



DIRECTORATE OF PLANNING  
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DIRECTORATE GENERAL OF  
WATER RESOURCES DEVELOPMENT  
MINISTRY OF PUBLIC WORKS

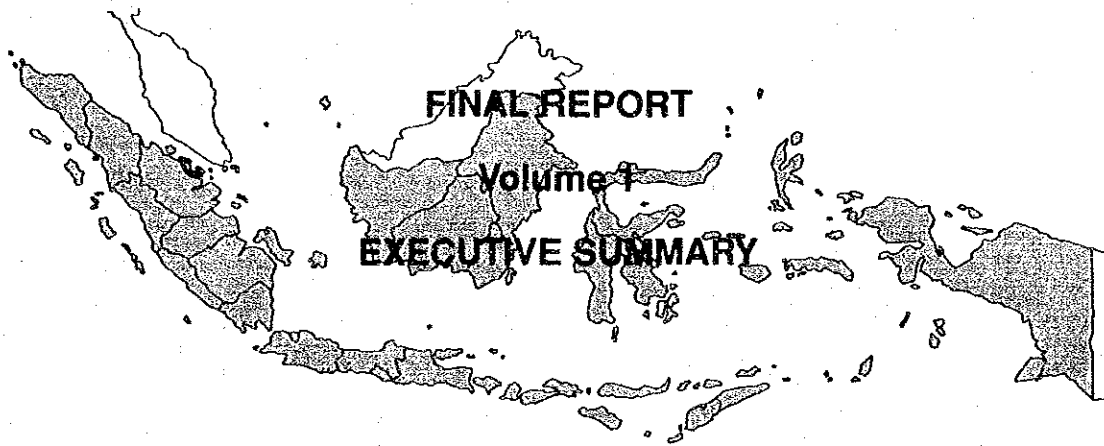


JAPAN INTERNATIONAL  
COOPERATION AGENCY  
J A P A N



B U R E A U O F  
WATER RESOURCES AND IRRIGATION  
B A P P E N A S  
REPUBLIC OF INDONESIA

**THE STUDY  
FOR  
FORMULATION OF IRRIGATION DEVELOPMENT PROGRAM  
IN  
THE REPUBLIC OF INDONESIA**



November 1993



**NIPPON KOEI CO., LTD.**  
**TOKYO, JAPAN**  
IN ASSOCIATION WITH  
**JAPAN IRRIGATION AND  
RECLAMATION CONSULTANTS CO., LTD.**

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THE STUDY FOR

FINAL REPORT Volume 1 EXECUTIVE SUMMARY







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**FINAL REPORT**

**Volume 1**

**EXECUTIVE SUMMARY**

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## PREFACE

In response to a request from the Government of the Republic of Indonesia, the Government of Japan decided to conduct a Study for Formulation of Irrigation Development Program and entrusted the study to the Japan International Cooperation Agency (JICA).

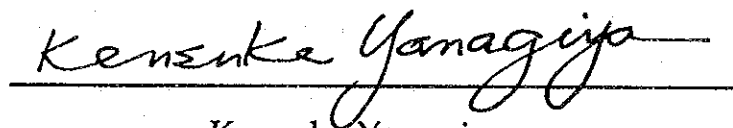
JICA sent to the Indonesia a study team headed by Dr. Yasuhiko KUNIHICO, Nippon Koei Co., Ltd., four times between April 1992 and August 1993.

The team held discussions with the officials concerned of the Government of the Indonesia, and conducted field surveys at the study area. After the team returned to Japan, further studies were made and the present report was prepared.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of the Republic of Indonesia for their close cooperation extended to the team.

November, 1993



Kensuke Yanagiya  
President

Japan International Cooperation Agency



## Executive Summary

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## Abbreviations

AMDAL	Environmental Impact Assessment
APBN	Anggaran Pendapatan dan Belanja Negara
APBD	Anggaran Pendapatan dan Belanja Daerah
BAPPEDA	Badan Perencanaan Pembangunan Daerah - Provincial Development and Planning Agency
BAPPENAS	Badan Perencanaan Pembangunan Nasional - National Development and Planning Agency
BIMAS	Mass guideline for agricultural development
BPP	Bina Program Pengairan - Planning Division of Water Resources
BULOG	Badan Urusan Logistik - Agency for National Logistics Administration
CBS (BPS)	Central Bureau of Statistics (Biro Pusat Statistik)
DGWRD	Directorate General of Water Resources Development in MPW
DOI	Directorate of Irrigation
DPU	Provincial Public Works
EOM	Efficient Operation and Maintenance
FAO	Food and Agriculture Organization of the United Nations
GIS	Geographical Information System
GOI	Government of Indonesia
IBRD	International Bank for Reconstruction and Development
JICA	Japan International Cooperation Agency
Kanwil	District Office of a Line Agency under Minister
KUD	Village cooperative
MOA	Ministry of Agriculture
MOF	Ministry of Forestry
MOH	Ministry of Home Affairs
MPW	Ministry of Public Works
OECE	Overseas Economic Cooperation Fund, Japan
P3A	Water Users Association
Palawija	Secondary food crops (grown mainly in dry season)
PBME	Project Benefit Monitoring and Evaluation
PIK	Proyek Irigasi Kecil (Handing over small scheme)
PIR	Perkebunan Inti Rakyat (Nuclear Estate Schemes)
PJPT I	Pembangunan Jangka Panjang Tahap I
PJPT II	Pembangunan Jangka Panjang Tahap II
p.m.	pre memoria
PRAS	Provincial Agricultural Services
PRIS	Provincial Irrigation Services
PU	Ministry of Public Works
Repelita	Rencana Pembangunan Lima Tahun - Five-Year Development Plan
RePPProt	Regional Physical Planning Program for Transmigration
SUSENAS	Survei Sosial Ekonomi Nasional (National Socio-economic Survey)
USAID	United States Agency for International Development



## 1. Objectives of the Study and Study Area

The objectives of the study as agreed upon between DGWRD and JICA are the following:

- (1) To formulate an irrigation development program, in a long term range, which provides the current and future Repelita with rationale and guideline of irrigation development plans having regional priority, in line with overall food production increase program, thus contributing to the sustenance of self-sufficiency in rice, and
- (2) To carry out technology transfer to the Indonesian counterpart personnel in the course of the Study.

The study area covers the whole Indonesia with an area of 1.92 million square kilometers.

## 2. Necessity of Formulation of Irrigation Development Program

Although Indonesia has been self-sufficient in rice since 1984, continuous efforts to increase rice production are a prerequisite to meet the increasing demand. Irrigation development is expected to play a major role to overcome this issue.

Increase of rice production to attain and sustain self-sufficiency has mainly relied on irrigation development especially in Jawa, Sumatera and Sulawesi, as well as on intensification programs such as supra-insus. However, further rice production increase will not be expected much from these programs. In Jawa, land has almost been fully utilized and the level of paddy farming technology has already been high, which implies little possibility of big production increase. On the contrary, recent urbanization and industrialization around large cities have resulted in the decrease of productive paddy fields including irrigated ones. In the present Repelita, development effort is going towards areas outside of Jawa.

The irrigation development program in Repelita V consists of three components: (1) rehabilitation and maintenance, (2) new irrigation development, and (3) swamp development. While each program has a target area, and while concrete plan has recently been established, those targets or plans have not been formulated based on the strategy how to maintain self-sufficiency in rice.

The irrigation development should be programmed, in line with the national development policy and food production program, to meet the increase in rice demand. To ensure reliability such a program should be soundly formulated, based on basic data such as land and water potential and human resources. Also since it takes long time to realize irrigation development from the identification stage, the program should be formulated in a long term basis.

### 3. Socio-economic Condition

#### Land area and population

Indonesia, consisting of more than 13,000 islands, is the largest island country in the world with total area of 1.9 million km<sup>2</sup>. The territorial extent is huge; some 5,000 km in east-west direction which is almost the same as that of the U.S., and 3,000 km in north-south direction. Thanks to the wide areal extent and unique topography, Indonesia enjoys various climate patterns with which agriculture could have various options.

Land Area, Population, Population Density and Urban Population

Island/Province	Land area (km <sup>2</sup> )	Population (thousand)	Pop. density (person/km <sup>2</sup> )	Urban pop. (thousand)
Sumatera	473,481	36,420	77	9,291
Jawa	132,186	107,518	813	38,335
Bali, Nusa Tenggara and Timor	88,488	10,162	115	1,747
Kalimantan	539,460	9,103	17	2,507
Sulawesi	189,216	12,511	66	2,761
Maluku & Irian Jaya	496,486	3,480	7	748
<b>Indonesia</b>	<b>1,919,317</b>	<b>179,194</b>	<b>93</b>	<b>55,389</b>

Source: Central Bureau of Statistics

Share of Area in Each Land Use Category

Unit: %

Island/Province	Lowland Paddy	Arable Upland	Grassland/ Fallowland	Swamp/ Water	Estates	House Compound	Forest/Wood /Bush	Total Area
Sumatera	26.9	32.9	28.3	35.0	51.0	35.1	20.1	24.7
Jawa	42.6	23.7	1.2	3.2	5.7	33.3	2.8	6.9
Bali, Nusa Tenggara & Timor	5.3	7.7	16.6	0.4	3.3	4.4	3.5	4.6
Kalimantan	15.3	16.8	25.1	28.7	18.7	13.0	31.7	28.1
Sulawesi	9.9	11.6	13.4	4.7	14.0	8.3	9.3	9.9
Maluku & Irian Jaya	0.1	7.2	15.4	27.9	7.2	5.8	32.6	25.9
<b>Indonesia</b>	100.0 (4.4)	100.0 (6.9)	100.0 (6.4)	100.0 (3.9)	100.0 (6.1)	100.0 (2.6)	100.0 (69.7)	100.0 (100.0)

Source: Central Bureau of Statistics

#### Economic growth

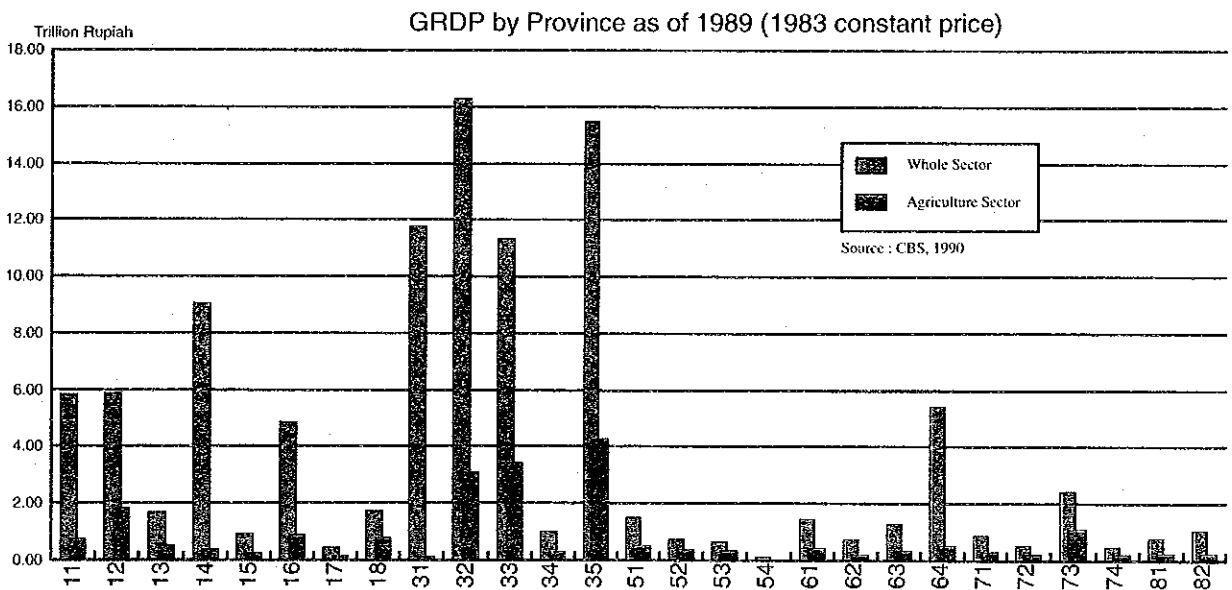
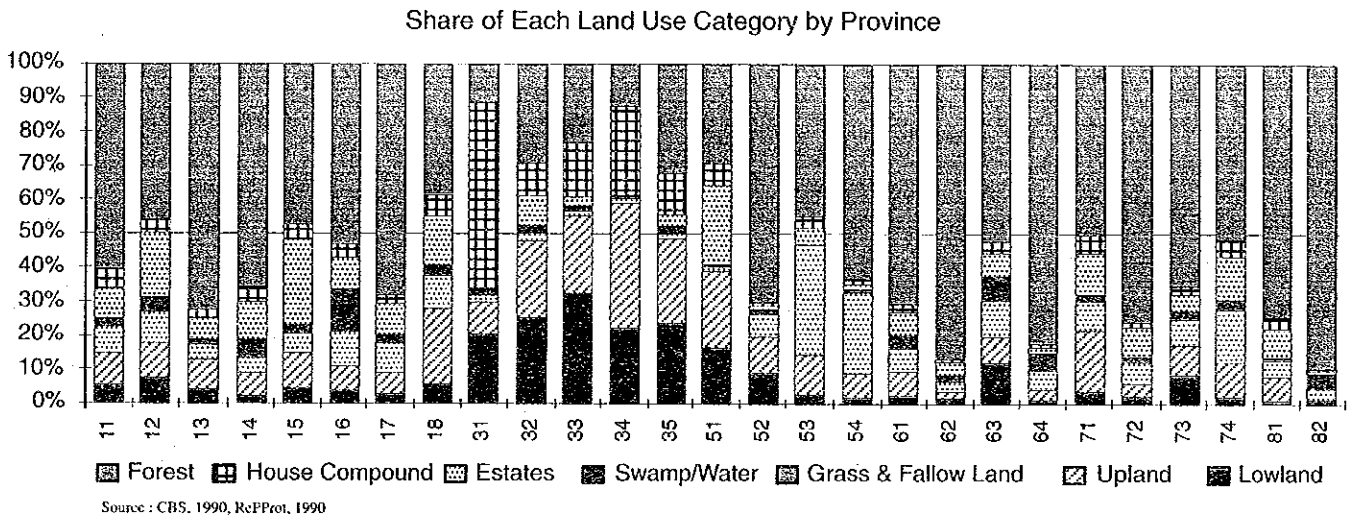
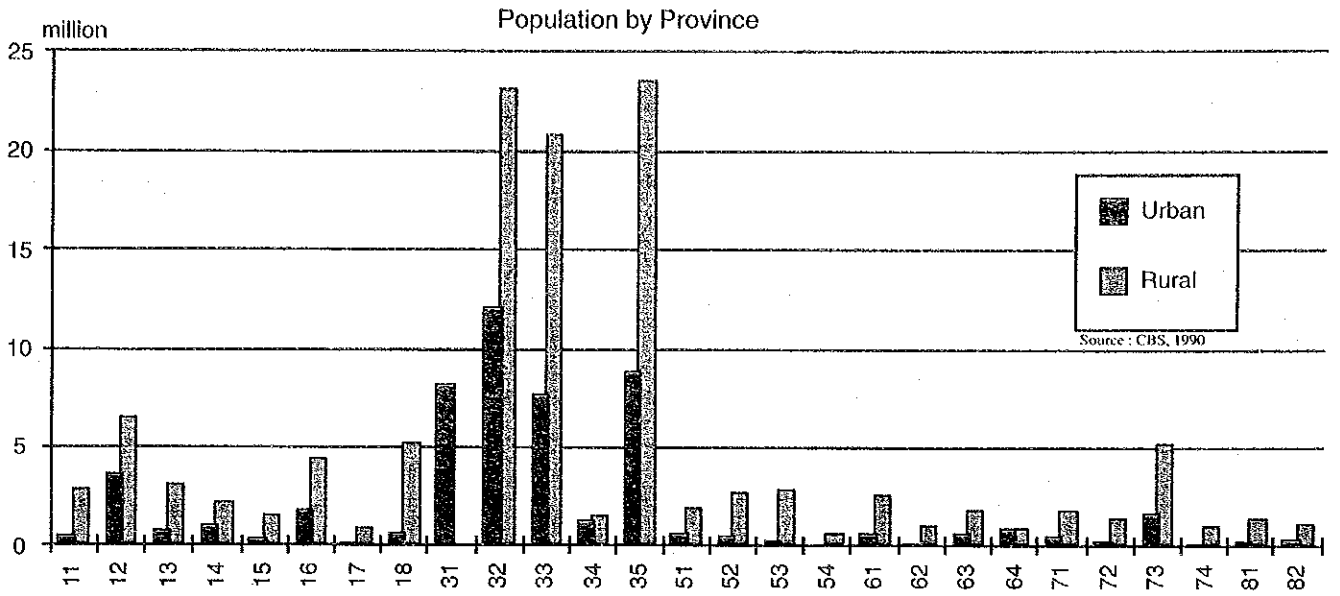
So far Agricultural sector including food crops, estates, forestry and fisheries has played a leading role in economic growth. In 1969/71 the agricultural sector accounted for almost half of the total GDP. Among others food crops, especially rice contributed more than 25% of total GDP. Although the agricultural sector has grown, the growth rate has decreased from more than 4% during 1965/80 to 3% during 1980/90. Besides other sectors have grown rather higher rate than the agricultural sector. Hence the share of the agricultural sector GDP in total GDP declined from 45% in 1969/71 to 21% in 1989.

