# ROLE OF WATER RESOURCES IN AGRICULTURAL DEVELOPMENT

## A Case Study in Tamil Nadu

BY

K. R. GITA

CENTRE FOR THE STUDY OF REGIONAL DEVELOPMENT
SCHOOL OF SOCIAL SCIENCES
Jawaharlal Nehru University
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of the Requirements for the
Degree of Master of Philosophy

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School of Social Sciences,
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## CONTENTS

## PREFACE

"DAYS EVAPORATE UNDER THE HOT SUN" - Beth Brunschweig.

Days are evaporating under the hot sun without water in most of the regions of India which is due to the unequal distribution of rainfall. Further, this is also mainly due to the various natural, physical and hydrological disparities among the regions. From time immemorial water is an important input of agriculture and is considered responsible either for the prosperity or for the backwardness of a region.

The role of water in Agricultural Development is of vital concern and harnessing it when in abundance and ameliorating it when in scarce; both creates a multitude of problems and hence requires a careful planning of this precious, scarce resource.

The present crucial period of water scarcity in our country has its impact on all manifestations of our everyday life like perpetual scarcity in the farm front for irrigation, inadequate supply of potable water in all urban areas and the water levels of reservoirs touching the lowest ebb during summer months creating problems for the hydel power production in turn affecting the industries which are all creating many economic problems in the country by affecting the production in farm and factories.

Tamil Nadu, the macro-region is chosen for this study, where the perpetual scarcity of this "mobile constituents of nature" is there with perennial problems; which is a part of the programme of my Master of Philosophy.

This study examines the contribution of water in the agricultural development of this macro-region and as well as it brings out the regional agricultural and economic disparities.

This study is mainly an attempt to analyse the part played by water in agricultural development and this is expec ted to serve as a broad base for further detailed analysis of this specific problem.

I take this opportunity to express my deep sense of gratitude to Mr. Ashok Rao who supervised my work. I am also indebted to Dr. Sivaswamy and Dr. L.S. Bhat for giving me valuable suggestions and constructive criticisms. I acknowledge my thanks to Prof. Moonis Raza for his valuable suggestions, keen interest and encouragement.

I am much indebted to Mr. Winnfred, Executive Engineer (Gauging Division), P.W.D., Tamil Nadu, for his valuable suggestions and also for providing me with statistical data for analysis.

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Gita K.R.

Date: K.R. Gita

New Delhi.

# INTRODUCTION

Water, the earth's most abundant compound, is a vital constituent in all living matter. Its unique properties and ubiquitous nature always affect all aspects of human activities and endeavours in innumerable ways. It continues to reshape the landscape and hence, is a dominant factor governing all aspects of the environment on the earth's surface. Since, it has been involved in the rise and fall of civilization, from the beginning the use and control of water is therefore is of vital concern to every human-being and to every nation.

W.W. Eckenfelder says "water in todays market place is an indispensable resource when measured in terms of weight, water is by far the greatest resource used by man. For example, water use per capita in the U.S. is greater by a large factor than all other resources combined. However there is an important element in the development of a water resource which distinguishes from that of other physical systems namely man's vital ability to use water, pollute water supplies, reuse water which has a recent history recycle, slightly used water and renovate the most objectionable water" [1].

The emergence of water resource as a field of study involves the factors of what constitutes a proper assessment of such resources, the

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[1] W.W. Edkenfelder: International Conference on Water for Peace Vol.IV, 1967.

estimation of physical potential, the determination of technical and economic feasibility and the evaluation of social desirability. Further, the availability of water in any region leads to a deeper understanding of natural endowments and their fusion with the resource further reflects the fact that it is not only a commodity, which is directly used by man, but it is often the main spring for extensive economic development, commonly an essential element in man's asthetic experience and always a major formative factor of the physical and biological environment which provides the stage for his activities. As a result, the water resource of any region can be regarded as a highly variable and mobile resource in the widest sense.

High mobility is one of the distinguishing characteristics. Since, it is the only compound that exists naturally in substantial quantities in the three physical states - solid, liquid and gas; this compound also plays a major role in the thermal economy of the earth and its atmosphere. The high mobility and thermal behaviour of water are well illustrated, in the series of interconnected dynamic events that are collectively called the "Hydrological cycle".

## The Hydrological Cycle

The noted Greek Philosopher Plato (427-347 B.C.) recognised that the earth's rivers were fed by rain and that water moved in a continuous ocean-land-ocean cycle what we know today as the 'Hydrological Cycle' [1].

Precipitation when it comes, it falls both over land and the ocean. A part of it get evaporated from the ocean and reaches the atmosphere as water vapour. Similarly from the land, a part of it get evaporated from the water bodies existing over the land surface and a part of it is get transpired from the vegatative cover. Over the land, the remaining part will become surface run-off and finally, after its utilisation during its course it finally reaches the sea. Those part of precipitation which goes as water vapour both from the land and the ocean due to the horizontal advection of water vapour in the atmosphere, comes back again as precipitation over the land and sea and the cycle again continues like this.

Although, fluctuations in the rate of water may occur in certain segments of the above cycle, the total water volume has remained constant for millions of years. The cycle is powered by the solar energy, the daily input being greater than all energy utilised by man. Since the dawn of civilisation, in actuality water is not continuously moving. It may be temporarily stored (for centuries) either within the earth's crust, on the earth's surface or in the atmosphere. At any instant it has been found out that only 0.005 per cent of the total water supply is moving through the cycle [2].

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[1 & 2] Owen S. Oliver: "Natural Resource Conservation" (An Ecological Approach). The MaCmillan Company, New York 1971, pp. 117.

<u>Availability of water at the Global Context</u>

We shall trace the major pathways of the hydrological cycle, beginning with the oceans which cover 70% of the earth's surface with salt water up to 7 miles deep. The oceans contain 97.2% of all earth's water which is over 317 million cubic miles (1 quadrillion acre ft.). As water molecules at the ocean's surface warm up, they reach the atmosphere by evaporation. It is estimated that more than 83,700 cubic miles of fresh water are evaporated from the world's salty oceans annually. When the oceans are not constantly refilled, the oceans would drop by 39 inches yearly. This atmospheric moisture forms a blanket around the earth which retards heat loss by radiation. Without this water vapour mantle, the earth would have a temperature of — 300 degrees [1].

As the water vapour rises, it gradually cools, condenses and forms clouds. Of the 83,700 cubic miles evaporated from the ocean 71,000 cubic miles return to the ocean as precipitation and 9,000 cubic miles fall on land. The atmosphere holds a constant volume of less than one hundred thousandths (3100 cubic miles) of the total water supply. This atmospheric moisture represents latent energy originally derived from the sun which is released through storms [2].

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[1 & 2] Owen S. Oliver: "Natural Resource Conservation" (An Ecological Approach). The MaCmillan Company, New York 1971, pp. 117.

Further 75% of the total fresh water is locked up in glaciers and ice sheets while almost all the remaining water is in the form of groundnut. It is an astonishing fact that rivers and lakes hold only 0.33% of all fresh water and the atmosphere a mere 0.035% [1].

Availability of water in India

Adequate, accurate and long range study of the flow in rivers are becoming essential to estimate the surface water resources of any country.

In India, due to hydrological, geographical and political factors acting with regard to catchment areas resulted in inadquacy of the data. Though rainfall data are available, the river flows are not available even for many of the most important river basins. As a result, present assessments are mainly based upon the co-efficients of run-off.

According to the studies made by Dr. Khosla the total annual flow for all the river systems in India comes to 16,72,599 m.cu.m or 1356 million acre ft.[2].

The annual rainfall over the entire country is just over 37,000 mill. ha. cm. (300 m.a.ft.) of water. Of this about 12,350 mill. ha. cm. (1000 m.a.ft.) of water is lost by evaporation and roughly 8,020 mill. ha. cm.

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[1] Chorley, R.J. ed.: Water, Earth and Man. London, Methuen & Co. 1969, p. 11

[2] Khosla, A.N.: "An Appraisal of water resources". Unesco. 1951.

(650 mill. acre. ft.) seeps into the soil leaving 16,760 mill. ha. cm (1360 mill. a. ft.) to flow into the river systems. The surface flow however, cannot be utilised in toto because of limitations imposed by topography, flow characteristics, and soil conditions. It has been estimated that only about 5,550 mill. ha. cm. (450 mill. acre ft.) can be utilised for irrigation.

Of the 8,020 mill. ha. cm. (650 mill. a. ft.) of water that annually seeps into the soil 4,320 mill. ha. cm. (350 mill. a. ft.) remains in the top layers and contributes to soil moisture which is essential for the growth of vegetation. The remaining 3,700 mill. ha. cm. (300 mill. a. ft.) percolates in the porous strata and represents the annual enrichment of underground-water [1].

The central water and power commission has also worked out the surface water resources of different regions during the period 1954-66. This study was based largely on statistical analys is of the flow data wherever it was available and on suitable rainfall- run-off relationships wherever observed data is meagre. According to this study in the year 1960, the water resources of the various basins accounted to 18,81,057 m.cu.cm. (1525 mill. a. ft.) [2].

Out of the total amount of groundwater recharge estimated, a part of it will be lost as evapo-transpiration and sub-surface flow etc. Different percentages of such losses were assumed for different areas based on topography, rainfall and other geohydrological and physiographic conditions of the areas and also on the basis of earlier studies and experience. After deducting such losses from the total available groundwater recharge works out to be of the order of 219 mill. a. ft. per year.

## Availability of water in Tamil Nadu

Located in the south, eastern part of the country and coming under the influence of the maldistribution of rainfall of both the southwest and northeast monsoons, the importance of water in the state is well recognised.

At present 94% of its surface water has been utilised and the available groundwater according to the Groundwater Directorate is 11.79 million acre ft. and the present extraction accounts for 6.966 mill.a. ft. and the remaining will be extracted within a period of years.

## Water Resource and Agriculture

Water is considered as an important input in agriculture and hence agricultural water management receives greater attention from the past.

By releasing several high yielding strains of different crops, especially cereals and with the development of multiple cropping techniques, crop scientists have made a major contribution in setting the green-revolution in Indian agriculture. The immense potentialities of these new varieties and modern techniques of crop production cannot be realised, unless water management practices and the associated needs are tailored to suit them. Concepts in soil-plant, climate-water relationships have changed radically from the past, but the irrigation practices are remaining the same.

Efficient water management is an essential feature of irrigation planning. Integrated development of water resources, efficient methods of conveyance and distribution of water on the farm, suitable methods of water application, soil management practices and cropping patterns for high water use efficiency, timing of irrigation to suit crop growth stages and the removal of excess water are important aspects of a comprehensive irrigation development programme. Further irrigation projects cannot be considered complete, until it can apply water efficiently at times and in amounts consistent with soil condition and plant growth requirements.

Mid term review by Madras Planners writes "Madras is among the few states in India where there has been no default in the fulfillment of the there is always an imbalance between population and resources in the state. Though agriculture has reached a fairly high level of production,the scope for development is limited and the scantiness of water resources in the state is considered as the main criteria which always creates fluctuations in the economy of different regions of the state.

In the coastal regions of the state, the largest number of east flowing rivers and an appreciable amount of rainfall received from the southwest and northeast monsoons are playing major role in the agricultural prosperity of the region. In the interior part, the subsoil water is frequently too deep for use except by pumping and the rainfall is also poor than in the coastal areas. Hence, the interior part of the state are the main water deficit areas.

Owing to these above geographical and climatic differences there have been wide discripencies between the agricultural development of the coastal regions with that of the other interior regions.

Water resources and Agricultural Development

Always a minimum analysis is necessary to determine the possible contribution of water resources in agricultural deveopment so that it helps in knowing how far water as an input stimulate agricultural growth and development and at the same time it also helps in knowing about the return of the irrigation investments of the state.

Water availability in return to regional agricultural development has been assessed in so many studies which found out that water always constitutes a bottleneck to agricultural economic growth in water deficit areas of the country and that its presence in large quantities in other regions guarantee rapid growth. The studies have further confirmed the fact that water resources developments are good tools in accelerating regional agricultural growth provided the other factors are also favourable.

For analysing the above fact irrigation which is familiarly known as the "Productivity Criterion" has been mostly taken since, it has been felt that remunerative irrigation works are always expected to develop the country's water resources to the full and in the optimum manner. Further, irrigation is only one of the factors in agricultural development and best results are naturally obtained when there is a balanced development of various factors, the yield of each factor being as much a function of its own growth as of the growth of other complementary factors.

When the regional agricultural development is analysed taking irrigation as the main criterion (by means of emphirical tests) in Tamil Nadu, there is lot of imbalances seen among the canal irrigated region and the tank irrigated region. The main reason for this is that from the past many medium and minor irrigation facilities have been extended in (high and medium rainfall) the canal irrigated region, With a view of providing security against droughts which have become stimuli for the highest development and the low priority in the tank irrigated region is due to the unstable demand for irrigation.

This in turn also has modified the structure of irrigation rates which has been more in the canal irrigated region due to higher demands and the unstable demand in the tank irrigated region has resulted in the low irrigation rates.

# CHAPTER I

# GEOGRAPHICAL BACKGROUND OF TAMIL NADU

INTRODUCTION

Natural resources are essentially parts of the environment to which man adapts himself and from which he derives his worldly goods. As his intellect grows and his numbers multiply, his needs become greater. His incessant endeavours and the sphere of activities are enlarged. As a result, he has to adjust his activities more carefully to accord with the natural conditions in order to utilise more efficiently, the natural resources available to him. He can achieve such adjustment and utilisation only when he comprehends his environment as a whole and recognises the intricate relationships among its parts. Hence, the basic factors he has to study for understanding the unity and interdependence of natural resources at his disposal are topography, location, drainage, soil and climate.

Topography is both a product of and contributor to environmental factors. For example windward slopes receive more rain than leeward side which results in a thick vegetative cover in that part which is a product of soil and rain. This in turn protects soil erosion and increases the soils' water storing capacity. Water storage in turn reduces soil injury by leaching. All these are mainly due to a single topographic element of exposure to winds. Hence, topography operates with equal or even greater potency in the variegation arrangement of the environmental composite or ecosystem.

Among the attributes of place, climate holds high rank but it cannot be regarded as a natural resource in the ordinary sense being essentially neither mutable nor destructable. But at the same abundance of resources or poverty, conservation or waste of natural resources cannot be interpreted without the inevitable persistent influence of climate.

Soil has developed naturally and remains undisturbed, which reflects the whole composite of environmental factors. Since it helps to sustain life it is called 'Biosphere' or 'Zone of life'. In youth it resembles its parent rock material and in maturity it conforms its climatic and topographic condition. Indeed soils epitomise the entire gamut of environmental factors and functions.

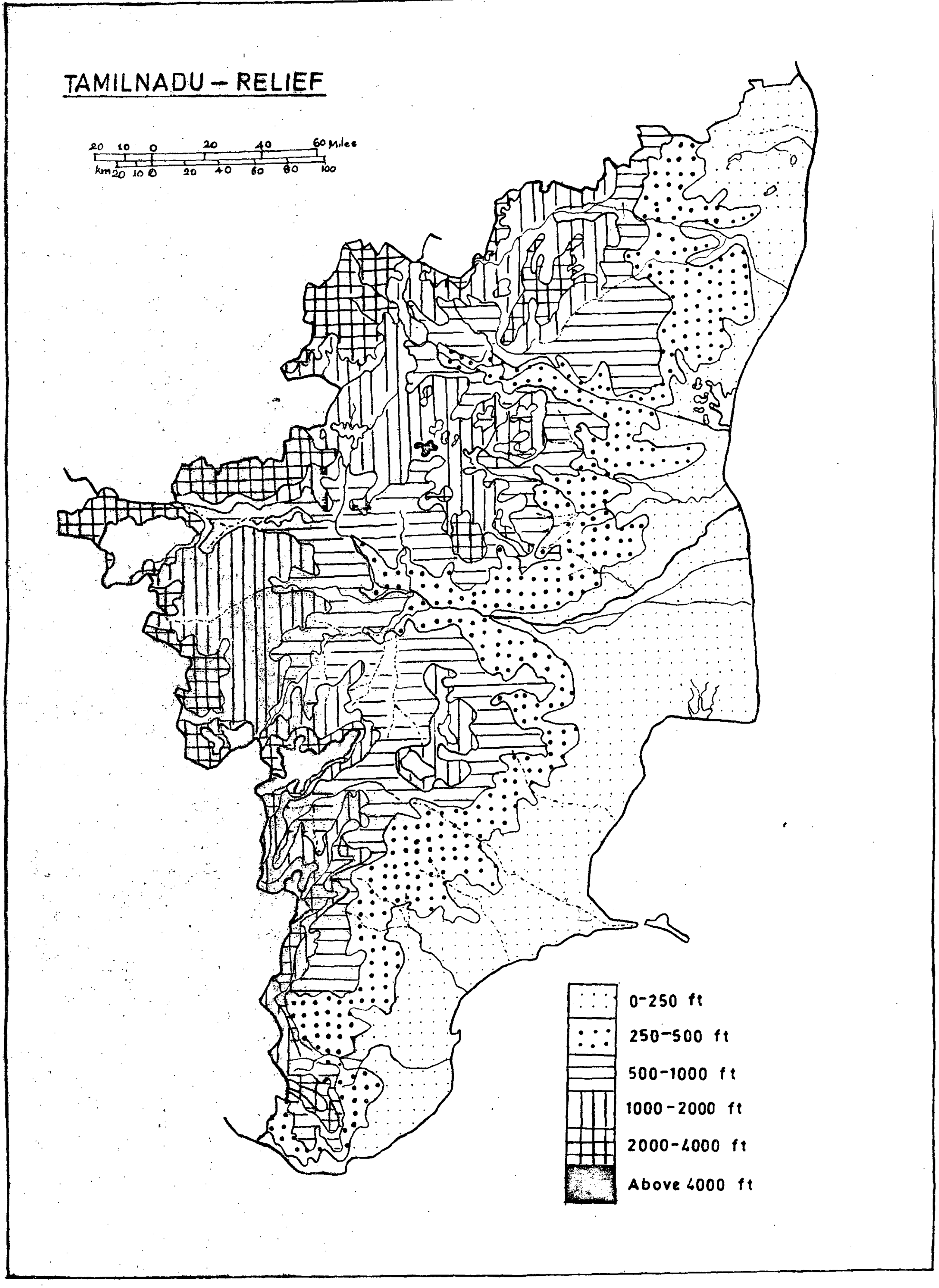
The above facters reveal that the study of these factors become sine qua non for the study of one of the precious resources namely water resources of Tamil Nadu.

LOCATION

Tamil Nadu situated at the south eastern extremity of the Indian peninsula has bay of Bengal as the eastern boundary and Indian Ocean in the south. To the north lie the states of Mysore and Andhra Pradesh and along the western flank lie the western ghats separating the state from Kerala. The state has a geographical area of 1, 30, 070 sq. km.

PHISIOGRAPHY

Topographically there are several divisions in the state. Parallel to the coast is seen a broad strip of coastal plain which can be divided into


TAMILNADU – RELIEF
20 10 0 20 40 60 Miles
km 20 10 0 20 40 60 80 100
0-250 ft
250-500 ft
500-1000 ft
1000-2000 ft
2000-4000 ft
Above 4000 ft

three parts. First, the Coromandal plains comprising the districts of Chingleput, South Arcot and North Arcot. The alluvival plains of the Cauvery delta extending over all of Thanjavur and part of Tiruchirapalli district and the dry southern plains in Madurai, Ramanathapuram and part of Tirunelveli districts.

Between the Palar and the Cauvery the Coastal plain is backed by the extension of the eastern ghats in a chain of low flat topped hills, the Javadis, the Shevroys, the Kalrayan and the Pachchamalais which continue south of the Cauvery in an even more broken formation and eventually meet the Cordamom hills in Madurai district. Between these hills and the western ghat is a plateau (average elevation 1000') rising westward. The Cauvery valley divides the plateau into two parts — one comprising most of Salem district and part of North Arcot district and the other comprising most of Coimbatore district.

There is a narrow mountaineous strip all along the western boundary of the state except for the gaps at Palghat and Shencottah. The average height is above 4000' and the highest peak in the Ootacamund area is 8500' above sea level.

RIVERS

All rivers in the state flow eastward from the western ghats and are rain fed. Palar, Poonaiyar and Cheyyar are the three important rivers flowing in the north which are not perennial. The centre of the state is drained by the Cauvery which is perennial and it flows alongwith its tributaries towards east namely Bhavani and Amravathi. The other three rivers which are south of the Cauvery are Vaipar, Vaigai and Tambraparni and apart from these, there are numerous rivers and streams flowing in the state. Among these the Cauvery and the Tambraparni are two important perennial rivers of the state over which the whole agricultural economy of the state depends [1].

## CLIMATE

The climate is tropical but more equable. The maximum temperature is rarely above 110°F (43°C) and the minimum seldom below 65°F (18°C). The average rainfall in the state varies from area to area over a wide range of 25" to 75". The mountainous region and in particular, the Nilgiris accounts for the maximum rain, most of it from the south-west monsoon. Kanyakumari also gets relatively high rainfall on account of precipitation during the two monsoon seasons as well as in summer. Of the remaining area the Coromandal coast has the highest precipitation of 40" to 50". The rainfall decreases westward in the plateau and southward along

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[1] 'NCAER: Techno-economic survey of Madras - Economic Report Report of the National Council of Applied Economic Research 1961'.

the coastal plain, the Coimbatore and the southern districts like Ramanathapuram and Tirunelveli get the minimum rainfall.

## SOILS

The soils of the state fall into four groups:

(i) Red and laterite soils.
(ii) Black soils.
(iii) Alluvial soils.
(iv) Forest and hill soils.

Red and Laterite soils are found almost in every district of the state. Their greatest concentration lies in the districts of Madurai, North Arcot, Chingleput, Salem, Coimbatore, Tirunelveli and Tiruchirapalli. These soils are not predominant in Ramanathapuram and Thanjavur districts only. Though red soils are generally less fertile than black soils, their loamy structure and the intermixture of thin and fine textured soils make them more versatile than the black soils [1].

Black soils are found all over the state with the longest concentration in Ramanathapuram, South Arcot, Tiruchirapalli and Thanjavur districts. They cover less than 25 per cent of the area of the state. They are fertile but poor in organic matter, nitrogen and phosphoric acid.

