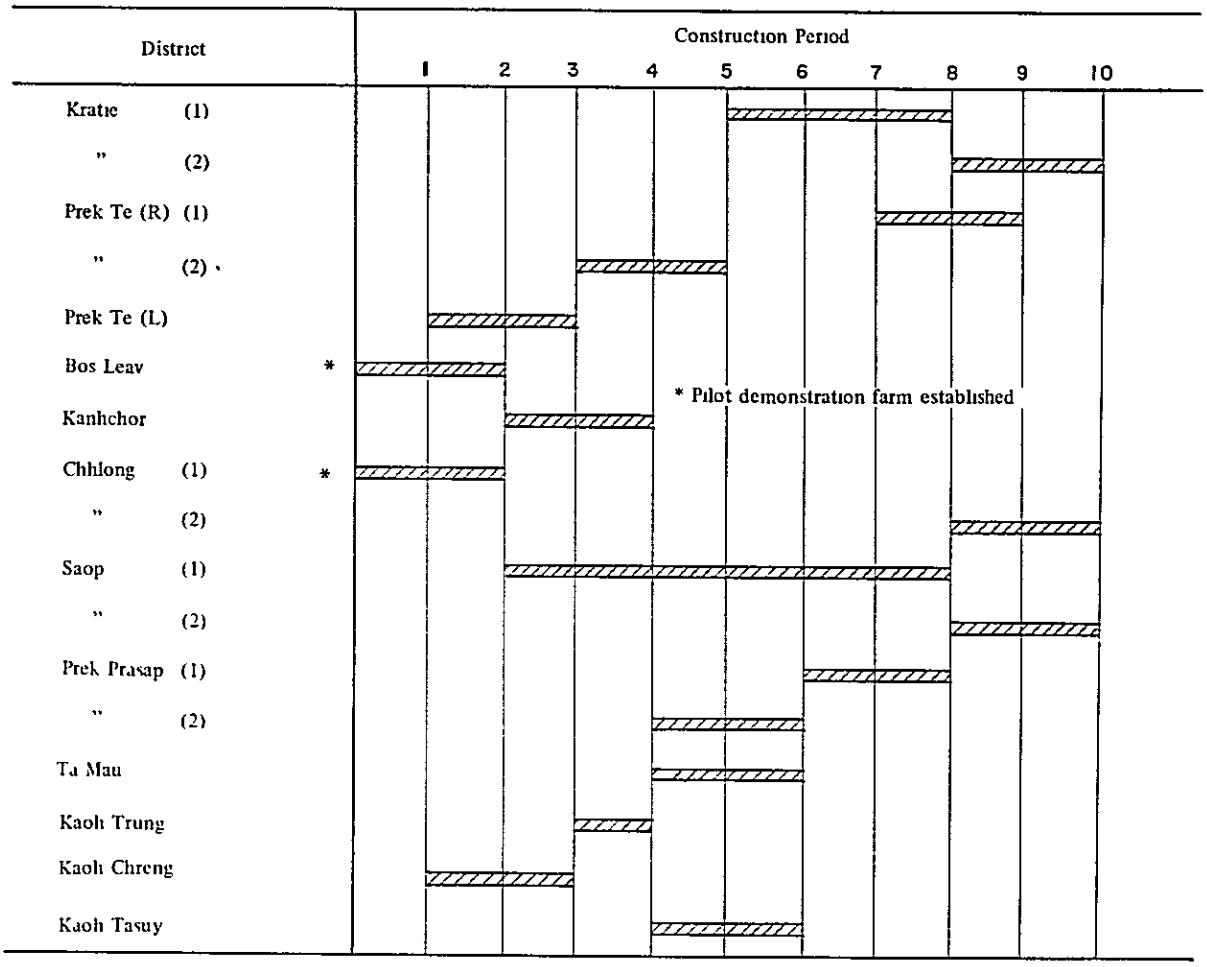
An up-to-date technique must be introduced for the construction methods and supervision, and training center required for many skilled works is also necessary to be established at an early stage.

One of the special features of this project site is the climate, the rainy season lasts six months, but to carry out the works efficiently it is required to continue some portion of the works even during this period. For this purpose, further checks and studies should be made on the hydrological and meteorological conditions, and workable days, type of works, suitable machinery schedule should be made. Work hazards by inundation is another big problem. It is not necessary to construct the access road for this project, however, the existing roads will be exposed to a heavy traffic during the construction, and they are likely to be damaged, effecting the efficiency of the construction.

A proper system for the smooth operation in supplying materials and labors and an appropriate legal measure for the construction must be established.

In order to solve the above mentioned problems, and to advance the construction rationally, the establishment of a management system will be necessary and effective.

Fig. IV-28 Construction Schedule




Note: Kratie and Chhlong districts are divided into two districts respectively by the construction plan, that is, Kratie (2), Chhlong (2) have the drainage improvement works and the remainder is (1) districts And Prek Te (R), Saop and Prek Prasap Districts besides the above Kratie District are also divided into two districts by irrigation system, that is, (1) districts rely on the Sambor reservoir as water resources and (2) districts rely on the local water resources

# CHAPTER G. COST ESTIMATE

# CHAPTER G. COST ESTIMATE

## G-1 Assumption and Result of the Cost Estimate

The construction cost is estimated by referring and adopting the domestic and foreign construction unit cost, efficiency per unit work in which the local condition is taken into account, and the unit price used by the Ministry of Public Works and Communications of Cambodia.

Ten percent of the net construction costs is reserved for an engineering fee for definite design, supervision and so forth.

For contingencies, also 10% of the net construction costs is fixed for the preparation to meet an unexpected additional cost, such as rise of the commodities prices geological phenomena and so forth, which normally occur during the construction of the project.

An associated cost is included in the project cost as the expenses for establishing the demonstration pilot farms at two places to improve farmer's knowledge and understanding and to propagate agricultural techniques in executing the project.

Furthermore, all project costs are estimated in U S. Dollars. However, the local currency is calculated at the rate of 35 Riels per dollar.

Total cost of the project for agricultural development is S34,900,000, approximately 50% of which would be occupied by foreign currency of $S17,043 \times 10^3$

Foreign currency is used mainly for the cost of motor and its attachments, construction machinery, pipes and piles, and so forth.

As for the reclamation works, a depreciation cost of the earthwork equipments is covered by foreign currency.

As for the irrigation and drainage works, all machinery and equipment used for canal construction are mainly covered by the foreign currency.

## G-2 Cost of the Major Works

a. Reclamation works

Of the beneficial area, 34,000 ha, the projected area for a reclamation is 28,903 ha, of which paddy fields are 14,803 ha, and upland fields are 14,180 ha. This reclaimed upland fields of 14,180 ha includes the existing upland fields of 7,452 ha requiring a land leveling.

The reclamation, such as lumbering, stumping, and land-leveling will be made by using the 18 tons bulldozers. 50 man-day per ha is estimated for land-leveling and other finishing works.

The construction cost for the reclamation area of 28,983 ha is $S10,640 \times 10^3$

b. Irrigation canal works

Irrigation canal is designed to be the unlined canal having the side slopes of 1:2. Drag shovels and bulldozers will be employed in this construction, and excavated soil will be used for the road embankment.

The whole length of the irrigation canals is 557.4 km, and the construction cost required for this works is $S9,030 \times 10^3$.

