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THE MASTER PLAN STUDY
ON
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WATER [illegible]

FINAL REPORT

VOLUME VII

ANNEX VI AGRICULTURAL DEVELOPMENT
AND IRRIGATION

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

THE SOCIALIST REPUBLIC OF VIET NAM
MINISTRY OF AGRICULTURE AND RURAL DEVELOPMENT

THE MASTER PLAN STUDY
ON
DONG NAI RIVER AND SURROUNDING BASINS
WATER RESOURCES DEVELOPMENT

FINAL REPORT

VOLUME VII

APPENDIX VI AGRICULTURAL DEVELOPMENT AND IRRIGATION

AUGUST 1996

NIPPON KOEI CO., LTD., TOKYO JAPAN

This Report consists of

Volume I	Executive Summary	
Volume II	Main Report	
Volume III	Appendix I	Socio-economy and Institution
Volume IV	Appendix II	Topography and Geology
	Appendix III	Meteorology and Hydrology
Volume V	Appendix IV	Natural Environment
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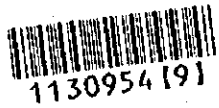
Volume VII	Appendix VI	Agricultural Development and Irrigation
Volume VIII	Appendix VII	Domestic and Industrial Water Supply
Volume IX	Appendix VIII	Flood Mitigation and Urban Drainage
	Appendix IX	Salinity Intrusion
Volume X	Appendix X	Formulation of Master Plan
Volume XI	Data Book	



The cost estimate was based on the December 1995 price level and expressed in US$ according to the exchange rate of US$ 1.00 = Vietnamese Dong 11,014 = Japanese Yen 101.53 as of December 15, 1995.

LIST OF ABBREVIATIONS

AFS	Agriculture and Forestry Service (PC)
CEMMA	Committee for Ethnic Minorities and Mountainous Areas
DCWSSS	Design Company for Water Supply and Sanitation System (HCMC-PC)
EA	Environment Assessment (Multi-lateral Lending Agencies)
ECSP	Evaluation Commission for State Projects
EIA	Environmental Impact Assessment
ENCO	Ho Chi Minh City Environmental Committee
EVN	*General Company of Electricity of Viet Nam (Abolished and renamed in November 1995 as Vietnamese Power Corporation)*
FIPI	Forest Inventory and Planning Institute (MOARD)
GCOP	Governmental Committee on Organization and Personnel
GDLA	General Department of Land Administration
GDMH	General Department of Meteorology & Hydrology
GOV	Government of Viet Nam
GSO	General Statistical Office
HCMC	Ho Chi Minh City
HEC	Ho Chi Minh Environment Committee (HCMC)
HIDC	Hydraulic Investigation and Design Company (MOARD)
HPC	Ho Chi Minh People's Committee (HCMC)
HSDC (or SDC)	Ho Chi Minh Sewerage and Drainage Company (HCMC)
HWSC (or WSC)	Ho Chi Minh Water Sypply Company (HCMC)
IDD	Irrigation and Drainage Department (MOARD)
IEE	Initial Environmental Examination
IER	Institute for Economic Research (HCMC-PC)
IHPH	Institute of Hygiene and Public Health (MOPH)
IM	Institute of Mines (MOID)
INVESCo	Investment Company for the Development of Water Sector (HCMC-PC/TUPWS)
IOE	Institute of Energy (MOID)
IURP	Institute of Urban and Rural Planning (HCMC-PC/Construction Service)
IWRE	Institute of Water Resources Economics (MOARD)
IWRP	Institute of Water Resources Planning (MOARD)
IWRR	Institute of Water Resources Research (MOARD)
JICA	Japan International Cooperation Agency (Japan)

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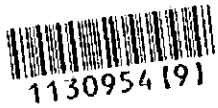

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IWRP	Institute of Water Resources Planning (MOARD)
IWRR	Institute of Water Resources Research (MOARD)
JICA	Japan International Cooperation Agency (Japan)

MOAFI	*Ministry of Agriculture and Food Industry (Abolished and integrated into the new MOARD)*
MOAP	Ministry of Aquatic Products
MOARD (New)	Ministry of Agriculture and Rural Development (Created in October 1995 by the merger of the former Ministry of Water Resources, Ministry of Agriculture and Food Industry and Ministry of Forestry)
MOC	Ministry of Construction
MOCI	Ministry of Culture and Information
MOD	Ministry of Defence
MOE	*Ministry of Energy (Abolished and integrated into the new MOID)*
MOET	Ministry of Education and Training
MOFI	Ministry of Finance
MOFO	*Ministry of Forestry (Abolished and integrated into the new MOARD)*
MOFA	Ministry of Foreign Affairs
MOHI	*Ministry of Heavy Industry (Abolished and integrated into the new MOID)*
MOID(New)	Ministry of Industry (Created in November 1995 by the merger of the former Ministries of Heavy Industry, Light Industry and Energy)
MOJ	Ministry of Justice
MOIT	Ministry of Interior
MOLI	*Ministry of Light Industry (Abolished and integrated into the new MOID)*
MOLWISA	Ministry of Labour, War Invalids and Social Affairs
MOPH	Ministry of Public Health
MOPI (New)	Ministy of Planning and Investment (Formed from a merger of the former SPC amd SCCI)
MOSTE	Ministry of Science, Technology and Environment
MOTC	Ministry of Transport and Communications
MOT	Ministry of Trade
MOWR	*Ministry of Water Resources (Abolished and integrated into the new MOARD)*
MPAC	Ministrial Project Appraisal Committee
NEA	National Environment Agency
NGO	Non-Governmental Organization
NIAPP	National Institute for Agricultural Planning and Projection
NPAC	National Project Appraisal Committee
OECC	Overseas Environmental Cooperation Centre
OECF	Overseas Economic Cooperation Fund (Japan)
PC	People's Committee (executive arm of the People's Council)

PCC	Power Construction Company (VPC)
PIDC	Power Investigation and Design Company (VPC)
PPC	Provincial People's Committee (City People's Committee = CPC)
SBV	State Bank of Viet Nam
SCCI	*State Committee for Cooperation and Investment (Abolished and integrated into the new MOPI)*
SFEZ (or SFEA)	Southern Focal Economic Zone (or Southern Focal Economic Area)
SIWRP	Sub-Institute of Water Resources Planning (MOARD-IWRP)
SIWRR	Southern Institute of Water Resources Research (MOARD)
SPC	*State Planning Committee (Abolished and integrated into the new MOPI)*
SRV	Socialist Republic of Viet Nam
UNDP	United Nations Development Programme
UNICEF	United Nations International Children's Education Fund
UNIDO	United Nations Industrial Development Agency
VPC (New)	Vietnam Power Corporation (the former General Company of Electricity of Viet Nam = EVN)
WASECO	Water and Sewerage Construction Company (MOC)
WB	World Bank
WHO	World Health Organization
WPMI (IWRPM)	Water Planning and Management Institute (MOARD)
WRD(or WRS)	Water Resources Department or Water Resouce Service (PC)
WSC	Water Supply Company (under Construction Services of the PC)

Note : Abbreviations in *Italics* are no more existent (already abolished and integrated in November 1995).

Measurements

Length

mm	=	millimeter
cm	=	centimeter
m	=	meter
km	=	kilometer
ft	=	foot
yd	=	yard

Area

cm^2	=	square centimeter
m^2	=	square meter
ha	=	hectare
km^2	=	square kilometer

Volume

cm^3	=	cubic centimeter
l	=	litre
kl	=	kilolitre
m^3	=	cubic meter

Weight

g	=	gram
kg	=	kilogram
ton	=	metric ton

Time

s	=	second
min	=	minute
h	=	hour
d	=	day
y	=	year

Electric Measurements

V	=	Volt
A	=	Ampere
Hz	=	Hertz (cycle)
W	=	Watt
kW	=	kilowatt
MW	=	Megawatt
GW	=	Gigawatt

Other Measures

%	=	percent
PS	=	horsepower
^{0}	=	degree
10^3	=	thousand
10^6	=	million
10^9	=	billion

Derived Measures

m^3/s	=	cubic meter per second
kWh	=	Kilowatt hour
MWh	=	Megawatt hour
GWh	=	Gigawatt hour
kVA	=	kilovolt ampere

Currencies

US$	=	US Dollar
VND	=	Vietnamese Dong

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Appendix VI

AGRICULTURAL DEVELOPMENT AND IRRIGATION

APPENDIX VI
Agricultural Development and Irrigation

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1. AGRICULTURAL DEVELOPMENT

1.1 Background of the Study

1.1.1 Current Situation of the Agricultural Sector

Viet Nam is basically an agricultural country where over 80 % of the population still live on rural areas, supported by farming, forestry and fishery. Grain crops, dominated by paddy, generate half the output value of this sector. Besides, a high proportion of industry and services derives their demand from agriculture. But, because of its vagaries of nature, the growth rate of agriculture witnesses large fluctuations than that of industry. The agriculture sector, including forestry and fishery, accounts for 36 % of GDP in the year 1993, nearly three-quarters of national employment and about 50 % of export earnings.

Due to the liberalization of distribution system in the agricultural sector, paddy production recorded 26 % growth in the year 1987 to 1989, and this permitted Viet Nam to move from a position of net importer of 700,000 to 800,000 tons of rice in the year 1986 to 1988 to a net exporter of around 2 million tons of rice per annum in the year 1989 to 1992.

1.1.2 Problems to be Solved in the Sector

Available land is limited. Average farming area per capita is small and still decreasing. Clearing of waste land for extension of cultivable area and increase of crops will require large capital investment and time. Population is large and not evenly distributed. Demographic growth is very high. Material and cultural living conditions of the rural population are low with a substantial segment being still in poverty, creating serious social and employment problems. The capacity of self investment for increasing production is therefore very limited.

Agricultural production still largely depends on natural conditions. The monsoon climate is favourable for cultivation but also causes frequent disturbances such as typhoon, flood, waterlogging, drought, pests and diseases, climatic irregularities and so on, adversely affecting production, processing, storing, transport and consumption of products.

Physical and technical facilities are very poor. Production level is low. Small scale and manual production with low output and efficiency is still predominant. Due to lack of fund, the possibility of modernizing equipment and industrial facilities, in particular those for post-harvest work and for processing of farm products and foods, is very limited.

A shift to market-oriented production will require to secure consumption markets. However, the foreign markets are unstable and difficult for a new comer such as Viet Nam to penetrate. While, local markets are still limited due to the slow increase in the purchase power of people.

In summary, national agriculture is facing new possibilities and challenges in the 1990s. The most important constraint is the lack of capital and technology. To ensure development it is essential to adopt a flexible strategy aimed at fully exploiting the local potential, seeking possible external sources, avoiding difficulties and continuing to quickly shift the national agriculture to market-oriented production through progressive modernization stages.

1.1.3 National Policies for Agricultural Development

(1) National Policies

Based on the national reform policy and socio-economic development strategy, the Ministry of Agriculture and Rural Development made the agricultural development policies for the 1990s as summarized below:

- To quickly focus the agriculture on market-oriented production through both internal and external economic systems combining agriculture and industry, production and market, in order to meet local demands, to increase exports and to accumulate hard currency and capacity for participating in the world markets,

- To comprehensively develop the agricultural ecology and to diversify production, mainly foods and especially rice and pigs, as well as to efficiently exploit the land, labour, physical and technical factors, and potential of ecological regions, to urgently create major highly efficient production establishments combining agriculture, forestry and fishery and to protect and improve the environment,

- To develop and apply the most recent technological and industrial process to production, paying attention to biological, labour-intensive and least-capital industries in order to increase production, labour output, quality and efficiency of agricultural production and food industries,

- To make large and steady investments for replacement of existing equipment and structures, to construct new production facilities mainly at medium and small scale, and to promote post-harvest and food processing industries as a first step to industrialization and modernization of agriculture;

Crop diversification or extensification, raising of yields and quality and reducing production costs of products are essential. In agricultural production and food processing industry, effort should be concentrated on developing directly available potential with a short time period of capital repayment. Reclamation of waste land and large investment with a long time period of capital repayment should be made with limitation except for the time when they are actually effective or necessary for development at further stages.

- To continue capital investment for development of important agricultural production areas and to appropriately invest for agricultural production in areas with poor ecological features by exploiting the potential of each area so that all areas are provided with possibilities for development, and

- To put emphasis on establishing new rural communities of socialist style, with a view of developing rural economy, exploiting favourable conditions of each region, creating small scale industries and businesses, providing employment, increasing income, promoting wealth, eradicating poverty, strengthening production infrastructure and improving the material and cultural living conditions of rural population.

In the process of shifting agriculture to market-oriented production involving farming, food processing industry, transport and consumption of agricultural products, it is necessary to accumulate a large reserve fund and hard currency required for industrialization of agriculture, leading step by step to industrialization of the whole country.

(2) Objectives and Basic Strategies

The overall objective of economic development up to the year 2000 is to get rid of poverty, to stabilize socio-economic and political life, to reinforce security and defense and to create favourable conditions for rapid development of the nation in the future stages. To attain the above general goal, the objectives of agricultural development up to the year 2000 are set as follows:

- To meet the increasing food demands of the whole nation, to raise the nutritive intake to 2,300 to 2,400 kcal/person/day, to secure food reserves, to develop stock farming, to settle the problem of malnutrition of children and to obliterate hungry and poverty,

- To urgently create a number of production establishments, to exploit the advantages of tropical climate, to secure supply of raw materials for processing industry and to increase export volume and income, thus satisfying the foreign currency demand for imports for farming, accumulating economic development fund and reinforcing the nation's position in the world market,

- To secure employment of labour, to shift a substantial labour force to rural industries and businesses, to decrease the population growth rate, to increase per capita income in rural areas by twice as much as compared to that in the year 1990, to improve living, education and health conditions and cultural and spiritual activities of the people in all rural areas, to implement democracy and social equality and to construct new rural communities with developed socio-economic systems and enough and stable modern living conditions, and

- To substantially strengthen physical and technical facilities for agricultural development and food processing industry, with priority to irrigation, mechanization, electrification, application of biology, renewal of production equipment, progressive modernization of post-harvest processing and food industries, raising the technological and production level, increasing output, quality and benefits and accumulating fund for promoting industrialization, modernization of agriculture and food industry in the next stage.

Efforts should be made to attain an annual gross agricultural product of 5.5 % to 6 % by the year 2000 through basic shifting of production system to market-oriented system, comprehensive development, diversification of crops suitable to ecological characteristics and application of high technological and industrial production practices with high output and quality. Supply of foods will steadily be secured. Food production and consumption quantities will largely be increased. Supply of raw materials for processing industry will be secured. Export volume and income will rapidly be increased, enabling to meet foreign currency requirements for imports and to accumulate fund for industrialization. Employment problem will basically be settled. Income and purchase power of population will significantly be increased. Material and cultural life will clearly be improved. Rural areas will be in a much better condition.

1.1.4 Regional Policies for Agricultural Development

Agricultural development objectives and strategies set by the Ministry of Agriculture and Rural Development for the respective regions are as follows:

(1) Mekong delta region

Blessed with favourable natural and socio-economic conditions, the region will not only satisfy its local food demands but also supply rice to the whole nation. Intensified and integrated farming with crop cultivation, animal husbandry, fishery and forestry should be promoted. Strategies for the agricultural development are summarized as follows:

- extension, intensification and export of rice;
- intensification of meat production, particularly of pig meat; and

- intensification of other crops such as pineapple, banana, coconuts, soybean, sugarcane and jute.

(2) N - E Southland region

The development pace in the region was slow in recent years and food production could satisfy only 50 % of demands in food stuffs. The export value of farm produce is still low compared to the regional production potentials. Therefore, future development should be focused on speeding up production of industrial annual crops, rubber and fruit. The food deficits can be made up with food supplies from the Mekong delta. Strategies for the agricultural development are as follows:

- intensification of food crops such as rice;
- extension of industrial crops such as soybean, groundnuts, sugarcane, tobacco and cotton;
- intensification of rubber production through such means as replacing old trees; and
- extension of fruit tree cultivation such as coffee, pineapple, banana and cashew, and cattle raising for meat and milk.

(3) South Central Coast region

It is considered through past development process that the region can produce foods sufficiently not only for its consumption but also for west highland. Plantation of industrial crops for supplying raw materials to processing industry and export is also possible in the region. Strategies for the agricultural development are as follows:

- extension and intensification of rice and maize cultivation;
- extension and intensification of sugarcane cultivation including expansion of cane processing capacity;
- restriction of cotton growing;
- development of bare or sandy land by growing perennial trees such as coconut, and pasture crops;
- expansion of sericulture; and
- expansion of animal industry such as cattle and pigs for export.

(4) Central Highlands region

In recent years, projects under direct government financing or foreign cooperation programmes have been implemented to settle an additional population in this region. Many export crop plantations have been created with large production shares in the national economy such as coffee, rubber, silk and tea. At present its development potentials have not been fully exploited. Agriculture should be developed both intensively and extensively. Strategies for the agricultural development are as follows:

- expansion of coffee and rubber plantation;

- expansion of sericulture; and
- expansion of dairy industry including cow raising.

1.2 Present Conditions of the Agriculture in the Study Area

1.2.1 Reference and Materials Used for the Study

Socio-economic conditions in Viet Nam as well as in the Study Area have been rapidly changing. Descriptions of the agricultural conditions by previous studies made in several years ago become obsolete and seem not always to reflect actual conditions. In the field work of the Master Plan Study, both the Experts of Agriculture and Irrigation made several field visits to grasp the actual conditions by collecting written data and information. Main findings presented on agricultural supporting services and irrigation sector institutions are from the field survey. In addition, an inventory survey of agriculture and irrigation was carried out for all the existing and proposed irrigation schemes with each area of more than 100 ha by the questionnaire method. The purposes of inventory survey are to make a database for formulating the master plan projects in this Study and to identify the constraints and required improvements in the irrigated agriculture. The written questionnaire was distributed to SIWRP and the Department of Agriculture and Forestry/Water Resources of all the concerned provinces in the Study Area in the course of field survey. Filled questionnaire for about 250 schemes was collected by the end of this field work period, and these inventory data were compiled and analyzed in the home office work of the Phase I study.

