JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

MINISTRY OF WATER RESOURCES, GOVERNMENT OF INDIA
PUBLIC WORKS DEPARTMENT, GOVERNMENT OF TAMIL NADU

THE STUDY
ON
THE REHABILITATION OF MINOR IRRIGATION TANKS
FOR RURAL DEVELOPMENT
IN
TAMIL NADU

FINAL REPORT

VOLUME II
MASTER PLAN

JANUARY 1998

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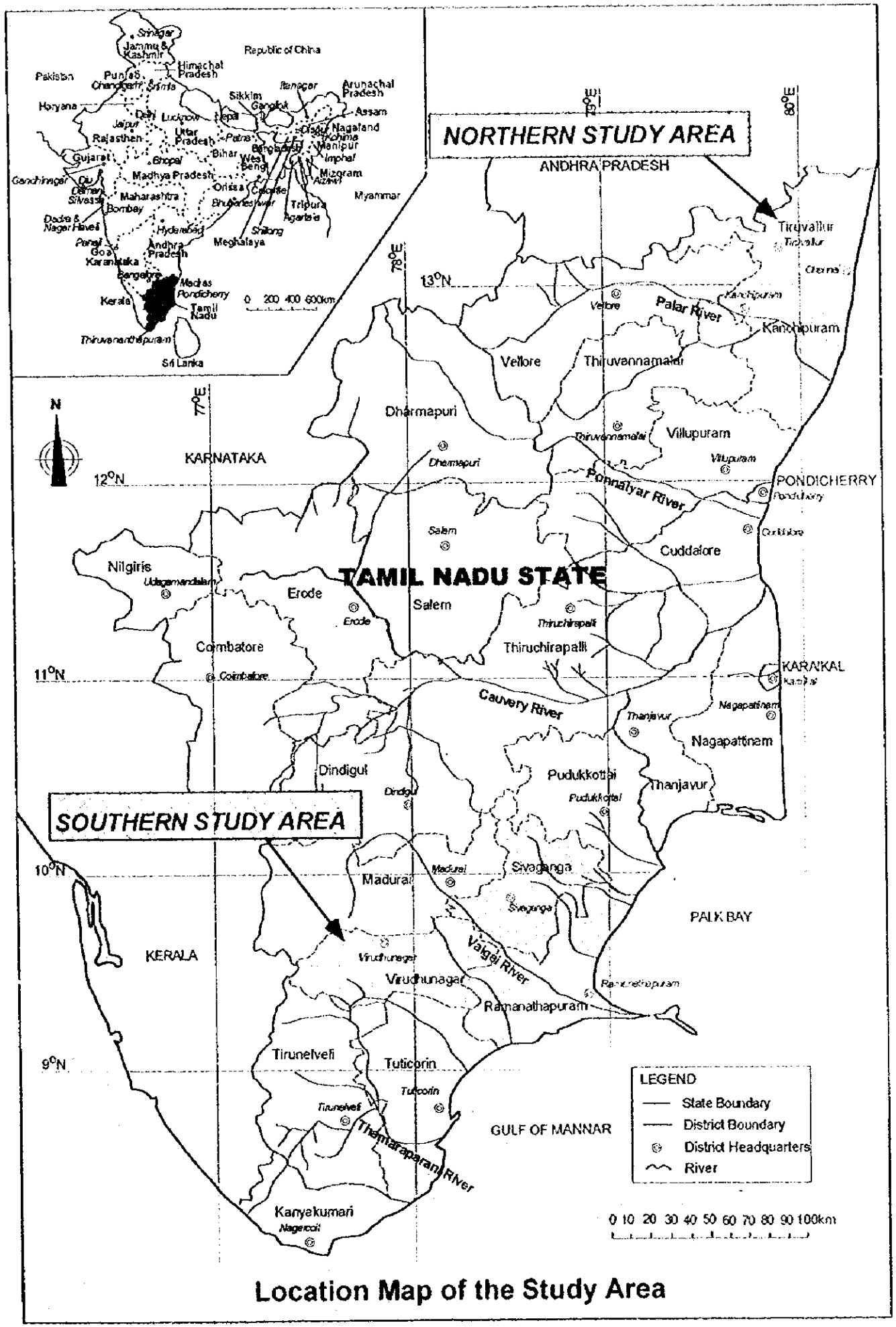

Location Map of the Study Area

THE STUDY ON THE REHABILITATION OF MINOR IRRIGATION TANKS FOR RURAL DEVELOPMENT IN TAMIL NADU

FINAL REPORT
VOLUME II : MASTER PLAN REPORT

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ABBREVIATIONS

AD	Agricultural Department of Tamil Nadu State
AED	Agricultural Engineering Department of Tamil Nadu State
ATC	Agricultural Training Centre
BC	Backward Caste
CSSM	Child Survival and Safe Motherhood
CHC	Community Health Centre
CO	Community Organizer under EC Tank Modernization Project
DEA	Department of Economic Affairs of MOF, GOI
DRCS	Design, Research and Construction Support, WRO, PWD
EC	European Community (presently EU : European Union)
EC	Electric Conductivity (1.0 μS/cm=1.0 mmhos/cm=0.001 dS/m)
EFD	Environment and Forest Department of Tamil Nadu State
EID	Environmental Impact Assessment
FAO	Food and Agriculture Organization of the United Nations
FFDA	Fishery Farmers Development Association
GDP	Gross Domestic Product
GOI	Government of India
GOJ	Government of Japan
GOTN	Government of Tamil Nadu
HD	Horticulture Department, GOTN
IBRD	International Bank for Reconstruction and Development, World Bank
ICDS	Integrated Child Development Services
ICRSAT	International Centre for Research in Semi-arid Tropics
IMTI	Irrigation Management Training Institute of PWD, Tiruchy
IMR	Infant Mortality Rate
IHH	Institute of Hydraulics and Hydrology of PWD, Poondi
IWS	Institute of Water Studies of PWD, Taramani
JICA	Japan International Cooperation Agency
MBC	Most Backward Caste
MEF	Ministry of Environment and Forestry
MIDS	Madras Institute of Development Studies
MOA	Ministry of Agriculture
MOF	Ministry of Finance
MRD	Ministry of Rural Development
MWR	Ministry of Water Resources
NABARD	National Bank for Agriculture and Rural Development
NEP	New Economic Policy
NGO	Non Government Organization
NNP	Net National Product
O&M	Operation and Maintenance
OECF	Overseas Economic Cooperation Fund of Japan
PCB	Pollution Control Board
PHC	Primary Health Centre
PRA	Participatory Rural Appraisal
PRADAN	Professional Assistance for Development Action (NGO)
PWD	Public Works Department of Tamil Nadu State
RDD	Rural Development Department of Tamil Nadu State
RRA	Rapid Rural Appraisal
Rs.	Indian Rupees
SC/ST	Scheduled Caste/Scheduled Tribes
SDP	State Domestic Product
TNAU	Tamil Nadu Agricultural University
UNDP	United Nations Development Program
UNICEF	United Nations Children's Fund
VAO	Village Administration Officer
WRO	Water Resources Organization in PWD
WUA	Water Users' Association

CHAPTER I : INTRODUCTION

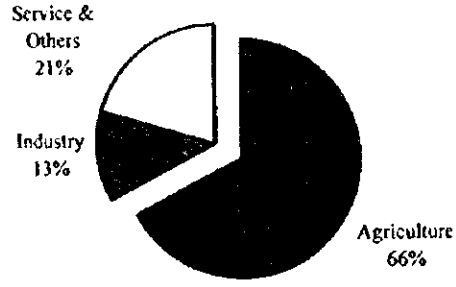
CHAPTER 1 INTRODUCTION

1.1 Background of the Study

(1) New Economic Reform Policy and Economic Growth in India

In June 1991, the Government of India implemented the new economic reform policy for stabilised and sustained economic growth and opened up the Indian economy by devaluation of exchange rate, liberalisation of trade barriers and introduction of foreign capital investment. As a result of these new measures, foreign capital investment and foreign currency reserves have increased to more than anticipated level and the Indian economy has been revitalized. In that process, the GDP growth rate has increased from 0.5% in 1991/92 to 6.2 % in 1995.

The sector-wise structural division shows that agriculture and industry sectors share 29 % each while service sector account for 42% of GDP in 1994. Even though service sector contributes more for GDP, agriculture still plays an important role in Indian economy since it employs more than 60% of the labor force.



Share of Labour Force by Sector (1991)

(2) Agriculture and Tank Irrigation System in Tamil Nadu

Tamil Nadu State is located in the Southeastern part of India. Agriculture is dominant in the State. The State covers an area of 130,210 km^2 with a population of 56 millions, accounting for 4 % and 7 % of all India respectively. There are 29 districts in the State and State capital is Chennai with a population of 3.9 millions (1991 Population Census). In spite of, recent rapid industrialization in the State, agriculture sector still plays an important role in the State economy, occupying 30% of income generation and 60% of labor absorption in the State.

Cultivated area occupies about 45% of the State land, with 5.73 million ha in 1991. The area under rice, which is the main crop is about 36% of the total cultivated area, has a tendency to increase, while area under other grain crops and beans shows a decreasing trend. Oil seed crops, such as groundnut, fiber crops and sugarcane are also widely cultivated.

In the State, the annual available water resources per capita is estimated at 600 m^3, which is quite small compared to 4,000 m^3 of the national average. Hence it becomes necessary to utilize limited water source efficiently in the State. Since total surface water sources in the State is estimated about 3.4×10^{10} m^3 and the developed surface water is 3.33×10^{10} m^3, it is difficult to develop new water resources for irrigation. Then, it is urgently needed to establish efficient water use methodologies based on the rehabilitation of existing irrigation facilities and the improvement of irrigation systems. At present, the rivers, tanks and groundwater are the major water

resources for irrigation. Recently, the command area of tanks is decreasing but groundwater irrigated area is increasing.

In 1990-91, there are about 39,200 tanks in the State with a command area about 530,000 ha. Existing tank irrigation facilities are deteriorated as a result of reduction in the storage capacity by sedimentation from catchment area, reduction of free board of bund caused by slope erosion, leakage of water through cracks in intakes(sluices) and spillway (surplus weir) and canal lining and so on, which are required to be rehabilitated. On the other hand, there are many problems with respect to its water management system, cultivation system, application of pesticide and so on in the command area. They need to be improved for sustainable agricultural development.

(3) Background of the Request for the Study

As stated above, the deterioration of irrigation tanks in the State is severe and development of new water resources has limited potential in the State. Therefore, the Government of Tamil Nadu has started the rehabilitation of irrigation tanks and completed the modernization of about 500 tanks under the assistance of EC (presently EU) since 1980's. There are more than 39,000 tanks in the State, no standard rehabilitation programme is formulated up to now then agriculture remains as the most important economic sector in the State, employing many poor. Therefore the perspective development of agriculture for the improvement of farmers' living standard is the most urgent requirement of the State.

Under the above mentioned circumstances, in August 1995, the Government of India made a request to the Government of Japan to extend its technical cooperation for formulating a master plan for the rehabilitation of minor irrigation tanks in the Tamil Nadu State and to conduct feasibility studies in the selected irrigation tank command areas.

In response to the request of the Government of India (GOI), the Government of Japan (GOJ) has decided to conduct the Study on the Rehabilitation of Minor Irrigation Tanks for Rural Development in Tamil Nadu (hereinafter referred to as "the Study") in accordance with relevant laws and regulations in force in Japan. Accordingly, Japan International Cooperation Agency (hereinafter referred to as "JICA"), the official agency responsible for the implementation of technical cooperation programs of GOJ, dispatched a preparatory study team to India on 29th July, 1996. The team agreed upon the scope of work of the Study (hereinafter referred to as "S/W") between GOI and the Government of Tamil Nadu (hereinafter referred to as "GOTN") on 9th August, 1996, as attached in Attachment A of this report. Based on the S/W, the JICA organized and dispatched a team to conduct the Study (hereinafter referred to as the Study Team).

1.2 Objectives of the Study

The Objectives of the Study are :

(1) To formulate a master plan on the Rehabilitation of Minor Irrigation Tanks for

Rural Development for the State of Tamil Nadu.

(2) To conduct feasibility studies in the selected areas where tank irrigated agriculture is predominant in the rural society, and

(3) To carry out technology transfer to the Indian counterpart personnel through on the job training in the course of the Study.

1.3 The Study Area

Among the 29 districts in Tamil Nadu State five districts are selected as the Study Area as shown in the Study Location Map. They can be divided into two regions, namely the Northern Study Area, consisting of Kanchipuram and Tiruvallur districts (former Chengalpattu-MGR district), and the Southern Study Area, consisting of Ramanathapuram, Sivaganga (former Pasumpon Muthuramalinga Thevar) and Virudunagar (former Kamarajar) districts. The total area of these 5 districts is estimated at 20,463 km^2, belonging to different agro-climatic zones. About 35% of PWD rainfed tanks and 43% of PWD rainfed tank command area in Tamil Nadu State are concentrated in the Study Area. The Study focuses on the PWD rainfed tanks which are estimated about 2,400 tanks in the Study Area.

1.4 Scope of the Study

This Study was out in accordance with the Scope of Work (S/W) and the Minutes of Meeting (M/M) agreed on August 9, 1996. Work items of the Study are shown in Table 1.4.1. Total working schedule of the Study is shown in Fig. 1.4.1.

Following reports have been submitted and discussed to/with Indian counterparts. This final report is submitted based on the results of the Draft Final Report.

	Report	No. of Copy	Timing	Contents
Preparatory	Inception Report	30 Copies	at the commencement of Phase 1 Field Survey (December 1996)	• background and objectives of the Study • contents and methodology of the Study • implementation plan of the Study
Master Plan	Progress Report (1)	30 copies	at the end of Phase 1 Field Survey (February 1997)	• results of Phase 1 Field Survey • concepts of master plan • results of technology transfer during the Survey
	Interim Report	30 copies	at the end of Phase 1 Home Office Study (May 1997)	• Master Plan Study of irrigation tank rehabilitation in TN • Selection of pilot scheme for feasibility Study
Feasibility Study	Progress Report (2)	30 copies	at the end of Phase 2 Field Survey (July 1997)	• results of Phase 2 Field Survey • concepts of master plan • results of technology transfer during the Survey
	Draft Final Report	30 copies	at the end of Phase 2 Home Office Study before explanation in India (September 1997)	• master plan report • feasibility study report on pilot scheme areas • manual for irrigation tank rehabilitation project
Final Report		50 copies	within one (1) month after receiving comments on D/F report	• after reviewing the received comments on D/F report, the report was finalized

Table 1.4.1 Work Items of the Study

Year and Phase				No.	Study Item
First Year (1996/97)	Preparatory Works in Japan			[1]	Study and Confirmation of the Project Requested
				[2]	Collection and Analysis of Relevant Data and Information
				[3]	Preparation of the Study Concept and Study Schedule
				[4]	Study of Work Items
				[5]	Preparation of notes for Social Environmental Study
				[6]	Preparation of Methods for Technical Transfer
				[7]	Preparation of Inception Report
	Phase 1	Field Works	Formation of Tank Rehabilitation Plan	[8]	Explanation and Discussion on Inception Report
				[9]	Preparation and Discussion of Technical Transfer Program
				[10]	Collection and Review of Relevant Data and Information
				[11]	Investigation for Classification of Minor Irrigation Tanks
				[12]	Field Investigations
				[13]	Social Environment Survey
				[14]	Analysis of Developmental Potential and Constraints for Rehabilitation Plan of Minor Irrigation Tanks
				[15]	Study on Concept for Rehabilitation Plan of Minor Irrigation Tanks
				[16]	Preliminary Formulation of Master Plan for Rehabilitation of Minor Irrigation Tanks
				[17]	Selection of Pilot Area for Rehabilitation Plan for Minor Irrigation Tanks
				[18]	Preparation and Discussion of Progress Report (1)
		Works in Japan	Formulation of Tank Rehabilitation Plan Master Plan	[19]	Report of Phase 1 Field Investigation Results
				[20]	Analysis of Phase 1 Field Investigation Results
				[21]	Formulation of Master Plan for Rehabilitation of Minor Irrigation Tanks
				[22]	Determination of Pilot Area for Rehabilitation Plan
				[23]	Preparation of Interim Report
Second Year (1997/98)	Phase 2	Field Works	Plan Formulation of Pilot Schemes	[24]	Explanation and Discussion on Interim Report
				[25]	Field Investigation of Pilot Area for Rehabilitation Plan
				[26]	Economic Investigation for Farmers
				[27]	Topographic Survey
				[28]	Preliminary Formulation of Rehabilitation plan of Minor Irrigation Tanks
				[29]	Preliminary Formulation of Guidelines for Rehabilitation Plan of Minor Irrigation Tanks
				[30]	Preparation and Discussion of Progress Report (2)
		Works in Japan	Feasibility Study on Pilot Areas	[31]	Report of Phase 2 Field Investigation Results
				[32]	Analysis of Phase 2 Field Investigation Results
				[33]	Formulation of Rehabilitation Plan of Minor Irrigation Tanks in Pilot Areas
				[34]	Formulation of Guidelines for Rehabilitation Plan of Minor Irrigation Tanks
				[35]	Overall Evaluation and Recommendations for Rehabilitation Plan of Minor Irrigation Tanks
				[36]	Preparation of Draft Final Report
		Explanation /Discussion		[37]	Explanation and Discussion on Draft Final Report
		Preparation of Final Report		[38]	Preparation of Final Report