GDP by Sector in 1983 and 1989

Unit: Billion Rupiah

Sector	GDP in 1983	GDP in 1989	Growth Rate (% share)	Growth Rate (annual ave. %)
Agriculture, Forestry and fisheries	16,118	22,184	21.3	5.5
Mining and quarrying	13,942	16,006	15.4	2.3
Industry	12,927	23,933	23.0	10.8
Electricity, gas and water supply	603	1,250	1.2	12.9
Wholesale and retail trade & restaurants	11,557	17,970	17.2	7.6
Transportation, storage & communications	4,333	6,545	6.3	7.1
Finance, Insurance, real estate & business services	3,717	5,850	5.6	7.9
Public Services	5,168	7,004	6.7	5.2
Others	2,453	3,467	3.3	5.9
<b>Total</b>	<b>70,818</b>	<b>104,210</b>	<b>100.0</b>	<b>6.6</b>

Source: Central Bureau of Statistics



#### 4. Physical Potential for Irrigation Development

In case the necessity of irrigation development is justified, one of the next subjects will be where to develop irrigation. Land and water resources are fatal limiting factors to consider the possibility of irrigation development. Land and water resources are assessed based upon the existing data.

##### Land Potential

Unit : 1,000 ha

Region	Irrigable rainfed field	Fully suitable	Conditionally suitable	Marginally suitable	Total potential
Sumatera	388	342	681	2,932	4,343
Jawa	602	27	55	1,086	1,770
Bali & NT	29	70	40	420	559
Kalimantan	258	529	166	2,740	3,693
Sulawesi	220	171	124	375	890
Maluku & IJ	0	1,293	725	565	2,583
Indonesia	1,496	2,432	1,791	8,117	13,836

Source: JICA-FIDP Team calculation.

##### Water Potential

Unit: 1,000 ha

Region	1990	1995	2000	2005	2010	2015	2020
Sumatera	10,398	10,378	10,341	10,315	10,283	10,264	10,228
Jawa	83	80	72	69	67	65	62
Bali & NT	98	97	95	94	93	92	90
Kalimantan	16,506	16,502	16,494	16,488	16,479	16,472	16,464
Sulawesi	1,249	1,247	1,242	1,239	1,235	1,232	1,228
Maluku & IJ	13,813	13,812	13,809	13,807	13,804	13,803	13,800
Indonesia	42,148	42,115	42,053	42,012	41,960	41,928	41,872

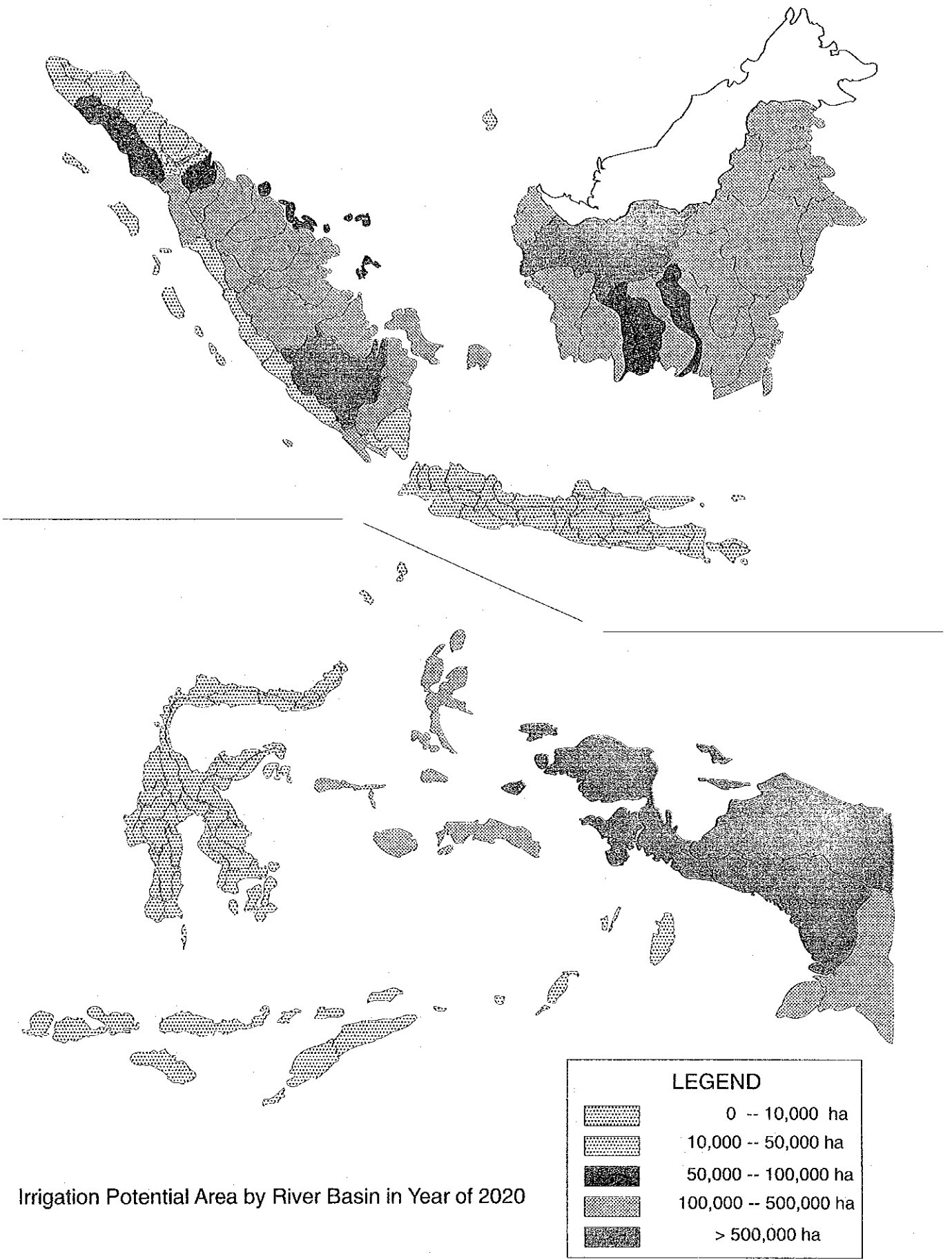
Source: JICA-FIDP team estimate.

##### Irrigation Development Potential by Region

Unit: 1,000 ha

Region	1990	1995	2000	2005	2010	2015	2020
Sumatera	4,009	4,006	3,997	3,991	3,983	3,980	3,972
Jawa	83	80	72	69	67	65	62
Bali & NT	98	97	95	94	93	92	90
Kalimantan	3,693	3,693	3,693	3,693	3,693	3,693	3,693
Sulawesi	535	534	532	530	528	526	524
Maluku & IJ	2,525	2,525	2,525	2,525	2,524	2,524	2,524
Indonesia	10,944	10,934	10,913	10,901	10,887	10,879	10,865

Source: JICA-FIDP team estimate.



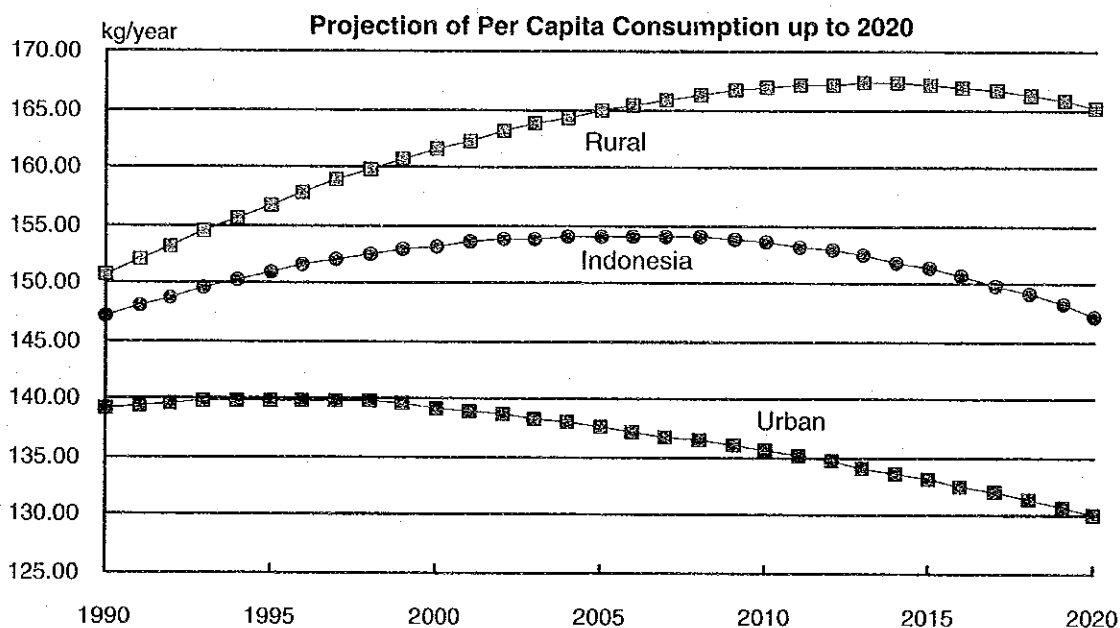
Irrigation Potential Area by River Basin in Year of 2020

## 5. Rice Demand Projection

In this study, total annual rice demand is forecasted at first by estimating per capita consumption in each year. "Consumption" here is given in terms of "disappearance base" rather than of "actual food consumption". After multiplying this disappearance base consumption by population, feed and seed use and wastes are added to obtain total demand amount.

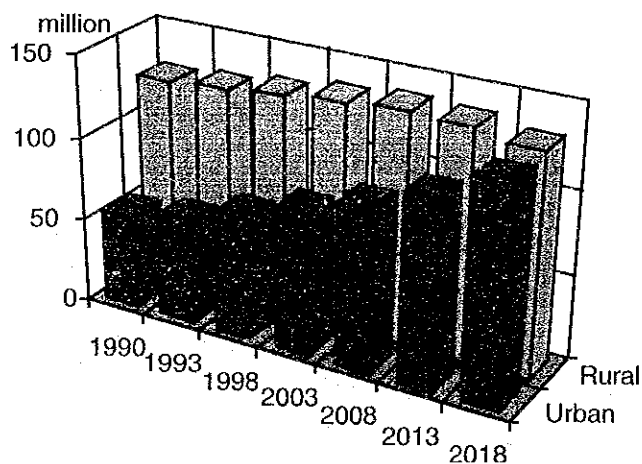
### Projection of Per Capita Rice Consumption (PCC)

While urban PCC will hit the peak in the middle of 1990s and then sluggishly decrease after then, rural PCC is expected to increase until the middle of 2010s. On the national average, starting from 147.1 kg/year in 1990, PCC will reach a peak at 154.1 kg/year in 2005 and then gradually decrease to be 147.3 kg/year.



### Population Projection

Total population in the year 2020 will reach at 262 million. Urban population is expected to catch up rural population and the urbanization rate will reach 50% around 2020.



### Total Demand

Finally the amount of paddy needed to be supplied for Indonesian market was estimated after multiplying population and converting from food consumption to total demand base.