Field surveys of Phase II were conducted by the agronomist with the help of an engineer from the Sub-institute from June 8 to 24 for the ground check of the interpretation of Landsat imagery on the potential irrigation scheme areas and for the farm interview surveys. In the farm surveys, a total of 12 farmers in the potential irrigation schemes were interviewed using pre-prepared questionnaires. The farm surveys were made to understand the economic and physical backgrounds of farmers, who are deemed to be the key players in agricultural development. Without their decision making in accepting some particular crops or offering their land for any given water resources development projects, etc., any agricultural development trials would fail, particularly in free market economy. Understandings of their situations are thus indispensable in planning appropriate agricultural development schemes.

Farmers in the prospective irrigation schemes were selected in the fields at random. Most of farmers selected are in plains, where rice based farming is practiced. Their land holding is smaller than that of upland crops based farming. Therefore, their characteristics are not necessarily the same as corresponding to the Viet Nam Living Standard Surveys, which did not

describe rice based farmers separately. A sample of farm survey is given in Table 1.1, and the results are summarized in Table 1.2.

Crop and animal production statistics by related province, and crop budgets were collected from the Ministry of Agriculture and Rural Development. Land resource information such as present land use, soil and land suitability to agriculture is also from the same Ministry.

1.2.2 Agricultural Setting-up in the Study Area

(1) Soils and Land Use

Land use

The present land use in the Study Area has been identified by the Sub-national Institute for Agricultural Planning and Projection (NIAPP) in HCMC based on satellite imagery of LANDSAT TM5 taken in February and March 1994 as shown in Table 1.3 and summarized below:

Unit: %

Description	Mekong Delta	Southeast Region	Central Highland	Coastal Region	Study Area
1. Triple irrigated rice	0.06	0.00	0.00	0.00	0.00
2. Double irrigated rice	21.29	3.82	1.71	1.05	3.65
3. Single irrigated rice	5.69	6.72	0.00	0.00	3.56
4. Double rainfed rice	17.63	0.00	0.00	0.00	0.97
5. Single rainfed rice	5.97	0.00	0.00	0.00	0.33
6. Single irrigation/rainfed rice + upland crops	6.16	7.95	5.24	0.00	5.38
7. Upland crops	0.00	12.27	3.49	15.95	10.45
8. Pineapple/sugarcane	7.01	2.41	0.00	0.00	1.55
9. Shifting land	0.00	1.82	2.23	3.26	2.15
10. Coffee/Tea/Mulberry	0.00	0.88	0.75	0.00	0.60
11. Rubber	0.00	11.81	0.00	0.00	5.71
12. Cashew	0.00	4.42	0.00	0.00	2.14
13. Mulberry	0.00	0.00	0.00	0.06	0.01
14. Cinnamon	0.00	0.00	0.00	0.12	0.03
15. Fruit trees	0.00	1.39	0.00	0.00	0.67
16. Forest	3.81	24.29	66.29	35.55	35.38
17. Bush/grass	0.00	4.54	0.00	23.91	7.78
18. Salt pans	0.00	0.04	0.00	0.00	0.02
19. Bare land	28.82	14.94	18.41	16.89	16.95
19. Settlement/orchards	0.50	0.25	0.25	0.34	0.28
20. Rocky hill	0.00	0.00	0.00	0.11	0.03
21. Water body	3.06	2.44	1.65	2.75	2.37
Total	100	100	100	100	100
Total (1,000 ha)	223.4	2,338.8	1,142.7	1,142.2	4,847.1

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

Mekong delta in the Study Area covers about 5.5 % of the Study Area. Paddy field is the major land use in the Mekong area, occupying 56.8 % of the area. Canal network has been well constructed for the irrigated paddy cultivation. Irrigated paddy area covers 50.8 % of the area. However, only about 42 % of the irrigated paddy area is under double and triple irrigation. Another noteworthy fact is that the double or single rainfed rice cropping is practical in an area of 64,000 ha. The Mekong delta area has been well developed except for bare land which might be left behind from the development due to acid sulphate soil. It is noted that the word of Mekong delta in the Study Area is used for ecological discussions and that the word of HCMC-Long An delta is used for the same area when discussions are made for specific projects.

Southeast region in the Study Area is the largest area sharing about 48.3 % of the Study Area. About 53 % of the area has been developed for agricultural production. Main land uses in the remaining areas are a forest of 24.29 % and a bare land of 14.94 %. About 18.5 % of the area is irrigated, of which only 3.82 % is double irrigated. Single irrigated rice fields extend for 160,750 ha. Rubber and paddy are the main crops in the area.

Central highlands in the Study Area covers 22.8 % of the Study Area. The area is mountainous with a forest coverage of 66 % and is one of the least developed areas in the country. Agricultural land is as little as 13.42 % of the area. Bare land occupies about 18.4 % of the area. Irrigated area is 6.95 %, of which 1.71 % is currently used for double cropping of rice.

Coastal region in the Study Area covers 13.4 % of the total Study Area. Soil fertility is low with large extents of sandy soils and with an arid climate. Forest area covers 35.55 % of the area, followed by bush/grass area of 23.9 % and bare land of 16.89 %. Irrigated rice area occupies only 1.05 % of the area.

Soils

According to the information from NIAPP, land in the Study Area has 36 soils grouped by the Vietnamese standard. Their areal extension is shown in the following Table:

Soil Classification in the Study Area

Vietnamese Soil Classification	Area		Vietnamese Soil Classification	Area	
	ha	%		ha	%
SANDY SOILS	206,730	4.17	YELLOW-RED SOILS	2,331,380	47.06
Marine sandy soils	92,400	1.86	(FERRALITIC SOILS)		
Yellow sand dune soils	33,130	0.67	Purplish-brown soils on Basalts	130	0.01
Red sand dune soils	81,200	1.64	Red-brown soils on basic and neutral igneous rocks	341,320	6.89
SALINE SOILS	140,670	2.84	Yellow-brown soils on basic and neutral igneous rocks	505,340	10.2
Mangrove saline - potential acid sulphate soils	98,720	1.99	Yellow-red soils on claystones and metamonphic rocks	532,980	10.76
Severely saline soils	13,790	0.28	Red-yellow soils on acid igneous	829,910	16.75
Slightly saline soils	28,030	0.56	Light-yellow soils on sandstones	50,270	1.01
Alkaline saline soils	130	0.01	Yellow-brown soils on old alluvium	64,600	1.3
ACID SULPHATE SOILS	196,990	3.98	Yellow-red soils transformed by paddy growing	6,830	0.14
Potential acid sulphate soils	104,880	2.71			
Actual acid sulphate soils	92,110	1.87			
			HUMIC YELLOW-RED SOILS ON MOUNTAINS	33,180	0.67
ALLUVIAL SOILS	268,720	5.42	Humic Yellow-red soils on clay-stones and metamorphic rocks	5,110	0.1
Annual deposited alluvial soils	8,670	0.17	Humic Yellow-Red soils on acid igneous rocks	28070	0.57
Undeposited alluvial soils	75,350	1.52			
Mottled alluvial soils	62,510	1.26			
Gleyic alluvial soils	90,020	1.82			
Alluvial soils of streams	32,170	0.65			
			HUMIC SOILS ON HIGHT MOUNTAINS	610	0.01
SWAMPY AND PEATY SOILS	1,340	0.03	Humic light yellow soils on hight mountains	610	0.01
Swampy soils	1,340	0.03			
GREY SOILS	1,032,460	20.84			
Grey soils on old alluvium	815,440	16.46	COLLUVIAL SOILS	208,940	4.22
Grey soils on acid igneous rocks and sand stones	138,020	2.79	Colluvial soils	208,940	4.22
Humic gleyic grey soils	79,000	1.59	ERODED SOILS	203,710	4.12
			Eroded rocky soils	203,710	4.12
RED & BROWNISH-GREY SOILS	75,090	1.52			
Brownish-grey soils in semi-arid area	75,090	1.52	OTHERS		
			Lakes, stream, rivers	117,240	2.37
			Settlement	14,100	0.28
BLACK TROPICAL SOILS	122,470	2.47			
Black tropical soils on volcanic tuff and ash	6,860	0.14	TOTAL PROJECT AREA	4,953,630	100
Black tropical soil on Basalts	115,610	2.33			

Predominant soil in the Study Area is Yellow-red soil (Ferralitic soil) covering 47 % of the total area, followed by Grey soil of 20.84 %.

Land suitability for crop production in the Study Area is identified based on the information from the Sub-national Institute for Agricultural Planning and Projection. Land suitability classification criteria made by the sub-institute are presented in the following Table:

Land Suitability Criteria for Crop Production

Crop	Requirement		Factor Rating			
	Land Quality	Daignostic Factor	Highly suitable	Moder. suitable	Margin. suitable	Non arable
1. Irrigated Paddy	Soils	Soil type	6,7	2,5,8	4	1,3,9,10,11,12
		Soil depth (cm)	> 50	< 50	< 50	< 50
	Slope	Slope(°)	0-8	0-8	0-8	> 8
	Irrigation	Irrigation possibility	by surface water	by surface water	by surface water	by ground water, non-irri.
	Hydrological condition	Flooding depth (cm)	< 30	< 30	30-60	> 60
		Salt water intrusion	non-exist	non-exist	non-exist	exist
2. Rainfed paddy	Soils	Soil type	6,7	2,5,8,9,10	4	1,3,11,12
		Soil depth (cm)	> 50	< 50	< 50	< 50
	Slope	Slope(°)	0-8	0-8	0-8	> 8
	Irrigation	Irrigation possibility	exist	non-exist	non-exist	non-exist
	Rainfall	Rainfall(mm)	> 1800 if irrigable	> 1800 if non-irrigable	< 1800 if non-irrigable	< 1800 if non-irrigable
	Hydrological condition	Flooding depth (cm)	< 30	30-60	> 60	> 60
		Salt water intrusion	no, only in dry season	no, only in dry season	no, only in dry season	exist always
3. Perennial crops	Soils	Soil type	9,7	8	6,10	1,2,3,4,5
		Soil depth (cm)	> 100	50-100	50-100	< 50
		Stoniness	exist	non-exist	non-exist	non-exist
	Slope	Slope(°)	0-8	8-15	8-15	> 15
	Irrigation	Irrigation possibility	by gravity	by groundwater	rainfed	rainfed
	Rainfall	Rainfall(mm)	> 1500	< 1500	< 1500	< 1500
	Hydrological condition	Flooding depth (cm)	< 30	< 30	30 - 60	> 60
		Salt water intrusion	no-exist	no-exist	no-exist	exist

Note:

(1) Soil types: 1. Sand dune siols, 2. Marine sandy soils, 3. Mangrove saline soils, 4. Acid sulphate soils, 5. Saline soils, 6. Alluvial soils and colluvial soils, 7. Black tropical soils, 8. Grey soils, 9. Yellow red soils on basalt, 10. Yellow red soils on other parent materials, 11. Humic soils on mountains, 12. Eroded soils and other soils

(2) Land suitability is expressed by expected crop yields as percentage of yields in the absence of inputs specified to the land quality considered as follows: 1. Highly suitable: > 80 %, 2. Moderately suitable: 40 -80%, 3. Marginally suitable: 20 -40 %, 4. Non arable: < 20 %.

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

Areal extents by the land suitability for irrigated paddy, rainfed paddy and perennial crops are shown in the following Table:

Land Suitability Classification for Crops

Suitability	HYV Paddy		Local Paddy, Upland Crops		Perennial Crops	
Unsuitable	4,376,530ha	91 %	2,845,640ha	59 %	2,484,610ha	52 %
Highly suitable	157,640ha	3 %	269,380ha	6 %	0ha	%
Moderately suitable	195,000ha	4 %	1,524,360ha	32 %	1,143,250ha	24 %
Marginally suitable	93,120ha	2 %	182,910ha	4 %	1,194,430ha	25 %
Total	4,822,290ha	100 %	4,822,290ha	100 %	4,822,290ha	100 %

Remark: River, lake, city and town areas of 131,340 ha are excluded in the calculation.

Land suitable for paddy development is estimated at 9 % of the area, while at present 13.89 % of the area has already been developed for paddy areas. It can be said that almost all land suitable for paddy development had already been developed for paddy fields and that there is over exploitation in the unsuitable areas for paddy fields such as steep land, land on strong acid sulphate soils and sandy land.

Land suitable for upland crops is estimated at 42 % of the area. Land utilized for upland crops including fruit trees and plantation crops is 23.31 % of the area. Major parts of present paddy fields could be utilized for upland crops if drainage facilities are provided. So, 37.2 % of the area could have been used for upland crops. There is some potential for further development of land for upland crops, fruit trees and plantation crops.

Seven areas which have high potential for irrigation development were classified by present land use and land suitability for irrigation agriculture in the first home office work. The present land uses identified were revised based upon the ground checks. Land suitability maps prepared by Sub-NIAPP are too small in scale, 1: 250,000, to identify potential for irrigation development by project-wise, so the agricultural development expert made land suitability maps based on physiography, which was identified using 1: 100,000 topographic maps. Land suitability criteria for irrigation development are shown in the following Table:

Land Suitability Criteria for Irrigation Agriculture

Land System	Land Form		Land Unit	Dominant Slopes	Land Suitability	
					Paddy	Upland Crops
1	Alluvial plain	1a	Present river channel		B	B
		1b	Sand and gravel bars		B	B
		1c	Low terrace		A	A
		1d	Higher terrace		A	A
2	Alluvial fans or aprons	2a	Very gentle slopes		A	A
		2b	Gentle slopes	1-5°	A	A
		2c	Undulating	1-3°	A	A
		2d	Highly dissected	0-20°	B	A
3	Depositional basin or plateau	3a	Depression	< 0.5°	A	A
		3b	High position, non-dissected	< 2°	A	A
		3c	Gently rolling	1-5°	A	A
		3d	Highly dissected	0-30°	B	B
4	Mountain or hill	4a	Moderate to steep slopes	< 20°	B	A
		4b	Steep to very steep slopes	> 20°	B	B
5	Tidal swamp	5a			B	B

Remarks: A; Suitable, B; Unsuitable

Development areas in the individual schemes were classified according to the present land use and land suitability to irrigation development. The results are presented in Table 1.4.

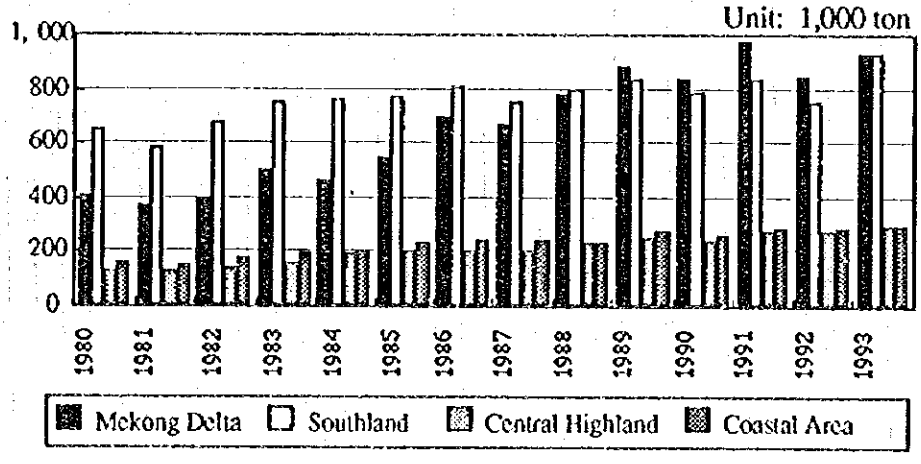
(2) Crop Production

Crop production in a related province and by crop from the year 1980 to 1993 is shown in Table 1.5. Main crops in the respective regions are:

Mekong delta:	paddy, pineapple , fruit trees and sugarcane;
N-E Southland:	paddy, rubber, maize, sugarcane, cashew, tobacco and coffee;
Central highlands:	coffee, tea, mulberry and paddy; and
South Central Coast:	paddy, grape, sugarcane, cotton, cashew, tobacco, tang rong and water melon.

The most important crop related to the water resources development is lowland paddy. Regional production trends of paddy are shown in the following Figure:

Paddy Production in the Related Regions



Figures in Mekong delta express ones for the entire Long An province. The Study Area covers only 50 % of the Long An province and 15 % of the Dac Lac province. The total paddy production in the Study Area is estimated as follows:

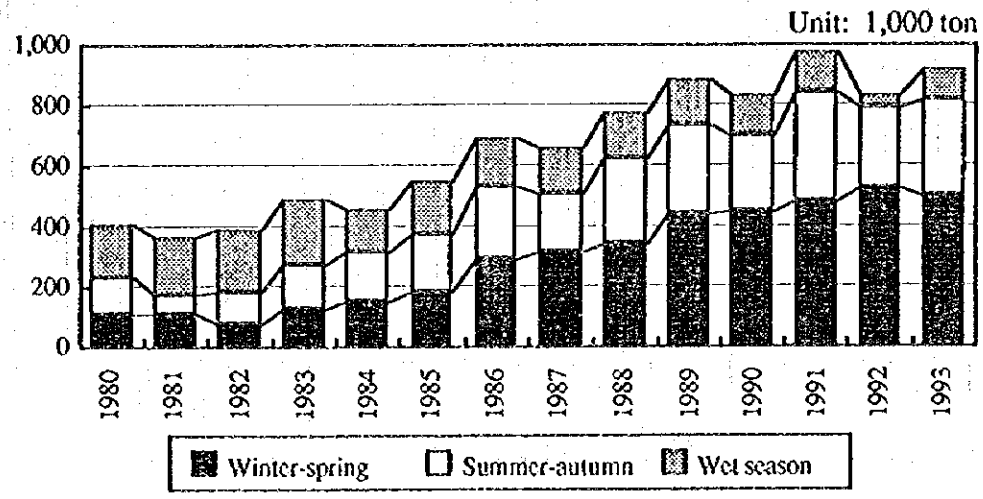
Paddy Production in the Study Area

Unit: 1,000 ton

Year	1980	1981	1982	1983	1984	1985	1986
	1,064	978	1,111	1,255	1,276	1,363	1,489
Year	1987	1988	1989	1990	1991	1992	1993
	1,417	1,520	1,658	1,563	1,715	1,564	1,795

Mekong delta and the southeast region are the major rice producing area, accounting for about 69 % of the total production in the Study Area in the year 1993. Coastal area and the north central region are minor rice production areas in the Study Area. Paddy production in the Mekong Delta shows significant increases by 160 % between the year 1981 and 1991. While, increase in N-E Southland region is comparatively small with a rate of about 40 %, in the same time period. Major parts of the increases in Mekong delta are made by the increase of winter-spring paddy and summer-autumn paddy, and wet season paddy production is decreasing as shown in the following Figure:

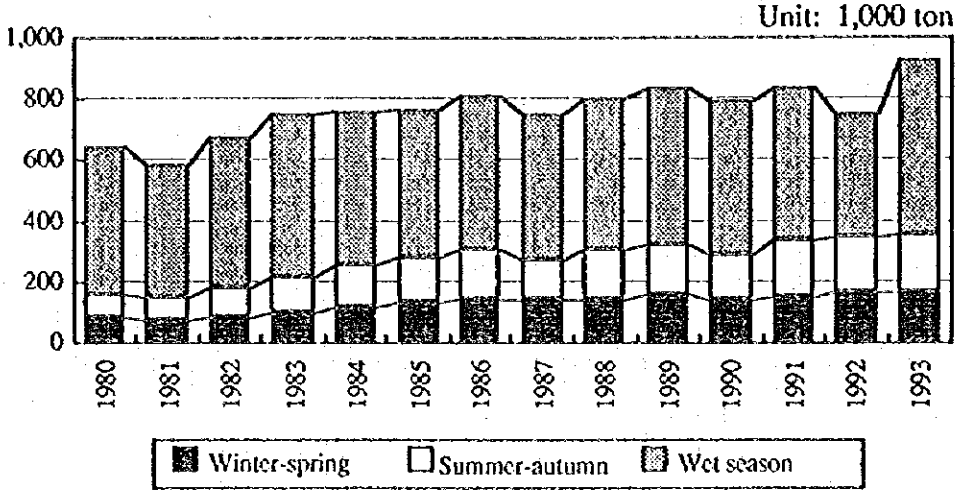
Paddy Production by Season in Mekong Delta Parts



Development of canal networks in Mekong delta seems to have contributed significantly to the increase in winter-spring or summer-autumn paddy production by enabling dry season irrigation possible. Dilution of accumulated salt or acid water by discharge of flood water through the canal network is indispensable for the dry season irrigation development.