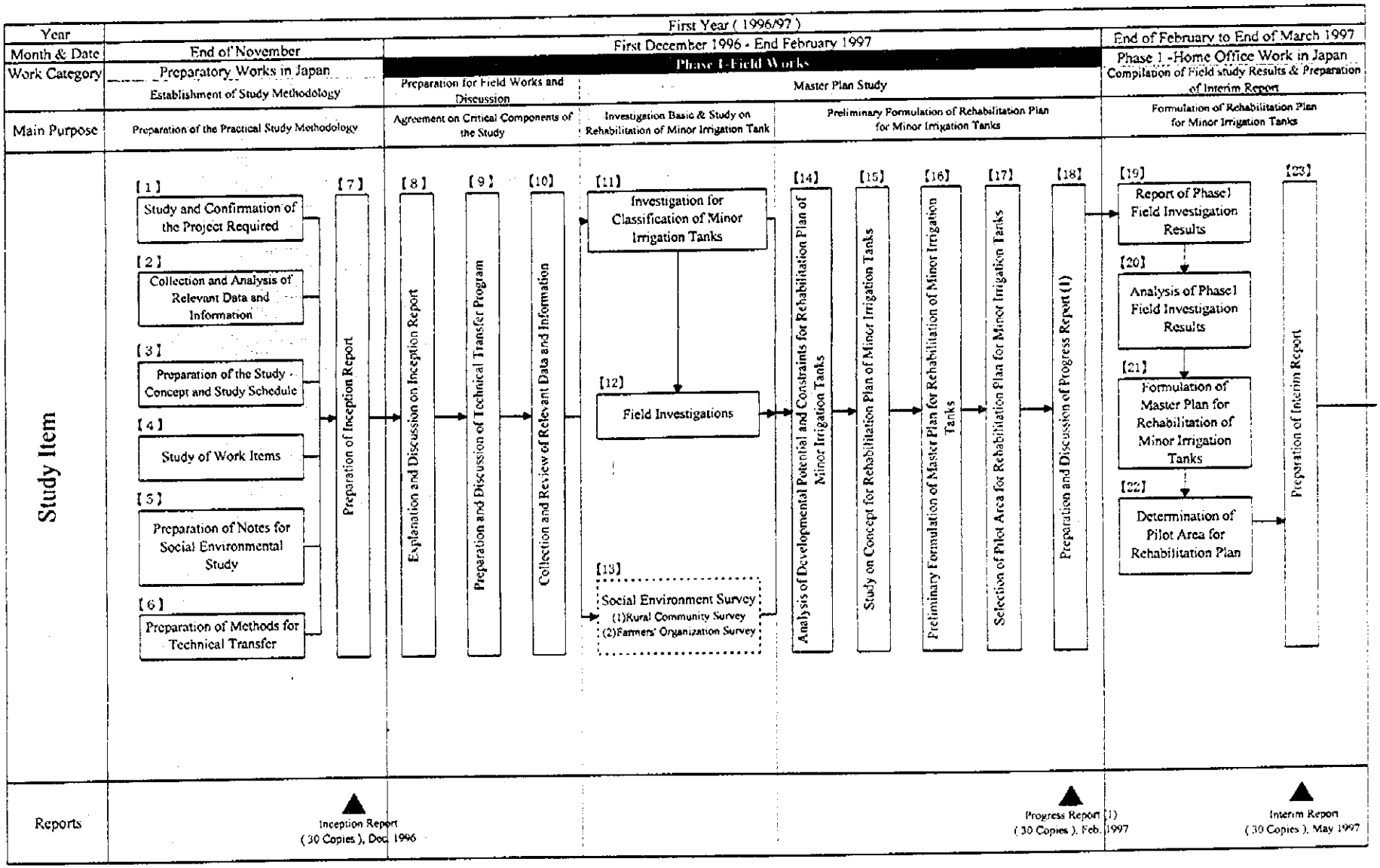


Fig. 1.4.1 Work Flow Chart Over The Study Period (1/2)

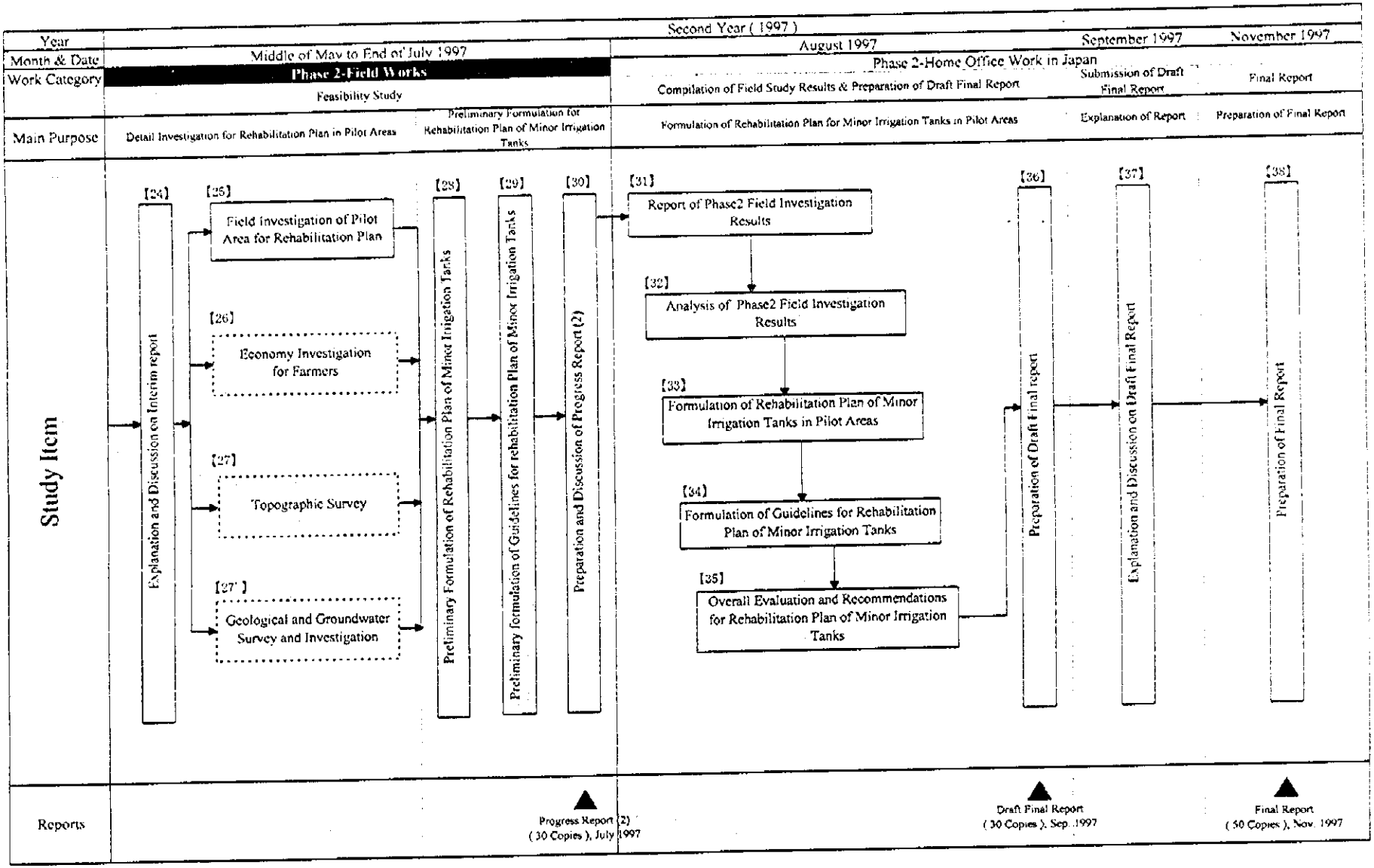


Fig. 1.4.1 Work Flow Chart Over The Study Period (2/2)

CHAPTER 2 : BACKGROUND

CHAPTER 2 BACKGROUND

2.1 The Nation

2.1.1 General

(1) Land

India covers a total area of 3,287,590 km^2 with its land area of 2,973,130 km^2 and a population of 883 million inhabitants (population census 1991), presently estimated at more than 900 millions accounting for one-sixth of the world population.

The country is located on a sub-continent formed as a peninsula of reverse triangular shape faced with Bay of Bengal on the east and Indian ocean on the west, meanwhile its northern hilly and Himalayan mountainous regions are bordered with Pakistan, china, Nepal, Bhutan, Bangladesh and Myanmar.

Geo-climatically, the Indian sub-continent is made on the landform of a large plateau (Deccan Plateau) with three mountainous ranges, Himalaya on the north, Eastern Ghats on the northeast and Western Ghats on the southwest forming two narrow coastal plains on both sides and a large plain on the north made by fertile valleys of the Ganga and Bhramaputra rivers. Since this is a large country, it belongs to various climatic zones from tropical in the south to sub-tropical in the middle and moderate on the north, making the climatic differences between regions. Besides, the country is endowed by two monsoons, the southwest monsoon from June to September in all parts of the country and the northeast monsoon from October to December in the southern part faced with Bay of Bengal along with various surface water resources, India's natural conditions are making most lands in all parts of the country suitable for agricultural production.

From its natural conditions, India has approximately 55 % of the national land as arable land, 23 % as forest and woodland, 4 % as meadows and pastures, and 18 % for other purposes, implying major potentials for the agricultural production in order to basically solve the problem of food sufficiency for its growing population.

(2) People

On the cultural aspect, India is placed among the oldest civilization of the world originated from more than 5,000 years with various religions and cultural practices influenced by Hinduism, effecting the present life style of India and a major part of south Asia up to now.

Indian population which is presently estimated at more than 900 millions is made of various ethnic (Indo-Aryan: 72 %, Dravidian: 25 %, Mongoloid and others: 3 %). Combining a variety of ethnical cultures and languages of Hindi, Bengali, Telugu, Marathi, Tamil, Urdu, Gujarati, Malayalam, Kannada, Oriya, Punjabi, Assamese,

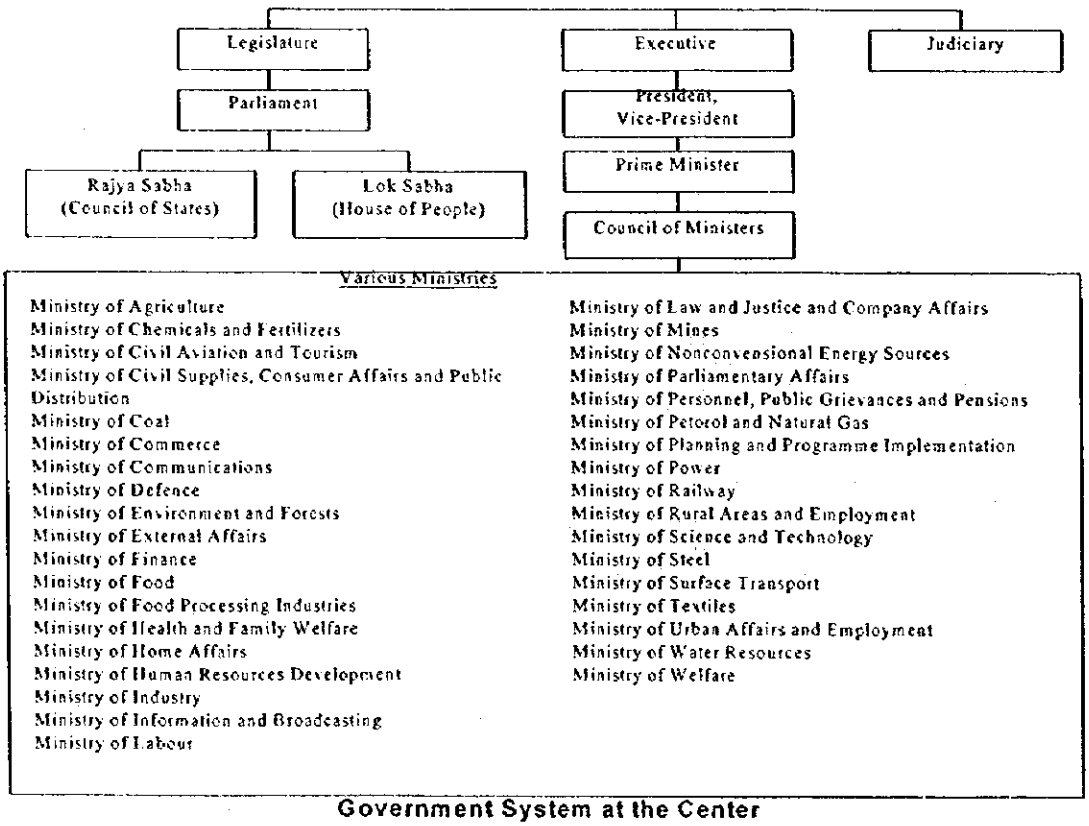
Kashimiri, Sindhi and Sanskrit the Indian culture is a mixture of various ethnical cultures and civilizations along with the caste-system society.

Out of its population of approximately 900 million inhabitants, India has a labor force of 284.4 millions, about one-third of its population, which more than 65 % are considered being deployed in the agriculture sector .The unemployment rate was high, 20 % in 1990. Its present literacy is approximately 50 % and life expectancy at birth is 62 years in average, 61 for male and 63 for female. The present population growth rate is about 2 %.

(3) Administration

India has been formed as a federal republic nation after gaining independence from the British colony in 1947 after a crucial struggle for independence under the leadership of Mahatma Gandhi, for empowering a legislative system of social democracy for proceeding towards the present social order. Administratively, India is divided into 25 states.

Like a federation, India has a dual system of government, with division of powers between the center and the states. The central government consists of the ministries and departments under the Government of India (allocation of business) Rules, 1961, and ministries in 1995 is shown in the figure below:



Government System at the Center

2.1.2 National Socio-economy

(1) Five Year Plans

Since its independence from Britain in 1947, the republic of India has continuously committed to the socio-economic development as its national top priorities by implementing successive national development plans for mobilizing the national resources for its socio-economic stabilization and national development with the First Plan (1951-56), the Second Plan (1956-61), the Third Plan (1961-66), the Annual Plans (1966-69), the Fourth Plan (1969-74), the Fifth Plan (1974-78), the Sixth Plan (1980-85),the Seventh Plan (1985-90) Eighth Plan (1992-97) and the recent Ninth Plan (1997-2002).

Despite of a recent growth of 4.5 % per annum in the last period of the Eighth Plan (target growth of 5.5-6.0 % per annum), the performance of national economy in India has been considered not always in a good trend in comparison with the neighboring ASEAN countries where an average annual growth of 8 % has been constantly carried out in their national economy.

However, for this task of socio-economic development, the effort can be recognized through a constant increase of corresponding expenditures in Indian national plans presented in budget percentages as shown in the following table.

(unit :billion Rs.)

	First ('51-55)	Second ('56-61)	Third ('61-66)	Fourth ('69-74)	Fifth ('74-79)	Sixth ('80-85)	Seventh ('85-90)
Agriculture	14.8	11.7	12.7	14.7	12.3	13.5	12.7
Irrigation	22.2	9.2	7.8	8.6	9.8	9.9	9.4
Electricity	7.6	9.7	14.6	18.6	18.8	28.0	30.5
Rural industries	2.0	4.0	2.8	1.5	1.5	1.8	1.5
Mining	0.8	20.0	20.1	18.2	22.8	13.8	10.9
Transport & communication	26.5	22.0	24.6	19.5	17.4	15.9	16.4
Others	24.0	23.4	17.4	19.0	17.4	16.0	18.4
Total	100%	100%	100%	100%	100%	100%	100%
Expenditure	19.6	46.8	85.8	158.8	394.3	1,108.2	1,800.0

Source; Indian economy , V.N.Vara Subramaniyam, 1990

The net national products resulted from these national plan are shown as follows:

	1970-71 5th Plan	1980-81 6th Plan	1984-85 6th Plan	1992-93 8th Plan
NNP (billion Rs.)	365	1,106	1,850	3,435
NNP per capita (Rs.)	675	1,630	2,504	5,234
Variation		241.5%	154%	20%

Source: Indian economy 4th edition, Sultan Chand & Sons 1996

Through these national plans, except for the First Plan with a GDP growth of about 18%, other successive plans could not obtain its corresponding target growth but limited at a stagnant growth rate of mostly 2.5 to 3.5% per annum, resulted in a low

figure of current GDP at about US$ 350 per capita (IBRD, 1995)as other low income countries in the third world.

Therefore, prior to the implementation of the 8th Five Year Plan (1992-97), India launched a new economic policy (NEP) for fundamental economic reforms aiming at two objectives: the macro stabilization of Indian socio-economic conditions and the structural adjustment program (SAP) in every important economic sector in order to achieve a higher economic development to tackle sufficiently the national task of an affluent society at its basis.