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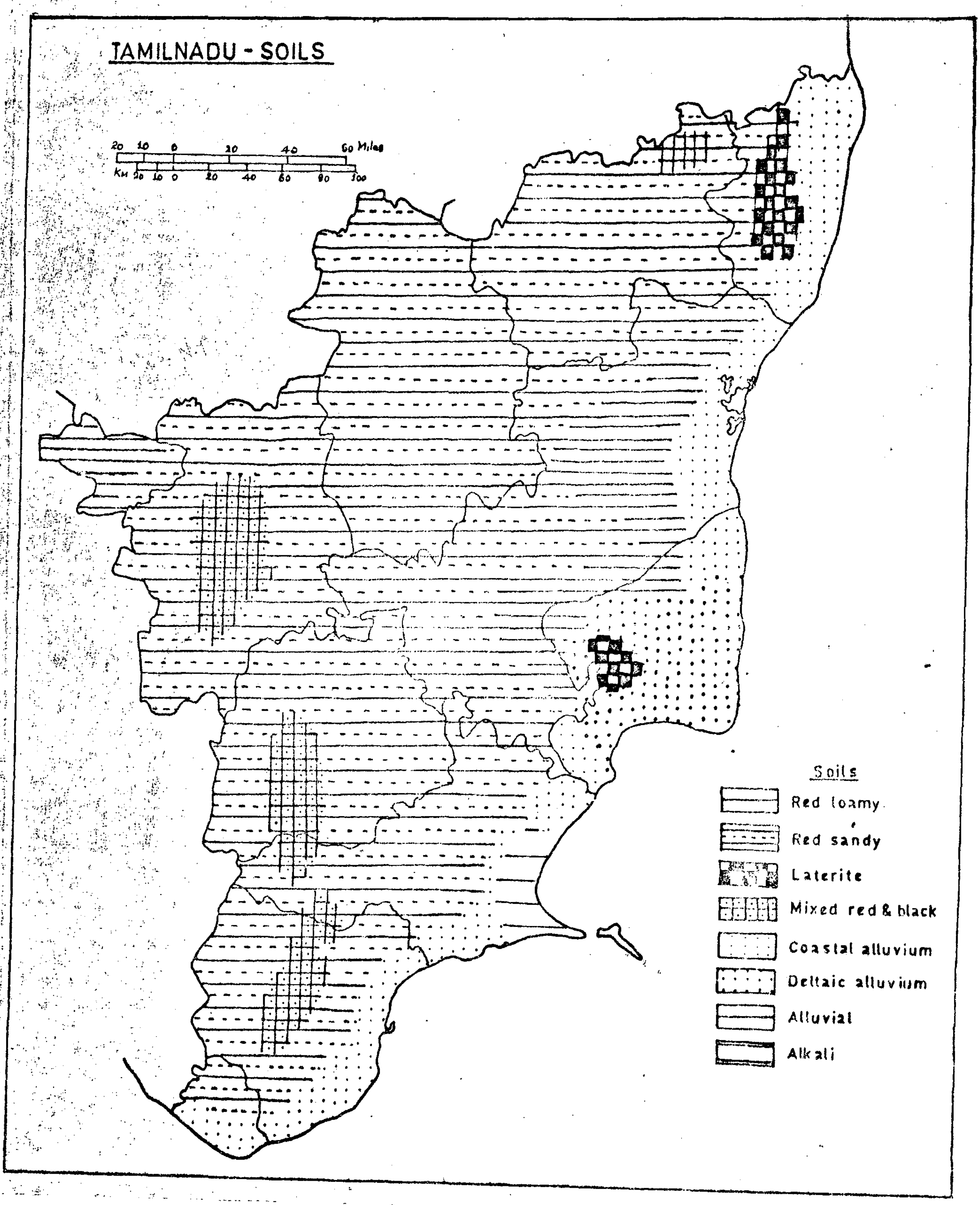
[1] 'Report of the Irrigation Commission, vol. II, Part II. 1972'.


TAMILNADU - SOILS
20 10 0 20 40 60 Miles
Km 20 10 0 20 40 60 80 100
Soils
Red loamy
Red sandy
Laterite
Mixed red & black
Coastal alluvium
Deltaic alluvium
Alluvial
Alkali

The concentrations of alluvial soils are found in the Cauvery delta which consists of the districts of Thanjavur and along the banks of the river in Tiruchirapalli district. The Cauvery alluvium is rich and well supplied with potash and magnesium although it is poor in nitrogen.

Forest and hill soils predominate in the Nilgiri hills and in the Kanyakumari district. They are porous in texture and rich in organic matter with nitrogen and other nutrients.

## CONCLUSION

The above geo-physical factors identify the "Ecological Mileu" of Tamil Nadu and the natural endowments seen among the 'Mileu' is greatly influenced by all the factors directly as well as indirectly. Hence it becomes man's imperative necessity to adapt and to adjust to his surrounding natural factors and its ecosystem which enables him to utilise the precious and the scarce resource to his optimum benefits.

# CHAPTER II

# WATER RESOURCES OF TAMIL NADU

## INTRODUCTION

Water as a natural resource has the pride of place in the prosperity of a nation. It is not only indispensable for the sustenance of life, but also for the economic and social development of the community. As a result, from the beginning of civilisation, man's eternal struggle always centers around water and his ability to control and harness the water resources available to him.

The numerous tanks and ancient anicuts that dot the landscape of Tamil Nadu bear testimony to this struggle for the assured supply of water. The century old constructions of many big and small dams across the rivers flowing through the state resulted in the maximum utilisation of the available surface water resources. With no more significant possibility for harnessing the surface water resources the task of meeting the demand for water in a growing economy is the greatest problem faced by this state and it has been found out that this demand can only be met where there is a proper planning for the coordinated exploitation of both surface and underground water resources of the state.

All water resources studies must start from an assessment of the available supplies and such an assessment depends on the availability of relevant data. So this chapter begins with the nature of hydrological data available and then outlines the available water resources.

## HYDROLOGICAL NETWORKS AND DATA

Tamil Nadu has the longest record of weather observations in India. The first Meteorological observatory in India was established at Madras in the year 1792 by the East India Company. Since then, the rainfall measurements are systematically done not only by the Meteorological Department but also by the Public Works Department of Tamil Nadu. According to the Indian Meteorological Department, Tamil Nadu is having 374 reporting raingauges and 184 non-reporting raingauges [1]. Rainfall is recorded daily at all the raingauge stations at 08.30 hrs. IST and represents the total for the proceeding 24 hrs. This state also has 15 modern self reporting raingauges. The daily and monthly rainfall data of all these stations are published annually by the Public Works Department of Tamil Nadu, whereas Indian Meteorological Department has brought out mean annual and monthly rainfall for 50 years (1901-1950).

Several authors, both the Meteorologists and Geographers have analysed the rainfall data; some are related to point rainfall taking only one station. (Ramakrishnan 1963, Ramamurthy 1968, Soundararajulu, K. &

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[1] Personal Communication: Report on gauge and discharge sites for which discharge data is available for more than 25 years. P.W.D. Govt. of Tamil Nadu as on 26.8.1971. Reporting raingauge stations in various river catchments for India, IMD.

Srinivasan, A 1965 and some for the whole of Tamil Nadu or part of it, Ramamurthy, K 1968; George, C.J. & Vasudevan, V.K. 1963) [1, 2].

## MEASUREMENT OF EVAPORATION

No systematic work has been done in the evaluation of evaporation for the whole state and the limited number of evapor imeter stations in the state further confirms this fact. According to the Indian Meteorological Department the pan evaporimeter stations in this state are only 7 and all these stations are installed only after 1955 [3] (Appendix). No 1

## SURFACE WATER OBSERVATIONS

There is no separate organisation in the state for carrying out hydrological observations and this work is done by the officers in-charge of reservoirs and anicuts. The observations relate only to the supplies brought down and utilised under the related project. For major projects, however, the observations and readings include the daily flows at the gauge sites, the utilisation and the surplus.

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[1] Ramakrishnan, K.P.: A study of fifty years of rainfall of Madras City, Indian J Met Geophysics No 4, 123-144 (1963).

[2] Ramamurthi, K.: A study of 100 years of rainfall of Madras City, Indian Geographical Journal, XLIII (1-4) (1968).

[3] Personal Communication: Catchmentwise list of open Pan Evaporimeter stations in India as on 1st August 1972, IMD.

## GROUNDWATER INVESTIGATIONS

Although there are no systematic groundwater observations in the state, recently under the United Nations Development Programme, the Tamil Nadu has initiated a groundwater survey of the basins of Cauvery, Palar, Kortalayar, and Araniyar and in the Neyveli area. In addition to the United Nations Development Programme and the Groundwater Directorate, there are several other agencies doing investigations and development of the groundwater resources in the state. There are

a) The Central Groundwater Board,
b) The Department of Agriculture,
c) The Public Health & Highways Department,
d) The Agricultural Refinance Corporation.

From the foregoing paragraphs, it can be inferred that except rainfall data, no other data on the other components of water resources are available for Tamil Nadu. Sporadic observations that too for a particular period of time are, however, available in the official records. This is a serious handicap while studying the water resources of Tamil Nadu.

So all the assessments of the availability of water resources are made using emphirical formulae.

## FACTORS CONTROLLING THE WATER RESOURCES

## RAINFALL AND EVAPO-TRANSPIRATION

The nature of the utilisable water in rivers and aquifers is determined by the balance which is struck in any area between the incoming precipitation and the demands which are made upon it by evaporation and transpiration from natural surfaces.

## RAINFALL

The only source of water for Tamil Nadu is rainfall which results from the depressions and cyclones that cross this state during the two monsoon periods and the local thundershowers during the hot season.

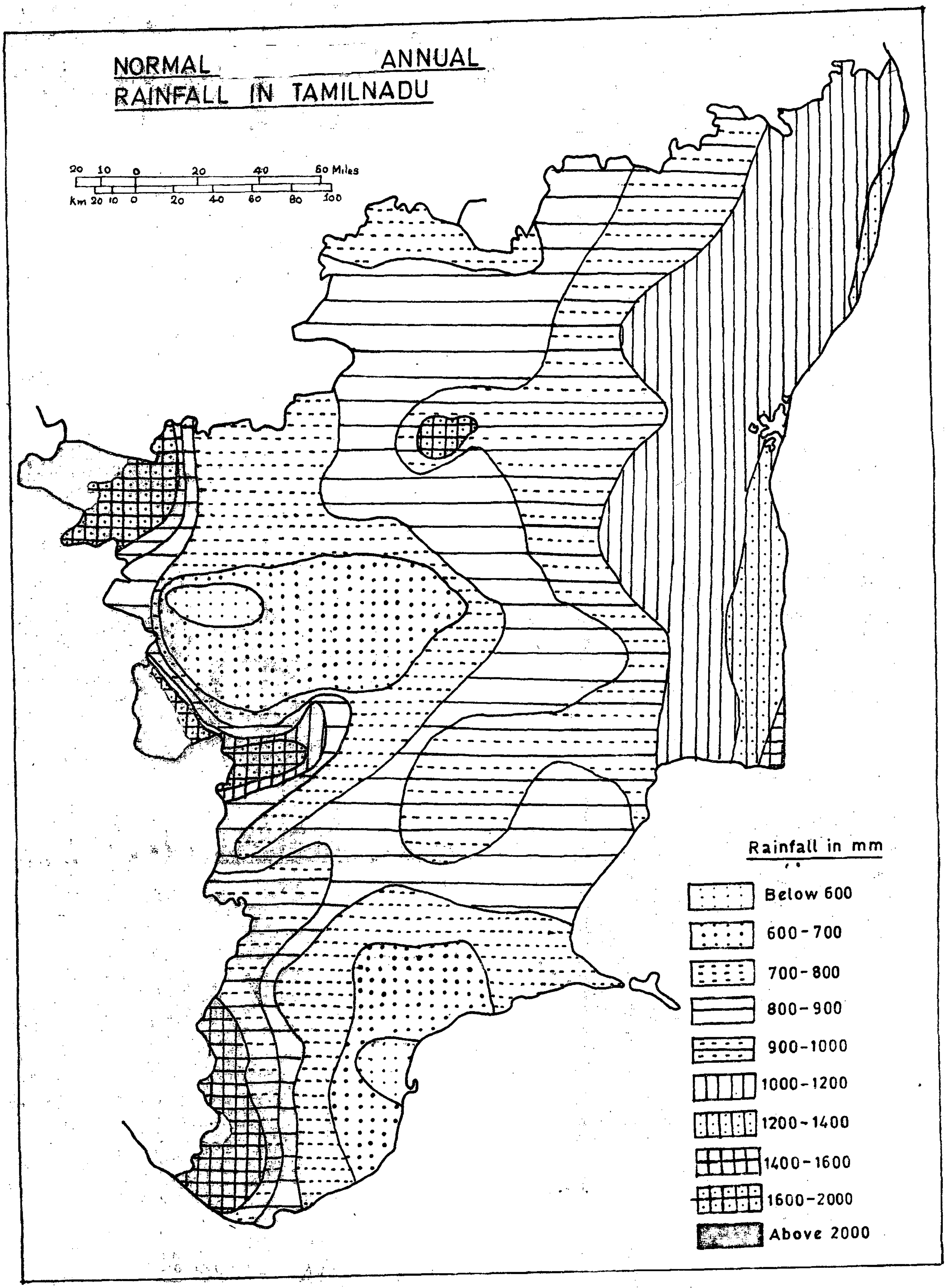
The mean annual rainfall in Tamil Nadu generally decreases from the coast towards the interior and increases with height. Thus along the coast, the mean annual rainfall is over 1,200 mm (Madras - 2,680 mm, Nagapattinam - 1,406 mm) and in the mountains it increases to (1303 mm at Ootacamund and 1,688 mm at Kodaikanal & Palni hills). Three fourths of Tamil Nadu lies in the rainshadow region of western ghats and the rainfall in these areas (Coimbatore, Madurai, Tirunelveli) are between 500-1000 mm. The coastal regions of Ramanathapuram and Tirunelveli receive low rainfall below 600 mm. The following table shows the average annual rainfall for the districts of Taml Nadu.

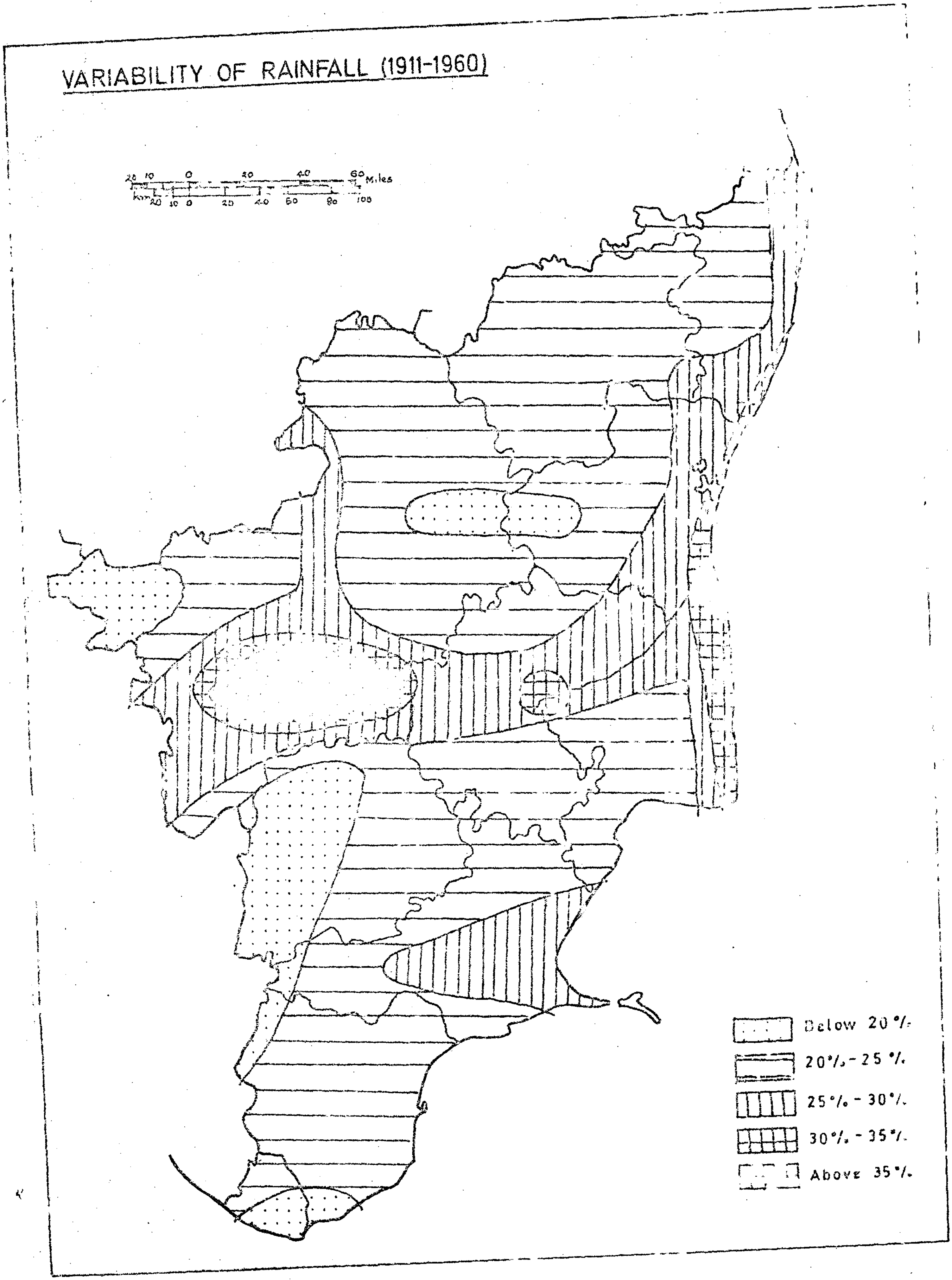
**Annual Distribution of Rainfall in Tamil Nadu (1970)**

| Districts | | Actual Annual Rainfall in mm. | Normal Rainfall in mm. |
|---|---|---|---|
| 1. | Madras | 1,219.1 | 1,285.6 |
| 2. | Chingleput | 1,396.1 | 1,211.0 |
| 3. | South Arcot | 1,359.7 | 1,188.9 |
| 4. | North Arcot | 1,217.1 | 971.1 |
| 5. | Salem | 914.7 | 842.4 |
| 6. | Dharmapuri | 930.4 | 844.3 |
| 7. | Coimbatore | 747.9 | 718.4 |
| 8. | Tiruchirapalli | 898.0 | 877.1 |
| 9. | Thanjavur | 1,422.4 | 1,147.8 |
| 10. | Madurai | 816.6 | 854.8 |
| 11. | Ramanathapuram | 862.9 | 839.5 |
| 12. | Tirunelveli | 867.5 | 814.8 |
| 13. | Nilgiris | 2,052.8 | 1,920.8 |
| 14. | Kanyakumari | 1,365.9 | 1,469.7 |

Source: Abstract of Statistics, Quarterly, March 31st, 1971.

The above table shows the fact that the districts like Thanjavur, South Arcot, Chingleput and North Arcot which lie in the eastern part of the state are more fortunate in getting enough rainfall from both the monsoons. Hence, in these districts, the total rainfall is higher than the other districts


NORMAL ANNUAL
RAINFALL IN TAMILNADU
20 10 0 20 40 60 Miles
Km 20 10 0 20 40 60 80 100
Rainfall in mm
Below 600
600-700
700-800
800-900
900-1000
1000-1200
1200-1400
1400-1600
1600-2000
Above 2000



VARIABILITY OF RAINFALL (1911-1960)
Miles
Km
Below 20 %
20% - 25 %
25% - 30%
30% - 35%
Above 35%

excluding Nilgiris and Kanyakumari which receive an average rainfall varying from 145 to 190 cm.

## VARIABILITY OF RAINFALL

The annual rainfall varies greatly from year to year. The co-efficient of variation in the state ranges from 20 to 35 per cent all over the state. The maximum variability is seen in Coimbatore district and a part of South Arcot which is above 35 per cent and in the districts like Nilgiris and Kanyakumari the variability is below 20 per cent. In the eastern part of the coastal region, it varies from 25 to 30 per cent. The variability on the whole depicts the fact that the incidence of rainfall is highly irregular and stresses the importance of irrigation needs in the state.

## SEASONAL DISTRIBUTION OF RAINFALL

Tamil Nadu receives rainfall in both the South-west and North-east monsoons and also in the hot weather period due to local thundershowers. Although Tamil Nadu as a whole receives 43 per cent of its annual rainfall during the North-east monsoon season, the coastal districts receive more than 70 per cent of its rainfall during the North-east monsoon while the Nilgiris and Palnis receive the maximum rainfall in the South-west monsoon. The interior gets rainfall in both the seasons and here the amount of rainfall due to local thundershowers is significant.

The following table shows the seasonal distribution of rainfall in Tamil Nadu between 1961-71.

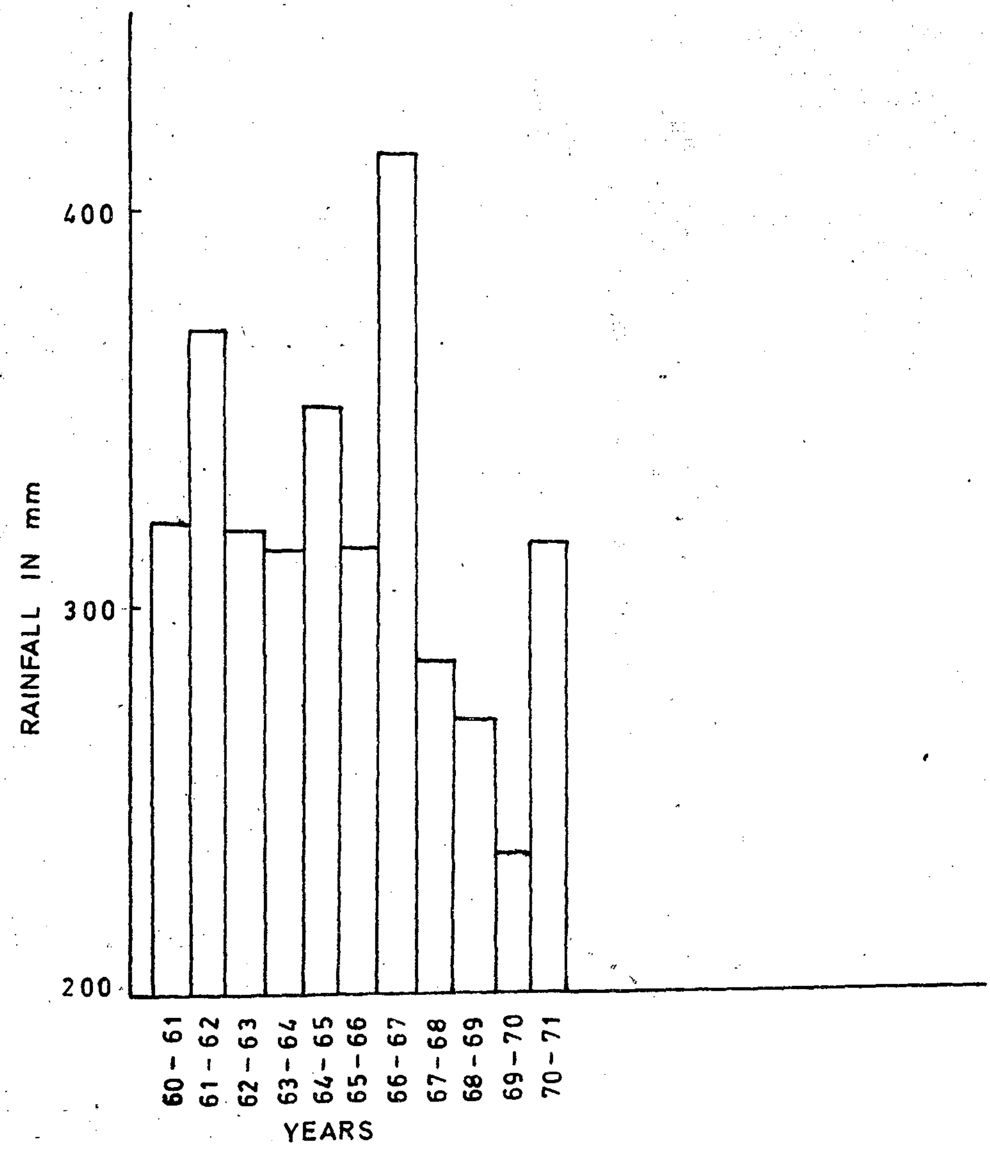
## Seasonwise Distribution of Rainfall (in millimetres)

| Year | South West monsoon (June to Sept.) | | North East monsoon (Oct. to Dec.) | | Winter Period (Jan. to Feb.) | | Hot Weather Period (March to May) | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Normal | Actual | Normal | Actual | Normal | Actual | Normal | Actual | Normal | Actual |
| 1960-61 | 307.3 | 317.3 | 449.7 | 486.4 | 50.9 | 86.8 | 137.8 | 87.8 | 945.7 | 978.3 |
| 1961-62 | * | 371.0 | * | 309.8 | * | 31.1 | * | 155.1 | * | 867.0 |
| 1962-63 | * | 324.7 | * | 394.6 | * | 76.1 | * | 136.0 | * | 931.4 |
| 1963-64 | * | 315.0 | * | 506.1 | * | 10.7 | * | 75.8 | * | 907.6 |
| 1964-65 | * | 346.6 | * | 405.5 | * | 7.7 | * | 99.3 | * | 859.1 |
| 1965-66 | * | 314.9 | * | 441.4 | * | 18.9 | * | 95.7 | * | 870.9 |
| 1966-67 | * | 415.8 | * | 606.0 | * | 29.3 | * | 101.7 | * | 1,152.8 |
| 1967-68 | * | 285.0 | * | 495.9 | * | 12.2 | * | 165.7 | * | 958.8 |
| 1968-69 | * | 270.9 | * | 312.1 | * | 8.2 | * | 91.3 | * | 662.5 |
| 1969-70 | * | 238.4 | * | 612.6 | * | 33.1 | * | 152.6 | * | 1,036.7 |
| 1970-71 | * | 318.0 | * | 420.1 | * | 27.4 | * | 152.6* | * | 918.6* |