There have been no big changes in wet season paddy production in the southeast region in the last 14 years even if there is big irrigation system such as Dau Tieng irrigation system and Tri An reservoir as shown in the following Figure:

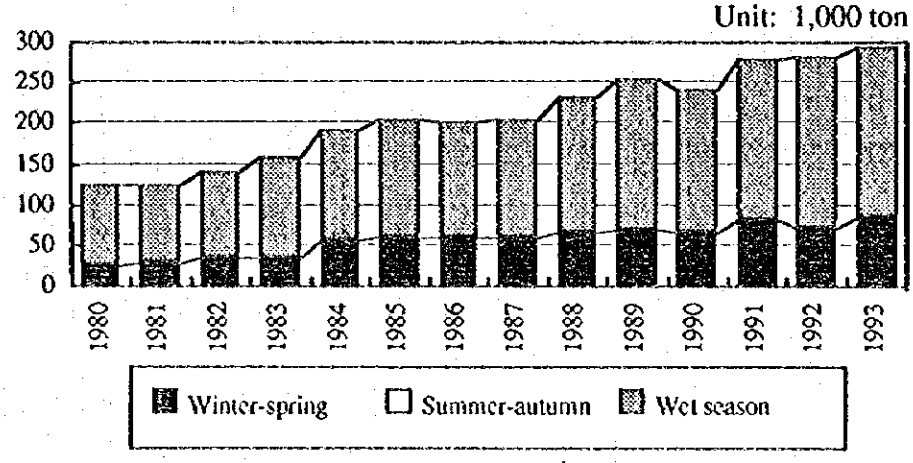
Paddy Production by Season in Southeast Region



Insufficient development in tertiary or on farm irrigation systems seems to have been restricting the development of winter-spring and summer-autumn paddy production under irrigated condition.

Paddy production in the north central region comes mainly from increase in wet season paddy. About 70 % of the paddy is produced from wet season paddy in the year 1993 as shown in the following Figure:

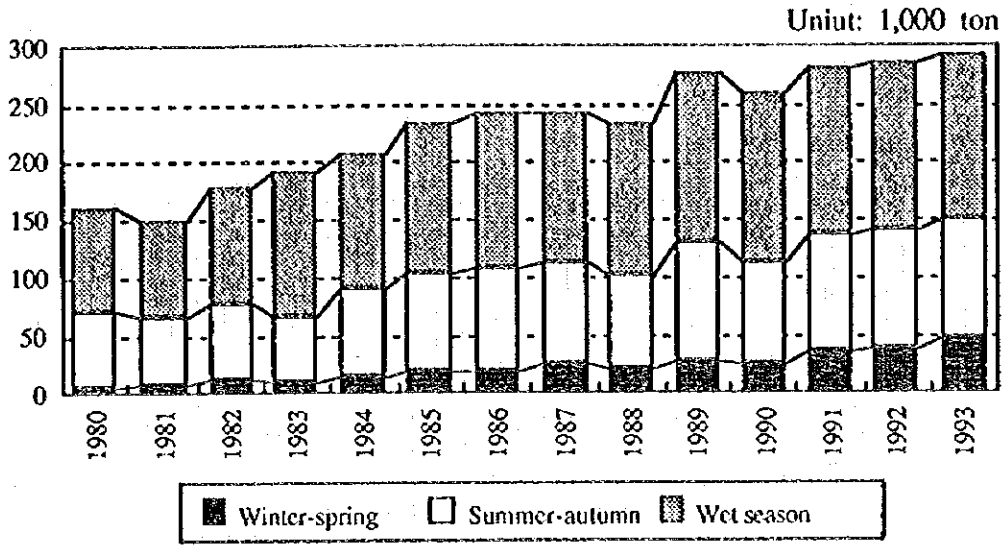
Paddy Production by Season in North Central



Floods and insufficient development in irrigation systems appear to limit the development in winter-spring or summer-autumn HYV paddy production.

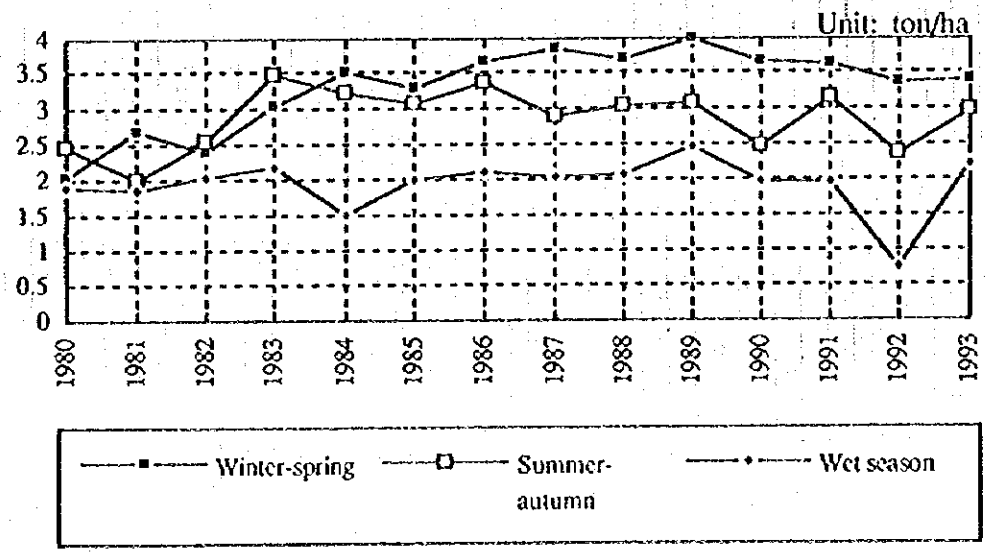
Paddy production in the coastal area has increased steadily from the year 1981 to 1993, but wet season paddy cultivation still plays an important role, sharing nearly a half of the total production as shown in the following Figure:

Paddy Production by Season in Coastal Area



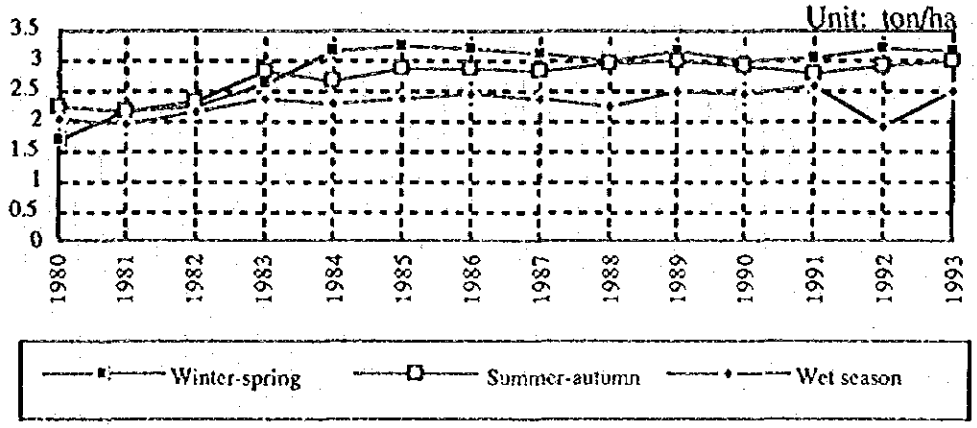
Winter-spring paddy has been restricted by shortage of water resources in the dry season. According to the agricultural statistics of the Ministry of Agriculture and Rural Development, paddy yields in Mekong delta are 3.5 ton/ha for the winter-spring paddy, 3.0 ton/ha for the summer-autumn paddy and 2.0 ton/ha for the wet season paddy. Yields of wet season paddy have been stable at around 2.0 ton/ha. However, yields of winter- spring and summer-autumn paddy are decreasing in the last several years as shown below:

Paddy Yield Trend in Mekong Delta

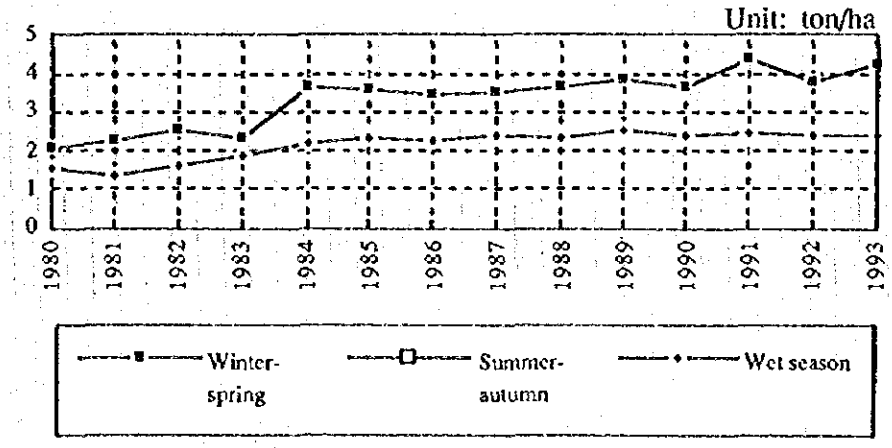


Paddy yields in the southeast region have been stable for the last 10 years. Yields of the winter-spring paddy have been increasing but those of wet season and summer-autumn paddies have been stable in the coastal and highland areas as shown below:

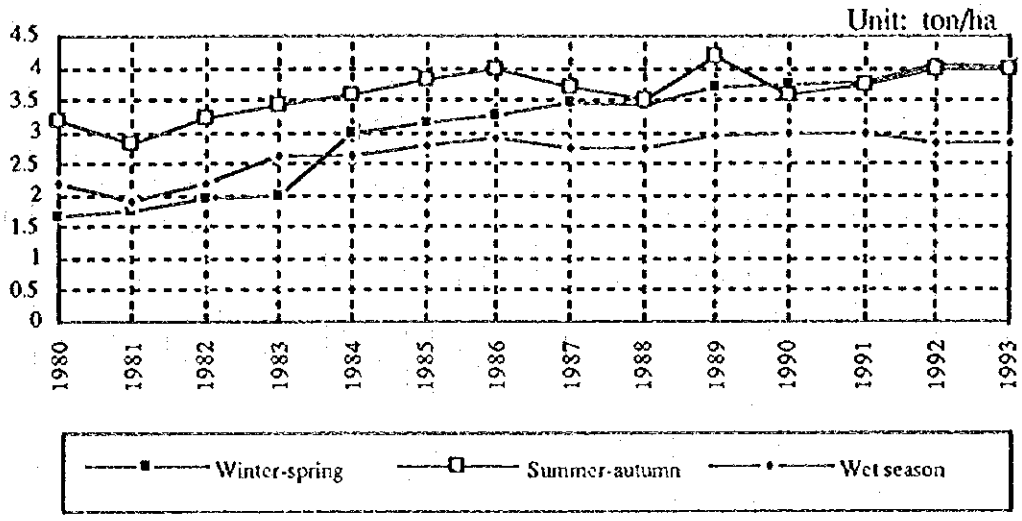
Paddy Yield Trend in Southeast Region



Paddy Yield Trend in Highland



Paddy Yield Trend in Coastal Area



(3) Animal Production

Animal husbandry such as pig , chicken and cattle is one of important sources of income for the farm households, particularly in remote rural areas. Land preparation for crop cultivation is still done by draft animal in some cases, even though tractor plays the main role in land preparation. Big expenses are covered by selling livestock in many cases in rural areas. Numbers of animal by kind in the last 14 years in the related provinces are given in Table 1.6.

Modern animal industry has not yet been developed in the Study Area even near the big cities. Lack of improved breeds, feed industry, marketing facilities, extension services, financial services and processing facilities is the causes of least development of animal industry.

(4) Agricultural Households and Land Holding

Total agricultural population and agricultural households in the Study Area in the year 1993 are estimated at 5.3 million and one million respectively by assuming that 15 % and 50 % of the respective total corresponding figures for Dac Lac and Long An provinces are in the Study Area. An average agricultural household size is calculated at 5.3 persons as shown below:

Agricultural Population, Agricultural Land and Land Holding Size in the Related Provinces, 1993

Region/Province	Agricultural Population	Agricultural Households
	x 1,000 head	x1,000 unit
Lam Dong	516.7	97.5
Dac Lac	799	154.5
HIGHLAND	**1,315.7**	**252**
Ninh Thuan	292.8	50.6
Binh Thuan	542.4	103.6
COASTAL AREA	**835.2**	**154.2**
Song Be	668.8	134.2
Dong Nai	1,112.9	191.8
Ba Ria-Vung Tau	320.5	64.1
Tay Ninh	588.8	115.8
HCMC	624.4	112.5
SOUTHEAST	**3,315.4**	**618.4**
Long An	1062.4	206.3
MEKONG DELTA	**1,062.4**	**206.3**
STUDY AREA	**5,318.35**	**996.425**

Average agricultural land holding sizes are estimated at 1.53 ha for the coastal area and 2.07 ha for the southeast region based on the land use data from NIAPP. An average agricultural land holding size in the highland or in Mekong delta is 2.1 ha according to the interview surveys in agricultural offices.

(5) Agricultural Extension and Research Services

The agricultural extension services are given to farmers through formal agricultural extension offices, cooperatives and farm input merchants. There is an agricultural extension service station in each district and a few extension workers in a village. A station has 2 to 3 extension workers in provinces except for Long An province, which has 10 to 15 extension workers. In the capital city of a province there is an extension centre with 6 to 10 officers. Main work of extension offices is the extension of technologies, operation of demonstration plots in farmer's fields, collection of agricultural statistics and other administrative work. Most of the extension workers are graduates of primary schools. There is no systematic Training and Visit Agricultural extension (TV system) services in Viet Nam.

The Ministry of Agriculture and Rural Development is responsible for agricultural research activities. The Scientific Council of the Department of Agricultural Science and Technology is the coordinating organization for the Research and Development (R&D) programmes. Significant research institutions are:

1. National Institute of Agricultural Sciences;
2. Institute of Soils and Fertilizers;
3. Institute of Agricultural Technology;
4. Institute of Food Crops;
5. Institute of Technical Crops;
6. Institute of Animal Husbandry;

7. Institute of Plant Protection;
8. Veterinary Institute;
9. Institute of Agricultural Mechanization;
10. Institute of Agricultural Economics;
11 Research Institute of South Viet Nam;
12. Research Centre of the Mekong Delta;
13. Research Centre of the Central Highlands;
14. Cotton Research Centre;
15. Maize Research Centre;
16. Pulses Research Centre;
17. Sericulture Research Centre;
18. Rubber Research Centre;
19. Forestry Research Institute;
20. Inland Fisheries Research Institute; and
21. Shrimp Culture Research Institute.

The major sources of external resources support are UNDP and FAO. Other external assistance comes from CIMMYT (maize), IRRI (rice), Denmark (sugarcane), India (dairy buffalo) and France (coconut, rubber and maize).

(6) Rural Credit Services

According to the results of Viet Nam Living Standard Survey 1992 to 1993, an average income in the rural area is VND 4,629,500 per household per annum. Credit given to a rural household amounts to VND 603,800, in which about 40 % is used for agriculture/fishery operation. Agriculture/fishery credit demand per household is VND 241,500, which corresponds to 5.2 % of the average income in rural area. So, credit demand for agriculture/fishery in the rural area is rather small probably due to mainly subsistent nature of the existing agriculture. Non-formal credits, which are from individuals and money lenders, play a main role in rural credit, sharing 73 % of the total credits as shown below:

Rural Credit

Unit: %

Type of Lenders	Share in Rural Credit
1. Individual without interests	39.94
2. Money lenders with interests	33.11
3. Government bank	22.53
4. Cooperatives	3.25
5. Others	1.17
Total	100

Source: Viet Nam Living Standards Survey 1992-1993

Formal agricultural credits are given by the Agricultural Bank and cooperatives. Most of farmers borrow money from the agricultural bank directly. There is no credit in kind in Viet Nam, nor long term loan of more than three years in loan period such as loans for investment in construction of infrastructure and fruit tree cultivation. Most of the funds for the loan are supplied through savings from customers. Shortage of funds has been supplied from the state

bank. Interests given by the state bank are 2 % per month for the short term loan and 1 to 1.5 % for the medium term loan. Interests given to loan are 2.55 % per month for the short term loan and 1.7 % for the medium term loan. Interests given by user are 5 to 10 % per month. Saving interest rates are 1.6 % per month for the 3 month fixed deposit, 1.8 % for the 6 month fixed deposit and 2 % for the 12 month fixed deposit. About 90 % of the total loan disbursement by the bank is received by farmers and 10 % by cooperatives. Ten to twenty farmers are organized into a group. The bank demands collateral for lending such as land use certificates, agricultural produce, building and cattle and guarantors. The maximum loan amount allowed is VND 100 million. Eighty percent of collateral value is allowed for the loan. Repayment rate of the loan is as high as 96 % in case of Bac Binh district in Binh Thuan province. The agricultural bank has a branch office in each district as well as a provincial head office.