The 8th five year plan insists a five-point strategy of (1) infrastructure development, (2) poverty alleviation, (3) employment generation, (4) population control and (5) provision of health and drinking water.

The implementation of this latest plan has showed a steady growth of 4.2% in 1992-93, 4.6% in 1993-94, 5.34% in 1994-95 and 5.42% in 1995-1996, though not achieving the planned target level of 5.5 - 6.0% per annum but considered as considerably improved figures at the moment for Indian economy after a long period of economic stagnation due to various over protection and over centralization procedures on implementations for the national economic development.

In sectoral shares, a proportional balance with a steady growth in each sector has been observed but the scrutiny in implementation of each sub-sector and at each terminal level should be reinforced for more effective results.

From this background, the 9th National Plan (1998 - 2003) being drafted is reportedly aimed at a higher annual growth target in the range of 7.0 - 8.0% with proposed dynamic measures for basic structural re-adjustments in every national and state level aspect, especially in the financial aspect.

(2) Economic Development

Recent basic economic indicators of India are shown as follows:

Item	
GDP (1995-96) at current prices (provisional)	Rs.9,822 billion
GDP per capita (1995-96, provisional)	Rs.10,676
Share of agriculture and allied sector	29.5 %
Share of industrial sector	29.0 %
Share of services sector	41.5 %
Annual GDP growth rate	6 %
Foodgrain production	185 million ton
Foodgrain per capita	0.2 ton
Exports 1995-96 : tea, coffee, fish, chemicals, textiles, engineering goods etc.	Rs. 1,064 billion
Imports 1994-96: Petroleum, capital goods, chemicals, iron, edible oils	Rs. 1,216 billion
Electricity Generation	414 billion KWH

Sources: Statistical Outline of India 1996-97, Tata Service Limited

(3) Social Development

Since the 70s the Government of India took a number of steps to improve the health status of the population, especially for women. Primary Health Centers (PHCs) and sub-Centers were expanded throughout the country. By 1993 there were 21,000 PHCs, 131,000 sub-centers and 2,000 Community Health Centers (CHCs). During 1975-76 the Integrated Child Development Services (ICDS) was launched. By 1995 this scheme covered 17.81 million children and 3.82 million mothers. Child Survival and Safe Motherhood (CSSM) was launched in 1992-93.

Besides the immunization program was universalized in all the districts of the country. By 1993 - 94 immunization coverage was 92 %, resulted in the sharp fall in Infant Mortality Rate (IMR), for females from 131 (every 1000) in 1978 to 80 in 1992, and for the male from 123 to 79 during the same period.

In 1992 the National Plan of Action for Children was implemented. This plan of action identified quantifiable targets in terms of major as well as supporting sectoral goals representing the needs and aspirations of almost over 300 million children in India in the spheres of health, nutrition, education and related aspects for social supports. In this framework, Water and Sanitation Programs have been carried out up to now.

2.1.3 Agriculture and Irrigation

(1) Agricultural Policy

Since its independence in 1947, India has formulated and implemented the 7 five year plans with specific objectives to attain economic prosperity and social development. Presently, the 8th five year plan is in progress. The 8th five year plan (1992 - 1997) has identified financing, trade, industry and human resource development as the priority sectors. Taking policy initiatives in these sectors and giving clear priority to the sectors/projects for easy implementation, financial resources were generated subsequently for assurance of completion of prioritized plans. Through the process of creating new job opportunities, improvement of health/sanitation conditions and expansion of educational facilities, the social insurance shall be established by creating proper organizations and distribution systems so that the social sector investment benefits reach the beneficiaries surely and equally.

The agricultural development, targets not only on food self sufficiency but also on export of surplus agricultural production. But high priority has been put on the improvement of agricultural productivity to satisfy the food demands of ever increasing population.

Significant increase in agricultural production was accomplished on several crops rapidly through five year plans until the 7th Plan. However, due to regional differences in agricultural infrastructure development, regional gaps in agricultural production

increased, and per capita agricultural production has not increased so much. Therefore, the dissolution of regional gaps and increase in total production is emphasized in the 8th Plan.

In addition to the above, it is emphasized on the improvement and stabilization of agricultural production in semi-arid zone where rainfed cultivation is practiced. In rainfed agriculture zone, it is planed to improve the cultivation system for sustainable land and water resources utilization and to increase the farmers' income through diversification of agricultural production, scientific management of land, land consolidation, maintaining soil moisture. It is promoting the plan of garden plantation and agro-forestry which can extend the job opportunity for unskilled labors in rural areas. On the other hand, it also promotes agricultural diversification for the upliftment of small holding farmers who occupy most majority of farmers in India.

In irrigated agricultural zone, it is promoted to introduce watershed management under the environmental conservation together with extension of improved cultivation techniques and rationalization of water use through farmers' organizations. In addition to giving emphasize on sustainable agricultural development and improvement of farm economy, the effective use of chemical and organic fertilizers and integrated pesticide management (IPM) are introduced to reduce the volume of chemicals and to promote environmental conservation.

(2) Population and Agricultural Workers

The total population in India is estimated at 846.3 millions in 1991 with the annual compound growth rate of 2.14 %, of which 74.3 % lives in rural areas. The agricultural workers in the same year is estimated at 185.3 millions including cultivators and agricultural labors, which corresponds to 64.8 % of the total workers in India. The agricultural workers show a tendency still to increase though the rate to total workers is decreased.

Year	Total Population (Millions)	Rural Population (Millions)	Percent to Total Population (%)	Total Workers (Millions)	Cultivators + Agri. Labors (Millions)	Percent to Total Workers (%)
1951	361.1	298.6	82.7	140.0	97.2	69.4
1961	439.2	360.3	82.0	188.7	131.1	69.5
1971	548.2	439.1	80.1	180.5	125.8	69.7
1981*	685.2	525.5	76.7	244.6	148.0	60.5
1991**	846.3	628.7	74.3	285.9	185.3	64.8

* Figures of total/rural population include the projected population of Assam, where in respect of data on 'workers', Assam has been excluded.

**1991 census was not conducted in Jammu and Kashmir. Total/Rural population India includes the projects figures of J and K. However, the figures of workers exclude J and K.

Source: Registrar General of India.

(3) Gross Domestic Product of Agriculture

The agricultural gross domestic product in India is estimated at Rs. 625,890 million at 1980-81 prices in 1992-93, which share 28.0 % of the total domestic product. The percentage share of agriculture is falling year by year in spite of the increased rate of 47 % for the 12 years from 1980-81 to 1992-93 due to the larger growth of the total gross domestic product (83 %).

Gross Domestic Product

(Unit : Rs. million at 1980-81 Prices)

Year	Total Gross Domestic Product	Agricultural Gross Domestic Product	Percentage Share of Agriculture
1980-81	1,224,270	424,660	34.7
1982-83	1,339,150	445,700	33.3
1984-85	1,504,330	497,020	33.0
1986-87	1,63,2710	489,950	30.0
1988-89	1,884,610	579,400	30.7
1990-91	2,127,600	609,910	28.7
1992-93*	2,234,380	625,890	28.0

*: Provisional

Source: Agricultural Statistics at a Glance

(4) Land Holdings and Land Reform

The average size of operational holdings in India is estimated at 1.57 ha in 1990-91. However, about 60 % of the operational holdings is marginal holdings with average operated area of 0.4 ha, especially in the States of Kerala, Goa, Bihar, Jammu & Kashimir, West Bengal, Utter Pradesh and Tamil Nadu, over 70 % of the holdings are marginal holders.

State-Wise Number of Farm Holdings and Average Size

1990-91(Provisional)

State	No. of Holdings (x 1,000)			Average Size (ha)	
	Marginal	All	% of Marginal	Marginal	All
Nagaland	13	142	9.15	0.64	6.84
Arunachal Pradesh	16	94	17.02	0.61	3.71
Gujarat	924	3,517	26.27	0.53	2.93
Punjab	296	1,117	26.50	0.56	3.61
Rajasthan	1,517	5,107	29.70	0.48	4.11
Maharashtra	3,275	9,470	34.58	0.49	2.21
Meghalaya	59	162	36.42	0.54	1.80
Madhya Pradesh	3,136	8,401	37.33	0.45	2.63
Karnataka	2,262	5,776	39.16	0.47	2.13
Haryana	622	1,530	40.65	0.47	2.43
Mizoram	29	61	47.54	0.64	1.37
Manipur	69	142	48.59	0.55	1.23
Sikkim	26	53	49.06	0.44	2.11
Orissa	2,118	3,948	53.65	0.49	1.34
Andhra Pradesh	5,211	9,290	56.09	0.45	1.56
Assam	1,451	2,419	59.98	0.41	1.31
Himachal Pradesh	538	844	63.74	0.41	1.20
Tripura	217	318	68.24	0.40	0.97
Tamil Nadu	5,848	7,999	73.11	0.36	0.93
Uttar Pradesh	14,819	20,074	73.82	0.38	0.90
West Bengal	4,639	6,284	73.82	0.45	0.90
Jammu & Kashmir	901	1,217	74.03	0.39	0.83
Bihar	8,976	11,711	76.65	0.37	0.93
Goa	58	72	80.56	0.32	0.93
Kerala	5,016	5,419	92.56	0.18	0.33
All India	62,106	105,278	58.99	0.40	1.57

Source: Agricultural Census Division, Min. of Agriculture

Except for specific areas of town communities etc., from these above figures, South India which includes Tamil Nadu, Kerala etc. has been observed as a region with lowest average farm sizes and highest proportions of marginal farmers in all India.

The present situation of land tenure has been considered as consequence of land reforms from the three systems of land tenure in pre-independence India : (1) *Zamindari* system or landlord tenant system (the landlord owns and provides the land, pays the revenues to obtain a predetermined share of the produce; meanwhile, the tenant provides all the management and labour), (2) *Mahalwari* system or communal system of farming (Land ownership by a collective body as village made for a management unit to distribute each portion to individual peasant for collecting revenues. Revenue to the State was paid by the village) and (3) *Ryotwari* system or owner-cultivator system (Proprietorship of a farmland portion to a peasant for agricultural production and revenue-payment). In pre-independence India more than 60 percents of farmland areas were under the first two systems.

In the era of post-independence, India had continuously implemented a land reform program by abolishing the *Zamindari* system (landlord system) by the U.P. *Zamindari* Abolition and Land Reform Act in 1950 with necessary legislation enacted in all States in 1952. This had facilitated the distribution of about 5.8 million hectares of land to landless farmers in the whole country. However, due to social system, some kinds of land-types were not subjected to the law, permitting the presence of landlords in some areas.

The fixation of ceiling on land holding was an important aspect in the land reform program in India. The Working Group on Land Reforms appointed by the National Commission on Agriculture had proceeded related formula and regulations enacted in two distinct phases: (1) First phase up to 1972 for deciding ceiling limits per State. Before 1971 the ceiling limit in Tamil Nadu varied from 12 to 60 acres. Since 1972, these limits have been rationalized i.e. 10 to 18 acres for land with assured two crops and water supply, 1.25 acres for 1 acre if private irrigation for assured two crops, limit of 27 acres for provision of irrigation for only one crop and limit to 54 acres for the remaining land type, and (2) Second phase from 1972 for the adoption of "National Guidelines" prepared by the Central Government for uniformly implementing in all States. The provisions under the ceiling laws consisted of (1) The unit for ceiling application, (2) The level of ceilings and (3) Exemptions allowed. The main objectives of land reform program are for (1) social justice and (2) economic efficiency.

In 1990, out of 70 million holdings in the whole country, 64 millions or 92 percents of holdings are wholly owned and self-operated, 3 millions are partly owned and partly rented, and 3 millions are wholly leased. On areas of farmland, out of 162 million hectares under holding, 148 million hectares or 91 % are wholly owned and self-operated, 10 million hectares or 6 % are partly owned and partly rented, and the balance of 4 million hectares or 3 % are wholly leased.

(5) Major Crops

The major crops cultivated in India are rice, wheat, jowar (Cholam or Great millet, Sorghum bicolor), bajra (Bulrush or spiked millet, Pennisetum Typhoides), groundnut, cotton, gram, rapeseed and mustard, maize, soybean, Tur (red gram or pigion pea, Cajanus cajan) and sugarcane, as shown in the following table.

Among these crops food grains occupied 66.5 % of the total cropped area followed by oil seeds with the share of 13.6 % and fiber crops with the share of 4.6 %. The other hand, vegetable and fruit crops shared only 2.2 % and 1.5 % of the total cropped area, respectively.

Area, Production and Yield of Major Crops in India (1992-93)

Crop	Area (M Hects)	Production (M Tons)	Yield (kg/Ha)	Area (%)
Rice	41.78	72.85	1744	22.5
Wheat	24.59	57.21	2327	13.3
Jowar	13.04	12.81	982	7.0
Bajra	10.62	8.88	836	5.7
Maize	5.96	9.99	1676	3.2
Ragi	2.057	-	-	1.1
Barley	0.936	-	-	0.5
Other Cereals	2.024	-	-	1.1
Total Cereals	101.007	-	-	54.5
Gram	6.45	4.42	684	3.5
Tur(Arhar)	3.58	2.33	652	1.9
Other Pulses	12.33	6.07	492.2952149	6.6
Total Pulses	22.36	12.82	573	12.1
Total Food Grains	123.367	-	-	66.5
Groundnut	8.87	8.56	1049	4.8
Rapeseed & Mustard	6.19	4.8	776	3.3
Sesamum	2.283	-	-	1.2
Linseed	0.816	-	-	0.5
Other Oil Seeds	7.75	-	-	4.2
Total Oil Seeds	25.24	20.11	797	13.6
Cotton	7.51	1.14	257	4.1
Jute & Mesta	0.93	8.59	1658	0.5
Total Fibers	8.47	-	-	4.6
Soybean	3.79	3.39	894	2.0
Sugarcane	3.57	228.03	63874	1.9
Condiments & Spices	2.685	-	-	1.4
Fruits	2.81	-	-	1.5
Potato	1.65	15.23	13458	0.6
Onion	0.32	3.49	10791	0.2
Total Vegetables	4.14	-	-	2.2
Tobacco	0.42	0.6	1425	0.2
Coconut	1.54	332.43	7310	0.8
Other Crops	9.45	-	-	5.1
Gross Cropped Area	185.487	-	-	100.0

Source: Agricultural Statistics at a Glance, Min. of Agriculture

The major food grain production states are Uttar Pradesh, Punjab, Madhya Pradesh, Maharashtra, West Bengal, Bihar and Andhra Pradesh, and over 70 % of the national production amount was covered by these states in 1993-94 (Table 2.1.1).

(6) Average Yield and Production

The average yields of these crops in kg/ha are 1,744 in rice, 2,327 in wheat, 982 in jowar, 1,676 in maize, 573 in pulses, 1,049 in groundnut, 797 in oil seeds, 257 lint in cotton, 894 in soybean and 64, 000 in sugarcane in 1992-93 as shown in the above table. The production amounts of these crops in national level are shown in the same table.

At present, India has been produced enough amount of food grains for self sufficiency. On rice, the main production states are West Bengal, Uttar Pradesh, Andhra Pradesh, Punjab, Tamil Nadu, Orissa, Bihar and Madhya Pradesh. The growth of production keeps in pace with population.

The main wheat production states are Uttar Pradesh, Punjab, Haryana and Madhya Pradesh. The production in India is increasing at a greater pace than the population. Since the introduction of high-yielding dwarf varieties in 1965, there has been a continuous increase in both production and productivity. This has been achieved without any increase in area and mainly by breeding high yielding new genotypes.

The major oilseed crops in India are groundnut, rapeseeds, mustard and soybean, which are mainly produced in the states of Madhya Pradesh, Andhra Pradesh, Rajasthan, Maharashtra, Tamil Nadu, Karnataka and Gujarat where the annual

amount of rainfall is around below 1,000 mm (Table 2.1.1). Oilseeds production in India increased about 28% during the half decade of Nineties. However, the amount is not to meet the demand for edible oils because of oilseed crops are grown under rainfed conditions and on low fertility soils with inadequate indigenous production such as continuous cropping in the traditional areas without crop rotation.

(7) Agricultural Marketing

1) General Situation

In general, the dominant marketing practice for agricultural products in India is an old and complicated conservative system carried out by multi-level traders to buy and sell these produces on the way to reach to consumers in urban areas from the ancient time up to nowadays. Recently the Government has been involved in this domain by setting up various facilities such as the Regulated Markets system to control the market prices and to collect revenues from these transactions.

This marketing system, despite of keeping a constant flow of major agricultural commodities, could not handle effectively the marketing of minor commodities and assure the good qualities of produces, especially for vegetables.

Besides, in the framework to help farmers in marketing their produces, to regulate the market of agricultural products, the government acts as an intermediary to buy and store certain major agricultural produces such as rice with fixed minimum prices based on market prices at corresponding periods and to issue legislative control acts and to implement facilities for proceeding this task.

