

2.5.4 Proposed Small Scale Irrigation Schemes

The new small scale irrigation schemes including extension of existing irrigation schemes proposed by the respective provinces are 65 in total as listed in Table 2.15, and their locations are identified in Figure 2.9. Following shows a summary of those schemes by province except for HCMC and Long An province:

Province	Number of Ext. and Proposed Small Schemes	Total of Irrigation Area
Lam Dong	3	3,050
Dac Lac	0	0
Ninh Thuan	3	6,400
Binh Thuan	2	608
Ba Ria-Vung Tau	18	8,450
Dong Nai	7	9,770
Song Be	20	11,094
Tay Ninh	12	21,870
Total	65	61,242

2.5.5 Rehabilitation of Existing Irrigation Schemes

As the results of inventory survey for the existing irrigation schemes made in the Phase I study, it was found that the area actually irrigated is as low as around 40 % of the designed scale mainly because of insufficient development of on-farm facilities, inadequate design of irrigation systems, water shortage, damage and deterioration of facilities and poor operation and maintenance. Therefore, almost all the schemes require the rehabilitation and improvement. Through the field reconnaissance, it was confirmed that the provincial administrations had heavy stress in shortage of fund for maintenance and rehabilitation of the existing schemes, and strong intention to implement those rehabilitation and improvement works. In addition, they have many short range plans on irrigation development, which includes extension of existing irrigation schemes, water resources development encountering the present water shortage and the development of new irrigation systems.

As one of the three strategic approaches to the development policy of the agricultural sector launched by the Government of Viet Nam, public investment should be expanded to the most fundamental part in the development of the agricultural sector as well as to the most notably research and extension services, irrigation and water resources management and rural infrastructure. Along with this development strategy and as a critical element in developing the agricultural sector, the Government intends to continue to rehabilitate, upgrade and repair existing irrigation, dikes and drainage structures as well as to expand the irrigation and water resource management systems in many parts of the country. In addition, the Government is to

strengthen rural infrastructure and linkage with economic growth areas. Particular attention is to be drawn to improving farm-to-market roads, rural electrification, supply of safe drinking water and sanitation facilities. These improvement will encourage the commercialization of agricultural sector and the diversification in the rural employment opportunities. This policy will result in increasing the farmer's income, enhancing the living standard in the rural area and ultimately narrowing down the economic disparity between urban and rural areas.

With such background as mentioned above and moreover in view of economically high efficiency, i.e. quick and high return with small and short-term investment, it is proposed to formulate an implementation plan for the rehabilitation of the existing irrigation schemes in the Study Area including the development plan of new small irrigation schemes proposed by the respective provinces. The procedure for this implementation plan will be as follows:

- a) Inventory survey for all the irrigation and drainage schemes;
- b) Establishment of database for the schemes;
- c) Analysis, classification and grouping of the schemes;
- d) Priority setting among the schemes;
- e) Preparation of the development plan including the implementation programme;
- f) Arrangement of internal and external finances; and
- g) Implementation of rehabilitation project.

The above procedure is schematically shown in Figure 2.10.

2.6 On-going and Planned Irrigation Schemes

There are four major on-going and planned irrigation schemes in the Study Area as follows:

- | | | |
|--|---|--------------|
| - Dau Tieng irrigation scheme (93,390 ha) | : | On-going; |
| - Phuoc Hoa irrigation scheme (45,680 ha) | : | Planned; |
| - Hoc Mon-Bac Binh Chanh irrigation scheme (12,197 ha) | : | Planned; and |
| - Song Quao irrigation scheme (8,120 ha) | : | On-going. |

Location of the above irrigation schemes is identified in Figure 2.8. The more detailed information on the present situation of the above schemes is described below along with the results of review made through the field work of Phase II study. The Song Quao irrigation scheme is separately discussed in the subsequent Sub-section in connection with the potential Phan Thiet Plain irrigation scheme.

2.6.1 Dau Tieng Irrigation Scheme

(1) Present Condition

The Dau Tieng reservoir was constructed in the Saigon River in the year 1985 initially for a purpose to irrigate 172,000 ha consisting of a gravity irrigation area of 67,000 ha and a pump area of 105,000 ha. The Government reviewed the scheme in the year 1991, and reduced the irrigation area because of increase of perennial crops such as rubber in the upstream area, enlargement of social infrastructure area and less economic viability of pump irrigation. At present, the scheme is to irrigate an area of 93,390 ha in total as the maximum potential scale in Tay Ninh province and HCMC as summarized below:

Description	Unit : ha				
	Total	Tay Ninh Province		HCMC	
		Gravity	Pump-up	Gravity	Pump-up
Tan Hung zone	16,000	-	16,000	-	-
West canal zone	26,340	21,000	5,340	-	-
East canal zone	41,050	24,000	2,490	12,450	2,110
Reservoir peripheral zone	10,000	-	10,000	-	-
Total	93,390	45,000	33,830	12,450	2,110

In addition, the Dau Tieng dam is obliged to supply irrigation water to the riparian area along the East Vam Co River in Tay Ninh and Long An provinces with an area of 28,140 ha in total and also to release an amount of water of 20 m³/sec for repulsion of sea water in the downstream reaches of the Saigon River for a time period of March to May.

The progress of construction of irrigation system to date and the irrigated farming situation are summarized below:

Tay Ninh province

- The construction of canal system is on-going in the west and east canal zones at present. The construction of Tan Hung canal is to be started from the end of the year 1995, targeting the completion in the year 2000. The development for the peripheral zone of reservoir is suspended.
- The gravity irrigation system down to tertiary canals has been completed for an area of 36,000 ha, and it is to be increased to 40,000 ha by the end of the year 1996. Each of tertiary canals constructed by the Government commands an area ranging from 20 to 30 ha, and the on-farm system is to be constructed by farmers on their own.
- For pump-up areas, the irrigation system down to secondary canal in the west and east canal zones is to be completed in the year 1996. However, farmers are responsible for the

construction of tertiary canals leading irrigation water from the secondary canal. This is caused mainly by the shortage of fund and lower economic viability in the pump-up area than the gravity area according to the Department of Water Resources of the Tay Ninh province. In general, farmers construct the tertiary canals where their land is near to the secondary canal with a length of less than 300 m, however, such areas are as little as accounting for about 15 % of the entire pump-up area (7,830 ha) in the west and east canal zones. Most of farmers in the pump-up area dig shallow wells, and pump up groundwater, of which quantity increased and water level rose after the Dau Tieng reservoir had been constructed.

- The dominant crops in the irrigation area are paddy and upland crops, particularly groundnut with high marketability. The farming situation in the 45,000 ha area extending in the east and west canal zones is as follows:

Cropping Season	Irri. System Completed (36,000 ha)			Rest (9,000 ha)		
	Irrigated		No-irri.	Paddy		Fallow
	Paddy	G.nut	G.nut	Paddy	G.nut	Fallow
Winter-Spring	14,000	22,000	0	0	4,500	4,500
Summer-Autumn	20,000	6,000	10,000	9,000	0	0
Rainy season	12,000	0	24,000	9,000	0	0
Total	46,000	28,000	34,000	18,000	4,500	4,500

HCMC

- The irrigation area in HCMC is 14,560 ha commanded by the east canal, and consists of two sub-areas, i.e. Cu Chi (12,000 ha) and Ben Muong Lang The (2,560 ha) as shown below:

Sub-area	Total	Unit : ha	
		Gravity	Pump-up
Cu Chi	12,450	10,500	1,950
Ben Muong Lang The	2,110	1,500	610
Total	14,560	12,000	2,560

- The gravity irrigation system down to tertiary canals for an area of 9,000 ha has been completed in the gravity area of Cu Chi sub-area, and the rest is under construction. The farming situation is described in the subsequent Sub-section on the irrigated agricultural development in HCMC.

(2) Review of Project Implementation

The current implementation of Dau Tieng irrigation scheme is reviewed in respect of water balance and economic viability, and the results of review are briefly described below:

Water Balance

Water balance of the Dau Tieng reservoir is calculated under the situation without supplemental water supply from the Dong Nai River basin in future. Other conditions for water balance besides the above are as follows and further details are referred to the simulation model made in the Project Preparation Study of Hoc Mon-Bac Binh Chanh Irrigation Scheme by IBRD:

- Inflow at Dau Tieng reservoir : 75 % discharge estimated by the study hereof;
- Mandate release to the Saigon River : 18.5 m³/sec consisting of 3.5 m³/sec for water supply to HCMC and 15 m³/sec for salinity repulsion; and
- Irrigation area: 13,000 ha for riparian area of the Saigon River and 12,197 ha for the Hoc Mon-Bac Binh Chanh irrigation scheme.

Table 2.16 shows the results of water balance calculation, revealing that the reservoir would not permit the irrigation of more than 50,000 ha in the Dau Tieng scheme, unless supplemental water is supplied from the Be River as discussed in Appendix X.

Economic Viability

Economic viability is assessed to the remaining area of 48,390 ha (93,390 ha-45,000 ha) to be facilitated with irrigation systems. The project benefit is assessed based on the project review report prepared by the Government in the year 1991 as well as the results of field investigation made in Phase II. The annual incremental benefit is estimated at US\$ 1,128/ha as calculated in Table 2.17. While, the economic cost of irrigation development is estimated at US\$ 1,300/ha including construction of secondary and tertiary irrigation canals, on-farm facilities and small pump stations for an area of 35,940 ha in total. Judging from the above result, the development of the remaining irrigation area is inferred to be economically viable, provided that irrigation water enough to feed the entire scheme is secured.

(3) Irrigation Development in the Tay Ninh Riparian Schemes

In connection with the further development of the Dau Tieng irrigation scheme, the irrigation development in the Tay Ninh riparian schemes located in the right bank of the East Vam Co River in Tay Ninh province is discussed here because this area is expected to be fed partly with water from the Dau Tieng reservoir by diverting irrigation water to the East Vam Co River when additional water is supplemented to the Saigon River basin from the Dong Nai River basin. There are three existing pump irrigation schemes in this area between the East Vam Co River and the Cambodian border, and other twelve similar schemes under planning exist here

according to the proposal of Tay Ninh province as listed in Table 2.15. These schemes are grouped into two sub-areas; (i) Upper Sub-area including five proposed pump irrigation schemes with an area of 15,100 ha, and (ii) Lower Sub-area including ten schemes of 14,300 ha in total, of which there are three existing schemes with an area of 3,300 ha and seven proposed schemes with an area of 11,000 ha.

The upper sub-area of 15,100 ha is not fed with water from the Dau Tieng reservoir due to higher elevation, and therefore is to be irrigated solely relying on the East Vam Co River. The lower sub-area of 14,300 ha is situated downstream of the expected outlet of the diversion channel led from the Dau Tieng reservoir. This situation makes it possible to this sub-area to draw irrigation water from the Dau Tieng reservoir.

Development costs for both the upper and lower sub-areas are estimated based on the study results of the latest and similar irrigation schemes such as Hoc Mon-Bac Binh Chanh as summarized in Table 2.18. From the above result, annual economic costs including O&M costs are estimated at US\$ 292/ha for the upper sub-area and US\$ 290/ha for the lower sub-area. With regard to the incremental benefit, the same value of US\$ 1,128/ha per annum assessed for the Dau Tieng irrigation scheme is adopted because both the areas have similar agricultural conditions. Judging from these economic values, the pump irrigation schemes in the Tay Ninh riparian area are economically viable.

2.6.2 Phuoc Hoa Irrigation Scheme

(1) Objectives and Socio-economic Situation

The objective of the Phuoc Hoa Irrigation Scheme (the Scheme) is to stabilize and increase mainly agricultural production of food crops in the southern part of Song Be province by constructing the proposed Phuoc Hoa dam. The scheme is also to supply water to the lower reaches of the Saigon River for the purposes of deltatic and riparian agriculture, domestic and industrial use and mitigation of saline water intrusion. A pre-feasibility study for an area of 45,680 ha was undertaken by the Ministry of Agriculture and Rural Development and its report was prepared in May 1995.

The command area is bounded by the Saigon River on the southwest and by the Dong Nai River on the southeast as shown in Figure 2.11. The area includes the whole of Thuan district and Thu Dau Mot city (the capital of Song Be province) and part of Tan Uyen, Ben Cat and Binh Long districts. The population in the command area is estimated at 420,000 in total as of the year 1992, accounting for about 40 % of the total provincial population.

Mean annual rainfall is 1,980 mm at the Phuoc Hoa damsite and 1,880 mm at Thu Dau Mot, respectively. Mean air temperature in the area is 26 to 27°C. The area is not regularly affected by typhoons. There are no meteorological constraints to crop production. The soil originates from old alluvium deposit, consisting of grey soil prevailed in the command area, followed by brown-yellow soil. The soil having a depth more than 100 cm prevails, and it is not less than 50 cm in general. Originating from old alluvium, the soil is in general rich in sand with poor clay contents. These soils are considered to be suitable for both paddy and upland crops.

Situating close to the important economic triangle zone, i.e. HCMC-Bien Hoa-Ba Ria and Vung Tau, Song Be province is endowed with considerable socio-economic advantages. The provincial agriculture and forestry are well capable of developing various food and industrial crops thanks to vast land areas and favourable natural conditions.

(2) Outlines of the Scheme

The features of the Phuoc Hoa irrigation scheme and its proposed facilities are summarized below:

Irrigation area

45,680 ha, consisting of a gravity irrigation area of 30,649 ha and a pump-up area of 15,031 ha.

Land use

The present and proposed land uses under the with-and-without condition of the scheme are shown in Table 2.19 and its summary is given below:

Land Use	Unit : ha	
	Present	Proposed
Annual crops	34,810	45,680 (*1)
Perennial crops	43,932	33,998 (*2)
Grass land	261	0
(Total of agri. land)	(79,003)	(79,678)
Forest	13,492	313
Infrastructure, others	21,885	34,389
Total	114,380	114,380

(*1) : To be irrigated including fruits

(*2) : Non-irrigated

Proposed crops

The proposed crops to be irrigated are paddy, upland crops including groundnut, beans, maize, tobacco, sugarcane and fruits. The present perennial crops are rubber and cashew, and an area of 744 ha of rubber and an area of 7,207 ha of cashew are expected to be converted to annual

crops including sugarcane. The proposed scheme area with proposed land use is shown in Figure 2.11.

Headworks

The Phuoc Hoa dam is proposed to be built in the Be River about 23.8 km upstream of the Phuoc Hoa bridge spanning over National Highway No.13. The catchment area at the dam site is 5,247 km² and the mean annual flow is 203.3 m³/sec according to this hydrological study. The major features of proposed Phuoc Hoa dam are as follows:

- FSL : 45.0 m and MOL : 43.0 m with an active storage capacity of 66.61 million m³ as schematically shown in Figure 2.12;
- Reservoir surface area of about 3,800 ha;
- Two earthfill type dams with dimensions of:

	<u>Main dam</u>	<u>Auxiliary dam</u>
Crest EL (m)	48.5	47.5
Crest length (m)	1960	960
Crest width(m)	10	10
Max. dam height (m)	30	15.5
Earthfill volume (m ³)	1.22 mill	0.36 mill

- A spillway structure with a crest elevation of EL. 31.0 m, a crest length of 108.8 m, eight radial gates (H=14.0 m and W=11.0 m) and one radial gate (H=14.0 m and W=4.8 m);
- Hydropower equipment to be installed in the spillway structure having a generation capacity of 1,500 kW;
- Connection channel between two dam reservoirs with a length of 820 m, a base width of 40 m and a base elevation of EL.38.0 m; and
- Intake structure with four gates, a bottom elevation of EL.39.0 m and a length of 123 m.

Canal system

The total length of primary canals is 65.3 km, consisting of main canal with a length of 46.6 km and subsequent south main canal of 18.7 km long. There are 30 secondary canals with a total length of 144.3 km, consisting of 22 canals of 34.4 km in total length for gravity irrigation area and eight canals for pump-up area of 109.9 km in total length. Seven pump stations are to be constructed on the upper reaches of the main canal. The total capacity of pumps has not been calculated, but is assumed to be about 700 kW.

Water diversion to the Saigon River

The Phuoc Hoa dam is to divert part of the Be River flow to the Saigon River for the purposes of supplemental water supply to the Hoc Mon-Bac Binh Chanh scheme and riparian and deltatic

agricultural land in HCMC, and water supply as well. It is diverted through the main canal and the Thi Tinh River with a maximum discharge of 42 m³/sec, consisting of 15 m³/sec for saline water repulsion, 5 m³/sec for domestic water use in HCMC, and the rest for irrigation use in the downstream area of the Saigon River. The diversion canal is to be branched off 10.65 km downstream of the main canal intake. Its length is 6.4 km with dimensions of 20 m wide and 3 m high.

(3) Review of Planning:

The planning of Phuoc Hoa irrigation scheme is reviewed in respect of water balance, cost estimate, benefit estimate and economic viability. The results of review are briefly described below:

Water balance

Water balance at the Phuoc Hoa reservoir site is calculated using 75 % flow after the regulation by the Thac Mo reservoir as summarized in Table 2.20. Other necessary data for water balance calculation such as water demand of irrigation, mandate release to the Be River and domestic water supply in the scheme area are referred to the planning report currently available as shown in Figure 2.12. The result of water balance study reveals that the diversion amount of water to the Saigon River should increase from 42.0 m³/sec of the current estimate to 54.6 m³/sec.

Cost estimate

The planning report currently available works out the construction cost to be about US\$115 million in total. Having reviewed, the following facts are identified:

- The headworks and major irrigation systems cover the full command area of 45,680 ha, however, the costs of irrigation and drainage systems are made to an area of 29,496 ha out of gravity irrigated area of 30,649 ha, and costs for the pump-up area of 15,031 ha including pumps are not included;
- The cost of on-farm facilities is not included;
- The cost of land preparation for converting cashew and rubber plantations to the irrigated annual crops is not included; and
- Physical contingency is given at 5 % only.

Incorporating the above factors and applying the unit costs estimated in this study, the construction cost of the Phuoc Hoa irrigation scheme is preliminarily updated for the following four cases without hydropower facilities in any case:

- Case-A : 29,496 ha area according to current planning;
- Case-B.1 : 45,680 ha with diversion to the Saigon River;
- Case-B.2 : 45,680 ha without diversion to the Saigon River; and

Case-C : 45,680 ha by pump intake without diversion to the Saigon River.

It is noted that both the Case-A and Case-B.1/B.2 are with Phuoc Hoa reservoir as having been planned, while the Case-C is an alternative proposal with Phuoc Hôa pump station instead of the reservoir. The costs estimated for the above four cases are shown in Tables 2.21 and 2.22, and are summarized below:

Description	Unit: million US\$			
	Case-A	Case-B.1	Case-B.2	Case-C
Headworks	88.5	88.5	76.5	30.5
Irrigation system (Direct cost)	121.6 (210.1)	146.1 (234.6)	140.6 (217.1)	140.6 (171.0)
Compensation	12.1	12.1	11.3	5.0
Administration, etc.	39.9	44.6	41.3	32.5
On-farm works and land preparation	0	11.7	11.7	11.7
Total	262.1	302.9	281.4	220.2

As shown in the above Table, there is a considerable gap in the cost estimates between the planning report currently available and the updated above. The capital cost of pump irrigation alternative (Case-C) instead of the Phuoc Hoa reservoir is the lowest.

(4) Benefit and Economic Viability

The project benefit is assessed by reviewing the planning report made by the Government in the year 1995. The annual incremental benefit is estimated at US\$ 1,174/ha as calculated in Table 2.23, consisting of US\$ 750/ha from irrigation and US\$ 424/ha from water supply to the southern part of Song Be province. While, the annual economic cost of the Phuoc Hoa scheme including O&M cost is estimated at US\$ 571/ha in the Case-B.2 and US\$ 502/ha in the Case-C. This assessment reveals that the economic viability of the Phuoc Hoa irrigation scheme would not be very high as far as the function of Phuoc Hoa reservoir is limited only to the irrigation scheme in Song Be province. As recommended in the said planning report, the Phuoc Hoa irrigation scheme should be justified in both technical and economic points of view in the context of an overall water resources development of the Dong Nai River and surrounding river basins in particular the diversion of water from the Be River to HCMC-Long An delta (Mekong delta in the Study Area) as discussed in the Appendix X.

So far as the irrigation scheme concerned, alternative irrigation planning of the Phuoc Hoa irrigation system would be required for seeking more technically, economically and environmentally sound solutions in such a manner as re-assessment of the proposed land use, small scale irrigation developments partially by exploiting groundwater particularly for upland crops and so on.

2.6.3 Hoc Mon-Bac Binh Chanh Irrigation Scheme

The feasibility study of the Hoc Mon-Bac Binh Chanh irrigation scheme was finished in the year 1993/4 with a technical assistance of IBRD, and its appraisal by IBRD was made in the year 1995. The scheme is in the preparatory stage for implementation as at the end of the year 1995. This scheme aims to improve the drainage and irrigation conditions for an area of 12,197 ha in the lower delta of HCMC and a part of Long An province. The main source of water for the scheme is the Saigon River, which since 1985 has been regulated by the Dau Tieng reservoir, through Rach Tra canal connecting between the Saigon River and the East Vam Co River.

The agricultural development of the scheme in terms of the proposed cropping pattern and cultivating areas is summarized below:

									Unit : ha	
Annual Crops							Perennial crops			
Paddy				G.nut	Vegetables			Banana/	Sugar	
Wet	W-S	S-A	Total	W-S	W-S	S-A	Fruits	cane	Total	
6,541	3,513	3,279	13,333	1,053	1,732	527	1,532	3,572	21,749	

The main constraint of the scheme is salinity intrusion, which once reached the intake of Rach Tra canal, but now is pushed downstream by the regulated flow from the recently constructed Tri An and Dau Tieng reservoirs. However, salinity intrusion into the irrigation system of the scheme still takes place from the south by an effect of the tidal fluctuation.

Monthly water requirements for crop yield and acid soil reclamation and monthly water demands for domestic use are as follows:

Des.	Unit	Jan.	Feb.	Mar	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
CWR	CMS	9.3	10.2	10.7	9.8	2.7	0.0	1.5	5.0	1.6	0.6	6.0	8.5
Others	CMS	1.6	3.1	3.5	1.9	0.8	0.2	1.9	3.4	0.7	1.5	2.4	1.1
Leaching	CMS	1.5	1.5	1.5	1.5	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	CMS	12.4	14.8	15.7	13.2	5.0	0.2	3.4	8.4	2.3	2.1	8.4	9.6
	MCM	33.2	35.8	42.1	34.2	13.4	0.5	9.1	22.5	6.0	5.6	21.8	25.7

CWR : Crop water requirements for 12,197 ha

Others : Domestic water supply, etc.

Leaching : Water requirement for acid soil reclamation until the year 2004

The project benefits are estimated from the anticipation of increased cropping intensity from about 98 % at present to about 176 % at full development as well as water conditions,

availability of irrigation water and increased use of agricultural inputs. The economic internal rate of return is estimated at 12 %.

2.7 Potential Irrigation Schemes in HCMC-Long An Delta

2.7.1 Features of HCMC-Long An Delta

The HCMC-Long An delta discussed here is defined as the deltatic and salinity affected area in HCMC and Long An province including the east end of the Mekong delta as shown in Figure 2.13.

The Mekong delta is divided into several ecological regions. The HCMC-Long An Delta belongs to three regions, i.e. High Terrace, Plain of Reeds and Eastern Coastal Zone as shown in Figure 2.13. Long An province in the Study Area is divided into seven areas and these areas are classified below:

<u>Region</u>	<u>Zone code</u>	<u>Area Name</u>
High Terrace	XIX-112	North Moc Hoa
	XIX-113	Duc Hue
	XX-116	Duc Hoa
	XX-117	Ben Luc
Plain of Reeds	XIX-114	Thu Thua (Bo Bo)
Eastern Coastal Zone	XIX-115	Tan Tru
	XX-118	Can Duoc
	XX-119	Can Giuoc.

The High Terrace and the Plain of Reeds in the Study Area are characterized as the land covered by acid sulphate soils in its most part and lacking of fresh water in the dry season. The High Terrace is generally free from flooding, while the Plain of Reeds is subject to the annual flooding over the consecutive two to three months. Therefore, these areas, particularly the Plain of Reeds, have been left behind as a wild area where melaleuca forest prevails for a long time except for a small area of floating rice cultivation. There have been no social infrastructures allowing the settlement of people, too.