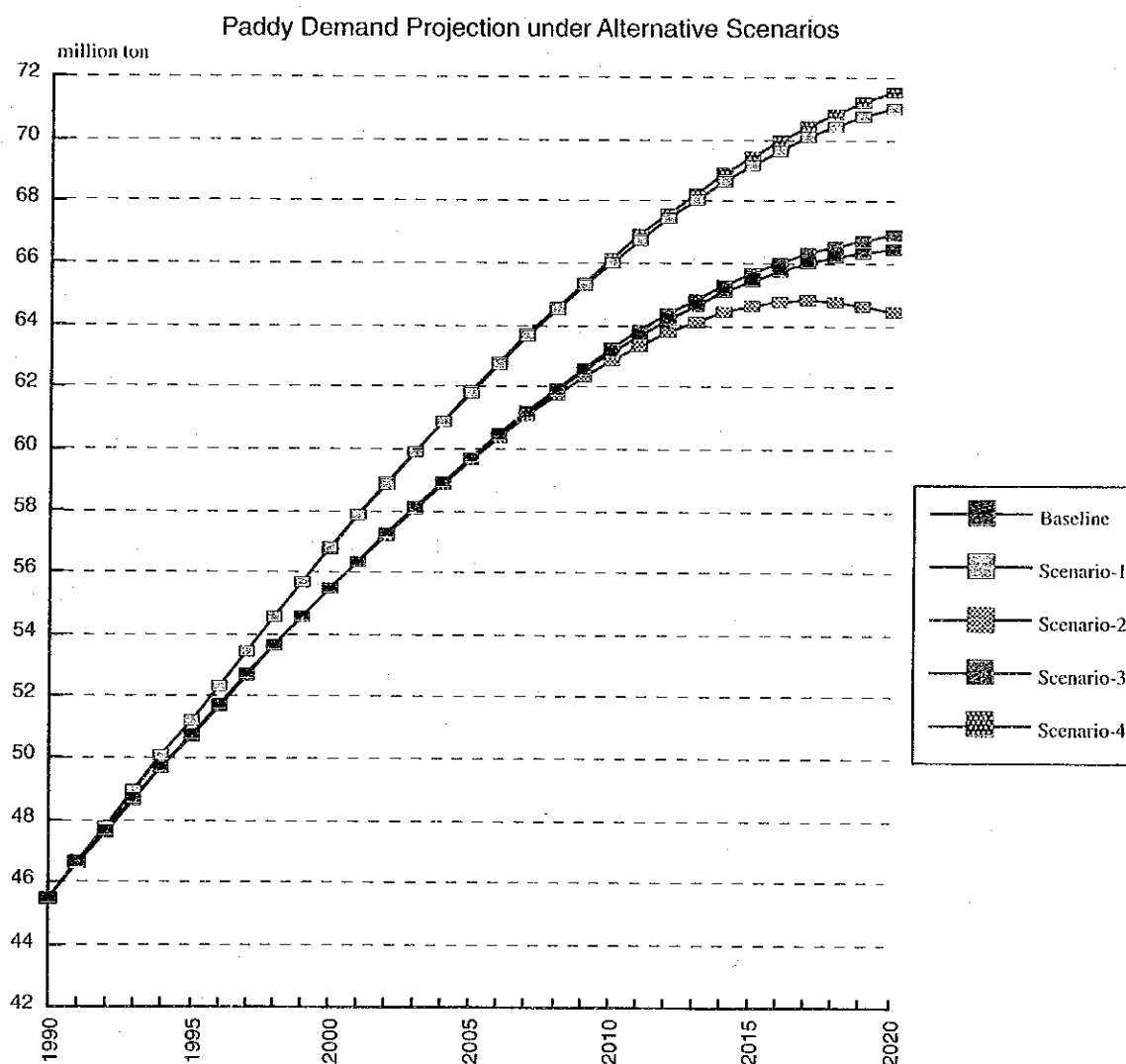
Unit: million ton

Scenario	Repelita					
	V	VI	VII	VIII	IX	X
Food Consumption in milled rice	28.30	31.19	33.77	35.97	37.60	38.50
Total Demand in rough rice	48.68	53.66	58.09	61.87	64.67	66.23
Annual Average Growth Rate (%)	-	1.97	1.60	1.27	0.89	0.48

### Alternative Study

Unit: million ton, rough rice

Scenario	Repelita					
	V	VI	VII	VIII	IX	X
Baseline	48.68	53.66	58.09	61.87	64.67	66.23
1. Higher Population Growth	48.95	54.60	59.89	64.49	68.09	70.47
2. Lower Income Elasticity	48.68	53.66	58.07	61.73	64.15	64.80
3. Lower Economic Growth	48.66	53.63	58.10	61.96	64.87	66.59
4. 1) + 3)	48.93	54.58	59.91	64.59	68.29	70.85



## 6. Rice Production Potential

Irrigation development is a measure to increase crop production as well as create stable production circumstances. Crop production is expressed as functions of harvested area and yield. Harvested area is further divided into two functions: planted (field) area and cropping intensity. Thus, crop production is expressed as the following formula:

$$\text{Production} = \text{Planted Area} * \text{Cropping Intensity} * \text{Yield}$$

Irrigation development contributes to all of three factors as explain below:

### Paddy Area by Water Regime

Paddy Area by Water Regime (Year 1991)

Unit: 1,000 ha

Province/Island	Irrigated land				Rainfed	Tidal Swamp	Inland swamp and others	Total	Ratio Irrigated Field to Total
	Technical	Semi technical	Simple	Sub-total					
Sumatera	167.9	228.0	514.2	910.1	606.5	216.1	486.5	2219.3	41.0%
Jawa	1,425.8	438.7	681.6	2,546.1	847.5	0.5	25.5	3,419.5	74.5%
Bali & Nusa Tenggara	45.9	170.6	91.0	307.5	70.8	0.0	30.0	408.3	75.3%
Kalimantan	12.5	13.4	114.1	139.9	369.1	283.2	510.1	1,302.4	10.8%
Sulawesi	183.1	99.2	246.3	528.6	271.1	1.8	63.9	865.5	61.0%
Maluku & Irian Jaya	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	
Indonesia	1,835.1	950.0	1,647.1	4,432.2	2,165.1	501.7	1,116.0	8,215.0	54.0%

Note: Simple irrigation includes village irrigation. Others including temporary fallow land.

Source: Central Bureau of Statistics

### Utilization of Land

Cropping intensity in lowland area (Cip) by island group as of 1989

Province/Island	Planted area (1,000 ha)				Cropping Intensity (Cip)		
	Field area (1,000 ha)	Paddy	Palawija	Estate crops	paddy	paddy & palawija	paddy, palawija & estate crops
Sumatera	2257.4	2,156.5	105.2	89.2	0.96	1.00	1.04
Jawa	3445.7	4,695.7	1,381.3	444.1	1.36	1.76	1.89
Bali & Nusa Tenggara*	409.9	484.4	180.3	15.0	1.18	1.62	1.66
Kalimantan	1282.3	608.9	9.1	11.3	0.48	0.48	0.49
Sulawesi	831.3	931.7	86.5	21.5	1.12	1.23	1.25
Maluku & Irian Jaya	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Indonesia	8226.6	8,877.1	1,793.4	580.8	1.20	1.30	1.37

Remarks: \*: Data on Timor Timur not available; n.a.: data not available.

Source: JICA-FIDP team calculation based on the CBS data and MOA.

Planted area based Paddy Cropping Intensity (Cip) by Ecosystem 1991

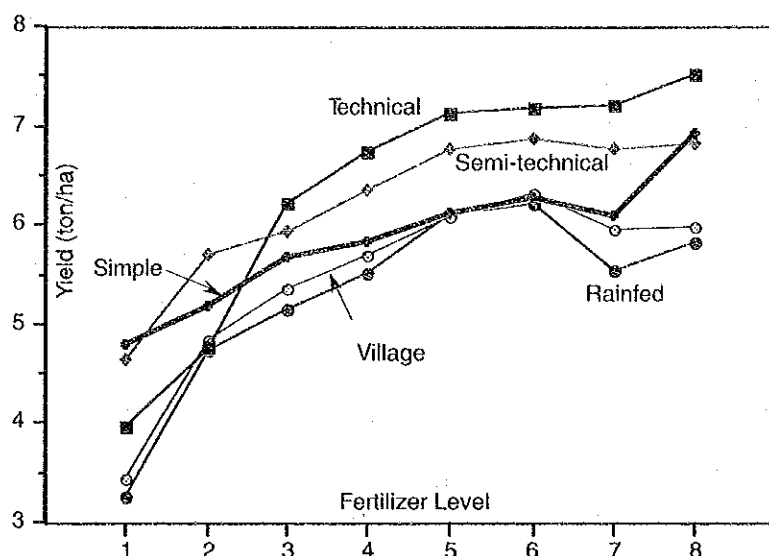
Province/Island	Irrigated		Rainfed		Others		Total	
	Field area	Cip	Field area	Cip	Field area	Cip	Field area	Cip
Sumatera	910.1	1.38	606.5	0.84	702.6	0.58	2,219.3	1.03
Jawa	2,546.1	1.66	847.5	1.16	26.0	0.60	3,419.5	1.57
Bali & Nusa Tenggara	307.5	1.56	70.8	1.03	30.0	0.03	408.3	1.28
Kalimantan	139.9	0.79	369.1	0.47	793.4	0.39	1,302.4	0.56
Sulawesi	528.6	1.39	271.1	1.03	65.7	0.19	865.5	1.12
Maluku & Irian Jaya	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Indonesia	4,432.2	1.55	2,165.1	0.93	1,617.7	0.48	8,215.0	1.20

Source: JICA-FIDP calculation based on Land Area by Utilization and Production of Cereals, 1991, CBS.



## Yield of Lowland Paddy

Effect of Interaction Irrigation and Fertilizer on Paddy Yield



Fertilizer Level

1: no application; 2: 1-150 kg/ha; 3: 151-250 kg/ha;  
 4: 251-350 kg/ha; 5: 351-450 kg/ha; 6: 451-550 kg/ha;  
 7: 551-650 kg/ha; 8: 651-800 kg/ha

Paddy Yield under Different Ecosystem 1991 (ton/ha)

Province/Island	Irrigated	Rainfed	Others	Whole Area
Sumatera	4.33	3.92	2.81	3.92
Jawa	5.39	4.47	2.25	5.19
Bali & Nusa Tenggara	4.63	3.27	2.53	4.46
Kalimantan	3.06	2.65	2.46	2.67
Sulawesi	4.22	3.95	2.94	4.13
Maluku & Irian Jaya	-	-	-	-
Indonesia	4.96	4.04	2.67	4.57

Note: Others include tidal swamp, inland swamp and other area

Source: JICA-FIDP calculation based on Agricultural Survey Production of Cereals 1991

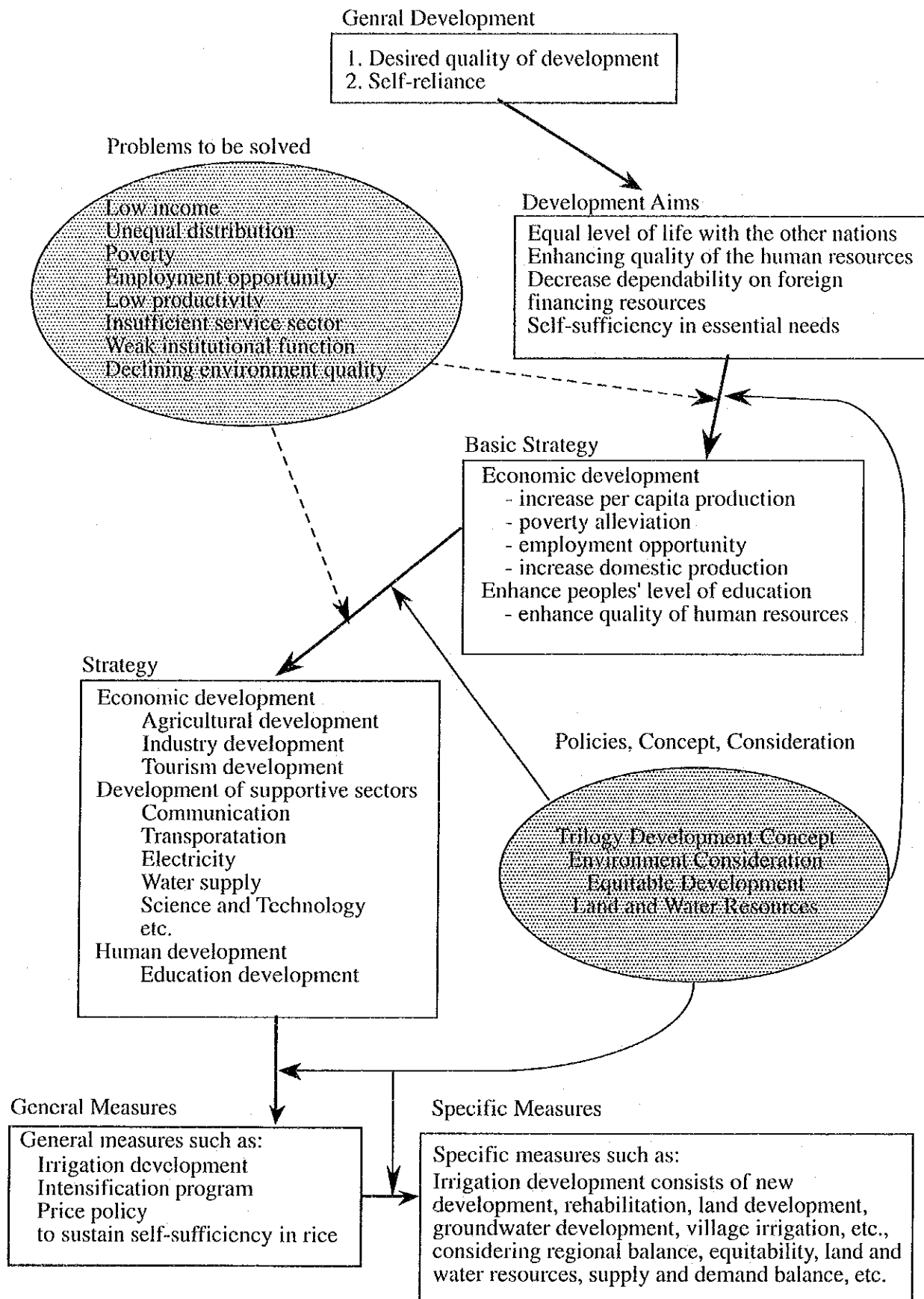
## Area of Leading Varieties

Area of Leading Varieties in 1988/89 ('000 ha)

Province/Island	PB 36	Cisadane	IR 64	Kr.Acch	PB 42	Semuru	IR 46	Others	Traditional	Total
Sumatera	76.6	58.0	109.6	24.1	42.6	13.5	155.8	309.1	289.9	1,079.2
Jawa	561.5	793.4	967.1	187.6	6.6	166.3	0.8	355.0	210.5	3,248.8
Bali & NT	82.5	2.5	13.7	77.8	0	14.1	0	25.0	7.7	223.4
Kalimantan	17.5	19.0	6.6	9.1	42.9	0.1	3.4	103.4	206.3	408.3
Sulawesi	37.9	50.2	36.2	2.7	158.5	3.6	23.3	140.5	36.9	489.8
Maluku & Irian Jaya	0.0	0.0	0.3	0.1	0.0	0.0	0.2	1.9	0.5	3.0
Indonesia	775.9	923.1	1,133.6	301.4	250.7	197.6	183.4	934.9	751.9	5,452.4