2) Present Types of Agricultural Markets

Apart from the direct selling the produces at farms from farmers to traders during the harvest times for quickly gaining the capital for next crops etc., there are 7 types of major markets for agricultural products which are functioning each specific marketing role in India as follows: 1) Primary or Local Market, 2) Secondary Market, 3) Terminal Market, 4) Fairs, 5) Regulated Markets, 6) Co-operative Marketing, and 7) State Trading.

(8) Agro-industry

Despite agriculture is the traditional and major industry in the national economy, the situation of agro-industries is observed to be under developed in India due to the status-quo of present marketing system of agricultural produces dually controlled by traders and regulated markets of the Government.

In general, there are two categories for agro-industries which are (1) cottage industries carried out by farmers themselves with almost simple procedures and tools at mostly home base in rural or semi-urban areas, and (2) Agro-based industries for processing

agricultural produces which can be organized in (i) cottage scale, (ii) small scale with some mechanical techniques and/or some hired employees, or (iii) large scale with large mechanization and/or large number of employees in the production line. Rural agro-based industries are almost cottage or small scale industries. Meanwhile, large scale agro-based industries are generally set up in large cities or semi urban areas.

In India cottage and small scale industries have been carried out mainly with hand loom products and some simply processed agricultural products only e.g. drying chili, date, coffee etc. This situation, therefore, could not absorb a considerable number of labor forces in the rural areas where there is a surplus of labor forces. For products of rather complicated processes, these products are mostly made by large-scaled industries with a mechanized procedure with a certain number of employees only.

(9) Irrigation

The monsoon is a minister of agriculture in India. Climate is the ultimate determinant of water supply, through the pattern of rainfall. There are much rain in the eastern part of the country and less rain in the western part.

In 1991-92, total 48.8 million ha of land are irrigated by several water sources in India . The major irrigation water source was canal at 42.1% in 1960s, but in 1970s groundwater replaced it. In 1991-92, the groundwater, canal and tank water irrigates 51.2%, 35.4% and 6.8% of irrigated area respectively.

Irrigation Area by Water Sources in India

(Unit: 1,000ha)

Year	Tank	Canal		Well		Others	Total
		Government Canal	Private Canal	Tubewell	Other Wells		
1960	4,561	9,170	1,200	135	7,155	2,440	24,661
1970	4,112	11,972	866	4,461	7,426	2,266	31,103
1980	3,198	14,456	836	9,527	8,207	2,585	38,809
1990	3,245	16,393	507	14,211	9,999	3,079	47,434
1991-92	3,300	16,800	500	25,000		3,200	48,800

Source : GOI, "Indian Agriculture in Brief" and Statistical Outline of India 1996-97

The tank irrigation significantly reduced its command area in these 30 years. The tank irrigation area is concentrated in the southern part of State, and 16% of tank irrigation areas are in the State in 1990. The percentage of irrigated area to total principal crops in India is 35.7% in 1992-93 (Table 2.1.2). The state which has highest percentage of irrigated area is Punjab with the percentage of 94.2%, followed by Haryana (76.4%), Uttar Pradesh (62.3%), Tamil Nadu (47.9%), Bihar (43.2%), Jammu & Kashmir (40.7%), Manipur (40.1%) and Andhra Pradesh (39.9%).The lowest state is Mizoram with the percentage of 7.8%. The crop which has the highest percentage of irrigated area is sugarcane (87.9%), followed by wheat (84.3%),barley (60.8%), rapeseed and mustard (57.5%), rice (46.8%), tobacco (41.2%) and cotton (33.2%). The lowest crop is bajra (5.8%).

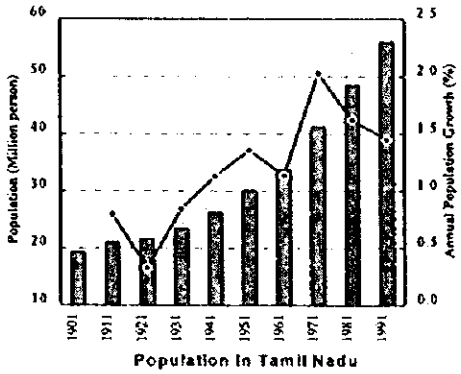
2.2 Tamil Nadu State

2.2.1 General

Tamil Nadu State (hereinafter referred to as "the State") is an important state in South India (comprising Tamil Nadu, Kerala, Pondicherry, Karnataka and Andhra Pradesh), situated on the southeast of the Indian Peninsula, bounded on the north by Karnataka and Andhra Pradesh, in the west by Kerala, in the east by Bay of Bengal and the South by Indian Ocean. The state has been inhabited by various ethnic groups, mainly Tamil.

(1) Population

The population of The State is 55.859 million, the 7th. largest in India sharing about 6.6 % of the whole India's population. The annual population growth rate varies from 0.33 % to 2.03 %, and calculated to be 1.45 % for the period from 1981 to 1991 as shown in the figure.



With about 8 millions of farm house holdings, making the agricultural population of approximately 40 millions (average 5 members per farm) or about 72 % of its total population.

(5) Administration

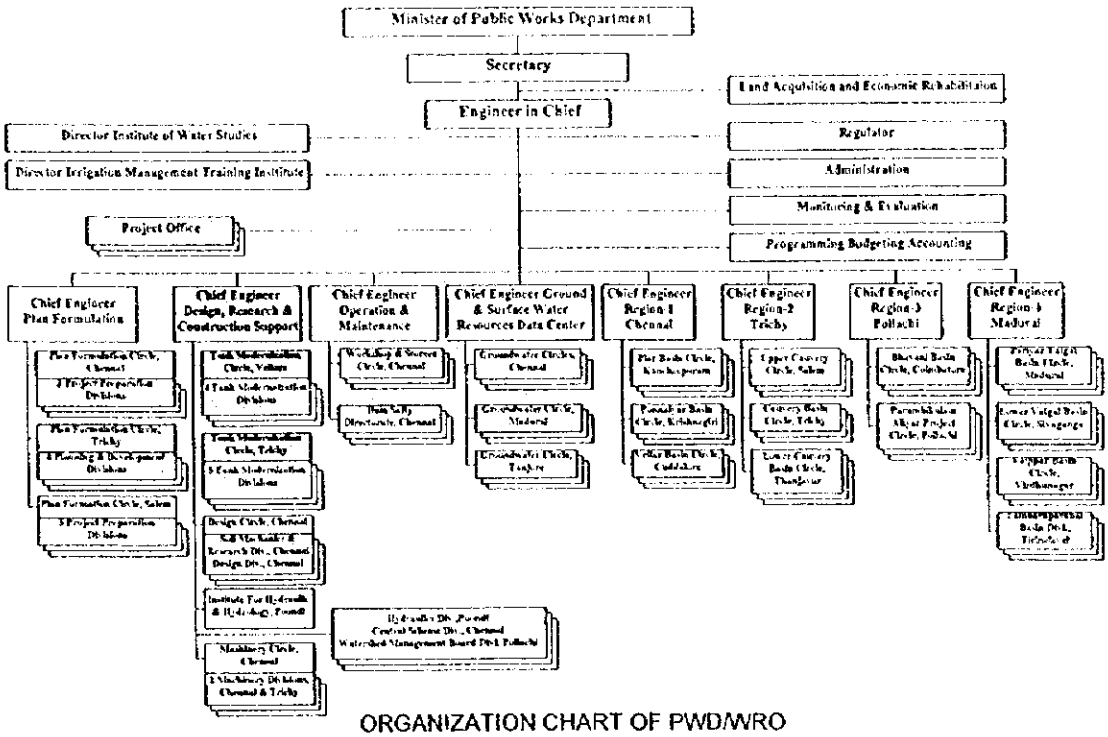
The State of which capital city is Chennai (formerly Madras) is divided into the following 29 districts.

Districts in Tamil Nadu State

Districts*	Area (km^2)	Population** (10^3 person)	Districts*	Area (km^2)	Population** (10^3 person)
1. Madras	174	3,842	12. Tiruchirapalli	11,096	4,138
2. Tiruvallur	7,857	4,654	13. Thanjavur	8,280	4,531
3. Kanchipuram			14. Pudukottai	4,651	1,327
4. Cuddalore	10,895	4,878	15. Madurai	6,565	3,450
5. Vellore	6,077	3,026	16. Dindigul	6,058	1,760
6. Tiruvannamalai	6,191	2,043	17. Ramanathapuram	4,232	1,144
7. Salem	8,649	3,896	18. Virudunagar	4,288	1,565
8. Dharamapuri	9.622	2,428	19. Sivaganga	4,086	1,078
9. Erode	8,029	2,320	20. Tirunerlveli	6,810	2,501
10. Coimbatore	7,469	3,508	21. Tuticorin	4,621	1,456
11. The Nilgiris	2,549	710	22. Kanniyakumari	1,685	1,600

Notes: *: As of May 1996
**: Population Census 1991

The structure of the Public Works Department (PWD)/Water Resources Organization (WRO) is shown below.



ORGANIZATION CHART OF PWD/WRO

2.2.2 Natural Conditions

(1) Topography

It covers a total area of 130,069 km^2 extending from northern latitude of 8°-5' to 13°-35'N and eastern longitude from 76°-15' to 80°-20'E. The State has a long coast on the east stretching for nearly 920 km from the Pulicat Lake in the north to Kanyakumari in the south and south-west. The folded ranges of Western Ghats and the connecting broken lines of hills of the Eastern Ghats namely Javadhur Shevaroys, Kalrayan, Pachamalai, Kollimalai, etc. form the western boundary of the state. The land gently slopes from the foot of the hilly ranges on the west and north towards east and south to meet the sea as shown in Fig. 2.2.1.

(2) Geology and hydrogeology

Geologically the entire State can be broadly divided into two geological zones namely, the hard rock and the sedimentary terrains.

1) Hard rock

Nearly 73% of the State is covered by hard rocks. Various terms have been ascribed to rocks based on the mineral content and origin. The major rock types which are found in the State are charnockite, peninsular gneiss and granites.

By and large, the occurrence of ground water in these formations depends on intensity and depth of weathering, fractures and joints present in them. In hard rock terrain only open dug wells are suitable. The open dug wells in hard rock terrain generally have depths ranging between 6 m and 15 m below ground level and depths to water table ranges between 4 and 14 m below ground level. The yield of the large diameter open well is varying between 4 and 12 litres per second, while the bore well in these rocks may yield between 2 and 5 litres per second only.

Charnokite variety of rocks are not found to be promising except in certain isolated pockets. The potential hard rock aquifers are located in Coimbatore, Dharmapuri, Madurai and Sivaganga Districts. The existence of deeply weathered and fissured zones are noticed along certain lineaments which are capable of yielding fairly good amount of groundwater. Groundwater is mainly occurring under water table conditions.

2) Sedimentary formations

These formations consist of coastal sandy zones, river alluvial (sand) formations, sand stones (both porus and compact) shales, clay etc. Except the compact sandstone (upper Gondwana) which are not yielding much, the rest of the formations form potential aquifer and could be located along the eastern coastal region.

The tertiary formations, consisting of porous and permeable sand stone, are having confined aquifer and occur under artisan/sub- artisan conditions. These are free flowing wells and the pressure heads range between 5 and 17 m above ground level with a free flow varying from 50 to 100 m^3/hour. Depending upon topography and thickness of overburden the piezometric heads vary widely. The discharge also varies from 10 and 150 m^3/hour. Flowing wells are struck notably in Cuddalore, Cauvery Delta of Thanjavur, eastern parts of Pudukottai, Ramanathapuram and Sivagangai Districts.

The recent alluvial sediments occurring along the coastal regions are represented by laterites, older alluvial sands, recent wind blown sands (teri sands of Ramanathapuram and Tuticorin districts). Rivers such as Palar, Ponnaiyar, Cauvery and Vaigai have deposited rich alluvium mainly in their deltaic regions and groundwater is found to both under semi-confined and water table conditions.

Generally filter points and shallow to medium tube wells could be drilled successfully in these regions and water bearing zones are found to occur mostly between 7 and 17 m below the ground level which may yield copious supply of water.

3) Groundwater and groundwater potential

The district-wise groundwater potential and utilisation of groundwater reserves for irrigation for all districts of the State were estimated. Out of the total groundwater recharge about 15 percent is kept reserved to meet the domestic and industrial uses. The balance 85 percent is taken as utilisable groundwater recharge for irrigation purposes.

The groundwater recharge, net extraction and balance ground water available for development have been worked out separately for all the 384 Panchayat Unions (Blocks) of the State.

The block-wise estimation of groundwater resources in the State revealed that as on January, 1992 in about 89 blocks, the level of groundwater development is more than 85.1 % (categorised as Dark) of utilisable groundwater resources; in about 86 blocks the groundwater development varies between 65 percent and 85 percent (categorised as grey) and in the remaining 209 blocks the level of extraction is less than 65 percent (categorised as white).

From time immemorial, groundwater is being developed in the State for various purposes, primarily for irrigation. Especially after independence, rapid progress has been made in the development of groundwater resources. In the State the number of dug wells has increased from 790,000 to about more than 1,800,000 and the shallow tube wells from few hundreds to 135,000 in the last four decades. During 1950-51, the irrigation development by groundwater was about 0.5 million hectares only. During 1993-94 it was 1.30 million hectares. Such an overall increase by groundwater was accomplished by means of rapid energisation of pump sets and availability of institutional finance mainly for medium and small farmers. The total number of energised wells during 1950-51 was merely 14,400 whereas it is the order of 1,448,000 as on April 30, 1994. The State stands second in having number of energised wells. Tamil Nadu has 1,414,000 of energised wells out of 9,186,000 of energised wells in whole of India.

The ultimate irrigation potential from groundwater is estimated at 3.144 M.ha, then irrigation potential created is 1.954 M.ha. and the balance available is 1.19 M. ha.

4) Regulatory instruments and procedures in force for groundwater development

Spacing norms have been prescribed based on the guidelines issued by NABARD (National Bank for Agriculture and Rural Development) for adoption between any two wells. These range from 150 m (for any two dug wells) to 600 m (for any two deep tube wells). These spacing norms are applicable throughout the State for availing institutional finance.

Groundwater development has been extensive in the coastal districts in view of

favourable hydrogeological condition existing along the coastal area. Over extraction in the coastal area may lead to sea water intrusion. As a precautionary measure, certain restrictions have been imposed for financing minor irrigation schemes involving development of groundwater to a distance of 10 km from the coast of Tamil Nadu.

In the State, the groundwater development is mostly by private individuals with their own finance. Hence virtually no groundwater discipline is being followed in the development of groundwater for minor irrigation purposes.

A comprehensive proposal for groundwater management and regulation has been proposed by the Groundwater Wing of PWD and it is under active consideration of the Government for credit and electricity.

At present, in principle, electricity is supplied free of cost for running authorised agricultural pump sets. Both the small farmers as well as big farmers are benefited by this scheme. Since electricity is made available free, there may be a tendency for the user to pump haphazardly over and above the actual irrigation requirements, thus depleting the groundwater storage.

A change in credit policy may also be brought out for the benefit of the small and medium farmers of the State who constitute the majority among the groundwater users for irrigation purposes. The bulk of the finance for groundwater schemes are now being made available from the institutional finance including the Land Development Banks, Co-operative Bank, Commercial banks and the National Bank for Agriculture and Rural Development (NABARD).

For groundwater development in hard rock, dug wells are most suitable. NABARD has fixed unit cost for dug wells which ranges up to Rs. 45,000/well depending upon the area. This is some what affordable by the farmers. However the groundwater development in sedimentaries is very expensive. The depths of tube wells in sedimentary areas extend to 100 metres or more. The cost of these wells vary between Rs. 300,000 to 500,000. Due to high cost of its installation, the individual farmers do not go for such ventures, though groundwater potential available is in surplus. Credit policies should there be suitably modified to develop the areas.

(3) Climate and Rainfall

Its climate is basically tropical, exposing to both Southwest and Northeast monsoons. The average number of rainy days in the State is 50 days per year for an annual rainfall of 925 mm, mainly precipitated in two monsoons which are the Southwest monsoon from June to September (average approx. 310 mm) for the rainfed cultivation in the whole state and the Northeast monsoon from October to December (average approx. 440 mm) on the Southern part of Bay of Bengal.

Some hundreds of rainfall gauging stations and about 35 meteorological stations are maintained by the various government organizations in the State such as PWD, agriculture, railway etc.

1) Rainfall

Rainfall in the State widely varies from 600 mm in the area east to Coimbatore to 2,000 mm in the mountainous ranges along the western edge of the State. Generally the rainfall in Tamil Nadu increases in mountainous area of Western Gaht and the coastal areas, and decreases inland areas near Coimbatore and southern area. The State has three distinct rainy seasons; Southwest monsoon (SW monsoon) during June to September, Northeast monsoon (NE monsoon) during October to December and transitional season during January to May.

The incidence of annual rainfall has been grouped into four ranges, viz., less than 600 mm, 600 mm to 800 mm, 800 mm to 1,000 mm and above 1,000 mm. The area lying under these four ranges of rainfall and their percentage of area with reference to the total area of Tamil Nadu are given in the following table.