The Government has been developing these areas by constructing canal networks (creeks) for the last 20 years. Figure 2.14 shows the comparison of canal network between the years 1992 and 1975. The people gradually settled in the developed area, however, they are still kept in the difficult conditions.

The Eastern Coastal Zone is characterized by the natural paddy lands on the heavy soils, and the land is affected by the saline water intruded from the sea. The agriculture in this area

remains under the rainfed paddy cultivation due to sea water throughout the year, however, two paddy crops are prevailing except for the area along the rivers where floods allow only the single paddy.

Although HCMC is not included in the Mekong delta in general, the northern part of HCMC belongs to the High Terrace and the southern part to the Eastern Coastal Zone. As shown in Table 2.25 (refer to Figure 2.16), HCMC is divided into five zones, and most part of HCMC except for a part of Zone I which is a high land area commanded by the Dau Tieng Irrigation Scheme, i.e. Cu Chi and Ben Muong Lang The, is included in the HCMC-Long An delta.

2.7.2 Present Land Use

The present land use in the HCMC-Long An delta is identified for the Long An province and HCMC as shown in Tables 2.24 and 2.25, respectively and is summarized below:

Land Use	Unit : ha		
	Long An Prov.	HCMC	Total
Paddy	142,450	25,870	168,320
Paddy+upland crops	15,510	6,430	21,940
Vegetables	0	3,500	3,500
Sugarcane, etc.	24,660	19,800	44,460
Orchards	0	10,250	10,250
Rubber plantation	0	4,000	4,000
Forest	5,170	750	5,920
Reeds	4,240	1,700	5,940
Fallow/wild land	38,160	2,350	40,510
Town, etc. (*)	0	131,000	131,000
Total	230,190	205,650	435,840

(*) : Other land use including town area in Long An province included in the respective land use.

The land use maps for the delta are shown in Figures 2.15 and 2.16, respectively.

2.7.3 Agricultural Area Potentially Irrigated by the Saigon River and the East Vam Co River

The agricultural area in the HCMC-Long An delta potentially irrigated by the Saigon River and the East Vam Co River is delineated with an area of 100,000 ha in total as shown in Table 2.26 and is schematically illustrated in Figure 2.17. This is summarized below:

Province	Unit : ha			
	Saigon River		East Vam Co R.	
	Long An	HCMC	Long An (*)	Total
Gross area	30,100	-	82,900	-
Net Area	21,000	24,800	54,000	100,000

(*) : including a small part of Tay Ninh province

Considerations and assumptions described below are incorporated in the areal delineation:

- In Long An province, the agricultural land is divided broadly into three zones in view of water sources; the Mekong River, the East Vam Co River and the Saigon River. The review of previous studies, discussions with the concerned agencies of the Government and field reconnaissance result in that:

- From the Mekong River : North Moc Hoa (XIX-112) and the western half of Thu Thua (XIX-114);
- From the East Vam Co River : Duc Hue (XIX-113), the eastern half of Thu Thua (XIX-114) and the western half of Duc Hoa and Ben Luc (XX-116 & 117); and
- From the Saigon River : The eastern half of Duc Hoa and Ben Luc (XX-116 & 117).

- Judging from the salinity intrusion study made in this Study, Tan Tru (XIX-115), Can Duoc (XX-118) and Can Giouc (XX-119) would remain saline-affected in the dry season and not be irrigated directly from the rivers and creeks unless fresh water is conveyed by appropriate canal systems from the upstream reaches.
- The Thu Thua area (XIX-114) is the typical Plain of Reeds in the Mekong delta covered by the acid sulphate soil, and most parts in the area are left behind as wild land except for those along the West and East Vam Co rivers and the Bo Bo canals running through the area from north to south. A recommendation exists that this area should be reserved for Melaleuca forests for reasons of maintaining inland swamp ecosystem and possible negative impacts of reclamation to the downstream agricultural lands by releasing acid subject to the shortage of fresh water in the dry season. The Duc Hue area (XIX-113) belongs to the High Terrace, lying on the acid sulphate soil similar to the Thu Thua area.

The Government has been undertaking the land reclamation in these two areas since the year 1980, and its progress in construction of canal network is shown in Figure 2.18. The total length of canals constructed to date amounts to 330 km in the three areas of Thu Thua, Duc Hue and a part of North Moc Hoa with an area of 99,500 ha in total. The population in the

Thu Thua and Duc Hue areas is estimated at 98,000 with about 19,200 families in the year 1994, having increased from the no-man's land in the year 1975. It is forecast to increase to 111,000 persons or 21,700 families in the year 2000. Water quality in terms of acidity has been remarkably improved by developing canal networks as shown in Figure 2.19, and in fact this has been contributing to expansion of the cultivation area of winter-spring paddy.

Taking all the above facts and situation into account, both the areas of Thu Thua (Bo Bo) and Duc Hue are taken as the agriculturally potential development area, provided that enough fresh water for acid flushing and irrigation is available. The area potentially irrigated by the East Vam Co River with supplemental water supply from the Dong Nai River basin is estimated at 38,000 ha in net as shown in Table 2.27, consisting of 27,000 ha of the whole Duc Hue and 11,000 ha of the eastern half of Thu Thua. The western half of Thu Thua area is regarded to be fed from the Mekong River judging from the topographical condition.

- Both the Duc Hoa (XX-116) and Ben Luc (XX-117) areas are fully cultivated at present. However, fresh water for irrigation in the dry season is seriously lacking except for the area partly along the creeks connecting between the Saigon River and the East Vam Co River and areas irrigated by the groundwater in the central part. At present, there are no definite plans for supplying fresh water either from the Saigon River or the East Vam Co River except for an area partly to be commanded by the Hoc Mon-Bac Binh Chanh irrigation scheme. Despite having a possibility to be irrigated by groundwater, this area is taken as a potential irrigation area by the Saigon River and the East Vam Co River.
- In HCMC, Zones I and II are considered for the potential areas to be irrigated by the Saigon River. Its net area is estimated at 24,800 ha in total, excluding the area commanded by the east canal system of the Dau Tieng irrigation system in Zone I. The command area of the proposed Hoc Mon-Bac Binh Chanh irrigation scheme is included in the said potential area.

2.7.4 Planning and Economic Viability of Development Schemes

(1) Agricultural Development

In the area irrigated by the Saigon River, similar cropping system as proposed in the Hoc Mon-Bac Binh Chanh irrigation scheme is applied with a cropping intensity of about 178 % being composed of paddy, groundnut, vegetables, sugarcane and fruits. The cropping system in the area irrigated by the East Vam Co River is represented by that adopted to the Duc Hue and the Thu Thua areas with a cropping intensity of about 181 % including paddy, sugarcane, upland crops such as groundnut and fruits as shown in Table 2.28.

(2) Irrigation Requirement

Irrigation requirements for the agricultural development in the HCMC-Long An delta are provisionally referred to those of Hoc Mon-Bac Binh Chanh irrigation scheme as mentioned in preceding Sub-section 2.6.3.

(3) Investment Cost

Investment costs for the irrigation and drainage development of the HCMC-Long An delta are provisionally assessed at US\$ 2,770/ha for the area irrigated by the Saigon River based on the cost estimate of Hoc Mon-Bac Binh Chanh irrigation scheme, and US\$ 2,400/ha for the area irrigated by the East Vam Co River estimated by the expected work quantities as shown in Table 2.29. The annual economic costs including O&M costs are estimated at US\$ 253/ha and US\$ 233/ha, respectively.

(4) Benefit and Economic Viability

The annual incremental benefit in the area irrigated by the Saigon River is provisionally taken at US\$ 474/ha as estimated in the Hoc Mon-Bac Binh Chanh irrigation scheme. While, the benefit in the area irrigated by the East Vam Co River is assessed at US\$ 457/ha as calculated in Table 2.28. The irrigated agricultural development schemes in HCMC-Long An delta are considered to be economically viable.

2.8 Potential Irrigation Schemes in the East Coast and La Nga and Other River Basins

2.8.1 Delineation of Potential Irrigation Schemes

Over the past three decades in Viet Nam, the various studies have been made by the Government herself partly with technical assistance of international agencies and donor countries for formulating many potential irrigated agricultural development projects in the South Central Coast Region, or so called the East Coast and La Nga River and neighbouring basins in the Study Area covering Ninh Thuan, Binh Thuan and Ba Ria-Vung Tau provinces and a part of Dong Nai province. With these information and the results of inventory survey carried out in the Phase I of this Master Plan Study, a total of ten potential irrigation schemes are identified in these area. These potential schemes are demarcated on the basis of the land suitability maps prepared in this Master Plan Study together with various planning reports so far prepared domestically and internationally, inventory data on the existing and proposed irrigation systems and the availability of water resources. As the results, the potential irrigation schemes identified are listed in Table 2.30 and summarized below:

Potential Scheme	Potential Irrigation Area		Area with existing irrigation facilities	Potential irrigable area
	Gross	Net		
Unit : ha				
<u>East Coast Area</u>				
Phan Ri Plain	56,700	32,000	6,113	25,887
Phan Thiet Plain	46,680	24,400	11,605	12,795
<u>La Nga River Basin (Lower La Nga Plain)</u>				
Ta Pao	29,330	23,000	10,235	12,765
Vo Dat	22,920	15,000	0	15,000
<u>Other River Basin</u>				
Phan Rang Plain	21,350	15,400	5,075	10,325
Tuy Phong Plain	4,700	4,200	2,150	2,050
Song Phan Plain	7,100	5,030	0	5,030
Ham Tan Plain	27,450	8,000	1,210	6,790
Ray River Plain	19,600	13,710	4,050	9,660
Dinh River Plain	6,800	4,740	1,950	2,790
Total	242,630	145,480	42,388	103,092

(*1) : Estimated

(*2) : Estimated without existing Phan Rang and Song Pha irrigation schemes

The location of these schemes is shown in Figure 2.8. The general maps and the irrigation system diagrams of the respective potential irrigation schemes are prepared as listed below:

Potential scheme	General map	Irr. system diagram
Phan Rang Plain	Figure 2.25	Figure 2.32
Tuy Phong Plain	Figure 2.26	Figure 2.35
Phan Ri Plain	Figure 2.27	Figure 2.33
Phan Thiet Plain	Figure 2.28	Figure 2.33
Song Phan Plain	Figure 2.29	Figure 2.34
Ham Tan Plain	Figure 2.29	Figure 2.34
Lower La Nga Plain	Figure 2.30	Figure 2.35
Ray River Plain	Figure 2.31	Figure 2.36
Dinh River Plain	Figure 2.31	Figure 2.37

The potential irrigation schemes are categorized into two groups upon the water sources available for irrigation; one is schemes receiving or expecting water sources from both the own and other river basins and the other is those from the own basins only. The former schemes would be three schemes including Phan Ri, Phan Thiet and Ham Tan Plains, and the rest would belong to the latter. The preliminary development plans of these potential irrigation schemes are reviewed and updated in this Study, and three schemes of Phan Ri, Phan Thiet and Lower La Nga are intensively discussed in this report with regard to the water balance, development costs, benefit and economic viability in connection with the optimum water allocation of water resources in the Dong Nai River and surrounding basins.

2.8.2 Phan Ri Plain Irrigation Scheme

(1) Physical Features of Phan Ri Plain

The Phan Ri plain is extending over the Luy River basin in Binh Thuan province in the South Central Coast region as shown in Figure 2.8, about 220 km northeast of Ho Chi Minh City. The Phan Ri plain stretches about 50 km west-east and 30 km north-south. The Luy River originating from the highlands of Lam Dong province is composed of such major tributaries as the Luy, Mao, Ca Giay and Ca Tot rivers and drains a catchment area of 1,973 km² at the estuary.

The Phan Ri plain belongs administratively to the Bac Binh district and a part of the Ham Thuan Bac district. The total population of Bac Binh district is 87,700 in the year 1989 with a working population of about 38,800. The majority in the district is the Kinh tribe with a rate of 68 %, and the rest are minorities such as Cham (15 %), Chinese (9 %) and others.

Annual rainfall recorded at Phan Ri town is 696 mm on an average for the past 28-year period, and it is 970 mm at the Luy River station for the past 16-year period, and 783 mm at the Mao River station. Rainfall concentrates in the rainy season from May to November with a high ratio of more than 90 %.

A discharge gauging station exists at a point having a catchment area of 982 km² of the Luy River and is operated since the year 1978. Mean annual discharge recorded here is 12.6 m³/sec, ranging from 1.07 m³/sec in February to 54.64 m³/sec in October. The estimated discharges at the proposed three storage dam sites are 1.75 m³/sec at Ca Giay (146 km²), 6.83 m³/sec at Luy (554 km²) and 1.89 m³/sec at Ca Tot (140 km²), respectively.

The agricultural land of annual crops in the Bac Binh district is 15,883 ha (surveyed in the year 1992), of which a land of 7,010 ha is paddy field. The annual cultivating area is about 21,590 ha, consisting of the winter-spring crops of 3,070 ha, the summer-autumn of 7,050 ha and the rainy season of 11,470 ha. The main crops in the plain are paddy, peanut, tobacco, maize, cassava and sugarcane.

There are 27 irrigation systems in the Phan Ri plain with a total irrigation area of 6,113 ha, drawing water from 16 solid and 16 semi-solid weirs and one pumping station constructed in the Luy River basin. The majority of these weirs is of small scale structures being used mainly for the rainy season crops.

(2) Potential Irrigation Area

The potential irrigation area of Phan Ri plain to be fed by the Luy River is proposed to be 32,000 ha in net, estimated by:

- the present land use and preliminary land evaluation maps prepared in this Master Plan Study, processed from the LANDSAT imaginary with a scale of 1 : 100,000; and
- the present land use, soil and irrigation system maps with a scale of 1 : 100,000 and relevant data prepared by the Water Resources Department of Binh Thuan province.

The present land use and potential irrigation area are shown in Table 2.31 and summarized below:

Present Land Use	Area	Unit: ha
		Potential Irri. Area (net)
Irrigated single paddy	2,738	2,460
Rainfed paddy	12,968	11,670
Upland crops	8,354	5,870
Shifting land	890	0
Bush/Grass	24,672	12,000
Forest	6,235	0
Town, river, etc.	847	0
Total	56,704	32,000

(3) Anticipated Cropping Patterns and Irrigation Water Requirements

With the study results of agricultural development and climatic conditions, two cropping patterns are anticipated; one is three paddies a year (Case-A) and the other is diversified cropping composed of paddy, cotton, sugarcane and an appropriate winter upland crop like groundnut (Case-B). The cropping intensities of both patterns are 300 % for Case-A and 240 % for Case-B which includes the paddy cultivation with a 150 % intensity. These cropping patterns and irrigation requirements are shown in Figures 2.3 and 2.20, respectively. Following is the summary of irrigation diversion requirements for both cases:

Case	Unit: lit/sec/ha											
	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
A	1.56	1.84	1.46	0.73	0.93	0.94	0.87	0.00	0.36	0.87	1.29	1.28
B	0.78	1.18	0.78	0.48	0.62	0.66	0.62	0.10	0.30	0.69	1.09	0.79

(4) Irrigation System and Water Balance

It has been proposed in the Luy River basin to construct three major reservoirs of the Luy, Ca Giay and Ca Tot by the Ministry of Agriculture and Rural Development as shown in Figure 2.27, and the irrigation system diagram of Phan Ri scheme is shown in Figure 2.33. In addition, the proposed Dai Ninh hydropower project, which is a trans-basin hydropower project from the Dong Nai River to the east coast, is expected to release water with a constant daily discharge of 24.5 m³/sec at the maximum to the Luy River. By combining the regulation function of three reservoirs and water from the Dai Ninh power station, water balance to ensure the entire potential irrigable area of 32,000 ha is made for two cases of cropping patterns; one is the case to use potential water to full extent by three paddies a year (Case-A) and the other is the case to apply diversified farming including upland crops (Case-B).

Water balance is at first made without diverted water from the Dong Nai River; that is, tributaries of the Luy River are only relied on as water sources, and the second case includes the diverted water from the Dong Nai River besides available water in the Luy River basin.

Irrigable area without diversion

Availability of the respective tributaries as water sources is assessed by two cases, i.e. with and without reservoirs, by applying two cropping patterns. The results are summarized below:

Name of Tributaries	Water Intake Site	Site C.A. (km ²)	Cropping Pattern	Max.Irri.	With Reservoir		Remarks
				Area by Natural Flow (ha)	Max.Irri. Area (ha)	Req. Store Volume (MCM)	
Luy	Proposed	540	Case-A	530	5,200	84	
	Luy Res.		Case-B	820	7,800	65	
Ca Giay	Proposed	146	Case-A	140	1,350	22	
	Ca Giay Res.		Case-B	210	2,050	21	
Ca Tot	Proposed	140	Case-A	130	1,300	21	
	Ca Tot Res.		Case-B	200	1,950	20	
Suoi Da	Exist. Suoi Da Res.	48	Case-A	-	400	6.2	Existing
			Case-B	-	650	6.2	Reservoir
Dong Moi	Exist. Dong Moi Weir	536	Case-A	510	1,700	-	Irr. 1,700 ha by Luy Res.
			Case-B	820	1,700	-	

Overall water balance with Dong Nai diversion

Water balance with Dong Nai diversion is made to some possible cases and the results are stated below:

- Water resources of the Luy River basin and water from Dai Ninh power station with a constant discharge of 24.5 m³/sec will accommodate most part of the entire 32,000 ha with the full cropping of three paddies a year even without the Ca Giay and Cat Tot reservoirs as shown in Table 2.32. The required storage capacity of the Luy reservoir is estimated at 226 million m³, which lies in the topographic limit judging from the area-storage capacity curve given in Table 2.33.
- In case of diversified farming, the calculations of water balance are made in possible three cases, i.e. (i) with Ca Giay reservoir only, (ii) with Luy reservoir only and (iii) with both Luy and Ca Giay reservoirs, whilst diversion from Dai Ninh power plant selects three discharges of 24.5, 20.0 and 15.0 m³/sec as a sensitive analysis against a possible alteration of the scale of Dai Ninh hydropower project. These calculations are shown in Tables 2.34, 2.35 and 2.36 respectively and those results are summarized below:

Case	Unit: ha				
	Ca Giay Res. Only			Luy Res. Only	Both Res.
Res. & Weir /D. Ninh Water(m ³ /s)	24.5	20.0	15.0	24.5/20/15	24.5/20/15
Luy Reservoir	20,000	16,500	12,000	29,700	27,700
Ca Giay Reservoir	2,000	2,000	2,000	-	2,000
Suoi Da Reservoir (Existing)	600	600	600	600	600
Don Moi Weir (Existing)	1,700	1,700	1,700	1,700	1,700
Total	24,300	20,800	16,300	32,000	32,000

The above results suggest that:

- Without the Luy reservoir, water from the Dai Ninh power station in conjunction with natural flow of the Luy river and the Ca Giay reservoir irrigates 24,300 ha in case of the Dai Ninh water of 24.5 m³/sec, 20,800 ha in case of 20 m³/sec and 16,300 ha in case of 15 m³/sec;
- Full potential area of 32,000 ha in the Phan Ri plain including the existing 2,300 ha by Suoi Da reservoir and Don Moi weir is irrigated by constructing the Luy reservoir which regulates both the flows from Dai Ninh and Luy river irrespective of existence of the Ca Giay reservoir; and
- Surplus water besides irrigating the full 32,000 ha takes place by constructing the Luy reservoir.

The required storage capacity of Luy and Ca Giay reservoirs and the amount of surplus water in the Luy River vary depending on the diversion amount from the Dai Ninh power station as summarized below:

Discharge from Dai Ninh (m ³ /sec)	Luy Reservoir only		Luy and Ca Giay Reservoir		
	Luy Res. Storage (MCM)	Surplus water (m ³ /sec)	Luy Res. Storage (MCM)	Ca Giay Storage (MCM)	Surplus water (m ³ /sec)
24.5	26.0	9.7	20.5	19.5	11.0
20.0	70.0	5.2	45.5	19.5	6.6
15.0	135.0	0.2	110.5	19.5	1.6

(5) Formulation and Viability of the Scheme

Intending the full use of water diverted from the Dong Nai River through the Dai Ninh power station, the Phan Ri plain irrigation scheme should be formulated and evaluated in conjunction with the irrigation development of Phan Thiet plain. These are discussed in subsequent Sub-section 2.8.3.

2.8.3 Phan Thiet Plain Irrigation Scheme

(1) Physical Features of the Phan Thiet Plain

The Phan Thiet plain is composed of two major river basins, i.e. the Quao River and Ca Ty River basins, as shown in Figure 2.28. The Quao River, originating from Tanh Linh district, flows southward and spreads mainly over the Ham Thuan Bac district of Binh Thuan province. Its catchment area is 800 km² at the estuary. The Ca Ty River basin belongs to Tanh Linh and

Ham Thuan Nam district of the Binh Thuan province, and has a catchment area of 775 km² at the estuary. Both rivers pour into the Pacific Ocean at Phan Thiet town located about 160 km east of Ho Chi Minh City. Rainfall data recorded at Phan Thiet over the past 51-year period show an average annual of 1,116 mm.

The Phan Thiet plain administratively covers the whole of Phan Thiet town, Ham Thuan Bac district and Ham Thuan Nam district and the half of Than Linh district. The total population of the Phan Thiet plain is estimated at 355,000 (the year 1989) with a working population of about 140,000. The majority in the plain is the Kinh tribe with a rate of 95 %. The rest are minorities including the Cham tribe and Chinese people.

There is a discharge recording station at Phan Thiet town, however, no details about this station are available. A storage dam named Song Quao reservoir is being constructed on the Quao River toward the completion by the end of year 1996. The project site lies in Thuan Hoa village of Ham Thuan district, or about 14 km north of the National Highway No.1. Its catchment area is 296 km² and average annual discharge is 3.52 m³/sec at the site. In the Ca Ty River basin, there are three proposed dam sites, i.e. Ka Bet, Mong and Ba Bau. The Ministry of Agriculture and Rural Development estimates average annual discharges of 2.2 m³/sec at Ka Bet (136 km²), 1.6 m³/sec at Mong (101 km²) and 5.24 m³/sec at Ba Bau (347 km²), respectively.

The agricultural land of annual crops in Ham Thuan Bac district and Phan Thiet town, mostly occupied by the Quao River basin, is 17,774 ha (surveyed in the year 1992), of which a land of about 12,550 ha is paddy field. The annual cultivating area is about 27,830 ha; 1,790 ha of winter-spring crops, 9,640 ha of the summer-autumn and 16,400 ha of the rainy season. The main crops in the plain are paddy, sweet potato, tobacco, maize, cassava and sugarcane.

The agricultural land of annual crops in Ham Thuan Nam district and Phan Thiet town, mostly occupied by the Ca Ty River basin, is 4,770 ha (surveyed in the year 1992), of which a land of about 2,477 ha is paddy field. The annual cultivating area is about 7,640 ha, consisting of the winter-spring crops of 700 ha, the summer-autumn of 2,180 ha and the rainy season of 4,760 ha. The main crops in the plain are paddy, sweet potato, tobacco, maize, peanut and cassava.

There are 73 irrigation schemes in the entire plain with a total area of 11,605 ha. The Quao reservoir is to serve an area of 8,120 ha, most of which is facilitated with the existing irrigation systems relying on the Quao River basin.

(2) Potential Irrigation Area

From the same data and information used for the Phan Ri plain, the potential irrigation area of Phan Thiet plain in the Quao and Ca Ty River basins is estimated at 32,400 ha in net. Of 32,400 ha, an area of 8,000 ha is possibly irrigated when the La Nga No.3 reservoir and the

trans-basin diversion tunnel from the La Nga River to Ca Ty River would be constructed. The said 8,000 ha is provisionally named as "Extension Area", and the rest are called "Proper Area" as shown in Figure 2.28. The present land use and potential irrigation area including the Extension Area are shown in Table 2.37 and summarized below:

Present Land Use	Area	Unit: ha		
		Potential Total	Irrigation Proper Area	Area Ext. Area
Irrigated single paddy	5,011	4,490	3,550	940
Rainfed paddy	17,339	15,600	14,390	1,210
Upland crops	6,675	5,300	2,820	2,480
Cashew	785	0	0	0
Bush/Grass	15,138	7,010	3,640	3,370
Town, river, etc.	2,538	0	0	0
Total	46,686	32,400	24,400	8,000

The Proper Area of 24,400 ha is further divided by the river basins into two sub-areas of the Quao and Ca Ty as shown in Table 2.37 and summarized below:

Present Land Use	Unit: ha		
	Total	Quao Basin	Ca Ty Basin
Irrigated single paddy	3,550	2,880	670
Rainfed paddy	14,390	11,370	3,020
Upland crops	2,820	2,300	520
Bush/Grass	3,640	1,450	2,190
Total	24,400	18,000	6,400

(3) Anticipated Cropping Patterns and Irrigation Water Requirements

The same cropping patterns proposed for the Phan Ri plain, i.e. Case-A (three paddies a year) and Case-B (diversified farming), are adopted, and irrigation water requirements are the same as those of the Phan Ri plain, accordingly. These cropping patterns and irrigation requirements are shown in Figure 2.20.