## Table IV- 92 Detail of construction cost

| Name of district | Reclamation works | | Irrigation canal works | | Drainage canal works | | Pumping station works | | Tank reservoir works | | *Colmatage* works | | Net construction cost ($10^3) | Engineering fee and contingencies ($10^3) | Associated cost ($10^3) | Total ($10^3) | Cost per ha ($10^3 ha) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Area (ha) | Const cost ($10^3) | Distance (km) | Const cost ($10^3) | Distance (km) | Const cost ($10^3) | Number (location) | Const. cost ($10^3) | Number (location) | Const. cost ($10^3) | Number (location | Const cost ($10^3) | | | | | |
| Kratie | 5,124 | 2,200 | 128 6 | 2,180 | 18.1 | 276 | 3 | 778 | 1 | 49 | 1 | 82 | 5,565 | 1,112 | 16 | 6,693 | 1,049 |
| Prek Te (R) | 895 | 460 | 27.9 | 470 | - | - | - | - | 1 | 118 | - | - | 1,048 | 208 | 3 | 1,259 | 936 |
| Prek Te (L) | 951 | 400 | 22.5 | 220 | - | - | 1 | 194 | - | - | - | - | 814 | 162 | 2 | 978 | 1,024 |
| Bos Leav | 2,573 | 810 | 40.7 | 570 | - | - | 4 | 697 | 1 | 38 | 1 | 77 | 2,192 | 438 | 7 | 2,637 | 978 |
| Kanhchor | 2,120 | 790 | 40.9 | 610 | - | - | 3 | 651 | 1 | 24 | 3 | 272 | 2,347 | 468 | 6 | 2,821 | 1,138 |
| Chhlong | 3,737 | 1,330 | 49 6 | 1,010 | 12 4 | 272 | 6 | 1,094 | 4 | 63 | - | - | 3,769 | 752 | 13 | 4,534 | 887 |
| Saop | 6,288 | 2,500 | 122 0 | 1,780 | - | - | 1 | 180 | 5 | 1,463 | - | - | 5,923 | 1,184 | 18 | 7,125 | 993 |
| Prek Prasap | 4,006 | 1,210 | 65.7 | 1,240 | - | - | 1 | 242 | 1 | 990 | 2 | 473 | 4,155 | 830 | 10 | 4,995 | 1,208 |
| Ta Mau | 1,598 | 620 | 29 4 | 470 | - | - | 5 | 723 | 2 | 50 | 1 | 106 | 1,969 | 392 | 5 | 2,366 | 1,166 |
| Kaoh Trung | 247 | 50 | 8 8 | 100 | - | - | 1 | 100 | - | - | - | - | 250 | 50 | 1 | 301 | 1,219 |
| Kaoh Cheng | 638 | 120 | 9 2 | 170 | - | - | 1 | 167 | - | - | - | - | 457 | 90 | 2 | 549 | 861 |
| Kaoh Tasuy | 806 | 150 | 12.1 | 210 | - | - | 1 | 174 | - | - | - | - | 534 | 106 | 2 | 642 | 797 |
| Total | 28,983 1/ | 10,640 | 557.4 | 9,030 | 30.5 | 548 | 27 | 5,000 | 16 2/ | 2,795 | 8 | 1,010 | 29,023 | 5,792 | 85 | 34,900 | 1,026 |

Remarks: Prek Te (R): Right bank of Prek Te
Prek Te (L): Left bank of Prek Te

1/ Reclamation area of 28,983 ha, as stated in para. E-4-2, includes 14,803 ha of paddy fields, 6,728 ha of upland fields reclaimed from uncultivated area and 7,452 ha of existing upland fields which require the land leveling.

2/ 16 reservoirs consist of 3 tank reservoirs, 10 gates, and 3 intakes from Sambor reservoir.

Table IV- 91 Foreign currency for construction cost

| Construction works | Construction cost | Foreign currency | Ratio of foreign currency |
|---|---|---|---|
| Reclamation works | 10,640 ($10^3$) | 6,400($10^3$) | |
| Irrigation canal works | 9,030 | 3,100 | |
| Drainage canal works | 548 | 190 | |
| Pumping station works | 5,000 | 1,930 | |
| Tank reservoir works | 2,795 | 1,670 | |
| *Colmatage* works | 1,010 | 380 | |
| Total | 29,023 | 13,670 | (47%) |
| Engineering fee | 2,896 | 2,027 | |
| Contingency | 2,896 | 1,303 | |
| Associated cost | 85 | 43 | |
| Total | 34,900 | 17,043 | (49%) |

c. Drainage canal works

The drainage improvement area is 2,721 ha of the Kratie District and 1,175 ha of Chhlong District.

In Kratie District drainage canal of 18.1 km long and three pumping stations will be constructed. In Chhlong District, constructions of a dike having a length of 7.0 km from Prek Kompong Reang to Mekong bank, and a polder dike of the arable land of 1,175 ha will be provided. A drainage station and a drainage canal of 12.4 km long will be provided. The construction cost required for these works is S548 x $10^3$.

d. Pumping station works

The construction cost for pumping station includes costs of the pump, motor and its accessories, foundation works and building. Furthermore, it includes the construction cost of transmission line from the power station of the Sambor dam.

The power required for the operation of 27 pumping stations (23 for irrigation and 4 for drainage), is 8,796 kw and the construction cost is S5,000 x $10^3$.

e. Tank reservoir works

There is a total of 16 reservoir works as follows: 3 tank reservoirs by construction of earth-fill dams, 10 reservoirs by installation of gates, and 3 intakes from the Sambor reservoir. The construction cost required for these works is S2,795 x $10^3$.

f. *Colmatage* works

Eight *colmatage* works are provided, and the construction consists of canal and bridge works.

Excavation of the canal will be conducted by drag shovel. Side slopes are designed at 1:1, and the surface of the canal body is lined with concrete to prevent erosion.

There are canal construction of 8,600 m long and bridge construction at eight places and the construction cost is S1,010 x $10^3$.

# CHAPTER H. ECONOMIC ANALYSIS

# CHAPTER H. ECONOMIC ANALYSIS

## H-1 Introduction

In examining the agricultural products in Cambodia during last decade, it is observed that the production output per hectare has still hung low as ever.

According to the statistics of UN in 1965, it is presumed that the rate of natural increase of population in Cambodia will be 3.0% per annum, therefore the subject for self-sufficiency will come into the question. The actual results of the national trade in 1964 and 1965 show that the rice export occupies 35.4% among the primary agricultural products in both of the years, and in addition rice, corn and natural rubber exceed 90% of total export. Accordingly, it is desirous to increase agricultural products, especially cash crops, since agriculture in Cambodia will occupy the most important position for the time being.

In Kratie Province, they only produce paddy as much as 60% of their consumption, therefore they have to purchase paddy from the neighbor provinces.

Generally the factor for an increase of food demand depends mainly upon an increase of population, and on the other hand crops demand will increase at least 454 g to comply with every $2 of net income per capita per annum. When an economic environment is given for underdeveloped conditions, Engel's coefficient and income elasticity of food expenses are generally high, therefore the increased portion of income reflects directly to the increase of food consumption.

The main purpose of this project is to establish self-sufficiency in this province, and then this project aims at increase of export-crops to rise income-level, and lastly it leads to the improvement of labor productivity in the future. Both increasing production and promoting export correspond with the policy of the Government of Cambodia.

Transportation and communication in the 20th century being remarkably improved, the developing countries are affected by the developed countries in the aspects of agriculture, industry, commerce, trade, transportation, finance and so forth, and inhabitants in the developing countries have an intention to make an effort to make a rapid advance in economic development even if they have to sacrifice themselves to a certain extent. If this project is implemented, it would surely give this area a motivation to get development. Accordingly it will bring about the increase of income, and will promote a cooperation of farmers, and finally the demonstration effect will influence on other surrounding provinces and the whole country as well.