Rainfall Ranges and Area

Districts Covered	Rainfall Range (mm)	Area under the Ranges (km^2)	Percentage of Areas with Reference to Total Area of the State.
Coimbatore (part)	Less than 600	2,183	1.7
Coimbatore (part), Erode, Tuticorin Virudhunagar, Tiruchirapalli (part), Ramanathapuram (part), Madurai (part)	600 - 800	30,733	23.6
Tiruchirapalli (part), Ramanathapuram(part), Madurai (part), Dindigul, Salem, Dharmapuri, Tirunelveli, Sivaganga, Pudukottai, North Arcot	800 - 1,000	47,863	36.8
Tiruvannamalai, Thanjavur, Nagapattinam, South Arcot, Villupuram, Tiruvallur & Kanchipuram, Chennai, Kanyakumari and Nilgris	Above 1,000	49,290	37.9

(3) Soils

Regarding the soil characteristics, the predominant soils in the State are red loam, laterite soil, black soil, alluvial soil and saline soil. Except for saline soil appeared in minor parts of the state, particularly in the Southern dry regions, most soils are suitable for common agricultural productions of paddy, sugarcane, cotton, root crops and vegetables depending upon the availability of water supply.

Soils in the State are divided into five (5) orders; Entisol (Redloam), Inceptisols (Lateritic), Vertisols (Black), Alfisols (Sandy Coastal Alluvium) and Ultisols (Red Sandy). The characteristics of each soil order are described in the table below:

Soil Orders in Tamil Nadu

Soil Order	Occurrence	Brief Description
1. ENTISOL (Redloam)	All over the state to the extent of 792,900 ha (6.1 %)	This comprise mostly shallow soils exhibiting no diagnostic horizon development. Erosion remove surface material from the site as faster than most pedogenic horizons can form. Initial materials resistant to weathering is often present. Root zone limitation, droughtness, gravelly nature are the dominant constraints.
2. INCEPTISOLS (Lateritic)	All over the state except Thanjavur and Nagapattinam districts to the extent of 6,534,900 ha (7.0 %)	This includes moderately deep to deep soils. They are immature soils having profile features more weakly expressed. Landscape position limit soil development. All the pedogenic processes are active to some extent but none predominates. Erosion, root zone limination, droughtness are the dominant limitations.
3. VERTISOLS (Black)	All over the state except Kanyakumari and the Nilgiris districts to the extent of 910,700 ha (7.0 %)	They are deep to very deep, heavy textured, black soils. They present gilgai micro relief and slickenside phenomena in the sob-surface. They are cracking soils on account of the shrink swell clay of montomorilloniterl. impeded drainge and development of alkalinity are associated with these soils.
4. ALFISOLS (Sandy Coastal Alluvium)	All over the state to the extent of 3,916,600 ha (30.3 %)	These are deep to very deep, well developed soils exhibiting illeuviation of clay in the 'B' horizon. Most suited for extensive and intensive agriculture. More or less these are well settled soils with soil erosion kept at minimum.
5. ULTISOLS (Red Sandy)	Parts of Nilgiris, Salem and Dharmapuri districts to the extent of 126,900 ha (1.0 %)	These are low based status soils and have a base saturation of less than 35 %. They are very deep, acidic, well drained and distributed at the higher elevation with high rainfall. Usually organic matter content is greater than other soil orders.

2.2.3 State Socio-economy

(1) State Economy

Endowed by favorable natural conditions of climate, land, sea, surface water resources and a potential labor force and traditional civilization, the economy of the State has been gradually increased as shown in the following table:

	1970-71	1980-81	1984-85	1992-93
Net SDP (million Rs.)	23,710	72,180	120,280	252,250
India NNP (million Rs.)	3,65,030	1,106,850	1,850,620	3,435,660
Share in %	6.49	6.52	6.49	7.35
SDP per capita (Rs.)	581	1,498	2,341	6,205
NNP per capita (Rs.)	675	1,630	2,504	6,234

Source: Indian Economy, 4th Edition, Sultan Chand & Sons

These figures show that the net State Domestic Product (SDP) shared 6.5 to 7.5 % of the Net National Product, proportionally with the population figures with recent improvements in the last decade. And the SDP per capita is somehow lower than the NNP per capita, but improvements could be obtained also in the last decade.

In terms of sectorial division, the shares of (1) primary sector of agriculture, forestry, fishing, mining and quarrying, (2) secondary sector of manufacturing, construction, electricity, gas and water supply, and (3) tertiary sector of transport, communications, trade, banking, insurance, finance, real estate and other services in the State are shown in percentage as follows:

Sector	1960-61	1970-71	1980-81	1984-85	1989-90
1. Primary	52.0%	40.9%	28.9%	28.0%	20.5%
2. Secondary	17.6%	25.6%	32.7%	27.2%	30.9%
3. Tertiary	20.4%	35.5%	38.4%	44.8%	48.6%
Total	100.0%	100.0%	100.0%	100.0%	100.0%

Source: Indian Economy 4th Edition

From the above tables, there has been a steady decline in the share of the primary sector mainly contributed by agriculture in the whole performance of state economy during these two successive periods. Besides, there have been tremendous increases in secondary and tertiary sectors of the State economy.

In general, however, the trend of economic development in the State is considered stagnant, closely to the whole performance of national economy, especially after the mid-eighties. Therefore, the Net SDP per capita of the State could catch up with the level of NNP per capita at the early nineties as observed in the above figures, due to the slow down of NNP during this period.

The range of approximately US$ 300 (approx. Rs.11,000) for net SDP per capita in the State, as for all India at the present time, however, implies the socio-economic characteristics of a developing society. Major socio-economic indicators of the State are shown in the table below.

Item	Tamil Nadu	All India	Share in %	Year
1. Area (km^2)	130,000	3,287,000	About 4%	1991
2. Population (Million)	55.6	843.9	7%	1991
3. Density (Persons/km^2)	428	267		1991
4. Sex Ratio (Female/Male)	0.97	0.93		1991
5. Urban Population Percent	34.8	25.7		1991
6. Rural Population Percent.	65.2	74.3		1991
7. Population in Poverty (%)	32.8	29.9		1991
8. Percentage of Agr. Workers	59.1	64.9		1991
9. Female Workers Rate	30.9	22.7		1991
10. Literacy Rate	84	52		1991
11. Infant Mortality Rate	5.6	7.4		1991
12. Population Growth (%)	2.0	2.2		1991
13. GDP (Rs $X10^7$)	35,225	543,566	About 7%	1992-93
14. GDP per capita (Rs)	6,205	6,234	98%	1992-93
15. Share of Primary Sector (%)	20.5			1992-93
16. Share of Secondary S. (%)	30.9			1992-93
17. Share of Tertiary S. (%)	48.6			1992-93
15. Foodgrain Production (t)	7,747,000	167,064,000	4.8%	1991-92

ource: Indian Economy, Sultan Chand & Sons

(2) Social Infrastructure

In general, the conditions of social infrastructures in the State are observed in a rather proper situation, especially on the aspects of communications, water supply, electrification and education. This situation implies the recent efforts for social development in rural areas of the State. The expects of housing and sewerage, however, are considered still inferior, particularly in areas for agricultural laborers. Health care system also requires some improvements on nutrition and health-check for landless marginal and small farmers in order to improve their living conditions.

Most of rural roads are intermittently unpaved with surface-damages. The railway system passes through all districts of the State. Apart from the efforts for social development from the Government, the key indicators on development of social infrastructure in the State are shown in the table.

Development of Social Infrastructure in Tamil Nadu

Indicator	Unit	Reference Year	Tamil Nadu	All India
1. Population Growth Rate	%	1981 - 1991	1.43	2.14
2. People below Poverty Line	%	1987-88	33	30
3. Literacy Rate				
(1) Male	%	1991	74	64
(2) Female	%	1991	51	39
(3) Total	%	1991	63	52
4. Vital Rate				
(1) Birth Rate	1,000 popu.	1993	19	29
(2) Death Rate	1,000 popu.	1993	8	9
(3) Infant Mortality Rate	1,000 live birth	1993	56	74
(4) Life Expectancy at Birth	%	1986 - 1990	61	58
5. Gross Enrollment Ratio				
(1) Primary School Level	%			
(a) boys	%	1992 -1993	149	155
(b) Girls	%	1992 - 1993	141	93
(c) Total	%	1992 - 1993	145	105
(2) Middle School Level				
(a) Boys	%	1992 - 1993	111	79
(b) Girls	%	1992 - 1993	91	55
(c) Total	%	1992 - 1993	101	67

Source: Economic Appraisal of Tamil Nadu (1996)

1) Rural Electrification

On the aspect of rural electrification, the Government has made this implementation carried out in most villages and hamlets in the State including the Study Area. In the State, except for 51 hamlets, all the other rural areas have been electrified. This Program was done under the rural energisation for promoting agricultural activities in this state.

2) Rural Road Network

The situation of road networks in the Study Area as on March 31, 1994 is illustrated in the figure, and those in the districts in the State are tabulated in Table 2.2.1. Apart from the road network, the railway system is observed passing through all districts of the State. These transportation networks imply the existence of rather proper transportation facilities for rural life and economic activities.

3) Rural Water Supply and Sewerage

For domestic use and drinking purposes, the rural water supply system in the State considered pretty encouraged where the well water is available and in case of no proper well water, the river water is stored in an overhead-tank for gravity discharge to various water taps in each village for public use.

This water supply system in rural areas is a great effort of India in the framework of improving rural living conditions which has been carried out by the Government with top priorities. As a result of this effort, rural villages in State including five (5) districts of the Study Area are basically supplied with domestic water supply system has been simply carried out by filtration through gravel and sand layers in the upper tank with, sometimes, chlorination prior to its discharge. The operation and maintenance of related facilities is assigned to the corresponding village(s). The situation of drinking water supply in State is shown in the table.

Drinking Water Supply to Town and Rural Areas in Tamil Nadu (1995)

Civic Status	Number of Towns	With Water Supply Provided	Water Supply to be Provided
1. Corporation excluding Chennai	5	5	-
2. Municipalities	96	94	2
3. Municipal Township	7	5	2
4. Panchayat Townships			
(1) Urban	13	12	1
(2) Rural	3	3	-
5. Town Panchayat			
(1) Urban	355	307	48
(2) Rural	265	157	108
Total	744	583	161

The sewerage system in rural areas, however, is not systematically carried out. Some 10 % of village houses have simple septic tanks for sewage purpose with, sometimes, treatment for bio-gas. However, most of 90 % of houses in rural areas have no proper sewerage facilities. In fact, the hygenic conditions in rural sewerage system is not worse than those in urban areas where there are many locations with sewage water logged for longtime without proper treatment. This would permanently cause serious public health care problems.

4) Education System and Literacy Profile

In the State, the literacy rate is 62.66 % with males at 73.75 % and females at 51.33 %. This is due to vigorous efforts of the State government and the NGOs, that have pushed up the enrollment rates and incentives especially to the girl child has brought down the drop out rates as shown in the following table.

Enrollment and Drop-out Rates in Tamil Nadu

	1990/91	1991/92	1992/93	1993/94	1994/95
Primary Education Enrollment (X10')	50.15	56.25	56.72	57.20	57.34
Drop-out Rate(%)	20.32	19.31	18.27	17.30	16.34

Source: An Economic Appraisal 1994-95, TN

The focus of attention is to attain universal literacy by 2000. The implementation of the Noon-Day Meal scheme has improved enrollment rates. In order to achieve the universalisation of education and prevent drop-out rates the World Bank has assisted the State government to launch the District Primary Education

Program (DPEP). The center and the state government share the expenditure on a 85:15 basis. This program was launched at the backward. Accessibility to schools is necessary. Children can not trek long distance to reach a school. All the 340 habitants of the State have a primary school with one (1) km distance.

The following table gives number of instructors, students and teachers in the State in 1992-93.

	Instructors	Students			Teachers
		Boys	Girls	Total	
Primary Schools	30,098	3,038,862	2,633,249	5,672,111	121,212
Middle Schools	5,608	1,714,650	1,403,241	3,117,891	65,895
High Schools (State Board)	2,396	819,553	662,993	1,482,486	35,004

Note: Compiled from Statistical Handbook of Tamil Nadu - 1994

7) Health Care

Regarding health care facilities, there are services from the city-based Public hospital, the District hospital and the Primary Health Centers and Sub centers at the village levels. This again is augmented by private hospitals and dispensaries. "Health for all by 2000" is the slogan promoted by the Government.

Next to Kerala, Tamil Nadu has been considered as the second in good health services. The National Health Policy is based on an earlier hospital-based creative system to a preventive, primary health care delivery package system.

The major communicable diseases in the State are Cholera, acute gastro-enterites, typhoid, infective hepatites, malaria, filaria, encephalites and tuberculosis. This is an indication for existence of poverty, lack of potable water, lack of sanitation and malnutrition. At the district levels there are the taluk headquarters hospital and non-taluk hospitals run by the State Government.

8) Telecommunications

The situation of telecommunications in the State is considered effectively working thanks to 1) the sufficient rural road network, 2) the large-scale network of rural electrification and 3) the rural administration system based on village council.

Post offices are existing in districts, taluks and sub-taluks (blocks) where services for postage, telegraph and telephone have been carried out. In each village, there is also an officer in charge of post services for sending and delivering letters. Villagers, however, should borrow telephones from private individuals (owners), generally big farmers, in case of needing telephone uses.

2.2.4 Agriculture

(1) General

Agriculture is the traditional and major industry in the State, employing almost 60% of its labour force, more than 65% of the State population living in rural areas, and contributing approximately 25% to the State Net Product.

Water is the main factor deciding the agricultural production in the State. The Northern regions obtaining a considerable annual rainfall of approximately 1,000 mm, therefore, have enjoyed a perfect rainy season-crop and a relatively good dry season crop with irrigation measures such as from tank sources. The Southern regions, on the contrary, could not constantly obtain a sufficient annual rainfall of mostly 400 - 500 mm with erratic patterns for cropping paddy, sugarcane, vegetables etc., have been often suffered from drought casualties, causing an unstable situation in agricultural production. Apart from the agricultural fields with water supply from system-tanks, other fields in the Southern dry regions should be relied on the groundwater source, particularly in the dry season, for carrying out the agricultural production due to no available water from the rainfed tanks.

The net cultivated area in the State is roughly estimated at 5.85 million ha or about 45% of the State land area. With the recent gross cropped area of around 6.95 million ha, its cropping intensity is about 1.2. This is mainly due to the irrigation water conditions. Only 2.62 million ha or 47% of the cultivated area are under irrigation. Besides, the per capita arable land in the State is only 0.105 ha.

The State is divided into 7 agro-climatic zones as shown in Fig.2.2.1 and as follows:

No.	Name of Zone	Distribution
1	North Eastern	This zone covers the districts of former Chengalpattu, Vellore, Thiruvannamalai, partly Cuddalore ,and partly Tiruchirappalli.
2	North Western	This zone comprises almost districts of Dharmapuri, Salem and partly Tiruchirappalli.
3	Western	This zones comprises the districts of Erode, Coimbatore, partly Salem, partly Tiruchirappalli and northern part of Madurai.
4	Cauvery Delta	This zone covers partly districts of Thanjavur, Nagapattinam , Tiruchirappalli and Cuddalore.
5	Southern	This zone includes the districts of Ramanathapuram, Virudhunagar, Tuticorin, Sivaganga, Tirunelveli, partly Madurai and partly Pudukottai.
6	High Rainfall	This zone consists of Kanyakumari district only.
7	Hilly	This zone covers the hilly regions bordered Kerala State from Nilgiris district to Tirunelveli district.

Cultivated area occupies about 45% of the State land, with 5.73 million ha in 1991. The area under rice, which is the main crop is about 36% of the total cultivated area, has a tendency to increase, while area under other grain crops and beans shows a decreasing trend. Oil seed crops, such as groundnut, fiber crops and sugarcane are also widely cultivated.

(2) Agricultural Development Plan in the Eighth State Five Year Plan

In the 8th Five Year plan of the State, the agriculture in the State was the main sector and its targets are as follows:

1) With a view to improve the economic status of the poor farmers, it is proposed to bring the fallow lands under the cultivation in about 10,000 ha every year.

2) Promoting less water consuming horticulture crops, through special schemes for production and distribution of quality seeds and seedlings of fruit trees, flowers and vegetables and also establishing Horticulture Estates.

3) To give impetus to training the farmers in modern technology, through Farmers Training Centers also imparting Orientation Courses for the school students in agriculture.

4) Encouraging self-employment, especially in seed production and agro-based industries.

5) Increasing the forest coverage of the State through, conservation forestry, community forestry and commercial forestry with special emphasis on fuel and fodder plantations under Sustainable District Forestry Programme(SDFP).

6) Emphasis will be laid on Coastal Aquaculture, to step up the prawn production in the blackish water area of the State, consisting of back water, tidal estuaries, mangrove, swamp and lagoons, by establishing Brackish Water Fish Farmers' Development Agencies.

Also as a vital source for agricultural production, the irrigation focused to develop under the following consideration:

1) Emphasis will be given to completion of all irrigation schemes that are pending and repairing tanks, ponds, *anicuts* (weir), etc., all over the State, that are a state of disrepair and maintaining them properly. New ponds, tanks and *anicuts* will be built wherever necessary.