(4) Irrigation System and Water Balance

There are three proposed storage dams and one diversion weir in this scheme, of which the Song Quao dam in the Quao River with an effective capacity of 67.3 million m³ is to be completed in the year 1996 and the construction of Ba Bau weir started in March 1995. The rest are Ka Bet and Song Mong reservoirs in the Ca Ty River basin. Incorporating the three reservoirs, the calculations of water balance are made to the entire potential irrigable area of 32,400 ha by applying two cropping patterns; one is the case to use potential water to full extent

by three paddies a year (Case-A) and the other is the case to apply diversified farming including upland crops (Case-B) as shown in Tables 2.38 and 2.39, respectively.

Water supply capacity of the respective tributaries is assessed for two cropping patterns under the condition with and without reservoirs as summarized below:

Name of Tributaries	Water Intake Site	Site C.A. (km ²)	Cropping Pattern	Max.Irri.	With Reservoir	
				Area by Natural Flow (ha)	Max.Irri. Area (ha)	Req. Store Volume (MCM)
Quao (Cai)	Quao Res.	296	Case-A	-	5,750	67.3
	under const.	(*1)	Case-B	-	7,900	67.3
Mong	Proposed	101	Case-A	100	940	15.5
	S.Mong Res.		Case-B	150	1,400	14.0
Ka Bet	Proposed	136	Case-A	130	1,250	20.0
	Ka Bet Res.		Case-B	200	1,900	19.0
Ba Bau	Ba Bau Weir	110	Case-A	110	110	-
	under const.	(*2)	Case-B	180	180	-

(*1): Catchment area of Dan Sach weir in the La Nga basin, diverting supplemental water to Song Quao reservoir is not included.

(*2): Remaining catchment area excluding those at Song Mong and Ka Bet reservoirs sites

The above results indicate that the water resources in the Quao and Ca Ty River basins are absolutely insufficient to the full development of irrigated agriculture in the Phan Thiet plain without constructing additional reservoirs and/or drawing supplemental water supply from other river basins. The overall water balance in the Phan Thiet plain including the amount of water shortage is summarized below:

Reservoir/Weir	Case - A		Case - B	
	Irri. Area (ha)	Water Short (m ³ /sec) (*)	Irri. Area (ha)	Water Short (m ³ /sec) (*)
Irrigated				
Song Quao Res.	5,750	-	8,000	-
Song Mong Res.	940	-	1,400	-
Ka Bet Res.	110	-	180	-
Ba Bau Weir	1,250	-	1,900	-
Irrigated total (1)	(8,050)		(11,480)	
Un-irrigated				
Proper Area in Cai Basin	12,250	12.6	10,000	6.9
Proper Area in Ca Ty Basin	4,100	4.2	2,920	2.0
Extension Area	8,000	8.3	8,000	5.5
Un-irrigated total (2)	(24,350)		(20,920)	
Total (1)+(2)	32,400	25.1	32,400	14.4

Note (*): Annual average

(5) Formulation and Viability of the Scheme

From the results of overall water balance study in the Phan Thiet plain, the preliminary conclusions are given to the irrigated agricultural development in this plain as mentioned below:

- Farming by three paddies a year (Case-A) will not be considered in the irrigated agricultural development plan because of low benefitability and shortage of water;
- For the potential area in the Quao River basin, an area of 18,000 ha will be fully developed by the Song Quao reservoir under construction and by the surplus water diverted from the Phan Ri plain. Therefore, the irrigation development of this area should be formulated and evaluated in conjunction with the Phan Ri plain irrigation scheme, and is discussed in subsequent Sub-section 2.8.4.
- Water diverted from the Phan Ri plain will not be able to feed the Ca Ty River basin topographically. Therefore, an area of 6,400 ha of the Proper Area in the Ca Ty River basin is to be solely irrigated by the Ca Ty River and its tributaries, or supplemented from the La Nga River. In case of irrigating by the Ca Ty River basin only, an area of about 3,500 ha will be irrigated under the diversified farming when two reservoirs of Song Mong and Ka Bct are constructed. The rest of 2,900 ha, including the reclaimed land of about 2,200 ha, will remain un-irrigated. This means that the existing paddy and upland crops fields could be marginally irrigated by the Ca Ty River and its tributaries subject to ensuring the economic viability with slightly lower cropping intensity than 240 % and by constructing two reservoirs. However, the cost of two dams is roughly esteemed at more than US\$ 35 million, which seems excessive for economically viable development for the 6,400 ha area.
- An alternative development plan is to irrigate an area of 24,400 ha, i.e. all the potential area excluding 8,000 ha area fed by Song Quao reservoir, with the La Nga No.3 reservoir and the trans-basin diversion tunnel from the La Nga River. However, the preliminary cost analysis suggests that the construction cost of La Nga No.3 reservoir be estimated at US\$ 246 million including power plant and a trans-basin tunnel and be excessive in terms of economic viability even if the power project shares a part of its cost.
- From the above discussions, the development plan of the Phan Thiet plain irrigation scheme is formulated as follows:
 - a) The Extension Area of 8,000 ha is excluded from the potential area, thereby an area of 24,400 ha of the Proper Area is taken as the potential irrigation area of the Phan Thiet plain;

- b) An area of 8,000 ha of the Proper Area in the Ca Ty River basin is not considered as a candidate of the master plan projects; and
- c) An area of 18,000 ha of the Proper Area in the Quao River basin is proposed as one of the candidates of the master plan projects in the Study, and is formulated and evaluated as the Phan Ri-Phan Thiet diversion scheme.

2.8.4 Phan Ri-Phan Thiet Diversion Scheme

(1) Delineation of Development Area

As discussed in preceding Sub-section 2.8.2, water from Dai Ninh power station in conjunction with water resources of the Luy River basin will accommodate the full cropping of three paddies a year in the entire 32,000 ha area, and will give surplus water of about 10 m³/sec to 11 m³/sec on an annual average in case of introducing diversified farming involving more upland crops. This surplus water can topographically be conveyed to the Phan Thiet plain for the use of its supplemental irrigation. The area to be fed by the water conveyed from the Luy River will topographically be limited to the east part of the Phan Thiet plain, i.e 18,000 ha area in the Quao River basin as discussed in preceding Sub-section 2.8.3. Since an area of 8,000 ha is to be irrigated by the Song Quao reservoir which is under construction, the maximum irrigable area by the water available including that from Dai Ninh becomes 10,000 ha. Thus, an area of 42,000 ha in both the Phan Ri and Phan Thiet plains would be fed by the trans-basin diversion through the Dai Ninh project in conjunction with the existing Suoi Da reservoir and Dong Moi weir in the Phan Ri plain.

(2) Irrigation System and Water Balance

As shown in general maps and irrigation system diagrams of the Phan Ri and Phan Thiet plain irrigation schemes, the main canal of about 25 km long from the existing "812 weir" on the Luy River will be constructed to feed the eastern part of Phan Ri scheme area, and will finally reach the Song Quao River basin. By extending the main canal by about 2 km long, it joins the main stream of the Song Quao River about 3 km downstream of the Song Quao dam. By this, water from the Phan Ri plain is virtually diverted to the Phan Thiet plain, and its eastern part will be irrigated in conjunction with water from the Song Quao reservoir through the existing irrigation systems, which should require rehabilitation and improvement.

To estimate the irrigable area in the Phan Ri and Phan Thiet plains under the diversified farming (Case-B) including irrigation of the full area of the Phan Ri plain (32,000 ha), the calculations of water balance are made for possible alternative cases, i.e. with and without the Ca Giay reservoir in the Phan Ri Plain, by selecting three diversion discharges of 24.5, 20 and 15

m³/sec from Dai Ninh power station as a sensitive analysis against a possible alteration of the scale of Dai Ninh hydropower project. The results of water balance calculations are given in Tables 2.40 and 2.41, and are summarized below:

(i) Case without Ca Giay Reservoir			
Water from Dai Ninh (m ³ /sec)	Irrigable Area in Phan Thiet Plain (ha)(*)	Div. Req. to Phan Thiet Plain (m ³ /sec ann. av)	Req.Luy Res. Storage Capacity (MCM)
24.5	10,000	6.7	131
20.0	7,700	5.2	162
15.0	0	0	135

(ii) Case with Ca Giay Reservoir			
Water from Dai Ninh (m ³ /sec)	Irrigable Area in Phan Thiet Plain (ha)	Div. Req. to Phan Thiet Plain (m ³ /sec ann. av)	Req.Luy Res. Storage Capacity (MCM)
24.5	10,000	6.7	107
20.0	9,700	6.5	162
15.0	2,300	1.5	138

It should be noted that the construction of Ca Giay reservoir is scheduled from the year 1996 according to the Ministry of Agriculture and Rural Development and the Department of Water Resources of Binh Thuan province. Therefore, the Phan Ri-Phan Thiet irrigation project is to be formulated with a condition that the Ca Giay reservoir is incorporated in the proposed irrigation system.

(3) Formulation and Viability of the Scheme

a) Stagewise development

As long as a discharge of 24.5 m³/sec released from Dai Ninh power station will be secured, natural flow of the Luy River in conjunction with water from the Dai Ninh power station, Ca Giay reservoir being planned and other small existing irrigation systems would be able to irrigate an area of about 24,300 ha without the proposed Luy reservoir as discussed in Sub-section 2.8.2, subject to introducing a diversified agriculture with a cropping intensity of 240 %. While, the existing agricultural land in the project area is estimated at 30,000 ha in total. A comparison of them is shown below:

Irrigable Area without Luy Res. (ha)		Existing Agricultural Land (ha)	
Ca Giay Res.(planned)	2,000	Phan Ri Irri. Paddy	2,460
Suoi Da Res.(existing)	600	Phan Ri Rainfed Paddy	11,670
Dong Moi Weir (existing)	1,700	Phan Ri Upland Crops	5,870
Luy River plus Dai Ninh Water	20,000	Phan Thiet Rainfed Paddy	10,000
Total	24,300	Total	30,000

The above comparison suggests that the Project without the Luy reservoir would irrigate the entire existing agricultural land in the Phan Ri plain and a part of 10,000 ha land in the Phan Thiet plain or all of the Phan Thiet 10,000 ha with omitting upland crops land in the Phan Ri plain. In due consideration of time-frame condition of the Dai Ninh hydropower project and associated factors mentioned above, the Phan Ri-Phan Thiet irrigation project would be implemented on a stagewise development basis. A possible development step would be as follows:

- Construction of an intake on the Luy River and irrigation system for the existing agricultural lands in the Phan Ri plain;
- Extension of main canal to and construction of irrigation system in the Phan Thiet plain; and
- Construction of the Luy reservoir and land reclamation of newly development land.

b) Investment cost

The construction cost of the Luy reservoir with a storage capacity of 107 million m³ is estimated at about US\$ 46 million based on the preliminary study by the Ministry of Agriculture and Rural Development and unit prices estimated in this Master Plan Study. The cost of irrigation system is assessed on the basis of several reference irrigation schemes being planned by the Ministry of Agriculture and Rural Development. Based on the reference costs per unit development area (ha), construction costs of irrigation systems in the Phan Ri and Phan Thiet plains are estimated at about US\$ 93 million for 32,000 ha and US\$ 18.2 million for 10,000 ha respectively including the costs of bush clearing in the newly reclaimed lands and on-farm facilities.

c) Benefit and economic viability

The incremental benefits of the Phan Ri and Phan Thiet plains are estimated at US\$ 990/ha in the Phan Ri plain and US\$ 962/ha in the Phan Thiet plain respectively as shown in Tables 2.42 and 2.43. The economic internal rate of return (EIRR) is preliminarily estimated at 16 %, and thus the Phan Ri-Phan Thiet diversion scheme is considered to be economically feasible.

2.8.5 Lower La Nga Plain Irrigation Scheme

(1) Physical Features of the Lower La Nga Plain

The Lower La Nga plain is defined as an area along the La Nga River from Ta Pao down to the confluence of the Dong Nai River with a land of about 2,100 km² in total. The plain has a

length of about 58 km and a width of about 46 km, and administratively covers the whole of Tanh Linh and Duc Linh districts of Binh Thuan province and a part of Tan Phu, Xuan Loc and Thong Nhat districts of Dong Nai province. The La Nga River originates from the mountainous region of Di Linh and Bao Loc highlands in Lam Dong province, and the Lower La Nga plain occupies about 51 % of the entire La Nga basin. The total population in the plain is estimated at 490,000 (survey in the year 1991). The majority is the Kinh tribe, occupying 90 % of the population and most of them are migrants from the northern and central regions of Viet Nam since the year 1954 and after the year 1975.

There are three rainfall gauging stations in the plain; Phu Dien, Ta Pao and Vo Xu. The average annual rainfall recorded at the Ta Pao station is 2,388.8 mm for the past 18-year period. Rainfall concentrates in the rainy season from May to November with a high ratio of 90 %. Two discharge gauging stations exist at Ta Pao and Phu Dien. The former lies at the upstream end of the plain with a catchment area of 2,000 km², whilst the latter at the downstream reach with a catchment area of 3,060 km². Average annual discharge recorded at Ta Pao for the past 30-year period is 75.68 m³/sec, ranging from 9.8 m³/sec in March to 189.29 m³/sec in August. Meanwhile, mean annual discharge at Phu Dien is 120.93 m³/sec for the past four-year period with a range from 14.78 m³/sec in April to 307.18 m³/sec in September.

The most part of the plain is occupied by flood-prone area, about 55 km in length along the La Nga River of Ta Pao down to the confluence with Dar Cha River, about 8 km upstream of the proposed Vo Dat diversion damsite. The land of 3,000 ha to 5,000 ha in the plain suffers from floods annually, and inundation reached about 10,000 ha in the years 1978 and 1984. The flooding period generally lasts for a period from 20 days to 60 days. The major causes for flooding in the Lower La Nga plain are considered to be the low flow capacity of La Nga River, being about 200 to 300 m³ at the maximum, and the existence of constriction of river course at the downstream end of flood-prone area by outcrops of rock layer on the river bed. This flooding problem is the prime constraint to the agricultural development in the plain, followed by poor rainfall in the dry season and lack of irrigation facilities.

The agricultural land of annual crops in the plain is 54,235 ha (surveyed in the year 1990), of which an area of 21,150 ha is paddy field. Furthermore, out of 21,160 ha of paddy field, triple cropping is made in the area of 200 ha, double cropping in 6,550 ha and single cropping in 14,400 ha. Other than paddy, main crops are maize, potato and cassava.

A total of 37 existing irrigation schemes are identified in the plain with an area of 10,235 ha in total including a medium scale pumping irrigation scheme, named Vo Xu with an irrigable area of 3,800 ha, of which the present conditions are described in Sub-section 2.5.2.

(2) Potential Irrigation Area

The Lower La Nga plain irrigation scheme consists of two sub-irrigation schemes; (i) Ta Pao irrigation scheme, and (ii) Vo Dat irrigation scheme. Based on the LANDSAT imaginary maps, relevant maps and information obtained from Binh Thuan and Dong Nai provinces, the potential irrigation area in the Lower La Nga is estimated at 38,000 ha in total, subdivided into 23,000 ha and 15,000 ha, respectively. The existing Vo Xu pump irrigation scheme with a designed area of 5,000 ha is included in the Ta Pao irrigation scheme. The present land use and proposed irrigation area are shown in Tables 2.44 and 2.45, and summarized below:

a) Ta Pao irrigation scheme

Present Land Use	Area	Unit: ha
		Irrigation Area
Irrigated single paddy	3,728	3,360
Rainfed paddy	19,016	17,070
Upland crops	3,091	2,570
Sugarcane	12	0
Cashew	3,881	0
Town, river, etc.	672	0
Total	30,400	23,000

b) Vo Dat irrigation scheme

Present Land Use	Area	Unit: ha
		Irrigation Area
Rainfed paddy	1,010	980
Upland crops	6,860	6,200
Cashew	2,130	0
Bush/Grass	4,968	3,020
Forest	8,550	4,800
Town, river, etc.	1,902	0
Total	25,420	15,000

(3) Anticipated Cropping Patterns and Irrigation Water Requirements

Diversified farming will be adopted with a combination of paddy, cotton, sugarcane and an appropriate winter upland crop like groundnut. The cropping intensity of the Ta Pao irrigation scheme is set at 228 % smaller than the Vo Dat irrigation scheme with 240 %, because a land of about 6,500 ha is considered to be flood-prone area. A half of the flood-prone area, i.e. 3,250 ha in the Ta Pao scheme, is tentatively kept uncultivated. These cropping patterns and irrigation requirements are shown in Figures 2.21 and 2.22, respectively. The irrigation requirements of both schemes are summarized below:

Case	Unit: lit/sec/ha											
	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Ta Pao	1.15	0.99	1.12	1.12	0.31	0	0.02	0.02	0.02	0.03	0.49	0.84
Vo Dat	1.21	1.02	1.06	1.03	0.29	0	0.03	0.04	0.04	0.05	0.46	0.79

(4) Irrigation System and Water Balance

Two irrigation systems in the Lower La Nga plain, (i) Ta Pao irrigation scheme including the existing Vo Xu pump irrigation scheme and (ii) Vo Dat irrigation scheme, depict their layouts and system diagrams as shown in Figures 2.30 and 2.35, respectively. Two diversion weirs have been proposed; one is the Ta Pao weir and the other is the Vo Dat weir. Both weirs are to be constructed on the main stream of the La Nga River. General features of both the diversion weirs are as follows:

Description	Unit	Ta Pao Weir	Vo Dat Weir
Catchment area	Km ²	2,000	3,080
Type of weir		Rockfill	Rockfill
Full supply level	EL. m	125	105
Crest Length	m	120	204
Dam height	m	10	12
Embankment volume	1,000 m ³	100	340
Concrete volume	1,000 m ³	20	32

Water balance is made at the proposed Ta Pao and Vo Dat weirs by incorporating with the flow regulated by the Ham Thuan and Da Mi reservoirs, which are under implementing, lying upstream of La Nga River. The results of water balance are shown in Table 2.46, and summarized below:

- The Ta Pao irrigation scheme (23,000 ha) is fully irrigated; and
- The Vo Dat irrigation scheme with a proposed full command area of 15,000 ha will marginally be irrigated by taking advantage of the return flow from the Ta Pao scheme area.

(5) Formulation and Viability of the Scheme

a) Investment cost

Construction costs of diversion weirs and irrigation systems for both schemes are preliminarily estimated on the basis of the preliminary study by the Ministry of Agriculture and Rural Development and unit prices estimated in this Master Plan Study as shown below:

Work	Unit: million US\$	
	Ta Pao Scheme 23,000 ha	Vo Dat Scheme 15,000 ha
Weir	14.9	19.4
Irrigation System	59.9	76.2
Total	74.8	95.6

b) Benefit and economic viability

Incremental benefits of both Ta Pao and Vo Dat schemes are estimated at US\$ 753/ha and US\$ 975/ha respectively as shown in Table 2.47. The economic internal rate of return (EIRR) is preliminarily estimated at 15 % for the Ta Pao scheme and 14 % for the Vo Dat scheme.

From the results of water balance study and the above economic analysis, the preliminary conclusions are given to the formulation of irrigation development in the Lower La Nga plain as mentioned below:

- The Ta Pao irrigation scheme has no constraint in water resources available. Although further technical assessments such as flood protection are required, the Ta Pao irrigation scheme is selected as a candidate for the master plan project.
- The Vo Dat irrigation scheme with a command area of 15,000 ha seems economically feasible, however, this scheme has a constraint in water resources available, and moreover will reduce discharge in the lower reaches of La Nga River in the dry season remarkably after the scheme is put into operation. This may affect to the total power generation of Tri An hydropower station situated downstream of the Dong Nai River unless additional reservoirs are constructed in the Dong Nai River basin to compensate the reduction of discharge from the La Nga River. An alternative is to feed the Vo Dat scheme of 15,000 ha by the proposed La Nga No.3 reservoir. However, the construction cost of La Nga No.3 dam is excessive to make the development of the entire Vo Dat irrigation scheme economically feasible.
- The Vo Dat scheme is taken as a candidate of the master plan projects and its optimum scale is to be sought by the simulation model for optimal allocation of water available in the Dong Nai River, which is discussed in Appendix X.

2.8.6 Phan Rang Plain Irrigation Scheme

(1) Physical Features of the Phan Rang Plain

The Phan Rang plain extends from the foothill of central highland to the coast facing the South China Sea over about 45 km in north-south and about 40 km in east-west. The main river is the Cai River which originates from the mountains forming a boundary with the Cam Ranh River basin and flows westward by collecting small tributaries originating from the steep southeastern slope of the Da Lat mountain area with an elevation of more than 1,000 m. It flows down through steep hill areas, and comes out in the Tan My plain of old alluvium. In

this plain, three major tributaries, the Sat River on the left bank and the Ong River and the Cha River on the right bank, merge into the Cai River. After flowing through the Tan My plain, the river runs in the low flat land of the Phan Rang plain. Another tributary, the Lu River, joins the Cai River from the right bank near the estuary. The catchment areas at the Nha Trinh diversion dam and the estuary are 2,140 km² and 3,250 km², respectively.

The plain belongs administratively to Phan Rang city and three districts of Ninh Phuoc, Ninh Hai and Ninh Son in Ninh Thuan province. The total population of the development area is estimated at 450,000 in the year 1993 with a working population of about 225,000. The majority in the area is the Kinh tribe with a rate of 78 %, and the rest are minorities represented by the Cham tribe. More than 80 % of the working population is engaged in agriculture.

Average annual rainfalls are 716 mm at Phan Rang city for the past 47-year record and 784 mm at Nha Ho for 13 years. More than half of annual rainfall concentrates in three months from September to November. Mean annual air temperature is 27°C with little seasonal variation throughout the year.

The main crop grown in the Phan Rang plain is paddy. The cropping season and area of these crops, especially paddy, are affected by seasonal distribution of rainfall and flood and vary year to year. Upland crop area extends mainly on the middle and high terraces. Main upland crops in the area are tobacco, cotton and sugarcane. These crops are planted at the onset of the rainy season and grow under rainfed condition. Cultivation of grapes has extensively been introduced in the Phan Rang plain recently as a profitable cash crop taking advantage of natural conditions. Unit yield of paddy in the Phan Rang irrigation area of 12,800 ha is reported at 4.0 tons/ha of winter-spring and summer-autumn crops and 3.0 tons/ha of rainy season crops under irrigated condition.

There are 51 existing irrigation schemes with an area of 21,300 ha in total in the Phan Rang plain, consisting of 18 schemes with the designed irrigation area larger than 100 ha and 33 schemes with the area less than 100 ha. The irrigation areas of those 18 and 33 schemes are 20,157 ha and 1,143 ha in total respectively. The major existing irrigation schemes are:

- Song Pha irrigation scheme (actually irrigated area is 3,500 ha out of designed 4,710 ha);
and
- Nha Trinh-Lam Cam (Phan Rang) irrigation scheme (12,800 ha).

The features of both the schemes are described in Sub-section 2.5.2 in detail. The rest irrigation schemes with a total area of about 5,000 ha are scattered in the Phan Rang plain, mainly along the Lu River.