The objective of this project can be achieved by establishing the irrigation farming, such as operation of irrigation water, fertilization, pest controlling and improvement of varieties, as well as by the construction of the facilities for irrigation and drainage, and will be carried out through the process of agricultural production by farmers. Some periods will be required for the establishment of the irrigation farming.

In analyzing economic evaluation on this project, an analysis period is decided at 50 years, and total increased value during this period is assessed as an equivalent annual value (annual benefit). By using this annual benefit and annual cost obtained from other assessment, a internal rate of return is measured, and is used as an index for economic evaluation.

An average value of the construction cost is estimated at $1,026/ha and also an average value of the increased net benefit is estimated at $163.9/ha, hence the average internal rate of return is figured to be 7.9%.

## H-2 Cost

### H-2-1 Construction Cost

Construction cost, as described under Chapter G. Cost Estimate, is estimated by adding the engineering fee, contingencies and associated cost to the net construction cost Engineering fee and contigencies are estimated at 10% of the net construction cost.

The necessary construction costs for economic analysis on the overall project and each district project are given in Table IV-93.

Table IV-93 Construction cost of overall project and each district project

| Name of district | Total construction cost ($10^3) | Construction cost per ha (S/ha) |
|---|---|---|
| Kratie | 6,693 | 1,049 |
| Prek Te (R) | 1,259 | 936 |
| Prek Te (L) | 978 | 1,024 |
| Bos Leav | 2,637 | 978 |
| Kanhchor | 2,821 | 1,138 |
| Chhlong | 4,534 | 887 |
| Saop | 7,125 | 993 |
| Prek Prasap | 4,995 | 1,208 |
| Ta Mau | 2,366 | 1,166 |
| Kaoh Trung | 301 | 1,219 |
| Kaoh Chreng | 549 | 861 |
| Kaoh Tasuy | 642 | 797 |
| Total | 34,900 | 1,026 |

### H-2-2 Annual Cost

Total initial investment cost necessary for the economic analysis of this project is estimated by adding the interest during the construction period to the construction cost. Total initial investment costs are converted to an equivalent uniform annual amount (annual cost) over the period of analysis by applying the Capital Recovery Factor (T-3). Annual cost includes the following items, such as amortization of total investment cost, replacement cost of pumps, maintenance and operation cost, and power cost In this case, durable period of the pump facilities is set at 25 years. In order to obtain the internal rate of return, study is made by shifting the interest rate from 4% to 10%.

Annual cost of overall project and each district project is calculated as shown in Tables IV-94 & 95.

Table IV-94 Annual cost of overall project (unit: $10^3)

| Item | Interest rate (%) | | | | | | |
|---|---|---|---|---|---|---|---|
| | r = 4% | 5 | 6 | 7 | 8 | 9 | 10 |
| Amortization of total investment cost | 1,676.6 | 1,988 2 | 2,320 3 | 2,670.5 | 3,035.3 | 3,413.2 | 3,801 6 |
| Replacement cost of pumps | 87.3 | 80.9 | 73.9 | 66 8 | 59.7 | 52 9 | 46.6 |
| Maintenance and operation cost | 870 7 | 870.7 | 870 7 | 870 7 | 870.7 | 870.7 | 870.7 |
| Power cost | 86.7 | 86.7 | 86.7 | 86 7 | 86 7 | 86.7 | 86.7 |
| Total | 2,721 3 | 3,026 5 | 3,351.6 | 3,694.7 | 4,052.4 | 4,423 5 | 4,805.6 |

Remarks: (i) Amortization of investment cost is calculated by the following formula:

Amortization of investment cost =

$$\text{total investment cost}^{*} \times \frac{1}{\sum_{n=1}^{n=50} \frac{1}{(1+r)^n}}$$

Where, r = interest rate (%)
n = period of analysis of 50 years

(ii) Replacement cost of pumps is calculated by the following formula:

Replacement cost of pump =

$$\text{Pumping station cost} \times \frac{1}{(1+r)^{25}} \times \frac{1}{\sum_{n=1}^{n=50} \frac{1}{(1+r)^n}}$$

* Interest during construction is assessed by using the following assumption;
0 4 \ interest rate (%) \ construction cost (S/ha) \ construction period, and is included in this total investment cost

(iii) Maintenance and operation cost includes wages necessary for the maintenance of facilities, and expenses required for repairing the irrigation canal. In both cases of gravity irrigation and pumping irrigation, maintenance and operation cost is estimated at 3% of the net construction cost.

(iv) Power cost is estimated by multiplying unit power cost of $5/1,000 kWh by the power consumption volume required for pumping up the necessary amount of irrigation water, of which an annual available precipitation is taken into consideration.

Table IV-95 Annual cost of each district (unit. S/ha)

| Item | Interest rate (%) | | | | | | |
|---|---|---|---|---|---|---|---|
| | r = 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| Kratie | 83.1 | 93.4 | 104.5 | 116.5 | 129.0 | 142.4 | 156.3 |
| Prek Te (R) | 69.7 | 78.7 | 88.4 | 98.7 | 109.7 | 121.0 | 132.9 |
| Prek Te (L) | 83.9 | 92.7 | 102.2 | 112.1 | 122 6 | 133.4 | 144.5 |
| Bos Leav | 81.1 | 89.5 | 98.4 | 107.9 | 117.7 | 128.0 | 138.5 |
| Kanhchor | 93.9 | 103.8 | 114.2 | 125.3 | 136.8 | 148.8 | 161.1 |
| Chhlong | 72.8 | 81.1 | 90.0 | 99.5 | 109.5 | 120.0 | 130.9 |
| Saop | 77.6 | 88.6 | 100 5 | 113.5 | 127 3 | 142.0 | 157.5 |
| Prek Prasap | 92.7 | 104.2 | 116 7 | 129.9 | 143.9 | 158.5 | 173.7 |
| Ta Mau | 94.9 | 104.9 | 115.5 | 126.7 | 138.3 | 150 5 | 163.0 |
| Kaoh Trung | 98.4 | 108.5 | 119 4 | 130.0 | 141.7 | 153.4 | 165 6 |
| Kaoh Chreng | 71.6 | 79.9 | 86.8 | 95.0 | 103.6 | 112.7 | 121.9 |
| Kaoh Tasuy | 65.6 | 72.6 | 79.9 | 87.5 | 95.5 | 103.8 | 112.4 |
| Average | 80.0 | 89.0 | 98.6 | 108.7 | 119.2 | 130.1 | 141.3 |

## H-3 Benefit

### H-3-1 Calculation of Benefit

With enforcement of the agricultural development in Sambor Project, direct benefit and indirect benefit can be anticipated.

However in evaluating this project, the direct benefit obtained from an increase of agricultural products, is adopted.

An increase of agricultural production will rely on the following factors. By securing of irrigation water during the dry season, land reclamation of paddy fields and upland fields, introduction of the double-cropping, highland utilization, advance and stabilization of agricultural products along with the stabilization of irrigation water resources for paddy fields and upland fields will be anticipated.

On the other hand, by the supplemental irrigation water during the rainy season, agricultural products of rainy seasonal paddy fields or upland fields, which is strongly dominated by the distribution of rainfall, will be stabilized in the future.

To put them concretely, as follows.