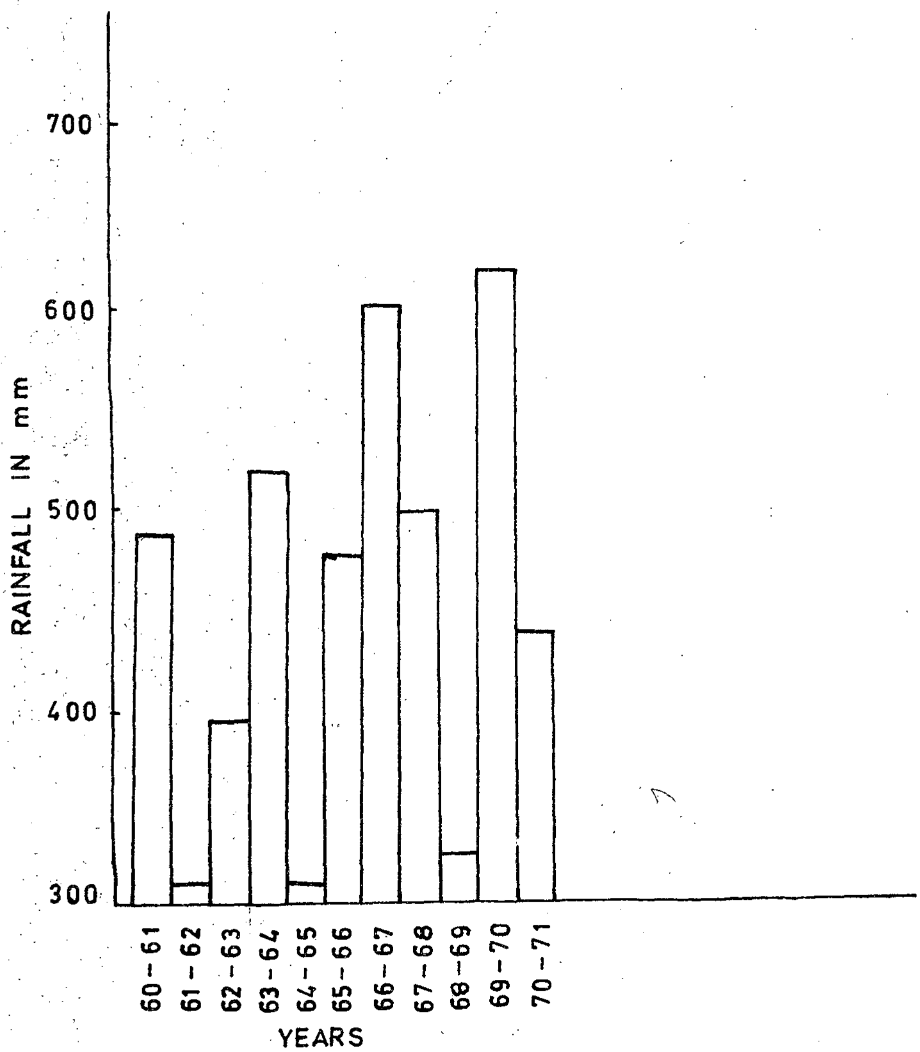
* Provisional

Source: 'Tamil Nadu - an economic appraisal, 1972'.
Madras, Government of Tamil Nadu.

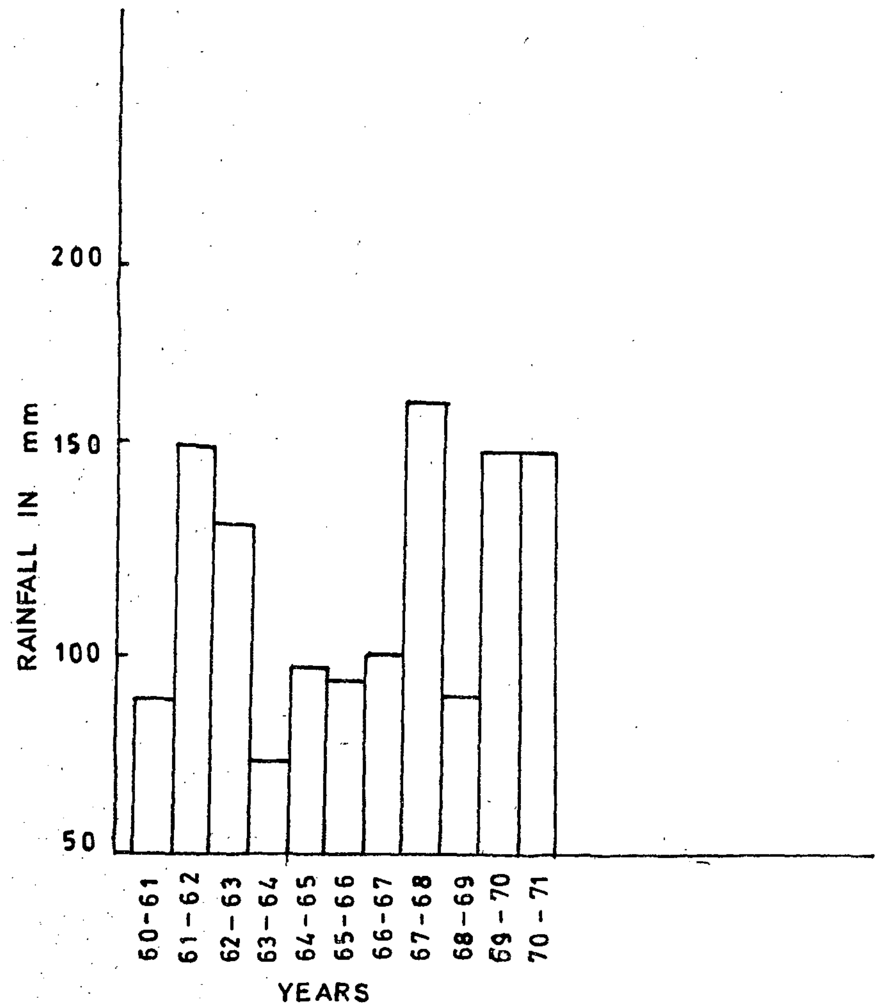
SEASONWISE DISTRIBUTION OF RAINFALL
SOUTHWEST MONSOON (1961-71)



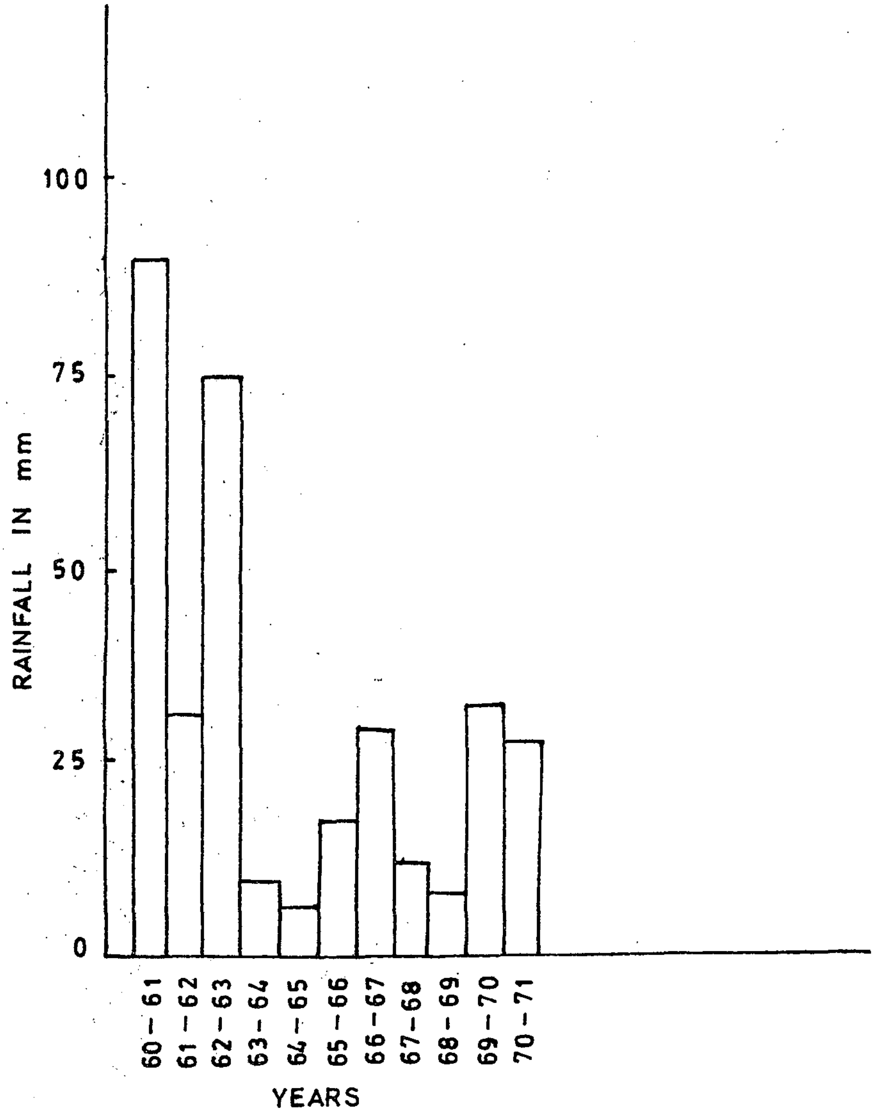
SEASONWISE DISTRIBUTION OF RAINFALL
NORTH-EAST MONSOON (1961- 71)



SEASONWISE DISTRIBUTION OF RAINFALL
HOT WEATHER PERIOD (1961 - 71)



SEASONWISE DISTRIBUTION OF RAINFALL
WINTER PERIOD (1961-71)



The above table reflects the fact that during the South-west monsoon season, the amount of rainfall is low but extremely reliable. But during the retreating monsoon, there is high variability with heavy falls in some years (1966-67, 1969-70) and complete failures in few years (1961-62 and 1968-69).

INTENSITY OF RAINFALL

Since rainfall in Tamil Nadu in general is associated with the passage of depressions and cyclones, the intensity of rainfall is great resulting in floods.

Among these, the work done by O.H. Dhar & G.C. Ghose [1] has been taken for discussion about the tropical disturbances (from 1891-1960) in Tamil Nadu (Appendix). No. 8

During the pre-monsoon period (April & May) the number of tropical disturbances experienced (1891-1960) in the basin which has east flowing rivers between Pennar & Cauvery were seven, but it has been found out that the frequency of occurences of these disturbances over this basin are very few.

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[1] Dhar, O.N. & Ghose, G.C.: 'Spatial and sequential distribution of depressions/storms over Peninsular India', Seventh symposium the Civil and Hydraulic Engineering Dept, "Water Resources", May 11-16, 1971. Indian Institute of Science, Bangalore, 1971, pp. A 10-1 - A 10-17.

During the post monsoon season (October to December) the Cauvery basin and the basin which has east flowing rivers between the Pennar & Cauvery had experienced 22 and 29 tropical disturbances respectively. Hence, it has been found out that the maximum cyclones occur only during the North-east monsoon period.

The study further reveals the fact that Tamil Nadu Coast experiences the tropical disturbances in the months of April, May, October & November. November, however, is the month when the frequency of these disturbances is the highest.

EVAPORATION

As stated earlier no direct measurement of evaporation is done systematically in Tamil Nadu. In the absence of observed data, there have been few attempts to calculate the evaporation particularly evapo-transpirations from meteorological formulae. There are derived values of evapo-transpiration for few stations in Tamil Nadu in the Works of Emmanuel Adiceam (1966) based on Papadakis's formulae and of V.P. Subramaniam's based on Thornthwaite's formulae. A.N. Khosla (1951) also derived a formula for the computation of evaporation losses in Tamil Nadu.

Since it is outside the scope of the present study, the accuracy of these derived values and the applicability of these methods for this state are not dealt in this. However to give an indication of the extent of losses due to evapo-transpiration, the derived values based on Papadakis method is given in the table below.

### Evapo-transpiration (in cms.)

| Station | Jan. | Feb. | Mar. | April | May | June | July | August | Sept. | Oct. | Nov. | Dec. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Madras | 7.5 | 8.9 | 10.0 | 11.4 | 16.2 | 15.9 | 13.3 | 12.0 | 11.5 | 8.2 | 6.2 | 6.9 | |
| Vellore | 8.4 | 11.3 | 14.8 | 16.4 | 18.3 | 14.6 | 12.9 | 11.9 | 11.0 | 8.8 | 7.0 | 6.0 | |
| Salem | 13.0 | 14.0 | 14.8 | 17.6 | 11.8 | 16.9 | 11.3 | 11.3 | 11.1 | 10.0 | 8.9 | 9.5 | |
| Cuddalore | 5.9 | 6.6 | 7.6 | 8.4 | 12.5 | 14.7 | 12.9 | 11.2 | 9.5 | 7.0 | 6.1 | 5.5 | |
| Coimbatore | 9.8 | 13.3 | 16.2 | 14.8 | 13.2 | 9.3 | 8.2 | 8.5 | 9.0 | 8.5 | 7.9 | 8.3 | |
| Tiruchirapalli | 9.7 | 12.8 | 16.2 | 17.4 | 18.1 | 16.6 | 15.8 | 14.7 | 14.5 | 10.1 | 7.7 | 7.9 | |
| Nagapattinam | 5.5 | 6.4 | 7.4 | 7.5 | - | 14.0 | 13.2 | 11.1 | 9.8 | 7.2 | 5.3 | 5.0 | |
| Madurai | 9.1 | 6.7 | 15.0 | 15.1 | 16.1 | 15.8 | 16.4 | 14.0 | 12.4 | 9.7 | 7.7 | 7.5 | |
| Kodaikanal | 4.1 | 4.3 | 5.1 | 4.7 | 5.2 | 3.0 | 5.5 | 2.4 | 2.3 | 2.3 | 2.0 | 3.4 | |

Source: Le GEOGRAPHIE DE L' IRRIGATION
DANS LE TAMIL NADU, by EMMANUEL ADICEAM.
Paris, Ecole Francaise D'extreme - Orient, 1966.

**DISTRIBUTION & POTENTIAL EVAPO-TRANSPIRATION IN TAMIL NADU**

It has been found out that the potential evapo-transpiration distribution in Tamil Nadu during winter is high and it ranges from 12 cm to 14 cm per month.

During the South-west monsoon period the potential evapo-transpiration distribution (June to September) exceeds over 180 cm in the extreme south-eastern part of Tamil Nadu. In general the annual potential evapo-transpiration ranges between 140 to 180 cm in the state. For the extreme south eastern part, the Tuticorin area shows the high values of the order of 180 cm. In parts of Tamil Nadu potential evapo-transpiration continues to be high upto August. [1]

The high rate of potential evapo-transpiration as seen above depicts the need for minimising this process which will enable the conservation of this precious resource.

**HYDROGRAPHY OF TAMIL NADU**

The Public Works Department of Tamil Nadu and the Central Water & Power Commission has grouped the rivers of Tamil Nadu into 3 major basins and they are:

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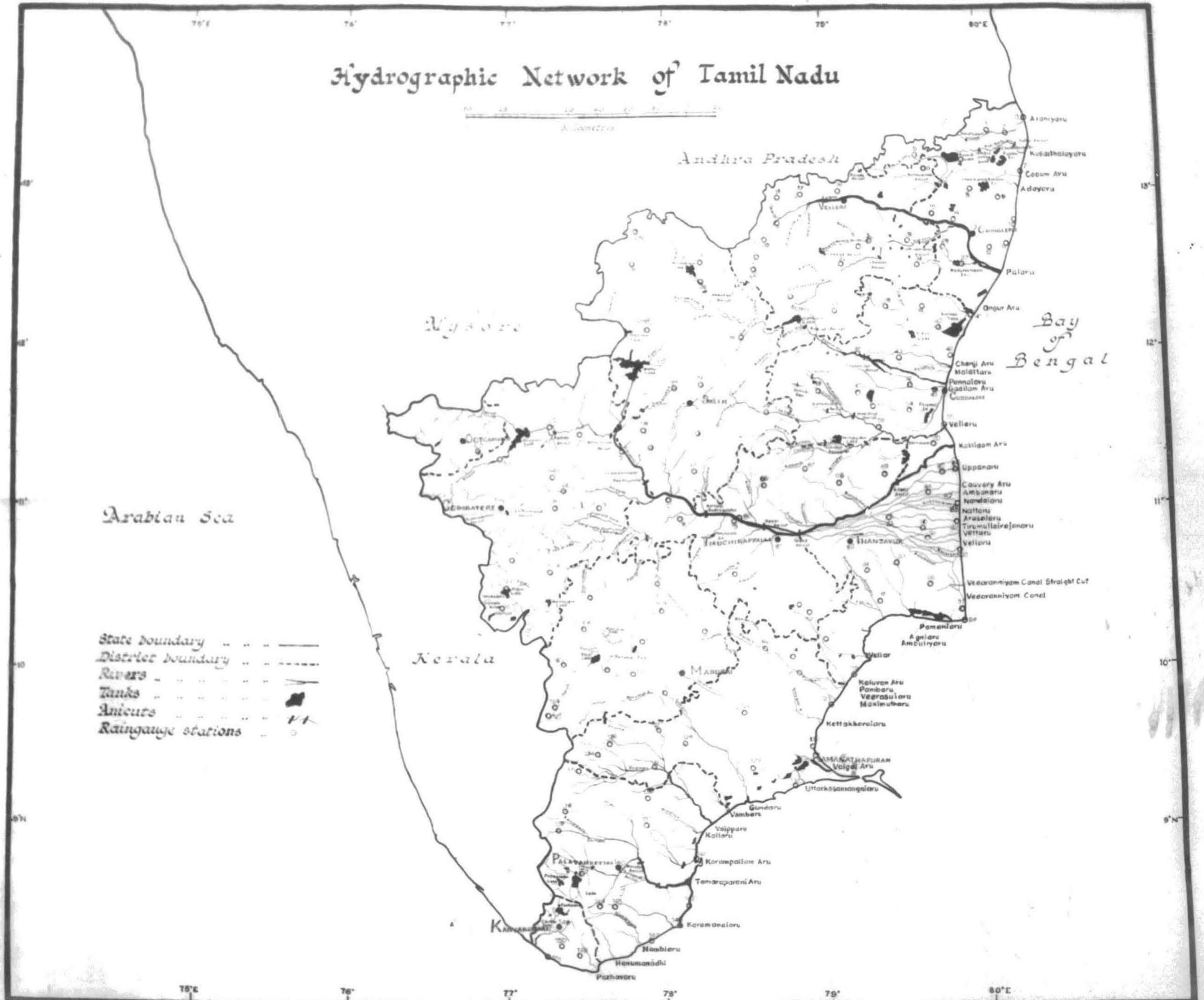
[1] Rao, K.N., George, C.J. & Ramasastry, K.S.:"Potential evapo-transpiration over India" Seventh Symposium, The Civil & Hydraulic Engineering Dept, "Water Resources", May 11 to 16, 1971. Indian Institute of Science, Bangalore (India), pp. A 2-1 to A 2-7.

TABLE : The Characteristics of the Important Rivers of Tamil Nadu

| No. | Serial No. of the Basin as per C.W.& P.C. | Basin and Main Rivers within the Basin | Length of the rivers km. | Catchment area km² | Mean annual Rainfall mm. | Mean annual loss. mm. | Mean annual run-off. mm. |
|---|---|---|---|---|---|---|---|
| I | 301 | Basin from Cape Comorin to Cauvery | | 35,090 | 903 | 732 | 177 |
| | | Tambaraparani | 130 | 5,482 | | | |
| | | Vaipar | 130 | 5,288 | | | |
| | | Gundar | 146 | 4,838 | | | |
| | | Vaigai | 258 | 7,741 | | | |
| | | Varshalli | 125 | 3,104 | | | |
| | | Vellar | 128 | 1,484 | | | |
| II | 302 | Cauvery | 800 | 87,900 | 988 | 867 | 121 |
| | | Cauvery within Tamil Nadu | 416 | 48,730 | 1315.7 | | |
| | | Bhavani | 216 | 7,144 | 1344.8 | | |
| III | 303 | Basin of East flowing rivers between the Pennar & Cauvery | | 65,849 | 963 | 817 | 146 |
| | | Basin within Tamil Nadu | | 41,836 | | | |
| | | Vellar | 193 | 8,558 | | | |
| | | Pennaiar | 396 | 16,019 | | | |
| | | Ginje | 94 | 3,369 | | | |
| | | Palar | 348 | 17,871 | | | |
| | | Kortalaiyar | 131 | 3,521 | | | |
| | | Araniar | 108 | 1,290 | | | |

Source:- Report of the Irrigation Commission Vol. II & Vol. III (Part 2), 1972. (Chairman: Ajit Prasad Jain). New Delhi, Ministry of Irrigation & Power.



Hydrographic Network of Tamil Nadu
Kilometres
Andhra Pradesh
Mysore
Kerala
Arabian Sea
Bay of Bengal
State boundary
District boundary
Rivers
Tanks
Anicuts
Raingauge stations
Araniyaru
Kusasthalayaru
Cooum Aru
Adayaru
Palaru
Ongur Aru
Chenji Aru
Malattaru
Pennalaru
Gadilam Aru
Velliaru
Kollidam Aru
Uppanaru
Cauvery Aru
Ambanaru
Nandalaru
Nattaru
Arasalaru
Tirumullaivasalaru
Vettaru
Vellaru
Vedaranniyam Canal Straight Cut
Vedaranniyam Canal
Pamaniaru
Agniaru
Ambuliyaru
Vellar
Koluvan Aru
Pambaru
Veerasularu
Manimutharu
Kottakkaraiaru
Ramanathapuram
Vaigai Aru
Uttarkosamangaiaru
Gundaru
Vambaru
Vaipparu
Kallaru
Korampallam Aru
Tamaraparani Aru
Karamanaiaru
Nambiaru
Hanumanadhi
Pazhavaru
Vellore
Thanjavur
Tiruchirappalli
Madurai
Coimbatore
Palayamkottai
Kanyakumari
75°E
76°
77°
78°
79°
80°E
13°
12°
11°
10°
9°N

1. East flowing rivers between the Pennar & the Cauvery.
2. Cauvery.
3. East flowing rivers between the Cauvery & Kanyakumari.

The hydrographic characteristics of the basins are given below.

1. Basin of East flowing rivers between Pennar & Cauvery:-

The total area of the basin is 65049 sq. km. The important rivers of the basin are Palar, Ponnaiyar and Vellar. The physiography of this region has (1) the hill ranges of the eastern ghats, (2) the table land of the plateau region, and (3) the Coastal plain in the hill range of eastern ghats.

The rivers are having their sources in the hilly ranges of the Eastern ghats (Javadi hills, the Shevroy hills and the Kalrayan hills). The rainfall in the catchment area is not very high (1500 mm). The rivers also claim smaller areas in this tract and it creates water scarcity in table land and the coastal plains. One important characteristic feature of the hydrography of this basin is the prevalence of numerous tanks fed by the seasonal flow of these rivers, for example the Palar anicut area near Arcot feeds 876 tanks.

2. Cauvery Basin:-

The river Cauvery is one of the major rivers of Tamil Nadu which rises at Talakavari in the Coorg district of Mysore state at an elevation of

1341 ft. After flowing through Mysore state for 320 km. it enters Tamil Nadu, flowing east and draining into Bay of Bengal. The important tributaries joining Cauvery in Tamil Nadu are the Bhavani, Amaravathi & Noyil. It is an important river over which the main economy of the state depends and it is the maximum utilised river in the whole country [1].