(2) Proposed Development Plans

The Da Nhim No.1 power station was constructed in the year 1964 as the first step of the water resources development in the Dong Nai River basin, regulating water of Da Nhim River. This hydropower project diverts water from the Da Nhim reservoir to the Cai River basin in the east coast through the Da Nhim power station (160 MW) with a firm discharge of 15 m³/sec. To efficiently utilize water released from the Da Nhim power station and coupled with natural flow of the Cai River, the Phan Rang irrigation project was formulated, and the construction of main canal systems covering an area of 12,800 ha was completed in the year 1967, with a financial assistance of the Government of Japan (Reparations Agreement). The project restored the Nha Trinh diversion dam and extended the main canal systems. The project aims at cultivation of the paddy and dry field crops in the lower land and at cultivation of sugarcane in the higher land.

The Phan Rang irrigation project was contemplated to extend to 24,300 ha in total on a three-stage development, i.e. 12,800 ha in the first stage, 4,700 ha in the second stage and 6,800 ha in the third stage. The extension area of 11,500 ha will be developed by utilizing the increased water released from the extended Da Nhim power station, i.e. Da Nhim third stage project discharging 23.5 m³/sec including the said 15 m³/sec. Although some studies have been made for the second- and third-stage irrigation development during a period of the year 1968 to 1974, these could not be brought in the implementation because of suspension of the Da Nhim third stage project.

The recent hydropower study in the Dong Nai River phased out a possibility of the Da Nhim third stage project, hence the extension project of the Da Nhim power station is unlikely to be realized in the near future. Therefore, the further irrigation development in the Phan Rang plain will have to be re-formulated, and two possible development alternatives conceived at present are as follows:

- To rehabilitate the Phan Rang irrigation project (locally called Nha Trin-Lam Cam scheme) of 12,800 ha and the Song Pha irrigation scheme of 4,710 ha; and
- To expand the irrigation area by exploiting water resources of the tributaries in the Cai River basin and the neighbouring rivers.

As discussed in Sub-section 2.6.2, the feasibility study on rehabilitation project of the Phan Rang irrigation project (Nha Trin-Lam Cam scheme) was made in the year 1990 by the Government of Viet Nam. Therefore, it should be put into implementation together with Song Pha irrigation scheme although both the schemes need updating as soon as after the fund is arranged.

(3) Extension Scheme and Water Balance

The expansion of irrigation area in the Phan Rang plain is anticipated by exploiting the water resources in the Cai River basin and the neighbouring rivers. A total area of 15,400 ha is identified as the potential irrigation area in the Phan Rang plain besides the existing two irrigation schemes (Song Pha and Nha Trinh-Lam Cam), and this is defined as the Phan Rang extension irrigation scheme. The general plan and schematic diagram of irrigation systems including those of the existing schemes are shown in Figure 2.25 and 2.32. The extension irrigation scheme of 15,400 ha is divided into the following four sub-schemes upon the water resources for use:

Sub-scheme	Area (ha)
Song Sat Scheme	1,600
Song Trau Scheme	2,300
Tan Giang Scheme	2,600
Nha Trinh Pump Scheme	8,900 (Right:4,200/Left:4,700)
Total	15,400

Of the above four sub-schemes, three reservoir schemes, i.e. Song Sat, Song Trau and Tan Giang, are being proposed to irrigate the respective potential irrigation areas at present, and construction of the Tan Giang dam is scheduled from the year 1996. The features of these reservoirs are tabulated below:

Description	Unit	Song Sat Res.	Song Trau Res.	Tan Giang Res.
Name of River		Sat	Trau	Giang (Lu)
Catchment Area	km ²	130	65	140
Annual Discharge	m ³ /sec	2.44	1.22	2.62
N. Water Level	EL. m	NA	41.0	NA
Effect. Storage volume	MCM	36	19	11
Dam Height	m	NA	27	NA
Crest Length	m	NA	NA	NA
Irrigation Area	ha	1,600	2,300	2,600
Existing	ha	0	50	1,420
Newly Expanded	ha	1,600	2,250	1,180
Present Status		F/S on-going	F/S completed	To be constructed

Three schemes of Song Sat, Song Trau and Tan Giang are formulated independently in the Phan Rang plain by utilizing water resources of the small rivers in the Cai River and neighbouring basins, and are in the preparatory stage for implementation. While, Nha Trinh pump scheme with an area of 8,900 ha relies on the Cai River together with the existing Song Pha and Nha Trin-Lam Cam schemes. The water balance of the Cai River is made to seek the possibility of expanding irrigation area. Assuming cropping pattern and irrigation requirement

as shown in Figure 2.23, the calculation of water balance is shown in Table 2.48 and its result is tabulated below:

Category	Scheme	Irr. Area (ha)	Reservoir (MCM)
Existing Scheme	Song Pha	4,710	Not required
	Nha Trin-Lam Cam	12,800	Not required
Extension Scheme	Nha Trin Pump-1	2,450	Not required
	Nha Trin Pump-2	6,450	26 (Cai River)
Total		26,410	26

The result of water balance suggests that the Cai River including the discharge released from the Da Nhim power station can feed both the existing irrigation schemes fully, and an additional 2,450 ha in the extension area without regulating the river flow. For the rest 6,450 ha, a regulating reservoir with a storage volume of 26 million m³ is required upstream of the Cai River, provisionally siting about 25 km upstream of the confluence with the Sat River with a catchment area of about 660 km². This site has a topographic condition sufficient to create a reservoir with such a scale. The approximate dimensions of dam are 40 m in height and 200 m in crest length.

(4) Formulation and Viability of the Extension Scheme

As mentioned above, three schemes of Song Sat, Song Trau and Tan Giang are formulated independently in the Phan Rang plain and would be put into construction according to the implementation programme established by the Ministry of Agriculture and Rural Development and Ninh Thuan province. Since no details about the three dams are available, however, those economic viability is not assessed.

The present land use in the Nha Trinh pump scheme of 8,900 ha is estimated as follows:

Present Land Use	Unit: ha		
	Left Bank	Right Bank	Total
Rainfed paddy	200	1,400	1,600
Upland crops	500	400	900
Uncultivated	4,000	2,400	6,400
Total	4,700	4,200	8,900

source: Feasibility Study on Rehabilitation and Improvement of the Phan Rang Irrigation Project, August 1990 by Ministry of Agriculture and Rural Development

The investment cost of the Nha Trinh pump scheme is preliminarily estimated to be about US\$ 50 million in total including dam to be built upstream of the Cai River (26 MCM), two pump stations, canal system, land preparation in the presently uncultivated area and on-farm work. Its cost would make the scheme in a marginal level in terms of economic evaluation, while the incremental benefit is estimated to be US\$ 1,000/ha approximately. At present, no

definite plans on the pump schemes have been exercised, and further investigation, and thus study on an overall water resources development plan would be required for expanding the irrigation systems in the Phan Rang plain under a crucial condition that no more water than Da Nhim is expected from the Dong Nai River basin. In view of relatively low economic viability and immature stage for implementation of Nha Trin pump scheme, the Phan Rang extension irrigation scheme is not considered as a candidate for the master plan projects.

2.8.7 Tuy Phong Plain Irrigation Scheme

(1) Physical Features of the Tuy Phong Plain

The Tuy Phong plain is stretching along the lower reaches of Long Song River located in the Tuy Phong district of the Binh Thuan province as shown in Figure 2.8, about 235 km northeast of Ho Chi Minh City. The Long Song River originates from the northeast slope of Di Linh plateau with an elevation of 1,000 m, passing through the high mountain and dense forests toward the north-south direction and finally pouring into the South China Sea at Tuy Phong town. The catchment area of the Long Song River is 520 km² at the estuary. Annual rainfall recorded at Phan Ri, the nearest place to the Tuy Phong Plain, is 638 mm on an average, and the short-term observation during a period from the year 1988 to 1992 at Lien Huong in Tuy Phong district gives an average annual rainfall of 527 mm. It is reported that this plain is the driest region over the whole country.

The total population of Tuy Phong plain is estimated at 97,000 in the year 1989 with a working population of about 35,000. The majority is the Kinh tribe, occupying 95 % of the population and the rest are the Cham tribe and other minorities.

There is no discharge gauging station in the Long Song River. Referring to the hydrological data recorded in the neighbouring river basins, annual discharge at the proposed dam site, i.e. Long Song storage dam with a catchment area of 394 km², is estimated at 5.11 m³/sec with a probability of 50 %, 3.68 m³/sec with 75 % probability and 3.26 m³/sec with 95 % probability according to the Ministry of Agriculture and Rural Development.

The agricultural land of annual crops in the plain is 5,224 ha (surveyed in the year 1992), of which a land of 2,330 ha is paddy field. The annual cultivating area is about 4,800 ha, consisting of the winter-spring crops of 733 ha, the summer-autumn of 1,348 ha and the rainy season of 2,718 ha. Main crops in the plain are paddy, peanut, tobacco, maize and cassava.

There are four irrigation systems drawing water from the fixed weir constructed on the Long Song River with an irrigation area of 1,670 ha in total, and in addition some small systems use

small pumps and wells with an irrigation area of about 480 ha. The total irrigation area is 2,150ha.

(2) Development Plan and Water Balance

The potential irrigable area of the Tuy Phong irrigation scheme is estimated at 4,200 ha to be fed by the Long Song River. A storage dam named the Long Song reservoir is proposed for supplying irrigation water for the 4,200 ha area, and is located about 12 km north of the National Highway No.1. Its effective capacity is estimated at 40.5 million m³.

The preliminary calculations of water balance are made to the two cases of cropping pattern as discussed previously, i.e. the case of maximum potential water use by three paddies a year (Case-A), and the case of diversified agriculture including upland crops (Case-B). The water balance calculation is shown in Table 2.49, and is summarized below:

Case	Maximum irrigable area	Unit: ha
Case-A	2,500	
Case-B	4,100	

The Long Song River is considered to have the capacity to irrigate all the potential areas of Tuy Phong plain. However, the construction cost of the Long Song dam is preliminarily estimated to be ranging from US\$ 30 to 35 million, which seems excessive to prove that the development of the irrigation scheme with a command area of 4,200 ha is economically feasible.

2.8.8 Song Phan Plain Irrigation Scheme

(1) Physical Features of the Song Phan Plain

The Song Phan plain stretches along the Phan River, which flows north-south direction and pours into the South China Sea at Tam Tan town located about 134 km east of Ho Chi Minh City as shown in Figure 2.8. Its catchment area is 400 km² at the estuary. The Song Phan plain belongs administratively to Tanh Linh, Ham Tan and Ham Thuan Nam districts of Binh Thuan province. The total population of the plain is estimated at 30,000.

No meteo-hydrological stations exist in the Song Phan plain. Average annual rainfall in the plain is represented by the data recorded at the Ham Tan station, where average annual rainfall is estimated at 1,597 mm for the past 43-year period. Annual discharge of the Phan River is estimated at 2.01m³/sec at the proposed Phan reservoir with a catchment area of 136 km².

The agricultural land of annual crops in the plain is 3,627 ha (surveyed in the year 1992) including 800 ha of paddy field. The annual cultivating area is about 4,020 ha, consisting of the winter-spring crops of 240 ha, the summer-autumn of 1,880ha and the rainy season of 1,900 ha. The main crops in the plain are paddy, sweet potato, tobacco, maize, cassava and sugarcane. There are two small reservoirs in the plain with a service area of about 460 ha in total.

(2) Proposed Development Plan

The potential irrigation area of the Song Phan plain is estimated at 5,030 ha, of which the general layout and schematic irrigation diagram are shown in Figures 2.29 and 2.34. The Ministry of Agriculture and Rural Development proposes to construct a storage dam named Phan reservoir on the main course of the Phan River with a storage capacity of about 23 million m³, located 2 km upstream of the railway. The preliminary calculations of water balance are made to the two types of cropping systems, i.e. three paddies a year as the case of maximum water use (Case-A) and diversified agriculture (Case-B) as shown in Table 2.50, and summarized below:

Case	Irri. Area (ha)	Song Phan Res. Req. Storage Volume (MCM)
Case-A	1,500	20
Case-B	2,200	19

The above result suggests that the water resource of the Phan River is limited to a capacity of irrigating an area of 2,200 ha at most. However, the construction cost of the Song Phan dam is preliminarily estimated to be US\$ 18.2 million, which seems excessive to prove that the development of the irrigation area with a command area of 2,200 ha is economically feasible.

2.8.9 Ham Tan Plain Irrigation Scheme

(1) Physical Features of the Ham Tan Plain

The Ham Tan plain stretches along the Dinh River, which flows south-east direction and pours into the South China Sea at Ham Tan town located about 121 km east of Ho Chi Minh City as shown in Figure 2.8. Its catchment area is 862 km² at the estuary. The Ham Tan plain belongs administratively to Tanh Linh and Ham Tan districts of Binh Thuan province. The total population of the plain is estimated at 122,000.

Rainfall data are recorded at Ham Tan town, and its annual average is 1,597 mm for the past 43-year period. There is a discharge gauging station at Ham Tan town, however, no details

about this station are available. The estimated discharges at the proposed two storage dam sites in the Dinh River basin are 1.70 m³/sec at Gieng reservoir (93 km²) and 7.89 m³/sec at Dinh No.3 reservoir (551 km²) according to the Ministry of Agriculture and Rural Development.

The agricultural land of annual crops in the plain is 8,558 ha (surveyed in the year 1992) including 2,065 ha of paddy field. The annual cultivating area is about 9,770 ha, consisting of the winter-spring crops of 840 ha, the summer-autumn of 3,370ha and the rainy season of 5,560 ha. The main crops in the plain are paddy, sweet potato, tobacco, maize, cassava and sugarcane.

There are nine existing irrigation schemes in the Ham Tan plain with a total irrigation area of 1,210 ha, drawing water from seven weirs constructed on the Dinh River basin.

(2) Development Plan

The potential irrigable area of the Ham Tan plain irrigation scheme is provisionally estimated at 19,300 ha to be fed by the Dinh River and its tributaries. There are two proposed storage dams, i.e. Song Gieng reservoir with an effective capacity of 13.9 million m³ and Song Dinh reservoir (60.15 million m³), according to the Ministry of Agriculture and Rural Development.

The preliminary calculations of water balance are made in the same manner as in the Song Phan plain, and shown in Table 2.51. The results are that:

- In Case-A, the area to be irrigated is estimated at 5,150 ha only, and 14,150 ha is left un-irrigable;
- In Case-B, an area of 7,800 ha is to be irrigated, and 11,500 ha remains un-irrigable; and
- The shortage of water is estimated to be the mean annual of 14.6 m³/sec or 460 million m³ in annual total for Case-A, while 9.7 m³/sec or 307 million m³ for Case-B

The irrigation areas served by the respective reservoirs and required storage volumes are summarized below:

Reservoir	Unit: ha			
	Case-A		Case-B	
	Area (ha)	Store (MCM)	Area (ha)	Store (MCM)
Song Gieng Reservoir	850	14	1,300	13
Song Dinh Reservoir	4,300	70	6,300	62
Area un-irrigated	14,150	-	11,700	-
Total	19,300	84	19,300	75

The following two scenarios of development plan in the Ham Tan plain are conceivable:

Supplemental Water Supply from the La Nga River

For Ham Tan plain, a plan of supplemental water supply from the La Nga River has been discussed, and in fact there is a possible diversion route from the main canal branched off from the Ta Pao diversion weir. The length of diversion canal is estimated at about 26 km from the Ta Pao weir and about 20 km from the off-take point of the Ta Pao main canal. Although the technical and economic assessment is required in a more detailed manner, the diversion alternative seems infeasible due to limited water available in the La Nga River in case of full development of the Lower La Nga plain, and high construction cost of diversion canal. In addition, the "potential irrigation area" as marked in Figure 2.29, having an area of about 12,500 ha in net, is not highly suitable for irrigated agriculture due to unfavourable soil conditions. In particular, sandy soils are prevailing in the coastal area.

Water Resources Development Plan within the Ham Tan Plain

The results of water balance calculations suggest that the maximum irrigable area would be 7,600 ha, which covers the most arable land suitable for irrigated agriculture in the Ham Tan plain, by developing the water resources within its plain. Therefore, the scale of irrigation development in the Ham Tan plain would be limited to more or less 8,000 ha as have been proposed by the Ministry of Agriculture and Rural Development. However, the construction costs of the Song Gieng and Song Phan dams are preliminarily estimated to be US\$ 11.5 million and US\$ 20.3 million, thus being about US\$ 32 million in total, which seems excessive to prove that the development of the irrigation area with a command area of 7,800 ha is economically feasible.

2.8.10 Song Ray Plain and Song Dinh Plain Irrigation Schemes

(1) Physical Features of the Song Ray and Song Dinh Plains

The Song Ray and Song Dinh plains occupy almost all the land of Ba Ria-Vung Tau province, and belong to three districts of Xuyen Moc, Long Dat and Chau Thanh as shown in Figure 2.31. The Song Ray plain is located in the east part of Ba Ria-Vung Tau province, including all of the Xuyen Moc and Long Dat districts and a part of Chau Thanh district. While, the Song Dinh plain is located adjacent to the Song Ray plain and in the central part of Chau Thanh district. The total area of both plains is estimated at 1,510 km², consisting of 1,150 km² of Song Ray and 360 km² of Song Dinh. The total population is estimated at about 398,000 (survey in the year 1991), consisting of 290,000 in the Song Ray and 108,000 in the Song Dinh.

There are five rainfall gauging stations having longer observation period more than 50 years in both plains. Average annual rainfall in the plain is about 1,800 mm ranging from 1,370 mm at Vung Tau and 2,012 mm at Long Thanh located in the upper Song Dinh River basin.

The Song Ray River basin has a catchment area of about 1,300 km² at the estuary, a large part of which belongs to the Dong Nai province. The main river course has a length of about 120 km, and passes in the Ba Ria-Vung Tau province for 40 km long. Average annual discharge of the Ray River is estimated at 22.6 m³/sec at the Ray diversion dam with a catchment area of 829 km².

The Dinh River originates from the Chau Thanh hilly area with an elevation of about 100 m in the central part of Ba Ria-Vung Tau province, having a length of 42 km with a catchment area of about 400 km² at the estuary. Average annual discharge of the Dinh River is estimated at 7.54 m³/sec at the proposed Da Den storage dam with a catchment area of 302 km².

The agricultural land of annual crops in both plains is estimated at 40,400 ha including paddy field of 11,800 ha. The main crops are paddy, maize, peanut, soybean, sugarcane and tobacco. There are 11 existing irrigation schemes with an area of 6,000 ha in total, consisting of seven schemes of 4,050 ha in the Song Ray plain and four schemes of 1,950 ha in the Song Dinh plain. Each of those 11 existing irrigation schemes has an area of larger than 100 ha.

(2) Development Plan

The total potential irrigation area in both the Ray and Dinh River plains is estimated at 18,450 ha, consisting of 13,710 ha including the existing irrigation schemes of 4,050 ha in the Ray River plain and 4,740 ha in the Dinh River plain including existing 1,950 ha. There are numerous existing and proposed reservoirs, most of which are of small scale, in both the Ray and Dinh River plains, and these reservoirs are expected to feed the above potential irrigation area. The general layouts and schematic irrigation diagrams of the irrigation schemes in both the plains are shown in Figure 2.31 and 2.36 and 37, respectively.

Besides the irrigation development, a large amount of domestic and industrial water demands is called for extensive water resources developments in Ba Ria-Vung Tau province in the light of rapidly inflating industrial zones along National Highway No.51. For this, the Ministry of Agriculture and Rural Development and the provincial authorities have a proposal to construct two major storage dams, i.e. Ray and Da Den reservoirs. The presently available study report of the Da Den dam estimates that the immediate requirement of domestic and industrial use fed by this reservoir is 100,000 m³/day, and it will further increase upon the industrial development. The proposed Ray reservoir is expected to encounter such increased demand in future.

As shown in the schematic irrigation diagrams in both the plains, the Ray reservoir is expected to irrigate an area of 3,500 ha in total, while the Da Den reservoir is to irrigate 2,020 ha. The water balance of both the reservoirs are simulated to verify the possibility of required irrigation by taking into account the possible capacity of domestic and industrial water supply within the topographical limits at the proposed dam sites. The calculation of water balance is shown in Table 2.52 on the basis of a proposed cropping pattern as shown in Figure 2.24, and its result is summarized below:

Reservoir	Irrigation Area (ha)	Potential Water Supply (m ³ /day)	Required Storage Volume (MCM)
Ray	2,900	1,400,000	240
Da Den	2,020	250,000	57
Total	4,920	1,650,000	297

The above result suggests that the Da Den reservoir be able to irrigate the proposed area fully, while the Song Ray restricts the development to an area of 2,900 ha out of the total potential area of 3,500 ha. However, water development sought to the Song Ray reservoir for domestic and industrial water supply to the Vung Tau and Phu My areas is 450,000 m³/day by the year 2015 (refer to Appendix VII). Taking into account this fact, it would be possible to irrigate all the potential irrigation area of 3,500 ha, even if an agreement is necessary in water use between the water supply project and the irrigation project.

From an economic point of view, the irrigation schemes in both the plains will not be able to afford the full investment cost of the dams, referring to those costs of US\$ 66.3 million of the Ray dam and US\$ 26.6 million of the Da Den dam estimated in Appendix VII "Domestic and Industrial Water Supply". In principle, both the reservoirs are given the priority in developing the water resources for the water supply sector, subject to ensuring the irrigation water for the said potential areas of 3,500 ha and 2,020 ha respectively.

2.9 Selection of Candidate Master Plan Projects

2.9.1 Proposed Strategy of Irrigation Development

With the national policies for irrigation development and the present conditions of the irrigated agriculture in the Study Area confirmed by data and information obtained through the field reconnaissance and inventory survey for the existing irrigation schemes, it seems appropriate to take the following approaches for formulating a master plan of irrigation development in the Study Area, coupled with the afore-mentioned strategy for agricultural development:

- Placing the prime purpose of irrigation development on stabilization of agricultural production, it will be formulated comprehensively in association with environmentally sound improvement and upgrading of socio-economic conditions of rural areas that ultimately aim to enhance the living standard of people and to narrow down the regional gap of socio-economic conditions;
- As an immediate irrigated agricultural development in the Study Area, the highest priority will be given to the Rural Agricultural Development Project which is based on the rehabilitation and upgrading of the existing irrigation schemes including the exploitation of additional water resources, followed by completion of on-going schemes and technically and economically viable schemes among the presently proposed small irrigation schemes; and
- Parallely, water resources development projects will be promoted for the potential irrigation schemes by giving the highest priority to the exploitation of locally available but untapped rivers, and to technically and economically viable water diversion schemes from other river basins in coordination with hydropower development and water supply schemes.

2.9.2 Screening of Candidate Schemes for Master Plan Projects

According to the framework of irrigation planning set out in Section 2.3, all the existing and proposed irrigation schemes in the Study Area have been individually discussed with regard to those present conditions and current status for development, land use and proposed development plan, technical issues and economic viability. These schemes are screened for selecting candidates for master plan projects to be examined by the simulation model study to seek an optimal allocation of water resources available in the Dong Nai River and surrounding basins as discussed in Appendix X. On the basis of the results of individual studies above mentioned, the following factors are adopted to the screening of candidate schemes for master plan projects:

- Water resources, either Dong Nai River including diversion or surrounding basin;
- Availability of water;
- Maturity of planning;
- Social impacts
- Natural environmental impacts; and
- Economic viability.

The screening matrix incorporating the above factors is shown in Table 2.53, and results in selecting the following schemes as the candidates for the master plan projects:

- a) Rural Agricultural Development Project for candidate small irrigation schemes including 164 existing schemes of 67,745 ha in total and 65 new schemes of 61,242 ha;
- b) Remaining development area of 48,390 ha of the Dau Tieng irrigation scheme (Dau Tieng Extension);
- c) Phuoc Hoa irrigation scheme of 45,680 ha;
- d) Irrigated agricultural development schemes in the HCMC-Long An delta with an area of 100,000 ha in total, consisting of HCMC Delta of 46,000 ha and Long An Delta of 54,000 ha;
- e) Phan Ri irrigation scheme with an area of 29,700 ha excluding the existing 2,300 ha irrigated by the Suoi Da reservoir (600 ha) and the Dong Moi weir (1,700 ha);
- f) Phan Thiet irrigation scheme with an area of 10,000 ha; and
- g) Lower La Nga Plain irrigation scheme with an area of 38,000 ha in total, consisting of Ta Pao irrigation scheme of 23,000 ha and Vo Dat irrigation scheme of 15,000 ha.