(1) Land reclamation of paddy fields and upland fields ..... 21,531 ha

(i) Paddy fields to be reclaimed ..... 14,803

| | |
|---|---|
| From clear forest | 1,508 |
| From dense forest | 75 |
| From grassland | 9,643 |
| From bushwood | 3,577 |

(ii) Upland fields to be reclaimed ..... 6,728

| | |
|---|---|
| From clear forest | 1,006 |
| From dense forest | 1,040 |
| From grassland | 2,516 |
| From bushwood | 2,166 |

From the above figures and Table IV-72, it is noted that 5,017 ha of existing paddy fields will increase to 19,820 ha (about 4 times) and 7,452 ha of existing upland field to 14,180 ha (about 1.9 times) in the future.

(2) Increase of land utilization ratio

Potential arable land of the project area is selected according to the topographic and soil conditions, but the land utilization ratio of arable land is affected by the flood inundation from the Mekong and its tributaries during the rainy season from middle of July to middle of October.

This project does not function the flood control and also there is no realized undertaking on the flood control on the Mekong Mainstream Projects, therefore the conditions concerning flood inundation is considered to be the same before and after the completion of the project, and an area of 18,988 ha is classified as flood inundation area out of the project area of 34,000 ha taking into account the water level of the Mekong, elevation of arable land and information gathered from the inhabitants (for details refer to C-4-7 and Table IV-72).

Land utilization ratio in this area is comparatively low at present in comparison with other areas. But in the future land utilization ratio will be increased from the present 136% to 179% by the project.

Table IV-96 Variation of land utilization ratio

| Items | Arable area (A) | Cropping area (B) | Land utilization ratio (B/A) |
|---|---|---|---|
| Present | 12,469 ha | 16,980 ha | 136% |
| Future | 34,000 | 60,739 | 179 |

Remarks: Computed from Table IV-46 under para. E-3 Plan of land utilization.

Variation of the cropping area by crops in the project area before and after the implementation of the project is given in Table IV-97.

Table IV-97 Variation of cropping area

| | Present (A) | | Future (B) | | B/A |
|---|---|---|---|---|---|
| Paddy | 5,240 ha | 30.9 % | 28,726 ha | 47.4 % | 5.5 |
| Maize | 8,390 | 49.4 | 17,829 | 29.3 | 2.1 |
| Mung bean | 1,170 | 6.9 | 7,434 | 12.2 | 6.4 |
| Peanut | 490 | 2.9 | 2,665 | 4.3 | 5.4 |
| Tobacco | 940 | 5.5 | 1,375 | 2.3 | 1.5 |
| Sesame | 750 | 4.4 | 753 | 1.2 | 1.0 |
| Fodder | - | - | 1,957 | 3.2 | - |
| Total | 16,980 | 100.0 | 60,739 | 100.0 | 3.6 |

Remarks: Computed from Table IV-46 under para. E-3 Plan of land utilization.

(3) Increase of entire agricultural production

Expansion of cultivated area, advancement of land utilization ratio and introduction of irrigation farming technique will bring an increase of agricultural production.

Table IV-98 Variation of agricultural production

| | Present (A) | Future (B) | B/A |
|---|---|---|---|
| Paddy | 5,673 ton | 86,169 ton | 15.2 |
| Maize | 10,299 | 71,488 | 7.0 |
| Mung bean | 819 | 9,714 | 11.9 |
| Peanut | 343 | 3,504 | 10.2 |
| Tobacco | 658 | 2,179 | 3.3 |
| Sesame | 450 | 699 | 1.5 |
| Fodder | - | | - |

Remarks: Computed from Table IV-68 under para. E-3 Plan of land utilization.

From the above table, production of paddy will increase 15 times and maize 7 times:

(4) Increased net benefit

Benefit is calculated into dollar value by figuring the agricultural production amount within the project area when the objective is achieved. In calculating the benefit, following facts are considered.

(i) Evaluated price on agricultural products

Producer price (D-3 Price of Product, Table IV-39) is used as reference. In the future, quality improvement of the agricultural products can be expected by the improvement of varieties, but the rise of evaluated price affected by the quality improvement of the agricultural products is not considered.

(ii) Farm management expenses

In the future, highland utilization and increase of the agricultural products can be expected by the introduction of irrigation farming, but with a progress of this, more expenditure for farm management will be required in comparison with the present conditions. These expenditures includes the labor expenses for management of irrigation water, fertilizer expenses, pest control expenses and labor expenses for harvest, transportation and storage. These expenses plus production expenses by each present crop are the basis of future production costs.

(iii) Increased net benefit

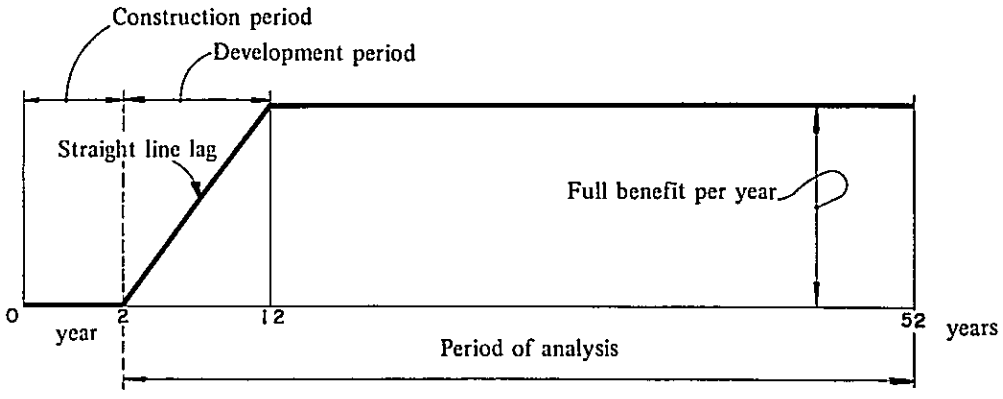
Increased net benefit can be obtained by the difference of the net benefit before and after the completion of the project. Increased net benefit of overall project and each district project is indicated in Table IV-99. The increased net benefit of the overall project is $163.9/ha, and by district, Prek Te (R) is $123.5/ha which is the minimum, and Koah Chreng is $220.7/ha, the maximum.

### H-3-2 Annual Benefit

An annual benefit is equivalent to a value of the increased annual net benefit discounted for the established analysis period of 50 years with an average annual interest rate (As to the increased annual net benefit, H-2 should be referred).

The process of materializing full benefit is illustrated in Fig. IV-29.