Source: Direktorat Bina Produksi, MOA

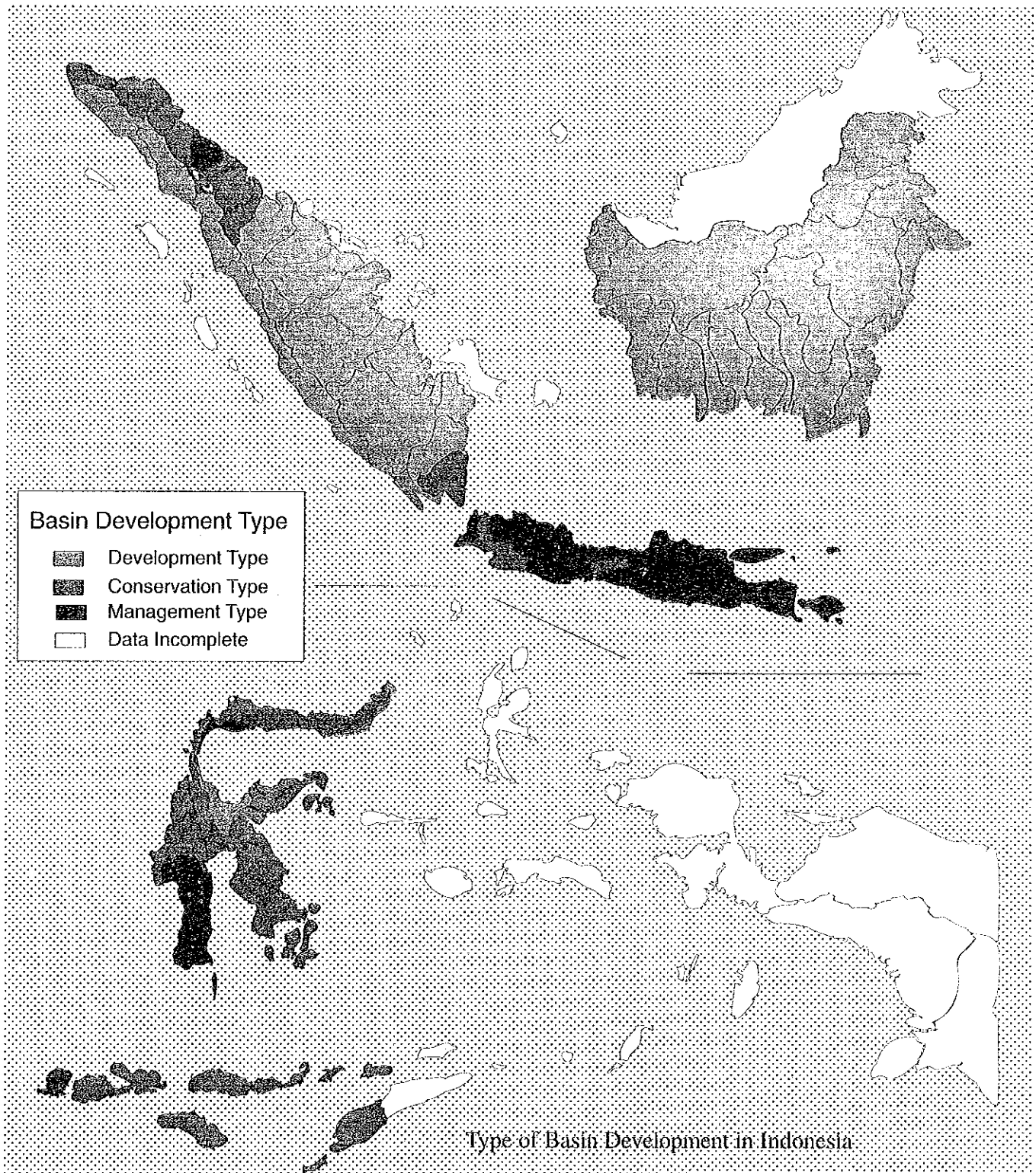
## 7. Conceptual Flow of the Formulation of Development Plan



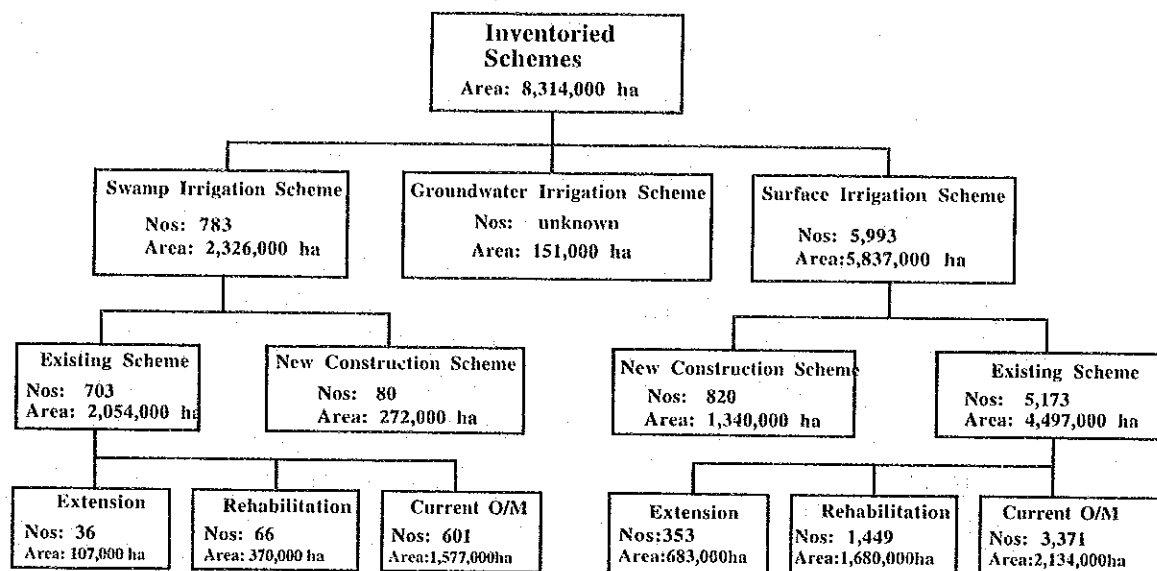
## 8. Basin Development

In view of irrigation development, river basin were evaluated and categorized into following three development type for further development direction taking into account basin's characteristic, rainfall variation, total population and vegetation.

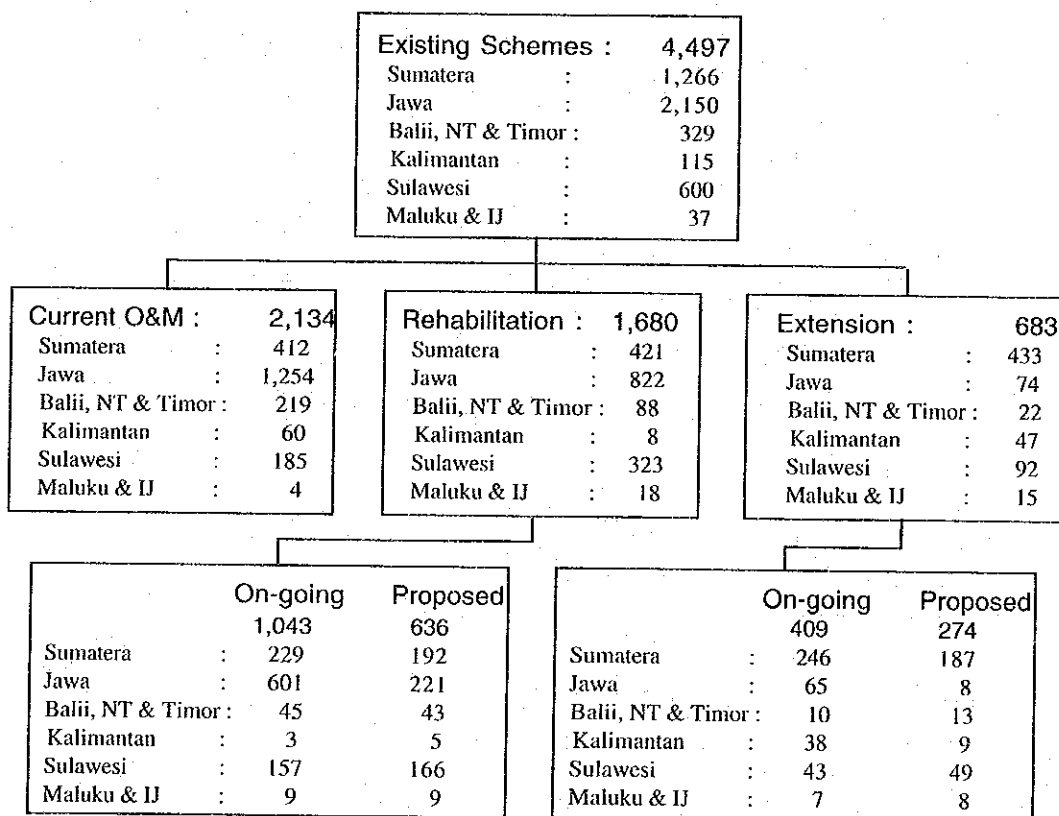
- 1.: Development Basin has much development potential. Basin development should be pay attention to basin environment and conservation.
- 2.: Conservation Basin can be developed if basin environment and conservation assessment result allow to develop.
- 3.: Management Basin should be developed under the control of overall water resource development management.



## 9 Present Condition of Irrigation Schemes and Possibility for Expansion (The Results of Inventory Survey)



Classification of Inventoried Government Irrigation Schemes (as of 1992)



Breakdown of Existing Surface Irrigation Schemes (Design Area: 1,000 ha)

## Possibility of Expansion

### Present Condition of Existing Irrigation Schemes

	Number of Scheme	Designed Area	Irrigated Paddy Field	Not yet Irrigated Paddy Field	Unit : 1,000ha	
					No Longer Available for Paddy	Potential Area for Irrigation
Sumatera	1,489	1,266	792	473	27	446
Jawa	2,475	2,150	2,025	125	46	79
Bali/ Nusa Tenggara	515	329	261	68	4	64
Kalimantan	167	115	29	86	2	84
Sulawesi	491	600	381	218	21	197
Maluku/ Irian Jaya	36	37	11	27	1	26
Indonesia	5,173	4,497	3,499	997	101	896

### Classification of Convertible Land

	Present Condition		Required Works	
	Construction of Main Canal	Land Development	Construction of Main Canal	Land Development
Category 1	Not Yet Finished	Not Yet Finished	Required	Required
Category 2	Not Yet Finished	Finished	Required	Not Yet Required
Category 3	Finished	Not Yet Finished	Not Required	Required
Category 4	Finished	Finished	Not Required	Not Required

### Breakdown of Potential Expandable Area for Paddy Field (Existing Scheme)

	Unit : 1,000ha				
	Category 1	Category 2	Category 3	Category 4	Total
Sumatera	92	77	149	128	446
Jawa	8	18	22	31	79
Bali/ Nusa Tenggara	11	4	41	8	64
Kalimantan	20	35	14	15	84
Sulawesi	47	41	73	36	197
Maluku/ Irian Jaya	8	0	11	7	26
Indonesia	186	175	310	225	896

Categories 1,2 and 3 (670 thousand ha in total) are considered potential area for expansion of irrigation area, while category 4 needs field survey to examine the reason for not-irrigated.

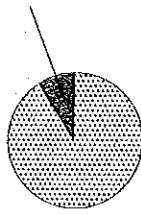
### Assessment of Effect of Irrigation Development on Paddy Production Increase

- (1) New Irrigation Development/Extension
  - Surface water  
Besides paddy area expansion, cropping intensity and yield increases are expected.
  - Groundwater  
Being supplemental water supply for its main purpose, area expansion will not be expected. As for paddy production, yield increase and cropping intensity are expected in wet season only.
- (2) Rehabilitation/Special Maintenance  
Recovery from not-irrigated condition to irrigated condition is expected in a part of the design area. Cropping intensity and yield increase will likely be a result.
- (3) Village Irrigation  
Same as rehabilitation/special maintenance except yield increase is not much due to simple water control system.

Present Status of Existing Surface Irrigation Scheme

LEGEND

Non-Irrigated Area



Irrigated Paddy Field Area

SUMATERA

- 11 D.I.Aceh
- 12 Sumatera Utara
- 13 Sumatera Barat
- 14 Riau
- 15 Jambi
- 16 Sumatera Selatan
- 17 Bengkulu
- 18 Lampung

JAWA

- 31 D.K.I.Jakarta
- 32 Jawa Barat
- 33 Jawa Tengah
- 34 D.I.Yogyakarta
- 35 Jawa Timur

BALI & NUSA TENGGARA

- 51 Bali
- 52 Nusa Tenggara Barat
- 53 Nusa Tenggara Timur
- 54 Timor Timur

KALIMANTAN

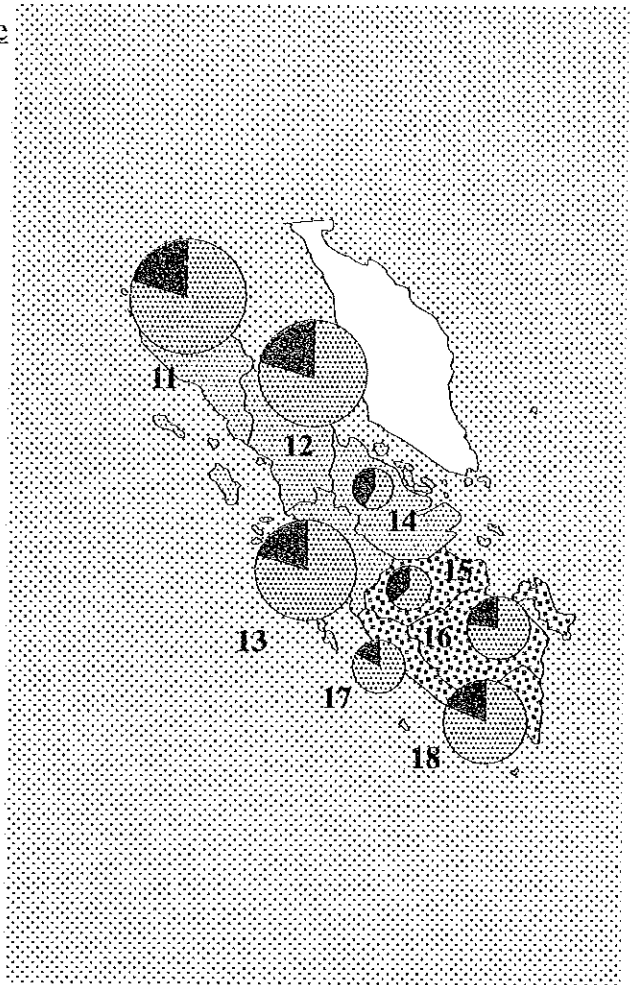
- 61 Kalimantan Barat
- 62 Kalimantan Tengah
- 63 Kalimantan Selatan
- 64 Kalimantan Timur