2) Emphasis will also be on the technological progress and better water management to ensure sustainable growth through higher productivity.

Strategy for the development of irrigation sector were planned as follows:

The State has exploited almost 83% of the ultimate irrigation potential and utilized the potential to an extent of 98.5%. This means that:

i) new irrigation works or project is extremely limited unless new additional water

sources become available by inter-basin transfer could be secured by inter-state agreement,

ii) the plan can only reckon with sub-marginal potentials and may even be obliged to take into account lowering the period of dependability (50% instead of 70%) for future projects, this will naturally result in high cost per unit irrigated area.

Therefore, the remaining countermeasure is to conserve, manage and optimize the use of available water. This requires a conscious attention to rehabilitate the existing irrigation projects, canal systems, *anicuts* and tanks to make them functionally most effective in quick and optimal delivery of inflows received without allowing them to go waste, and economizing on the delivery and use of water utilized.

Therefore, the emphasis in the 8th Plan has been on schemes for modernization of canal system and tanks and water management. The two significant aspects of water management are the control and conjunctive use of water and on-farm development management techniques to be propagated by the combined efforts of the irrigation and agricultural agencies with the cooperation of the farmers. To achieve those objectives, the following are envisaged:

- Early completion of the major and medium and minor irrigation projects and accelerating the pace of works, with matching provisions.
- Modernizing the irrigation canal and system, deltaic system and also the tank system, securing external assistance whenever it is forthcoming.
- Intensification of ground water utilization taking care to see that there is no over extraction.
- Organizing a better water management mission and practices and on-farm management for better water use by farmers and all concerned with irrigation.

(3) Situation of the State's Agriculture

The situation of the State's agriculture in the national agriculture is characterized as below.

1) Small size of operational holdings

The average size of operational holdings in the State is small; 0.93 ha, which correspond to 59% of the national average (1.57 ha) in the table. Further, 73.1% of the holdings are marginal holdings with the average size of 0.36 ha.

2) High irrigation rate

The State ranks the 3rd among the most advanced states in percentage of irrigated area to total under principal crops, that is, the percentage is 94.6% in Punjab, 62.3% in Uttra Pradesh, 47.9% in The State and 35.7% on the average of all India (Table 2.2.1).

3) High agricultural input

The consumption of fertilizer in the State is 136.64 kg/ha on average in 1994-95, which is 81% higher than the national level (75.68 kg/ha), and ranks the 2nd, next of Punjab (174.75 kg/ha), among the States (Table 2.2.1).

4) High yield per unit area

As shown in the table below, the average yields of rice, bajra, groundnut, sugarcane and cotton in the State in 1992-93 are 3,116 kg/ha, 1,144 kg/ha, 1,486 kg/ha, 107 ton/ha and 289 kg/ha, respectively, which are higher than those of national average by 79%, 37%, 42%, 67% and 13%, respectively.

5) Agricultural production share of the State in India

The share of agricultural production of the State in the national production is 20.5% in groundnut, 9.7% in sugarcane, 9.3% in rice and 4.1% in cotton. The share of total foodgrains of the State in the national production is nothing but 4.7 % only.

(4) Land Use Pattern

The land use pattern in the State for the period 1993-94 is presented in the table below.

Land Use Pattern in Tamil Nadu

S/N	Particulars	(in 1,000 ha)	% to Total
I.	Total Geographical Area	13,021	100.0
II.	Land Utilization		
1.	Forest	2,144	16.5
2.	Barren and uncultivable Land	515	3.9
3.	Land put to non-agricultural uses	1,884	14.5
4.	Cultivable waste	307	2.4
5.	Permanent pastures and other grazing lands	122	0.9
6.	Land under miscellaneous tree crops and groves not included in net area sown	241	1.8
7.	Current follows	933	7.2
8.	Other follows lands	974	7.5
9.	Net area sown	5,901	45.3
III.	Area sown more than once	1,257	
IV	Gross cropped area	7,158	
1.	Area under food crops	4,901	
2.	Area under non-food crops	2,257	
V.	Cropping intensity (%)	121.3	

Source: Tamil Nadu - An Economic Appraisal 1994-95.

Out of the total geographical area of 13.0 million ha, 16% is occupied by forest, 14% by non-agricultural use, 11% by current fallow and 44% by net area sown. 20% of the net area sown(1.1 million ha) was sown more than once, that is, the cropping intensity is 120%.

(5) Irrigated Area

The percentage of the net area irrigated to the net area sown is 46% on the average during the two year period of 1991 to 1993. The percentage had a tendency to slightly increase during the last 20 years. The major sources of irrigation are wells (45%), canals (32%) and tanks (23%) in 1991-93. The share of area irrigated by well increased during the last 20 years from 31% in the early seventies to 45% in the early nineties. On the contrary the share of area irrigated by tank decreased from 34% to 23%.

(6) Land Tenure System and Holding Area

The predominant system of land tenure in the State is the *ryotwari* system, under which a land owner is free to alienate his right over the land by sale or gift. The State Government has imposed a ceiling of 6.07 ha on land holding. About 83 % of the holdings are small and below 2 ha. Further, 64.7 % of the holdings covering an operational areas of 21.1 % of the land area are less than 1.0 ha.

Size (ha.)	No. of operational holdings(in '00')	Percentage (%)	Area of operational holdings (in '00'ha)	Percentage (%)
Below 0.5	26,293	43.0	6,496	8.5
0.5 - 1.0	13,219	21.6	9,579	12.6
1.0 - 2.0	11,257	18.4	15,864	20.8
2.0 - 3.0	4,591	7.5	11,206	14.7
3.0 - 4.0	2,240	3.7	7,552	9.9
4.0 - 5.0	1,263	2.1	5,580	7.3
5.0 - 10.0	1,792	2.9	12,051	15.8
10.0 - 20.0	385	0.6	5,002	6.6
20.0 - 30.0	50	0.1	1,146	1.5
30.0 - 40.0	11	0.0	394	0.5
40.0 - 50.0	4	0.0	191	0.3
Above 50.0	9	0.0	1,224	1.6
Total	61,114	100.0	76,285	100.0

Source: Tamil Nadu- An Economic Appraisal - 1987-88

(7) Principal Crops

The principal crops in terms of cultivated area in the state are paddy, groundnut, pulses, cholam (*Sorghum Vulgare*), sugarcane and Cotton, which occupied 32.2 %, 16.2 %, 9.6 %, 7.1 %, 3.5 % and 3.2 % of the total cultivated area of 7,158,000 ha in 1993-94, respectively (Table 2.2.2).

(8) Average Yield

The average yield of these crops in the same year is estimated as 2,927 kg/ha in paddy, 1,611 kg/ha in groundnut with shell, 400 kg/ha in pulses, 960 kg/ha in cholam, 104,386 kg/ha in cane of sugarcane and 316 kg/ha in lint of cotton (Table 2.2.2).

(9) Production and Its Yearly Variation

Sugarcane has the biggest amount of production with 26.0 million tones in cane among the crops cultivated in 1993-94 sharing 60.1 % of the total crop production in the State, followed by paddy (15.6 % in rate of the share), tapioca (7.4 %), groundnut (4.3 %), cholam (1.1 %) and mango (1.0 %) (Table 2.2.2). The yearly variation of production amount is the largest in groundnut (20.7 % in coefficient of variation) followed by cholam (15.5 %), pulses (10.0 %), cotton (9.4 %), cumbu (9.3 %), paddy (7.1 %), ragi (6.2 %) and sugarcane (5.4 %) (Table 2.2.3). The large yearly variations of groundnut and cholam are caused by both the variations of cropped area and yield per unit area.
In the recent 5 years, the sown areas and the productions of paddy and groundnut have a tendency to increase but those of pulses tend to be decreased (Table 2.2.3). There is an even increasing demand for most of the essential commodities including pulses, oilseeds, fruits, vegetables, cotton, sugarcane etc. in the State.

(10) Use of Agricultural Inputs

The consumption of fertilizer in the State is 136.64 kg/ha on average in 1994-95, which is 81% higher than the national level (75.68 kg/ha), and ranks the 2nd, next of Punjab (174.75 kg/ha), among the States (Table 2.2.1).

(11) Cropping Sequences/Cropping Systems

The main cropping sequences/cropping systems in different parts of the State are summarized as below.

1) Rainfed

Single crop (Kharif)
Groundnut, cumbu, ragi, cholam, kodo millet *(Paspalum scrobiculatum L.)*, redgram and cotton are cultivated in Kharif in rainfed area. Often lab lab, redgram, dewgram, castor, cowpea etc. are grown as intercrops with millets or groundnut as main crop. Tapioca is grown in rainfed area through a year.

Double crop (Kharif / Rabi)
Groundnut, cumbu, ragi are cultivated as the 1st crop in Kharif and horsegram, gingelly, bengalgram, coriander and cotton are cultivated as the 2nd crop in Rabi. In the cases of gingelly / castor (Kharif) - horsegram (Rabi) and cotton / groundnut

(Kharif) - bengalgram / sorghum (Rabi) are also found out.

2) Irrigated

Cropping sequences in the irrigated areas of the State are found out as follows:

- Rice - rice
- Rice - rice - rice / vegetables / ragi / cumbu
- Rice - pulses / groundnut / gingelly / maize / cotton
- Rice - tapioca
- Cotton - sorghum / millets
- Cumbu / ragi - vegetables - summer groundnut
- Ragi / sorghum - cotton
- Redgram - maize - groundnut
- Sugarcane / banana / betel vine / ornamentals (2-3 years)

(12) Livestock and Poultry

Cattle is the major livestock bred and ranked first among all the livestock bred in the State as shown in table below, which shares 35.5 % of the total number of livestock of 26,366,220 heads in 1989, followed by goats, sheep, buffaloes, dogs and pigs.

	Kanchipuram & Thiruvallur	Ramanathapuram	Virudhunagar	Sivagangai	Total		
					Study Area	Tamil Nadu Total	
Cattle	744,758	230,086	132,821	251,367	1,359,032	9,353,141	35.5%
(%)	8.0	2.5	1.4	2.7	14.5	100.0	--
Buffaloes	337,637	30,507	65,025	45,518	478,687	3,128,256	11.9%
(%)	10.8	1.0	2.1	1.5	15.3	100.0	--
Sheep	328,948	271,521	187,186	350,551	1,138,206	5,880,788	22.3%
(%)	5.6	4.6	3.2	6.0	19.4	100.0	--
Goats	327,093	154,253	172,747	133,339	787,432	5,919,713	22.5%
(%)	5.5	2.6	2.9	2.3	13.3	100.0	--
Pigs	18,560	7,757	15,696	3,956	45,969	660,676	2.5%
(%)	2.8	1.2	2.4	0.6	7.0	100.0	--
Dogs	129,121	12,273	11,032	41,759	194,185	1,366,950	5.2%
(%)	9.4	0.9	0.8	3.1	14.2	100.0	--
Others*	1,255	3,451	2,391	1,485	8,582	56,696	0.2%
(%)	2.2	6.1	4.2	2.6	15.1	100.0	--
Total	1,887,372	709,848	586,898	827,975	4,012,093	26,366,220	100.0%
(%)	7.2	2.7	2.2	3.1	15.2	100.0	--
Fowls	1,113,726	377,856	438,055	468,612	2,398,249	21,037,244	98.1%
(%)	5.3	1.8	2.1	2.2	11.4	100.0	--
Others**	167,209	529	5,303	887	173,928	413,394	1.9%
(%)	40.4	0.1	1.3	0.2	42.1	100.0	--
Total	1,280,935	378,385	443,358	469,499	2,572,177	21,450,638	100.0%
(%)	6.0	1.8	2.1	2.2	12.0	100.0	--

Note : * Includes Donkey, Horses, Ponies, Mules and Camels
** Ducks and Drakes
Source: 14th Livestock and Poultry Census-1989, Commisioner of Statistics, Madras-6.

The number of poultry in the State in 1989 is 21,450,638 of which 98% is occupied by fowls and the rest is ducks and drakes.

The milk and egg productions in the State rose to 3,483,400 tones and 2812 million pieces per year on the average of the 5 years from 1990-91 to 1994-95, respectively.

The average yields of milk and per capita consumption of milk and egg are at very low level.

	District/ State	Unit	1990-91	1991-92	1992-93	1993-94	1994-95 (P)	Average (1,000ton)	Percentage to State
Milk	Kanchipuram & Tiruvallur	(1,000 tonnes)	373.8	357.5	308.0	349.9	341.0	346.0	9.9
		(%)	108.0	103.3	89.0	101.1	98.6	100.0	
	Ramanathapuram*	(1,000 tonnes)	161.7	195.3	199.3	179.7	355.0	218.2	6.3
		(%)	74.1	89.5	91.3	82.4	162.7	100.0	
	Total Study Areas	(1,000 tonnes)	535.5	552.8	507.3	529.6	696.0	564.2	16.2
		(%)	94.9	98.0	89.9	93.9	123.4	100.0	
	STATE	(1,000 tonnes)	3,374.7	3,356.8	3,468.2	3,524.3	3,693.0	3,483.4	100.0
		(%)	96.9	96.4	99.6	101.2	106.0	100.0	
Egg	Kanchipuram & Thiruvallur	(Lakhs)	667.2	768.5	1,058.8	1,137.3	1,019.0	930.2	3.3
		(%)	71.7	82.6	113.8	122.3	109.5	100.0	
	Ramanathapuram*	(Lakhs)	514.0	516.3	555.0	530.6	677.0	558.6	2.0
		(%)	92.0	92.4	99.4	95.0	121.2	100.0	
	Total Study Areas	(Lakhs)	1,181.2	1,284.8	1,613.8	1,667.9	1,696.0	1,488.7	5.3
		(%)	79.3	86.3	108.4	112.0	113.9	100.0	
	STATE	(Lakhs)	25,507.8	27,036.9	28,445.8	29,140.0	30,509.0	28,127.9	100.0
		(%)	90.7	96.1	101.1	103.6	108.5	100.0	

Notes : * Includes the districts of Ramanathapuram, Sivaganga and Virdunagar
(%) Percentage to average
(P) Provisonal
Source: 14th Livestock and Poultry Census-1989, Comissioner of Statistics, Madras-6.

(13) Farm Household Economy

1) General characteristics

The basic aspects of farm holding economy in India including the State are characterized by two major issues: the limited agricultural land for a large agricultural population making the presence of landless farmers (agricultural laborers) in rural areas and the low agricultural revenues to farmers, especially marginal and small farmers, resulted from mostly old-typed farming practices affected by various causes including unstable irrigation water, traditionally staple foods production, old-fashioned farming system, rather mono-channel marketing system fluctuated pricing system and rather weak agricultural supporting framework.

The rural population in the State as well as in all India is estimated at more than 65 % of the total population; meanwhile, in general, the population of landless farmers is more than half of the rural population or approximately 35 % of the total population.

The categories of farmers and holding areas based on farm-sizes in India and Tamil Nadu are shown as follows:

Category	All India			Tamil Nadu		
	Hold. No. (million)	Area (ha)	Per Hold. (million)	Hold. No (mil. ha)	Area (ha)	Per Hold. (mil. ha)
Marginal Farm (to 1 Ha)	56.74	21.61	0.38	5.85	2.12	0.36
(%)	(58.05)	(13.18)		(74.0)	(28.4)	
Small Farm (1 to 2 Ha)	17.88	25.33	1.43	1.27	1.79	1.41
(%)	(18.29)	(15.45)		(16.1)	(23.95)	
Semi-Medium (2 to 4 Ha)	13.25	36.58	2.76	0.62	1.69	2.72
(%)	(13.56)	(22.32)		(7.85)	(22.62)	
Medium (4 to 10 Ha)	7.92	47.01	5.94	0.23	1.30	5.70
(%)	(8.10	(28.68)		(2.91)	(17.40)	
Large Farm (10 Ha up)	1.93	33.19	17.2	0.03	0.57	19.15
(%)	(1.97)	(20.24)		(0.86)	(7.63)	
Total	97.73	163.91	1.68	7.9	7.47	0.94
(%)	(100)	(100)		(100)	(100)	

Source: Indian Economy 1996 and Agrostat 94

2) Farm household economy

Based on the characteristics of farm householding situation in the State as well as in India, the farm holding economy for each category of farmer is generally specified as follows:

Firstly, for agricultural laborers or landless farmers, as they possess no farmland and carry out farming activities on seasonal basis of hiring, their farming income are very unstable, depending on seasons and employers. As they are classified as unskilled workers, their daily salaries are Rs.30-50 for men and Rs.15-30 for women upon work-type, region and season. There is a tendency of relatively high daily salary rate in Northern Tamil Nadu where agricultural production is well done; meanwhile, a low rate in Southern Tamil Nadu where drought conditions are severe for the agricultural production. Besides, as a matter of fact, the population of agricultural laborers (landless farmers) in the South is much less in comparison with the North.