Fig. IV-29 Target for construction and benefit



## Table IV-99 Calculation of increased net benefit

| Name of districts | Present | | | | | | Future | | | | | | Increased net benefit | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Arable area (ha) | Cropping area(ha) | Gross income ($) | Production cost ($) | Net benefit ($) | Net benefit per ha ($/ha) | Arable area(ha) | Cropping area(ha) | Gross income ($) | Production cost ($) | Net benefit ($) | Net benefit per ha ($/ha) | Gross income ($) | Production cost ($) | Net benefit ($) | Increased net benefit per ha ($/ha) |
| Kratie | 1,791 | 2,130 | 209,231 | 135,520 | 73,711 | 41 2 | 6,381 | 11,704 | 2,660,943 | 1,673,866 | 987,077 | 154 7 | 2,451,712 | 1,538,346 | 913,366 | 143 1 |
| Prek Te (R) | 454 | 740 | 58,312 | 36,704 | 21,608 | 47 6 | 1,345 | 2,461 | 535,208 | 347,442 | 187,766 | 139 5 | 476.896 | 310,738 | 166,158 | 123 5 |
| Prek Te (L) | 179 | 280 | 34,941 | 23,274 | 11,667 | 65.7 | 955 | 1,422 | 330,832 | 191,434 | 139,398 | 146.0 | 295 891 | 168,160 | 127,731 | 133 4 |
| Bos Leav | 1,215 | 1,760 | 188,783 | 124,463 | 64,320 | 52 9 | 2,696 | 4,873 | 1,255,605 | 686,056 | 569,549 | 211.3 | 1,066,822 | 561,593 | 505,229 | 187.5 |
| Kanhchor | 466 | 460 | 41,761 | 28,547 | 13,214 | 28 4 | 2,478 | 4,355 | 1,062,512 | 559,694 | 502,818 | 202 9 | 1,020,751 | 531,147 | 489,604 | 197.6 |
| Chhlong | 2,696 | 3,610 | 372,694 | 257,601 | 115,093 | 42.7 | 5,114 | 9,324 | 2,376,916 | 1,397,548 | 979,368 | 191 5 | 2,004,222 | 1,139,947 | 864,275 | 169 0 |
| Saop | 1,527 | 1,840 | 180,168 | 115,618 | 64,550 | 42.3 | 7,176 | 12,285 | 2,741,038 | 1,612,434 | 1,128,604 | 157 3 | 2,560,870 | 1,496,816 | 1,064,054 | 148 3 |
| Prek Prasap | 1,744 | 2,560 | 290,099 | 185,417 | 104,682 | 60 0 | 4,135 | 7,545 | 1,865,664 | 991,643 | 874,021 | 211 4 | 1,575,565 | 806,226 | 769,339 | 186.1 |
| Ta Mau | 706 | 840 | 76,473 | 51,108 | 25,365 | 35 9 | 2,029 | 3,566 | 847,379 | 484,515 | 362,864 | 178 8 | 770,906 | 433,407 | 337,499 | 166 4 |
| Kaoh Trung | 247 | 380 | 41,504 | 28,242 | 13,262 | 53.7 | 247 | 474 | 134,463 | 68,356 | 66,107 | 267 6 | 92,959 | 40,114 | 52,845 | 214.2 |
| Kaoh Chreng | 638 | 980 | 107,980 | 75,600 | 32,380 | 50.8 | 638 | 1,238 | 357,956 | 184,846 | 173,110 | 271 3 | 249,976 | 109,246 | 140,730 | 220.7 |
| Kaoh Tasuy | 806 | 1,400 | 140,342 | 88,003 | 52,339 | 64 9 | 806 | 1,492 | 395,777 | 200,412 | 195,365 | 242.4 | 255,435 | 112,409 | 143,026 | 177 4 |
| Total | 12,469 | 16,980 | 1,742,288 | 1,150,097 | 592,191 | 47.5 | 34,000 | 60,739 | 14,564,293 | 8,398,246 | 6,166,047 | 181 4 | 12,822,005 | 7,248,149 | 5,573,856 | 163 9 |

Remarks (1) Present net benefit.

Production by crops (ton/ha) x unit price ($/ton) – Production cost [1/] ($/ha) .. .... .. . ..... (A)

Production cost [1/]. includes home labor and employed labor, fertilizer, pest control, seed, taxation and depreciation (refer to E-3-6 Production expenses, Table IV-52)

(2) Future net benefit.

Production by crops (ton/ha) x unit price ($/ton) – production cost [2/] ($/ha) . ..... .... (B)

Production cost [2/] is obtained by adding the previous present production cost [1/] to increased production cost of fertilizer, pest control, labor, taxation and depreciation. (refer to L-3 6 Production cost, Table IV-52)

(3) Increased net benefit.

Increased net benefit in future (B) – increased net benefit at present (A)

(1) Construction period: Construction period of each district project is set at 2 years.

(2) Development period: With the completion of reclamation and construction of facilities, land utilization and production level at present will immediately reach to the degree of the moment and agricultural production increase will be expected, however, in order to realize the proposed production level stated under Para. E-3 Plan of land utilization, the irrigation, fertilization, and pest control technique should be introduced, and moreover, the farmers should make effort to bring themselves on these new technique and new varieties.

To realize the full-benefit of this project, a certain length of time will be required, and ten years is presumed as a development period in this project. During this period, benefit will be gradually increased and this benefit will attain its best in twelve years after construction is completed.

(3) Annual benefit: Taking the aforementioned facts into consideration, annual benefit will be calculated depending on the following formula:

$$\text{Annual benefit} = \left[\frac{1}{10}\sum_{n=1}^{n=10}\frac{n}{(1+r)^n} + \frac{1}{(1+r)^{10}} \times \sum_{n=1}^{n=40}\frac{1}{(1+r)^n}\right] \times B \times \frac{1}{\sum_{n=1}^{n=50}\frac{1}{(1+r)^n}}$$

Where, r = interest rate (%)

n = period of analysis for 50 years

B = annual full benefit ($/ha)

By using the above formula, annual benefits for overall project and each district project are calculated with the various interest rate, and are given in Table IV-100.

Each district project will attain the objective depending on the aforementioned agricultural development process, but in this case, the construction for each district will not always be started and completed at the same time.

Table IV-100 Annual benefit (unit: $/ha)

| Name of district | Interest rate | | | | | | | Annual full benefit |
|---|---|---|---|---|---|---|---|---|
| | r = 4.0% | 5.0 | 6.0 | 7.0 | 8.0 | 9.0 | 10.0 | |
| Kratie | 117.2 | 113.5 | 109.8 | 106.3 | 102.8 | 99.1 | 96.3 | 143.1 |
| Prek Te (R) | 101.1 | 97.9 | 94.7 | 91.8 | 88.7 | 85.5 | 83.2 | 123.5 |
| Prek Te (L) | 109.2 | 105.8 | 102.3 | 99.1 | 95.8 | 92.4 | 89.8 | 133.4 |
| Bos Leav | 153.5 | 148.7 | 143.8 | 139.3 | 134.7 | 129.8 | 126.2 | 187 5 |
| Kanhchoi | 161.8 | 156.7 | 151.6 | 146.8 | 141.9 | 136.8 | 133.0 | 197.6 |
| Chhlong | 138.5 | 134.1 | 129.7 | 125.7 | 121.5 | 117.1 | 113.9 | 169.1 |
| Saop | 121.4 | 117.6 | 113.7 | 110.2 | 106.5 | 102.7 | 99.9 | 148.3 |
| Prek Prasap | 152.4 | 147.6 | 142.7 | 138.3 | 133.7 | 128.9 | 125.3 | 186.1 |
| Ta Mau | 136.2 | 132.0 | 127.6 | 123.7 | 119.5 | 115.2 | 112.0 | 166.4 |
| Kaoh Trung | 175.3 | 169.9 | 164.3 | 159.2 | 153.9 | 148.3 | 144.2 | 214.2 |
| Kaoh Chreng | 180.7 | 175.0 | 169.3 | 164.0 | 158.5 | 152.8 | 148.6 | 220.7 |
| Kaoh Tasuy | 145.3 | 140.7 | 136.1 | 131.8 | 127.4 | 122.8 | 119.4 | 177.4 |
| Average | 134.2 | 130.0 | 125.7 | 121.8 | 117.7 | 113.5 | 110.4 | 163.9 |

## H-4 Economic Justification and Profitability of the Project

### H-4-1 Internal Rate of Return

Economic evaluation of this project is made by using the internal rate of return. Firstly, increased annual net benefit and annual cost are computed by discounting the present value of cost and increased net benefit during the period of analysis (50 years) with various interest rates, and secondly, a compound interest rate, which equalize the present value, is measured and this value is employed as an index of the economic evaluation for this project.