SULAWESI

- 71 Sulawesi Utara
- 72 Sulawesi Tengah
- 73 Sulawesi Selatan
- 74 Sulawesi Tenggara

MALUKU & IRIAN JAYA

- 81 Maluku
- 82 Irian Jaya



Non-irrigated Area in Existing Scheme

LEGEND

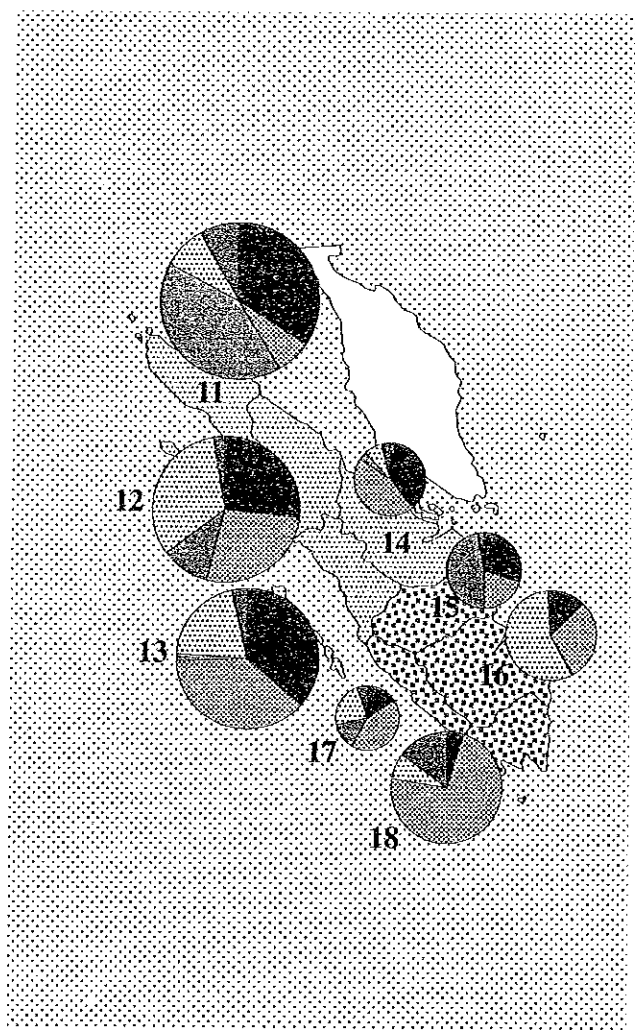
No longer available for paddy field

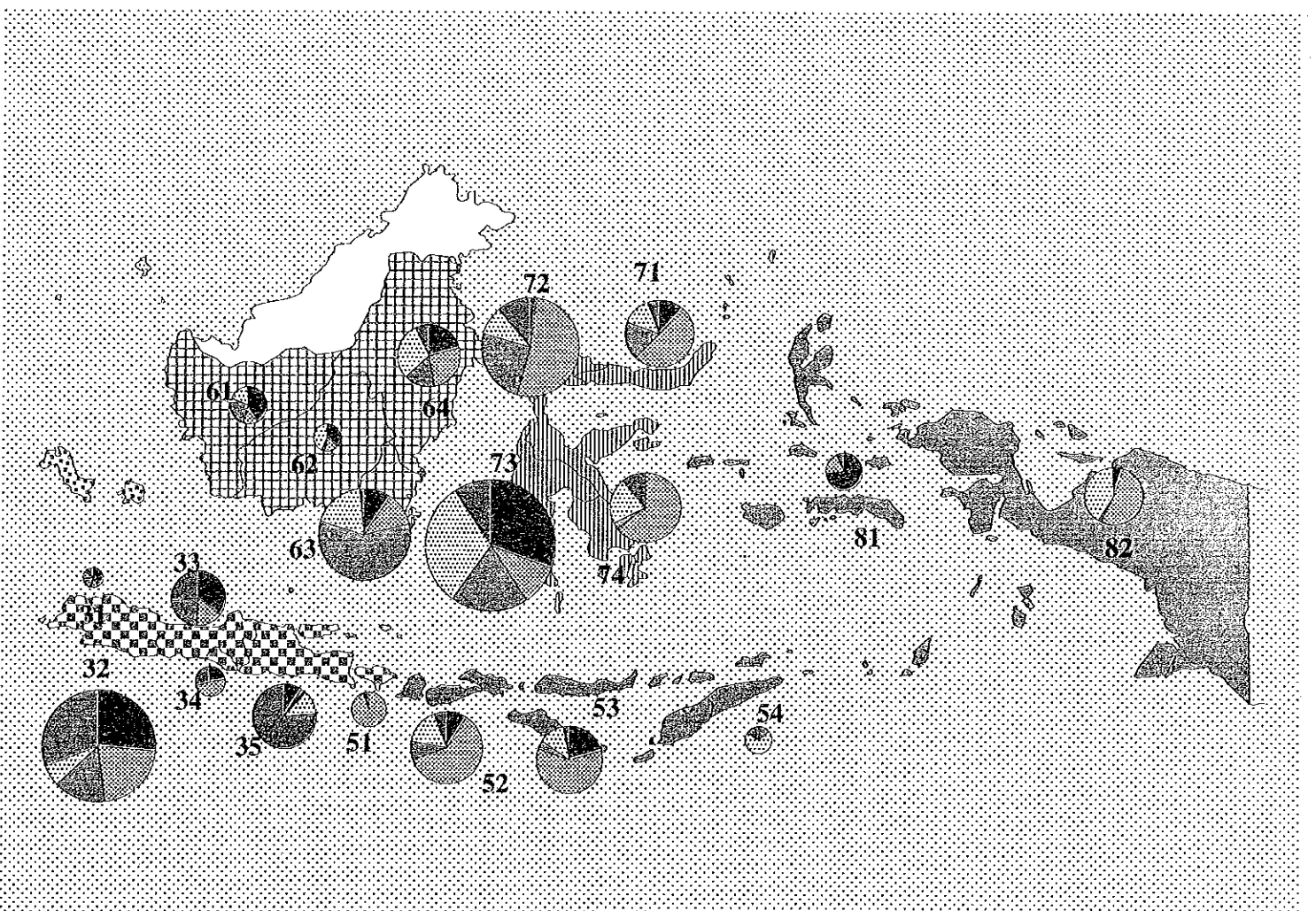
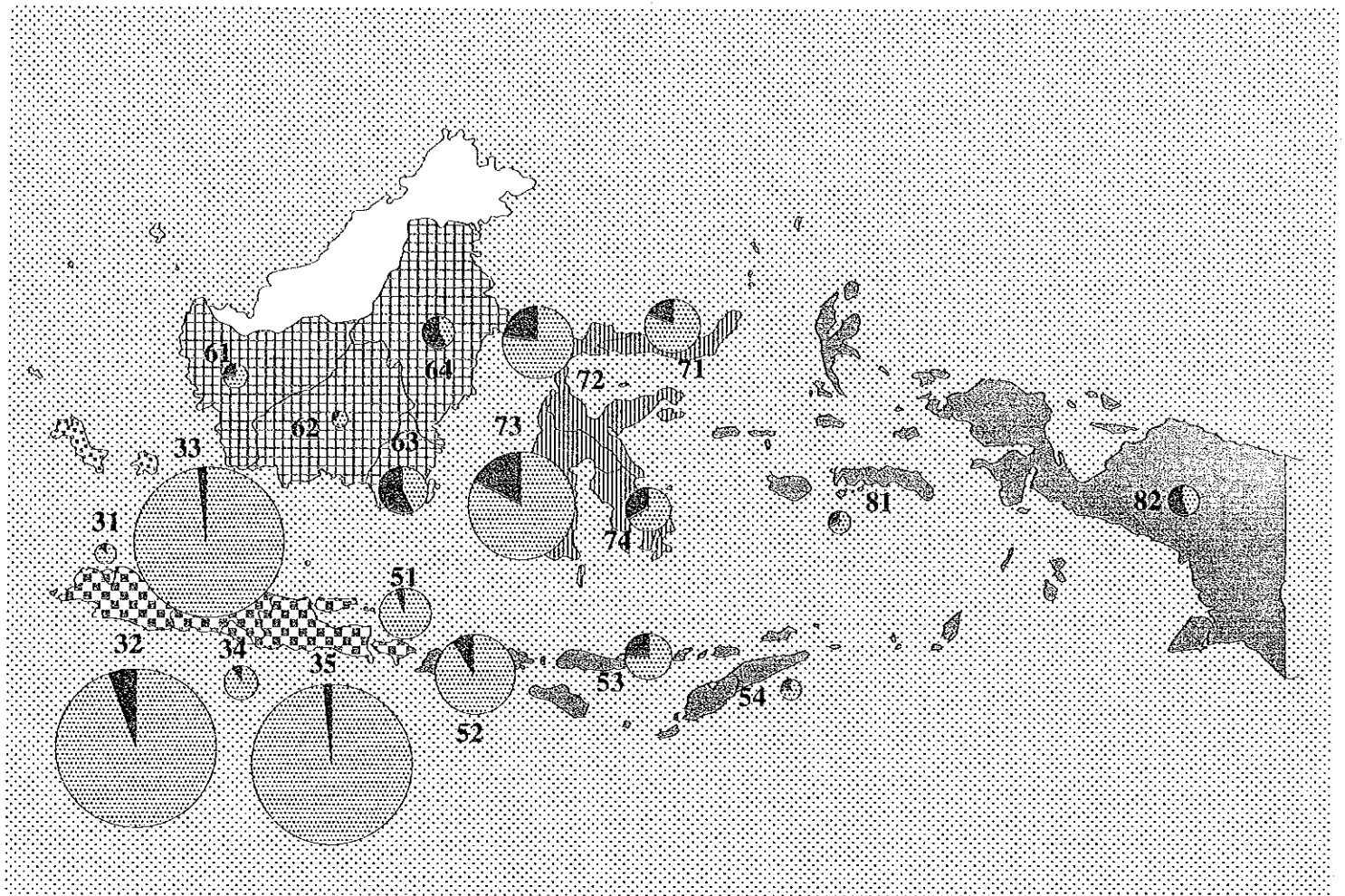
Non-irrigated Paddy Field

Both canal construction and land development are required

Canal is completed, but Land Development is required

Land development is completed, but canal construction is required





## 10. Justification of Irrigation Development in PJPT II

In order to assess the necessity of new irrigation development, paddy production increase under without new irrigation development condition is projected, taking all the factors affecting paddy production into consideration, to compare with projected paddy demand.

### Factors Affecting Paddy Production

- (1) Factors affecting Cropped (Harvested) area
  - (a) Farmers' incentive to cultivate paddy (Government price policy)
  - (b) Land conversion as negative factor (from paddy to other purposes)

Projected future land conversion (annual average)

Unit: ha

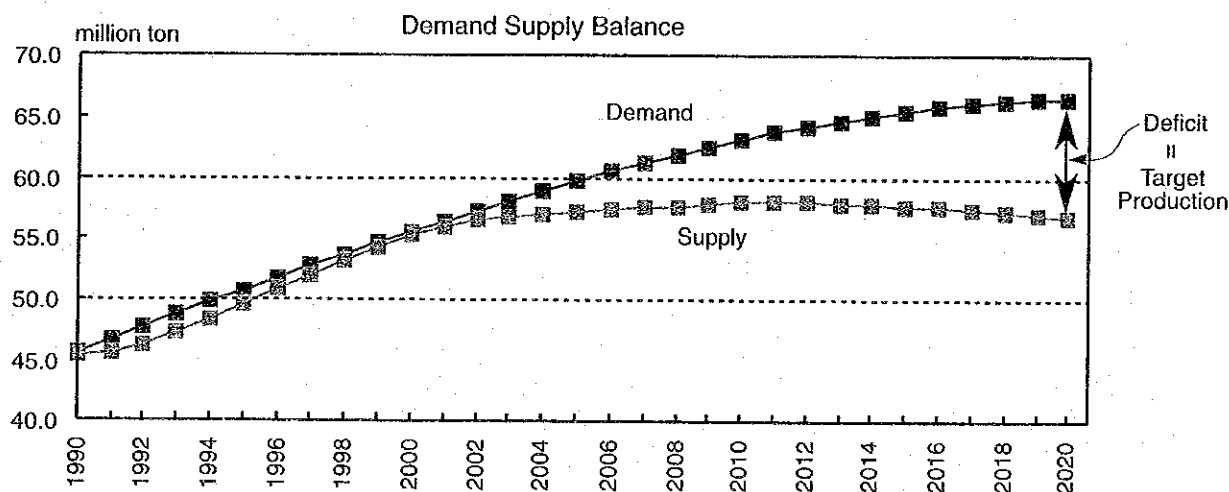
Year	Jawa		Bali		Sumatera		Sulawesi		Total	
	Irrig.	Non-irrig.	Irrig.	Non-irrig.	Irrig.	Non-irrig.	Irrig.	Non-irrig.	Irrig.	Non-irrig.
1991-1995	20,000	2,600	1,000	0	1,000	1,000	500	500	22,500	4,100
1996-2000	22,000	2,560	1,000	0	1,500	1,500	500	500	25,000	4,560
2001-2010	22,000	4,200	1,000	0	2,000	2,000	1,000	1,000	26,000	7,200
2011-2020	25,000	5,200	1,000	0	3,000	3,000	2,000	1,000	31,000	9,200
Total Accum.	680,000	119,800	30,000	0	62,500	62,500	35,000	20,000	807,500	207,300

Source: JICA-FIDP Team estimates.

- (c) Irrigation development and land development
- (d) Sugarcane and tobacco cultivation area in Jawa

### (2) Increase Productivity

- (a) Improve farming practice
- (b) Irrigation development



The above result shows that paddy production will not meet the increase demand of paddy under without new irrigation development condition. It is concluded therefore that irrigation development is still necessary in the next national development stages.



## 11. Irrigation Development Objectives and Strategies

### Irrigation Development Objectives

- Objective (a): To expand irrigation area to increase crop production, especially paddy, through surface water/groundwater development so as to meet the increasing demand for food as well as to contribute to further development in economically depressed areas;
- Objective (b): To upgrade/rehabilitate existing irrigation network to increase or not to reduce their productivity; and
- Objective (c): To improve water management system involving beneficiary farmers in order to maximize the water use efficiency.

### Irrigation Development Strategy

#### (1) Rehabilitation strategy

This strategy will propose the more economically efficient development. This includes upgrading and improvement as well as rehabilitation of existing facilities. Under this strategy land and water use efficiency of existing irrigation networks will be maximized. Rehabilitation works are expected to increase production with lower cost relative to new irrigation development. With the introduction of high management system, more intensive farming will be pursued. Farmers' involvement in water management will more be promoted under this strategy.