(7) Agricultural Marketing

As shown in the following Table, private merchants play an important role in the marketing of agricultural produce under the new market-oriented agricultural policy in place of cooperatives that were the sole outlet of produce for most of farmers before the introduction of new policy.

Marketing Outlets of Agricultural Produce

Unit: %

Produce	Outlets				
	Government	Cooperative	Private	Own Uses	Other's Needs
Paddy	8.33	1.67	75	50	5
Other food crops	3.33	0.83	63.33	44.17	12.5
Industrial annual crops	8.33	0.83	48.33	17.5	7.5
Industrial trees	1.67	0	24.17	3.33	0.00
Fruit trees	0.83	0	25	5	1.67
Forest trees	0.83	0	14.17	2.5	0.83

Source: Viet Nam living standards survey 1992-1993
Note: based on community questionnaire

Seventy-five percent of communities answered that they market their paddy through private merchants. Only 1.67 % of them market their paddy through cooperatives. Most of agricultural inputs such as fertilizers and chemicals seem to be obtained by farmers through the same private merchants as the agricultural produce. Provincial agricultural authorities have established various agricultural inputs supply companies and are competing with the private merchants. Issues lie in the virtual state company monopoly of export processing and marketing such as rice, rubber, cashew and coffee. Quota system is exercised in the export of important agricultural produce. Private companies can get the quota by filling some conditions such as minimum export amount of US Dollar 1.3 million per year. Such requirement can only

be filled by big companies such as state companies. Transportation of food crops out of a province is limited to authorized transportation companies such as those having export quota.

Farmers are placed at a disadvantage in marketing with limitation in transportation, little market information, poor rural roads, cash shortage in and around harvesting seasons, insufficient storage facilities, lack of transportation means and so on.

(8) Characteristics of Farmers in Irrigation Schemes

The characteristics of farmers in the major irrigation schemes in the Study Area identified through the farm survey carried out in the Phase II work are:

a) Small holding in land, animal, cash and machinery,
b) Rice based subsistence agriculture with chronic extreme poverty,
c) No substantial assistance in extension or management services, and
d) Low technological level with primitive agricultural educational backgrounds.

Small holding in land, animal, cash and machinery

The average land holding size of samples, which were collected from the rice based farming, is 0.65 ha per household with the family size of 4.3 persons, in which 1.5 persons are children. This landholding size is not enough to sustain livelihood of this size of family by farming even under irrigated condition. The land consists of 4.6 plots. Scattering of the farm land over many small plots is a big obstacle for efficient farming. Most of the land they cultivate is owned land. Only one case has no legitimate land ownership because he practices shifting cultivation of maize in unregistered land.

Livestock holding is small; one pig and one head of cattle on an average. Animal husbandry is specialized by livestock farms. Integration of crop farming and livestock raising is a rare form of cropping system in the potential irrigation schemes. This phenomenon may be attributable to lack of funds, technology and poor marketing channels. Aquaculture is rare in the areas. Fish catching in rivers and ponds is practiced in some cases.

Institutional agricultural credit system has not been well established. Only two farms out of 11 farms use loan from the agricultural bank. Most of the farmers use their own money earned in farming to buy farm inputs such as fertilizers and chemicals. A high interest of 2.5 % per month, collateral requirements, bureaucratic red tape in credit arrangement, high risk in crop prices and market outlets, lack of agricultural extension services, lack of irrigation services or unreliable supply of irrigation water are the main problems in agricultural financing.

Agricultural mechanization is not well developed. Only one case out of 12 cases has his own tractor. Draft power is supplied from hired tractor (42 %), own animal (25 %), hired animal

(17 %), own tractor (8 %) and manual (8 %). There is enough draft power in the areas. Only 2 cases out of 11 farmers answered shortage in draft power.

Rice based subsistence agriculture with chronic extreme poverty

The main source of livelihood of farmers in the scheme areas is rice farming. Nine farmers out of 12 samples identify themselves as rice farmers. Diversification from rice farming to cash crops such as sugarcane and cotton, animal husbandry, aquaculture, vegetable growing, etc., has not yet been substantially implemented even after liberation in economy in the potential irrigation scheme areas. Working in the large cities such as Jakarta or Manila in off-farming season is a commonly observed phenomenon in Southeast Asia, but in Viet Nam, seasonal immigration of farmers to the large cities such as Ho Chi Minh City has not been observed in the farm surveys due to few opportunities of employment, high living costs there, few connections to city dwellers and no availability in needed skills on the part of farmers.

An average annual income per household is estimated at VND 10.5 million which is equivalent to VND 2.44 million per person (US$ 220). About 42 % of the income is generated in field crop raising, followed by livestock raising (19 %), non-farming activities (6 %) and fishing (2 %). But, livestock raising, fishing or fruit growing is much specialized. As stated in the preceding Sections, integrated farming is not a common form of farming in the areas. Farming in the potential irrigation schemes is subsistence agriculture in principle. Avoiding risks is a principal important requirement in farming.

The average annual household cash expenditure is estimated at VND 8.7 million, in which 68 percent of the total expenditure is spent for food. The second largest expenditure groups are housing and housing furnishing/equipment (19 %). One of noteworthy facts is the negligibly small expenditure in education. Only 0.6 % of the total expenditure is spent for education. The farmers cannot afford to spend for the education of their children.

No substantial assistance in extension or management services

Until several years before, the agricultural cooperatives had played the main role in agricultural production, supplying farm inputs, management services, extension services, marketing services, irrigation services, etc. to farmers. After the collapse of cooperatives, farm input supply and marketing services have been smoothly replaced mainly by private merchants. Irrigation services have also been taken over by the government irrigation companies. However, extension services and farm management services have not been taken over by any appropriate organizations. According to the results of the farm survey only one farmer out of 10 samples gets technological information from the government extension worker. The existing extension worker's specialties as well as the existing agricultural research institution's specialties lie mostly in rice farming. Technologies in other areas such as livestock, horticulture, aquaculture and agro-processing, which are very important in market economy,

are not available to general farmers. New genetic resources of crop species, varieties and animal breeds, which are indispensable to make success in market economy, are also very difficult for individual farmers to obtain.

Farmer's weak technological and legal backgrounds

Most of farmers are literate having received primordial education such as primary school or junior high school in most cases. But, agricultural education has not been given systematically to common farmers. Effective management of their farms in growing and marketing cash crops in the market economy would be difficult without re-education in farm management or some assistance from outsides such as government or agribusiness companies. The farmers are not familiar with common senses regarded necessary in market economy. Frequent breakage of contracts, when market prices show higher prices than those stipulated in the contracts, is one of the big problems to agro-processors.

1.3 Agricultural Development Strategy

1.3.1 Problems of Agriculture in the Study Area

Viet Nam is developing and strengthening the market economy in place of the centrally controlled economy. Judging from the recent economic development in Southeast and East Asia, it seems that the complete development of the market-oriented economy would lead to prosperity of the people and the nation. From this viewpoint, there are yet the following many constraints hindering the market-oriented economy of agriculture in the Study Area.

(1) Restrictions on the Marketing Activities

Licensing system in the transportation of agricultural produce beyond province restricts competition in transportation as well as economic competition between provinces, resulting in inefficiency in transportation of agricultural produce as well as in inefficiency in the total economy. Export quota system without auction in agricultural produce also restricts competition between exporters and would lead to inefficiency in economy. Too much price margin for exporters assured by the quota system means low profit for the producers.

(2) Lack of Marketing Infrastructure

Poor rural road, bridge and electricity development are one of the most important constraints on economic activities of farmers in rural areas. Farmers in remote rural area cannot participate in market economy without development of all-weathered rural roads and bridges. Electrification is indispensable for agricultural processing and information development.

There are virtually no marketing cooperatives or groups in the Study Area. Farmers are small in land or animal holding, and produce small marketable surpluses of produce. They cannot exercise economic scale merits in marketing of produce without joint collective power through cooperatives or groups. Farmers have weak bargaining power against middlemen or state/private companies and are at the mercy of them.

Farmers in rural areas have no access to market information such as on prices and market outlets of produce. Lack of dissemination services on market information such as agricultural market news in radio and television programmes is one of weak points of farmers against middlemen and state/private companies in dealing in them.

(3) Lack or Insufficient Development of Irrigation and Drainage System

High productivity in farming is one of the key points in success in market economy. Without irrigation systems for the dry season there would be little chance to get high productivity in cultivation of diversified crops such as vegetables and fruit trees. Drainage development in paddy fields is indispensable for the cultivation of vegetables and fruit trees in paddy fields, i.e. diversification from paddy. Present irrigation systems in the Study Area have problems such as less development of tertiary and on-farm irrigation canals, poor operation and maintenance of system, which cause low recovery rates in collection of irrigation water charges and less participation of beneficiaries in project planning, construction, operation and maintenance.

(4) Insufficient Development of Rural Financial System

Successes or survive in market-oriented agricultural economies needs to produce large quantity of produce to satisfy steady demands of consumers as well as to enjoy economic scale merits. This requirement needs large capital. Because farmers in the Study Area have no sufficient capital to fill the requirement, institutional credit services together with financial management guidance are required to supply enough funds and financial guidance to farmers. The present official credit system depends much on its fund resources in saved money, which is not enough to meet rising fund requirements. Financial and technical guidance for farmers by the agricultural bank seems to be insufficient in personnel and quality.

(5) Insufficient Development of Agricultural Processing Facilities

Development of agricultural processing facilities in rural areas can generate more job opportunities and value added than the simple production of agricultural raw materials. Absorbing labour forces in rural industries would mitigate the problems caused by the population concentration in HCMC. There are many opportunities for the development of rural industries in the Study Area such as dairy processing, cashew processing, coffee processing,

rubber processing, meat processing, sugarcane processing, feeds processing and rice processing.

(6) Shortage of Technological and Management Skills Suitable to Market Economy

Rural leaders in politics and business have few chances in accessing to modern technologies, foreign made technologies in particular. Technology development is a competitive edge and is prerequisite in success in market economy. Local leaders are adapted to a socialistic top-down management style. They have difficulties in management of organization in a manner suitable to market-oriented economy. Identification of market needs and suitable market outlets is one of the most important work in management in market-oriented economy. Personnel and financial management methods have also to be adapted to market economy. Motivation of employees by bottom-up management style or decentralization is a key in personnel management. Book keeping by double entry through computers is effective in efficient financial management. Balance sheet and profit and loss statement would have to be made every year to monitor the financial condition of the organization. All these would have to be taught to local leaders in special training courses.

1.3.2 Framework of Agricultural Development Plan

From the socio-economic study presented in Appendix I and identification of present agricultural situation mentioned above, a proposed framework of agricultural development plan including rural development is set by dividing the Study Area into the four ecological zones as shown in Figure 1.1, and as summarized below:

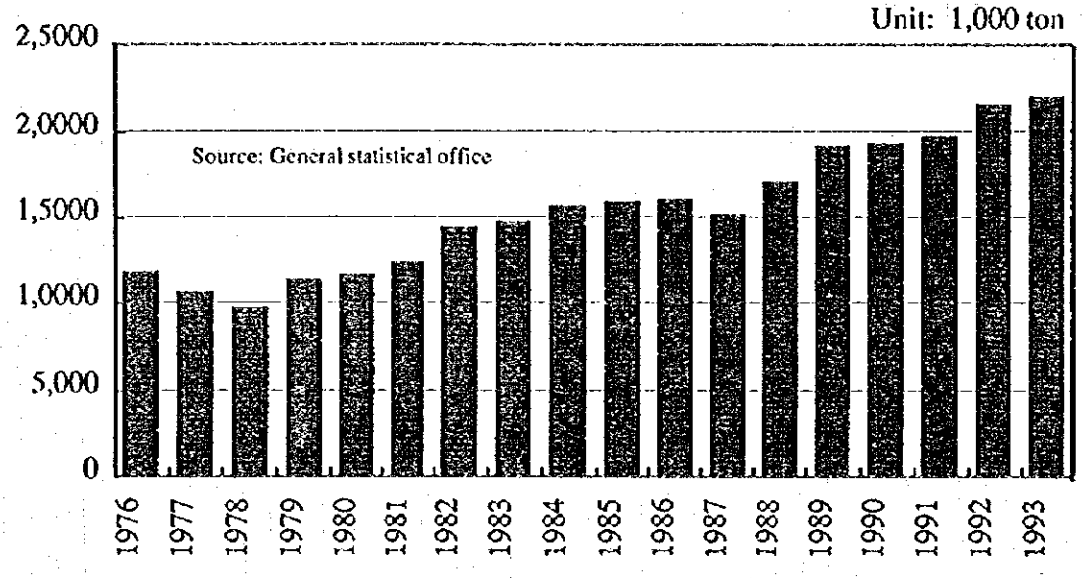
Ecological Zone	Major Agricultural Development Schemes	Major Rural Development Schemes
Mekong Delta	- Irrigation dev. & drain. improv. - Flood control and protection - Prevention of salinity intrusion	- Water supply & sewerage improv. - Rural electrification - Agro-industrial dev.
N-E Southland	- Upland pump irrigation dev. - Small water impounding - Reservoir fishery dev.	- Watershed conservation - Rural electrification - Water supply & sanitation improv.
Central Highland	- Small water impounding - Irrigation dev. for rainfed areas - Reservoir fishery dev. - Watershed conservation	- Rural electrification - Water supply & sanitation improv.
South Central Coast	- National communal irrigation dev. - Fishery and processing dev. - Coastal rehabilitation and resources management	- Water supply & sanitation improv.

1.3.3 Rice Demand and Supply Projection in Viet Nam

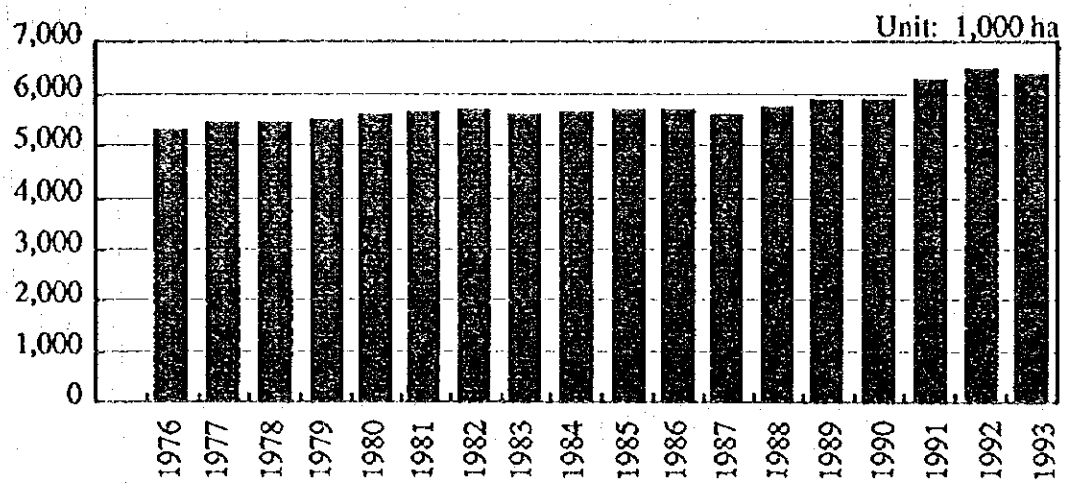
(1) Historical Background

Rice demand and supply in Viet Nam were studied to evaluate the significance of rice production in the Study Area. The historical paddy production, harvested area and unit yield in Viet Nam are shown in the following Figures:

Paddy Production Trend in Viet Nam

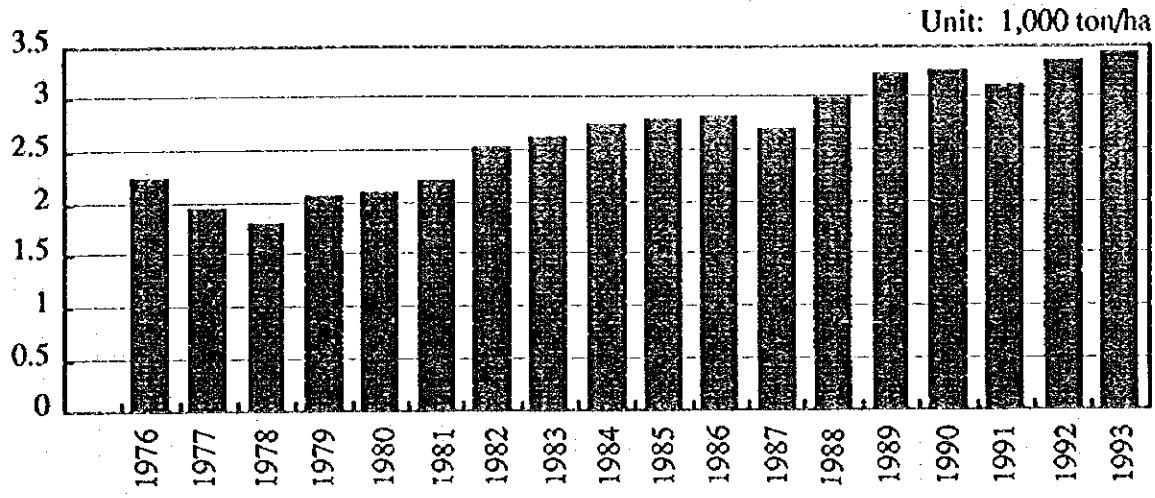


Paddy Harvested Area Trend in Viet Nam



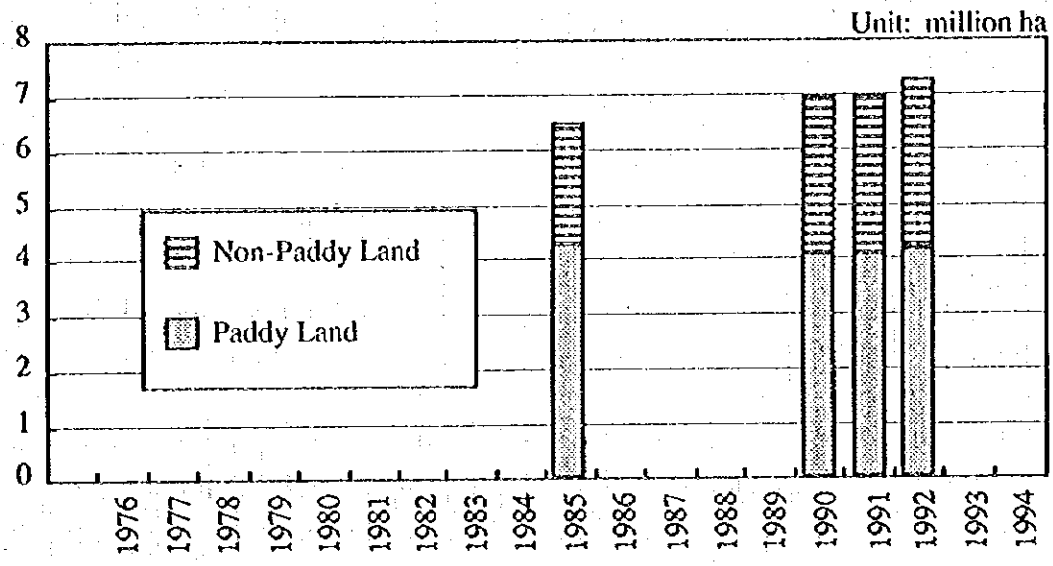
Remark: Figures in 1991, 1992 and 1993 are sown areas.