The length of the river within Tamil Nadu is 416 km and for 64 km it forms the common boundary between Mysore state and Tamil Nadu. It drains an area of 2930 $km^2$ in Kerala, 36,240 $km^2$ in Mysore and 48,730 $km^2$ in Tamil Nadu. So 55.4 per cent of its drainage area lies within Tamil Nadu.

Bhavani the important tributary of Cauvery in Tamil Nadu drains an area of 7144 $km^2$ and flows a distance of 216 km in Salem and Coimbatore district which has got important tributaries like Kundah, Conoor and Moyar.

The three main physiographical divisions of the basin are the (i) western ghats, (ii) plateau of Mysore, and (iii) the delta. In Tamil Nadu it occupies the complete delta which is the most fertile tract.

It receives bountiful rainfall around 3000 mm in its catchment area. Most of the rainfall in the catchment area is received during the south-west monsoon. A notable feature of the pattern of rainfall in this region is that its deviation from normal is very low.

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[1] Report of the Irrigation Commission. Vol III (Part 2). 1972.

The average annual rainfall in a large part of the basin of the state is very low and the annual precipitation generally ranges between 508 mm to 1016 mm creating semi-arid conditions. Some districts get rain both from south-west and north-east monsoons and others mainly from north-east monsoon. Thanjavur district gets a fairly well distributed rainfall from both the monsoons and Coimbatore and Tiruchirapalli get less rainfall, a major portion of which is contributed by the north-east monsoon.

Both the monsoons are of great importance to the basin especially the South-west monsoon. The North-east monsoon is chiefly important as the source of water supply for tanks where the topography and soil type and their construction. Apart from that in the two monsoon periods precipitation take place during the hot weather period (March to June). Though early rains in March, April and May are of no use for agriculture, it improves the drinking water situation. Nilgiri's district always gets this type of rainfall and on the whole this district has a much higher rainfall and a better distribution over the year (1930 mm).

Irrigation has been practised for centuries in the Cauvery basin through tanks and anicuts. There are inumerable such works, using the waters of the Cauvery and its tributaries for irrigating the fields within their command. Now, the utilisation of the available flows in the Cauvery basin particularly within Tamil Nadu has been almost complete. The important works across the Cauvery in the state are Grand Anicut, Upper Anicut, Lower Anicut and Mettur Dam.

3. **Basin of the East flowing rivers between the Cauvery & Kanyakumari**

There are two major topographical divisions in this basin and they are (i) the hilly area, and (ii) the plains.

The main rivers in the basin are the Vellar, the Vaishali, the Vaigai, the Gundar, the Vaippar, the Thambraparai and among them Thambraparai is the only perennial and maximum utilised one for agriculture. There are numerous small streams between these rivers.

The mean annual rainfall in the catchment area is around 1000 mm. The lower reaches receives very low rainfall and so except the rivers like Vaigai and Thambraparai, the other rivers drain only the flood waters.

The annual run-off of this basin was estimated as 7800 m. cu. m. based on Khosla's formula and the average annual run-off in various rivers at different sites are given below:

**Average Annual run-off in various rivers at different sites**

| Sl. No. | Name of the river | Site | Catchment area in sq. km. | Normal rainfall in mm. | Average annual flow in m. cu. m. | Remarks |
|---|---|---|---|---|---|---|
| 1. | Vaigai | Vaigai reservoir | 2253 | 99.6 | .911 | Average struck from 1959-60 to 1967-68. |
| 2. | Vaigai | Peranai reservoir | 3600 | 99.6 | 1102 | Average struck from 1928-29 to 1959-60 except 1939-40 & 1952-53. |

| | | | | | | |
|---|---|---|---|---|---|---|
| 3. | Tambraparni | Srivaikuntam | 4504 | 70.1 | 821 | Average struck from 1931-32 to 1962-63 except 1940-41 & 1945-46. |
| 4. | Manimuthar in Tambraparni basin | Manimuthar reservoir | 162 | 410.3 | 255 | Average struck from 1958-59 to 1968-69. |

One important feature of the water availability of this basin is the diversion of water from Periyar river into the Vaigai river through its tributary suruliyar.

Because of the seasonal characteristics of the flow, the water of many of the streams are stored in tanks as in the basin north of Cauvery. The tanks are many in Ramanathapuram district as well as in the adjoining districts like Madurai & Tirunelveli.

Tanks:-

Tanks are very important with reference to Tamil Nadu mainly because of nearly 36,665 small tanks in the state are utilised for irrigation. Water is usually led from streams through spring channels to feed the tanks provided the topography of the region permits. The spring channels drawn from the Vaigai in Madurai and Ramanathapuram districts are typical examples. Important tanks in the state are Kotiveli, Chambrambakkam, etc. The following table shows the number of tanks in each district of Tamil Nadu (1968-69).

| District | No of Tanks with ayacuts of 100 acres & more | No of Tanks with ayacuts of less than 100 acres. | Total |
|---|---|---|---|
| Chingleput | 1483 | 1714 | 3197 |
| S. Arcot | 1254 | 1646 | 2900 |
| N. Arcot | 927 | 2262 | 3189 |
| Salem | 137 | 498 | 635 |
| Dharmapuri | 838 | 1294 | 2132 |
| Coimbatore | 57 | 57 | 114 |
| Tiruchirapalli | 354 | 7502 | 7856 |
| Thanjavur | 146 | 737 | 883 |
| Madurai | 348 | 5147 | 5495 |
| Ramnadapuram | 2365 | 3001 | 5366 |
| Tirunelveli | 477 | 1940 | 2417 |
| The Nilgiris | 1 | 1 | 2 |
| Kanyakumari | 55 | 2394 | 2449 |
| | 8442 | 28193 | 36665 |

Source:- Season & Crop Report of Tamil Nadu 1968-69
Govt. of Tamil Nadu 1972.

It is an astonishing fact to note from the above table that Tiruchirapalli having only 9.9 per cent of its net area irrigated by tanks, is having the maximum number of tanks (7856) in the state while Ramanathapuram having its agricultural economy depending upon tanks stands third in the state (5366).

The main problem with reference to these sources is the high rate of evaporation and the tanks are becoming practically dry during the hot summer season. As a result some of the districts where tank irrigation have a predominant role, have to face a crucial period of water scarcity repeatedly in every summer. With reference to lakes, since they are used as storage reservoirs; the state is trying its best to minimise the rate of evaporation by adopting some chemical spray technique, etc.

## Estimation of Surface Water

Estimation of surface water requires a long range study of the flow in river in any region. In the case of Tamil Nadu, hydrological, geographical and political factors are playing important roles in the assessment of water resources in the catchment areas and this has resulted in the inadequacy of the data. Though rainfall data are available, the river flows data are not available. As a result, from the beginning the assessment in the state are mainly based upon the coefficients of run-off.

## Run-off

Run-off is the amount of water available for precipitation after accounting for evapo-transpiration and percolation or infiltration. Run-off in a region can be mainly affected by vegetation and soil.

**Methods used for calculating Run-off in Tamil Nadu**

For the computation of run-off many standard formulae have been used in this state and among them, one which has been used from the past in A.N. Khosla's formula which reads as

$$Rm = Pm - Lm \quad \text{and}$$

$$Lm = \frac{Tm-32}{9.5} \quad \text{where } Tm < 40^{\circ}$$

Based on the above formula, he has made a table which has been provisionally assumed as when

| | | | | | |
|---|---|---|---|---|---|
| Tm | $40^{\circ}$ | $30^{\circ}$ | $20^{\circ}$ | $10^{\circ}$ | $0^{\circ}F$ |
| Lm | 0.84 | 0.70 | 0.60 | 0.50 | 0.40 inches. |

where

Rm = monthly run-off
Pm = monthly rainfall
Lm = monthly evaporation loss
Tm = mean monthly temperature.

The annual run-off is the sum total of the monthly run-off. For the annual run-off the formula is

$$RA = PA - XTA$$

where

RA = Annual run-off
PA = Annual precipitation
TA = Annual temperature
X = Constant for a given catchment.

The constant X varies with the rainfall and topography of the catchment. [1]

Based on the above formula A.N. Khosla has divided the State's basins as

1. Rivers flowing from Cape Comerin to Cauvery.
2. Cauvery and
3. The rivers flowing from Cauvery to Pennar (excluding Pennar).

Strange's formula:

The only formula which has been used at present all over the state at different dam sites is 'Strange's formula' [2].

William Lumisden Strange in 1903 has carried out similar studies to estimate run-off from rainfall statistics in terms of percentage of the total fall of months, years or periods by classifying the catchments as good, average and bad in accordance with their run-off quantities. Strange had constructed tables giving percentage of run-off with reference to total monsoon rainfall of the year (Given in the Appendix). No. 10.

Limitations of Strange's formula

The above method of estimating run-off is open to great objection that it does not differentiate between different incidences of rain having the same

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[1] 'An appraisal of water resources by A.N. Khosla', Unesco 1951.

[2] W.M. Ellis: College of engineering manual 'Irrigation', Govt. of Madras. 1963.

total seasonal rainfall. For example, the run-off from 6 inches of rain falling into two consecutive days would be more than that from 6 inches falling in 24 days in quantities never exceeds half an inch in a day.

From 1964 onwards the Government has started using a modified Strange's formula due to the limitations imposed by the above one and that is called "dry, damp, wet method". This is mainly because of the fact that from that time onwards the state has felt that the major surface water resources have practically been exploited and there is the need to utilise even the last drop in the numerous minor streams and the necessity to assess the yield as correctly as possible with the available data has come to the forefront [1].

'Dry, Damp, Wet Method'

Strange's table of Run-off from daily rainfall for an average catchment
(For good or bad catchment add or deduct upto 25% of yield)

| Daily rain-fall in inches | Run-off percentage and yield when original state of the around was | | | | | |
|---|---|---|---|---|---|---|
| | Dry | | Damp | | Wet | |
| | Percentage | Yield | Percentage | Yield | Percentage | Yield |
| 0.25 | ... | ... | ... | ... | 8 | 0.02 |
| 0.50 | ... | ... | 6 | 0.03 | 12 | 0.06 |
| 0.75 | ... | ... | 8 | 0.06 | 16 | 0.12 |
| 1.00 | 3 | 0.03 | 11 | 0.11 | 18 | 0.18 |
| 1.25 | 5 | 0.06 | 14 | 0.17 | 22 | 0.28 |
| 1.50 | 6 | 0.09 | 16 | 0.24 | 25 | 0.38 |
| 1.75 | 8 | 0.15 | 19 | 0.33 | 30 | 0.52 |
| 2.00 | 10 | 0.21 | 22 | 0.44 | 34 | 0.67 |
| 2.50 | 15 | 0.38 | 29 | 0.73 | 43 | 1.08 |
| 3.00 | 20 | 0.60 | 37 | 1.12 | 55 | 1.65 |
| 4.00 | 30 | 1.20 | 50 | 2.00 | 70 | 2.80 |

---

[1] Informations gathered from Public Works Department, Madras.

Apart from using the above table based on the permeability, absorbing capacity of the soil, and sub-soil of the catchment and the daily rainfall, the following classification of dry, damp, wet conditions of the soil in the state has been formed which is also adapted [1, 2].

a) Conditions required for transition from 'dry' to 'damp'.

1/4 inch rainfall in the previous 1 day.
1/2 inch rainfall in the previous 3 days.
1 inch rainfall in the previous 7 days.
1 1/2 inch rainfall in the previous 10 days.

b) For transition from 'damp' to 'wet'.

1/3 inch rainfall in the previous 1 day.
1/2 inch rainfall in the previous 2 days.
1 inch rainfall in the previous 3 days.
1 1/2 inch rainfall in the previous 5 days.

c) Transition from 'dry' to 'wet' is made whenever 2 1/2 inches have fallen on the previous or on the same day. For instance, if 4 1/2 inches fall in one day on a dry catchment, the run-off would be

| | | |
|---|---|---|
| 2 1/2 inches on a dry catchment | = | 0.38 inches |
| (4 1/2-2 1/2)= 2 inches on a 'wet' | = | 0.67 inches |
| Total | | 1.05 inches |

d) Transition from 'wet' to 'damp'.

1/6 inch in the previous 1 day.
1/4 inch in the previous 2 days.
1/2 inch in the previous 3 days.
3/4 inch in the previous 5 days.

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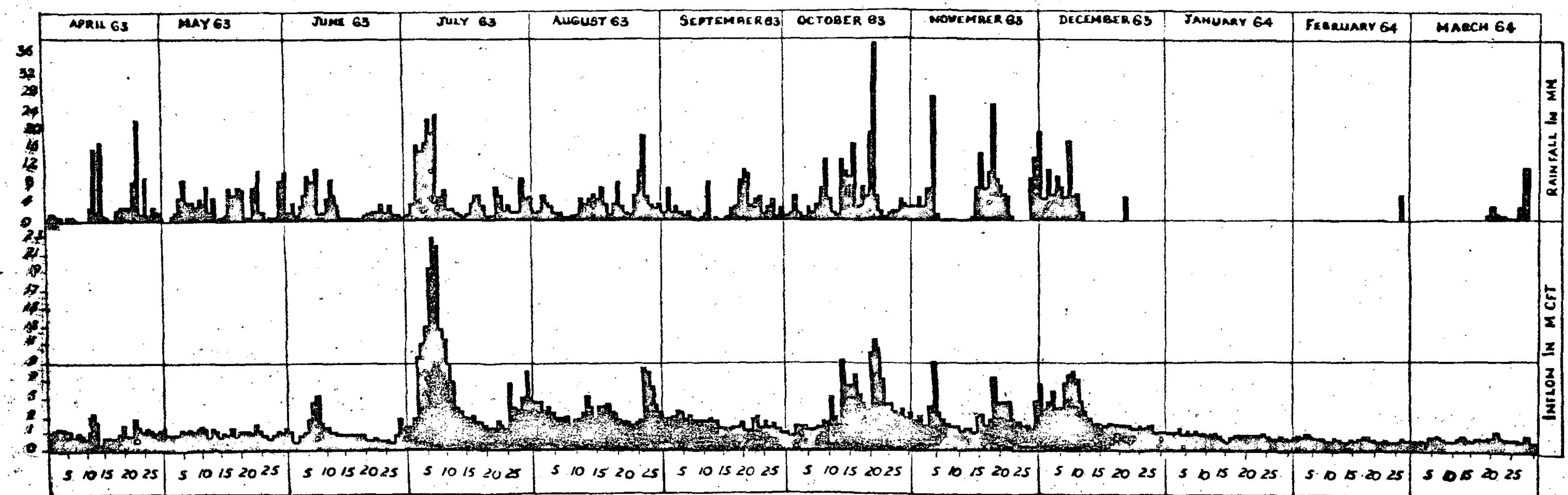
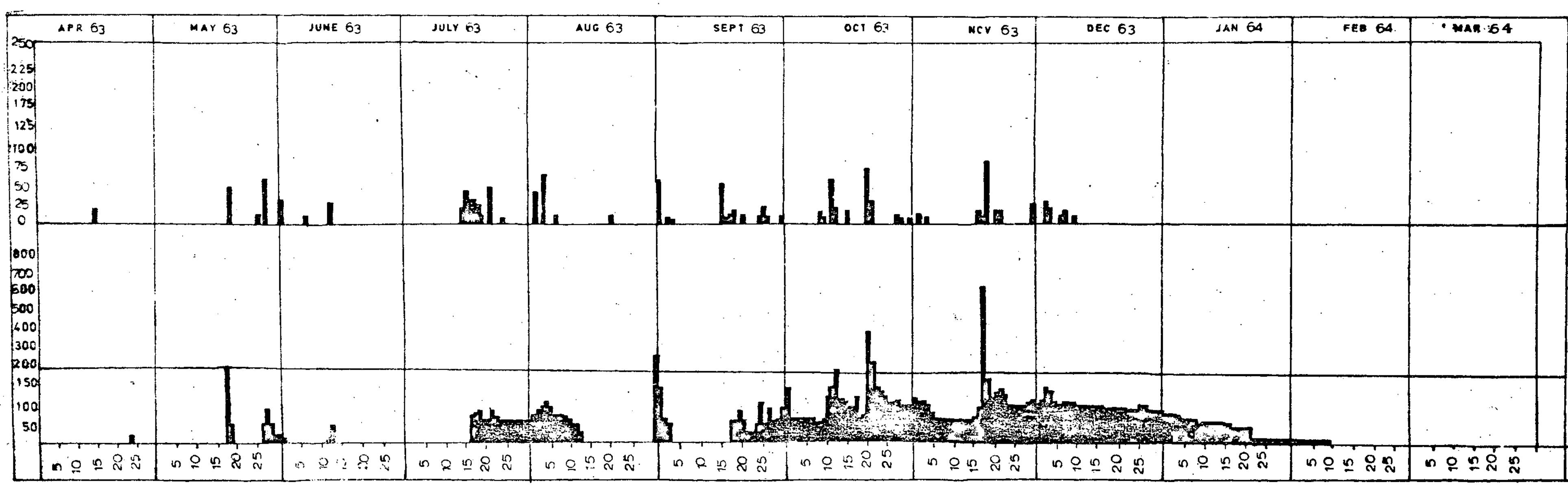
[1] W.M. Ellis: College of engineering manual 'Irrigation', Govt. of Madras, 1963.

[2] Informations gathered from the P.W.D., Madras.

RAINFALL & RUN OFF FOR BHAVANISAGAR RESERVOIR



RAINFALL & RUN-OFF FOR ALIABAD ANICUT 1963-1964



e) Transition from 'damp' to 'dry'.

Rainfall less than

1/8 inch in the previous 1 day.
1/4 inch in the previous 3 days.
1/2 inch in the previous 7 days.
3/4 inch in the previous 10 days.

On the above basis the yield has been calculated for Sattur Station for the year 1950-51 and it is given in the Appendix No. 3&5.

This process is also a laborious one and the figures arrived at are only approximate and sometimes underestimated.

It has been felt from the beginning that comparison of precipitation with run-off is complicated in general in Tamil Nadu state. This is due to the fact that run-off in the state is always utilised at various points by open channels without any sluice arrangements etc. Further, all these formulae have been used only for finding out the maximum discharge. But none of these methods have come out successfully in estimating the availability of water due to the regulations on the reservoirs which have never allowed to bring out the true picture due to human interventions.

Rainfall & Run-off Relationships

For the study of the rainfall-run-off relationships, the Aliabad Anicut across Kamandalar river, a tributary of Cheyyar which has a free catchment of 86 square miles lying almost entierely on a low plateau with the elevation ranging from 600 ft. to 2,000 ft. and the lower Bhavani reservoir with a free catchment of 1,583 square miles and a very small intercepted catchment of 38.12 sq. miles lying mostly in hills ranging from 7,500 ft. to 2000 ft. have been chosen as typical examples.

The river Bhavani is non-perennial which flows in Coimbatore district and the 10 days, 30 days and total annual run-off recorded in this reservoir for 1963-64 are 9,931 M.Cft., 14,495 M.Cft. and 64,156 M.Cft.

The graph drawn for daily rainfall and run-off data in Bhavanisagar reservoir shows the fact that the reservoir has got its maximum run-off in July 1963 is during the South-West monsoon period.

The river Kamandalar is also non-perennial which flows in North Arcot district and the 10 days, 30 days and total annual run-off volume recorded at the reservoir are 155.18 M.Cft., 306 M.Cft. and 1,366 M.Cft. for 1963-64. The graph drawn for the data collected at this reservoir shows the fact that the maximum run-off recorded is in November 1963 that is during the North-east monsoon period.

Hence, both the graphs drawn for finding out the rainfall run-off relationships show the fact that with increasing rainfall the run-off also increases and even when there is no rainfall (as seen in January and February months 1964 in both the reservoirs), the run-off exists for a period of time.

WATER BALANCE METHOD

The ideal method to arrive at a water balance is the balance struck between the amount of rainfall and the lossage of water through evaporation which reads as

$$P = O + E \pm \Delta S$$

where P = Precipitation

O = Outflow or Run-off

E = Evaporation

$\Delta$ S = Change in Storage.

For finding out the water balance of Tamil Nadu, different methods have been used in the past, and A.N. Khosla's (1951) formula is used generally and later the improvement is made on the Khosla's method by the Directorate of Surface Water Resources (1972). In all these methods there has been no attempt to estimate the storage in Tamil Nadu.

For finding the evapotranspiration, the formula by Pierce (1966) has been used by the Directorate of surface water resources which reads as

$$ET = PET \times L \times D \times C \times R.$$

where

| | | |
|---|---|---|
| ET | = | Evapo-transpiration |
| PET | = | Potential ET determined from Air temperature |
| L | = | Length of the day correction |
| D | = | Soil dryness correction |
| C | = | Crop storage correction |
| R | = | Rainy day correction |

The other method which is used for determining the water balance are evaporation and the consumptive use of water by plants. In the case of the evaporation data revealed by the Pan evaporative meters, a factor of 0.7 can be multiplied with the pan evaporation figures to convert it to potential evapo-transpiration from the area covered by forests and irrigated crops.

Using the above formulae, the water budgeting or water balance done by the Directorate of Surface Water Resources has been discussed for the basin of rivers flowing from Cape Comorin to Cauvery as classified by A.N. Khosla & Central Water & Power Commission.

The advantage of taking this basin for discussion lies in the fact that this basin contains numerous non-perennial rivers and streams except Tambraparani as well as it is the basin which suffers without adequate water both for agriculture as well as for domestic purposes.

The following table shows the water balance of the basin of rivers flowing from Cape Comorin to Cauvery (excluding Cauvery).

## COMPARATIVE STATEMENT OF ANNUAL RUN-OFF AS GIVEN BY KHOSLA AND AS OBTAINED BY WATER BALANCE METHOD

| Basin | Catchment Area (sq. kms.) | Mean Annual Rainfall (m.m) / m.cu.m. | Mean Annual Loss | Run-off (Khosla) mm. / m.cu.m. | Mean Rainfall Feb.-May | Mean Rainfall June-Sept. | Mean Rainfall Oct.-Jan. | Mean Pan Evaporation Feb.-May | Mean Pan Evaporation June-Sep. | Mean Pan Evaporation Oct.-Jan | Mean Evapo-transpiration =0.7 Pan evaporation loss Feb.-May | Mean Evapo-transpiration June-Sept. | Mean Evapo-transpiration Oct.-Jan. | Run-off m.m. / m.cu.m. Feb.-May | Run-off June-Sep. | Run-off Oct.-Jan. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Rivers from Cape Comerin to Cauvery (excluding Cauvery) | 44,418 | 909 / 40,375.962 | .177 / 22,516.976 | 158 / 7,861.986 | 220 / 7,018.044 | 220 / 9,771.960 | 553 / 24,563.154 | --- | 763 | 688 | ... | 534 | 482 / 21409.476 | ... | 0 | 71 / 3153.678 |

## REGIONAL WATER BALANCE

### STUDY BASED ON CONSUMPTIVE USE OF WATER

| Basin | Name of the state | Catchment area (sq.kms.) | Mean Annual Rainfall (in mm.) | Mean Annual loss as per Khosla's report (mm.) | Run-off (Khosla) mm. | Main Rainfall in mm. Feb.-May | Main Rainfall June-Sept. | Main Rainfall Oct.-Jan. | Consumptive use of water Feb.-May | Consumptive use June-Sept. | Consumptive use Oct.-Jan. | Surplus/Deficit in mm. Feb.-May | Surplus/Deficit June-Sept. | Surplus/Deficit Oct.-Jan. | Overall surplus or deficit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Rivers from Cape Comerin to Cauvery (excluding Cauvery) | Tamil Nadu | 44,418 | 909 | 732 | 117 | 158 | 220 | 553 | 390 | 570 | 475 | -142 | -350 | +78 | -414 |

Source: An Approach to the Study of Regional Water Balance in India, Volume I. Directorate of Surface Water Resources, April 1972.

The above table shows the fact that as by Khosla the run-off is 7861.986 M.Cu.me. but according to the water balance method of the Directorate of Surface Water Resources; it is 3153.678 M.cu.m. which is half the amount and which gives the true picture. Further the study based on the consumptive use of water which depicts the basin as the worst water deficit area (-414 mm) further confirms this fact.