For instance, if a ratio which equalize the present value of cost (C) and present value of increased net benefit (B) is given, relation of (A) and (B) is shown as follows:

$$C = \frac{B_1}{(1+r)^1} + \frac{B_2}{(1+r)^2} + \cdots\cdots\cdots + \frac{B_n}{(1+r)^n} = B \times \frac{(1+r)^n - 1}{r(1+r)^n}$$

From the above equation, internal rate of return is obtained by solving the interest rate of r (%). Table IV-101 shows the value of interest rate for benefit-cost ratio.

Table IV-101 Benefit-cost ratio

| Item | r = 4.0% | 5.0 | 6.0 | 7.0 | 8.0 | 9.0 | 10.0 |
|---|---|---|---|---|---|---|---|
| Annual benefit (B) | 134.2 | 130.0 | 125.7 | 121.8 | 117.7 | 113.5 | 110.4 |
| Annual cost (C) | 80.0 | 89.0 | 98.6 | 108.7 | 119.2 | 130.1 | 141.3 |
| B/C ratio | 1.68 | 1.46 | 1.27 | 1.12 | 0.99 | 0.87 | 0.78 |

Namely, interest rate to make (B) and (C) equal is approximately 8.0%.

The internal rate of return of each district can be computed by using the same method. The relation between the annual benefit and annual cost and its internal rate of return is shown in Fig. IV-30. The following table indicates each internal rate of return summarized from Fig. IV-30.

Table IV-102 Internal rate of return for each district

| Name of district | Internal rate of return (%) | Construction cost ($/ha) | Full benefit ($/ha) |
|---|---|---|---|
| Kratie | 6.3 | 1,049 | 143.1 |
| Prek Te (R) | 6.5 | 936 | 123.5 |
| Prek Te (L) | 6.0 | 1,024 | 133.4 |
| Bos Leav | 9.2 | 978 | 187.5 |
| Kanhchor | 8.3 | 1,138 | 197.6 |
| Chhlong | 8.9 | 887 | 169.1 |
| Saop | 6.9 | 993 | 148.3 |
| Prek Prasap | 7.5 | 1,208 | 186.1 |
| Ta Mau | 6.8 | 1,166 | 166.4 |
| Kaoh Trung | 8.7 | 1,219 | 214.2 |
| Kaoh Chreng | 11.7 | 861 | 220.7 |
| Kaoh Tasuy | 10.5 | 797 | 177.4 |
| Average | 7.9 | 1,026 | 163.9 |

From the above table, the internal rate of return of 12 districts distributes from 6.3% to 11.7%.

On the occasion of deciding a priority of undertaking the project for each district, the internal rate of return must be considered as well as the amount of investments for unit area.

Concerning the internal rate of return, following matters can be seen from Table IV-102.

(1) The districts having the internal rate of return of over 8.0% are Bos Leav, Kanhchor, Chhlong, Kaoh Chreng and Kaoh Tasuy. Both districts of Bos Leav and Chhlong are important cropping areas in the project, and the former has *colmatage* and pump irrigation plans, and the latter has drainage improvement and polder plans But in each case, the construction cost per unit area is lower than that of the construction cost of the overall project.

Kaoh Trung, Kaoh Chreng and Kaoh Tasuy Districts where there are pumping irrigation plans are isolated islands in the Mekong. Since their topographic conditions are plain, the construction costs for reclamation works and canal works are estimated to be low.

Net increased benefit per unit area of the above seven districts is higher than that of the overall project.

(2) The internal rate of return of the other five districts is around 6%. Most of these areas are used for paddy fields and are affected by the inundation during the rainy season. Therefore ratio of land utilization is low, for which efficiency of the investment is only a few.

The district of Prek Prasap has a *colmatage* plan, but since the topographic condition is complicated, the construction cost required for canal works and pumping station works is comparatively high.

The net increased benefit per ha of other districts is lower than that of the overall project.

Although the internal rate of return of Kratie District is 6.3%, this project has social influences to other districts, because this district is located in the suburb of Kratie City, and the project has an effective demonstration role such as gravity irrigation from the Sambor reservoir and drainage improvement by pump.

(3) In such districts as Kratie, Prek Te (R), Saop, and Prek Prasap, where rely on the Sambor reservoir as irrigation water resources, the constructions should be commenced in connection with the completion of the Sambor reservoir.

In other districts the constructions can be commenced regardless of the construction of Sambor dam.

### H-4-2 Economic Evaluation

As mentioned above, 7.9% of average internal rate of return for the overall project is not considered so high, but by using a low interest capital, the project implementation is made feasible.

When full benefit is obtained by completing all district projects, increased annual net benefit of $5.6 x $10^6$ may be expected from an increased agricultural production. This amount is equivalent to $163.9/ha/year.

The arable area per farm household in the present Sambor Project area is 2 ha, but judging from the present working conditions of the farmers, 4 ha will be possible to be cultivated; 2.3 ha for paddy fields and 1.7 ha for upland fields.

Tables IV-103 & 104 show the variation in cropping areas, and gross income, production cost and net benefit per farm household in Sambor area.

Table IV-103 Variation in cropping area (unit: ha)

| | Paddy | Maize | Mung bean | Peanut | Sesame | Tobacco | Fodder | Total |
|---|---|---|---|---|---|---|---|---|
| Present | 0.81 | 1.29 | 0.18 | 0.08 | 0.12 | 0.14 | - | 2.62 |
| Future | 3.38 | 2.10 | 0.86 | 0.31 | 0.09 | 0.16 | 0.23 | 7.15 |

Remarks: Figures at present can be obtained by dividing the cropping area shown in Table IV-68 by 6,500 of present farm households, and in the future by 8,500 farm households.

Table IV-104 Variation in gross income and production cost (unit: S)

| Item | Gross income | Production cost | Net benefit | Net benefit + labor expense |
|---|---|---|---|---|
| Present | 267 | 177 | 90 | 231 |
| Future | 1,714 | 987 | 727 | 1,246 |

Remarks: Figures at present can be obtained by dividing the present gross income, production cost and net benefit by 6,500 of present farm households and in the future by 8,500 farm households.

The present average cropping areas of 2.67 ha per farm household will increase to 7.15 ha in the future, and the present average net benefit of S90 per farm household will increase to S727, eight times of that of the present values, which will contribute to the rising standards of living of the farmers.

Upon execution of the project, following attractive secondary benefit can be expected:

i) Effect of employment;

ii) Increase of revenue brought from land tax in proportion to increase of cropping land;