Paddy Unit Yield Trend in Viet Nam



The paddy production increased by about 100 % from 10 million tons to 22 million tons between the year 1978 and 1993. The paddy harvested areas in the year 1991, 1992 and 1993 in the figure are sown areas. Assuming 5 % of the sown area was left unharvested due to damages such as by floods, insect pests, etc., the harvested areas in these years might be around 6 million ha. So, the paddy harvested area has slightly been increasing from 5.5 million ha to 6 million ha in the same period. Unit yield of paddy was increased by about 100 % from 1.7 ton/ha to 3.5 ton/ha in the same period. From above discussion, it can be said that major part of the paddy production increase in Viet Nam has been caused by increase in unit yield. The paddy land in Viet Nam is slightly decreasing from 4.3 million ha in the year 1985 to 4.2 million ha in the year 1992 as shown in the following Figure:

Trends in Paddy Area and Non-paddy Agricultural Area

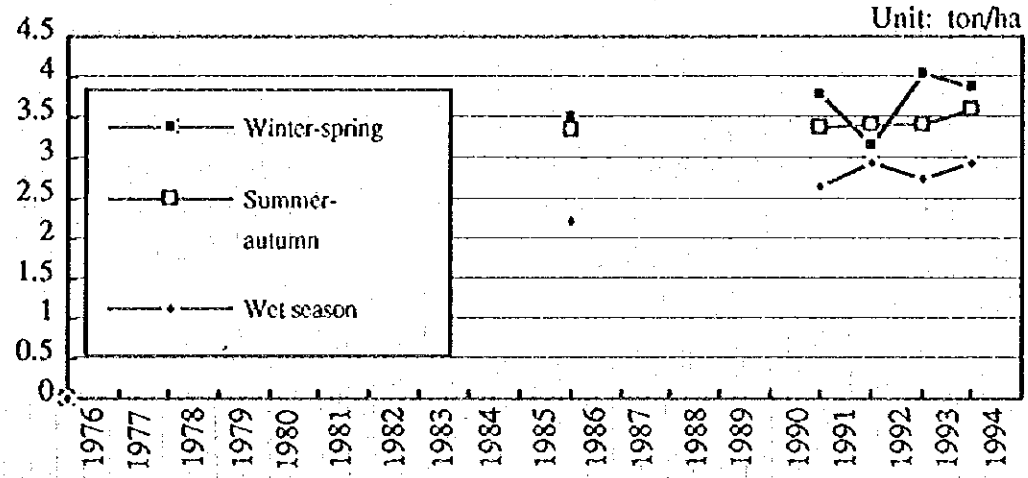


Source: General statistical office

Non-paddy agricultural land is increasing from 2.2 million ha to 3.1 million ha in the same period. Therefore, the paddy production increase in Viet Nam was caused by the intensification of cultivation, not by extensification of cultivation, i.e. expansion of paddy land.

Paddy cropping in Viet Nam consists of three types; (1) winter-spring, (2) summer-autumn and (3) wet season. Unit yields of the former two croppings are higher than the last because the former two grow under more suitable climate conditions and use improved high yielding varieties. Wet season paddy is traditional local varieties which have low responsiveness to fertilizer application. The unit yields in the year 1993 were respectively 3.9 ton/ha, 3.6 ton/ha and 2.9 ton/ha. Historical trends of these yields are shown in the following Figure:

Paddy Yields by Cropping Type in Viet Nam



Source: General statistical office, 1994

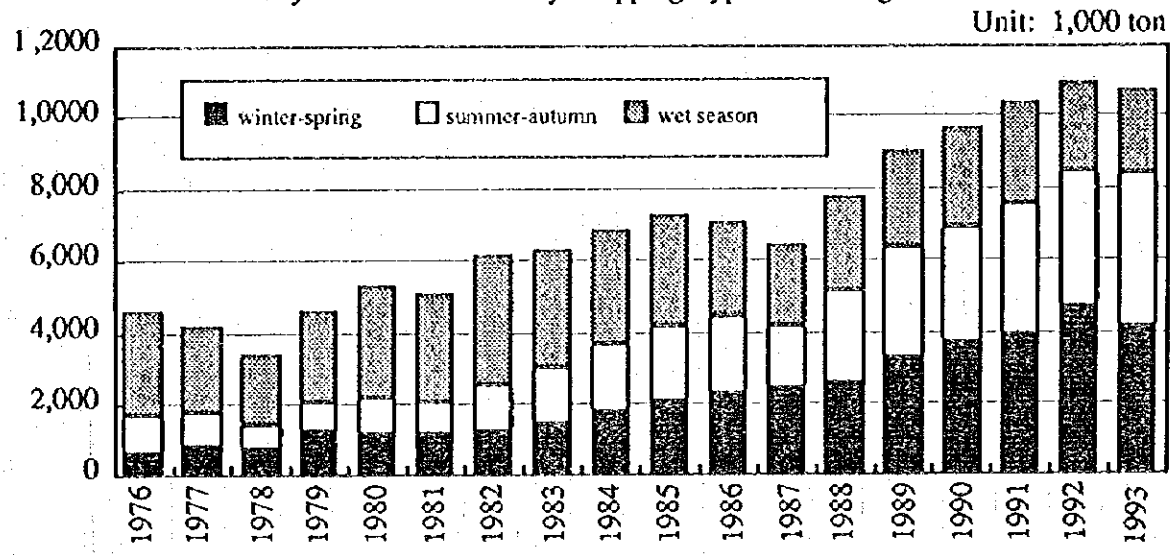
Area composition of paddy cropping types is changing. Wet season paddy has been replaced by winter-spring and summer-autumn types, which have higher unit yields than wet season paddy by approximately 1 ton/ha and 0.5 ton/ha, respectively.

Paddy production in Viet Nam depends much upon its production in the Mekong River delta and the Red River delta, which produced respectively 49 % and 21 % of the total paddy production in Viet Nam in the year 1993. Paddy production in the Red River delta has serious problems such as frequent floods caused by locally intensive rainfall, abnormally high tides and poor drainage in the wet season as well as droughts and cold damages in the winter season. Among these problems, poor drainage, which requires expensive pumpage, is one of the most significant constraints in improving paddy production efficiency. Phasing out of the subsidies of electric power for irrigation has been discouraging farmers to invest in irrigation development in the inferior areas. Further expansion of paddy land faces another difficulty of the high demands for dwelling land caused by high population pressure. Even though some

areas under heavy investment in irrigation, flood control and drainage structures such as in Hanoi and the southern part of the Ha Bac province show high yields of 10 ton per ha per year, the Red River delta would not be able to get out of subsistence paddy production unless further high investment will be made in flood control, irrigation development, road construction and drainage improvement besides some subsidies in pumping operation costs. This situation sometimes made the delta to the area to import rice from the Mekong delta.

Historical paddy production trend in the Mekong delta shows steady increase until the year 1992 as shown in the following Figure:

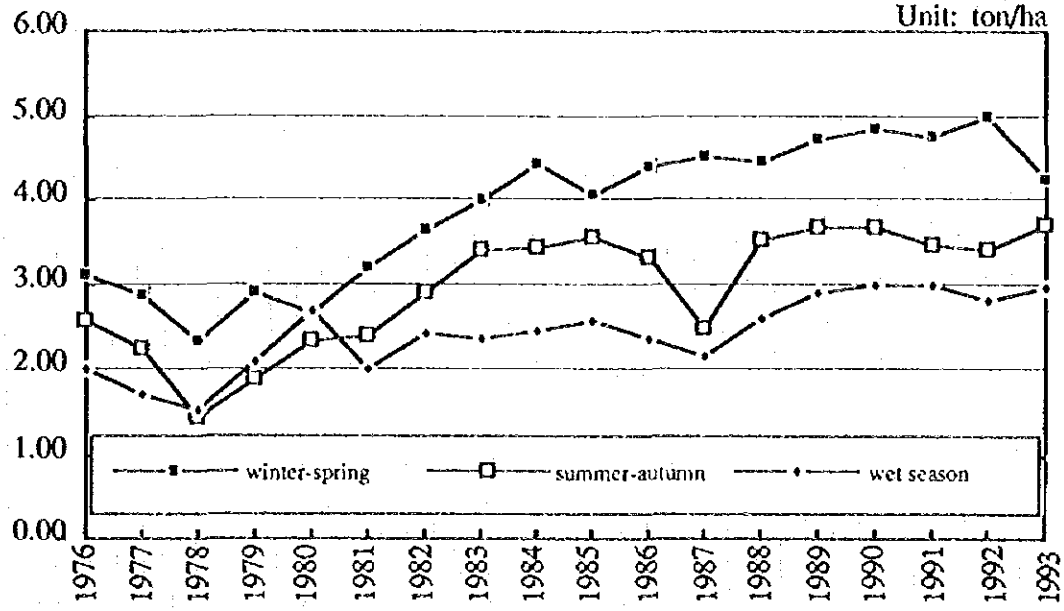
Paddy Production Trend by Cropping Type in Mekong



Sources: Mekong master plan, 1991, and General Statistical Office

However, substantial natural increases in the paddy production in the Mekong delta would be difficult because most parts of potential areas for paddy production have already been exploited in the delta. The paddy production in the delta had been increasing by introduction of the modern rice farming system with high yielding varieties, high dosage of fertilizers and irrigation water supply after the flood in the year 1978. Unit yields of paddy reached peaks in late 1980's or early 1990's and level off thereafter as shown in the following Figure:

Paddy Yield Trend by Cropping Type in Mekong Delta

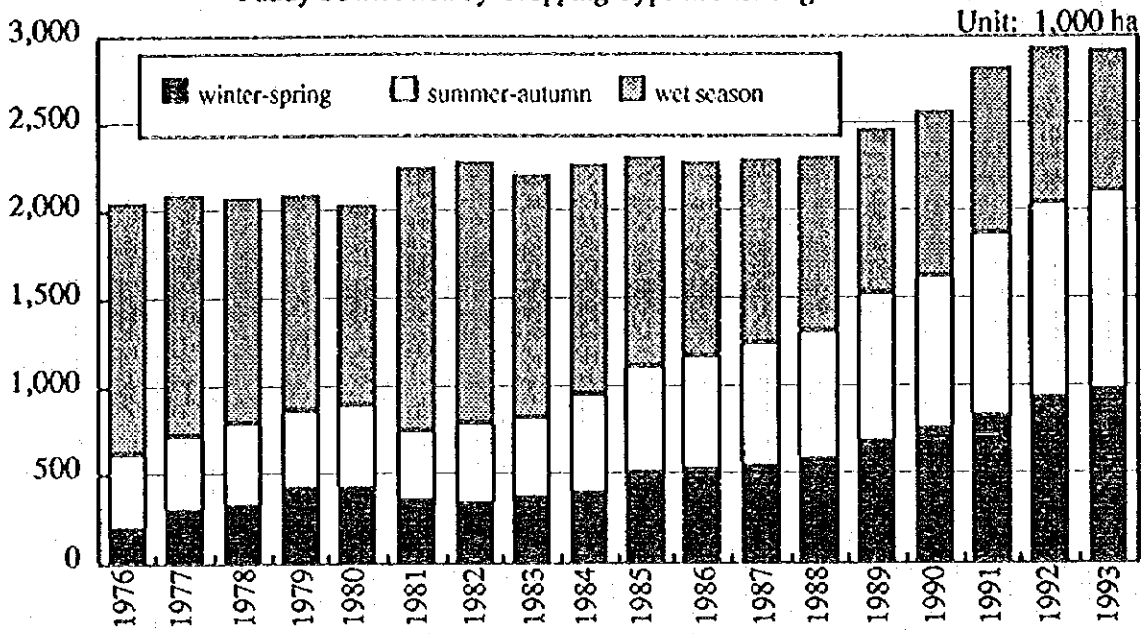


Source: Mekong Delta master plan, 1991, and General Statistical Office

The highest yields shown were 5 ton/ha for winter-spring paddy, 3.8 ton/ha for summer-autumn paddy and 3 ton/ha for wet season paddy.

From the year 1976 to 1988 there were no substantial increases in paddy sown area. Between the year 1989 and 1992, in which settlement in the Plain of Reeds was implemented with provision of irrigation water through the large canal networks on acid sulphate soil, the sown area increased by 616,000 ha. The sown area leveled off in the year 1993 as shown in the following Figure:

Paddy Sown Area by Cropping Type in Mekong Delta



Source: Mekong Delta Master Plan, 1991, and General Statistical Office

Low yielding wet season paddy has been replaced by high yielding winter-spring paddy and summer-autumn paddy under provision of irrigation water in the dry season as well as the wet season. By the year 1993, 73 % of the paddy sown area has been covered by winter-spring and summer-autumn paddy. Further substantial expansion of the paddy area and replacement of wet season paddy by winter-spring and summer-autumn paddy would be difficult with shortage of fresh water in the Mekong River in the dry season. The remaining areas for further possible paddy development in the Mekong delta are in northern parts of the Plain of Reeds and the Vam Co River area where fresh water supply by water transfer from the Be River through Dau Tieng reservoir is possible. Historical trends in land use in Mekong delta from the year 1880 to 1989 are shown in Figure 1.2, showing clearly the remarkable efforts of irrigation development on paddy production.

(2) Projection of Paddy Demand and Supply in the Year 2015

A nation wide and regional balance of the paddy demand and supply in the year 2015 is projected, incorporating the estimated paddy production by the Master Plan Projects in the Study Area, on the following conditions:

- Assuming that the present life style remains unchanged drastically and that per capita rice consumption increases to 160 kg in the year 2015 from the current level of 145 kg, making reference to the projected values made in the report on Mekong Delta Master Plan in the Year 1994 by State Planning Committee of the Government of Viet Nam/World Bank/Mekong Secretariat/UNDP and the Study for Formulation of Irrigation Development Programme in

the Republic of Indonesia in the Year 1993 by Japan International Cooperation Agency (JICA);

- The present paddy export of 3 million tons per annum is maintained;

- The incremental paddy production in the Study Area in the year 2015 is estimated at about 1.2 million tons by implementing all the Master Plan Projects including the proposed RADP, keeping paddy cropping area at about 60 % in the diversified agriculture; and

- Paddy productions in the areas other than the Study Area are projected by the 1993 Master Plan of the Mekong Delta and other latest agricultural statistics available.

The nation wide projection is made as shown in Table 1.7 (Demand) and Table 1.8 (Production), and summarized below:

Year	Population (Million)	Demand (Million ton)	Production (Million ton)
1994	71.5	23.2	23.5
2015	107.2	33.5	31.6

As known from the above Table, the demand - supply balance would become marginal in the year 2015.

The regional balance is projected as shown in Table 1.9 including the whole Mekong Delta, and the demand - supply balance in the year 2015 is summarized below:

Unit: 1,000 ton

Region	Demand in 2015	Production in 2015	Balance
Study Area (*1)	**5,563**	**2,561**	**- 3,002**
South Central Coast	611	759	+ 148
Central Highland	895	339	- 556
N- E Southland	4,058	1,463	- 2,595
Mekong Delta	**7,066**	**15,200**	**+ 8,134**
Total	**12,630**	**17,761**	**+ 5,131**

(*1) : excluding Long An Delta

The above result suggests that the South Central Coast (Ninh Thuan and Binh Thuan provinces) is expected to play a role as a food supply base for the Central Highland (Lam Dong and Dac Lac provinces), and the shortfall of food supply in the Study Area would be supplemented by the Mekong delta.

In conclusion, ensuring the national food security and earning of foreign exchange by rice production would meet difficulty in future, while promoting the diversification of agricultural structure. The Government would have to take further decisive measures for rice development such as more intensive investment in irrigation, drainage, flood control, improvement of operation and maintenance of irrigation and drainage structures, and agricultural credit and extension.

1.3.4 Projection for the Change of Cropping Patterns by Irrigation Development

One of the objectives of the present water resources development project is to supply irrigation water or to drain water for crop production. Other government interventions to agricultural production such as agricultural credit development, agricultural extension development, agricultural marketing development, etc. are not planned because these developments are out of the scope of work for the present study. But, their magnitude of importance or limitation for the agricultural development is studied to assess the impact of irrigation or drainage development on the agricultural development. In free market economy, farmer's decision making on the selection of crops is paramount importance in the agricultural development.

Main factors affecting crop selection by farmers are given below:

a) Household subsistence needs
b) Risks
   - Yield stability
   - Marketability
   - Prices guarantee
   - Technological familiarity
c) Profitability
d) Government interventions
   - Policy
   - Regulation
   - Subsidies
   - Extension services
   - Irrigation water supply.