2.10 Formulation of Master Plan Projects

2.10.1 Selected Master Plan Projects and Development Strategy

The study of optimal allocation of water available in the Dong Nai River basin discussed in Appendix X results in that all the eight candidate schemes are selected as the master plan projects with some variation in development areas from potential areas of candidates. The eight master plan projects are set with a total area of 242,560 ha as listed below in comparison with the candidate potential areas:

Unit: ha

No.	Name of Irrigation Scheme	Development Area	
		Master Plan	Potential
1.	Phuoc Hoa	45,680	45,680
2.	Dau Tien Extension	48,390	48,390
3.	Phan Ri	29,700	29,700
4.	Phan Thiet	10,000	10,000
5.	Ta Pao	19,000	23,000
6.	Vo Dat	12,620	15,000
7.	HCMC Delta (*1)	46,000	46,000
8.	Long An Delta	31,170	54,000
Total		242,560	271,770

(*1): including on-going Hoc Mon-Bac Binh Chanh irrigation project

Besides the above, the Rural Agricultural Development Project (RADP) is taken up as the master plan project aiming to rehabilitate and improve small scale irrigation schemes scattered throughout the Study Area, which will not benefited from the development of large scale master plan projects selected by the optimum water allocation of the Dong Nai River.

As a strategic approach to the implementation of the master plan projects in view of similarity of individual projects, transbasin diversions of water resources and regional developments, the master plan projects are categorized into five development packages. Towards the implementation of the individual master plan projects, further master plan and/or feasibility studies will have to be made to the respective development packages categorized below:

Development Package		Area (ha)	Master Plan Project	
1.	Rural Agricultural Development Project (RADP)	128,987	1.1	Small Existing Irrigation Schemes (67,745 ha)
			1.2	New Small Irrigation Scheme (61,242 ha)
2.	Phan Ri-Phan Thiet Irrigation Project	39,700	2.1	Phan Ri Irrigation Scheme (29,700 ha)
			2.2	Phan Thiet Irrigation Scheme (10,000 ha)
3.	Lower La Nga Plain Irrigation Project	31,620	3.1	Ta Pao Irrigation Scheme (19,000 ha)
			3.2	Vo Dat Irrigation Scheme (12,620 ha)
4.	Phuoc Hoa Irrigation Project	45,680		Phuoc Hoa Irrigation Project (45,680 ha)
5.	Dau Tien Extension and HCMC-Long An Delta Irrigation Project	125,560	5.1	Dau Tien Extension Irrigation Scheme (48,390 ha)
			5.2	HCMC Irrigation Scheme (46,000 ha) (*1)
			5.3	Long An Irrigation Scheme (31,170 ha)
Total			371,547 ha	

(*1): including on-going Hoc Mon-Bac Binh Chanh Irrigation Scheme of 12,197 ha

The individual master plan projects are updated in this Section for verifying those technical soundness and economic viabilities and for selecting the priority master plan projects among them, based on the additional data and information obtained in and the latest unit costs emated in the Phase III work.

2.10.2 Rural Agricultural Development Project

(1) Proposed Development Plan

The Rural Agricultural Development Project (RADP) aims at increasing the farmers' income, enhancing the living standard in the rural area, creating job opportunities and ultimately narrowing down the economic disparity between urban and rural areas. The prime objectives of RADP are to rehabilitate and improve the existing irrigation schemes including exploiting water resources, and to construct new small scale irrigation schemes, all of which are scattered over the Study Area and not covered by the selected eight master plan projects to be fed by the Dong Nai River and surrounding river basins. However, the RADP is not focused only on the irrigation and drainage facilities, but also on the improvement of farm-to-market roads, rural electrification, supply of safe drinking water and sanitation facilities. Besides, attention is to be given to upgrading the institutional framework in rural areas including agricultural supporting systems and farmers' cooperatives.

The RADP is proposed as the project urgently implemented, thereby a master plan study including feasibility studies for priority irrigation schemes is needed as soon as after the Master Plan on Dong Nai River and Surrounding Basins is finished. It is worthy of note that the RADP to be implemented in the Study Area would be the first case in Viet Nam, and therefore has an important role as a model project to be extended over the country.

(2) Preliminary Screening of Candidate Irrigation Schemes for RADP

The objective areas of RADP are those of the existing small irrigation schemes and new small scale irrigation schemes in the Study Area, excluding HCMC and Long An province where large scale master plan projects are contemplated. All the candidate schemes for RADP are preliminarily screened. The irrigation schemes excluded from RADP are those which are covered by the master plan projects, being constructed and to be implemented soon as classified in Table 2.54. The preliminary screening of candidate irrigation schemes for RADP results in selecting 118 existing small irrigation schemes with a total area of 50,382 ha and 58 new schemes with 52,294 ha in total as summarized below:

Province	A. Existing Small Scheme		D. New Small Scheme	
	Nos.	Area (ha)	Nos.	Area (ha)
Lam Dong	25	10,809	1	1,050
Dac Lac	1	120	0	0
Ninh Thuan	10	2,512	1	1,600
Binh Thuan	15	4,090	0	0
Ba Ria-Vung Tau	15	4,581	18	8,450
Dong Nai	33	16,930	6	8,230
Song Be	16	8,080	20	11,094
Tay Ninh	3	3,260	12	21,870
Total	118	50,382	58	52,294

(3) Priority Criteria

The priority schemes in RADP will be further screened and selected by the master plan and feasibility study of RADP in such a manner as analysing a database on the irrigation schemes established through an extensive and detailed inventory survey. Screening and priority selection would be based on future sustainability of schemes, composed of five aspects: (i) technical aspect; (ii) socio-economic aspect; (iii) institutional aspect, (iv) economic and financial aspect and (v) environmental aspect. Conceivable factors of each aspect would be as follows:

Technical aspect

- Condition of scheme facilities (extent of damages and deterioration);
- Availability of water resources; and
- Preparation for rehabilitation, improvement and construction.

Socio-economic aspect

- Number of direct and indirect beneficiary;
- Regional economic situation (poverty);
- Effect to enhancement of employment opportunity; and
- Effect to enhancement of rural industry.

Institutional aspect

- Capacity and capability of O&M organizations at the local level;
- Availability of agricultural supporting services; and
- Formation and activities of farmers' organization.

Economic and financial aspect

- Economic and financial feasibility; and
- Cost recovery at least for operation and maintenance.

Environmental aspect:

- Impact to natural environment; and
- Impact to social environment.

(4) Preliminary Cost Estimate and Economic Viability

The investment cost of RADP is preliminarily estimated on the basis of estimated costs of rehabilitation works for reference existing irrigation schemes as shown in Table 2.55, and also in consideration of present irrigation rate of about 40 % against the designed irrigation area

estimated by the results of inventory survey made in this Study. It is estimated to be US\$ 231 million including engineering and administration costs, as calculated in Table 2.56 and summarized below:

Description	Unit: million US\$
	Amount
Direct Cost	178
A. Small existing schemes	45
B. New small schemes	133
Indirect Cost	53
Investment Cost	231

The annual economic benefit of RADP is preliminarily estimated on the basis of average cropping intensity in the existing schemes obtained from the inventory survey and benefits estimated for the master plan project. The result of preliminary estimate is shown in Table 2.56 and summarized below, comparing with the annual equivalent economic cost:

RADP	Unit: million US\$	
	Annual Benefit	Annual Cost
Overall (102,676 ha)	44	23
Existing Schemes(50,382 ha)	11	6
New Schemes (52,294 ha)	33	17

Judging from the above estimate, the RADP is considered economically feasible.

2.10.3 Phan Ri-Phan Thiet Irrigation Project

(1) Proposed Development Plan

The study of optimum water allocation (refer to Appendix X), concludes that the Phan Ri-Phan Thiet irrigation project should be developed with a full potential area of 39,700 ha, consisting of 29,700 ha in Phan Ri plain and 10,000 ha in Phan Thiet plain by utilizing the tail water released from the Dai Ninh hydropower station in conjunction with water available in both the plains. The project will be formulated according to the discussion made in previous Sub-section 2.8.4, and the major features of the project are summarized below:

Description	Unit	Headworks		
		Ca Giay Res.	Luy Res.	
Water Source	From own basin	m ³ /sec	1.39	5.26
	From Dong Nai Basin	m ³ /sec	0	24.46
Net Reservoir Storage Volume	Mil. m ³		30	110
Irrigation Area	Phan Ri plain	ha	2,000	30,000 (*)
	Phan Thiet plain	ha	0	10,000
Max. Diversion Water Requirement	m ³ /sec		2.36	47.20

(*) including the existing 2,300 ha irrigated by the Suoi Da reservoir and the Don Mai weir.

(2) Technical Updating

The Luy reservoir and main canals as the major project facilities for the Phan Ri-Phan Thiet irrigation project are updated from technical point of view on the basis of the past preliminary planning made by both the Ministry of Agriculture and Rural Development and the Water Resources Department of Binh Thuan province, and field reconnaissance including topographic survey and geological investigation at the damsite carried out in the Phase III work.

Luy Reservoir

(a) Topographic and Geological Conditions

The proposed Luy dam is located on the main stream of the Luy River, about 1 km downstream of the confluence with its tributary named the Da Ke Trou River and about 24 km north-west from Phan Ri town, capital of Bac Binh district of Binh Thuan province. The proposed Luy damsite has a relatively flat topography on the about 4 km wide river bed and moderately steep abutments with a slope of about 30° on both the banks. Intrusive granite in the Cretaceous, being hard and blocky, exists in the right bank of damsite. While, exposed in the left bank are shale with a well developed bedding plane in the Middle Jurassic, rhyolite of Don Duong Formation in the upper Cretaceous and aplite in the Paleogene. Basaltic rocks, judged as lava flow taken place in the Quaternary, cover the entire riverbed and form a small scale gorge along the present river course. Colluvial deposit containing boulders lies over the foots of both banks.

No remarkable fractured zones like a large scale fault are observed at the damsite. These rocks have sufficient bearing strength in view of engineering geology although slightly weathered. A major geological constraint at the damsite is a possible leakage from the reservoir through the underlying basaltic rocks with horizontally continuous open cracks and the probable old and unconsolidated river deposits lying beneath the basaltic rocks. However, these formations are not observed from the field investigation and data available at present, and therefore the further geological investigations are needed. Upon the result of detailed geological investigations which may reveal the high permeability at

the presently proposed damsite, a place located about 2 km upstream of it, where alluvial deposits composed mainly of fine sand are prevailing in the riverbed, would be proposed as an alternative damsite.

Judging from the topographic and geological conditions, a rockfill type dam is recommended. Materials for dam construction are widely available in and around the damsite except for core materials. Granite distributed near the damsite will be used as rock-filling materials and coarse aggregates of concrete. Alluvial deposits lying upstream of the damsite as well as colluvial deposits and highly weathered rocks distributed near the damsite can be used for filter materials. Further extensive investigations are required for seeking core materials in and around the damsite.

(b) Preliminary Design of Luy Reservoir

Following the above topographic survey and geological investigation, a preliminary design of the Luy dam is prepared as shown in Figures 2.38 and 2.39. Its major features are summarized below:

- Type of dam		Centre core rockfill
- Full supply level (FSL)	EL. m	129.0
- Flood water level (FWL)	EL. m	132.0
- Minimum operating level (MOL)	EL. m	120.0
- Gross storage volume	Mil. m ³	137.0
- Net storage volume	Mil. m ³	110
- Dam height and crest length		
	Main dam	m 33.0 and 1,870
	Sub-dam - 1	m 4.0 and 430
	Sub-dam - 2	m 5.0 and 580
- Type of spillway		Side overflow
- Design flood discharge	m ³ /sec	1,000
- Max. outlet discharge	m ³ /sec	48
- Total embankment volume	m ³	2,751,000.

Main Canals

The general layout of the Phan Ri and Phan Thiet irrigation project is shown in Figure 2.40, and its irrigation system diagram is shown in Figure 2.41 in a more elaborated manner. Two main canals are required; one is the west main canal commanding west half of the project area and also conveying water to the Phan Thiet plain with an area of 10,000 ha area and the other east main canal. The proposed routes of main canals have relatively flat topography, however, it may encounter rock layers with relatively shallower depth in several places according to the field reconnaissance, although further extensive topographical and geological investigations are needed. The major features of main canals are summarized below:

		West Main Canal	East Main Canal
Command area	ha	24,000 (*)	16,000
Length	Km	25.5	8.0
Head discharge	m ³ /sec	28.3	18.9
Canal slope		1 : 10,000	1 : 10,000
Canal base width	m	12.0 to 6.0	9.0 to 5.0
Canal height	m	3.5 to 3.3	3.5 to 2.5
Excavation volume	m ³	1,240,000	400,000
Embankment volume	m ³	400,000	160,000

(*) including the existing 2,300 ha irrigated by the Suoi Da reservoir and Don Moi weir.

(3) Construction Cost

The construction cost of Phan Ri-Phan Thiet irrigation project is updated to be US\$ 209.1 million in total including the Ca Giay dam as shown in Tables 2.57 and 2.58 and summarized below:

	Amount (million US\$)
Ca Giay Reservoir System	
- Ca Giay dam	26.3
- Canals and on-farm works(2,000 ha)	2.3
Luy Reservoir System	
- Luy dam	80.8
- Land reclamation, canals and on-farm works in Phan Ri plain (30,000 ha) (*)	82.9
- Canals and on-farm works in Phan Thiet plain (10,000 ha)	16.8
Total	209.1

(*) including 2,300 ha irrigated by the Suoi Da reservoir and Don Moi weir.

(4) Implementation Schedule

As discussed in Sub-section 2.8.4, the Phan Ri-Phan Thiet irrigation project will be implemented on a stagewise development basis. The total construction period is set tentatively at 10 years, assuming the annual development of irrigation area to be about 4,000 ha. Two implementation schedules are conceivable either in combination with the Ca Giay reservoir system or not, since the construction of Ca Giay dam is expected to start soon as shown below:

a) Schedule Alternative-1 : 42,000 ha combined with the Ca Giay reservoir system

Year	Phan Ri (*)			Phan Thiet	Unit: ha
	Ex. Paddy	Upland	Reclaimed	Ex. Paddy	Total
1st	3,500				3,500
2nd	3,500				3,500
3rd	3,500				3,500
4th	3,630			1,000	4,630
5th		1,870		3,000	4,870
6th		2,000		3,000	5,000
7th		2,000		3,000	5,000
8th			4,000		4,000
9th			4,000		4,000
10th			4,000		4,000
Total	14,130	5,870	12,000	10,000	42,000

(*) including on-farm works for the existing 2,300 ha irrigated by the Suoi Da reservoir and Don Moi weir.

b) Schedule Alternative-1 : 40,000 ha independent of the Ca Giay reservoir system

Year	Phan Ri (*)			Phan Thiet	Unit: ha
	Ex. Paddy	Upland	Reclaimed	Ex. Paddy	Total
1st	3,000				3,000
2nd	3,000				3,000
3rd	3,000				3,000
4th	3,130			1,000	4,130
5th		1,870		3,000	4,870
6th		2,000		3,000	5,000
7th		2,000		3,000	5,000
8th			4,000		4,000
9th			4,000		4,000
10th			4,000		4,000
Total	12,130	5,870	12,000	10,000	40,000

(*) including on-farm works for the existing 2,300 ha irrigated by the Suoi Da reservoir and Don Moi weir.

(5) Economic Evaluation

The economic viability of the Phan Ri-Phan Thiet irrigation project is evaluated by calculating the economic internal rate of return (EIRR) for two alternative cases with and without the Ca Giay reservoir system. The cash flow of economic cost and benefits according to the two implementation schedules as mentioned above are shown in Table 2.59, and the results are summarized below:

Alternative	EIRR
42,000 ha combined with the Ca Giay reservoir system	12.6 %
40,000 ha independent of the Ca Giay reservoir system	14.8 %

The result of economic evaluation suggests that the Phan Ri-Phan Thiet irrigation project be economically feasible even constructing both the dams. Taking into account a possible risk that the commissioning of Dai Ninh power station would delay beyond the anticipated, year 2003 the proposal of immediate construction of the Ca Giay dam may be justified from an economic point of view.

(6) Alternative Plan of Reservoir and Irrigation System

The Government is to start the construction of the Ca Giay dam in the year 1996 with a storage capacity of about 30 million m³. While, there is a possible plan of Dai Ninh -2 hydropower project which would have a generating capacity of 65 MW by diverting water released from Dai Ninh power station built on the Luy River to the Ca Giay River and by harnessing a head of about 90 m. The capacity of the Ca Giay reservoir can be increased to 150 million m³ by raising the dam height of the currently proposed Ca Giay dam without affecting to the tail water of the Dai Ninh-2 hydropower station. The increased Ca Giay reservoir can regulate the flow from the Dai Ninh power stations without the Luy reservoir, and irrigate most part of the Phan Ri-Phan Thiet irrigation project area with minimal loss.

Subject to realization of the Dai Ninh-2 hydropower project, an alternative irrigation system of the Phan Ri-Phan Thiet irrigation project is designed as follows:

- The Ca Giay dam is raised in future for irrigating the project area, increasing to the net storage volume of 135 million m³ from the presently designed 29.4 million m³;
- The irrigation area is decreased to 40,700 ha in total including the Phan Thiet plain of 8,700 ha; and
- The irrigation system diagram is shown in Figure 2.41.

The cost of raised Ca Giay dam is preliminarily estimated to be US\$ 41.3 million. Assuming the construction of both the Dai Ninh-2 power station and the raised Ca Giay dam starts at the same time in the year 2003, the EIRR is calculated at about 10 %. Besides such a rather low economic viability, there is no certainty in planning of the Dai Ninh-2 hydropower project at present. Hence, the alternative irrigation system by the raised Ca Giay dam is omitted.

2.10.4 Lower La Nga Plain Irrigation Project

The study of optimum water allocation concludes that the Lower La Nga Plain irrigation project should be developed with an area of 31,600 ha in total, consisting of 19,000 ha of Ta Pao irrigation scheme and 12,600 ha of Vo Dat irrigation scheme. The project will be formulated according to the development concepts discussed in previous Sub-section 2.8.5, and the technical and economic updating of both schemes is described below.

(1) Ta Pao Irrigation Scheme

Against the potential development area of 23,000 ha, the Ta Pao irrigation scheme is to be formulated with an irrigation area of 19,000 ha in total. The reduced 4,000 ha is allocated to the flood-prone area of about 4,700 ha estimated by the flood mitigation study discussed in Appendix VIII, which corresponds to 4,000 ha in net approximately. With a changed irrigation area, the investment cost of Ta Pao irrigation scheme is updated at US\$ 77.3 million in total as shown in Table 2.60. The EIRR is assessed at 12.2 % as calculated in Table 2.61.

(2) Vo Dat Irrigation Project

Against the potential development area of 15,000 ha, the Vo Dat irrigation scheme is to be formulated with an irrigation area of 12,600 ha in total. The reduced 2,400 ha is allocated to the right bank of the La Nga River with an area of 2,800 ha in net, being classified as forest in the land use data as shown in Table 2.45. Thus, all the right bank area of the La Nga River is excluded from the irrigation development area. Under the reduced 12,600 ha area, the investment cost of Vo Dat irrigation scheme is updated at US\$ 83.2 million in total as shown in Table 2.60. The EIRR is assessed at 9.9 % as calculated in Table 2.61.

2.10.5 Phuoc Hoa Irrigation Project

The study of optimum water allocation selects the Phuoc Hoa irrigation project as one of the master plan projects with an area of 45,680 ha by pump irrigation method without the large Phuoc Hoa dam. The investment cost of the Phuoc Hoa irrigation project is estimated at US\$ 220.2 million as described in Sub-section 2.7.2. The EIRR is estimated at 10.9 % as shown in Table 2.62. While, it would be increased to 17.3 % when the benefit of domestic and industrial water supply is added.

Although the Phuoc Hoa irrigation scheme is selected as one of the master plan projects with remaining agricultural development concept unchanged from the planning report made by the Government in the year 1995, the way of agricultural development in the southern area of Song

Be province by the Phuoc Hoa irrigation scheme would have to be substantially re-assessed before entering in the implementation in view of the following three aspects:

Socio-economic aspect:

- Future land use in the southern part of the scheme area, i.e. southern Ben Cat district, Tan Uyen district and Thuan An district, situated close to the core zone of Southern Focal Economic Area (SFEA); and
- Farmers' intention to convert the cashew plantation with an area of about 7,200 ha (ages of trees are more or less 10 years) into paddy and upland crops fields.

Technical and project economic aspects:

- Possibility of groundwater irrigation development for the upland crops and fruits based agriculture in the southern part of the scheme area instead of constructing a long stretched canal from the Phuoc Hoa headworks which requires a large quantity of earthworks (about 15 million cu.m.); and
- Land use for diversified agriculture instead of paddy monoculture being developed in the land along the small streams by exploiting those surface and groundwater resources.

Environmental aspect:

- Natural and social environmental impacts by creating the Phuoc Hoa reservoir, which has a large water surface area of about 38 km² despite using only top 2 m out of about 25 m in the maximum depth of the reservoir.

2.10.6 Dau Tieng Extension and HCMC-Long An Delta Irrigation Project

(1) Updated Investment Cost

Investment costs of the irrigation schemes, which will receive by the Song Be-Dau Tieng diversion, are updated by referring to the cost estimates made in Sub-sections 2.6 and 2.7 and are estimated at US\$ 242.5 million in total as shown below:

Irrigation Scheme	Irri. Are (ha)	Cost (million US\$)
Dau Tieng Extension	48,390	74.0
HCMC Delta	46,000 (*1)	93.6 (*2)
Long An Delta	31,170	74.9
Total	113,360	242.5

(*1): including area of Hoc Mon-Bac Binh Chanh irrigation project

(*2): excluding cost of Hoc Mon-Bac Binh Chanh irrigation project

(2) Economic Evaluation of Fu Mieng Multipurpose Reservoir

The diversion from the Fu Mieng reservoir is selected in this study as the optimal diversion scheme to the HCMC-Long An delta through the Dau Tieng reservoir in comparison with the alternative diversion from the Phuoc Hoa reservoir. To confirm the economic viability of Fu Mieng multipurpose project including the hydropower project in comparison with the Phuoc Hoa alternative, the construction cost of Phuoc Hoa dam and diversion canal from the Phuoc Hoa reservoir to the Dau Tieng reservoir is updated at US\$ 196.2 million as shown in Table 2.63. An overall economic viability of the diversion scheme including the hydropower project is discussed in Appendix V, proving that the Fu Mieng diversion with hydropower generation is the most viable project between two. However, further detailed studies are required for selecting either of them due to the fact that the difference in terms of economic viability is marginal between them.

(3) Economic Evaluation

The irrigation schemes benefited by water transfer from Be River to Dau Tieng reservoir are three schemes, i.e. Dau Tieng Extension, HCMC delta and Long An delta. The incremental irrigation area owing to the diversion is given as the difference between the conditions of future with-project and future without-project, and is estimated for the respective schemes as follows:

Scheme	Unit: ha		
	Future With	Future Without	Incr. Area
Dau Tieng Extension	48,390	18,000 (*1)	30,390
HCMC Delta	46,000	12,200 (*2)	33,800
Long An Delta	31,170	0	31,170
Total	125,560	30,200	95,360

(*1): Additional water available in the Saigon River besides irrigating the present 45,000 ha in Dau Tieng area, referring to Table 2.16

(*2): Irrigation area of the Hoc Mon-Bac Binh Chanh irrigation project irrigated by the natural flow of the Saigon River

In evaluating the economic viability of the Project, costs of the Fu Mieng dam and the diversion channel have to be shared by the irrigation schemes. As estimated in Appendix V, an amount allocated is US\$ 149 million as the financial cost or US\$ 127 million as the economic cost, and this is further allocated to the respective schemes depending upon the irrigation area and benefit as shown below:

Scheme	Economic Cost (million US\$)
Dau Tieng Extension	82.0
HCMC Delta	24.0
Long An Delta	21.0
Total	127.0

The EIRR is calculated for the individual schemes as well as overall the Dau Tieng Extension and HCMC-Long An Irrigation Project involving three irrigation schemes as shown in Table 2.64 and summarized below:

	EIRR (%)
Overall Project	10.5
Dau Tieng Extension irrigation scheme	10.8
HCMC Delta irrigation scheme	8.0
Long An Delta irrigation scheme	8.6

2.10.7 Selection of Priority Projects

With the irrigation development strategy proposed in Section 2.9, the priority projects in this master plan study are to selected among those selected by the study of optimal allocation of water available in the Dong Nai River and surrounding basin. The said development strategy envisages the following two development categories:

- Rural agricultural development project based on the rehabilitation and improvement of the existing irrigation schemes as an immediate irrigated agricultural development plan; and
- Water resources development projects for the potential irrigation schemes.