Since these works need lower costs and shorter time to realize the same benefit relative to new development, quick yield is expected. Also since rehabilitation works are for existing networks, large increase of the number of beneficiaries will not be expected, and impact on social aspects will be smaller than new irrigation development.

#### (2) New construction strategy

Another distinct strategy may be to expand irrigation area in new areas. Selection of new irrigation area will depend primarily on the availability of land and water resources to agriculture as well as human resources. Under this strategy more dispersed paddy field area will be formed. Impact on production increase is generally large. Farmers' income will increase with use of high input and improved farming practice.

Development areas will be spread over the Indonesia, especially outer Jawa. It may be the most effective option from the equitable development' point of view. However, the public sector resource costs will become increasingly high to facilitate other infrastructure and utilities to meet the settlers/transmigrants' needs.

#### (3) Integrated planning strategy

Existing irrigation schemes covers some 3.5 million ha in whole Indonesia. While these existing systems should be maintained properly to keep their productivity as planned, new development should also be pursued towards equity and sustenance of self-sufficiency in rice. More balanced production area will be built.

## 12. Irrigation Development Frameworks

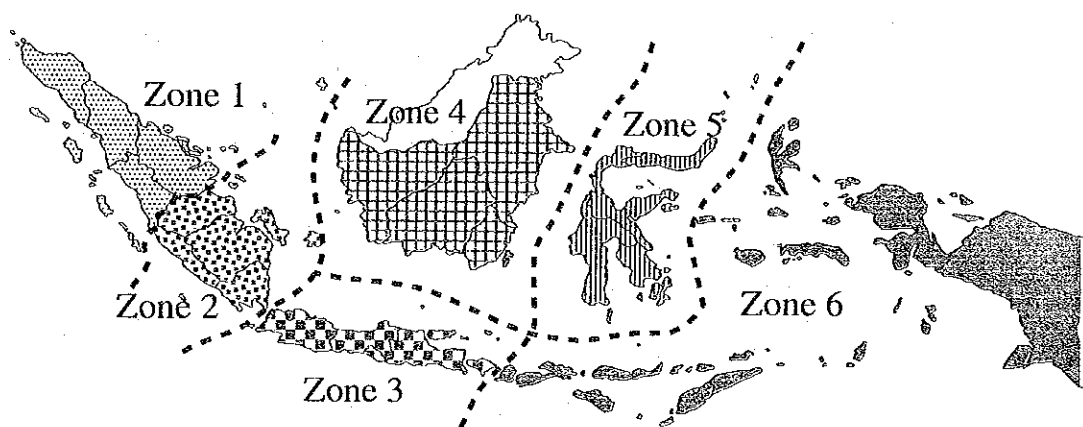
**G**iven that the policy of self-sufficiency in rice in Indonesia will be unchanged during the period of PJP II, target production amount of paddy is set at 66.2 million tons, which are equivalent to the paddy demand as of 2018 projected in this study. Production at 1990, setting as the base year, was 45.2 million ton. Paddy production, therefore, have to be increased by **21 million ton in 30 years.**

### 13 Macro Zoning of Irrigation Development

Considering the existing irrigated paddy area, future paddy demand, irrigation development potential and supply balance, economic situation and human resources, strategic regions for each development type are determined.

The whole Indonesia is divided into six strategic zones:

- Northern Sumatera zone (Zone 1) : D.I.Aceh, Sumatera Utara, Sumatera Barat and Riau,
- Southern Sumatera zone (Zone 2) : Jambi, Sumatera Selatan, Bengkulu and Lampung,
- Jawa & Bali zone (Zone 3) : all provinces in Jawa island and Bali,
- Kalimantan zone (Zone 4) : all provinces in Kalimantan,
- Sulawesi zone (Zone 5) : all provinces in Sulawesi, and
- Eastern zone (Zone 6) : the rest of provinces in eastern part of Indonesia.



Zone	Productivity	Future deficit	Dev.potential	Human res.	Infrastruct.	Evaluation
Zone 1	high	surplus	big	moderate	moderate	Full development
Zone 2	moderate	deficit	big	moderate	moderate	Full development
Zone 3	very high	deficit	none	high	high	Rehabilitation
Zone 4	low	deficit	big	scarce	scarce	Limited development
Zone 5	high	surplus	small	moderate	moderate	Limited development Rehabilitation
Zone 6	low	deficit	big	scarce	scarce	Limited development

#### Characteristics of Each Zone

Strategy for irrigation development in each region is briefly explained as below:

#### Northern Sumatera zone

Rehabilitation/upgrading of existing facilities to maintain and/or increase productivity as well as new irrigation development should be promoted. Also there remains uncompleted canals or land development in the existing irrigation networks. Earlier completion of those area is recommended.

#### Southern Sumatera zone

For its locational advantage for exporting rice to surrounding deficit region including Jawa (not at present but in future) and Kalimantan regions, large scale irrigation development should be sought in the region. Also small to medium scale irrigation development should be promoted to increase agricultural productivity.

#### Jawa and Bali zone

In this region, rehabilitation/upgrading and proper O&M should be put priority to maintain present high productivity and pursue high water use efficiency.

#### Kalimantan zone

Small to medium scale irrigation development as well as upgrading and/or rehabilitation of existing system including swamp should be promoted in order to increase self-sufficiency rate.

#### Sulawesi zone

Remaining irrigation development potential should be fully realized to keep its position as rice supply base for eastern island while maintaining existing facilities through rehabilitation as well as proper O&M.

#### Eastern zone

Only small to middle scale irrigation development should be promoted to increase self-sufficiency rate and activate economy within the provinces.

## 14. Formulation of Irrigation Development Program

### Type of Development

The following three types of development will be applied for future planning to the irrigation sector, considering the characteristics of each region in terms of economy, resources, rice supply and demand balance, etc.

- (1) Large scale (5,000 ha and over) irrigation development to contribute to the sustenance of self-sufficiency
- (2) Small (less than 500 ha) and middle scale (500 - 5,000 ha) irrigation development to contribute to the economic development
- (3) Rehabilitation/upgrade of existing irrigation network to contribute to the assurance of high water use efficiency as well as maintenance of crop productivity

### Priority of Development Type

Currently Indonesia keeps self-sufficiency in rice. Following the much surplus of paddy produced last year, climatic condition this year also favorable for paddy growth so far.

Considering such circumstances, small scale development and rehabilitation/special maintenance works should be put priority in earlier stage of the development period. New irrigation development in eastern islands may be reasonable as it will contribute to equitable development and alleviation of poverty, both of which will be national development objectives. In other part of the country, also small to middle scale development should be promoted to stabilize and increase harvest which will contribute to increase farm income.

From the view point of alleviation of poverty, rehabilitation/special maintenance of the existing irrigation networks in swamp area should be promoted, because of its low productivity. However, new swamp development for paddy field is not recommended from the economic view point. In such areas, drainage development for estate crops and development of fish-pond should be preceded, which are conducive to economic development.

On the other hand, large scale development should be prepared in earlier stage also in view of future large deficit to be occurred centering Jawa. As it usually takes long period to construct, identification and preliminary design of projects should be made earlier for quick implementation.

### Order of Formulating a Program

Aside from on-going projects, other projects are prioritized by type in a following manner:

- |   |                |                   |
|---|----------------|-------------------|
| (1) Land development projects                   | : 300,000 ha   | Repelita VI       |
| (2) Rehabilitation/special maintenance projects | : all proposed | Repelita VI       |
| (3) Extension projects                          | : all proposed | Repelita VI       |
| (4) Village irrigation projects                 | : 600,000 ha   | Repelita VI & VII |

Given the above condition, supply and demand balance of paddy is projected.

	1000tons					
	1995	2000	2005	2010	2015	2020
Zone 1	-278	227	26	-256	-357	-347
Zone 2	-1,160	-1,158	-1,588	-2,173	-2,584	-2,834
Zone 3	1,071	1,106	-192	-1,931	-3,214	-4,796
Zone 4	-631	-890	-1,194	-1,492	-1,649	-1,699
Zone 5	760	1,246	1,375	1,294	1,227	1,209
Zone 6	-858	-786	-923	-1,108	-1,188	-1,201
Indonesia	-1,097	-255	-2,497	-5,665	-7,766	-9,668

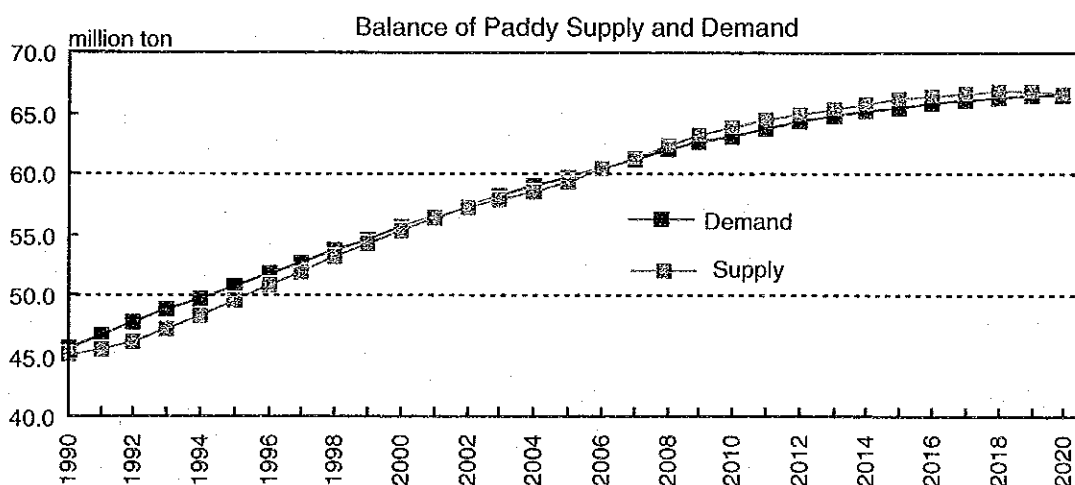
Expected deficit should be compensated by the implementation of new irrigation development to keep the 100 % of self-sufficiency as much as possible.

### Target Area of New Development to Each Region

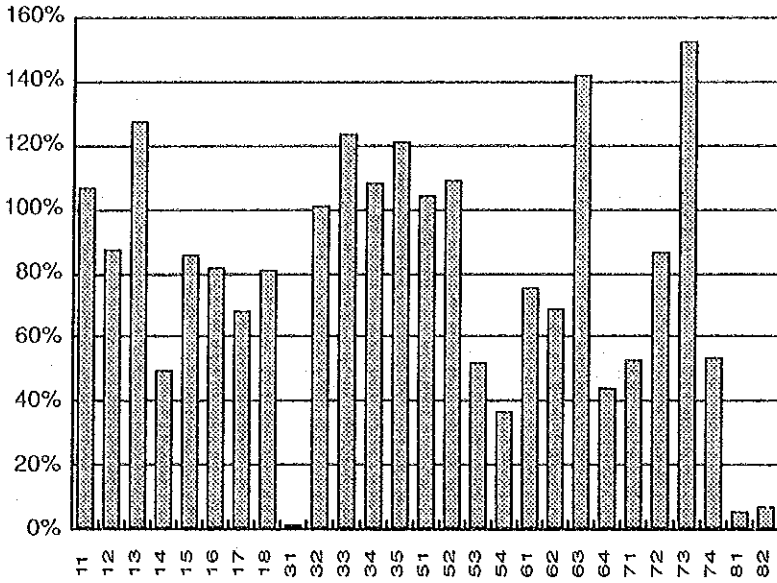
Self-sufficiency rate and development rate are set for determination of target area, considering past irrigation development progress, present infrastructure condition, present self-sufficiency rate, land and water resources, human resources, socio-cultural condition of the local people, etc. For getting optimal answer, a mathematical solution method so-called linear programming is adopted. The results are shown below:

Zone	Repelita VI	Repelita VII	Repelita VIII	Repelita IX	Repelita X	Total
Zone 1	204.1	245.1	113.2	19.0	5.0	586.4
Zone 2	104.8	112.2	186.4	189.5	33.3	626.2
Zone 3	344.3	134.5	24.0	14.0	16.0	532.8
Zone 4	16.1	48.4	73.0	58.0	20.1	215.5
Zone 5	136.4	164.4	77.6	27.5	8.6	414.4
Zone 6	70.8	80.2	30.0	19.0	4.0	204.1
Indonesia	876.5	784.7	504.2	326.9	87.0	2,579.4

Under the formulated program, paddy production in future almost catch up with the demand increase as shown below:



Self-sufficiency Rate in each Province in 1990



**SUMATERA**

- 11 D.I. Aceh
- 12 Sumatera Utara
- 13 Sumatera Barat
- 14 Riau
- 15 Jambi
- 16 Sumatera Selatan
- 17 Bengkulu
- 18 Lampung

**JAWA**

- 31 D.K.I. Jakarta
- 32 Jawa Barat
- 33 Jawa Tengah
- 34 D.I. Yogyakarta
- 35 Jawa Timur

**BALI & NUSA TENGGARA**

- 51 Bali
- 52 Nusa Tenggara Barat
- 53 Nusa Tenggara Timur
- 54 Timor Timur

**KALIMANTAN**

- 61 Kalimantan Barat
- 62 Kalimantan Tengah
- 63 Kalimantan Selatan
- 64 Kalimantan Timur