The farm surveys by the present study team showed that the farmers in the prospective irrigation schemes were too poorly endowed with land resources, funds, marketing infrastructure and technologies, resulting in chronic extreme poverty. Subsistence agriculture is the basic nature of their farming. Steady and sufficient supply of foods for family is the primary objective of the farming. Cash crops with high profitability but with high risks in price

changes or marketability would be difficult to be grown without some financial guarantee or subsidies to growers.

Paddy is the favourite crop of farmers for filling subsistence needs with low risk in technology and marketing even with low profitability. The farm surveys showed most of farmers grow paddy three times per year under year-round irrigation water supply. However, the paddy triple cropping will cause pests or diseases spread by accumulation of vectors such as rice brown plant hopper or mice. Cases in Indonesia showed that the chemical control for them was not effective. Only viable measure against them is the integrated pest control, in which enforcement of ban on the paddy triple cropping and the chemical control of pests in early stage in the spreading have been implemented.

The government is promoting cash crops in the Study Area according to the agricultural strategic development plan for the year 2000. The areas to be planted and areas actually planted in the year 1992 by cash crop in the related regions are given in the following Table:

Unit: ha

Crops	Central Coastal Region		Southeast Region	
	Target	Achievement in 1992	Target	Achievement in 1992
Sugarcane	57,000	28,300	57,000	27,000
Maize	80,000	29,400	-	-
Cotton	10,000	1,400	15,000	9,700
Tobacco	-	-	8,000	11,300
Groundnuts	-	-	85,000	57,300
Soybeans	-	-	36,000	26,400

Source : Sub-NIAPP and Statistical Year Book 1994

Three scenarios of the future cropping pattern in the prospective irrigation schemes can be drawn from the above discussion.

(1) Paddy triple cropping per year

This is the most probable cropping pattern to be selected by farmers under year-round irrigation water supply. Unless effective measures will be taken against this cropping pattern, paddy will get severe damage by the spread of insect, pests, diseases or mice. After receiving infliction of the severe damage, the farmers would be forced to abandon this cropping pattern. The incubation period of crop damage by this cropping pattern would be five to ten years after the introduction of this pattern in a large area. After the damage, environmentally sound alternative cropping patterns such as described below would be applied.

(2) Paddy - Paddy - Upland Crop with Sugarcane or Cotton

Assuming the farmers in the prospective irrigation schemes will accept the government plan to give the good cultivation conditions, i.e. irrigation water, agricultural credit, marketing services and extension services, the maximum areas to be planted by the promoted cash crops in the

prospective irrigation schemes would be the area balance between the target areas and accomplished areas as follows:

Unit: ha

Crops	Central Coastal Region Maximum Planted Area	Southeast Region Maximum Planted Area
Sugarcane	28,700	30,000
Maize	50,600	-
Cotton	8,600	5,300
Tobacco	-	filled
Groundnuts	-	27,700
Soybeans	-	9,600

Maize, groundnuts or soybeans have difficulty in growing in the wet season due to drainage problems and harvesting problems. The most suitable growing period for them is the dry season from January to April. Paddy areas would be the balance between total irrigable area and areas for upland crops. This scenario has least probability in adoption by the farmers.

(3) Moderate Cropping Pattern in-between the above Two Extremes

Adoption of the recommended crops by the farmers will much depend upon the price situations and commitments of related government agencies such as agricultural bank, agricultural extension offices and marketing organizations. After filling the subsistence requirements of farming, the farmers will sell marketable surpluses to local market, government marketing corporations or middlemen. The most probable cropping patterns to be selected by the farmers would be an in-between of the two extreme patterns.

1.3.5 Strategy for the Agricultural Development in the Study Area

The following strategies would be applied in making water resources related agricultural master plan for the Study Area.

(1) System Approach

Agricultural production is a kind of system consisting of production, marketing and various supporting services. If some components of the system do not work, the whole system would not work. Comprehensive approach is necessary for the successful implementation of a project.

(2) Sustainability

Most of the existing irrigation systems do not have enough sustainability concerning operation and maintenance of the systems. Financial and socio-economic soundness in the operation of system is prerequisite for the sustainability. Collection of sufficient amounts of irrigation water

charges is necessary. Accountable supply of irrigation water by irrigation company or office is indispensable for smooth collection of water charges. Checking of the management of irrigation company or office by beneficiaries is necessary for sound and efficient management of irrigation system.

(3) Participatory Approach

Participation of beneficiaries in planning, construction, operation and maintenance of development project showed remarkable results in Southeast Asia such as the Philippines. This approach develops feelings of belonging of project facilities by the beneficiaries, democratic decision making in each project cycle and autonomy in the operation of facilities.

1.4 Crop Budget Studies

Crop budgets of prospective and receptive main crops to be grown in the future are made to evaluate economic viability of prospective irrigation schemes. Economic prices are applied in making crop budgets to measure economic efficiency of farming of crops under most efficient economic conditions. Economic prices of foreign traded crops such as paddy, sugarcane, cotton, maize and groundnuts are evaluated at appropriate import or export border prices as follows:

Economic Farm Gate Price of Paddy

	Unit	Price
FOB price at Bangkok (*1)	US$/ton	291
Quality adjustment	US$/ton	204
Freight and insurance	US$/ton	60
CIF Saigon	US$/ton	264
Transport and handling cost	US$/ton	27
Dry rice equivalent	US$/ton	291
Conversion from rice to paddy	US$/ton	175
Milling charge	US$/ton	8
Inland transport, handling, etc.	US$/ton	8
Economic farm gate price	US$/ton	159

(*1) World Bank Commodity Price Forecast 1990-2005 in constant 1990 price, adjusting to 1995 price by applying MUV index.

Economic Farm Gate Price of Sugarcane

	Unit	Price
FOB North Europe	$/ton	335
Freight between Europe and HCMC	$/ton	57
Unloading cost	$/ton	5
CIF Saigon	1000 VND/ton of sugar	4,367
Costs between FOB and mill (200 km, 330d/km/ton)	1000 VNĐ/ton of sugar	66
Sugar recovery rate (1)	% of cane	9.1
Processing cost (1)	1000 VND/ton of cane	169
By-products (molasses: 5.2 %) (1)	1000 VND/ton of cane	(26)
Transportation cost between mill and farm (20 km, 485 d/km/ton)	1000 VND/ton of cane	10
Economic farm gate price of sugarcane	1000 VND/ton of cane	238

Remarks: molasses price: VNĐ 500/kg of molasses "source(1): La Nga Mill, 1995"

Economic Farm Gate Price of Seed Cotton

	Unit	Price
FOB Mexican Gulf	$/ton	1,800
Freight between Europe and HCMC	$/ton	57
Unloading cost	$/ton	5
CIF Saigon	1000 VND/ton of cotton lint	20,482
Costs between FOB and ginning factory (200 km)	1000 VND/ton of cotton lint	66
Lint recovery rate of seed cotton(1)	%	33
Processing cost(1)	1000 VND/ton of seed cotton	2,000
By-products(cotton seeds: 66.6 %)(1)	1000 VND/ton of seed cotton	7,326
Transportation cost between ginning factory and farm, 20 km	1000 VND/ton of seed cotton	10
Economic farm gate price of seed cotton	1000 VND/ton of seed cotton	12,053

Remarks: "By-product, cotton seed price, is VND 22,000/kg of seed."
Source(1); Nha Ho cotton research centre in Phan Rang

Economic Farm Gate Price of Maize for Feeds and Groundnuts

	Unit	Imported Maize	Exported Groundnuts
CIF or FOB Saigon	VND/kg	1,900	8,300
Loading or Unloading cost	VND/kg	55	55
Transportation cost between Ho Chi Minh City and farm, 220 km	VND/kg	73	73
Economic farm gate price	VND/kg	1,882	8,172

Economic prices of foreign traded farm inputs and labour are derived by referring to the factor costs analysis by the World Bank in Viet Nam Agricultural Marketing Study, June 1994. Conclusions are as follows:

a) Economic family labour cost and casual labour cost are estimated at VND 5,500 per day and VND 11,000 respectively taking underemployment in off-farming season or unemployment period. Farming labour sources are from family labour and hire labour. Their proportions are unknown. So, the average of them, VND 8,000 per day, is set for economic farm labour cost.

b) Shadow foreign exchange rate is estimated at a current exchange rate of VND 11,000 per US dollar since there is no clear evidence of overvaluation.

c) Economic fertilizer and agro-chemical prices are estimated at current market prices because there is enough competition in marketing of these commodities and are no tariff and subsidies on them.

Economic and financial prices of farm produce and inputs are summarized in the following Table:

Economic and Financial Prices (1995 farm gate prices)

	Unit	financial	economic
Paddy	VND/kg	1,200	1,749
Groundnuts	VND/kg	8,000	8172
Maize	VND/kg	930	1,882
Sugarcane	1000 VND/ton	300	238
Cotton	VND/kg	4,300	12,053
Coffee(Robusta)	VND/kg	27,000	27,000
Coffee(Arabica)	VND/kg	35,000	35,000
Cashew kernel	VND/kg	8,500	N.A
Urea(46 % N)	VND/kg	2,840	2,840
Super phosphate(16.5 % P2O5)	VND/kg	800	800
Kcl(60 %K2O)	VND/kg	1,840	1,840
Family labor cost	VND/man-day	N.A	5,500
Hired labour(average of male and female)without meals	VND/man-day	16,000	11,000
Farm labour cost (average)	VND/man-day	N. A	8,000

Remarks: Economic labour costs are referred to 'Agricultural Marketing Study' by IDA and increased by 10 % for inflation.

Crop budgets using economic prices are made to estimate approximately percents of net generated benefit in gross income for winter-spring paddy, summer-autumn, wet season paddy, sugarcane, cotton, groundnuts and maize (refer to Tables 1.10 to 1.18). Summary of the net benefit in gross income of the respective crops is given in the following Table:

Net Benefit of Crop Farming

Crops	Unit Yields Recorded	Net Income (x 1000 VND/ha)	Net Benefit in Gross Income (%)
Winter-spring paddy	4.5 ton/ha	2,446	42
Summer-autumn paddy	3.5 ton/ha	1,711	38
Wet season paddy	2.8 ton/ha	1,811	50
Groundnuts, shelled	1.75 ton/ha	8,778	61
Maize	5.5 ton/ha	7,041	68
Cotton	1.4 ton/ha	14,684	87
Plant sugarcane	57 ton/ha	6,090	45
1st ratoon cane	50 ton/ha	6,582	55
2nd ratoon cane	49 ton/ha	7,038	60

2. IRRIGATION

2.1 National Policies for Irrigation Development

Of the total 5.39 million ha of cultivated area for annual crops, about 2.1 million ha is facilitated with irrigation systems in Viet Nam, and about 1.3 million ha or 65 % of irrigated area exists in two large deltas of the Mekong and Red rivers. Despite rich rainfall ranging from 1,500 to 2,000 mm on a yearly average, irrigation has still an important role in the agriculture in Viet Nam to encounter uneven water distribution in both time and space. The responsibility of irrigation is to regulate and properly manage water resources to better serve the national economy. Specifically, the duties of irrigation sector including drainage in Viet Nam are to:

- develop, manage and protect water resources to support water related socio-economic sectors including agriculture as the first priority, domestic water supply, hydro-electric power, navigation, aquaculture, forestry and tourism; and
- protect lives and properties from floods and typhoons.

The population of Viet Nam in the year 2005 is forecast to increase to 91.5 million from the present level of 70 million in the year1993. To secure food supply of per capita 350 to 400 kg per annum, an annual food crop production of 32 to 35 million tons will be required. The effort should be continued to increase the crop production from the present level of 25 million tons. For this, it is essential to increase the cultivated area and crop yield, and an intention is to achieve it mainly by the intensive use of the present agricultural land rather than reclaiming and expanding the area. Specifically, the total cultivating area of food crops will be increased from 7.2 million ha in the year 1985 to 9.0 to 9.2 million ha with an increase of irrigated area from 1.9 million ha to 3.2 million ha and drainage improvement from 0.9 million ha to 1.1 to 1.2 million ha. To attain these targets, the Government of Viet Nam is to continue the irrigation and drainage development works in the following manner:

- to rationally utilize the existing schemes and fully exploit those capacity, especially in the northern area, to transform the winter cropping into the main cropping over 50 % of the cultivated area of food crops;
- to rationally exploit the favourable meteorological conditions to change the cropping pattern allowing double cropping in the existing single cropping area, and triple cropping in the existing double cropping areas, in combination with irrigation works suitable to the conditions of each region;
- to actively implement small irrigation schemes at both central and local levels;
- to appropriately invest fund and to apply technique in developing important areas, with priority for two large plains, Mekong delta and Red River plain, and peneplain; and
- to take decisive measures to minimize land loss for other purposes.

2.2 Institutions for Irrigation Development

Administrative structure in the irrigation sector of Viet Nam comprises three distinct levels; national, provincial and district. The key ministry with respect to irrigation and drainage is the Ministry of Agriculture and Rural Development (MOARD). According to Decree No.63/CP (August 1994), the Ministry has overall responsibility for state development, planning and management of water resources. As a result of the Government's effort to decentralize authority to local levels, management of irrigation facilities lies mainly on provincial governments. Among the most important functions falling in the control of the Ministry are project identification, planning, design and financing, for which specific tasks of MOARD are as follows:

- Planning : MOARD prepares long term and annual plans, policies, objectives and strategies for water resources development and management which are used as guidelines by the provinces in preparing their provincial plans, as well as makes a prioritized list of projects for consideration by Ministry of Planning and Investment (MOPI); and
- Management : MOARD supervises the management of irrigation and drainage structures, develops policy guidance for irrigation and management, produces and disseminates operations and maintenance guidelines and collects data. In addition, it oversees the management of 8,000 km long dikes built in Viet Nam and deals with emergency caused by flood and typhoon. Other functions include developing procurement and construction management policies and guidelines for the water resource sector and monitor the activities of construction enterprises belonging to MOARD in terms of administration.

The provincial administration governed by the Provincial People's Committee includes the Department of Water Resources or the Department of Agriculture and Forestry with the water resources division which is engaged in the irrigation and drainage development projects in the provincial level. Further, the same administration systems are organized in the district level as well. In general, no direct administrative relation between the Ministry and the provincial departments exists besides the technical assistance given from the Ministry to the provinces.

Under the current policy, investment for the main canals and structures of large irrigation, drainage and flood control projects is funded by the central government. While, secondary or ancillary works as well as all local projects are designed and funded by the provincial government with some assistance provided from the central government to the poor provinces. In terms of investment amount, the projects with investment costs falling in the range of VND 3 to 10 billion are generally funded by the central government, even if this policy varies province to province and depends upon the technical difficulties.

Under the provincial departments, two to three organizations are formed by the name of company or enterprise to deal with in series of work from design to management in water resources development projects. Varying province to province, the companies to undertake such work are as follows:

- "Water Resources Management Company" responsible for the operation and maintenance of irrigation and drainage facilities including collection of water charges;
- "Water Resources Construction Company" responsible for the construction of irrigation and drainage facilities; and
- "Water Resources Survey and Design Company" responsible for planning, investigation and design of irrigation and drainage schemes.

Information on the current organization for operation and maintenance services of water resources (irrigation) sector at both the provincial and district levels in the Study Area is collected with regard to the type of provincial department and provincial and district water resources related companies, and the number of staff belonging to the respective departments and companies. The results are presented in Table 2.1. There are two types of the provincial department on water resources; one is an independent department engaged in the water resources and the other is a department involving agricultural and/or forestry together with water resources. The status of the respective provinces is as follows:

Type of Department	Province
Department of Water Resources	Dac Lac, Ninh Thuan, Binh Thuan, Dong Nai and Tay Ninh
Department of Agriculture and/or Forestry and Water Resources	Lam Dong, Song Be, Ba Ria-Vung Tau, HCMC and Long An

The following Table summarizes the number of engineers engaged in the operation and maintenance of the irrigation systems at the respective levels of provincial department, provincial O&M companies and district O&M companies:

Province	Existing Irri. Scheme		Provincial Dept.		O&M Company		Dist. O&M Comp.	
	Nos.	Area (ha)	Eng. Nos.	ha/Eng.	Eng. Nos.	ha/Eng.	Eng. Nos.	ha/Eng.
Lam Dong	155	17,985	7	2,569	7	2,569	8	2,248
Dac Lac (*1)	12	394	3	131	6	66	6	66
Ninh Thuan	51	22,585	11	2,053	17	1,329	2	11,293
Binh Thuan	153	29,705	13	2,285	6	4,951	11	2,700
Song Be	50	5,587	6	931	15	372	2	2,794
Dong Nai	49	18,322	8	2,290	16	1,145	4	4,581
Ba Ria-Vung Tau	24	8,885	0	-	7	1,269	2	4,443
Tay Ninh	4	56,765	12	4,730	15	3,784	10	5,677
HCMC	6	31,330	13	2,410	35	895	21	1,492
Long An (*2)	9	59,200	8	7,400	10	5,920	8	7,400
Total	513	250,758	81	3,096	134	1,871	74	3,389

(*1) : data in the Study Area covering 19.4 % of entire Dac Lac province
(*2) : data in the Study Area covering 51.3 % of entire of Long An province

The irrigation area covered by an engineer at the three levels varies largely province by province, showing the shortage of engineers in general for proper operation and maintenance.

2.3 Irrigation Development in the Study Area

2.3.1 Overview

The Study Area is divided into four ecological regions: Mekong Delta Region; N-E Southland Region; South Central Coast Region; and Central Highlands Region. General characteristics of those regions in agriculture and irrigation are summarized below.

Mekong Delta is the largest rice production area of the country, and the Study Area occupies a land area of about 51 % of Long An province, which lies in the north-east corner of its delta, excluding its right bank of the West Vam Co River. This area is characterized by large seasonal fluctuation in flows of the Mekong and other in-coming rivers. High discharge in wet seasons causes extensive floods, while low water experienced in dry seasons brings severe shortage of fresh water coupled with sea-water intrusion. Besides, there are pedorogical constraints that acid-sulphate soils cover over 40 % of the entire delta. To cope with such constraints, the artificial waterway systems have extensively been constructed in the delta, functioning as a flood way, a navigation route and an irrigation canal. Many sluices and pumps including farmers' individual small-scale pumps are provided to encounter tidal action and to supply irrigation water for areas distant from the main rivers. The Government is continuing the efforts to expand waterway and dike systems including a land reclamation of 100,000 ha, targeting to increase the annual cultivating area from 2.6 million ha to 3.2 million ha up to the year 2000.