For a family of agricultural laborers with two labor forces (1 man and 1 woman) their average annual farming income would be in the range of Rs 5,000 for equivalent to a 5-month work-period per year. This would basically support their basic expenditure for mainly foods only. A lack of works would be resulted in no revenue for buying foods, causing a labor migration to other prospective areas, sometimes very far from the previous place, or looking for off-farm works in nearby urban areas. Basically, their farming economy is considered very severe to be subjected to basic living stabilization.

For other farm categories, details on their farm holding economy are described below. Basically, the surplus of their farm produces will be sold for using in family expenditure and operation capital for the next crops. On this basis, marginal farmers of less than 1 ha are basically found without considerable surplus, particularly in case of only one crop is available, for having some

revenue for even family expenditure. Most marginal farmers, therefore, have to carry out salary-works like coolies outside their farm works for supporting their family expenditure.

(14) Agricultural Marketing

1) Marketing of agricultural produces in the State

In order to facilitate the agricultural marketing in the State, the Agricultural Marketing Commission of Agriculture was independently formed as Agricultural Marketing Department at Trichy in 1977 and later shifted to Chennai in 1993.

With the operation of this Department, presently known as the Directorate of Agricultural Marketing Office, 14 market committees at district level with 270 regulated markets, 15 sub-regulated markets and 44 check posts have been set up. With related operations, 96 of the 270 regulated markets have been installed with commercial grading facilities and godowns of 1,000 ton were constructed in 98 regulated markets

The market committees functioning the collection of market fee of important agricultural commodities from Rs. 0.45 per Rs. 100 transaction (Marketing Act 1959) to Rs. 1.00 per Rs. 100 transaction (Modified Act 1991) bringing an increasing income for all Market Committees in the State from Rs. 11.5 million in 1991-92 to Rs. 106.8 million in 1995-96.

Numbers	Facilities
127	Godowns
98	Rural Godowns
178	Transaction Sheds
123	Drying Yards
65	Farmers Rest Sheds
134	Drinking Water Facilities
139	Sanitary Facilities
20	Electronic Weighing Scales
57	Generators
2,928	Dunnages
17	Digital Moisture Meters
29	Cool Drinking Water Facilities

Under the regulation act on marketing, for the semi medium farms and above, 80 % of the production of controlled commodities should be sold on the basis of regulated market to regulate the market prices and for collecting the revenue.

The list shows present major facilities related to 270 regulated markets in the State. Apart from this, 10 more rural godowns of 500 ton and 10 regulated markets are under construction in the State.

2) Marketing Welfare Scheme in the State

In order to help farmers to avoid distress sales during harvest times and inferior pricing periods, the State government offers pledge loan facilities in 98 rural godowns and 39 regulated markets having godown facilities with maximum ceiling limit of Rs. 10,000-25,000 per farmer with nominal interest of 15 %.

Besides, to attract the farmers for selling their produces through regulated markets and to get better prices, the Tamil Nadu Farmers Development and Welfare Fund was implemented in 1995. By this scheme, a farmer of 18-60 years old selling one metric tonne or more continuously will be compensated Rs 25,000 per year after his/her death or disability for an equivalent period of contribution.

3) Tamil Nadu State Agricultural Marketing Board

In 1970 the Tamil Nadu State Agricultural Marketing Board was established to carry out the development activities of market committees and liaison with the Government. All the market committees are to pay 15 % of their incomes to the Board, and the Board will allocate a half of this payment to the market development fund for development activities concerning marketing of agricultural produces, and another half for the Board expenses. Also with this income source, the new construction of a building for the Board and the Directorate of Agricultural Marketing Office at Guindy is under way.

Paralleling with technical innovations on marketing procedures, the Board and the Directorate of Agricultural Marketing Office in the State are paying efforts to put additional commodities for marketing control such as groundnut in the system of regulated markets in adjoining with neighboring states.

(15) Agro-industry

The general situation in the State is firstly similar to all India with a gloomy development in agro-industries. For large-scaled agro-industries, most factories have been installed in large cities, mostly in Chengalpattu, Madurai etc. For cottage and small scaled industries, the State has a rich heritage of hand-looms, ranking first in India with about 428,000 looms of which about 390,000 looms in cooperative units, mainly in South Tamil Nadu. In Salem, Madurai, Coimbatore, Hosur, Ranipet, Trichy, Dindigul, Tiruppur, Vellore, Katpadi, and Sivakasi, there are important centers of small industries.

In the State, the productivity per loom per day is about 4.77 m, compared with the national average of 5.12 m, due to the inferior working environment , old equipment and a rather low quality of the products. In order to assist this cottage industry, the Government has implemented various schemes for its promotion including the cooperative program. In the State 77 % of weavers have formed primary weavers cooperative societies. The primary societies and the cooptex are subjected to the concessional credit from the assistance framework of working capital by NABARD through the Tamil Nadu State Cooperative Bank and District Central Cooperative Banks.

Besides, in order to support this industry, programs have been undertaken by the State for modernization of handlooms and conversion to power-looms to deal with the situation of inferior working conditions and higher wages. Design development and

related market activities have been practiced at the same time to promote this important cottage industry in the State.

Regarding the situation of agro-processing in the State, important items are rice mills, oil mills and sugar factories which are performed in cottage and small industries types.

(16) Agricultural Supporting System

1) Agricultural Research and Technology Development

Agricultural research and technology development activities in the State are carried out by Tamil Nadu Agricultural University (TNAU).

There are 37 agricultural research stations in the seven (7) different agro-climatic zones in the State. The location of the research stations are shown in Fig. 2.2.3.

The research focuses on need-based field-oriented and location-specific research to develop the technology for the benefit of the farming community.

2) Technology Transfer Activities

Technology transfer activities are carried out by both of the Department of Agriculture and the TNAU in the State.

There are 384 main centers and 396 sub-centers for technology extension in the State. The organizational structures of State level, District level, Taluk level and Block level are shown in Fig. 2.2.4.

Districtwise Subdivision and Agricultural Extension Centers

District	Number of sub-division	Agricultural Extension Centers		
		Main	Sub	Total
TIRUVALLUR & KANCHI	13	27	31	58
VELLORE	7	20	19	39
TIRUVANNAMALAU	6	17	21	38
CUDDALORE	6	13	12	25
VILLUPURAM	8	21	22	43
TRICHI	10	33	15	48
PUDUKOTTAI	7	13	10	23
THANJAVUR	9	15	44	59
NAGAPATTINAM	11	19	59	78
RAMANATHAPURAM	5	11	6	17
MADURAI	9	23	25	48
DINDIGUL	5	13	11	24
SALEM	9	35	20	55
DHARMAPURI	8	18	7	25
ERODE	7	20	21	41
COIMBATORE	7	22	19	41
VIRUDHUNAGAR	6	11	1	12
SIVAGANGA	6	11	5	16
TUTICORIN	7	12	13	25
TIRUNELVELI	9	20	26	46
KANYAKUMARI	4	10	9	19
TOTAL	159	384	396	780

Source: Agrostat 94, Directorate of Agriculture, Madras.

Number of personnel concerned to the extension activities in the State are 7,695 personnel of which 4,126 personnel are Assistant Agricultural Officers who are the front workers at the sites as shown below. The number of operational holders to be taken charge by per assistant agricultural officer are 1,939 holders on average.

Number of Extension Personnel

Designation	Number of Persons
Joint Director of Agriculture (JDA)	21
Deputy Director of Agriculture-Subject Matter Specialist (DDA-SMS)	81
Deputy Director of Agriculture-Farmers Training Center (DDA-FTC)	12
Assistant Director of Agriculture-Information/Training (ADA-Inf/Trg)	24
Agricultural Development Officer (ADO)	374
Agricultural Officer-Training and Visit (AO-T&V)	750
Assistant Seed Officer (ASO)	369
Assistant Agricultural Officer (AAO)	4,126
Field Demonstration Officer (FDO)	935
Assistant Director of Agriculture (ADA)	159
Agricultural Officer-Subject Matter Specialist (AO-SMS)	679
Agricultural Officer-Farm Women Training (AO-FWT)	165
Total	7,695

The Directorate of Extension Education of the TNAU is vested with the responsibility of disseminating the latest technology emanating from the research programs to the farming community through various transfer of technology centers. Besides this, regional stations located at different agro-climatic regions of the State also undertake extension education activities.

As for the transfer of technology to farmers, the five technology transfer centers (Krishi Vigyan Kendras) at Coimbatore, Madurai, Trichy, Vrudhachalam and Salem conduct on campus and off-campus training programs on different aspects of agriculture and allied sciences for the benefit of various segments of the farming community. They also organize first line demonstration on oil seeds and pulses with a prime objective of establishing the potential of improved technology in increasing the productivity of oilseeds and pulses.

3) Crop Loan Scheme

In order to help marginal and small farmers in their agricultural production a short term loan scheme for cultivation purposes (Crop Loan Scheme) has been carried out by NABARD (National Bank for Agriculture and Rural Development) through Tamil Nadu State Cooperative Bank and District Central Cooperative Banks to Primary Agricultural Cooperatives for offering the crop loan to individual farmers. This scheme is basically for short term of 6 to 12 months upon crop type, and up to 18 months for sugarcane.

Besides the loan amount is made in two portions: cash and agricultural inputs decided by NABARD in principle. In general the loan amount for paddy is about Rs.3,000 per acre made in about Rs 1,000 by cash and the rest by materials. The annual interest is from 12 to 18 percents depending on season and region.

2.2.5 Water Resources and Irrigation

(1) Water Resources in the State

Basically, the State is deficient in water resources. Per capita water availability in the State is only 600 m^3 against the national average of 4,000 m^3. The annual average rainfall in the State is 943 mm (in winter: 50mm, summer: 143mm, SW monsoon 300 mm, and NE monsoon 450mm) as against the national average of 1,194 mm. Therefore it is necessary to explore the way and means to augment the available supplies and to use them more efficiently and economically. Lying in the tropical zone, the State has good sunshine for most of the year except in the months of November and December when the sky is usually cloudy.

As stated in the Explanatory Version of Tamil Nadu Water Policy, the State has surface flow potential of 340 million m^3 which about 333 million m^3 has been utilized already. A further augmentation of irrigation potentials by surface water could be achieved only by the modernization of existing irrigation systems. In 1951, some 2 million ha were irrigated which rose to the peak of 2.87 million ha in 1978. This was followed by a progressive decline to 2.45 million ha in 1987. It is noted that canal irrigation system, tanks and other surface sources command area which rose to their peak in 1971 have declined since. The major irrigation water sources of the State in 1992-93 are shown in Table 2.2.4 and Table 2.2.5, and summarized in the table.

Water Sources	Command Area (million ha)
Canals	0.85
Tanks	0.63
Groundwater	1.20
Others	0.01

Source:Season and Crop Report of Tamil Nadu for Agricultural Year 1992-93

Most of rivers in the State are dry except during monsoon seasons. Besides, the flat gradient of the State does not offer many sites for the construction of large storage. One-third of areas irrigated in the State are those irrigated by tanks. Therefore, the maintenance and development of these tanks is basically important for agricultural development in the State. Next to the tank irrigation is lift irrigation through wells individually owned. These are simple sources that beneficiaries bring sustainable benefits to the agricultural sector. Also the tank irrigation system has a special significance to the marginal and small scale farmers who make a very large number essentially depending on irrigation.

(2) Water Policy of the State

In 1987, the Government of India, Ministry of Water Resources, had formulated a National Water Policy. The Policy formulated based on the recognition that water is a prime natural resource, a basic human need and precious asset, and planning and

development of water resources need to be governed by national perspectives. The National Water Policy lays down general guidelines for preparing basin-wise master plans, priorities for water use, inter-basin transfer etc. It is suggested to formulate the State Water Policy within the framework of the National Water Policy. The Government of Sate has formulated a State Water Policy in 1994. It stresses to ensure equitable use of the scarce water resources, and, in the planning and operation systems, water allocation priorities should be broadly, applied for 1) drinking water, 2) irrigation, 3) hydropower, 4) industrial and other uses.

2.2.6 Environmental Conservation

(1) Environmentally Fragile Areas in Tamil Nadu

The entire coast of the State roughly about 6,000 km are ecologically sensitive as the support of large number of aquatic flora and fauna of rare values. Some of these species are highly endangered and figure in Red Data Book of IUCN. Taking this into consideration the Government constituted the first Marine Biosphere Reserve in South East Asia as Gulf of Mannar Biosphere Reserve comprising 21 Islands along the eastern coast from Rameswaram to Tuticorin.

The Marine National Park comprises these 21 islands lying off the eastern coast from Rameswaram to Tuticorin. These are ecologically highly fragile. These islands are mostly of coral origin and very significant from the zoological point of view. This area is the lost refuge of very significance off Indian coast of most endangered mammal, the Dugong (Dugong Dugon). The area contains the rare and unique species of fishes, dolphins, corals, sea grasses etc. Mangroves and sea groves help in sustaining the corals. The area is richly endowed with unique coral formation, marine shells, molasses and tropical fishes associated with coral Islands. All these need protection from irretrievable destruction.

The coastal stretch of Mandapam, Rameswaram, Tuticorin, Nagapattinam and Thanjavur delta are environmentally fragile for its sensitive marine ecology and being nesting and hatching sites of endangered turtles such as Olive Ridley as well as nearly 1200 species of resident and migratory birds.

Entirely different from coastal ecology, the Western Ghats in the State are ecologically one of the most sensitive and rich in natural endowments anywhere in the world. Because of this they were declared as one of the 18 hot spots of bio-diversity in the world. They are highly rich in floral values. The Kani tribes in Agartamalai hills has been given for the first time in the world patent for developing a medicine "Jeevani" from the rare herb of Truchopus Zelunycus. There are several rare plants of this kind in the western ghats. Some them have been deciphered whereas some are yet to deciphered. It is said that Nilgri District alone has more than 20,000 species of medicinal plants, several of which are yet to be deciphered.

The State part of the Western Ghats end up in Mahindragalor hills of Kanyakumari

division encompassing extremely rich bio-diversity. Kanyakumari Wild Life Sanctuary (proposed), Nellai Wild Life Sanctuary (proposed), Kalakad Mundanthurai, Tiger Reserve, Srivilliputhur, Kodaikanal (proposed) Indira Gandhi Wild Life Sanctuary/National Park are the protected areas situated in western ghats in The State region of the bio-geographic zone. This area has rare herbal plants of medicinal importance along with large tree species - many endangered species of smaller and larger mammals, amphitrians, reptiles are also spread in western ghats. The ghats are sensitive fragile mountain system which also form important catchment of the rivers in the eastern plateau as well as coastal plains. Contiguous forests of Mudumalai, Bandipur, Wynad, Nagarkoil complex are contiguous habitat for many species of mammals and birds which is important for long term survival of the wild life species as the hetrogyogosity is sustained.

Beyond Satyamangalam, there is a meeting point of the Eastern Ghats and Western Ghats which itself offer a wide range of bio-diversity. It also offers migratory routes for the endangered species of Asian Elephants which is important for genetic health.

The newly proposed sanctuaries of Cauvery, Satyamangalam and Kodaikanal form an important segment of floral and faunal diversity and are ecologically fragile. The entire western part stretch offers high degrees of endemism and also provide home to several groups of birds. The area is also home for important primate. Out of 18 prime species found in India, five are found in Kalakud Mundanthurai Tiger Reserve.

The Ministry of Environment and Forests have passed an Act "The Environmental Protection Act, 1986" to protect the environment and has also issued a hand book on environmental procedure and guidelines.

(2) Mangroves

Mangroves are very specialised forest eco-systems of tropical and sub-tropical regions of the world bordering the sheltered sea coasts and estuaries. They stabilise the shoreline and act as bulwork against encroachments by the sea. Mangrove forests are dominated by salt tolerant inter-tidal halophytic sea plants of diverse structures. Mangroves occur all along the Indian coast line in sheltered estuary, tidal creeks, back waters, salt marshes and mud floats covering a tidal area of 6,740 sq.km in India which is about seven percent of the world's total mangrove area. Based on the recommendations of the National Committee on wetlands, mangroves and coral reefs, 15 mangrove areas have been identified for intensive conservation and management purposes. Pitchavaram and Point Calimar are located in the State.

(3) Corals and Coral Reefs

Four coral areas have been identified in India, viz., Gulf of Mannar, Andaman and Nicobar Islands, Lakshadweep Islands and Gulf of Kutch for conservation and management.