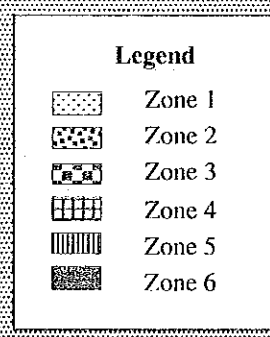
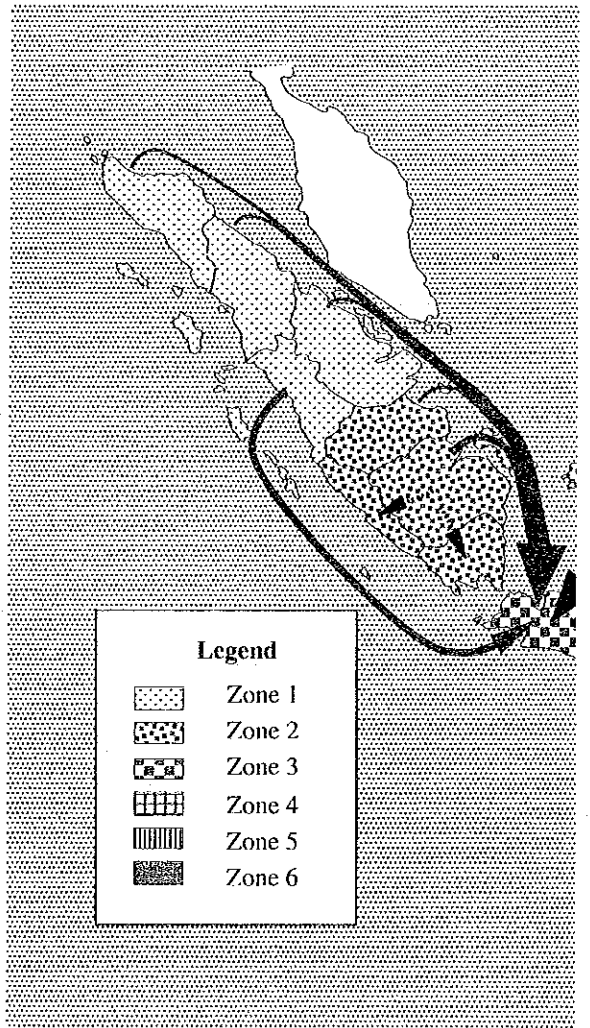
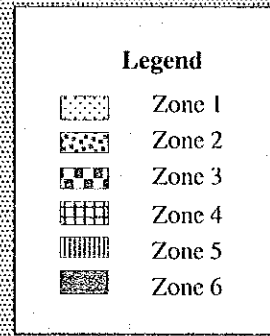
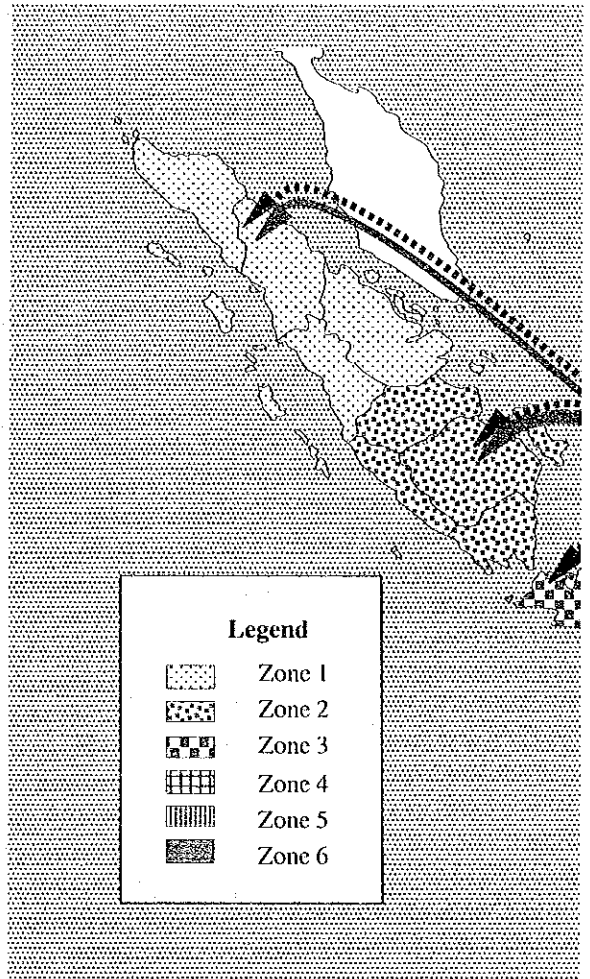
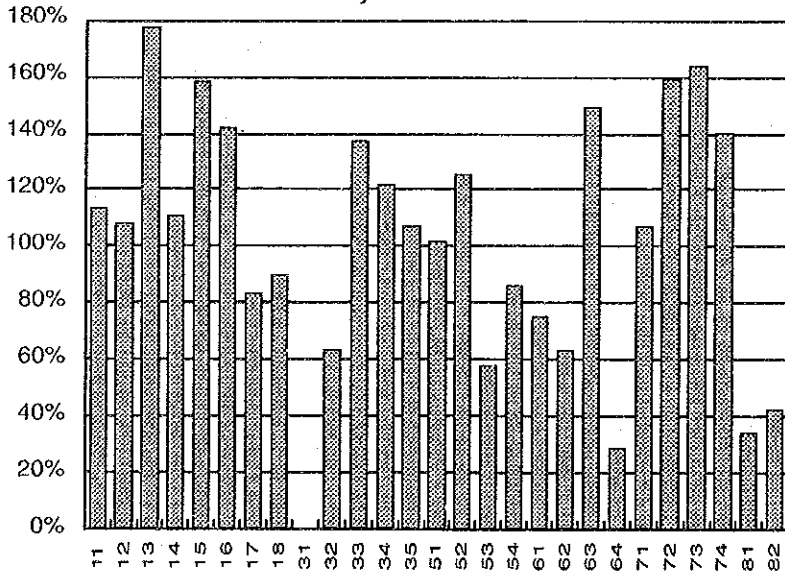
**SULAWESI**

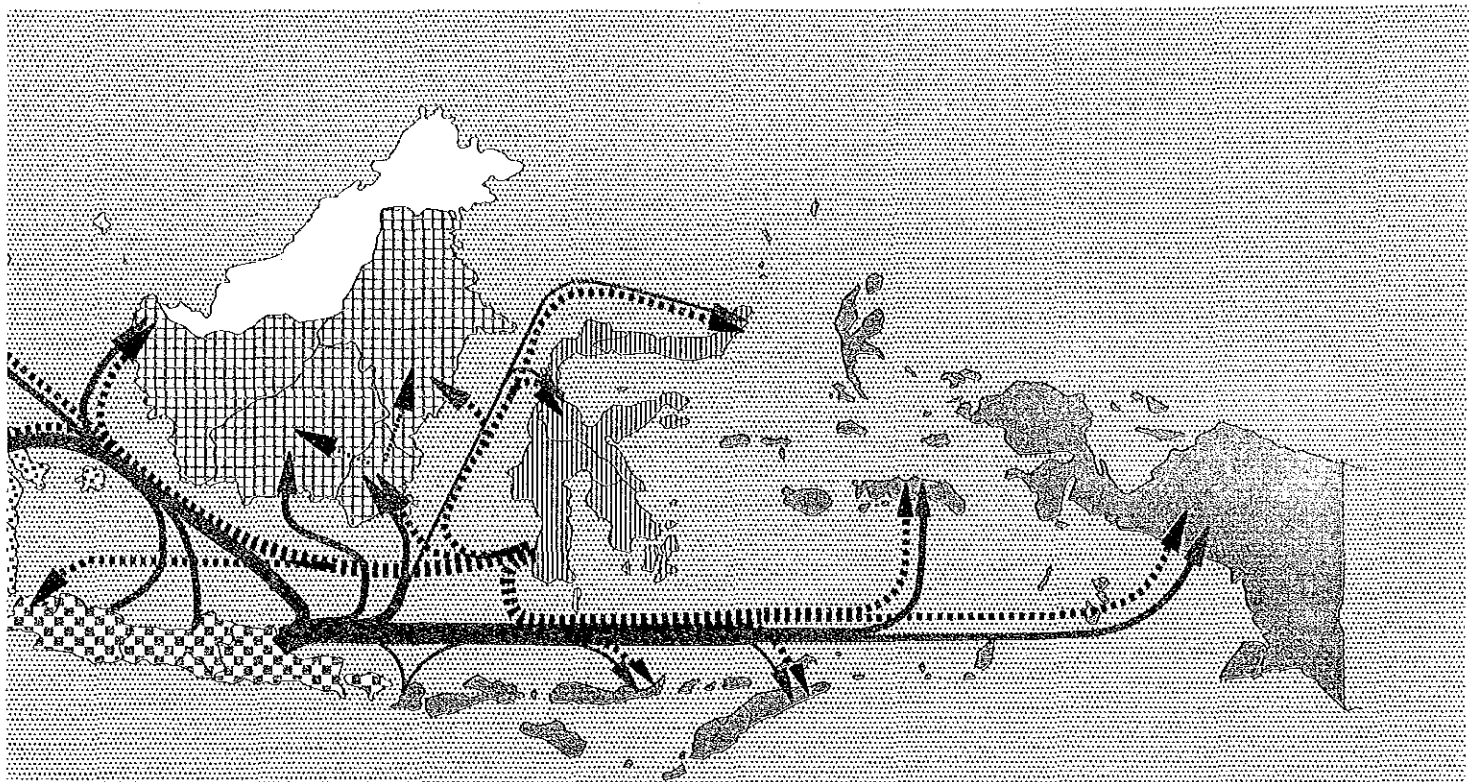
- 71 Sulawesi Utara
- 72 Sulawesi Tengah
- 73 Sulawesi Selatan
- 74 Sulawesi Tenggara

**MALUKU & IRIAN JAYA**

- 81 Maluku
- 82 Irian Jaya

Self-sufficiency Rate in each Province in 2020





Source: Prepared by JICA-FIDP team based on *Angkutan Beras antar DOLOG Tahun 1991*, CBS

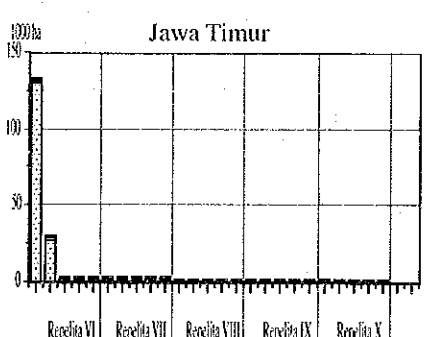
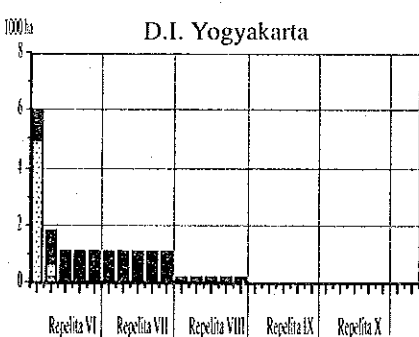
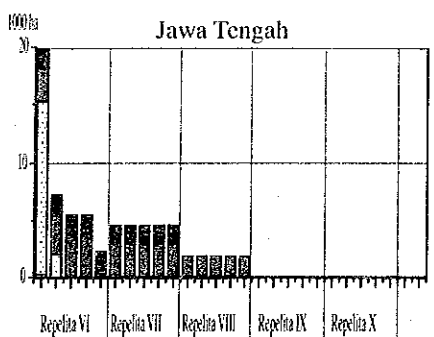
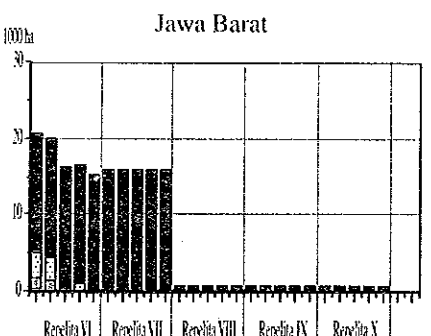
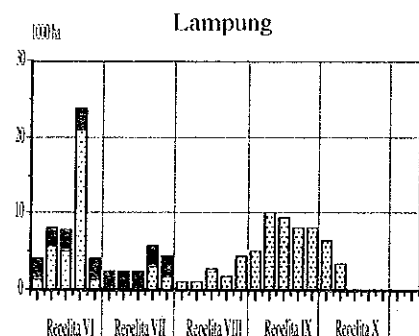
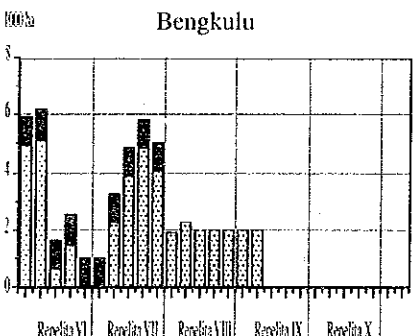
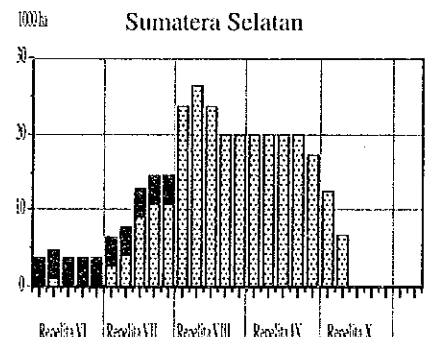
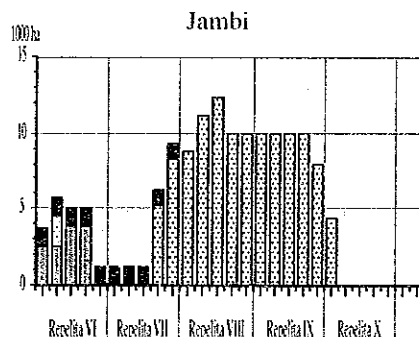
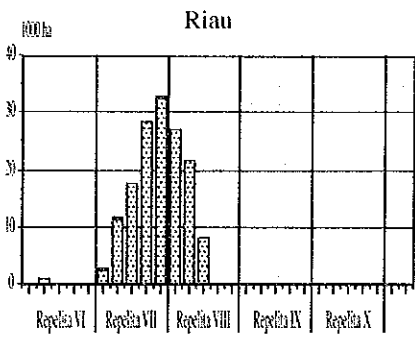
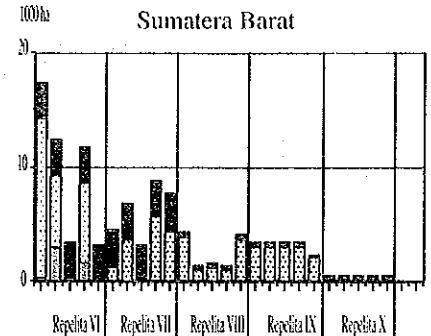
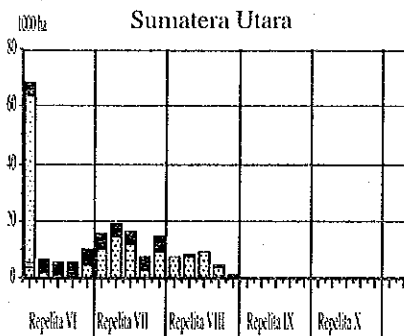
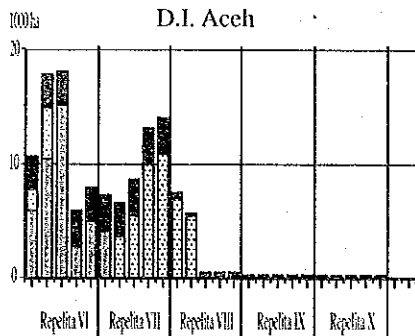
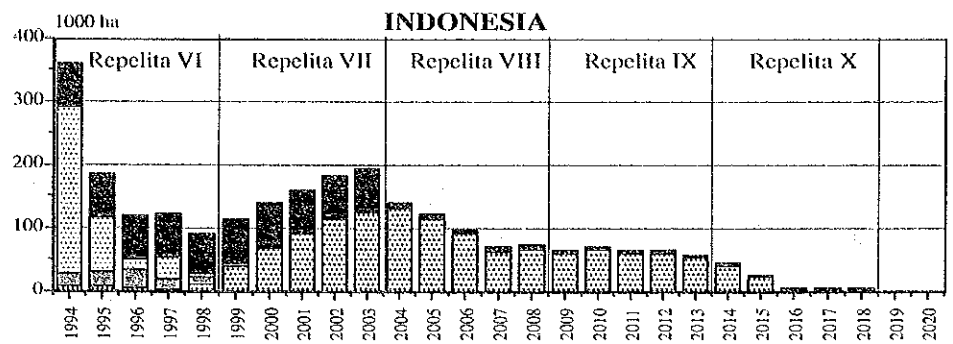
Flow of Marketed Paddy by DOLOG as of 1991