North-East Southland region, covering Dong Nai, Song Be, Tay Ninh and Ba Ria-Vung Tau provinces and Ho Chi Minh City, is largely divided into two zones; hilly area extending in the north-eastern part, and flat and fertile area extending in the lower reaches of the Dong Nai River and the coastal area. The development of this region was relatively slow by recent years. The food production could meet only 50 % of demand, and its deficit is made up from the Mekong delta. Except for the Dau Tieng project commanding about 100,000 ha, most of irrigation schemes are of small scale, drawing water from medium and small rivers, which are tributaries of the Dong Nai River. The rate of irrigated area is as low as about 10 % of agricultural land in the region. Since abundant water resources are available in the Dong Nai River basin, this region has a great potential of agricultural development through the promotion of Phuoc Hoa reservoir irrigation scheme, which is under the feasibility study, the implementation of the lower La Nga River plain within the Dong Nai province and the development of the medium rivers in the coastal area. While, the north-eastern part is characterized by the planting area of industrial crop such as rubbers, coffees, cashew, fruits and tobacco. Area and production of these crops are promised to be expanded.

South Central Coast region, covering Ninh Thuan and Binh Thuan provinces, is characterized by small rainfall ranging from 800 mm per annum in its coastal part to 1,500 mm per annum in its mountainous part with a large annual fluctuation. The coastal rivers drain the catchment area in the range of 1,000 to 2,000 km^2 at most. These unfavourable climatrogical and hydrological conditions limit to increase crop production. Irrigation systems are fed by many small rivers, and the rate of irrigated area is about 40 %, which is relatively greater than that of other regions in the Study Area except for the Mekong delta. However, the absolute shortage of water in the dry season causes a low cropping intensity of about 140 % in paddy cultivation of Binh Thuan province, and in addition the deterioration of irrigation facilities accelerates this condition. Nevertheless, this region has the highest physical potential of irrigated agriculture development. Most of potential irrigation schemes in the Study Area are concentrated in this region, through diverting water from the Dong Nai River basin to the coastal area in addition to the full exploitation of local water resources available in the coastal area like the existing Phan Rang irrigation project (12,800 ha). Further, this region has natural advantage to introduce the more diversified cropping system including sugarcane, cotton and fruits represented by grapes extensively grown in Ninh Thuan province.

Central Highlands region, covering Lam Dong province and part of Dac Lac province in the Study Area, lies in high elevation and is the largest production area of export crops such as coffee, rubber, silk and tea. This region is expected to absorb more labour force by developing perennial industrial trees. Its potential has not been fully exploited, and is to be developed both intensively and extensively. While, the food production is not a keen issue in this region, since the Mekong delta and the coastal area can supplement it. The policy of food production is to increase the cultivated area of paddy and other cereals like maize. The small scale irrigation

systems are dominant in this region, supplying water to valley bottoms for cultivating food crops and vegetables.

2.3.2 Classification of Irrigation Development Projects

With the results of the field reconnaissance, all the irrigation schemes in the Study Area are categorized broadly into three groups of:

A; Existing irrigation schemes;
B; On-going and planned irrigation schemes; and
C; Potential irrigation schemes.

Those are further classified into sub-groups as shown below:

Code	Classification of Schemes Main	Sub		Name of Schemes
A.	Existing Irrigation Schemes	A.1	Large and Medium Irrigation Schemes (Area larger than 2,000 ha)	Vo Xu, Phan Rang, Song Pha, Dai Don, Quan Hiep/Tyuen Lam and Phuoc Chi (6 schemes)
		A.2	Small Irrigation Schemes (Area larger than 100 ha and smaller than 2,000 ha)	161 schemes in total
		A.3	Extension or Proposed Small Irrigation Schemes	65 schemes in total
B.	On-going and Planned Irrigation Schemes			Dau Tieng, Phuoc Hoa, Hoc Mon-Bac Binh Chanh and Song Quao (4 schemes)
C.	Potential Irrigation Schemes	C.1	Potential Schemes in HCMC - Long An Delta (Deltatic and saline water affected area)	HCMC Long An province : Duc Hue, Duc Hoa, Ben Luc, Can Giouc, Can Duoc, Tran Tru, Thu Thua, Thanh Hoa and Moc Hoa (9 irri. blocks)
		C.2	Potential Schemes in East Coast expecting water resources diverted from the Dong Nai River basin	Phan Ri Plain, Phan Thiet Plain and Ham Tan Plain (3 schemes)
		C.3	Potential Schemes in La Nga River and other river basins	Lower La Nga Plain (Ta Pao and Vo Dat), Phan Rang Plain (Extension), Tuy Phong Plain, Song Phan Plain, Song Ray Plain and Song Dinh Plain (7 schemes)

All the irrigation schemes in the Study Area are discussed in this Master Plan Study on a category-wise basis as classified above. The existing irrigation schemes are reviewed and evaluated on the basis mainly of the results of inventory survey on the requirements of rehabilitation and improvement. The on-going and planned schemes are updated and evaluated

on the further inputs required for successful implementation. The potential schemes are reviewed and updated with regard to the land and water resources available, formulation of agricultural and irrigation development plan, cost estimate and economic viability. These studies are made according to the study objectives and items listed for each category as shown in Table 2.2 in such a manner as establishing the development strategy targeting to the year 2015.

2.4 Basic Data for Irrigation Planning

2.4.1 Basic Meteorological Data for Calculation of Irrigation Water Requirements

The meteorological data in the Study Area are collected from 20 climate observation stations during the Phase I study. Of these 20 stations, nine stations, which are considered to represent the regional climate, are selected for estimating irrigation water requirements. These are: Phan Rang; Lien Khuong; Di Linh; Bao Loc; Phan Thiet; Xuan Loc; Vung Tau; Tan Son Hoa; and Bien Hoa. The monthly meteorological data of these stations are shown in Table 2.3 with regard to those to be incorporated in the calculation of irrigation water requirements: mean air temperature; mean relative humidity; maximum humidity; sunshine hour; mean wind velocity; and evaporation.

In addition, mean monthly data of wind velocity observed every day at 1:00, 7:00, 13:00 and 19:00 hour are collected as well for three stations, Phan Thiet, Bao Loc and Tan Son Hoa, over the five-year period from the year 1990 to 1994. These data are used to predict the monthly rates of wind velocity at day time and night time which are essential data for calculating potential evapo-transpiration by Penman method. These data and rates between day and night are shown in Table 2.4.

2.4.2 Calculation of Potential Evapo-transpiration

The modified Penman method is adopted to the estimate of potential evapo-transpiration, since it is likely to provide the most satisfactory results. The details of Penman method are described in FAO Irrigation and Drainage Paper No. 24. The potential evapo-transpiration (ETo) for nine stations is calculated by using the modified Penman equation, and the meteorological data mentioned above are summarized in Table 2.5 together with comparison of evaporation observed at the respective stations.

2.4.3 Effective Rainfall

Nine rainfall gauging stations, having longer observation periods and being judged to have more reliable data, are selected for the irrigation planning with their names and observation period as given below:

Station	Observation period	Number of yearly data available
Bao Loc	1950 - 1992	41
Ham Tan	1959 - 1992	30
Lien Khuong	1949 - 1993	43
Phan Rang	1957 - 1992	31
Phan Thiet	1957 - 1992	33
Song Luy	1979 - 1992	15
Ta Pao	1977 - 1991	16
Tan Son Nhat	1956 - 1993	36
Vung Tau	1949 - 1992	43

Monthly effective rainfall with a 75 % exceeding probability (75 % rain) is separately calculated for paddy and upland field crops based on the monthly rainfall data available at the above-listed stations. For paddy, it is assumed to be 75 % of 75 % rain. For upland crops, an empirical method developed by USDA (United States, Department of Agriculture) is applied. The 75 % rain and effective rainfall provisionally estimated at the respective stations are shown in Table 2.6.

2.4.4 Irrigation Water Requirements

Irrigation water requirements are calculated from the meteorological data mentioned in the preceding Sub-section 2.4.1 and on the basis of the following conditions and assumptions:

Crop coefficient

A field experiment to obtain the crop coefficient was carried out by Nippon Koei Co., Ltd. in the year 1974 for the Binh Dinh irrigation project in Binh Dinh province. The results through the experiment are summarized in Figure 2.1 and are to be applied as the crop coefficient for paddy. For upland crops, crop coefficients of respective crops are determined with reference to the FAO Irrigation and Drainage Paper No. 24.

Deep percolation loss in paddy field

No experimental data of percolation loss in the paddy field have been found in the Study Area. It is thus assumed at 2 mm/day.

Puddling water requirement

Puddling water requirements for paddy are provisionally taken at 150 mm for summer-autumn crops and 60 mm for winter-spring and rainy season crops.

Irrigation efficiency

Overall irrigation efficiencies for paddy and upland crops are provisionally set at as follows:

Paddy	:	65 %
Upland crops	:	56 % (field efficiency: 80 % and conveyance efficiency: 70 %).

To provide the basic data for the water balance study in the Study Area, irrigation water requirements are calculated for the following cropping patterns:

- Paddies for W-S, S-A and Wet Season cropping; and
- Upland crops including W-S upland crop, cotton and sugarcane.

Monthly diversion water requirements for the above cropping patterns in the East Coast and the Lower La Nga plain are estimated as tabulated below:

3 - Paddies Crops — Unit : lit/sec/ha

Month	Schemes		
	Phan Rang	Phan Ri/Phan Thiet	La Nga
Jan.	1.61	1.56	1.48
Feb.	1.57	1.84	1.34
Mar.	1.81	1.46	1.71
Apr.	1.06	0.73	1.72
May	1.27	0.93	0.48
Jun.	1.29	0.94	0.00
Jul.	1.66	0.87	0.00
Aug.	1.18	0.00	0.00
Sep.	0.00	0.36	0.00
Oct.	0.58	0.87	0.00
Nov.	0.81	1.29	0.74
Dec.	1.18	1.28	1.34
Fig. No. (*)	2.2	2.3	2.4

Cropping calendar and water requirements of paddies in Phan Rang plain, Phan Ri and Phan Thiet plains and Lower La Nga plain are shown in Figures 2.2, 2.3 and 2.4, respectively.

Cropping calendar and water requirements of winter-spring upland crop and cotton in East Coast are given in Figure 2.5, whilst those of sugarcane in East Coast and winter-spring upland crop, cotton and sugarcane, in Lower La Nga plain are depicted in Figures 2.6 and 2.7, respectively. Following is a summary of those cropping calendar and water requirement:

Upland Crops lit/sec/ha

	W-S Crop		Cotton		Sugarcane	
Month	E/Coast	La Nga	E/Coast	La Nga	E/Coast	La Nga
Jan.	0.36	1.09	(2 crops)	(1 crop)	0.67	1.09
Feb.	1.17	0.47	-	-	0.19	0.68
Mar.	0.60	0.01	0.21	-	0.19	0.12
Apr.	0.00	-	0.59	-	0.40	0.00
May	-	-	0.59	-	0.31	0.00
Jun.	-	-	0.36	-	0.46	0.00
Jul.	-	-	0.00	-	0.48	0.14
Aug.	-	-	0.00	-	0.51	0.19
Sep.	-	-	0.00	0.00	0.41	0.19
Oct.	-	-	0.31	0.04	0.52	0.24
Nov.	-	-	0.69	0.49	0.87	0.68
Dec.	-	0.23	0.36	0.29	0.98	1.03
Fig. No (*).	2.5	2.7	2.5	2.7	2.6	2.7

(*): Figures show the cropping calendars and calculation of irrigation water requirements.

2.4.5 Water Resources Available

Water resources available for the irrigation development are estimated by classifying the Study Area into the following five regions upon the locations and characteristics of the river basins:

Region	Irrigation Schemes
East Coast	Phan Rang Plain Scheme, Tuy Phong Plain Scheme, Phan Ri Plain Scheme, Phan Thiet Plain Scheme, Song Phan Plain Scheme and Ham Tan Plain Scheme
La Nga	Lower La Nga Plain Scheme
Ba Ria-Vung Tau	Song Ray Plain Scheme and Song Dinh Plain Scheme
Be River	Phuoc Hoa Irrigation Scheme
Saigon River	Dau Tieng Irrigation Schemes, Hoc Mon-Bac Binh Chanh Irrigation Scheme, HCMC-Long An Delta Irrigated Agricultural Development Scheme

Water resources available for the respective regions are estimated in such a manner as described below:

East Coast

The East Coast region covers both the Ninh Thuan and Binh Thuan provinces. The Luy River is the sole river in this region with a longer observation period of runoff for 10 years from the year 1981 to 1990. Since the runoff characteristic of rivers in the East Coast region is considered to be similar, the runoff data of all the rivers used for irrigation planning in this region are estimated on the basis of simulated runoff of the Luy River for a 30-year period of the year 1963 to 1992 as described in Appendix III. It is noted that the Study Team confirmed in the field reconnaissance of Phase II that the hydrological gauging station at the proposed Ca Giay dam site (C.A.=146 km^2) lying in a tributary of the Luy River has been operated since September 1992 to date by the Hydro-meteorological Centre. The Study Team is requesting the concerned authorities to provide its runoff data for improving the quality of the said simulated runoff data.

La Nga

In the Lower La Nga River basin, there is a gauging station at Ta Pao (C.A.=2,000 km^2) where the construction of a diversion weir is proposed for irrigation in the Lower La Nga plain, and runoff records are available for a 22-year period of the year 1960 to 1990. Based on the recorded runoff data and basin rainfall, the runoff data are worked out at Ta Pao and Vo Dat (C.A.=3,080 km^2), where a diversion weir is also proposed, for a continuous 30-year period of the year 1963 to 1992 by the Tank Model simulation as described in Appendix III. In addition, runoff for the same period is also estimated under the condition that Ham Thuan and Da Mi reservoirs are completed in the upstream reaches of the La Nga River.

Ba Ria-Vung Tau

Two rivers, named the Ray and the Dinh, are to be developed for the potential schemes in the Ba Ria-Vung Tau province. The runoff data of two rivers are basically estimated from the simulated runoff of the neighbouring Labuong River, and verified with the runoff record measured at the proposed Song Ray dam site (C.A.=771 km^2) for a four-year period of the year 1979 to 1982. On this basis, the runoff data are estimated at the proposed Song Ray dam site, and at the proposed Da Den dam site of the Dinh River for a continuous 30-year period from the year 1963 to 1992.

Be River and Saigon River

The runoff data of the Be River and the Saigon River are estimated in Appendix III and Appendix V, respectively. The runoff data so worked out are those at the proposed Phuoc Hoa damsite (C.A.=5,247 km^2) of the Be River and at the existing Dau Tieng damsite (C.A.= 2,700 km^2) of the Saigon River for a continuous 30-year period of the year 1963 to 1992.

Flow at the Phuoc Hoa damsite includes the flow regulation by the Thac Mo reservoir, which was completed in the year 1995.

From the data obtained above, the river flow with a 75 % exceeding probability (75 % runoff) at the respective sites is calculated. The mean and 75 % monthly runoff are shown in Tables 2.7 and 2.8, respectively and those annual values are summarized below:

Scheme	River Basin	River	Site	C.A. (km^2)	Mean (m^3/sec)	75 % Flow (m^3/sec)
Phan Rang Plain	Cai/P. Rang	Song Pha	Song Pha Weir	99	1.86	1.45
		Song Sat	Song Sat Dam	130	2.44	1.90
		Song Trau	Song Trau Dam	65	1.22	0.95
		Cai	Nha Trin Weir	2,140	40.10	31.35
	Song Lu	Tan Giang	Tan Gian Dam	140	2.62	2.05
Long Song Plain	Long Song	Long Song	Long Song Dam	394	5.86	3.74
Phan Ri Plain	Song Luy	Ca Giay	Ca Giay Dam	146	2.17	1.39
		Song Luy	Song Luy Dam	554	8.24	5.26
		Ca Tot	Ca Tot Dam	140	2.08	1.33
Phan Thiet Plain	Cai/P. Thiet	Song Quao	Song Quao Dam	296	4.40	2.81
	Ca Ty	Ca Ty	Ba Bau Weir	347	5.16	3.29
		Ca Ty	Ke Bat Dam	136	2.02	1.29
		Song Mong	Song Mong Dam	101	1.50	0.96
Song Phan Plain	Song Phan	Song Phan	Song Phan Dam	136	2.02	1.29
Ham Tan Plain	Song Dinh	Song Dinh	Song Dinh Dam	551	8.20	5.23
		Song Gieng	Song Gien Dam	93	1.38	0.88
Lower La Nga Plain	La Nga	La Nga	Ta Pao Weir	2,000	83.73	71.77
			Vo Dat Weir	3,080	125.73	107.77
			Ta Pao Weir (*1)	2,000	83.72	72.46
			Vo Dat Weir (*1)	3,080	126.07	108.89
Song Ray Plain	Song Ray	Song Ray	Song Ray Dam	771	20.88	17.81
Song Dinh Plain	Song Dinh	Song Dinh	Da Den Dam	149	5.34	4.56
Phuoc Hoa Scheme	Dong Nai	Song Be	Phuoc Hoa Dam (*2)	5,247	203.30	177.99
Dau Tieng Scheme	Saigon	Saigon	Dau Tieng Dam	2,700	67.15	59.12

Note (*1) : Flow regulated by Ham Thuan and Da Mi reservoirs
(*2) : Flow regulated by Thac Mo reservoir

2.5 Existing Irrigation Schemes

2.5.1 Inventory of Existing Irrigation Schemes

(1) Inventoried Existing Irrigation Schemes

The irrigation area in the Study Area is assessed by the information obtained from SIWRP and the analysis of inventory survey of agriculture and irrigation. All the existing irrigation schemes with areas of more than 100 ha are listed in Table 2.9. The total area of existing

irrigation schemes including those with areas less than 100 ha in the respective provinces is shown in Table 2.10, and summarized below:

Province	Agricultural Area (ha)			Irrigation Schemes and Designed Area	
	Annual Crops	Perennial Crops	Total	Scheme No.	Area (ha)
1. Lam Dong	40,952	42,316	83,268	155	17,985
2. Dac Lac	4,461	1,552	6,013	12	394
3. Ninh Thuan	39,525	2,000	41,525	50	22,585
4. Binh Thuan	82,512	17,619	100,131	153	29,855
5. Song Be	79,300	139,400	218,700	50	5,587
6. Dong Nai	181,607	153,142	334,749	59	18,322
7. Ba Ria-Vung Tau	44,019	64,934	108,953	24	8,885
8. Tay Ninh	182,707	93,393	276,100	4	56,675
9. HCMC	80,822	12,424	93,246	6	31,300
10. Long An	139,696	-	139,696	9	59,200
Total	875,601	526,780	1,402,381	522	250,788

The irrigation area in the Study Area is estimated at about 251,000 ha in total, occupying about 28 % of the annual cropping area. The rates of irrigation area vary largely province by province, ranging from 57 % in Ninh Thuan province and 7 % in Song Be province.