## Availability of Surface Water in Tamil Nadu

All the rivers in the state are rainfed and their maximum discharge occurs during the monsoon months. Except the two important perennial rivers namely Cauvery and Tambraparani, all the other rivers in the state dry up completely in the hot season.

The assessment of surface water computed in different dam sites are as follows:

**Annual & Seasonal flows of rivers of Tamil Nadu**

| Name of the river/site | Total flow | Percentage yield June Sept | Oct. Dec. | Jan. May | Years for which average which has been worked out |
|---|---|---|---|---|---|
| 1. Cauvery | | | | | |
| a. Mettur Reservoir | 10,785 | 68 | 24 | 8 | 1934-35 to 1968-69 |
| b. Grand Anicut | 11,002 | 57 | 33 | 10 | 1930-31 to 1960-61 (except 1956-57) |
| c. Coleroon at lower Anicut | 4,413 | 43 | 45 | 12 | 1934-35 to 1963-64 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 2. | Bhavani at Bhavanisagar | 2,274 | 53 | 29 | 18 | 1954-55 to 1968-69 |
| 3. | Amaravathi at Pallapalayam Anicut | 667 | 30 | 54 | 16 | 1934-35 to 196 -65 |
| 4. | Palar at Palar Anicut | 135 | 7 | 90 | 3 | 1919-20 to 1952-53 (except 1943-44) |
| 5. | Ponnaiyar at Tirukoilur Anicut | 634 | 15 | 74 | 26 | 1926-27 to 1957-58 (except 1955-56) |
| 6. | Vaigai at Peranai Regulator | 1,102 | 25 | 49 | 26 | 1928-29 to 1959-60 (except 1939-40 and 1952-53) |
| 7. | Tambraparani at Srivaikuntam Anicut | 821 | 17 | 55 | 28 | 1931-32 to 1962-63 (except 1940-41 and 1945-46) |

Source: Report of the Irrigation Commission, Vol II, Part II, p. 366.

The above available water potential of the state has been fully utilised and it has been found out that 94 per cent of the surface water resources of the state has been fully exploited and there is little scope for further irrigation projects in the state. Further the run-off which is measured over the land surface is only 12 per cent after accounting for infiltration, seepage, etc. Among the rivers, Cauvery and Tambraparani are utilised to the maximum in the state and Cauvery ranks first in the maximum utilisation of water in the whole country.

Hence, with reference to surface water to meet the increasing demand of food, the state has therefore turned its attention to increase the efficiency of the existing irrigation systems.

Therefore, for further need of agriculture, industries and Municipal requirements, the state has to resort on undergroundwater.

Undergroundwater

It is a common experience in the state that the rains which come in south-west and north-east monsoons do not occur in sufficient quantities and at times when it is needed. In such cases, it will become dire necessity for any region to utilise the groundwater thereby supplementing the surface water.

Further, with the availability of groundwater, it is possible to tide over the periods of water shortage and also to provide water for the third crop. Further, with the proper integration of surface water and groundwater, it is possible to efficiently and effectively irrigate existing areas under irrigation and thus increasing the agricultural productivity.

For knowing about the underground water, it becomes necessary to know about the Geology of Tamil Nadu which in turn reflects the underground potentialities of the State.

## Geology of Tamil Nadu

Tamil Nadu forms the part of the peninsula shield and the major portions of it is composed of unclassified crystalline rocks of Archaean age. The sedimentary rocks occur all along the coast flanking the crystalline mass on the west. The sedimentary formations namely mainly consist of recent alluvial deposits, tertiary and cretaceous deposits. There are also sporadic occurance of upper Gondwana beds between the Archeans and the younger sedimentary formations. The coastal tract is covered by younger alluvial and deltaic deposits . Detailed districtwise geological formations are given in the Appendix No. 9

## Stratigraphic Succession

The basic stratigraphic succession of Tamil Nadu is as follows:

Quaternary : Recent & Pleistocene - alluvial formations.
Tertiary: Sand stone, clays, claybound sands, shales, and lignite.
Cretaceous: Limestones, and argillaceous sandstones.
Gondwanas: Conglomerates, shale and clay.
Archaean: Granites, charnockites & gneisses. [1]

## Archaean (95,677 sq. km)

They constitute about 73 per cent of the total area of Tamil Nadu. The main rock formations are granites, charnokites and gneisses. They

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[1] Working paper prepared by Dr.S. Panchanathan, Director, Groundwater Board.

are at many places intruded by quartz veins and ultra basics.

Generally, these rocks are not good water bearers. However, appreciable quantity of water could be expected in weathered zones, fissures and joint planes and faulted out face. Hydrogeological investigation is in progress in all hard rock areas of Tamil Nadu by groundwater Board.

Gondwanas (2,513 sq. km.)

The Gondwana formations of Tamil Nadu are of Upper Jurassic to lower cretaceous in age. They are found to occur in Chingleput, North Arcot, Tiruchirapalli and Ramanathapuram districts.

Generally these formations are not suitable for large scale development of groundwater since impervious materials like shales and clays form the important ones of this group. Moreover they are not extensively exposed [1].

Cretaceous (1,513 sq. km).

The Cretaceous formations occur in Tiruchirapalli district, also near Vriddhachalam in South Arcot district, near Pondicherry and west of

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[1] Working paper prepared by Dr. S. Panchanathan, Director, Groundwater Board.

Thanjavur. The cretaceous rocks generally consist of limestones, calcareous shales, arenaceous clays, sandstones and argillaceous sandstones.

The sandstones and limestones form a moderate source of groundwater in areas of south of Karaikudi. But in the main out crop area near Tiruchirapalli, the water quality is not good.

Tertiary (8,746 sq. km)

Laterite capped tertiaries and sandstones occur all along the east coast as detached patches. Of the above, the deposits found near Madras, Neyveli, Thanjavur and Karaikudi are important from the point of groundwater development. They consist of sandstone, sandy clays, clays and lignite [1].

So far, it has been found out that the tertiary formations near Madras predominantly clayey in character, hence is a poor water bearing formation. The deposit around Neyveli contains good sandstone horizons which form good aquifers. The tertiary formations near Thanjavur could form a moderate source of water for the area lying between Thanjavur and Gandarvakottai.

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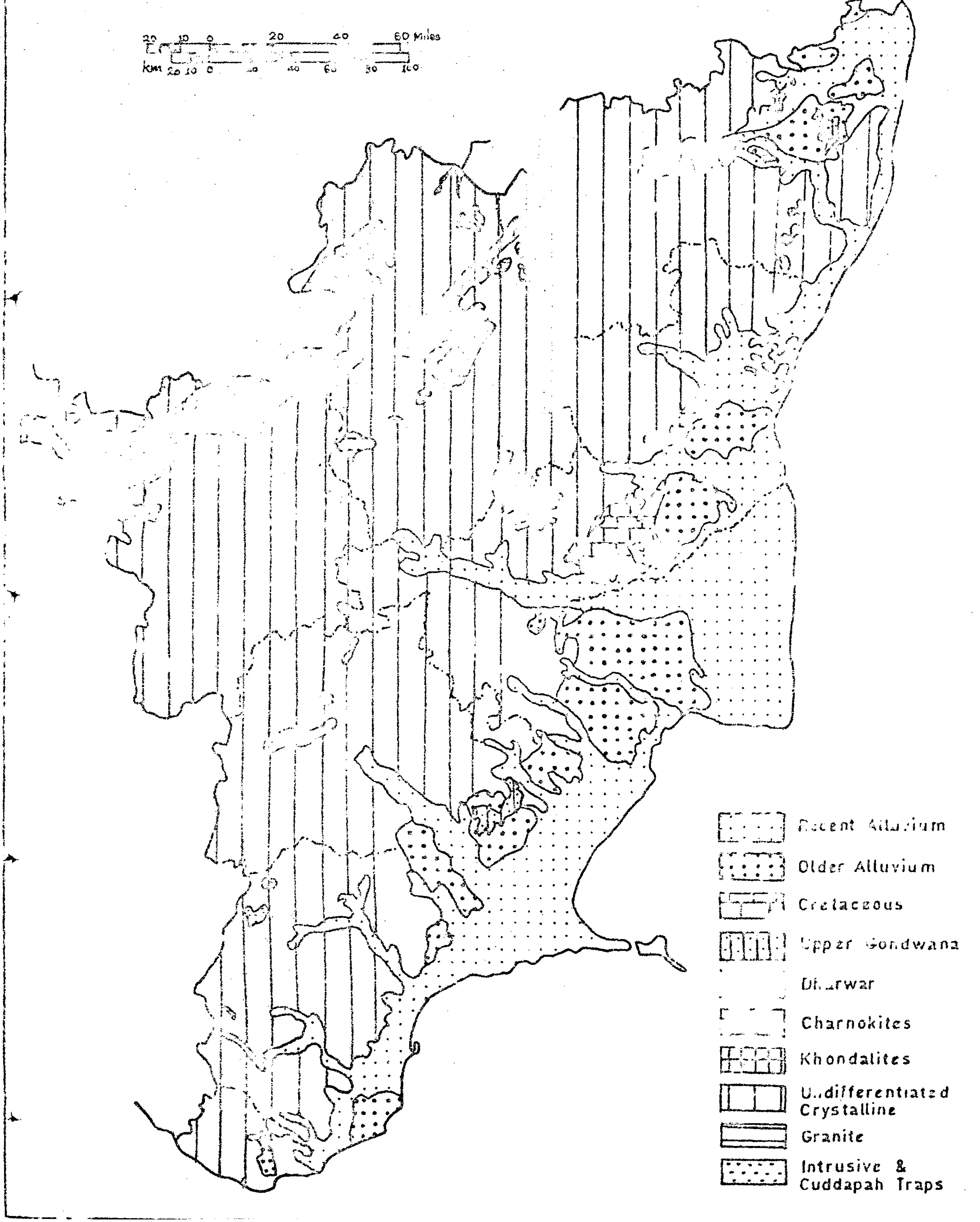
[1] Working paper prepared by Dr. S. Panchanathan for the State Planning Commission.

# GEOLOGY OF TAMILNADU



<u>Recent Alluvium</u> (21,908 sq. km.)

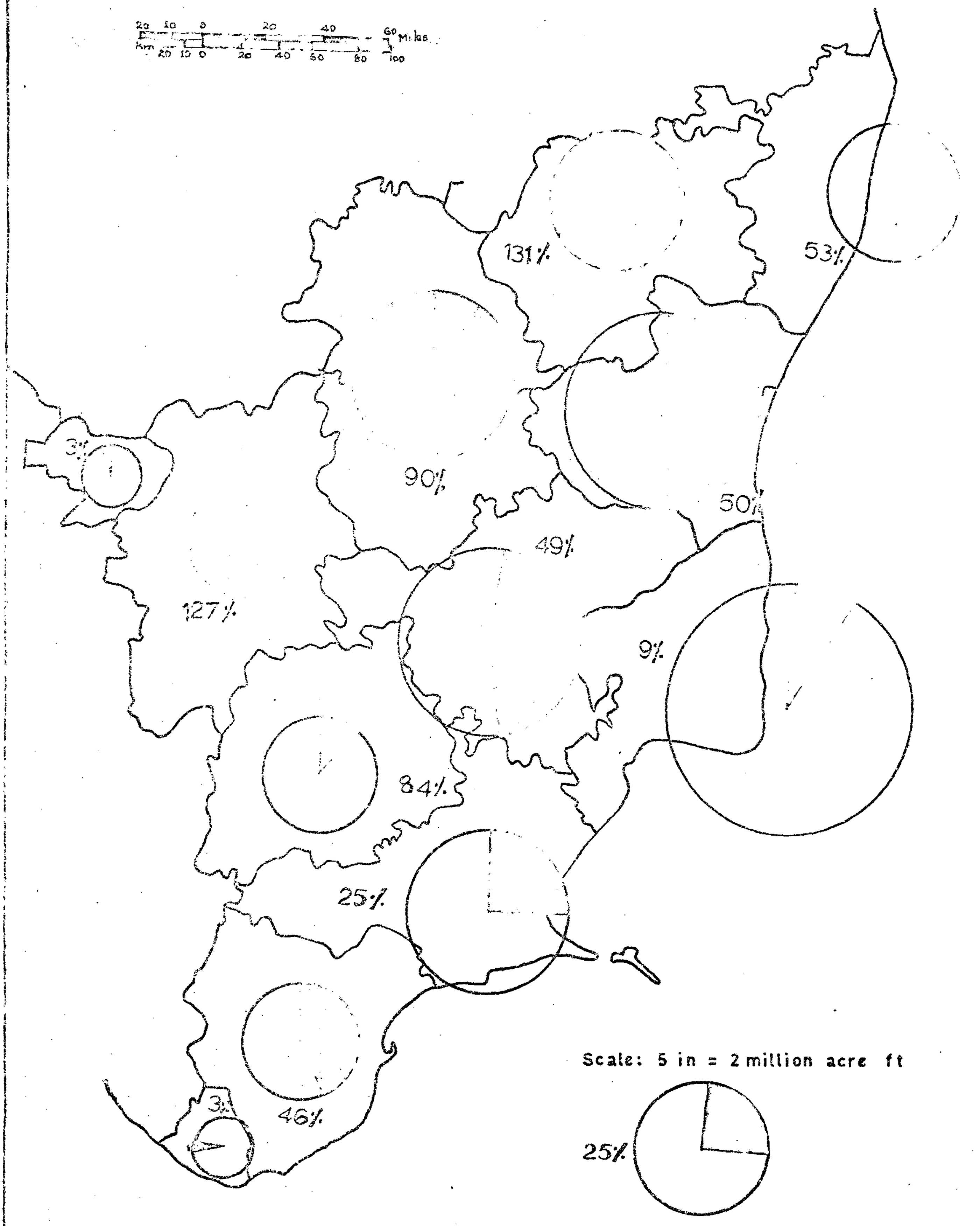
Almost the entire coast of Tamil Nadu is covered by alluvial deposits. The deposits consist of lenticular beds of sands and clays. Rivers such as Kortalaiyar, Palar, Ponnaiyar, Cauvery, Vaigai and Tambraparani have deposited rich alluvium in the deltaic regions. Cauvery has played a major role and has deposited alluvium of about 160 feet thickness consisting of clays, sand and gravels.

They are the important formations from the point of view of ground-water development. The alluvial areas around Madras have already investigated and found that these formations are the only source of water in this region. Detailed investigation in the alluvial formations of Cauvery is nearing completion. The rest of alluvial formations of Tamil Nadu are yet to be studied [1].

| Districts | Available groundwater in million acre feet per annum | Present extraction (approximated) in million acre feet per annum |
|---|---|---|
| Chingleput & Madras | 0.97 | 0.511 |
| South Arcot | 1.43 | 0.721 |
| North Arcot | 1.03 | 1.348 |
| Salem & Dharmapuri | 1.21 | 1.093 |
| Coimbatore | 0.88 | 1.102 |
| Nilgiris | 0.19 | 0.001 |

[1] Working paper prepared by Dr. S. Panchanathan for the State Planning Commission.

# AVAILABILITY OF UNDERGROUND WATER & PRESENT EXTRACTION



| | | |
|---|---|---|
| Tiruchirapalli | 1.32 | 0.649 |
| Thanjavur | 1.75 | 0.139 |
| Madurai | 0.86 | 0.726 |
| Ramanathapuram | 1.10 | 0.276 |
| Tirunelveli | 0.86 | 0.394 |
| Kanyakumari | 0.19 | 0.006 |
| Total | 11.79 or 12.00 | 6.966 or 6.97 |

Source : Working paper prepared by Dr. S. Panchanathan for the State Planning Commission.

The above table shows the fact that the extractable groundwater potential is 6.97 m. acre ft. and it has been estimated that this entire quantity can be fully extracted within a period of 20 years.

Since already the utilisation of surface water has reached the 'Saturation point' and the state is now facing the second phase of utilising the groundwater potential the state has to expect a period where the groundwater will also be utilised to the maximum.

Considering the present rate of consumption and its advantageous location along the coast, the only alternative which can face the future problems of this scarce resource is desalinasion of sea water.

Problems requiring consideration:

1. Inadequacy of Data: For water resource development, the basic, one must first understand is its nature and magnitude; since this is a resource

which is highly mobile, inexhaustible and the quantum available used to vary often. As for Tamil Nadu is concerned, it is the greatest problem one often come across and this is mainly due to the fact that only very little information is available outside of the Government of the extent and nature of water resources and the manner in which they are being utilised or allowed to go waste. Hence, unless the collection, compilation and publication of the basic data relating to water resources are available, it becomes difficult to conduct efficient academic researches as well as any official or government study and execution.

2. Estimation of Run-off: With reference to Tamil Nadu, the main problem is that water is always utilised at open channels in different points without sluices. Hence, it becomes the duty of the surface water legislation to prevent such mis-interferences.

Groundwater should be treated as a natural resource

Groundwater is also a natural resource which needs careful planning and judicious development to avoid indiscriminate groundwater mining which will cause hydro-geological imbalances in a basin. The development should not exceed the quantum of annual recharge in the basin. For example water levels in Coimbatore district is going down year by year due to over exploitation. The tentative preliminary estimates of recharge quantity works out to be 0.8 m. acre ft. whereas the present extraction is about 1.1 m acre ft. This results in the depletion of groundwater reservoir.

Proper utilisation of water

The areas in which there are high endowment of this scarce resources, we can see the fact from the past that people are in the habit of using the water lavishly (e.g. Thanjavur Delta) while there are areas which do not have even adequate resources to face the economy in the region (Ramanathapuram District). Hence it necessitates the 'efficient water management in the state'.

Reduction of evapo-transpiration losses: Under the influence of tropical climate the state has to face the high rate of evaporation and as a result, every summer, the state used to reach the crux of water problem. Hence reduction of evaporation losses from reservoirs and tanks become a necessity in the state.

For reduction of transpiration, removal of weeds along the tanks and jungles along the canal sides are important which will decrease the transpiration along the water resource sources.

Undergroundwater legislation: Groundwater legislation is necessary to prevent overdraft to avoid mutual interference of wells and to ensure proper construction of wells etc.

Sea water intrusion control: Along the sea coast restriction of extraction will have to be controlled to prevent sea water intrusion and consequent pollution of aquifers.

Control of pollution of groundwater recharge: Pollution should be prevented and for this proper control will be needed.

Artificial recharge: Areas suitable for artificial recharge and the periods during which surplus water will be available for recharging have to be studied.

## RECOMMENDATIONS

### Augmenting rainfall by artificial rain-making

Most of the districts mainly depend upon rain water both for surface as well as groundwater recharge and the state always faces the failure of rainfall either in quantity or time. Hence most of the areas suffer without water during the required period. For this purpose, it becomes the state's responsibility to augment 'artificial rainmaking' (cloud seeding) projects at least in the more deficit areas though all the areas face this problem.

### Industrial rotation of water

Water used for industries especially mainly in the areas like Coimbatore and Madras which comes as industrial waste can be recycled as pure water and again it can be utilised both for agriculture as well as for drinking purposes.

### Use of Brackish water

The greatest achievement of Tamil Nadu Government in changing the drainage waters of the Cooum river into clean water shows the fact that in future it will stand as a good example for changing the other drainage or brackish water channels of state. Though it is expensive for changing all the channels of the state, at least in more deficit areas it can be done. As the Cooum project, there are possibilities for the other channels to act as tourist centres as well they can also be utilised as navigation channels.

Desalination

The quality of water upto six miles all along the coast is not generally of desired quality due to the sedimentary deposits being marine in nature and there has been no proper breaching due to poor transmissienity values.

Further at present the state is in the second phase of the intensive utilisation of groundwater (since the utilisation of surface water has reached its 'saturation point', the alternation to supplement both in future will be expected to be this process. Hence, intensive research over this process will become dire necessity for facing the immediate future problems of the state.

Water, a commodity: not a free good

It has been felt from the beginning that a lot of difficulties in this field arise from the failure of people to recognise that under most circumstances water is a economic commodity and not a free good. If this realisation is taught to the people by the Tamil Nadu Government by and by, future improvements will be expected in the conservation of this scarce resource.

Inter-transfer of river basins

It has been estimated that nearly 40 per cent of the Indian population live in areas of water scarcity while large volume of water of Ganga and other rivers wastefully enters the sea during the monsoon which most of the times leads to misery and destruction in parts. Hence the government has felt that an equitable distribution of water can ensure growth which can minimise the regional imbalances in the distribution of this precious resource. Hence, the Ganga-Cauvery link has been suggested for the above.

As far as Tamil Nadu is concerned, the Ganga-Cauvery will be expected to solve the water resource problem of the state. Though Cauvery is an important river, it is mainly monsoon fed and due to erratic nature of rainfall large tracts of the state suffer from scarcity and severe drought occurs every three to five years.

In constructing the Ganga-Cauvery link the diversion will start near Patna and after it will be connected with Narmada, then the canal will be linked up with Wainganga which will take waters upto Godavari. From there the canal will flow to link up with the Krishna at Srisailam. Then it will pass through Cuddapah and join the Cauvery at the Upper Anicut instead of at Mettur Dam as originally proposed. This gravity canal will be over a distance of 1,600 miles involving lifts of about 1,650 ft. Hence, when the project will come into operation; an increase in the agricultural economy, navigation, and domestic consumption of water will be expected in the state [1].

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[1] K. Subbaroyan: Rivers of India Unite. Illustrated Weekly, March 4, 1973, p. 45.

The Ganga-Cauvery link projects merits and demerits are analysed by many experts in the country and according to Mr. P. Kumaraswamy, Director of the Irrigation Research Centre at Poondi (Tamil Nadu), "The quantum of water reaching the Cauvery Basin will be so small compared to its requirement of 162 million cubic metres in 2000 A.D. that the project is not worth the money and efforts" [1].

Hence it is expected that the development of water resources in the state will depend upon the amount of water ultimately received by Cauvery from this project.

Inter transfer of river basins suggested at the state level

A recommendation is made by the experts of the State for the linking up of the river Cauvery with that of another perennial river Tambraparani in the south and the excess of water from Cauvery can be directed towards the Tambraparani during the southwest monsoon period. This link will cover the two dry districts namely Ramanathapuram and Tiruchirapalli Districts and this may be further diverted towards the tanks of Ramanathapuram which are devoid of water during summer and this water received by these tanks may be helpful in bringing out one more crop in these two districts.

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[1] G. Rangaswamy: Changing the cropping pattern in Tamil Nadu. Feb. 1972, p.

Further when the Ganga will be linked with the Cauvery and in the meantime when the state will connect the Cauvery with that of the Tambraparani, the drought affected areas of the far southern part of the state namely the districts like Ramanathapuram, Tiruchirapalli and Tirunelveli will get more water both for agriculture as well as industries which can solve the future water problems of the state.

## CONSLUCION

Since already 94 per cent of the surface water is utilised which is the maximum and at present it is expected that at the present rate of consumption even the underground water will be fully utilised in the near future. Apart from increasing the efficiency of the irrigation works in the state, it becomes the imperative necessity and the responsibility of the Government to design so many new ways and means in this field of water resource development.

Though, the inter-transfer of river basins will solve the problem of the state, since it is a time consuming project, it will become necessary to take immediate steps to solve the existing water problems over the state. For this, it is advisable that the Experts in this field should be invited from different parts of the world to experiment various methods and among them which is efficient and cheap should be put into operation like desalination, artificial rain making etc. which can overcome the crucial period of water scarcity to a extent though not upto the fullest extent.

# CHAPTER III

# THE ROLE OF WATER RESOURCE IN REGIONAL AGRICULTURAL DEVELOPMENT

## INTRODUCTION

The agriculture of any region mainly depends on water and the efficiency of water is always taken as an index of development of the region or indirectly as a reflection on the use of scientific technology in agriculture.

Scarcity of water for irrigation is generally considered responsible for low crop yields, eventhough, poor quality of seeds, soil nutrient deficiency, pests and diseases and other factors that are limiting the growth may be concurrent or possibly dominant. But it has to be realised that water, one of the main inputs in agriculture, has the strategic role among them in the water, crop, soil conditions and in turn in agricultural development [1].