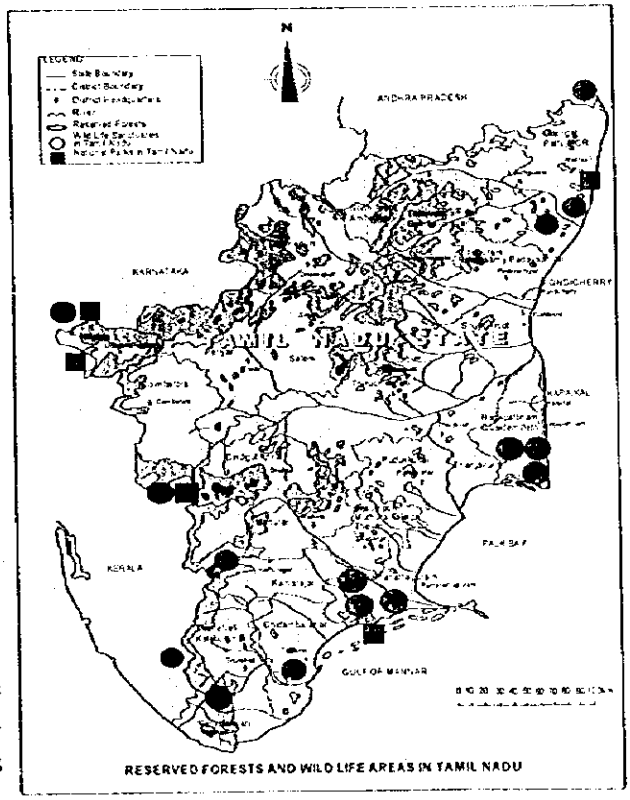
(4) Kalluru Reef

The western extreme of this reef is situated about 6 cables south-eastward of the eastern extreme of Kurusadi Theevu. It is of coral formation and has on it the Shingle Island and has bushes and shrubs on it. The sea breaks heavily on the south western edge of the reef.

The reef on which is Pumurichan Theevu and Kurusadi Theevu forms a natural break water, protecting Pamban Pass and channels leading to it from the swell of the south-west monsoon.

(5)National Parks and Sanctuaries

The State's diversity of flora and fauna is spectacular for its size due to a wide range of habitats. Dry deciduous forests, thorn forests, scrub, mangroves and wetlands occur in the dry tracts that occupy the plains and lower hills of most of the State. Moist deciduous and wet ever green forests, as also shoals and grassland occupy most of the hills in the moister parts of the State, chiefly in the western ghats. These forests are rich in plant and animal like farns. Out of 35,000 species of green plants found in India about 3,000 are found in the State. Most of the important species of the mammals of India are also found here. Among the species described by Dr Tikkedar, former Director of the Zoological Survey of India as indeterminate (i) Vulnerable (v) or endangered (e) the following are found in The State.



RESERVED FORESTS AND WILD LIFE AREAS IN TAMIL NADU

Slender Loris (v), Lion tailed macaque (e), Indian Pangolin (i), Jackal (v), India fox (e), Indian Wild Deer (v), Sloth Bear (v), Ratel (v) Striped Hyaena (v), Jungle Cat (v), Leopard (v), Tiger (v), Mouse Deer (v), Gaur (vb), Black Buck (e), Nilgri Tahr (e) Grizzled grey squirrel (v), Common Dolphin (i), Dugong (v).

The State has 15 wild life sanctuaries and 5 National Parks covering an area of 2,834 km^2, i.e. 12.48 % of the forest area, well above the 10% considered desirable.

The State has also the unique distribution of having two bio-sphere reserves, one in the Nilgris and another in the Gulf of Mannar.

The Gulf of Mannar lies in the southern study area. A tiger reserve under "Protect

Tiger" has also been established combining Mundathurai and Kalakad Wild Life Sanctuaries. An area of 252,601 ha. (2,526 km^2) has been declared as wild life sanctuaries. The Arignar Anna Zoological park at Vandalur is a modern Zoological park with open moat enclosures formed over an area 510 ha. of reserved forests near Chennai.

The Red Data Book on plants brought out by the BSI has identified 123 plants in the State as endangered. Plant sanctuaries have been created by identifying and protecting the locations in which these plants occur. For ex-situ and in-situ conservation of germ plasm, a genepoal garden has been created in Gudalur Taluk of Nilgris and another one for the sub-tropical region is proposed at Kodanad in Kotagiri Taluk of the Nilgris.

(6) Regulatory Procedures and Legislation

1) General

In India all the major legislation related to environment are enacted in the country by the Ministry of Environment and Forests (MEF). But beside these some States and Union Territories may also enact their own legislation.

The State Pollution Control Boards (SPCB) established in every state of the country are responsible for implementing these legislation as well as issuing the rules, regulations and notifications. In the case of Union Territories, the Pollution Control Committee (PCC) is responsible for this. The TNPCB is at Chennai city. The Central Pollution Control Board (CPCB) at New Delhi coordinates the activities of the state pollution control boards and the pollution control committees. The CPCB also advises the Central Government on environmental related matter, and facilitate circulation of Rules and Notifications in the country.

According to project categorization for environmental clearance, this project for Rehabilitation of Minor Irrigation Tanks falls into the River Valley Projects category. But it does not requires environmental clearance from the Central Government, because its investment is below Rs.500 million ceiling. So it only needs to obtain permit from the State authorities. Moreover this is a water related project, and water is a state subject, hence its storage, exploitation and uses are the responsibility of the state authorities.

2) Legislation and Acts

Several Acts adopted by the central government and the state government of Tamil Nadu relate to the water sector, to which this project belongs. These Acts are of three groups:

i) Acts related to environmental protection, such as Environmental (Protection) Act of 1986

ii) Acts relevant to the regulation of domestic and industrial discharge into water bodies, such as the Water (Prevention and Control of Pollution) Act of 1974.
iii) Acts relevant to the distribution and utilization of water for irrigation, such as the Tamil Nadu Irrigation Cess Act of 1965, Rules and Regulation : Part I-Rules for Water Regulation, PWD.

Out line of these legislation and acts are described in Volume IV : Appendix E.

The MEF establishes new rules and regulations on the basis of this Act. According to current procedures, the delineation between the central government, state governments and local agencies is as follows :

All the development projects which have large investments and may have a direct or indirect impact on air, water, land and coastal resources need a detail Environmental Impact Assessment (EIA) prepared by the proponents and submitted to the Government of India for scrutiny and clearance. The EIA is to be prepared using baseline environmental data, and quantifying impacts for each one of the natural resources, cultural/historical assets and social environment issues. An effective plan for environmental management and follow up action with periodic inspections during the construction and operation stages of the project should also be submitted. Flow chart of obtaining environmental clearance is presented in Fig. 2.2.5.

2.3 Background of the Study

2.3.1 Traditional Tank Irrigation

Most of the earlier tanks in southern India were constructed for the paddy cultivation, storing rainfall in the wet season and, with its water available, providing water for the second crop of paddy in the dry season. Limited cultivation of perennials (sugarcane, bananas) often developed in the lower portion of the command area with a supplemental irrigation in dry season from dug-wells or shallow tubewells supplied by seepage from the reservoir.

The area with abundant monsoon rainfall and opportunity for coverage of a considerable proportion of the area with supply from tanks in the dry season, the area is mostly exclusive for paddy (rainfed or with supplemental irrigation) during the monsoon. Also paddy is the choice of most cultivators as the crop in the dry season, if being given a supply of water. This cropping system is likely to be maintained.

On the other hand, the potential for tank development in semi-arid region is limited due to the low run-off for making a small preparation of the arable area only. The region, therefore, depends for the subsistence upon rainfed cultivation of jowar, bajra, oil-seeds, etc. in the monsoon season, and this will be continued. A tank in this situation may be used for a supplemental irrigation of crops in the monsoon season, and of similar crops

plus possible wheat in the dry season.

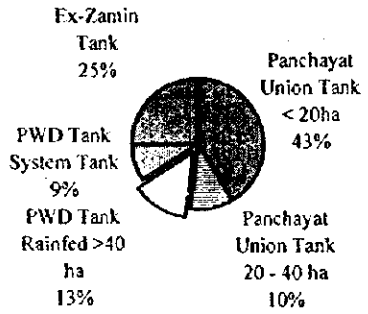
Minor Irrigation Census was conducted in 1987. The total number of tanks in India was counted 510,00, and they are concentrated in the states of Madhya Paradesh, Andhra Paradesh, Kerala, Karnataka, West Bengal and Tamil Nadu. The State share 7.8% of total tanks in the Nation. But the share of tank irrigation at 31% in the State 1983-84 was the largest among other states in the Nation

2.3.2 Classification of Tank Irrigation System

The irrigation tanks are classified based on the water supply system and maintenance agencies as shown in the following table.

Water Supply	O&M-wise
1. System Tank	1. Panchayat Union
2. Rainfed Tank (non-system tank)	2. PWD

The system tanks are getting their water supplied from semi-perennial rivers throughout a system of canals in to a series of tanks situated as a chain along the river. It may also have some catchment area. The supplied water from supply channel is taken from a river by the construction of weir/barrage across the river. The water from the river flows through the channel to the tanks and fills them one after other. Thus the second tank will get water only after the first tank is filled in and so on. In other aspects, these tanks are similar to the rainfed tanks with regard to irrigation and field etc.



SHARE OF IRRIGATION TANK TYPE IN THE STATE

The rainfed tanks store rainfall in their own catchments and they are supplied with surplus water from upper tanks through the supply channel, again they supply surplus water to lower tanks through surplus channel, which is called chained tanks.

Panchayat Unit tanks are tanks having a command area less than 40 ha, and under the control of village union (Panchayat union), PWD tanks are tanks having a command area more than 40 ha, and maintained by the PWD.

Ex-Zamin tanks were constructed by Zamindar (landlords) during the British administration. After abolishment of zamindari system by the State Government in 1957, they are transferred to Panchayat Union and PWD tanks based on their command area.

There are about 8,000 Ex-Zamin tanks of which more than 60 % are concentrated in undivided Ramanathapuram district.

Number of Irrigation Tanks in Tamil Nadu

No.	Name of District	Panchayat Union Tank			PWD Tank			Ex-Zamin Tanks	Grand Total
		< 20ha	20 - 40 ha	Total	Rainfed >40 ha	System Tank	Total		
1	Kanchipuram & Tiruvallur	1,241	542	1,783	1,202	5	1,207	756	3,746
2	Vellore	1,482	602	2,084	632	537	1,169	482	3,735
3	Cuddalore	1,213	553	1,766	573	184	757	79	2,602
4	Salem	449	100	549	188		188		737
5	Dharmapuri	1,451	128	1,579	98	3	101	154	1,834
6	Coimbatore & Erode	42	22	64	57	2	59		123
7	Thanjavur	338	153	491	5	680	685		1,176
8	Pudukottai	4,609	725	5,334	369	161	530	58	5,922
9	Trichy			0	173	85	258	214	472
10	Madurai & Dindugal	3,142	249	3,391	288	483	771	331	4,493
11	Sivagangai, Ramanathapuram & Virudhunagar	642	691	1,333	1,378	130	1,508	7,367	10,208
12	Tirunelveli & Tuticorin	806	159	965	288	397	686	445	2,096
13	Kanyakumari	1,062	12	1,074	26	960	984		2,058
14	Nilgiris			0			0		0
Total		16,477	3,936	20,413	5,276	3,627	8,903	9,886	39,202
Weight of Category		42%	10%	52%	13%	9%	23%	25%	100%
Study Area Total		1,883	1,233	3,116	2,580	135	2,715	8,123	13,954
Weight of Study Area		11%	31%	15%	49%	4%	30%	82%	36%

Source : PWD, 1996

2.3.3 State and Central Government sponsored Schemes

The minor irrigation schemes are considered to be those schemes which benefit an *ayacut* (command area) of less 2,000 ha. In the State, 67 % of net irrigated area comes under minor irrigation schemes. The major components of minor irrigation schemes relate to construction and maintenance of tanks, open wells and tubewells besides small irrigation works under streams. Apart from this, Special Minor Irrigation Programme (SMIP) contemplates formation of tanks, construction of *anicuts*, excavation of link channels, restoration of abandoned tanks, formation of percolation ponds, river pumping schems etc. Another Minor irrigation scheme viz., Desilting cum Reclamation (DCR) which include desilting of tanks to restore the capacity lost due to siltation by reclamation of foreshore lands is also undertaken regularly.

2.3.4 Pilot Study on Modernization of Tank Irrigation through Ford Foundation

In 1981, as a pilot study of modernization of tank irrigation was launched to investigate the present status of tank irrigation system, in Padinalur Tank, Chengalpattu District, by the Center for Water Resources, Anna University, Madras, with financial assistance from

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3	Cuddalore	1,243	553	1,796	573	184	757	29	2,602
4	Salem	449	100	549	188		188		737
5	Dharmapuri	1,451	428	1,879	98	3	101	151	1,831
6	Coimbatore & Erode	42	22	64	57	2	59		123
7	Thanjavur	338	153	491	5	680	685		1,176
8	Pudukottai	4,669	725	5,394	369	161	530	58	5,922
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the Ford Foundation. Data collected on soil, water and crop management aspects of the command area through a bench mark survey was analyzed. The proposals framed for the improvement of tank irrigation system has given the start for launching more and more of tank modernization schemes.

2.3.5 Modernization of Minor Irrigation Tanks through World Bank Assistance

Tank modernization of Periyar-Vaigai systems and water management projects under Sathanur, Thambaraparani, Kodayar systems etc., are projects to improve canal system efficiencies, taken up with the World Bank assistance. Through improving the operational and field application efficiency, 1,890 million m^3 of water is estimated to be saved and this may extend the irrigation area additional at about 60,987 ha.

2.3.6 Tank Modernization with EEC (EC) Assistance

(1) Project coverage

A preparation mission of the EEC (European Economic Committee) for identification of project for financial aid in 1983, observed that the program for modernization of minor irrigation schemes very attractive and would achieve relatively quick return to farmers living in depressed these area. The aim of the project is identified as to increase agricultural production and income of farmers through extended irrigation and better water management of system based on tank irrigation thus leading to a higher cropping intensity.

A financing agreement for modernization of 150 rainfed tanks with command area between 100 to 200 ha each was signed 1984 between EEC and GOI. EEC sanctioned a grant of ECU 25 million (European Currency Units) for this project and the GOI portion was ECU16.3 million (39.5% of total cost). Due to appreciation of ECU during the period of implementation, additional 56 tanks were included in the project, then totaling the number of phase I tanks increased to 206.

In 1989, an agreement was signed for Phase II under EEC grant ECU 24.5 million and GOI portion ECU 8.7 million (26.2% of total cost) to modernize 266 rainfed tanks and 80 Ex-Zamin tanks.

Again, due to the appreciation of ECU, the Phase II Extension was started based on the balance of Phase II assistance in 1994. Under the Phase II Extension, 50 rainfed tanks are under the construction and 50 tanks are under preparation.

EC Tank Modernization Project

Sr. No.	District	Phase I	Phase II		Phase II Extension		Total
		Rainfed	Rainfed	Ex-Zamin	Rainfed	Under preparation	
1	Kanchipuram & Tiruvallur	38	52	-	10	10	110
2	Vellore	21	11	-	1	2	35
3	Tiruvannamalai	13	15	-	7	9	44
4	Villupuram	34	22	-	4	5	65
5	Cuddalore	2	-	-	-	-	2
6	Perambalur	-	12	-	5	3	20
7	Karur	-	6	-	1	-	7
8	Tiruchi	-	6	15	-	2	23
9	Pudukottai	27	24	12	6	5	74
10	Dindigul	-	7	-	2	1	10
11	Madurai	-	19	-	4	3	26
12	Sivaganga	24	4	33	2	3	66
13	Ramanathapuram	25	10	10	3	2	50
14	Virudhunagar	22	11	10	1	4	48
15	Tuticorin	-	4	-	-	-	4
16	Tirunelvei	-	13	-	4	1	18
	Total	206	216	80	50	50	602

Note : as of January 1997

(2) Scope of works

Scope of the works of EEC project are as follows:

- rehabilitation of the main irrigation and drainage channels, lining of these channels and ancillary works
- rehabilitation of large tanks, bunds, sluices, surplus weirs and supply channels
- modernization and repair of limited number of similar small Ex-Zamin tanks
- on-farm development
- monitoring, evaluation and impact studies.

(3) Tank selection criteria

Selection of tanks for modernization was based on the request of farmers subject to hydrological and social viability. Project area under the scheme was earmarked by the EEC Appraisal Mission.

The norms of EEC for selection of tanks in Phase I and II are as follows:

Phase I	Phase II
- tanks should be rainfed tank - command area should be below 200 ha - B/C ratio should be higher or equal to 1.00 except for tribal areas where it shall be higher than or equal to 0.8.	- tanks should be rainfed tanks, - command area should be between 100 and 200 ha - EIRR should be more than 12% - for Ex-Zamin tanks, command area is to be between 4 to 50 ha - the gap between registered command area and cultivated area shall be between 10 and 25%

(4) Implementation of Phase II Extension

Based on the review and experience of EEC tank modernization projects, the following steps for selection of tanks are applied:

- a preliminary discussion by Superintending Engineer, tank modernization circles of PWD-WRO, with the concerned collectors for the approval of broad list of tanks,
- overall screening including rapid hydrological feasibility,
- social screening for arrangement of Community Organizer,
- Community Organizer mobilization for formation of Farmers' Association based on the social screening,
- provisions for tank bund, sluices, supply channel improvements, field channel lining, community well and catchment treatment works based on the discussion with farmers' association using community organizers,
- final selection at district level committee,
- preparation of feasibility report by feasibility report generator including the detailed estimate for the components, and
- approval by the Chief Engineer (DRCS) and recommendation to the Government for sanction.