Source: Team's estimate

Estimated Flow of Marketed Paddy in the Year of 2020

# Annual Target Irrigation Development Area







## Target development area of each category

Development Target by Category

Category						1000 ha
	Repelita VI	Repelita VII	Repelita VIII	Repelita IX	Repelita X	Total
New Construction	36.4	434.8	465.2	299.9	60.0	1,296.3
Extension	94.0	11.0	0.0	0.0	0.0	105.0
Rehabilitation	406.9	0.0	0.0	0.0	0.0	406.9
GW	43.2	43.0	39.0	27.0	27.0	179.2
Small scale	296.0	296.0	0.0	0.0	0.0	592.0
Indonesia	876.5	784.7	504.2	326.9	87.0	2,579.4

## Land development

Land Development Target Area

Zone						1000 ha
	Repelita VI	Repelita VII	Repelita VIII	Repelita IX	Repelita X	Total
Zone 1	89.5	99.6	76.3	9.5	0.0	274.9
Zone 2	59.6	54.2	131.4	130.7	21.6	397.4
Zone 3	28.2	0.0	0.0	0.0	0.0	28.2
Zone 4	15.4	26.8	50.6	40.6	13.4	146.8
Zone 5	83.4	47.9	25.4	15.1	4.2	175.9
Zone 6	50.3	29.8	19.6	11.9	0.0	111.6
Indonesia	326.4	258.2	303.3	207.7	39.2	1,134.8

## Implementation Schedule

Prior to the implementation of new construction works, feasibility study and detailed design work for these area must be carried out. To carry out a feasibility study, financial and administrative arrangement will take 2 or 3 years.

Overall implementation schedule including survey and design is shown below:

	Repelita VI	Repelita VII	Repelita VIII	Repelita IX	Repelita X
Extension	94,000ha	11,000ha			
Rehabilitation	407,000ha				
Groundwater					
Small scale	340,000ha	340,000ha	39,000ha	27,000ha	27,000ha
Land Development	326,000ha	258,000ha	303,000ha	208,000ha	39,000ha
New Construction	Project Identification				
	F/S or D/D		for further Repelita		
	10,000ha	435,000ha	465,000ha	300,000ha	60,000ha

## 14 Cost Estimates

The costs necessary for the irrigation development in PJPT II is estimated based on the previous implementation schedule. Cost estimates here is made basically by multiplying unit costs per hectare basis with development area. Only costs for survey and design are estimated to be certain ratio of new construction cost.

### Unit Cost

Estimated Unit Costs by Development Type at 1992 constant price

Type of Development	Unit Costs(Rp./ha)
New development	7,500,000
Extension	4,200,000
Groundwater development	6,300,000
Rehabilitation	3,000,000
Handing over small schemes	200,000
Regular O&M (surface irrig.)	17,300
Regular O&M (swamp)	11,700
EOM (surface irrig.)	31,300
EOM (swamp)	33,600
Swamp development	2,000,000
Land Development	500,000
Small scale irrigation (Irigasi Desa)	500,000

Note : All costs are tentative.

### Cost Estimates

Estimated cost for irrigation development by type for each Repelita in PJPT II

Description	Unit: Billion Rp.					Total
	Repelita VI	Repelita VII	Repelita VIII	Repelita IX	Repelita X	
New Construction	273	3,261	3,489	2,250	450	9,722
Extension	395	46	0	0	0	441
Rehabilitation	1,221	p.m.	p.m.	p.m.	p.m.	1,221
Groundwater Development	272	271	246	170	170	1,129
O&M Surface Irrigation*	501	584	642	650	674	3,050
Swamp Development	1,040	p.m.	p.m.	p.m.	p.m.	1,040
O&M Swamp**	105	151	178	178	178	789
Handing over Small Schemes	50	76	76	30	0	232
Land Development	163	129	152	104	20	567
Village Irrigation	149	149	p.m.	p.m.	p.m.	298
Survey, Design,etc.	353	349	225	45	p.m.	972
Total	4,521	5,016	5,007	3,427	1,491	19,461

Remarks: p.m.: pre memoria; \*: includes current O&M and EOM; \*\*: includes current O&M, EOM

Necessary total costs for irrigation development in PJPT II are preliminary estimated at Rp.19.5 trillion

## 16. Management of Irrigation Development Program

Formulated Irrigation Development Program should be maintained properly and revised periodically, according to the change in parameters due to the change of external circumstances. Several agencies/institutions may be necessary to be coordinated to maintain the program, since the program covers wide range of fields including socio-economic indicators, agricultural production data, regional development plan, etc.

For management of the program, integrated body which consists of related agencies is proposed. There will be a coordinating body, and other agencies responsible for a part of the program management. Each agency will form task force team for this purpose, and institutions/universities or consultants may be asked to join the team. Task force team in each agency will formulate a joint committee, and will meet periodically at the joint committee meeting where progress of works, information and issues/problems will be discussed.

The proposed organization for the maintenance of the irrigation development program will consist of the following five agencies:

- (1) BULOG;
- (2) BAPPENAS;
- (3) Central Bureau of Statistics (CBS);
- (4) Ministry of Agriculture (MOA); and
- (5) Ministry of Public Works (MPW)

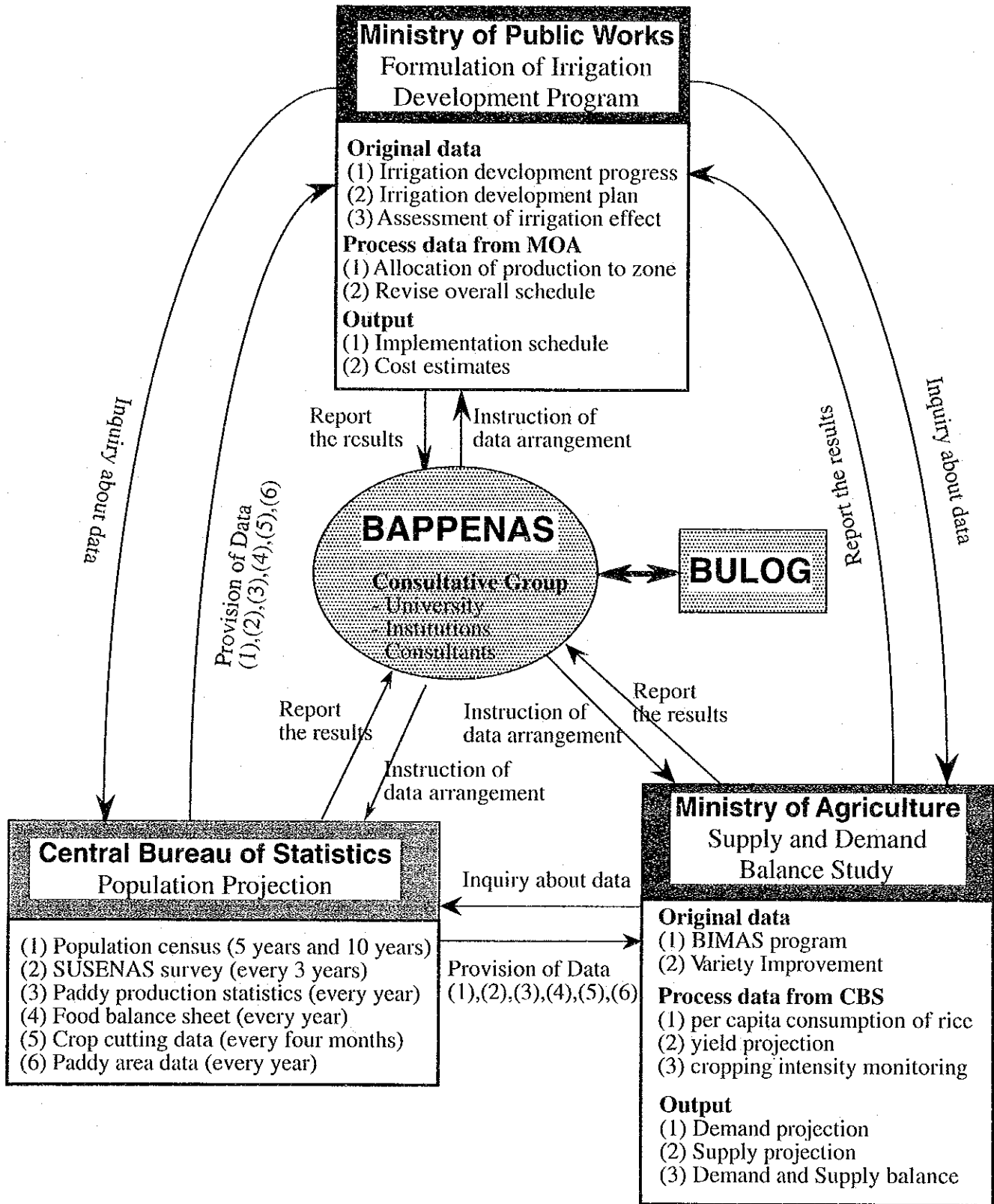
BULOG and BAPPENAS will jointly act as a chairman. While BULOG is responsible for all food policy matters including rice policy, BAPPENAS will coordinate all inter-agency matters including meeting, exchange of data and information, etc. BAPPENAS will approve and confirm any agreed matter between and/or among agencies.

CBS will be responsible for population projection as well as supply of data to be processed. Any data necessary for program formulation, such as area, production, yield, socio-economy, etc. will be provided to related agencies.

MOA will be responsible for estimating per capita consumption of rice based on SUSENAS, demand projection, change in paddy field area including land conversion and irrigation development and yield change. Based on the results of analysis, paddy supply and demand projection will be revised.

MPW will be responsible for the irrigation development program itself, and also acts as a secretariat to arrange meeting and communicate with related agencies. While consulting BULOG and BAPPENAS on development direction and macro framework, required development area which will be equivalent to the required increased production to meet the demand increase projected by MOA, will largely be determined considering the irrigation effect on paddy production increase.

Proposed Maintenance System of Irrigation Development Program



## 17 RECOMMENDATIONS

### (1) Revision of Inventory of Existing Irrigation Schemes (Rekapitulasi Inventarisasi Daerah Irigasi Pemerintah)

Directorate Irrigation I prepares the summary of inventory of existing government-managed irrigation scheme (Rekapitulasi Inventarisasi Daerah Irigasi Pemerintah) annually. It compiles mainly the dimension of the existing schemes; design area, irrigated area, canal length, number of structure, planted area, etc. However, such data as construction costs, construction year, present condition of the structures (necessity of rehabilitation), name of person responsible for O&M works, O&M costs, are not available. Net irrigated area can not be grasped from the data since the present condition of existing facilities are not described, which may cause the contradiction on irrigated area with CBS data. It is expected that the importance of O&M of existing facilities is emphasized more and more in the future, and that justification of the necessity of rehabilitation works is required as a basis for budgeting. It is recommended, on the basis of the above consideration, that the contents of present inventory be revised adding information to fill the above requirement.

### (2) Collection of Data on Project Stage of Proposed Projects

It is unfortunate that data on project stage of proposed projects which is one of the important criteria for priority ranking were not be able to be collected in the study period. The number of proposed projects differs much among provinces, and some province has already excessive number of proposed projects from the viewpoints of spatially equitable development. For the effective planning of irrigation development, project status (identification stage, feasibility study stage and detailed design) should be examined as soon as possible, with other data necessary for priority ranking.

### (3) Enforcement of Connection between DGWRD and Provincial Offices

It is recommended that DGWRD would communicate with provincial office in the following manner with regards to the exchange of data and information:

- (a) Regarding the data to be collected from provincial offices periodically, DGWRD shall list up all data, prepare the specification of each data (preferably with sample output by computer), and inform deadline and destination of data with each provincial office. This work shall be done in Directorate of Planning (Bina Program Pengairan; BPP) in consultation with related Directorates.
- (b) Each provincial office shall prepare the required data and put it into computer. The preparation of data shall be made in one section, which is also responsible for the data management. The revision of data shall be

made at a certain period of a year only, and no other correction or revision shall be made.

- (c) Data prepared by each provincial office shall be transmitted to related Directorates via BPP, DGWRD by using computer network. Communication method using computer network to be introduced shall be similar to that already introduced by PIADP project.

Through the establishment of the above system, unification of data will be maintained, and contradiction of figures by different data sources will be prevented.

#### (4) Crop Production Increase as a Standard for Irrigation Development Planning

Ultimate objective of irrigation development is to increase crop production. Irrigation development, therefore, will be evaluated by the attainment of crop production increase after the development rather than by the achievement of works scheduled. Being self-sufficient, necessary amount of paddy production to be increased is regulated by the demand increase. It is therefore recommended that future irrigation development scale be determined considering irrigation development effect on crop production increase, given the self-sufficiency in rice be maintained. In this sense, decision makers should be careful in crop production trend more than before, discussing not only with other staffs in DGWRD but also with MOA officials.

#### (5) Study on Development of Eastern Region

In line with the government policy on poverty alleviation and equitable development, irrigation development may be more directed to eastern region. However, deliberate planning will be necessary for determining development target taking into consideration of socio-cultural background (staple food, cultivated crops, level of farming practice, etc.) of local people, degree of social infrastructure development, land and water resources. Disordered development will not benefit the local people but even bring about the adverse effect on environment. For example, in order to be self-sufficient in Irian Jaya in 2018, 80 thousand ha of irrigation development will be required, given cropping intensity of 1.5 and yield of 4.5 ton/ha. In view of present irrigation are of 5,000 ha, and not much popularity on paddy cultivation in the island, realization of full development (80 thousand ha) may take longer time.

#### (6) Irrigation Development in Sumatera

In Sumatera, which is expected to be a rice supply center in place of Jawa in future, proposed irrigation development projects are mainly located in northern area although big land and water potential is identified also in southern area. It is recommended from the well-balanced development policy that irrigation development plan be formulated for the southern Sumatera area as soon as possible to prepare implementation.







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