Though water has been utilised from the past for various purposes in industries as well as for domestic purposes, its importance for utilisation is mainly considered for irrigation purposes over which sustenance of life and the development of a region depends.

As a result the development of an agrarian system heavily depends upon irrigation which is the availability and access to sufficient quantity and quality of water. Since the primary source of water availability exists in the

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[1] Indian Council of Agricultural Research - Symposium on Soil & Water Management. (Held in Hissar) March 11 & 13, 1969, p. 3 & 7.

form of irrigation, the study or irrigation conditions in Tamil Nadu becomes sine-qua-non in the role of water in the agricultural development of that region.

HISTORY OF IRRIGATION

Tamil Nadu is fortunate enough in having many irrigation facilities which are constructed centuries ago and which are good and in use at present also.

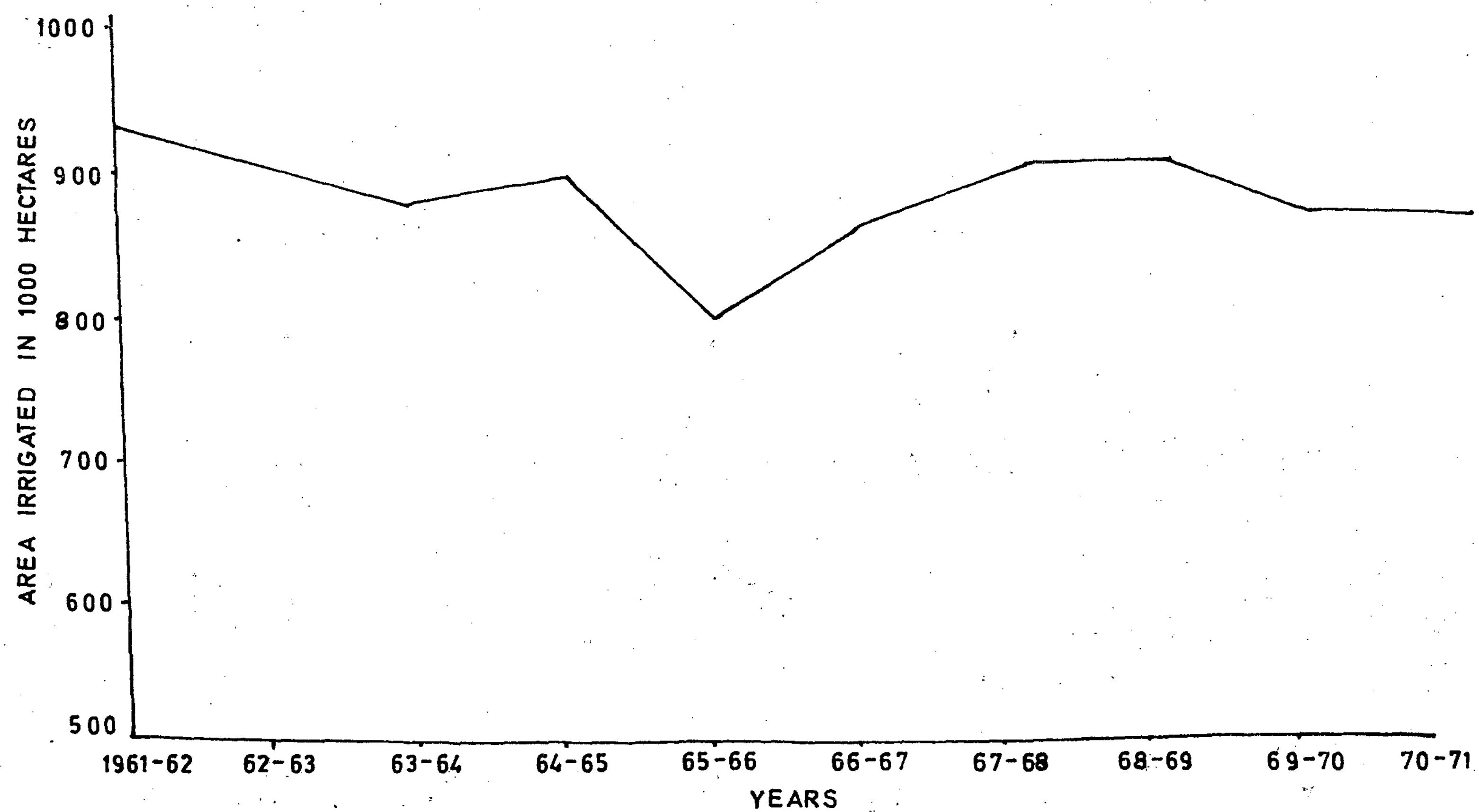
The most important one across the Cauvery is the Grand Anicut which was built by Karikala, the Great Chola King in the first century A.D. which is the oldest in India. For centuries, this anicut is responsible for the vast irrigation system in the Cauvery delta and for the agricultural porsperity of Thanjavur district, the granary of South India. The Grand Anicut is in its original form a masonry constructed over the Cauvery.

Other important anicuts across the Cauvery built long ago are the Upper Anicut constructed by Sir Arther Cotton in 1839 and the Lower anicut across the Coleroon built in the same period (1836).

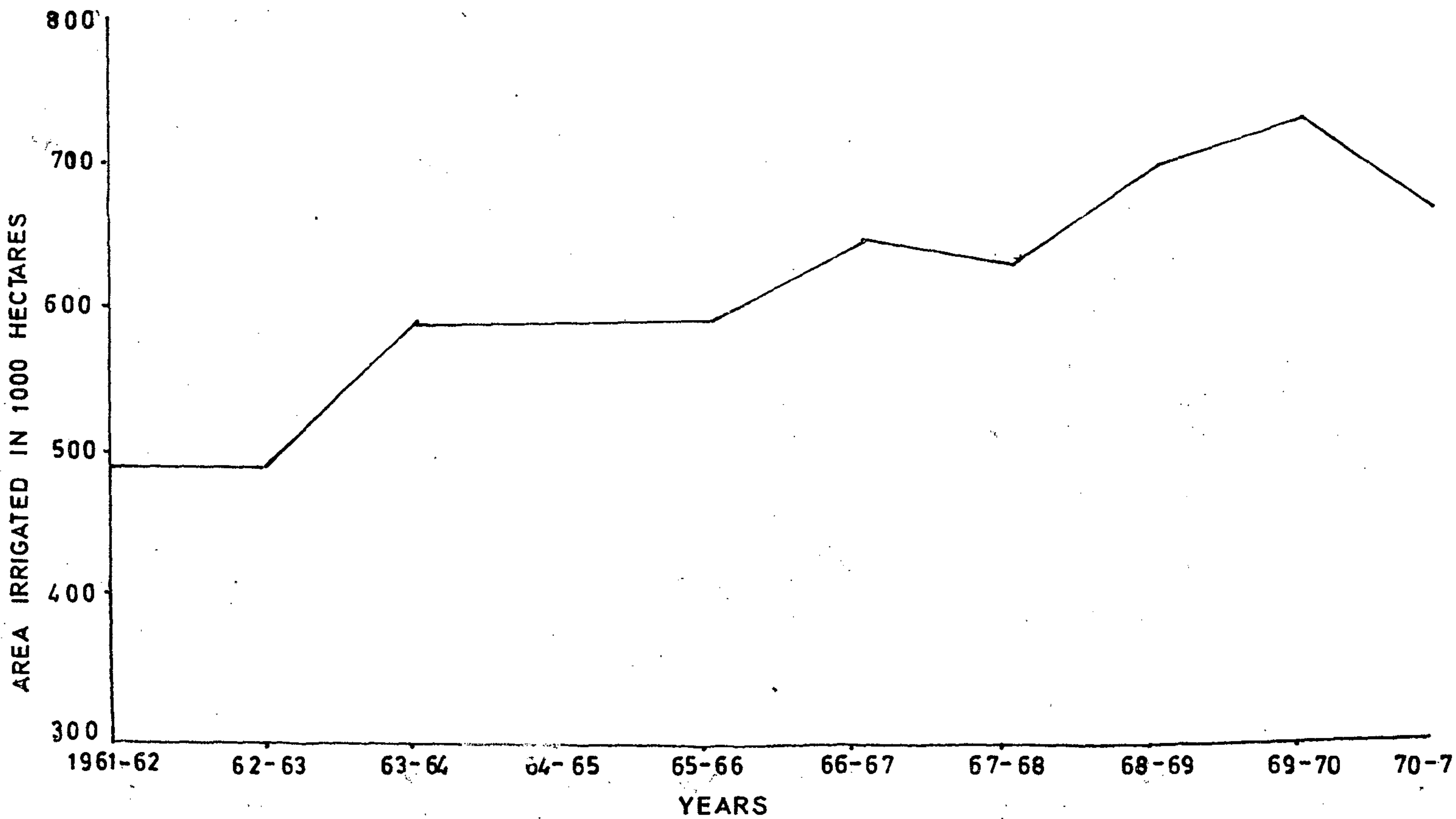
DEVELOPMENT OF IRRIGATION

The irrigation development in Tamil Nadu started much earlier and some of the systems are more than a century old. In 1901 nearly 5,65,580 hectares were benefitted from major and medium schemes and 89,034 hectares from minor irrigation schemes.

AREA IRRIGATED BY CANALS (1961 - 71)



## AREA IRRIGATED BY WELLS (1961-71)



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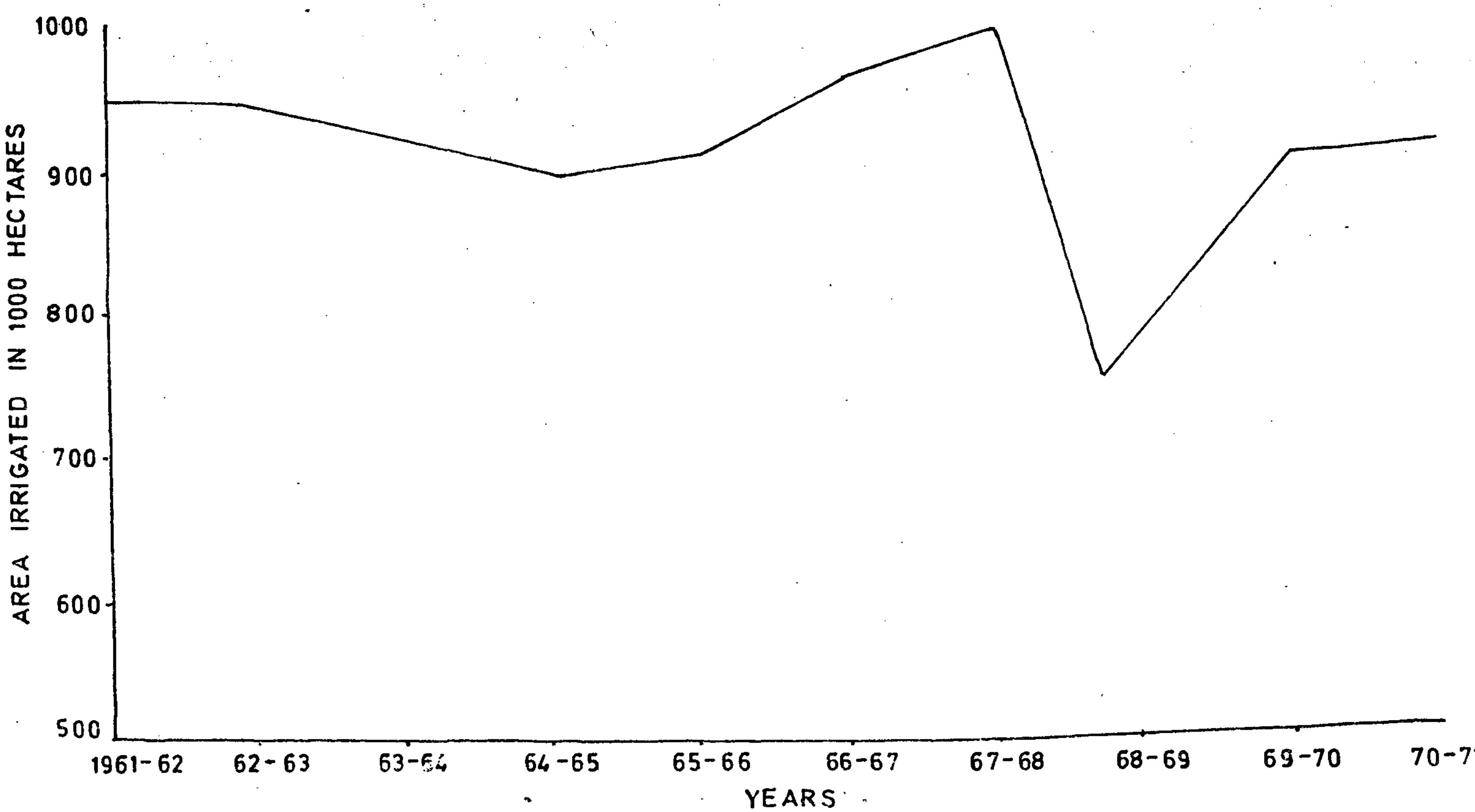
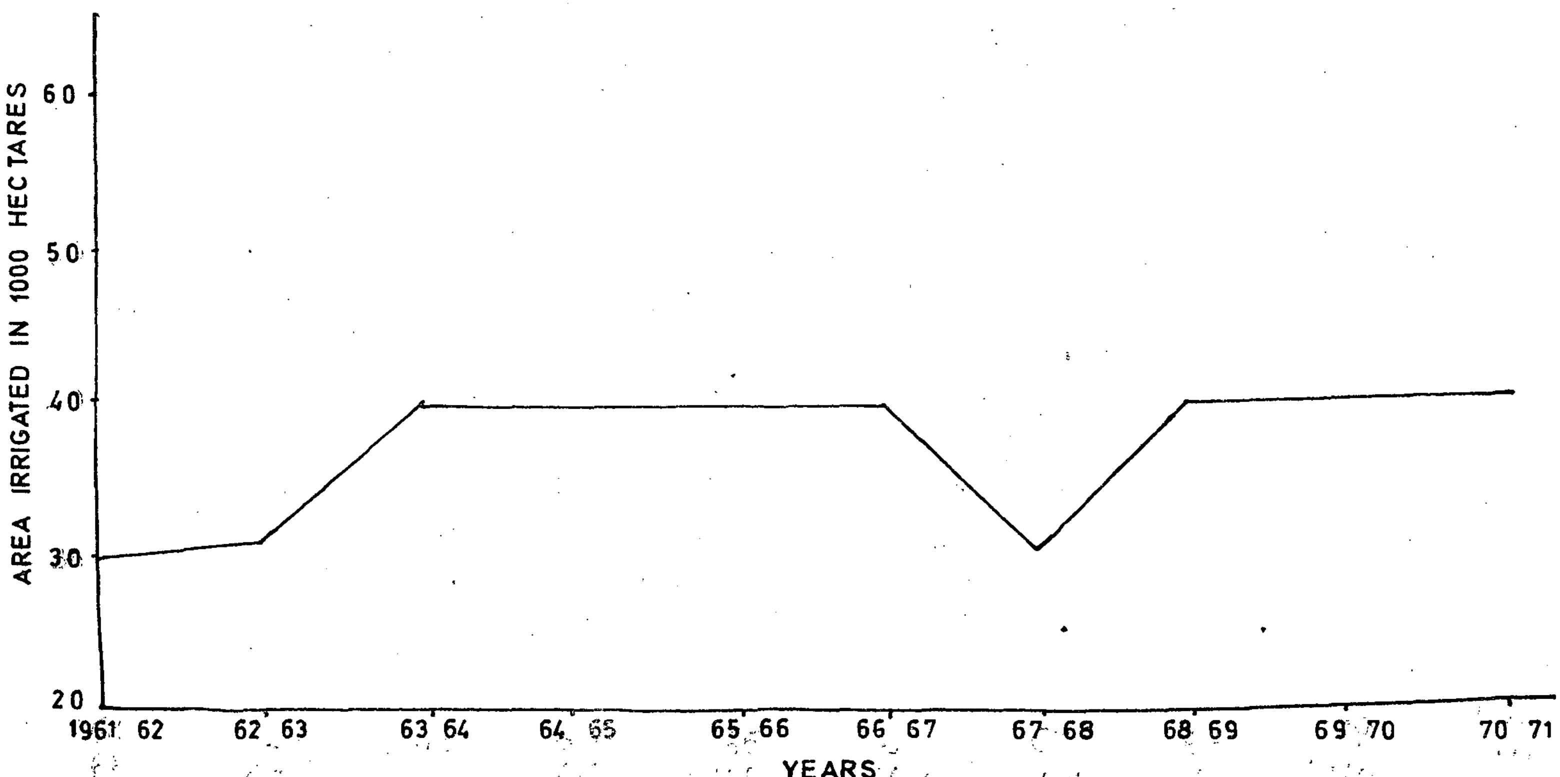
AREA IRRIGATED BY TANKS (1961 - 71)



## AREA IRRIGATED BY OTHER SOURCES (1961-71)



With the construction of Mettur reservoir (1924) there was an addition to this and in 1956 nearly 8,37,729 hectares were being benefitted from major and medium schemes and 97,128 hectares from minor schemes.

By 1971 there has been a further increase in irrigation, nearly, 11,02,389 hectares being benefitted from major and medium schemes and 11,16,000 hectares from minor irrigation[1].

For the study of the utilisation of surface water the command areas and capacities of the major, medium and minor irrigation projects come to the forefront and the following projects are playing major role in the agricultural economy of the state.

METTUR RESERVOIR

The reservoir is situated near Mettur in Salem district. The gross storage capacity of the reservoir is 2923 m.cu.m. while the live storage capacity is 2652 m.cu.m. The dam is one of the biggest in India, and at the time when it was built, was the biggest in the world. The water stored in the reservoir in addition to stabilising irrigation in the delta has extended over an area of 1,22,000 hectares under a new Canal called the Grand Anicut Canal.

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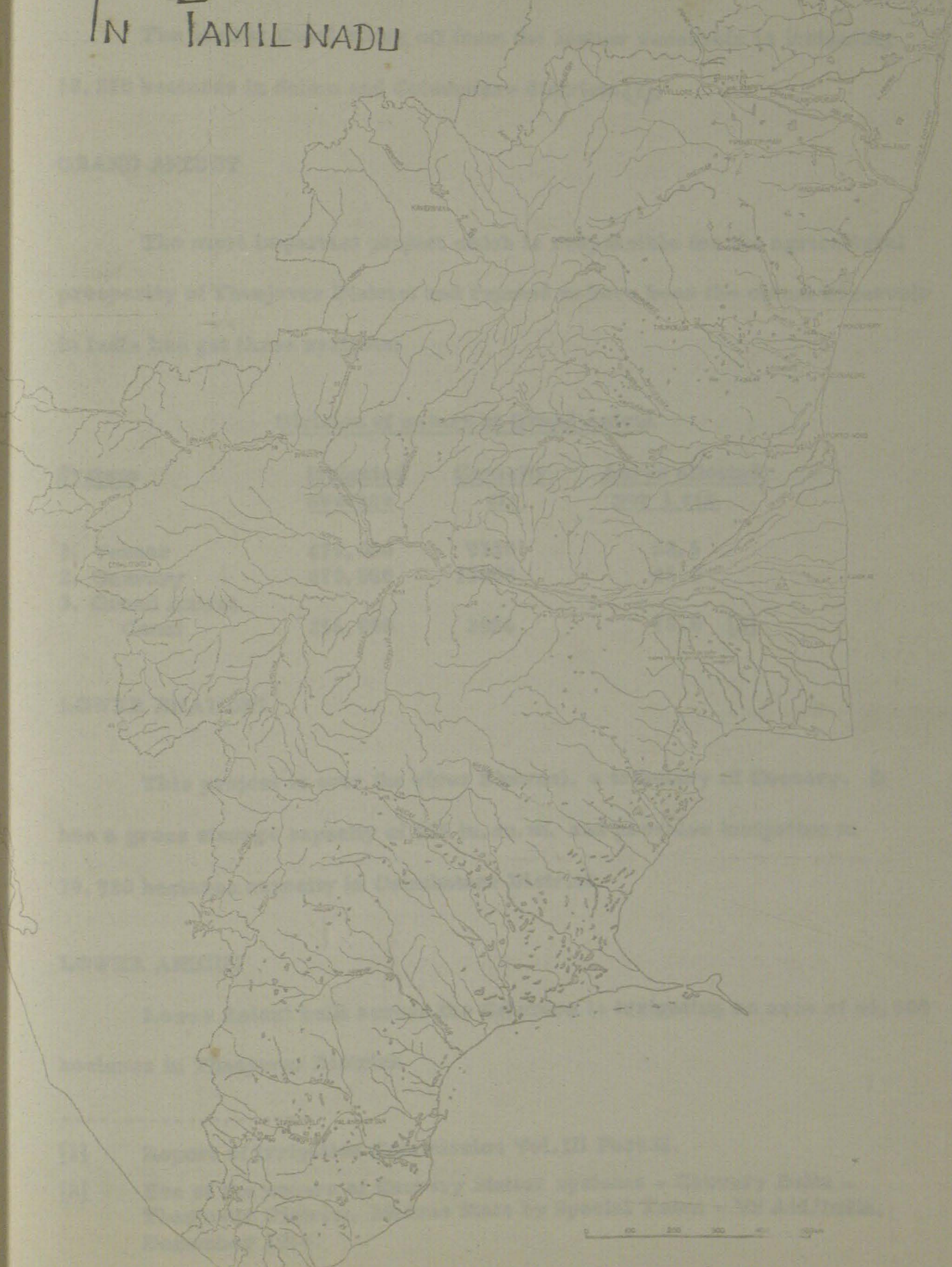
[1] Report of the Cauvery fact finding Committee, 15th Dec. 1972.

# IRRIGATION PROTECTS IN TAMIL NADU



The Mettur Canal taking off from the Mettur reservoir is irrigating 18,210 hectares in Salem and Coimbatore districts[1].

## GRAND ANICUT

The most important project which is responsible for the agricultural prosperity of Thanjavur District and reputed to have been the oldest reservoir in India has got three systems:

Division of waters at Grand Anicut

| System | Irrigated average | Capacity cfs | Acres allotted per 1 cfs. |
|---|---|---|---|
| 1. Vennar | 470,000 | 9380 | 52.5 |
| 2. Cauvery | 470,000 | 11000 | 43.0 |
| 3. Grand Anicut Canal | 256,000 | 3686 | 73.0 [2] |

## LOWER BHAWANI

This project is over the river Bhawani, a tributary of Cauvery. It has a gross storage capacity of 925 m.cu.m. and provides irrigation to 78,920 hectares capacity in Coimbatore District.

## LOWER ANICUT

Lower Anicut built across the Coleroon is irrigating an area of 44,500 hectares in Thanjavur District.

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[1] Report of Irrigation Commission Vol.III Part II.

[2] Use of the waters of Cauvery Mettur systems - Cauvery Delta - Thanjavur District, Madras State by Special Team - US Aid/India, December 1964.

## MANIMUTHAR PROJECT

This project with a reservoir of 156 m.cu.m. capacity is constructed over Tambraparani and it not only helps in irrigating an area of 33,586 hectares but also supplies water to number of precarious, rainfed tanks which irrigates an area of 8,094 hectares.

## PARAMBICULAM ALIYAR PROJECT

This ambitious project contemplates the harnessing of seven west flowing rivers and irrigates an area of 97,130 hectares in Coimbatore district.

Apart from this there are numerous major, medium projects in the State (Appendix No. 11&12).

## MINOR IRRIGATION

Irrigation by tanks and wells has been practised for centuries in the State. In 1968-69, the gross area irrigated by tanks are 750530 hectares and wells are 733914 hectares and nearly 36665 tanks are in the state which are mainly connected with the Streams (Madurai & Ramanathapuram). In the districts like Chingleput and N. Arcot supplies are drawn from spring channels and it is estimated that 30829 spring channels are in the state [1].

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[1] Report of Irrigation Commission Vol. III Part II.

The other important source of irrigation are the tube wells which has increased from 2649 in 1956 to 23,900 in 1969.