Accordingly, the two priority projects would be selected; one is the rural agricultural development project (RADP) covering 118 existing small irrigation schemes with a total area of 50,082 ha and 58 new schemes with 52,294 ha in total as discussed in Sub-section 2.11.2, and the other is the potential irrigation project chosen among the eight irrigation schemes as listed in Sub-section 2.10.1. In selecting the priority project for the latter, following factors are taken into accounts:

- Social Impact;
- Maturity of project preparation; and
- Economic viability.

The selection procedure of priority project is shown in Table 2.65 and summarized below:

Development Package	Master Plan Project	Area (ha)	Social Impact	Maturity	Economic Viability	Priority Ranking
Phan Ri-Phan Thiet Irrigation Project	Phan Ri (*)	29,700	A	B	A	1
	Phan Thiet	10,000	A	C	A	
Lower La Nga Plain Irrigation Project	Ta Pao	19,000	A	C	A	3
	Vo Dat	12,620	B	C	C	
Phuoc Hoa Irrigation Project	Phuoc Hoa	45,680	B	B	B	2
Dau Tieng Extension and HCMC-Long An Delta Irrigation Project	Dau Tieng Extension	48,390	B	B	B	4
	HCMC Delta	46,000	C	C	C	
	Long An Delta	31,170	C	C	C	

(*) including the existing 2,300 ha irrigated by the Suoi Da reservoir and Don Moi Weir.

From the above result, the Phan Ri-Phan Thiet irrigation project with an area of 42,000 ha is selected as the priority project together with the rural agricultural development project.

2.10.8 Implementation Schedule of the Master Plan Projects

(1) Investment Cost

The investment cost of the master plan projects is preliminarily estimated to be US\$ 1,037 million in total as shown below:

Development Package	Cost (million US\$)	Master Plan Project	Cost (million US\$)
1. Rural Agricultural Development Project (RADP)	231	Small Existing Irrigation Schemes	58
		New Small Irrigation Scheme	173
2. Phan Ri-Phan Thiet Irrigation Project	183	Phan Ri Irrigation Scheme (*1)	166
		Phan Thiet Irrigation Scheme	17
3. Lower La Nga Plain Irrigation Project	160	Ta Pao Irrigation Scheme	77
		Vo Dat Irrigation Scheme	83
4. Phuoc Hoa Irrigation Scheme			220
5. Dau Tieng Extension and HCMC-Long An Delta Irrigation Project	243	Dau Tieng Extension Irrigation Scheme	74
		HCMC Irrigation Scheme (*2)	94
		Long An Irrigation Scheme	75
Total			1,037

(*1): excluding cost of Ca Glay dam which will be constructed from the year 1996 according to the Ministry of Agriculture and Rural Development and Binh Thuan Province

(*2): excluding on-going Hoc Mon-Bac Binh Chanh Irrigation Scheme of 12,197 ha

(2) Implementation Schedule

The implementation schedule of the master plan projects is preliminarily prepared for the next 20-year period until the year 2015 according to the priority ranking discussed above in

principle and also taking into account the regional fairness in development and priority investment policy currently envisaged by the Government of Viet Nam. Besides the above, the implementation schedule is so set as to equalize both the annual irrigation development area and annual investment cost as much as possible. The implementation schedule of the master plan projects so preliminarily prepared is shown in Figure 2.42.

(3) Annual Development Area and Investment Cost

From the preliminary implementation schedule mentioned above, the annual irrigation development areas and annual investment costs are calculated as shown in Table 2.66, and summarized below:

Year	Annual Irrigation Development Area (ha)		Annual Investment Cost (million US\$)	
1996	0	0.0 %	0.0	0.0 %
1997	0	0.0 %	0.0	0.0 %
1998	0	0.0 %	0.0	0.0 %
1999	3,340	1.0 %	3.9	0.4 %
2000	3,340	1.0 %	14.9	1.4 %
2001	19,470	5.8 %	61.7	5.9 %
2002	19,470	5.8 %	74.4	7.2 %
2003	19,470	5.8 %	63.4	6.1 %
2004	25,440	7.6 %	95.6	9.2 %
2005	29,460	8.8 %	116.4	11.2 %
2006	26,970	8.0 %	92.5	8.9 %
2007	26,970	8.0 %	81.2	7.8 %
2008	25,970	7.8 %	75.3	7.3 %
2009	25,970	7.8 %	55.4	5.3 %
2010	22,170	6.6 %	43.9	4.2 %
2011	20,690	6.2 %	52.1	5.0 %
2012	20,690	6.2 %	60.5	5.8 %
2013	20,662	6.2 %	60.0	5.8 %
2014	12,510	3.7 %	45.0	4.3 %
2015	12,454	3.7 %	40.8	3.9 %
Total	335,046	100 %	1,037.0	100 %

2.10.9 Impact of Master Plan Projects

The impact of Master Plan Projects is evaluated by the outputs of the projects in terms of increment of paddy production and increment of cultivating area of cash crops. The increment paddy production in the year is estimated at 1.16 million tons including the Rural Agricultural Development Project. While the increased cultivating area of cash crops in the eight Master Plan Projects would be about 165,000 ha including sugarcane of 19,800 ha and cotton of 13,200 ha. These are shown in Table 2.67 and summarized below:

Project	Develop. Area (ha)	Increment Paddy Product. (ton)	Increment of Cultivating Area of Cash Crops			
			Sugarcane (ha)	Cotton (ha)	Other Crops (ha)	Total (ha)
Phuoc Hoa	45,680	99,730	2,110	0	34,810	36,920
Dau Tieng Extension	48,39	54,200	0	0	59,030	59,030
Phan Ri	32,000	152,160	5,850	6,400	10,670	22,920
Phan Thiet	10,000	39,270	1,830	2,000	3,880	7,710
Ta Pao	19,000	92,150	1,980	2,300	3,720	8,000
Vo Dat	12,600	78,200	2,270	2,520	1,930	6,720
HCMC Delta	46,000	165,830	5,620	0	14,840	20,460
Long An Delta	31,200	138,870	140	0	3,160	3,300
RADP	102,680	337,860	-	-	-	-
Total	347,550	1,158,270	19,800	13,220	132,040	165,060

With irrigation development of about 348,000 ha, the incremental paddy production is estimated to be 1.16 million tons per annum in the year 2015. While, the requirement of paddy to meet the population increased by 7.3 million in the Study Area for the year 1995 to 2015 would be about 2.1 million tons by assuming a per capita consumption of 285 kg/year. The irrigation development to the full extent under the optimum utilization of water resources in the Dong Nai and surrounding basins would contribute to the stable food supply in the Study Area, satisfying about 50 % of increased demand.

While, the cultivating area of cash crops is expected to increase remarkably. In particular, cultivation area of sugarcane in the eight Master Plan Project areas will share one-third of target increasing area of about 60,000 ha in the Study Area (refer to Sub-section 1.3.4), and those of cotton share the half of the target 25,000 ha as well. It should be noted, however, that the cultivation area of the respective cash crops adopted in this Master Plan Study are of indicative figures estimated by the agricultural development plans currently envisaged by the concerned national and provincial agencies and also for working out the water requirements in the Study Area which should ensure adequate irrigation against possible changes of crops in future depending upon the domestic and international circumstances. Therefore, in-depth studies for cropping systems should be made in the feasibility studies of the respective Master Plan Projects before they are put into implementation.

TABLES

Table 1.1 A Sample of the Farm Surveys (1/4)

1. Survey date

2. Farmer's name

3. Village name

4. Sub district name

5. District name

6. Project area name

7. Sex male female

8. Age

9. Highest educational career
 no schooling junior high school collage/ university other
 primary school high school vocational school

10. Profession for main source of income ,select only one
 rice farmer vegetable farmer clerk
 coffee farmer casual labourer government employee
 tea farmer fishman others
 rubber farmer skilled artisan
 sericulture farmer rickshaw driver
 tobacco farmer vehicle driver
 cashew farmer shopkeeper/trader

11. Number of family member including respondent

12. Adult male number, more than 15 years old

13. Adult female number, more than 15 years old

14. Children number

15. Number of adult family members working for non farming

16. Number of adult family members working for farming

17. Number of schooling family members

18. Number of ill or aged family members

19. Source of gross income of a respondent, million dong

Field crop income	<input type="text" value="1.8"/>
Livestock income	<input type="text" value="3.8"/>
Fishing income	<input type="text" value="0"/>
Nonfarming income	<input type="text" value="0"/>
Fruit/vegetable growing income	<input type="text" value="0"/>
Other income	<input type="text" value="6.5"/>
Total annual income	<input type="text" value="12.1"/>
Months worked for non-farming	<input type="text" value=""/>

Table 1.1 A Sample of the Farm Surveys (2/4)

20. Annual Household Cash Expenditures, 1000dong/year		21. Source of draft power, multiple selection ok
Food	<input type="text" value="2160"/>	<input type="checkbox"/> not used <input checked="" type="checkbox"/> owned animal <input type="checkbox"/> hired animal <input type="checkbox"/> borrowed animal <input type="checkbox"/> animal power custom service <input type="checkbox"/> own hand tractor <input type="checkbox"/> hired hand tractor from private <input type="checkbox"/> hired hand tractor from group/coop <input type="checkbox"/> borrowed hand tractor from private <input type="checkbox"/> borrowed hand tractor from group/coop <input type="checkbox"/> own 4 wheel tractor <input type="checkbox"/> hired 4 wheel tractor from private <input type="checkbox"/> hired 4 wheel tractor from group/coop <input type="checkbox"/> borrowed 4 wheel tractor from private <input type="checkbox"/> borrowed 4 wheel tractor from group/coop <input type="checkbox"/> others
Tobacco / cigarettes	<input type="text" value="1000"/>	
Housing	<input type="text" value="0"/>	
Fuel Light Water	<input type="text" value="0"/>	
Housing furnishing , equipment	<input type="text" value="40"/>	
Taxes	<input type="text" value="0"/>	
Medical expenses	<input type="text" value="0"/>	
Transportation , communication	<input type="text" value="0"/>	
Recreation	<input type="text" value="0"/>	
Education	<input type="text" value="0"/>	
Others	<input type="text" value="0"/>	
Total expenditure	<input type="text" value="3200"/>	

22. Machine land preparation cost per ha, 1000dong

23. Animal land preparation cost per ha,1000dong

24. Is there enough draft power in the commune ? yes no

25. Cropping Pattern in Normal Season

No. of farm plots	<input type="text" value="11"/>
Land holding, ha	<input type="text" value="0.8"/>
Land tenure	<input checked="" type="checkbox"/> 1.owned <input type="checkbox"/> 4.group owned <input type="checkbox"/> 2.sharecropped in <input type="checkbox"/> 5.shifting <input type="checkbox"/> 3.rented in
Max flood depth, cm	<input type="text" value="150"/>
Name of winter-spring crop	<input type="text" value="SUGAR"/>
Winter-spring crop area,ha	<input type="text" value="0.4"/>
Winter-spring season crop irrigation mode	<input type="text" value="rained"/>
Name of summer- autumn crop	<input type="text" value="FALL"/>
Summer-autumn crop area, ha	<input type="text"/>
Summer-autumn crop irri. mode	<input type="text"/>
Name of wet season crop	<input type="text" value="PADDY"/>
Wet season crop cropped area, ha	<input type="text" value="0.4"/>
Wet season crop crop irri mode	<input type="text" value="rained"/>

Table 1.1 A Sample of the Farm Surveys (3/4)

26. Cropping period	Sowing/planting		Harvesting	
	from	to	from	to
Winter-spring	May 1	May 30	Feb. 1	Feb. 28
Summer-Autumn				
Wet Season	June 1	June 30	Sept. 1	Sept. 30

27. Daily wage of casual male labor without meal, 1000dong

28. Daily wage of casual female labor without meal, 1000dong

29. Is farm work ever delayed for lack of manpower ? 1.yes 2.no

30. Sources of the most important fund for fertilizers , pesticides , select only one

<input checked="" type="checkbox"/> loan from agricultural bank	<input type="checkbox"/> cash from sales of crops
<input type="checkbox"/> loan from cooperative	<input type="checkbox"/> cash from sales of animal
<input type="checkbox"/> loan from private bank	<input type="checkbox"/> cash from sales of land
<input type="checkbox"/> loan from money lenders	<input type="checkbox"/> cash from sales of other assets
<input type="checkbox"/> borrow from relatives and friends	<input type="checkbox"/> cash from casual labour work
<input type="checkbox"/> borrow from fertilizer supplier	<input type="checkbox"/> other

31. Sources of agricultural technology , select most important one item only

<input type="checkbox"/> parents	<input type="checkbox"/> private merchants for farm inputs	<input type="checkbox"/> own experience
<input checked="" type="checkbox"/> neighboring farmers	<input type="checkbox"/> cooperatives	<input type="checkbox"/> books
<input type="checkbox"/> government extension workers	<input type="checkbox"/> newspapers	
<input type="checkbox"/> agricultural company	<input type="checkbox"/> radio/television	

32. Most needed development , select most needed one item only

<input type="checkbox"/> drinking water supply	<input type="checkbox"/> flood control facilities	<input type="checkbox"/> food storage
<input type="checkbox"/> roads	<input type="checkbox"/> education facilities	<input type="checkbox"/> parts supply
<input checked="" type="checkbox"/> irrigation water supply	<input type="checkbox"/> medical facilities	
<input type="checkbox"/> drainage/sewerage facilities	<input type="checkbox"/> electricity supply	

33. Irrigation water quality

<input checked="" type="checkbox"/> good quality
<input type="checkbox"/> slightly saline not effecting yields
<input type="checkbox"/> saline effecting yields

34. Irrigation water availability

<input type="checkbox"/> no- never a shortage year-round
<input type="checkbox"/> shortage in wet season
<input checked="" type="checkbox"/> shortage in dry season

35. Causes of shortage , select most important one item only

<input checked="" type="checkbox"/> lack of water in river or dam	<input type="checkbox"/> breakdown of weir
<input type="checkbox"/> fall in groundwater level	<input type="checkbox"/> electric power failure
<input type="checkbox"/> poor distribution from weir of pump station	<input type="checkbox"/> dispute with irrigation organization
<input type="checkbox"/> no operation of pump station	<input type="checkbox"/> others

Table 1.1 A Sample of the Farm Surveys (4/4)

36. Type of fishing never fish fish pond open water paddy fields

37. Approx annual average amount of fish caught , kg

38. Percentage of fish caught that you sell

39. Livestock

Number of pigs kept Number of cattle kept

Number of pigs breded Number of cattle breded

Number of pig sold Number of cattle sold

Number of buffalo kept

40. Marketed paddy , % of production

41. Marketed maize , % of production

42. Marketed soybean , % of production

43. Market outlets , select most important one item only

- | | |
|--|---|
| <input type="checkbox"/> private middlemen in the farm | <input type="checkbox"/> cooperative |
| <input type="checkbox"/> government agri-company in the farm | <input type="checkbox"/> processing company |
| <input checked="" type="checkbox"/> local market | <input type="checkbox"/> others |
| <input type="checkbox"/> large markets in a city | |

44. Distance to the nearest market, km

45. Transportation means to the markets , select most important one item only

- | | | | |
|------------------------------------|--|--|---|
| <input type="checkbox"/> handcarry | <input checked="" type="checkbox"/> oxcart | <input type="checkbox"/> boat | <input type="checkbox"/> wagon drawn by 4 wheel tractor |
| <input type="checkbox"/> bicycle | <input type="checkbox"/> horsecart | <input type="checkbox"/> truck/bus | <input type="checkbox"/> Xe van tai(farmer's truck) |
| <input type="checkbox"/> xitlo | <input type="checkbox"/> handcart | <input type="checkbox"/> wagon drawn by hand tractor | <input type="checkbox"/> other |

46. Transport cost from farm to the nearest market, 1000dong per ton/km

Table 1.2 Summary of the Farm Surveys (1/7)

Project area name	Age	Highest educational career	Profession for main source of income	Number of family member including respondent	Children number staying together
DAUTHIEN	58	primary school	rice farmer	5	0
PHUC HOA	38	junior high	others	4	2
SONG RAY	56	primary school	cashew farmer	8	2
SONG RAY	38	primary school	rice farmer	5	3
PHAN THIET	48	high school	rice farmer	2	0
PHAN THIET	40	primary school	rice farmer	4	2
SONG RI	59	no schooling	rice farmer	5	2
SONG RI	70	no schooling	rice farmer	3	0
PHAN RANG	33	primary school	rice farmer	4	2
SONG PHA	65	primary school	rice farmer	2	0
LA NGA	40	junior high	rice farmer	4	2
LA NGA	34	junior high	others	6	4
Average	48.			4.3	1.5

Table 1.2 Summary of the Farm Surveys (27)

Project area name	Food	Tobacco / cigarettes	Housing	Fuel Light		Housing		Medical	Transportation		Recreation	Education	Others	Total expenditure
				Water	Water	furnishing	equipment		expenses	communication				
DAUTHIEN	1500	0	0	240	0	240	100	0	0	0	0	0	0	2080
PHUC HOA	14400	0	500	0	60	0	0	0	0	50	0	0	0	15010
SONG RAY	10800	720	1000	1080	5000	200	0	0	1000	200	0	0	0	20000
SONG RAY	13600	720	2000	120	1300	500	0	0	0	120	0	0	0	18360
PHAN THIET	840	540	0	0	400	0	0	0	0	0	0	0	0	1780
PHAN THIET	1000	520	1000	0	180	0	0	0	0	0	0	0	0	2700
SONG RI	1800	0	599	120	300	300	0	0	0	0	0	0	0	3119
SONG RI	2160	1000	0	0	40	0	0	0	0	0	0	0	0	3200
PHAN RANG	2400	500	500	100	0	0	500	0	0	40	0	0	0	4040
SONG PHA	1440	250	1000	240	1000	50	200	0	200	0	0	0	0	4380
LA NGA	9000	100	0	250	500	200	60	60	0	100	0	0	0	10270
LA NGA	12000	100	2000	150	3000	100	100	2000	0	100	0	0	0	19550
Average	5911.	370.	716.	191.	981.	132.	80	171.	100	50.	0	0	0	8707.

Table 1.2 Summary of the Farm Surveys (37)

Project area name	Field crop income	Livestock income	Fishing income	Nonfarming income	Fruit growing income	Other income	Total annual income	(unit: million dong)
DAUTHIEN	6.4	6	0	0	1	0	13.4	
PHUCHOA	7.5	0	0	2.4	0	0	9.9	
SONG RAY	1.45	8	0	5	6	0	20.45	
SONG RAY	11.9	0	0	0	0	4	15.9	
PHANTHIEU	2.52	0	0	0	5	0	7.52	
PHANTHIEU	1.2	0	0	0	0	2.8	4	
SONG RI	2	0	0	0	0	0	2	
SONG RI	1.8	3.8	0	0	0	6.5	12.1	
PHAN RANG	4.8	0	0	0	0	0	4.8	
SONG PHA	4.5	2	1.35	0	0	0	7.85	
LANGA	8.5	0	1.35	0	2	0	11.85	
LANGA	0	4	0	0	0.6	12	16.6	
Average	4.38	1.98	.225	.616	1.21	2.10	10.5	

Table 1.2 Summary of the Farm Surveys (4/7)

Project area name	No. of farm plots	Land holding, ha	Land tenure	Name of winter crop		Winter spring crop %	Name of summer crop		Summer autumn crop %	Name of wet season crop		Wet season crop %
				winter crop	spring crop		summer autumn crop	wet season crop				
DAUTHIEN	2	1.8	1.owned	SOYBEANS		44.4	FALLOW		0	PADDY		44.4
PHUC HOA	5	0.3	5.shifting			0			0	CASSAVA		100
SONG RAY	2	1.2	1.owned	FALLOW		0	MAIZE		58.3	PADDY		12.5
SONG RAY	6	1.1	1.owned	PADDY		100	FALLOW		0	PADDY		100
PHANTHIEU	2	0.27	1.owned	PADDY, THANH LONG		100	PADDY		62.9	PADDY		62.9
PHANTHIEU	3	0.4	1.owned	FALLOW		0	FALLOW		0	PADDY		100
SONG RI	3	0.3	1.owned	FALLOW		0	PADDY		100	PADDY		100
SONG RI	11	0.8	1.owned	SUGAR CANE		50	FALLOW		0	PADDY		50
PHAN RANG	5	0.3	1.owned	PADDY		100	PADDY		100	PADDY		100
SONG PHA	10	0.4	1.owned	PADDY		100	PADDY		100	PADDY		100
LA NGA	6	0.8	1.owned	PADDY		100	PADDY		100	FALLOW		0
LA NGA	1	0.22	1.owned			0			0			0
Average	4.6	.65				49.5			43.4			64.1

Table 1.2 Summary of the Farm Surveys (577)

Project area name	Type of fishing	Approx annual average amount of fish caught, kg	Percentage of fish caught that you sell	Number of pigs kept	Number of buffalo kept	Number of cattle kept	Irrigation water availability in canals	Causes of shortage
DAUTHIEN	never fish			1			shortage in dry season	lack of water in river or dam
PHUC HOA				0	0	0		
SONG RAY	never fish			5		3		
SONG RAY	never fish			0	0	0	shortage in dry season	lack of water in river or dam
PHANTHIEU	never fish			0	0	0	shortage in dry season	lack of water in river or dam
PHANTHIEU	never fish			0	0	0		
SONG RI	never fish			0	0	0	shortage in dry season	lack of water in river or dam
SONG RI	never fish			0	0	6	shortage in dry season	lack of water in river or dam
PHIAN RANG	never fish					2	no- never a shortage year-round	
SONG PHA	fish pond	300	100	4		0	no- never a shortage year-round	
LA NGA	open water	300	67	0	0	0		
LA NGA	never fish							
Average		300	83.5	1	0	1.		

Table 1.2 Summary of the Farm Surveys (6/7)

Project area name	Sources of funds for fertilizers, pesticides	Sources of agricultural technology	Most needed development	Marketed paddy, % of production	Market outlets	Distance to the nearest market, km	Transportation means to the markets	Transport cost from farm to the nearest market per ton pe km, 1000dong
DAUTHIEN	cash from sales of crops	neighboring farmers	irrigation water supply	40	private middlemen in the farm			
PHUC HOA	cash from sales of crops		irrigation water supply		private middlemen in the farm			
SONG RAY	cash from sales of crops	neighboring farmers	electricity supply	0	local market	1	bicycle	
SONG RAY	cash from sales of crops	own experience	parts supply	67	local market	3	wagon drawn by hand tractor	6.7
PHAN THIET	cash from sales of crops	neighboring farmers	drinking water supply	0				
PHAN THIET	cash from casual labour work		irrigation water supply	0				
SONG RI	loan from agricultural bank	government extension	drinking water supply	10		0.2	hand carry	
SONG RI	loan from agricultural bank	neighboring farmers	irrigation water supply	0	local market	0.5	oxcart	20
PHUAN RANG	cash from sales of crops	neighboring farmers	food control facilities	50	local market	2	oxcart	5
SONG PHA	cash from sales of crops	neighboring farmers	electricity supply		local market	5	oxcart	6.6
LA NGA	cash from sales of crops	neighboring farmers	irrigation water supply	70	local market	1	bicycle	12
LA NGA		books			large markets in a city			
Average				26.		1.8		10.0

Table 1.2 Summary of the Farm Surveys (77)

Project area name	Source of draft power	Machine land preparation cost per ha, 1000dong	Animal land preparation cost per ha, 1000dong	Is there enough draft power in the commune ?	Daily wage of casual male labour without meal, 1000dong	Daily wage of casual female labour without meal, 1000dong	Is farm work ever delayed for lack of manpower ?
DAU THIEN	hired hand tractor from private	400		yes	15	12	2.no
PHUC HOA	hired 4 wheel tractor from private	300		yes	15	12	2.no
SONG RAY	owned animal			yes	15	15	
SONG RAY	own hand tractor	360		yes	17	15	2.no
PHAN THIET	hired hand tractor from private	600		yes	20	12	2.no
PHAN THIET	hired animal		200	yes	20	15	2.no
SONG RI	hired 4 wheel tractor from private	250	500	no	20	15	2.no
SONG RI	owned animal	180	300	yes	25	15	1.yes
PHAN RANG	owned animal	215	180	yes	20	15	2.no
SONG PHA	animal power custom service		600	yes	15	10	2.no
LA NGA	hired hand tractor from private	450		no	17	15	2.no
LA NGA	not used						
Average		344	356		18.	13.	