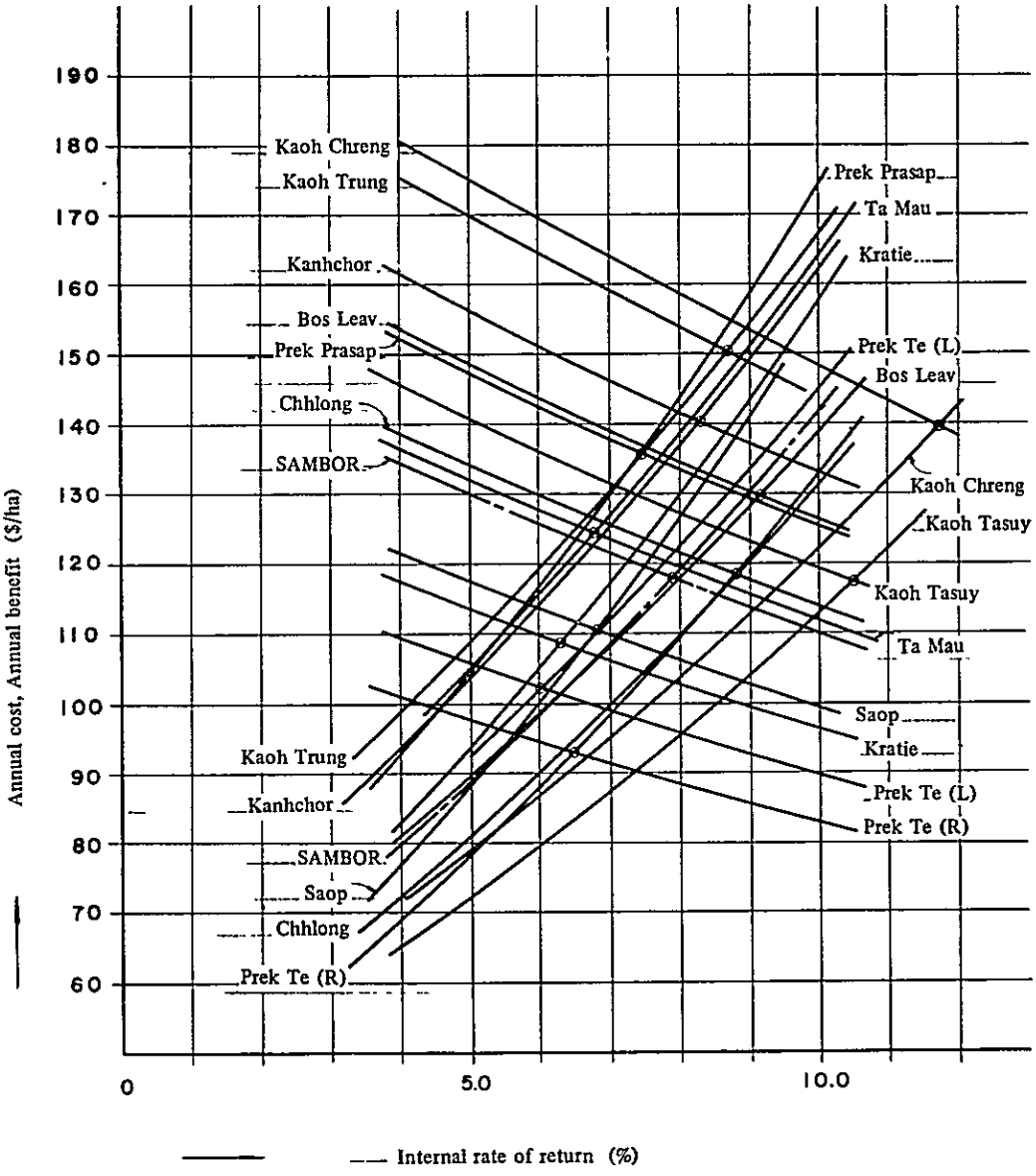
iii) Increase of agricultural production for export;

iv) Increase of additional value in relative works, such as manufacturing industry, transportation and other circulating services.

Furthermore, the willingness and vitality for production by the farmers and an effective investment for a development plan will be promoted.

This project will contribute directly or indirectly to the economic development of other districts with its demonstration effect which is extended through the utilization of local water resources and the appropriate farm management for local area. Therefore, this project will be great significant.

Fig. IV-30 Internal rate of return



# CHAPTER I. MANAGEMENT

# CHAPTER I. MANAGEMENT

## I-1 Introduction

It has generally been the case with all the irrigation projects that the management of the project has been in the hands of an organization considered to represent the interests of the farmers benefiting from the project, such as an irrigation association organized by the farmers, or in the hands of the chief of the area administration office in case when there is no irrigation association. Especially, when amortization of construction cost or depreciation of the facilities and maintenance expenses are involved, it is absolutely necessary to have an organization in charge of collecting these expenses and managing the project. In general, the same circumstances exist with the Sambor Project, and consideration should be given to the following special conditions:

Firstly, at present, it may be difficult for the farmers of Cambodia to operate and maintain the project facilities following their completion There are some irrigation facilities here and there, but almost all of them seem to be managed by the head of the central or local government authorities, and the farmers do not have any experience of functioning the irrigation association. Accordingly, while it is necessary to organize an association, it will be imperative for the time being to rely largely on the guidance by the central or local government, or it may be necessary to have a direct control by the central government for a certain period of time.

Secondly, it should be observed that the expenses, required for the operation and maintenance of the irrigation facilities, have to be borne by those who will benefit from the project. This principle is quite new to almost all Cambodian farmers. Of course, these expenses as water charges should not be collected until the farmers reach the point to enjoy a sufficient benefit in return for such payment, and until such time, the central or local government will have to bear such expenses on behalf of the farmers. It is desirable, even after a sufficient benefit has become available, to collect the lowest practical sum of expenses over a long period of time. At any rate, the facilities could only go to ruin unless controlled and maintained by the farmers utilizing them. If proper maintenance is provided for the facilities, and a part of the available benefits is spared for a new development or improvement of farming methods, it will eventually produce a greater benefit.

For the time being, consciousness of the farmers who have become aware of the problems will be certainly required to cooperate with government officials and other authorities concerned

## I-2 Suggestion on Management of the Project

This paragraph will give several practical suggestions on the management of the project facilities when they are completed.

The role of the demonstration farms

This project consists of twelve districts, but the construction in all these districts do not start or complete simultaneously. First the demonstration farms will be constructed, which will probably be operated by a government agency. The construction of the demonstration farms will be started earlier than that of any other districts, and the government agency operating the demonstration farms will manage the project for some time after they are completed. Farmers will learn about the irrigation and improved methods of cultivation from the demonstration farms, and additional demonstration farms managed by the farmers themselves will spread around the original demonstration farms. Based on the experience thus accumulated, the farmers will learn to organize irrigation association by and for themselves, and the management of the project facilities will gradually shift from the hands of government officials to those of farmers. In the future, the government agencies will only have to engage in technical studies, research work, guidance and advisory services on agriculture.

Irrigation Association in each district

Though construction in different districts is to start at different times, each project will follow the same or similar course of progress to that described above Each district is required to have its own irrigation association because the project construction for each district is completed at a different time from any others and because each district has its specific facilities which will naturally require individual operation and maintenance

Operation and management of the project

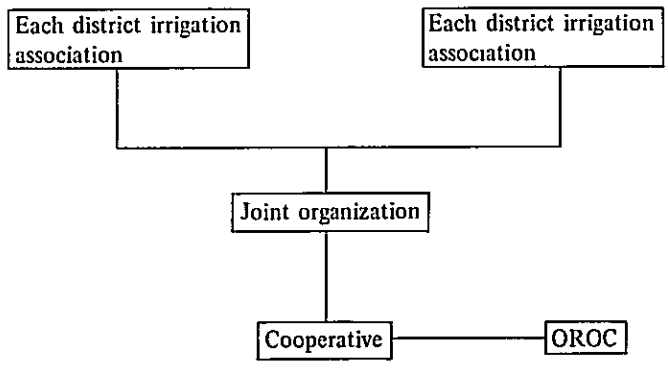
The amount of amortization for the construction cost will naturally differ from each district having different natural conditions, as amortization is based upon the scope of project investment which will depend upon the natural conditions of any particular land which will determine the productivity of that land. In general, the expenses of operation and maintenance will also differ from each district, as they are determined by the scale and function of the facilities. But in view of its nature, the expenses will be almost the same to each district unless there is a great difference in the land productivity. The allocation of such expenses should preferably be determined in accordance with the benefits of the districts. Accordingly the amortization and the cost of operation and maintenance should be considered separately. This will require a joint organization which will unite and coordinate the associations of all the districts.