Since the surface water in the state is utilised to the maximum, now the State has turned its attention in increasing the efficiency of irrigation works in the State. (Modernisation of Cauvery Delta).

DISTRIBUTION OF IRRIGATION WATERS IN THE STATE

The policy of irrigation which is followed from the past is "maximum water for the maximum number in the tracts commanded". As against this, the present policy of the given quantity of irrigation waters over relatively large areas to provide protection against drought and maximum utilisation of water for intensive cultivation in some district or areas of the State creates many problems in the State.

One of the most important problems arises out of the present method of irrigation policy, which has resulted in regional imbalances which in term has resulted in few people enjoying this scare resource lavishly, while the rest face the inevitable droughts.

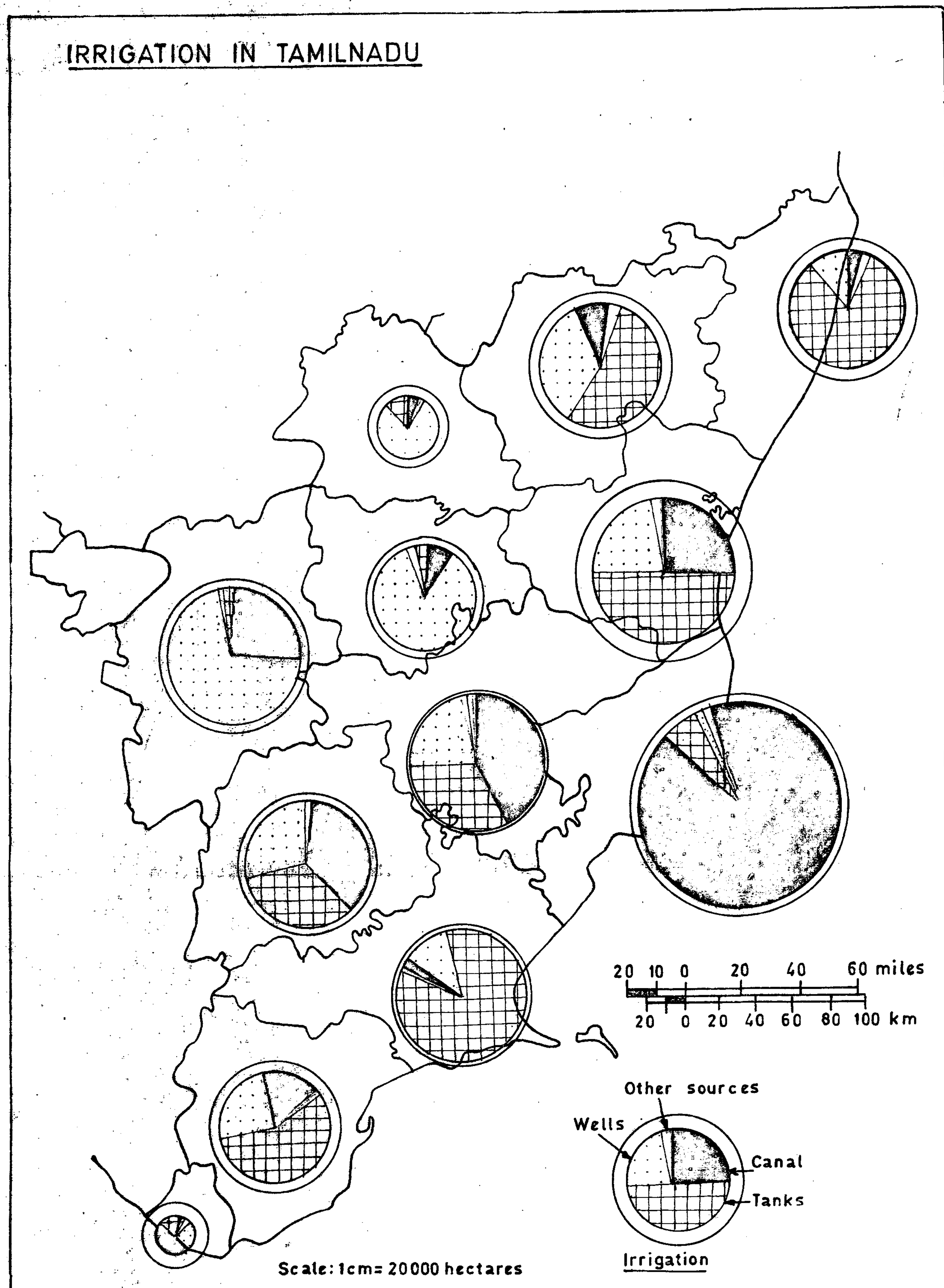
Hence it has become the responsibility of the state Government to tackle the policy of the distribution of irrigation waters from the point of overall gross production using a given quantity of water over a given area which may yield more than using the same water over a part of the state and having the rest to bear un-irrigated crops.

## REGIONS OF WATER UTILISATION

### Water Resource Region

The concept of water resource region in turn reflects the natural environment which has spatial dimension with distinct core areas and their influence on land use is significant atleast in some regions. Hence, the greatest responsibility of balancing the regional disparities with regard to the quantity of water availability needs efficient water management; which in turn requires a proper balance in forming the relationship between water supply and the soil, the kind of the crop, climatic conditions and other cultural practices etc. Compared to the other fields of water use, maximum utilisation is seen mainly for irrigation and it is a well known fact that of all the factors which affect the agricultural economy of the region, irrigation is the pivot around which the natural economy revolves.

Tamkl Nadu has reached almost the end of its tether in the utilisation of its surface water potential and the future irrigation development in the state has to depend mainly on improving the efficiency of water management and the present crucial period of water scarcity presses the need for knowing about the imbalances even in the distribution of irrigation water which has made the drought affected areas in the same suffering position from the past. As a result, it becomes important in studying the regional imbalances rather than the study of water resource availabilities which Chapter is almost over, as far as Tamil Nadu is concerned.


IRRIGATION IN TAMILNADU
20 10 0 20 40 60 miles
20 0 20 40 60 80 100 km
Other sources
Wells
Canal
Tanks
Irrigation
Scale: 1cm= 20000 hectares

Hence, the study of how far the impact of water availabilities in the form of irrigation has resulted either in the development or underdevelopment of a region will help in the efficient irrigation water management which will help in giving equal opportunities and equal distribution of water throughout the state.

Delineations of the Regions of Water Utilisation

Regions are delineated on the basis of proportion of area irrigated by different sources of water supply to the total cropped area. This broadly indicates how far water utilisation varies from region of one source of water supply to the other thereby bringing out the regional disparities in landuse, cropping pattern, productivity, etc. which enables the region either to change its cropping pattern according to the quantity of water availability from time to time as well as for economising the present use of water for cultivating different crops.

Based on the irrigated area by different sources of water supply (1968-69), Tamil Nadu has been divided into the following regions (Detailed tables showing the water supply and area irrigated by different sources are given in the Appendix No. 13. )

Method adopted for the Delineation of Regions

The Composite index is used for finding out the Levels of Irrigation Development in the different sources of water supply like canals, tanks, wells and other sources.

1. In this Composite index each variable for each district is divided by the average irrigated area by each source and then they are added. This gives the picture of the levels of development of irrigation in each district [1].

1. <u>Computation of Composite Index:- for finding the Levels of Development of Irrigation:-</u>

Let our variable be x, y, m, n which are of varying unit of observations. To make it undimensional we adopt the following procedures:-

1. Calculation of $\bar{x}, \bar{y}, \bar{m}$ & $\bar{n}$
2. Division of $x_1$, $x_2$ .....$x_n$ by x and similarly for y, m & n so that it is made scale free.
3. Add each row to get the composite score for each observation.

The greatest advantage of using the composite index for finding out the levels of development of Irrigation lies in the scarcity of weightage.

2. Then Weaver's crop combination method is adopted for finding out the predominance of irrigation in each district and they have been grouped according to the sources of irrigation* (Appendix No. 14 )

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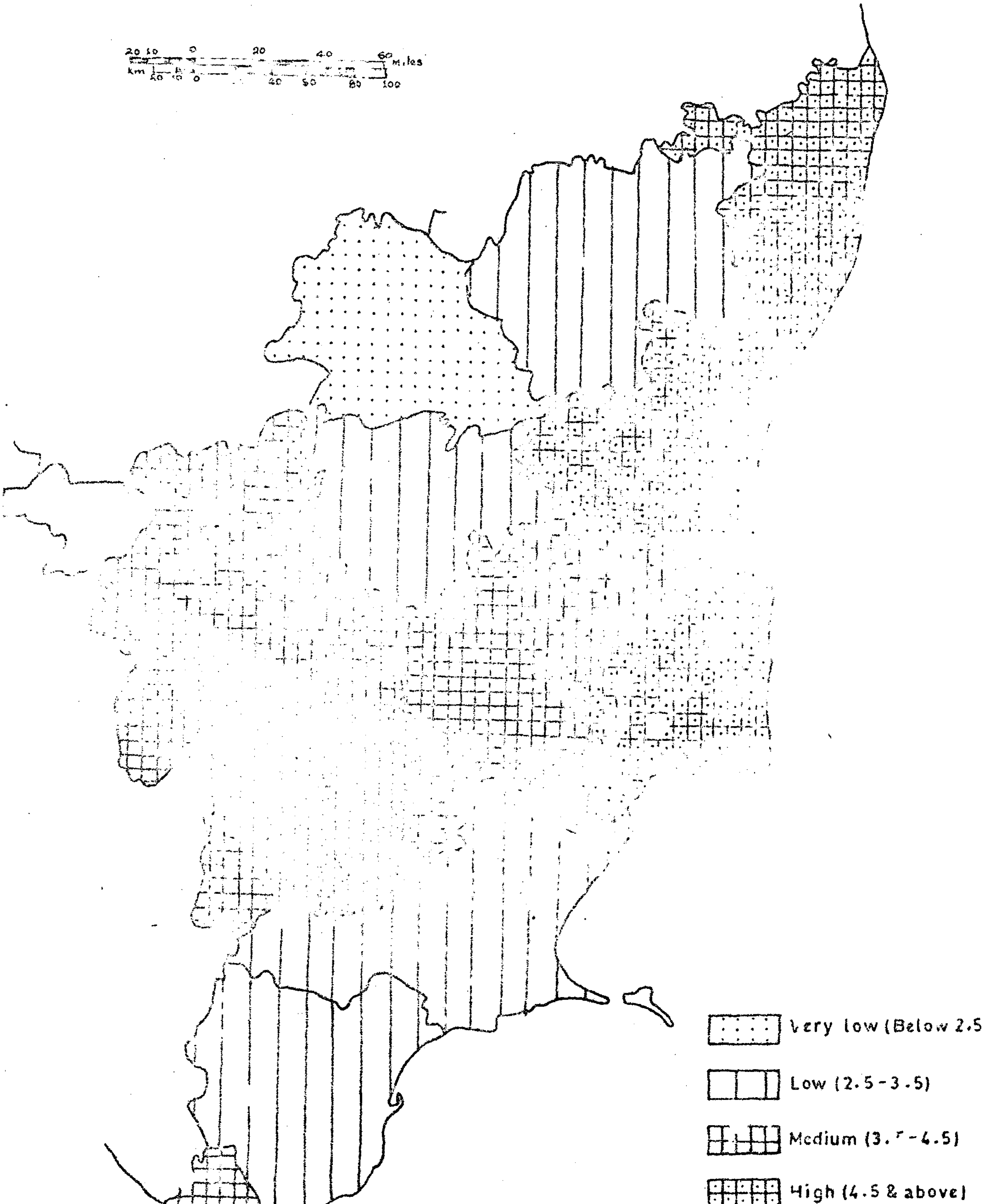
[1] Amitabh Kundu: "The Methods of Constructing a Composite index for Regionalisation - A Critique" Paper presented at the seminar on Regional Economic Planning, Ahmedabad, March 16-18, 1973.

* For the delineation of regions, only the predominant source of water supply is taken into consideration and it does not imply that the other sources are not playing their role in those areas wherever the agricultural development are considered, the role of other sources are also taken into consideration.

# LEVELS OF DEVELOPMENT OF IRRIGATION (1968-1969)



**Method used for Delineation of Regions**

1. Let our variables be X, Y, Z, and the following procedure has been used for the delineation of regions.

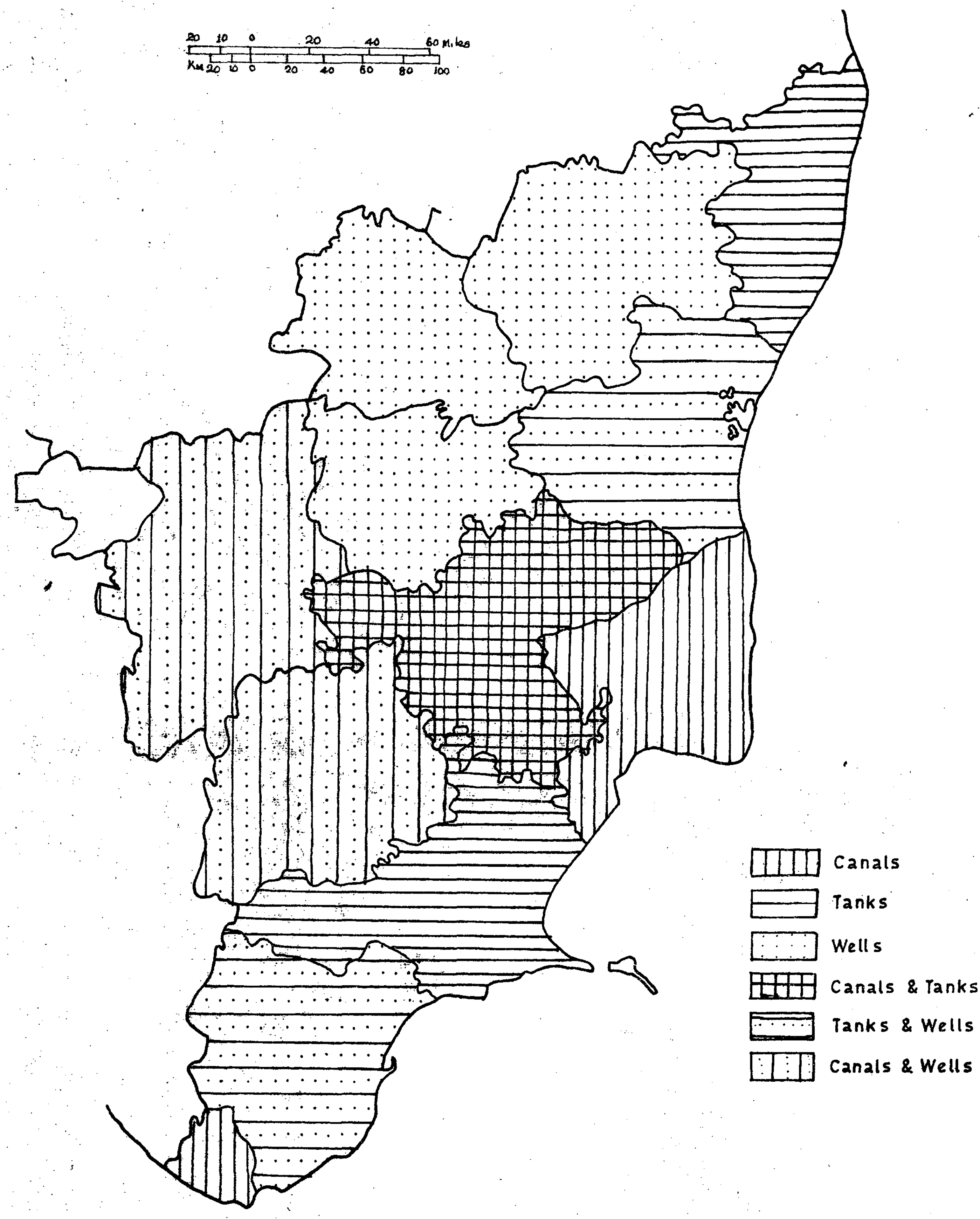
1. Calculation of $\overline{X}$, $\overline{Y}$, & $\overline{Z}$.

2. Division of $X_1$, $X_2$.....X by $\overline{X}$ and similarly for Y & Z and let us assume them as $X_1$, $Y_1$ and $Z_1$ and then they are added which represents the levels of development $P_1$, $P_2$.....$P_n$.

3. Ratio of each variable i.e. $X_1$ to the levels of development of each variable $P_1$, $P_2$ are calculated ($Q_1$, $Q_2$.....$Q_n$).

4. Weaver's formula: Taking the above variables $Q_1$, $Q_2$.....$Q_n$, from the hypothetical percentages of area index sources of water supply for canal irrigated area 100 per cent for tanks 50 per cent and wells 33.33 per cent (The area irrigated by other sources are excluded), the actual percentages of area under different sources of water supply are to be subtracted. These diviations are to be squared. The sum of the squared deviations for each combination is to be divided by the number of sources where $\frac{\Sigma d^2}{N}$ is lowest that combination of sources of water supply are dominant.

PREDOMINANT SOURCES OF IRRIGATION IN TAMILNADU (1968-1969)



**Regions of water utilisation**

Based on this method Tamil Nadu is divided into the following regions:

| Region | *Predominant source of irrigation | &Districts |
|---|---|---|
| I | Canals | 1. Thanjavur<br>2. Kanyakumari |
| II | Tanks | 1. Chingleput<br>2. Ramanathapuram |
| III | Wells | 1. North Arcot<br>2. Dharmapuri<br>3. Salem |
| IV | Canals & Tanks | 1. Tiruchirapalli |
| V | Tanks & Wells | 1. South Arcot<br>2. Tirunelveli |
| VI | Canals & Wells | 1. Coimbatore<br>2. Madurai |

* Season & Crop Report - 1968-69.

In the case of Nilgiris District there is no irrigation since the district has been endowed with immense water resources through rainfall.

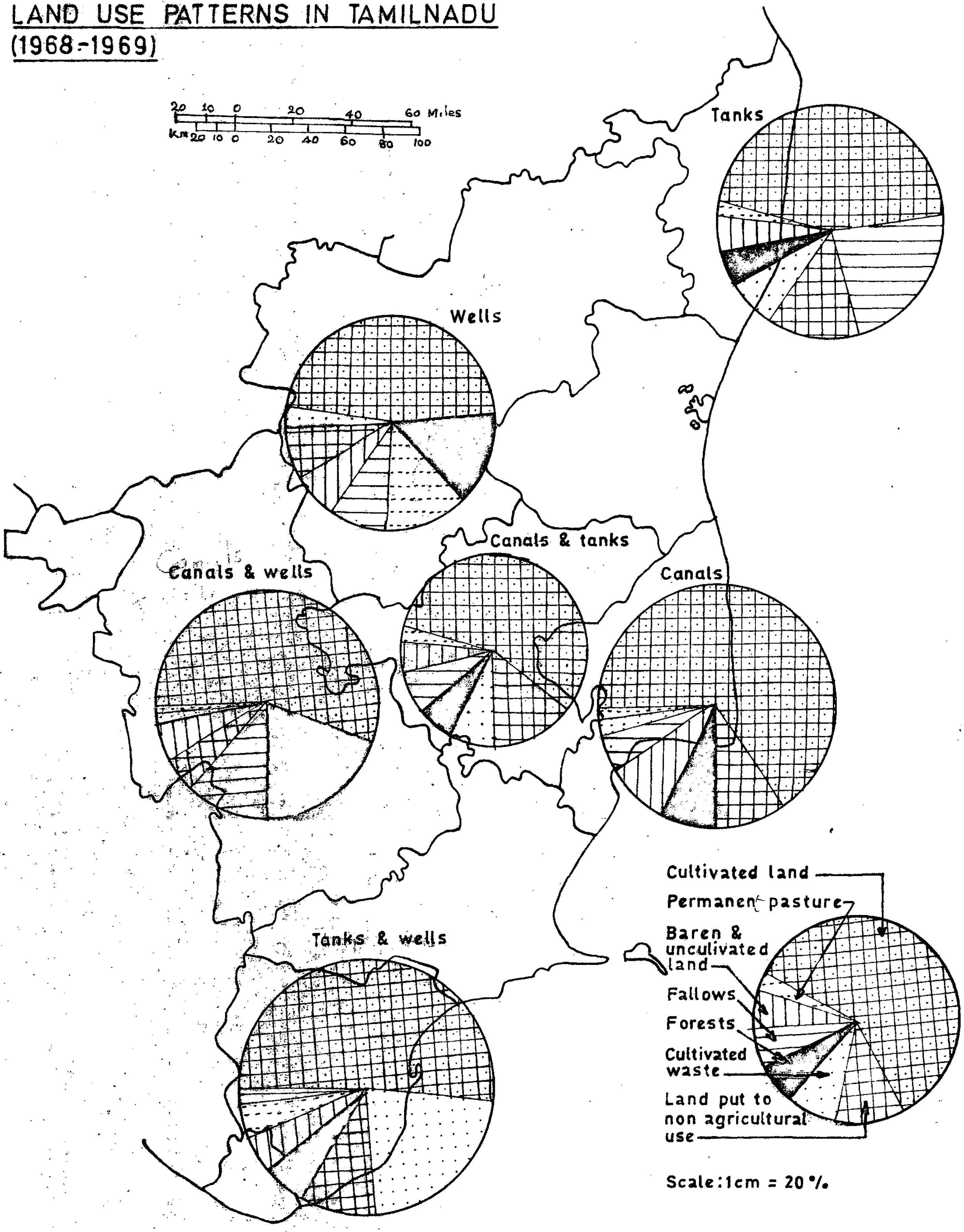
& The aim of this study is to bring out the development or under development in the regions of water civilisation. Hence, emphasis is given more on the utilisation point of view (irrigation) rather than from the availability point of view.

## LAND USE AND IRRIGATION

Though landuse of any region is determined by the ecological factors like physiography, climate, soil, etc. the other important factor which is also playing major role is water which forms the drainage pattern. Though in framing the pattern of landuse it plays a role indirectly unlike the other ecological factors (in the form of rainfall), its mark over its utilisation of any area is as impressive as that of other ecological factors. Hence, for water resource planning it has become indispensible to know about the existing landuse pattern which forms the basis for the regional agricultural development.

The following table shows the existing landuse pattern which differs from the One source of water supply to the other.

# SOURCES OF WATER SUPPLY AND LAND USE PATTERNS IN TAMILNADU (1968-1969)



**SOURCES OF WATER SUPPLY AND LANDUSE PATTERNS (Percentage to the total area, 1968-69)**

| Regions with the predominant sources of water supply | Forests | Barren & Uncultivable land | Landput to non-agri. uses | Permanent pastures & other grazing lands | Fallows | Cultivable waste | Cultivated areas |
|---|---|---|---|---|---|---|---|
| 1. Canals | 13.2 | 8.1 | 13.2 | 0.6 | 3.7 | 2.4 | 77.5 |
| 2. Tanks | 8.5 | 6.6 | 15.5 | 3.3 | 21.4 | 8.5 | 47.5 |
| 3. Wells | 26.1 | 8.2 | 7.9 | 1.5 | 10.7 | 3.2 | 47.6 |
| 4. Canals & Tanks | 1.5 | 4.8 | 15.2 | 2.6 | 5.5 | 6.8 | 55.8 |
| 5. Tanks & Wells | 34.4 | 9.8 | 9.2 | 1.9 | 16.1 | 5.1 | 55.2 |
| 6. Canals & Wells | 5.6 | 4.6 | 6.3 | 4.6 | 2.1 | 16.4 | 50.8 |

Source: Season & Crop Report, 1968-69.

The above table shows the fact that the tank irrigated area is not utilised to the maximum extent for agriculture. The same condition is also seen where wells are the predominant source of water supply.

The other fallow lands apart from the current fallows (1968-69) seen in the tank irrigated region is 4.6 which is more compared to the other regions, the land put to non-agricultural use is 15.5 per cent and the low percentage of 47.5 per cent cultivated area makes this region more distinct compared to other regions and this in turn reflects the water scarcity of this region. Hence it shows the fact that the development mainly depends upon the provision of water availability in this region and this is the main reason which makes it difficult to cope up with the regional agricultural development of other regions [1].