Table 1.3 Present Land Use in the Study Area

Present Land Use	Mekong Delta		Southeast Region		Central Highland		Coastal Region		Study Area	
	Area, ha	%	Area, ha	%	Area, ha	%	Area, ha	%	Area, ha	%
1. Triple irrigated rice	139	0.06		0.00		0.00			139	0.00
2. Double irrigated rice	47,559	21.29	89,249	3.82	19,505	1.71	12,024	1.05	168,337	3.47
3. Single irrigated rice	12,720	5.69	157,087	6.72		0.00		0.00	169,807	3.50
4. Double rainfed rice	39,380	17.63		0.00		0.00		0.00	39,380	0.81
5. Single rainfed rice	13,343	5.97		0.00		0.00		0.00	13,343	0.28
6. Single irr./ rainfed rice + upland crops	13,761	6.16	185,924	7.95	59,929	5.24		0.00	259,614	5.36
7. Upland crops		0.00		0.00		0.00		0.00	0	0.00
8. Pineapple/sugarcane	15,662	7.01	286,958	12.27	39,848	3.49	182,191	15.95	508,997	10.50
9. Shifting land		0.00	42,606	1.82	25,427	2.23	37,267	3.26	72,018	1.49
10. Coffee and Tea		0.00	20,688	0.88	8,519	0.75		0.00	29,207	0.60
11. Rubber		0.00	276,209	11.81		0.00		0.00	276,209	5.70
12. Cashew		0.00	103,428	4.42		0.00		0.00	103,428	2.13
13. Mulberry		0.00		0.00		0.00	671	0.06	671	0.01
14. Cinnamon		0.00		0.00		0.00	1,402	0.12	1,402	0.03
15. Fruit trees		0.00	32,551	1.39		0.00		0.00	32,551	0.67
16. Forest	8,523	3.81	568,170	24.29	757,498	66.29	406,112	35.55	1,740,303	35.90
17. Bush/grass		0.00	106,164	4.54		0.00	273,094	23.91	379,258	7.82
18. Salt pans		0.00	870	0.04		0.00		0.00	870	0.02
19. Bare land	64,393	28.82	349,402	14.94	210,327	18.41	192,952	16.89	817,074	16.86
19. Settlement/orchards	1,106	0.50	5,922	0.25	2,820	0.25	3,850	0.34	13,698	0.28
20. Rocky hill		0.00		0.00		0.00	1,303	0.11	1,303	0.03
21. Water body	6,843	3.06	57,177	2.44	18,797	1.65	31,374	2.75	114,191	2.36
Total	223,429	100	2,338,761	100	1,142,670	100	1,142,240	100	4,847,100	100

Source: Sub-National Institute for Agricultural Planning and Projection, 1994

Table 1.4 Land Suitability by Scheme and by Present Land Use, ha (1/2)

Lower La Nga LAND USE CATEGORY	Paddy		Upland crops	
	Suitable	Unsuitable	Suitable	Unsuitable
Triple irrigated rice	726	0	726	0
Double irrigated rice	51	0	51	0
Single rainfed rice	18417	0	18417	0
Upland crops	4543	0	4543	0
Sugarcane	12	0	12	0
Cashew	3,175	3	3,178	0
Evergreen forests	5429	0	5429	0
Bush/Grass	527	0	528	0
Settlement/Orchards	649	9	658	0
Total	33529	12	33541	0

Phan Thiet LAND USE CATEGORY	Paddy		Upland crops	
	Suitable	Unsuitable	Suitable	Unsuitable
Triple irrigated rice	4,174	0	4,174	0
Double irrigated rice	37	0	37	0
Single rainfed rice	17,340	0	17,340	0
Upland crops	5,122	77	5,165	34
Shifting land	771	0	771	0
Cashew	785	0	785	0
Evergreen forests	1	0	1	0
Bush/Grass	15,095	746	15,702	139
Salt pans	297	0	297	0
Settlement/Orchards	850	137	850	137
Total	44,471	960	45,121	310

Phan Ri LAND USE CATEGORY	Paddy		Upland crops	
	Suitable	Unsuitable	Suitable	Unsuitable
Single irri. + rainfed rice	2,279	7	2,284	10
Single rainfed rice	9,784	0	9,841	1
Single irri./rainfed rice + Upland crops	0	477	0	0
Upland crops	3,822	0	4,254	45
Sugarcane	0	210	0	0
Shifting land	680	0	781	108
Evergreen forests	1,693	242	1,758	177
Bush/Grass	13,550	4,613	14,814	3,349
Settlement/Orchards	1,435	51	1,469	16
Total	33,243	5,664	35,201	3,706

Phan Rang LAND USE CATEGORY	Paddy		Upland crops	
	Suitable	Unsuitable	Suitable	Unsuitable
Triple irrigated rice	14,191	28	14,191	28
Single rainfed rice	3,433	0	3,433	0
Upland crops	4,895	125	5,011	8
Shifting land	581	0	581	0
Mulberry	27	110	27	110
Fruit trees	3,092	54	3,093	54
Evergreen forests	40	2	42	0
Bush/Grass	4,484	597	4,529	552

Table 1.4 Land Suitability by Scheme and by Present Land Use, ha (2/2)

Bare land	352	162	352	162
Settlement/Orchards	969	13.6	969	14
Total	32,063	1,093	32,227	929

Song Pha LAND USE CATEGORY	Paddy		Upland crops	
	Suitable	Unsuitable	Suitable	Unsuitable
Triple irrigated rice	426	0	426	0
Single irri. + rainfed rice	140	0	140	0
Upland crops	1,534	0	1,534	0
Sugarcane	978.3	0	978	0
Bush/Grass	4,975	85	5,060	0
Bare land	29	0	29	0
Settlement/Orchards	279	0	279	0
Total	8,361	85	8,446	0

Song Ray LAND USE CATEGORY	Paddy		Upland crops	
	Suitable	Unsuitable	Suitable	Unsuitable
Triple irrigated rice	5,113	5	5,113	5
Single irri. + rainfed rice	2,773	28	2,801	0
Single rainfed rice	7,834	250	8,045	39
Upland crops	38,952	857	39,575	234
Shifting land	8,943	888	9,716	115
Rubber	18,478	1,005	19,238	245
Cashew	7,939	368	8,294	13
Mangrove forests	514	583	514	583
Evergreen forests	6,209	3,216	8,424	1,001
Bush/Grass	4,647	2,040	5,256	1,431
Salt pans	0	528	0	528
Bare land	390	738	390	738
Settlement/Orchards	882.1	40.9	922	1.4
Total	102,674	10,546	108,288	4,933

Phuc Hoa LAND USE CATEGORY	Paddy		Upland crops	
	Suitable	Unsuitable	Suitable	Unsuitable
Triple irrigated rice	1,742	0	1,742	0
Double irrigated rice	4,355	115	4,355	115
Single irri. + rainfed rice	246	0	246	0
Single rainfed rice	3,878	884	3,878	884
Single irri./rainfed rice + Upland crops	3,836	0	3,836	0
Upland crops	7,743	162	7,743	162
Rubber	1,753	104	1,753	104
Cashew	1,407	0	1,407	0
Bush/Grass	406	0	406	0
Settlement/Orchards	7,941	97	7,942	97
Total	33,306	1,362	33,306	1,362

Table 1.5 Crop Production in the Related Provinces (2/11)

Items	Province	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	
Paddy x 1000 ha	Lam Dong													9.6	9.6	
	Dac Lac													16	16	
	Ninh Thuan													3.7	3.8	
	Binh Thuan								3	3.3	3.5	2.9	3.4	18.5	17.7	
	Song Be	4.2	3.8	4	3.9	4.1	3.8	3.6	3.6	17.1	20.2	21.1	20.1	4	4	
	Dong Nai	11	11.7	13.2	14.3	16.7	19.5	21.9	21.9							
	Ba Ria Vung Tau															
	Tay Ninh	12.5	10.8	15.3	13.8	18.4	17	18	18	13.3	19.1	17.6	16.2	20.8	20.9	23.4
	HCMC	6.1	8	11.2	10.1	12.4	12.1	14.5	14.5	12.5	14.3	14.2	12.8	14.9	13.5	13.6
	Long An	48.6	32.3	42.6	42.6	51	60.7	71.9	71.9	66.7	93.6	94.1	99.6	113	112.7	106.6
	Thuan Hai	20.1	20.3	20.1	16.2	20.9	22.9	22.4	22.4	23	23.6	25.2	24.5	26.4		
	Paddy x 1000 ton	Lam Dong													40	40
		Dac Lac													62.2	62.2
		Ninh Thuan													10.9	11.1
		Binh Thuan													54.6	62
Song Be		8.6	7.7	8.6	10.5	11.4	10.6	9.7	9.7	8.6	9.7	10.2	8.4	71	71	
Dong Nai		27.2	27.9	33.1	42.1	51.2	63.6	70.1	70.1	57.1	65.1	67.6	59.7			
Ba Ria Vung Tau																
Tay Ninh		23.9	16.8	28.2	29.5	29.6	37.1	38	38	21.8	45.6	40.3	39	51.1	51.1	
HCMC		16.2	20.7	32.3	37.2	45.1	37.9	48.6	48.6	42.7	46.3	50.3	42.8	52.1	48.8	48
Long An		119.6	64.7	108.8	147.8	164.1	188.3	241.4	241.4	193.8	286.4	291.1	247.1	357.2	266	319.1
Thuan Hai		63.7	57.6	64.7	55.3	75.2	87.8	89.6	89.6	85.1	82.3	105.5	87.5	98.7		
Paddy ton/ha		Lam Dong													4.17	4.17
		Dac Lac													3.89	3.89
		Ninh Thuan													2.95	2.92
		Binh Thuan													2.95	3.50
	Song Be	2.05	2.03	2.15	2.69	2.78	2.79	2.69	2.69	2.87	2.94	2.91	2.90	3.03	3.03	
	Dong Nai	2.47	2.38	2.51	2.94	3.07	3.26	3.20	3.20	3.34	3.22	3.20	2.97	3.03	3.50	
	Ba Ria Vung Tau													0.00	2.34	
	Tay Ninh	1.91	1.56	1.84	2.14	1.61	2.18	2.11	2.11	1.64	2.39	2.29	2.41	2.46	2.40	
	HCMC	2.66	2.59	2.88	3.68	3.64	3.13	3.35	3.35	3.42	3.24	3.54	3.34	3.50	3.61	
	Long An	2.46	2.00	2.55	3.47	3.22	3.10	3.36	3.36	2.91	3.06	3.09	2.48	3.16	2.99	
	Thuan Hai	3.17	2.84	3.22	3.41	3.60	3.83	4.00	4.00	3.70	3.49	4.19	3.57			

Table 1.5 Crop Production in the Related Provinces (3/11)

Items	Season	Province	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993		
Paddy x 1000 ha	Wet season	Lam Dong	20.6	20.9	22.6	21.3	23.8	22.1	22.5	24.2	26.7	25.2	24.4	27.9	30	30	30	
		Dac Lac	44.5	49.3	45.5	46.6	38.6		39.1	40.8	35.7	46.1	48.2	49.7	51.7	57	57	57
		Ninh Thuan														12.3	12.3	12.3
		Binh Thuan														38.6	38.6	38.6
		Song Be	57.8	49	50.9	51.1	54.6	47.7	44.1	44.1	42.6	44.1	50.2	44.2	48.5	49.6	49.6	53.7
		Dong Nai	48.8	46.7	46.6	46.5	47.2	44.5	43.7	43.7	43.8	61.9	41.9	41.9	41.9	30.3	30.3	32.4
		Ba Ria Vung Tau	0.7	0.7	0.8	0.8	1	1	1	1	1	0.9	0.9	0.9	0.9	12.7	12.7	12.6
		Tay Ninh	74.8	70.5	70.2	68.6	58.4	58.4	59.2	57	60	58.4	59.7	44.3	44.3	64.6	64.6	73.6
		HCMC	57.9	58.3	59	59	56.9	53.2	54.9	56.2	51.5	55.4	57.3	57.2	57.2	56.6	56.6	56
		Long An	93.5	107	102	98.9	93.8	86.1	78	74.3	70	60.2	66.8	66.7	66.7	62.3	62.3	45.9
		Thuan Hai	40.9	44.2	46.5	47.5	43.8	46.2	46.4	47.7	46.8	49	49.1	49.1	49.1			
		Lam Dong	35.6	35.5	37.9	40.3	51.5	53.7	54.6	59.6	59.6	63.1	64	58.1	70	69.9	69.9	69.9
		Dac Lac	64.6	61.1	69.9	86	85.5	90.9	88.9	85.8	85.8	106	119.5	119.7	127.3	139.6	139.6	139.6
		Ninh Thuan														44	44	44
		Binh Thuan														98.8	98.8	98.8
Song Be	95.4	74.6	82.7	85.3	91.1	80.3	82.4	82.4	78.2	82	82	90.8	82.5	81.6	90.1	96.9		
Dong Nai	105.1	99.6	109.6	121.4	128.3	128	129.1	129.1	121.2	125.5	121	121	114.9	114.9	61.3	92.3		
Ba Ria Vung Tau	1.2	1.3	1.6	2	1.6	1.7	1.8	1.7	1.8	1.7	1.6	1.7	1.7	1.7	32.6	32.4		
Tay Ninh	129.6	112.8	128.7	143	104.9	112.8	120.8	103.6	103.6	118.2	121.1	121.1	134.1	134.2	93.3	169.3		
HCMC	150.8	148.2	165.3	179.8	170.9	163.9	165	170.9	165.2	165.2	176.3	163.5	163.5	125.3	125.3	177.5		
Long An	176.4	197.4	207.4	216.6	140.9	171.7	164.9	150.9	150.9	146	148.7	132	132	132	46.8	101.6		
Thuan Hai	89	84.7	101.1	125	115.1	127.7	134.8	130.5	130.5	128.1	143.3	147.1	147.1					
Lam Dong	1.73	1.70	1.68	1.89	2.16	2.43	2.43	2.46	2.46	2.36	2.54	2.38	2.51	2.33	2.33	2.33		
Dac Lac	1.45	1.24	1.54	1.85	2.22	2.32	2.18	2.40	2.40	2.30	2.48	2.41	2.46	2.45	2.45	2.45		
Ninh Thuan														3.58	3.58	3.58		
Binh Thuan														2.56	2.56	2.56		
Song Be	1.65	1.52	1.62	1.67	1.67	1.68	1.87	1.87	1.84	1.86	1.81	1.87	1.68	1.82	1.82	1.80		
Dong Nai	2.15	2.13	2.35	2.61	2.72	2.88	2.95	2.77	2.77	2.03	2.89	2.74	2.74	2.02	2.02	2.85		
Ba Ria Vung Tau	1.71	1.86	2.00	2.50	1.80	1.70	1.80	1.70	1.80	1.78	1.89	1.89	1.89	2.57	2.57	2.57		
Tay Ninh	1.73	1.60	1.83	2.08	1.80	1.93	2.04	1.82	1.82	1.97	2.07	2.25	3.03	1.44	1.44	2.30		
HCMC	2.60	2.54	2.80	3.05	3.00	3.08	3.01	3.04	3.04	3.21	3.18	2.85	2.86	2.21	2.21	3.17		
Long An	1.89	1.84	2.03	2.19	1.50	1.99	2.11	2.03	2.03	2.09	2.47	1.98	1.98	0.75	0.75	2.21		
Thuan Hai	2.18	1.92	2.17	2.63	2.63	2.76	2.91	2.74	2.74	2.74	2.92	3.00	3.00					

Table 1.5 Crop Production in the Related Provinces (4/11)

Items	Season	Province	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993			
Tobacco ha		Lam Dong	84	61	81	79	78	35	25	91	30	48	35	672	211	211			
		Dac Lac	15	34	53	53	121	126	76	76	91	30	48	45	72	51	51		
		Ninh Thuan														1386	1386		
		Binh Thuan														952	952		
		Song Be	717	366	411	453	527	429	591	591	516	711	488	543	739	424	434		
		Dong Nai	2927	3462	3256	3956	4854	5962	4702	4702	7119	7824	8062	8334	12142	9450	8636		
		Ba Ria Vung Tau														517	150		
		Tay Ninh	864	222	282	298	296	285	465	465	243	262	262	149	118	157	274	411	
		HCMC	872	456	568	767	713	530	919	919	812	838	838	745	817	911	956	522	
		Long An	1028	281	286	164	42	32	84	84	36	124	124	114		21	27	35	
		Thuan Hai	925	1072	502	1619	1685	2966	2426	2426	2119	1826	1950	1518		2314			
		Tobacco ton		Lam Dong	67	78	85	118	117	35	88	82	23	36	37	886	283	283	285
				Dac Lac	11	21	39	44	87	99	59	59	82	23	36	37	47	41	46
				Ninh Thuan														3614	3614
Binh Thuan																954	954		
Song Be	610			300	339	356	444	347	507	507	489	688	527	594	882	480	476		
Dong Nai	2689			3247	2540	2711	3279	3700	2920	2920	2780	4051	2436	3838	7300	6143	5145		
Ba Ria Vung Tau																87	87		
Tay Ninh	750			185	199	203	210	365	531	531	247	233	157	118	161	256	418		
HCMC	1384			707	997	1343	1167	820	1456	1456	1302	1307	1293	1416	1743	1643	914		
Long An	1028			254	286	164	33	32	76	76	32	124	120		21	26	30		
Thuan Hai	1187			1044	790	2462	3293	5029	4784	4784	2950	3160	3587	2667	4586				
Tobacco ton				Lam Dong	0.80	1.28	1.05	1.49	1.50	1.00	3.52	0.90	0.77	0.75	0.00	1.32	1.34	1.35	
				Dac Lac	0.73	0.62	0.74	0.83	0.72	0.79	0.78	0.78	0.90	0.77	0.75	0.82	0.65	0.80	0.90
				Ninh Thuan														2.61	2.61
		Binh Thuan														1.00	1.00		
		Song Be	0.85	0.82	0.82	0.79	0.84	0.81	0.86	0.86	0.95	0.97	1.08	1.09	1.19	1.13	1.10		
		Dong Nai	0.92	0.94	0.78	0.69	0.68	0.62	0.62	0.62	0.39	0.52	0.30	0.46	0.60	0.65	0.60		
		Ba Ria Vung Tau														0.42	0.57		
		Tay Ninh	0.87	0.83	0.71	0.68	0.71	1.28	1.14	1.14	1.02	0.89	1.05	1.00	1.03	0.93	1.02		
		HCMC	1.59	1.55	1.76	1.75	1.64	1.55	1.58	1.58	1.60	1.56	1.74	1.73	1.91	1.72	1.75		
		Long An	1.00	0.90	1.00	1.00	0.79	1.00	0.90	0.90	0.89	1.00	1.05	1.00	1.00	0.96	0.96		
		Thuan Hai	1.28	0.97	1.57	1.52	1.95	1.70	1.97	1.97	1.39	1.73	1.84	1.76	1.98				

Table 1.5 Crop Production in the Related Provinces (5/11)

Items	Season	Province	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993			
Sugar Cane x 1000 ha	Season	Lam Dong	0.1	0.2	0.5	1	1.4	1	1.1	2.2	3	2.4	2	2.3	2.2	2.2			
		Dac Lac	0.4	1.3	1.8	1.4	2.5	2.8	2.1	1.9	1.9	2.1	1.9	2	2	2.8	2.8		
		Ninh Thuan														0.5	0.5		
		Binh Thuan														1.7	1.7		
		Song Be	3.1	2.3	3.5	6.2	5.5	4	2.8	3.2	2.5	2.5	2.2	3	3.3	3.6	4		
		Dong Nai	6.7	5.8	7.1	8.4	12.1	11.5	9.7	9.6	10.2	9.7	9.7	10.6	7.4	6.1	8.3	8.3	
		Ba Ria Vung Tau				0.1	0.1	0.1	0.1	0.2	1.4	0.1	1.4	0.1	0.4	0.3	0.3	0.3	
		Tay Ninh	8	11.4	11.4	12.8	16.2	9.8	6.5	6.7	9	9.3	9.3	8.1	9.9	11.3	11.6	11.6	
		HCMC	2.4	4.1	5.1	5.3	6.9	6.3	5.9	6	5.4	5.3	5.4	5.3	5	5.8	6	5.5	
		Long An	5.4	5.7	5.2	6.4	7.4	6.5	5.2	6.9	7.2	7.2	7.7	7.7	8	11.1	10.8	11.6	
		Thuan Hai	0.9	1.8	1.8	1.8	3.3	3	2.1	2.4	2.4	2.4	2.4	1.3	1.3	2	2	2	
		Sugar Cane x 1000 ton	Season	Lam Dong	7.6	8.7	19.4	41.3	56.3	45.1	44.4	80.3	113.3	90	83.3	79.9	95.8	95.8	
				Dac Lac	18.1	43.5	61.4	52.5	77.9	96.7	77.6	65.2	80.1	80.1	78.7	83	85.2	115.2	115.2
				Ninh Thuan														16.5	16.5
				Binh Thuan														61.4	61.4
Song Be	141			101.5	145.5	213.3	205.7	157.1	109.5	121.8	100.3	100.3	85.1	115.3	130.4	140.6	159.3		
Dong Nai	292.5			229.8	296.7	332.7	490	427.2	355.7	371.9	392.9	392.9	391.4	428.5	299.1	249.1	355.5	355.5	
Ba Ria Vung Tau						0.2	3.6	4.7	1.6	5	3.1	5	3.1	31.1	13.6	10.4	7.7	7.7	
Tay Ninh	296.4			389.3	410.9	484.7	641.4	384.4	265.4	273.2	361.2	361.2	383.7	331.1	444.2	539.6	461.9	461.9	
HCMC	85.2			110.1	132.2	181.9	163.9	216.9	244.9	233.6	228.9	228.9	222.6	206.1	257.6	290	295	295	
Long An	228.2			243.3	222.1	328.3	315.1	293.5	221.4	284.9	298.6	298.6	328.7	343.7	418	452.8	473.1	473.1	
Thuan Hai	41.2			54.3	67.3	82.9	124.7	109.1	84.2	109.3	94.5	94.5	51.3	51.3	65.9	65.9	65.9	65.9	
Sugar Cane ton/ha	Season			Lam Dong	76.00	43.50	38.80	41.30	40.21	45.10	40.36	36.50	37.77	37.50	41.65	34.74	43.55	43.55	
				Dac Lac	45.25	33.46	34.11	37.50	31.16	34.54	36.95	34.32	38.14	38.14	41.42	41.50	42.60	41.14	41.14
				Ninh Thuan														33.00	33.00
				Binh Thuan														36.12	36.12
		Song Be	45.48	44.13	41.57	34.40	37.40	39.28	39.11	38.06	40.12	40.12	38.68	38.43	39.52	39.06	39.83		
		Dong Nai	43.66	39.62	41.79	39.61	40.50	37.15	36.67	38.74	38.52	38.52	40.35	40.42	40.42	40.84	42.83		
		Ba Ria Vung Tau				2.00	36.00	47.00	16.00	25.00	25.00	25.00	2.21	311.00	34.00	34.67	25.67		
		Tay Ninh	37.05	34.15	36.04	37.87	39.59	39.22	40.83	40.78	40.13	40.13	41.26	40.88	44.87	47.75	39.82		
		HCMC	35.50	26.85	25.92	34.32	23.75	34.43	41.51	38.93	42.39	42.39	42.00	41.22	44.41	48.33	53.64		
		Long An	42.26	42.68	42.71	51.30	42.58	45.15	42.58	41.29	41.47	41.47	42.69	42.96	37.66	41.93	40.78		
		Thuan Hai	45.78	30.17	37.39	46.06	37.79	36.37	40.10	45.54	39.38	39.38	39.46	39.46	32.95	32.95	32.95		