It is desirable that the joint organization will collect the expenses for the management of the project, and that the district associations will engage themselves in the operation and maintenance of the facilities separately or in conjunction with the joint organization.

In the early stages, it may be necessary to leave the control of the whole area in the hands of the government authorities in order to effect the amortization and management of the project. As a matter of fact, if the construction for the project is carried out under the control of the government, it may be the responsibility of the government to take care of the facilities completed until people get fully accustomed to the operation of the facilities. It is, however, important to instruct the farmers who will benefit from the project, so eventually they will be capable of managing it themselves.

The relationship between OROC and Irrigation Association

*Office Royal de Cooperation* (OROC) and many central and local cooperatives will probably help in many ways, the irrigation associations and the management of the completed project operated by the government. The individual farmers will continue to get help of the cooperatives in settling their problems such as financing, purchase of fertilizer, and transportation and sales of their products. What is most expected is that the irrigation associations are able to utilize the agricultural credit in respect of the amortization and expenses of operation and maintenance for the project. This will require partial revisions or consolidation of the applicable regulations such as the Irrigation Association law controlling the management organization. In addition to the management of the existing project, the irrigation association will desire to take the initiative in working on a new project for agricultural development. In this case, it will be necessary that the authority should grant the association to work on such a new project and furnish funds for that purpose. The relationship between the existing and established organization is shown as the following figure.




How to cope with the project efficiently

Able leaders and farmers' cooperation are most important for the smooth management of the project. What is no less important is the availability of technical advisers or extension workers. Whatever form it may take, the management organization will have to keep the following points in mind: (1) Consider the benefit of the farmers; (2) Work with the farmers; (3) Do not hunt for a graft; (4) Do not get involved in any affair other than the management of the project; (5) Do not be satisfied with things as they are, but make continuous research and survey for better management.

# CHAPTER J. CONCLUSION AND RECOMMENDATION

# CHAPTER J. CONCLUSION AND RECOMMENDATION

## J-1 Conclusion

Demand of the rice in this project area has to depend on the rice production of other provinces in Cambodia despite its sparse population. When the increase of its population in the future is taken into account, this development project is undoubtedly necessary for the purpose to meet the food self-sufficiency in the area. Moreover, the increase in export of agricultural products such as rice and maize will certainly contribute to the economic growth of the nation. The conclusions of this feasibility study is summarized as follows:

a. An irrigable area of 34,000 ha is selected suitable for the development from both technical and economical standpoints, after making a thorough investigation covering an area of 69,000 ha.

b. The prevention of floods and the improvement of drainage are, of course, important for the development of agriculture, but it will not be economically justified to put them in practice on a full scale because it requires a tremendous amount of expenses unless some measures are taken for the control of floods along the mainstream of the Mekong. There are, however, some areas where it is economically possible to carry out the projects for flood prevention and drainage improvement.

c. Irrigation: It is, first of all, important to supply supplemental water during the rainy season. Gravity irrigation is the most economical means from the operation and maintenance standpoints, but the cost of construction and topographical restrictions make it imperative to adopt lift irrigation in about 45% of the area.

d. The development of local water resources for supplemental water is considered to be comparatively economical, since approximately 16% of the total required supplemental water of 468 x $10^6 m^3$ a year, or 74 x $10^6 m^3$ is available from lakes, ponds and tributaries in the area.

e. Rice and maize should be taken up as the staple products for the agricultural development in this area. At the full benefit stage, present production of paddy rice of 5,673 ton/year will increase to 86,169 ton/year (about 15 times) and also 10,299 ton/year for corn to 71,488 ton/year (about 7 times).

f. Total construction cost required for this project is estimated to be $34,900,000, of which 50% of total construction cost is occupied by the foreign currency. Maximum construction cost per ha is $1,219 for Kaoh Trung and $797 is minimum for Kaoh Tasuy. The period of the agricultural development in the Sambor Project is set at ten years, and that of each district is set at two years basically.

g. Net benefit: A standard farm household with a cultivated land of 4 ha will be able to gain a net benefit of $727 every year.

h. The annual net benefit expected from the operation of this project will amount to $163.9/ha, and its internal rate of return will be 7.9%. These figures obviously attest the feasibility for carrying out the project.

i. The expenses is required for the operation and maintenance of the irrigation facilities. But these expenses should not be collected until the farmer reaches the stage to enjoy a sufficient benefit in return for such payment, and until such time, the central or local government will have to bear such expenses on behalf of the farmers. Annual maintenance and operation cost for the overall project is estimated at $870,700, therefore, average these expenses per farm household are estimated at $102 in the future

j. Land availability for settlers: If a farm household owns a cultivated land of 4 ha in the future, it would be sufficient to support a family by the labor of its own family members. Considering the irrigable area of 34,000 ha and the now living 6,500 farm households, it is possible to resettle 2,000 households who now live in the area which will be submerged in the water when the Sambor dam is constructed.

## J-2 Recommendation

The following actions are recommended to be taken in order that the project may be carried out successfully and to demonstrate a full effect at an early date:

a. The commencement of the construction for the project should be at the earliest practicable date and carried out steadily as scheduled. This is important because the development of agriculture is an urgent task not only in the Sambor area but in any other part of Cambodia as well. Moreover, agricultural development cannot be achieved by the mere installation of the facilities, but can only be realized if it is combined with the adoption of up-to-date technique to replace the conventional practice, extensive research work and diffusion of knowledge, and therefore, it will require a long period of time* for the achivement of the aforementioned objectives.

* This project is based upon an elementary but important technology, and the construction schedule is broken down into many small districts, so that upon completion of the construction in each district, its effect may be demonstrated individually. Therefore, the definite design may proceed by each district, so that it is believed unnecessary to spend a great deal of concentrated time and for that purpose.

b. The research organization should be established to perform researches on the varieties and the technique for cultivation and to promote and enforce the information service. A research laboratory is required to make research on the new varieties adaptable for the new land and provide inexperienced farmers with knowledge and information on fertilization, pest control and other related matters.

c. The demonstration farm should be established to extend the development effect, improve the cultivating technique and provide the technical training.

d. The administration and management organizations should be established and/or consolidated. The administrative organizations, such as OROC *(Office Royal de Cooperation)* and SONEXIM *(Societe National d'Exportation et d'Importation)*, are making great contributions for the development of agriculture by popularizing and expanding their financing to the farms, lease of farm implements and equipments and assistance in the joint transportation of products, but it is desirable to elevate to a further degree the efficiency of the existing system and organization.

In view of a sudden shift from the conventional method of agriculture to a modernized one, it is no doubt necessary to educate and train the farmers, but the project would not make a smooth progress without the guidance of a government authority. The importance and necessity of the construction supervision is described under Chapter F.

It is necessary to set up an organization for the operation and maintenance of the facilities when the construction is completed. Furthermore amendment and addition of the current rules and regulations will be required for proper water distribution, operation and maintenance, and collection of maintenance charges as described under Chapter I. Management Every beneficial farmer should become a member of such organization. The farmers who have learned to control water will probably expedite the project effect along with the acquired technique for farm management.

e. The further observation and survey should be continued for the definit study on the following items. (1) perform thorough observation to find out more about the water utilization and meteorological features in this area; (2) perform the field tests and observation in order to clarify the erosion behavior. (3) make a denser survey on the soil science in order to settle the proper water administration and fertilizer planning for each farm