In the Study Area, there are six large and medium scale irrigation schemes with an area of more than 2,000 ha except for the areas in HCMC-Long An province. The detailed features of these schemes with regard to the present conditions and requirements of rehabilitation are described in the subsequent Sub-section 2.5.2.

(2) Results of Inventory Survey for Existing Irrigation Schemes

To grasp the present conditions of the existing irrigation schemes in the Study Area, the inventory survey was carried out for the existing and proposed irrigation schemes with each area larger than 100 ha by distributing written questionnaire to SIWRP and the provinces, using an inventory form as shown in Annex-1. Filled questionnaires for 254 schemes were collected by the end of field work of Phase I. The results of inventory survey for the 156 existing irrigation schemes are summarized below.

a) Cropping Pattern

The results of inventory survey on cropping pattern are shown in Table 2.11. The rate of planting area in the irrigation schemes ranges from 92.6 % in Long An province to 181.5 % in Dong Nai province except for the extremely low rate of 42 % in Ba Ria-Vung Tau province, for which data seem to be filled inadequately. Excluding data of Ba

Ria-Vung Tau province, the mean rate of planting area is estimated at about 112 % as summarized below:

Winter paddy	:	33.7 %
Winter other crops	:	5.6 %
Summer paddy	:	28.0 %
Summer other crops	:	2.1 %
Wet season paddy	:	42.0 %
Wet season other crops	:	1.0 %
Total	:	112.3 %.

The above result reveals a fact that the actually irrigated area is less than 40 % against the designed irrigation area of schemes.

b) Yield of Paddy

The results of inventory survey on yield of paddy are shown in Table 2.12, revealing a production range from 1.7 tons/ha of wet season paddy in Song Be province to 3.8 tons/ha of winter season paddy in Ho Chi Minh City. In general, the delta has higher yield.

c) Water Charges

The results of inventory survey on water charges are shown in Table 2.13. There are two modes in paying water charge, either by paddy or by cash. The rate of water charge varies largely from province to province, ranging from 18 kg/ha for wet season paddy in Long An province to 190 kg/ha for summer paddy in Ninh Thuan province, and from VND 78,000/ha for summer paddy in Ho Chi Minh City to VND 300,000/ha for winter paddy in Tay Ninh province.

d) Problems

Problems involved in running irrigation schemes are identified through the inventory survey as shown in Table 2.14. The top five problems are:

- Insufficient development in on-farm irrigation systems;
- Inadequate or defective design of irrigation systems;
- Water shortage;
- Damage and deterioration of irrigation systems; and
- Poor operation and maintenance.

The reluctancy of farmers in planting crops and paying water charge follows the above top five problems. In case of pump irrigation systems, high electric tariff is one of the

major problems according to the interviews to the concerned people cried out during the field trips.

e) Irrigation Facilities

Inventory data on irrigation facilities with regard to type of headworks, storage volume of reservoir, head discharge and length of main canal are shown in Table 2.9. However, these data are generally insufficient because information was not fully filled up in the questionnaire sheet.

(3) Classification of Existing Irrigation Schemes

As classified in the "Framework of Irrigation Planning", the existing irrigation schemes are categorized into two groups; (i) large and medium scale irrigation schemes with each area larger than 2,000 ha and (ii) small scale irrigation schemes with an area ranging from 100 ha to 2,000 ha. In addition, the inventory survey included the identification of on-going and planned irrigation schemes. Irrespective of short and long range planning targeting the year 2015, the provincial administrations listed all the schemes whatever they are expecting at present. These new schemes including extension of the existing schemes with area of more than 100 ha are listed in Table 2.15, and these are tentatively categorized into third group of the existing irrigation schemes as "Proposed Small Irrigation Schemes".

2.5.2 Large and Medium Scale Irrigation Schemes

There are following six existing irrigation schemes with an area of more than 2,000 ha in the Study Area except for HCMC and Long An province:

a) Vo Xu irrigation scheme;
b) Phan Rang irrigation scheme;
c) Song Pha irrigation scheme;
d) Dai Don irrigation scheme;
e) Quan Hiep/Tuyen Lam irrigation scheme; and
f) Phuoc Chi irrigation scheme.

The location of the above schemes is shown in Figure 2.8. The present conditions and requirement of rehabilitation and improvement works are described below.

(1) Vo Xu Irrigation Scheme

The Vo Xu irrigation scheme is located in the Lower La Nga plain and its pump station was constructed in the year 1978 to 1982 with a design to irrigate an area of 5,000 ha for double

and triple paddy cropping. The command area covers five communes, i.e. Vo Xu, Nam Chinh, Duc Chinh, Duc Tai and Duc Hanh of Duc Linh district, Binh Thuan province. A total of 28 units of pumps with 33 kW electric driven each are installed with a design discharge of 6.7 m^3/sec in total. An approach canal is provided to draw water from the La Nga River to the pump station. The irrigation system consists presently of a main canal of 9.2 km long, ten secondary canals with a total length of 43 km, tertiary canals of 53 km in total length and flood protection dike of 13.2 km long along the La Nga River.

Since the year 1982, the pump station has been serving an area of 500 ha only for winter-spring paddy. In addition, an area of about 1,050 ha has been able to crop summer-autumn and wet season paddies thanks to the flood protection dike. The major causes of such ineffective operation are high electricity tariff, deterioration of irrigation and drainage facilities including the pump station due to poor operation and maintenance and so on. In the rainy season, the basement of pump station building is inundated by the leakage through the intake gate of approach canal, and therefore all the pumps are temporarily removed.

The Department of Water Resources of Binh Thuan province has a proposal to rehabilitate the whole system of the scheme so as to meet the requirements of irrigation, drainage and flood protection. The major works of rehabilitation are substantial restoration of the pump station including replacement of all the pump units with new equipment, rehabilitation of main and secondary canals, rehabilitation and improvement of tertiary canals and on-farm facilities, rehabilitation and construction of drainage canals, and rehabilitation of flood protection dike. Its cost is estimated at about US$ 9 million at present according to Binh Thuan province.

(2) Phan Rang Irrigation Scheme

The Da Nhim 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 m^3/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 sugarcane in the higher land.

Of 12,800 ha of the project area, the annual cultivating area is 22,500 ha in total at present, consisting of 8,730 ha of winter-spring paddy, 3,630 ha of summer-autumn paddy, 8,850 ha of the rainy season and 1,290 ha of upland crops. Cropping intensity is 175 %, being lower than designed 250 %. Several constraints cause such low cropping intensity. Those would be:

- Serious deterioration of irrigation and drainage facilities and lack of O&M roads;
- Shortage of irrigation water depending upon the release of water from the Da Nhim power station and abstraction of water in the upstream irrigation area;
- Flood and inundation;
- Insufficient O&M budget and staff; and
- High electricity charge for pump operation, which is necessary to draw water to the elevated area.

The agricultural area for annual crops in the Ninh Thuan province is estimated at 39,500 ha in total, of which an area of about 21,300 ha is facilitated with irrigation facilities. The project with an area of 12,800 ha occupies 32 % of the whole agricultural land for annual crops and 60 % of the irrigable area. Apparently, the rehabilitation of the project will increase the agricultural production substantially and is expected to enhance the socio-economic conditions of this region as well as the province, ensuring the sustainable operation and management of the project, coupled with the improved project O&M and agricultural supporting services.

The Government carried out a feasibility study on the rehabilitation and improvement of the project in the year 1990 with a technical assistance of a Japanese engineering consultant. This study inventoried all the requirements of rehabilitation and improvement works with preliminary cost estimate, and revealed the highly economic viability of the rehabilitation project with an internal rate of return of more than 25 %.

The features of rehabilitation project set in the 1990 feasibility study are summarized below:

- Restoration of south main canal (SMC) of 28.9 km long, north main canal (NMC) of 34.5 km long and Lam Cam main canal (LMC) of 19.8 km long including provision of concrete lining in SMC with a length of 28.9 km;
- Restoration and new provision of main canal related structures with a number of 219 and 56, respectively;
- Restoration of secondary and tertiary irrigation canals with a total length of 240 km;
- Restoration and construction of main drainage canals with a length of 31 km and 22.5 km respectively;
- Construction of secondary drainage canals with a total length of 191 km;
- Restoration of inspection roads with a total length of 83 km;
- Restoration and improvement of on-farm facilities for the entire 12,800 ha;
- Improvement of farm roads connected to the National Highway No.1 with a total length of 20 km; and
- Procurement of construction and O&M machinery and equipment.

The project cost is estimated at US$ 36 million in total at a price level of the year 1990.

(3) Song Pha Irrigation Scheme

The Song Pha irrigation scheme is located in the north-east of and about 40 km away from Phan Rang town, and belongs administratively to Ninh Son district of Ninh Thuan province. The scheme was constructed in the year 1978 with an initially designed irrigation area of 4,710 ha, consisting of 3,000 ha by the west canal and 1,710 ha by the east canal. The area actually irrigated at present is limited to 1,000 ha to 1,500 ha.

A diversion weir is provided on the On River, being about 6.5 km downstream of the Da Nhim power station. The weir is of fixed type concrete structure with dimensions of 71 meters in crest length and 2.5 meters in height. Two intakes are given for the east and west canals with diversion capacities of 2.57 m^3/sec and 5.00 m^3/sec, respectively.

The canal system is composed of the east main canal of 12.5km long with eight secondary canals and the west canal of 13.1km long with six secondary canals. The on-farm facilities including tertiary canals were to be constructed by farmers, however, few are completed even at present.

The annual cultivating area is reported to be about 2,300 ha, of which the dominant cultivation is food crops. The present crop yields are generally low; 2.8 to 3.2 tons/ha for paddy, 0.7 tons/ha for maize, 1.5 tons/ha for sweet potato, 39.7 tons/ha for sugarcane and 0.52 tons/ha for cotton.

The Song Pha irrigation scheme has been operated for 17 years since the year 1978, so many facilities are being degraded. The extensive rehabilitation and improvement of irrigation facilities including on-farm development are urgently needed. The major works are as follows:

- Diversion weir, which remains fairly in good condition, needs the removal of sediments deposited in front of the intakes, and gates may be replaced with new ones;

- East canal system, which also remains fairly in good operational conditions, needs minor restoration works of canal lining and structures including removal of sediments;

- West canal system needs substantial rehabilitation works including removal of sediments, re-shaping of canal section, enlargement for the designed canal section of about 500 m long where rocks are exposed in the foundation, canal protection against the crossing floods, construction of public and cattle washing basins and repair of canal structures; and

- New secondary canal in the terminal area of the west canal system with a length of about 3.5 km together with tertiary canals with a total length of 2.4 km, which command an area of 385 ha.

The Water Resources Department of Ninh Thuan province estimates the cost necessary only for the rehabilitation of west canal system including a new secondary canal system to be about US$ 0.65 million. As the results of the field reconnaissance made to the Song Pha scheme, recommendations are made for following:

- The main constraint is the lack of on-farm system, hence its extension and upgrading are prerequisite for increasing irrigation area with fair and efficient water distribution;
- The rehabilitation and improvement of primary canal systems including the east canal are urgently needed; and
- The facilities necessary for operation and maintenance such as construction of approach road to the diversion weir from National Highway No.25, installation of proper discharge measurement devices and so on should be improved and upgraded.

(4) Dai Don Irrigation Scheme

The Dai Don irrigation scheme is located along the upper reaches of the Da Dung River, one of large tributaries of the Dong Nai River, about 30 km southwest from Da Lat, capital of Lam Dong province. The scheme belongs administratively to Lam Ha and Duc Trong districts. Crops are paddy and upland crops including coffee and mulberry. The Dai Dong diversion weir was constructed in the year 1977 with a design irrigation area of 2,700 ha including a pump irrigation area of 500 ha. Its designed intake discharge is 6 m^3/sec. The irrigation system consists of a main canal of 1.7 km long and three secondary canals with a total length of about 24 km. A few tertiary canals are available, having been constructed by farmers themselves and partly by the provincial administration.

The area actually irrigated is limited to 1,400 ha, of which 1,200 ha is for paddy and 200 ha is for upland crops, and no irrigation is given to the pump area. No major problems are found in the diversion weir. However all the irrigation canals are heavily eroded and sedimented, and canal facilities including syphons and aqueducts are also damaged. For efficient irrigation and for expanding the irrigation area to the designed scale, these canals and facilities should substantially be rehabilitated. In addition, the tertiary canal systems including on-farm facilities would have to be constructed. Its cost is estimated at about US$ 1.0 million at the price level of the year 1995.

(5) Tuyen Lam/Quan Hiep Irrigation Scheme

The Tuyen Lam/Quan Hiep irrigation scheme is extended along the Da Tam River, a tributary of the Da Nhim River in the Dong Nai River basin, about 15 km south from Da Lat. The designed command area of the scheme is 2,832 ha. The scheme belongs administratively to Duc Trong district in Lam Dong province. The crops are paddy, vegetables, upland and tree crops including maize, mulberry, coffee and fruits like pineapple.

The scheme has one reservoir and two diversion weirs. The Tuyen Lam reservoir, constructed on the Da Tria River, a tributary of the Da Tam River, located 6 km southwest of Da Lat, has a storage capacity of 9.6 million m^3, whilst the catchment area at the site is 32.8 km^2. This dam was constructed in the year 1987, and its damaged spillway will be repaired by the end of the year 1995. Its designed intake discharge is 4.5 m^3/sec.

There are two diversion weirs for the scheme; one is the Dinh An weir constructed in the year 1987 with a design intake discharge of 1 m^3/sec, located about 13 km downstream of the Tuyen Lam dam. The other is the Quan Hiep weir constructed in the year 1979 with a design discharge of 4.5 m^3/sec, located about 6 km downstream of the Dinh An weir. The reservoir commands an irrigation area of 1,832 ha, and the rest catchment between the reservoir and two weirs covers the remaining 1,000 ha.

The area actually irrigated is limited to 700 to 900 ha mainly due to the damages to and lack of irrigation canals and facilities. In case of the Dinh An weir, its downstream river bed is scoured, and only one main canal of 2 km long is available and also needs repair. In the Quan Hiep irrigation system, the design was to construct a main canal of 9.6 km long, three secondary canals with a total length of 6 km and eight tertiary canals, however, one secondary and all the tertiary canals are still left unconstructed. In addition, all the existing canals and facilities need rehabilitation and improvement for damages, sediments in canals and water leakage. The cost necessary for rehabilitation and improvement is estimated at about US$ 0.5 million as of the year 1995 according to Lam Dong province.

(6) Phuoc Chi Irrigation Scheme

The Phuoc Chi irrigation scheme was constructed in the year 1977 to irrigate about an area of 6,000 ha extending in the right bank of the East Vam Co River. The major works were; an approach canal of 2.5 km long from the East Vam Co River to the pump station, a pump station, a main canal of 1.8 km long and three secondary canals with a length of 5 km in total. A total of 27 units of diesel engine driven pumps with a capacity of 12 HP each were installed and about 200 ha area was once irrigated in the first year, however, no irrigation had been made since then due to insufficient canal system and obstruction of saline water from the East Vam Co River.

In the year 1991, the above 27 pumps were removed, and five units of electric driven pumps with a capacity of 33 HP each or 900 m^3/hr were installed for irrigating about 580 ha. However, the area actually being irrigated at present is limited only to 150 ha due to insufficient canal system and lack of on-farm facilities.

Tay Ninh province intends to rehabilitate and upgrade the scheme enough to irrigate an area of 2,260 ha. The scheme belongs to Trang Bang district of Tay Ninh province, and has a flat terrain of about 2 m in elevation. The main crop is rainfed paddy. The water source relies on

the East Vam Con River affected by tidal action. After Dau Tieng reservoir was constructed, low flow in the dry season has considerably been increased by return flow from the Dau Tieng irrigation area and water diversion through Phuoc Hoi-Ben Binh drainage canal. This also resulted in decreasing the salt concentration of river water to a level of less than 1,000 PPM.

The major works to require rehabilitation and upgrading would be to:

- install additional ten units of pump including necessary electric facilities;
- extend the main canal with a length of 2 km;
- construct additional five secondary canals with a length of 13.5 km in total;
- construct tertiary canals with a length of 73 km in total;
- construct about 140 canal structures in the main, secondary and tertiary canals; and
- dredge the approaching canal (Tra Cao creek) with a length of 2.5 km.

Tay Ninh province estimates the construction cost to be about US$ 1.2 million in total. As the results of the field reconnaissance made to the Phuoc Chi scheme this time, recommendations are made for following:

- The existing pump station is well maintained, however, its restoration is required for installing additional pumps and efficient operation; and
- The main constraint is the lack of canal system including on-farm facilities, hence its extension and upgrading are prerequisite for increasing irrigation area with fair and efficient water distribution.

2.5.3 Small Scale Irrigation Schemes

Besides the large and medium scale irrigation schemes mentioned above and those in HCMC and Long An province separately discussed in the subsequent Section 2.7, a total of 161 small scale irrigation schemes are identified in the Study Area. These are listed in Table 2.9 and those locations are shown in Figure 2.9. The number of schemes in the respective provinces and their designed irrigation areas are summarized below:

Province	Number of Small Irrigation Schemes	Total of Designed Irrigation Area
Lam Dong	23	5,227
Dac Lac	1	120
Ninh Thuan	15	3,932
Binh Thuan	56	20,033
Ba Ria-Vung Tau	15	8,080
Dong Nai	33	16,930
Song Be	16	4,581
Tay Ninh	2	1,000
Total	161	59,953