Table 1.5 Crop Production in the Related Provinces (7/11)

Items	Season	Province	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993			
Groundnuts x 1000 ha		Lam Dong	0.9	1.6	2.5	2.4	2.2	2.5	1.7	1.9	2	1.8	2	1.7	1.4	1.4			
		Dac Lac	4.2	5.9	7.4	10.2	13.2	15.1	12.2	11.2	11.2	10.1	9.7	10.5	10.5	11.7	11.7		
		Ninh Thuan																	
		Binh Thuan																	
		Song Be	12.3	14.5	15.6	13.9	15.2	17.8	16.3	16.3	16.3	17.7	16.1	14.4	15.8	13.9	13.3		
		Dong Nai	8.1	10.7	11.3	10.9	11.8	12	12	11.4	11.6	11.6	10.7	8.1	8.3	4.5	4.4		
		Ba Ria Vung Tau																	
		Tay Ninh	10.4	13.3	11.9	10.6	11.3	15.9	20.4	19.9	19.2	19.2	19.3	22.3	29.7	31.7	33.1		
		HCMC	5.7	4.6	4.4	4.2	5	6.4	6.6	6.5	5.8	5.8	5.7	5.5	6.2	7.2	5.7		
		Long An	9	7.9	5.7	5.1	5.6	10.5	11.2	12.2	10.8	10.8	10.1	10.2	11.9	9.9	9.9		
		Thuan Hai	1.8	3.5	3	3.2	3.4	4.3	4	4.1	3.7	3.7	3.9	4.2					
		Groundnuts x 1000 ton		Lam Dong	0.8	1.2	1.9	1.8	1.7	1.8	1.1	1.3	1.5	1.5	1.3	1.2	1.1	1	
				Dac Lac	4.1	5.8	7.2	11.4	14	15.9	11.1	10.3	9.2	9.2	9.2	10.3	10.8	11.9	11.9
				Ninh Thuan															
				Binh Thuan															
Song Be	10.5			8.6	11.3	9.3	11.5	14	14.7	14.7	14.8	14.5	13.7	12.6	13.1	13.1	12.8		
Dong Nai	7.3			8.9	9.4	9.2	11	10.6	10.7	7.9	7.9	8.6	8.7	6.8	6.4	3.3	3.5		
Ba Ria Vung Tau																			
Tay Ninh	12			12	13.1	11.6	14.4	19.8	24.2	24.5	24.5	25	26.8	33	51.3	58	65.8		
HCMC	6			4.7	5.2	4.9	5.9	8.1	9.4	9	8.5	8.5	10.5	10	12.7	16.7	11.4		
Long An	7.6			9.2	5.1	5.3	7.1	13.4	14	14.4	14.8	14.8	14.5	18.9	20.3	18.3	18.4		
Thuan Hai	1.3			1.8	1.5	1.7	1.6	2.7	2.2	2.3	2	2	2.6	2.6					
Groundnuts ton/ha				Lam Dong	0.89	0.75	0.76	0.75	0.77	0.72	0.65	0.68	0.75	0.72	0.60	0.65	0.71	0.71	
				Dac Lac	0.98	0.98	0.97	1.12	1.06	1.05	0.91	0.92	0.92	0.91	0.95	0.98	1.03	1.02	1.02
				Ninh Thuan															
				Binh Thuan															
		Song Be	0.85	0.59	0.72	0.67	0.76	0.79	0.90	0.88	0.88	0.82	0.85	0.88	0.83	0.94	0.96		
		Dong Nai	0.90	0.83	0.83	0.84	0.93	0.88	0.89	0.89	0.69	0.74	0.81	0.84	0.77	0.73	0.80		
		Ba Ria Vung Tau																	
		Tay Ninh	1.15	0.90	1.10	1.09	1.27	1.25	1.19	1.23	1.30	1.30	1.39	1.48	1.73	1.83	1.99		
		HCMC	1.05	1.02	1.18	1.17	1.18	1.27	1.42	1.38	1.47	1.47	1.84	1.82	2.05	2.32	2.00		
		Long An	0.84	1.16	0.89	1.04	1.27	1.28	1.25	1.18	1.37	1.37	1.44	1.85	1.71	1.85	1.86		
		Thuan Hai	0.72	0.51	0.50	0.53	0.47	0.63	0.55	0.56	0.54	0.54	0.67	0.62					

Table 1.5 Crop Production in the Related Provinces (8/11)

Items	Season	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	
Sweet Potato x 1000 ha	Province															
	Lam Dong	5	3.1	4.6	4.1	4.3	4.6	4.4	4.2	4	2.5	2.5	2.5	2.1	2.1	2
	Dac Lac	6.6	4.7	6.5	6.4	5.8	6.2	5.5	6.1	6	4.4	4.4	5.4	5.5	2.8	2.4
	Ninh Thuan															
	Binh Thuan															
	Song Be	2.2	1.6	2.1	1.4	1.9	2	2	1.9	1.7	1.7	1.5	1.4	1.8	2.1	2
	Dong Nai	14.5	12.4	12.3	10.1	7.7	6.5	6.6	7.6	6.3	6.3	5.5	5.8	5.5	2.8	2.4
	Ba Ria Vung Tau	0.6	0.6	0.4	0.5	0.3	0.2	0.2	0.3	0.3	0.1	0.2	0.2	2	2.1	1.8
	Tay Ninh					0.1	0.2	0.3	0.1	0.1	0.1	0.5	0.6	0.2	0.5	0.9
	HCMC	1.5	1.3	1.5	1.1	1.3	0.8	0.9	0.7	0.6	0.6	0.5	0.6	0.3	0.4	0.3
	Long An	0.7	0.5	0.4	0.4	0.2	0.3	0.2	0.1	0	0.1	0.1	0.1	0.1	0.1	0.1
	Thuan Hai	14.8	12.4	14	14.5	14.7	14	11.3	11.9	10.8	8.1	8.1	8.8	0.3	0.4	0.1
	Lam Dong	28.1	17.3	28.1	23.8	27.2	27.5	28.6	26	24.9	16.1	15.4	15.4	13	13.6	13
	Dac Lac	45	35	41.5	44.7	42.7	47.4	43	48.8	50.4	37.6	48.5	48.5	22.8	11.9	12.4
	Ninh Thuan															
Binh Thuan																
Song Be	15.2	10.1	13.2	9.5	12.5	13.2	13.4	12.4	10.9	10.9	9.9	9.1	13	13.6	13	
Dong Nai	64.9	55.1	54.5	46.1	35	30.7	31.1	35.4	28.7	24.8	24.8	29.2	22.8	11.9	12.4	
Ba Ria Vung Tau	1.1	1.2	1	1.7	1	0.5	0.6	0.8	0.8	0.7	0.7	0.7	9.5	9.7	8	
Tay Ninh					0.1	0.3	0.6	1.5	0.5	0.3	0.3	0.3	1.2	3.5	7.3	
HCMC	8.5	7.6	8.9	6.9	8.8	5.4	6.7	5.3	4	4.6	4.6	4.7	2.7	3	2.4	
Long An	3	2.8	2	1.8	1.4	1	0.8	0.4	0.1	0.1	0.2	0.5	0.3	0.5	0.2	
Thuan Hai	83.5	65.8	63.9	67.5	74	68.2	58.7	59.4	53.6	38.2	43.6	43.6	0.3	0.5	0.2	
Lam Dong	5.62	5.58	6.11	5.80	6.33	5.98	6.50	6.19	6.23	6.44	6.16	6.16	6.44	6.48	6.50	
Dac Lac	6.82	7.45	6.38	6.98	7.36	7.65	7.82	8.00	8.40	8.55	8.98	8.98	8.55	4.25	5.17	
Ninh Thuan																
Binh Thuan																
Song Be	6.91	6.31	6.29	6.79	6.58	6.60	6.70	6.53	6.41	6.60	6.50	6.50	7.22	6.48	6.50	
Dong Nai	4.48	4.44	4.43	4.56	4.55	4.72	4.71	4.66	4.56	4.51	5.03	5.03	4.15	4.25	5.17	
Ba Ria Vung Tau	1.83	2.00	2.50	3.40	3.33	2.50	3.00	2.67	3.00	3.50	3.50	3.50	4.75	4.62	4.44	
Tay Ninh					3.00	3.00	5.00	5.00	3.00	6.00	6.00	6.00	6.00	7.00	8.11	
HCMC	5.67	5.85	5.93	6.27	6.77	6.75	7.44	7.57	6.67	9.20	9.00	7.83	9.00	7.50	8.00	
Long An	4.29	5.60	5.00	4.50	7.00	3.33	4.00	4.00	4.00	2.00	5.00	5.00	3.00	5.00	2.00	
Thuan Hai	5.64	5.31	4.56	4.66	5.03	4.87	5.19	4.99	4.96	4.72	4.95	4.95	3.00	5.00	2.00	

Table 1.5 Crop Production in the Related Provinces (9/11)

Items	Season	Province	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993				
Corn x 1000 ha		Lam Dong	12	12.2	13.9	16.5	16.4	17.3	15.9	14.4	14.4	13.5	14.1	12.8	14.3	13.2	13.2			
		Dac Lac	10.8	17	14.9	16.3	18.5	19	18.1	18.2	18.2	19.3	17.6	17.8	17.8	17.5	17.5	17.5		
		Ninh Thuan																		
		Binh Thuan																		
		Song Be	5.6	3.7	3.3	3.2	2.4	2.8	2.8	3.1	3.2	3.2	3.2	2.7	2.6	2.6	3.2	2.9		
		Dong Nai	38.4	40.7	43.6	48.8	51	51.6	51	56.1	51	51	45.8	45.5	44.7	42.4	34.4	35.9	35.9	
		Ba Ria Vung Tau	0.1	0	0.1	0.2	0.2	0	0	0	0	0	0	0	0	0	0.4	0.6	0.6	
		Tay Ninh	4.1	1	1.1	1.1	1.4	0.9	0.9	0.9	0.9	0.7	0.7	0.4	0.5	0.5	0.4	0.6	0.6	
		HCMC	1	2.4	2.1	1.8	2	1.7	1.6	1.6	1	1	1	0.8	0.7	0.5	0.5	0.5	0.5	
		Long An	0.1	0.1	0	0	0.1	0	0	0.2	0.2	0.2	0	0	0.1	0	0	0	0	
		Thuan Hai	13.3	11.2	12	9.8	10.9	11.9	10.2	10.2	10.1	9.9	9.9	10.5	10.6	10.9				
		Corn x 1000 ton		Lam Dong	18.9	20	24.4	32.8	38.3	36.4	33.8	28.4	26.9	26.9	33.6	26.9	23.3	26.4	26.4	26.4
				Dac Lac	16.4	27.4	23.9	31.1	40.3	42.5	41.3	39.6	43	43	41.7	43.7	45.8	44.5	44.5	44.5
Ninh Thuan																				
Binh Thuan																				
Song Be	6.4			3.8	2.3	2.6	2.3	3.8	4.2	4.2	3.7	4.2	4.2	3.6	3	3.1	3.9	3.5	3.5	
Dong Nai	55.9			61.3	66.2	83.7	99.3	108.4	101.6	73.4	75.6	75.6	75.6	75.2	66.9	67.4	54.6	81.7	81.7	
Ba Ria Vung Tau	0.1			0	0.1	0.4	0.2	0	0	0	0	0	0	0	0	0	0.4	0.8	0.8	
Tay Ninh	4.5			1.1	1	1	1.6	1.1	1	1	0.6	0.6	0.6	0.3	0.5	0.5	0.4	0.8	0.8	
HCMC	1.2			2.4	3	2.6	2.7	2.1	1.9	1.9	1.5	1.7	1.7	1.4	1.3	1	1	1	1	
Long An	0.1			0.1	0	0	0.1	0	0	0.1	0.2	0	0	0	0.1	0	0	0	0	
Thuan Hai	11.7			9.1	8	8.9	10.9	9.9	9.1	9.1	7.5	8.3	8.3	10.1	9.3	9.9				
Corn ton/ha				Lam Dong	1.58	1.64	1.76	1.99	2.34	2.10	2.13	1.97	1.99	1.99	2.38	2.10	1.63	2.00	2.00	2.00
				Dac Lac	1.52	1.61	1.60	1.91	2.18	2.24	2.28	2.28	2.18	2.23	2.23	2.37	2.46	2.57	2.54	2.54
		Ninh Thuan																		
		Binh Thuan																		
		Song Be	1.14	1.03	0.70	0.81	0.96	1.36	1.36	1.35	1.16	1.31	1.31	1.33	1.15	1.19	1.22	1.21	1.21	
		Dong Nai	1.46	1.51	1.52	1.72	1.95	2.10	1.81	1.81	1.44	1.65	1.65	1.65	1.50	1.59	1.59	2.28	2.28	
		Ba Ria Vung Tau	1.00	1.00	1.00	2.00	1.00	1.00	1.00	1.00	0.86	0.86	0.86	0.75	1.00	1.00	1.00	1.33	1.33	
		Tay Ninh	1.10	1.10	0.91	0.91	1.14	1.22	1.11	1.11	0.86	0.86	0.86	0.75	1.00	1.00	1.00	1.33	1.33	
		HCMC	1.20	1.00	1.43	1.44	1.35	1.24	1.19	1.19	1.50	1.50	1.70	1.75	1.86	2.00	2.00	2.00	2.00	
		Long An	1.00	1.00	1.00	1.00	1.00	1.00	0.50	0.50	1.00	1.00	1.00	0.96	1.00	1.00	1.00	1.00	1.00	
		Thuan Hai	0.88	0.81	0.67	0.91	1.00	0.83	0.89	0.89	0.74	0.84	0.84	0.96	0.88	0.91	0.88	0.88	0.88	

Table 1.5 Crop Production in the Related Provinces (10/11)

Items	Season	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	
Rubber ha	Province															
	Lam Dong															
	Dac Lac		3345	2606	2841	2777	2794	2794	3071	3246	3334	3051	3176	3556	3556	
	Ninh Thuan													42	42	
	Binh Thuan													16	16	
	Song Be		24233	25058	25391	25277	24437	23182	22883	22883	23130	26630	30116	38783	50907	56479
	Dong Nai		22728	22897	24112	25408	27161	29633	29577	28189	28596	36530	36530	36530	30007	30233
	Ba Ria Vung Tau														486	486
	Tay Ninh		6439	6054	5979	5060	5060	5126	5226	5200	5200	5200	5200	5200	5455	5455
	HCMC		121	114	114	114	140	114	112	112	112	115	126	174	682	682
	Long An															
	Thuan Hai			30	30	35	35	30	30	30	50	50	50	58		
	Rubber ton	Lam Dong														
Dac Lac			1408	1407	2032	1818	2043	2150	1788	2085	2060	2245	3185	2770	2770	
Ninh Thuan														96	96	
Binh Thuan														24	24	
Song Be			15617	17236	17207	17107	17655	16990	16730	18304	17288	20372	23991	29636	39470	
Dong Nai			19392	19626	20283	21367	21243	22613	21691	21837	22515	26866	27400	23637	23637	
Ba Ria Vung Tau														194	280	
Tay Ninh			4006	4255	4250	3955	3997	3700	3658	3667	3700	3700	3700	3700	4000	4000
HCMC			121	137	125	102	114	115	112	101	120	132	772	1180	1180	
Long An																
Thuan Hai				30	35	33	40	33	38	43	50	54	60			
Rubber ton/ha		Lam Dong														
		Dac Lac		0.42	0.54	0.72	0.65	0.73	0.77	0.58	0.64	0.62	0.74	1.00	0.78	0.78
	Ninh Thuan													2.29	2.29	
	Binh Thuan													1.50	1.50	
	Song Be		0.64	0.69	0.68	0.68	0.72	0.73	0.73	0.79	0.65	0.68	0.62	0.58	0.70	
	Dong Nai		0.85	0.86	0.84	0.84	0.78	0.76	0.73	0.77	0.79	0.73	0.75	0.79	0.78	
	Ba Ria Vung Tau													0.40	0.58	
	Tay Ninh		0.62	0.70	0.71	0.78	0.79	0.72	0.70	0.71	0.71	0.71	0.71	0.71	0.73	
	HCMC		1.00	1.20	1.10	0.89	0.81	1.01	1.00	0.90	1.04	1.05	1.05	4.44	1.73	
	Long An															
	Thuan Hai			1.00	1.17	0.94	1.14	1.10	1.27	0.86	1.00	1.08	1.03			

Table 1.5 Crop Production in the Related Provinces (11/11)

Items	Season	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	
Coffee ha	Province															
	Lam Dong	1024	1486	1374	1461	1374	2949	4769	5815	7386	11175	13788	13869	13869	13869	
	Dac Lac	5329	4686	6027	6363	6244	7754	8686	11139	15436	30147	37261	37261	37261	37261	
	Ninh Thuan													220	210	
	Binh Thuan														80	
	Song Be		103	103	143	144	268	388	300	535	339	298	259	149	149	
	Dong Nai		881	1145	1247	1645	4027	5028	5708	10116	12810	19365	19400	18013	16000	
	Ba Ria Vung Tau															
	Tay Ninh															
	HCMC		12				20	37	40	40	40	40				
	Long An															
	Thuan Hai				100	100	210	210	211	257	260	300				
	Coffee ton	Lam Dong	3640	1963	1832	2237	2934	9925	15022	21602	24195	39505	43465	50305	50305	50305
		Dac Lac	16847	16566	18881	15173	24448	39417	39380	55469	80340	142900	170305	210600	210600	210600
		Ninh Thuan													220	230
Binh Thuan															80	
Song Be			159	159	182	82	1154	1991	1200	1781	1512	1320	1179	665	665	
Dong Nai			1231	1695	1819	2336	5397	40304	43518	78250	100560	115900	126100	95470	91200	
Ba Ria Vung Tau																
Tay Ninh								36	39	40	40	40				
HCMC																
Long An																
Thuan Hai					17	19						1950	2400			
Coffee ton/ha		Lam Dong	3.55	1.32	1.21	1.53	2.14	3.37	3.15	3.71	3.28	3.54	3.15	3.63	3.63	3.63
		Dac Lac	3.16	3.54	3.13	2.38	3.92	5.08	4.53	4.98	5.20	6.75	5.65	5.65	5.65	5.65
		Ninh Thuan													1.00	1.10
		Binh Thuan														1.00
	Song Be		1.54	1.54	1.27	0.57	4.31	5.13	4.00	3.33	4.46	4.43	4.55	4.46	4.46	
	Dong Nai		1.40	1.48	1.46	1.34	8.02	7.62	7.74	7.85	5.99	6.50	5.30	5.30	5.70	
	Ba Ria Vung Tau															
	Tay Ninh															
	HCMC		0.00				0.00	0.14	0.13	0.18	0.00					
	Long An							0.00	0.00	0.00						
	Thuan Hai				0.17	0.19	0.00	0.00	0.00	0.00	7.50	8.00				

Table 1.6 Number of Livestock in the Related Provinces (1/2)

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
BUFFALOES													
x 1000 head													
Lam Dong	11.1	11.9	13	14.5	16.3	16.9	18.5	17.7	19.4	20.4	20.9	21.1	20.5
Dac Lac	10.5	11.7	12.2	13.4	14.5	16.4	17.1	18.2	18.9	19.1	19.3	11.5	12
Ninh Thuan												12.6	13.2
Binh Thuan												19.4	20
Song Be	28	31.9	36	38.3	38.6	38.8	40.5	39.5	38	32.3	32.9	31.5	31.1
Dong Nai	9.6	10.4	12.4	12.9	14.1	15.6	17.6	17.3	17.4	17.9	17.5	16.8	18
Ba Ria Vung	0.3	0.4	0.4	0.4	0.5	0.5	0.5	0.5	0.5	0.5		2.4	2.4
Tay Ninh	46.2	49.8	51	54.3	57.6	60.1	63	65.5	64.3	55.3	55.6	55.1	51.7
HCMC	30.5	31.9	33.8	35.3	33.3	32.9	34.1	32.4	33.1	32.5	32.1	30.8	29.8
Long An	51.8	56.6	61.2	62.2	60.7	63.2	64.9	66.7	60.1	51	45.6	36.6	34.2
Thuan Hai	19.1	21.3	24	24.6	25.6	26.1	27.7	28.3	27.9	27.9	28.3		
CATTLE													
x 1000 head													
Lam Dong	17.4	20.6	25.1	27.9	30.2	35.9	39.9	44.9	44.8	39.2	32.4	37.2	36.8
Dac Lac	36.5	42.7	53	61.1	69.5	85	98.4	109.8	107.9	105.3	114.3	118.7	116.5
Ninh Thuan												59.5	60
Binh Thuan												76.3	75.2
Song Be	36.8	39.8	43.7	48.2	50.6	53	55.3	56.3	58.3	53.4	52.3	50.3	47.9
Dong Nai	34.6	38.7	45.7	48.2	50.6	53	55.3	56.3	58.3	53.4	52.3	50.3	47.9
Ba Ria Vung	0.6	0.7	1.5	1.9	2	1.5	1.6	1.3	1.5	1.7		22.9	20
Tay Ninh	45.3	47.3	47.8	48.8	52	52.1	54.9	50.2	57.2	48.6	49.2	47.8	50.1
HCMC	40.5	44.5	50.2	54.3	49.9	48.8	49.9	46.2	45	45	43	39.8	40.4
Long An	21.4	24.1	27.7	30.2	34.3	37.5	41.4	41.6	36.6	26.2	23.8	20.2	18.8
Thuan Hai	73.3	80.8	95	100	109.7	118.2	129.6	137.2	131.9	122.1	126.8		
PIGS													
Lam Dong	63.1	66.1	73.1	87.7	82.2	87.6	92.3	93.5	102.8	100.9	99.1	109	108.6

Table 1.6 Number of Livestock in the Related Provinces (2/2)

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
x 1000 head													
Dac Lac	121.8	131.3	148.6	170.8	188.9	194.6	215.3	219.3	224.1	227.4	236.3	283.3	279.2
Ninh Thuan												45.9	47.2
Binh Thuan												102.7	101.6
Song Be	66.6	60.9	67.3	81.2	83.3	80.4	83.4	89.4	105.3	103.6	100.9	114	137.1
Dong Nai	139.9	137.9	148.2	173.9	191.2	185.3	195.6	187.4	222.1	191.1	223.9	198.5	244
Ba Ria Vung Tau						6.6	7.4	6	6.4	4.9		78.7	86.6
Tay Ninh	57.8	56.9	63.5	66.9	72.3	65.8	71.4	69.6	74.4	58.3	61.6	84	87.9
HCMC	209.5	194.6	204.7	232.4	229.1	227.1	228.3	179.4	182	157.5	151.4	170.6	178
Long An	105.5	114.1	105	106.1	113.8	129.8	139.2	137.5	149.6	137.9	121.7	177.6	174.9
Thuan Hai	121.6	107	99.9	101.1	108.3	92.1	104.8	97	99.5	105.2	120.6		
CHICKEN													
x 1000 head													
Lam Dong	297.8	335.4	286.7	391.3	460.1	471.4	544	597.1	662.7	640	680.2	679.8	721.8
Dac Lac	354.9	370.1	409.9	490.3	528.6	578.2	629.4	643.5	648.7	591.5	621	641.8	702.3
Ninh Thuan												351.6	402.8
Binh Thuan												450.2	489.1
Song Be	755.3	711.7	722.1	869.5	836.7	920.7	1008.1	1096	1171.8	1107.3	1312.5	1290.3	1461
Dong Nai	1311.7	1083.6	1440.1	1548.2	1856.1	1816.4	1784.5	1890.4	1784.2	1837.3	2078	2064	2075
Ba Ria Vung Tau	25.6	33.4	38	45	53	78.6	82.6	106	174.2	104	663	1188	889
Tay Ninh	1921	2196.5	2086.4	1942.1	1022.5	1122.4	861.2	853.7	1022.9	1020.6	1965.5	2114.6	1953
HCMC	1071	1944	1213.5	1326.9	1305.1	1640.8	1526.6	1554.5	1707.1	1846.3	1774.7	1915.6	1903
Long An	869.3	1039.2	971.2	1019.7	1051.4	1295.6	1296.7	1334.7	1383.2	1308	1432.6	1655.2	1798.4
Thuan Hai	673.1	647.2	630	581	598.9	652.3	678.3	726.6	622	739.2	780.4		