<u>Cropping Pattern:</u>

The composition of crops is a function of the interplay of climatic and soil conditions. While the ecological factors are playing major role in determining the cropping pattern of a region, the structure can be modified to a considerable extent with the help of some of the technological applications like irrigation, power, pesticides, etc. Though the dominance of ecological

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[1] The tanks in the state are irrigating 38.4% of the area, canals 34.3% and wells 27.3%. Though tanks are irrigating the maximum area in the state, the importance with reference to improvement in irrigation has been given from the beginning to canals rather than to tanks. Hence major irrigation schemes always verses with the minor over though minor irrigation plays predominant role in most of the districts of the state.

factors are seen elsewhere, the technological forces are seen more dominating over wider regions. The cropping pattern of a region is dominated more by the technological factors in spite of the ecological factors.

Among all these factors which confront the crop planning of the state, the important one is the maximum utilisation of water as and when released with fluctuations according to requirements, maximum efforts are taken to get maximum production from a field due to irrigation after evaluating the soil and its characteristics, and further it will become the greatest responsibility to get maximum financial return only due to irrigation. Hence, the farmer has to give appropriate weightage to each of them and combine all of them with each other by permutations and combinations, if necessary and finalise the crops in his farm [1].

<u>Cropping Pattern & Regions of water utilisation</u>

In the case of the area where the predominant source of water supply is canal, the main crops seen are Rice (62.35%), Coconut (6.4%) and Pulses (3.95%) [2].

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[1] These fluctuations will become wide when the project is multipurpose. The typical example is Mettur reservoir and its greatest fluctuations in water supply is a striking one. Further the assumptions regarding releases of water have themselves had to be changed in the light of an acute demand for power.

[2] State & Crop Report 1968-69.

The abundant water seen in this region has resulted in the double and even in treble cropping of paddy. The main problems due to abundance of water supply seen in this region are in the mangrove swamps (seen in the South eastern part of Thanjavur District) water logging near the river mouths, silting perennial tanks and breaching of bunds which should be considered [1]. Intensive cultivation in future in all these regions mainly depends upon by bunding of streams and repairing wells and tanks. Remodelling the old reservoirs and anicuts will become necessary [2].

Hence with the increase of the teeming millinns, future increase of food production in this region mainly depends upon the increase in the efficiency of irrigation practices.

Region II: (Tanks as predominant source)

Rice (55.05%) with the association of millets are seen. In the case of Chingleput, the smaller area irrigated by canals have double cropping of rice and in Ramanathapuram district, sugarcane is seen along the river Vaigai [3].

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[1] In all these areas fishing is also seen which is important from the point of view of regional development.

[2] Since centuries old anicuts and canals are still in use in the state.

[3] Season & Crop Report, 1968-69.

**Region III: (Wells as predominant source):**

Groundnut (23.4%), Rice (15.1%) and Pulses (11%), sugarcane (3.4%) occupies the major area. Hence diversified cropping is seen [1].

**Region IV: (Canals & Tanks as predominant sources)**

Diversified cropping is seen with emphasis on Rice (27.3%) is seen along the canal irrigated area. Intervening uplands which are having tank irrigation are seen with the crops like Ragi (2.0%), Groundnut (12.3%) and Bajra [2].

**Region V: (Tanks & Wells as predominant sources)**

Crops like Rice (33.8%), Groundnut (11.45%), Pulses (4.9%) are seen. The commercial crops, cotton is occupying the largest area 7.5% which in turn reflects the soil characteristics [3]

**Region VI: (Canals and wells as predominant sources)**

Arable farming is seen with the food crops like Cholam (23.3%), Cumbu (5.8%), Pulses (8.25%) and cash crops like cotton (7.15%), Groundnut (14.2%), Sugarcane (2.9%) and tobacco (0.9%). Rice (17.2%) is also cultivated in the smaller tracts of canal irrigated area [4].

The following table shows the existing landuse patterns and howfar the proper distribution of water can increase the regional agricultural development is also discussed in the light of regions with different sources of water supply[5].

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[1] - [4] Season & Crop Report 1968-69.

[5] Since the study is restricted for the analysis of the role of water availability in the form of irrigation in regional development, more importance is given towards the utilisation of water and hence it should be taken for granted that the ecological factors are mainly responsible for determining the cropping pattern alongwith the water availability.

## Water Resources & Regional Agricultural Development in Tamil Nadu

| Criteria for Delimitation | Regions | Districts | The predominent source of irrigation seen | Other types of irrigation seen (1968-69) | Existing Land use Pattern | Regional Development Norm | Remarks |
|---|---|---|---|---|---|---|---|
| Area irrigated by different sources are taken as the basis and regions are delimited according to the predominant source of irrigation. | 1. Area irrigated by Canal. | Thanjavur & Kanyakumari | Canal | Tanks, wells & other sources. (Spring channels) etc. | Rice & Coconut Cultivation | Intensive cultivation by bunding streams, & repairs to wells and tanks. Remodelling of the old reservoirs and anicuts will increase the double & treble cropping of rice. | The future increase of food production mainly depend upon the increase in the efficiency of irrigation. |
| | 2. Area irrigated by tanks. | Ramanathapuram & Chingleput | Tanks | Canals, wells & other sources (Spring channels) etc. | Coastal plains with rice with the association of millets. In the case of Chingleput Canal irrigation helps in double cropping of rice in Ramnad Sugarcane along the banks of Vaigai. Stock rearing & grazing is also seen. | The tanks which are at present connected with the non-perenial rivers, if provided with the perenial source of water will help even in changing the fruitful cropping pattern in future. | The perenial supply of water to the tanks which is a menance for the development of the region can be solved by this simple scheme. |

| Criteria for Delimitation | Regions | Districts | The predominant source of irrigation seen | Other types of irrigation seen (1968-69) | Existing Land use Pattern | Regional Development Norm | Remarks |
|---|---|---|---|---|---|---|---|
| | 3. Area irrigated by wells. | N. Arcot Salem | Wells | Canals, tanks & other sources (Spring channels) etc. | Woodlands, arable land under millets, rice under the irrigated areas & oilseeds & groundnuts. | Increasing the existing number of tube-wells and repairing the old wells is necessary for soil conservation & future development mainly depends upon irrigation. | Woodlands for soil conservation. Hence dry farming method can be advocated. |
| | 4. Area irrigated by Canals & tanks. | Tiruchirapalli | Canals & Tanks | Wells & other sources (Spring channels) etc. | Diversified cropping with emphasis on rice. Intervening uplands under ragi, bajra & groundnut. | Diversified farming with increasing the efficiency or irrigation. | |

| Criteria for Delimitation | Regions | Districts | The predominent source of irrigation seen | Other types of irrigation seen (1968-69) | Existing Land use Pattern | Regional Development Norm | Remarks |
|---|---|---|---|---|---|---|---|
| | 5. Area irrigated by tanks & wells. | South Arcot & Tirunelveli | Tanks & wells | Canals & other sources (Spring channels) etc. | Forests, permanent pastures & grazing lands, studded with palmyratrees millets and cotton is seen to a larger extent in Tirunelveli district which is associated with tank & well irrigation. | Increase in the efficiency of irrigation namely by providing water throughout the year connecting them with that of the perennial rivers will result in the increase of good variates of the cash crops. | |
| | 6. Area irrigated by canals & wells. | Madurai & Coimbatore | Canals & wells | Tanks & other sources (Spring channels) etc. | Forestry, Arable farming food crops (jowar, bajra) & cash crops (cotton groundnut, sugarcane & tobacco) | Intensive arable farming is possible with increasing efficiency of irrigation which requires emphasis on food & cash crops. | This region which stands out distinctly in its land-use further reflects the fact that this regions' high development is only due to irrigation method adapted from the past. |

## CROP COMBINATION REGIONS

*Weaver's formula is used in finding out the crop combination in regions of different sources of water supply, and the intensity of cropping patterns can be predicted by this.

The following observations are made from an analysis of the crop combination pattern in different sources of irrigation when super imposed on ecological and other patterns (Appendix No.

1. The canal irrigated area has got the crop combination of rice, coconut, pulses and groundnut. Rice crop is in the first rank and the second one is coconut.

2. The tank irrigated region has got the combination of rice, groundnut, cotton, cumbu, ragi, pulses and gingelly. Hence, dry farming with diversified cropping pattern is seen.

3. The well irrigated area has the combination of groundnut, rice, pulses, cholam, ragi and cumbu. While the other regions have got rice crop in the first rank, this region has got groundnut as the first ranking crop.

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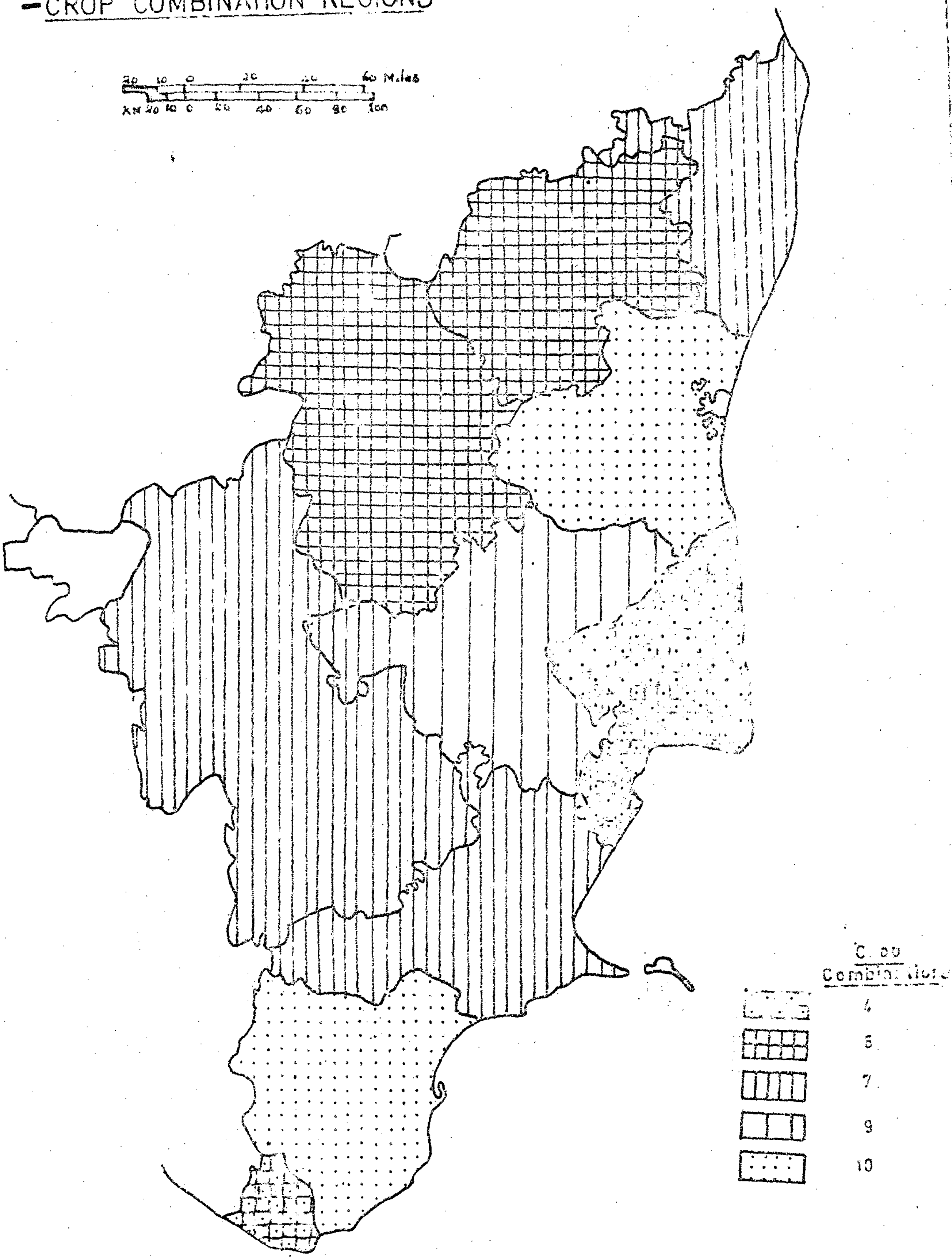
* From the hypothetical percentages of area under crops (one crop 100%, two crops 50% each, three crops 33.33% each, four crops 25%, five crops 20%.....) the actual percentages of area under the subjected crops are to be subtracted. These deviations are to be squared. The sum of the squared deviation for each combination is to be devided by the number of crops where $\frac{\Sigma d^2}{N}$ is lowest that crop combination is appropriate.

## SOURCES OF WATER SUPPLY - CROP COMBINATION REGIONS



4. The combination of rice, cholam, cumbu, groundnut, pulses, gingelly, ragi, sugarcane and cotton is seen in the canal and tank irrigated region. This depicts the fact that the predominance of two types of irrigation has resulted in both the dry farming and intensive farming.

5. The combination of cholam, rice, groundnut, pulses, cotton, cumbu, ragi, sugarcane, gingelly, and coconut is seen in the canal and well irrigated region and cholam occupies the first rank among them in this region.

6. The tanks & wells irrigated area has got the combination of rice, cumbu, groundnut, cotton, cholam, pulses and ragi.

<u>Water availability and core area of crops in regionalisation</u>

One of the main objectives in Crop planning is to make the best use of water availability for which it has optimal conditions for production. Since cropping patterns are largely influenced by regional variations in water availability as well as other physical conditions, there emerge distinct 'Core areas' of a crop or crop association which should be given priority in water resource plannings. The analysis of spatial patterns of water availability in Tamil Nadu reveals distinct regimes of crop or crop association which varies with the variability in water availability.

The following table indicates the relative shares of the 'Core areas' of the 'Core areas' of the crops in relation to total area of production and concentration with reference to different sources of water supply.

## CONCEPT OF WATER AVAILABILITY AND CORE-AREAS OF CROPS IN REGIONALISATION

| Crops | Regions with the predominant source of water supply [1] | Percentage of each crop to the total cropped area [2] | Percentage of production of each crop to the total cropped area [3] | Yield Kg/hectare | Remarks |
|---|---|---|---|---|---|
| Rice | Canal | 62.35 | 17.42 | 1,902 | The canal irrigated region occupies an extensive area under rice. This is mainly due to the perennial source of water supply. Water utilisation is seen to maximum in the large tracts occupied by this crop. (e.g. Thanjavur Delta). But the question is how much water is utilised and how much water is wasted to have the maximum output per acre of this crop. |
| Cotton | Tanks & Wells | 7.5 | 8.5 | 798 | The distinct development of this region is due to cotton production which in turn is due to intensive irrigation. Further exploration of underground water and diversion of Cauvery water will increase the production of cotton which can face the present demand. |
| Groundnut | Wells | 23.4 | 11.81 | 877 | With the introduction of numerous tubewells this important oil seeds area can be increased which can face the present demand for oil seeds in the state. |
| Pulses | Wells | 11.0 | 12.33 | 339 | Due to water scarcity, the largest area under this category is mainly occupied by horsegram in the state. By the installation of tubewells, other short gorwing varieties can be grown. |

| | | | | | |
|---|---|---|---|---|---|
| Sugarcane | Canals & Wells | 2.9 | 13.88 | 88.72 (tonnes) | Changing the tracts of rainfed sugarcane into irrigated areas in a well planned and systematic manner will increase the prosperity of this cash crop in this area. |

1, 2, 3 - Season & Crop Report 1968-1969.
Govt. of Tamil Nadu, 1972.

Changing the Cropping Pattern with reference to water availability

With the food supply increasing in arithmetic ratio and the population increasing in geometrical ratio, man in the midst of a "Revolution of rising expectations"; has to adjust himself to the necessities of life with the limited natural endowments given to him. Hence, to meet the growing future demand and to optimise the present availability, he has to modify some of the natural or traditional practices by adapting some of the modern scientific methods and using technological implements available in the farming. With the uncertainity of rainfall, its maldistribution and with the variation in the quantity of water often makes him to change the cropping pattern according to water availability [1].

As a region, endowed with immense water facilities, the canal irrigated area is taken as an example for this study.

As against the present requirements, 10 per cent more than the required quantity of rice and cholam are produced in the canal irrigated region. Hence, there is ample scope for reducing the area under cereals, so that other important crops like cotton can be grown in an intensive manner. It is estimated that 60,000 hectares of cotton can be introduced under irrigation in this region. The possibilities of growing cotton has been

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[1] Rangaswamy, G.: "Changing the Cropping Pattern in Tamil Nadu" Coimbatore, Feb. 1972.

already explored. The limitation being the availability of water during summer months, it has been estimated that at the most it can cover about 20,000 hectares of land under cotton in the rice fallows of the canal irrigated tracts [1].

But it is necessary to tap the underground water resources and also exploring the possibilities of diverting Cauvery water for irrigating cotton crop in these tracts. Apart from that, it will be necessary to find out the water requirements of crops and in a judicious manner, if water is given to farmers according to crop requirements, the excess water which can be used without the knowledge of the farmer can be used for raising this important cash crop in this tract [2].

Water Availability & Index of Land Productivity

The productivity of any region depends upon the yield of the crop and the yield in turn depends upon other ecological factors including water availability. As a result, it becomes necessary to find out, how far the index of land productivity varies from different sources of water supply which is important from the point of view of regional agricultural development.

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[1] & [2] Rangaswamy, G.: "Changing the Cropping Pattern in Tamil Nadu" Coimbatore, Feb. 1972.

The following technique is adopted to find out the imbalances in the land productivity among different sources of irrigation.

**Index of Land Producitivity Under Different Sources of Irrigation:**

Average yields of different principal crops for the year 1968-69 is taken as the measure of land productivity(l) where they are summed into a suitable index as defined below.

The index has been used by the Macro-Regional Survey of South India by Indian Statistical Institute which reads as follows:

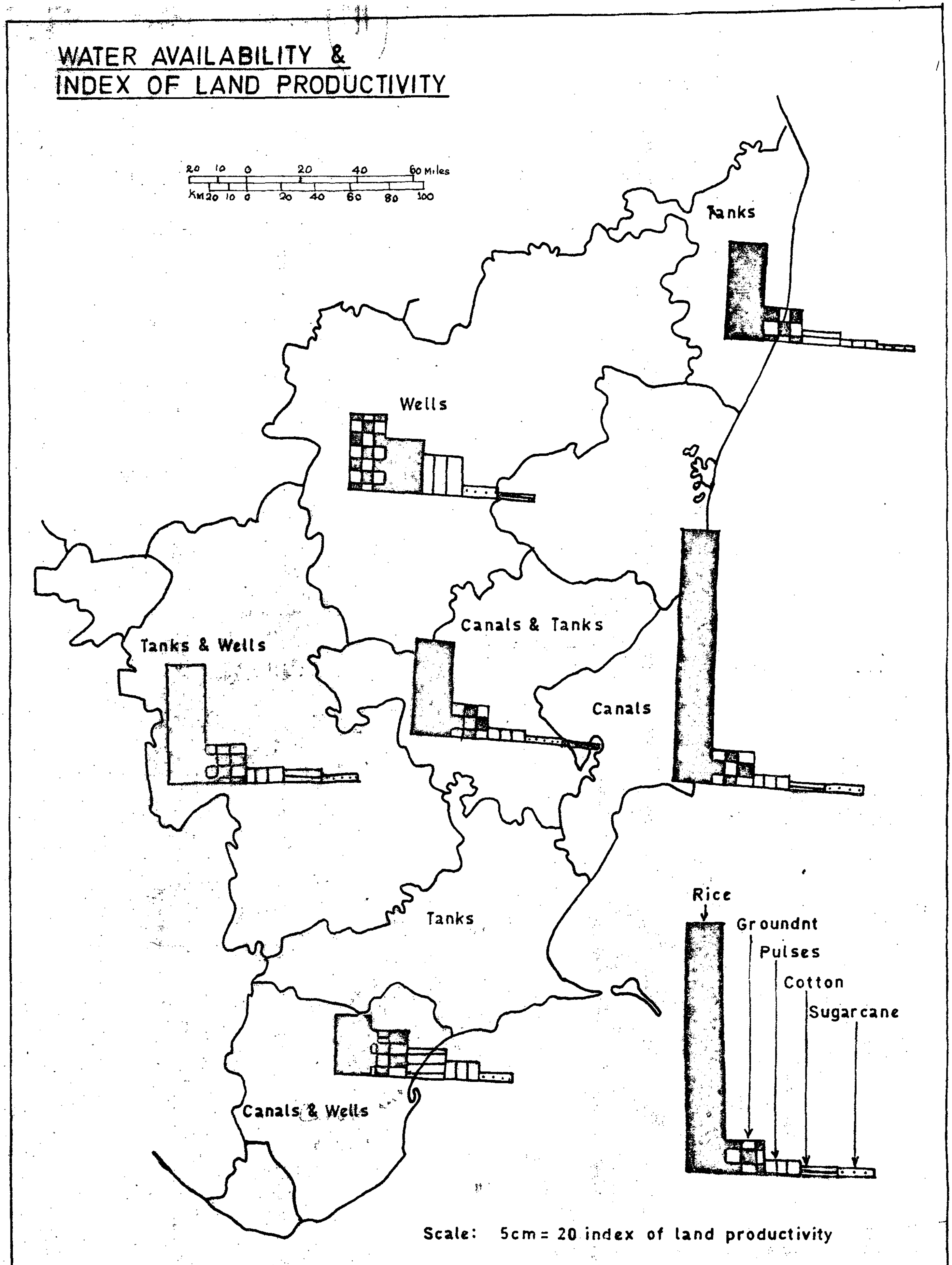
Let $Y_1, Y_2 \ldots\ldots Y_n$ be the state average yields of the crops $C_1, C_2 \ldots C_n$ Yij is the yield of the $i^{th}$ crop (i=1.....n) in the $j^{th}$ district when j ranges over all districts. Let Pij be the proportion of the $i^{th}$ crop in the $j^{th}$ district, in respect of the total land under the crops $C_1$ to $C_n$, so that

$$1 = \sum_{i=1}^{n} Pij \text{ for each } j$$

The index of land productivity for the $j^{th}$ district, Lj is defined as

$$\text{Eqn : } Lj = \sum_{i=1}^{n} \left( \frac{Yij}{Yi} \right) Pij$$

The logic of the construction of L is that the ratio (Yij/Yi) indicates the production advantage with respect to the state level of


WATER AVAILABILITY &
INDEX OF LAND PRODUCTIVITY
20 10 0 20 40 60 Miles
KM 20 10 0 20 40 60 80 100
Tanks
Wells
Canals & Tanks
Tanks & Wells
Canals
Tanks
Canals & Wells
Rice
Groundnt
Pulses
Cotton
Sugarcane
Scale: 5cm = 20 index of land productivity

productivity of each crop in a district and such ratios for all crops have been aggregated with due consideration of the local importance of the crops.

In this study 'j' ranges over 12 districts (excluding Nilgiris which does not come under irrigation) which has been made into 6 regions according to the sources of water supply in Tamil Nadu and n= 17.

(1) Rice (2) Cholam (3) Cambu (4) Maize (5) Ragi
(6) Varagu (7) Samai (8) Sugarcane (9) Chillies
(10) Other cereals (11) Cotton (12) Gingelly (13) Pulses
(14) Groundnut (15) Caster (16) Kora (17) Tobacco.

The regions with predominant sources of water supply which are having the index of land productivity of more than one are grouped ($L > 1$) as having a high level of land productivity and those for which the index of land productivity is ($L < 1$) less than one are having a lower level of land productivity than the state average.

Based on the above method, the index of land productivity has been calculated for the six regions with the different predominance of irrigation which are represented in the following table:

## Water availability and Index of land productivity

| Regions with the predominant sources of irrigation | Rice | Cholam | Cambu | Maize | Ragi | Varagu | Samai | Sugar-cane | Chillies | Other cereals | Cotton |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Canals | 78.8 | 0.18 | 0.55 | 0.30 | 1.84 | 0.55 | 0.01 | 0.06 | 0.23 | 0.01 | 0.67 |
| Tanks | 30.57 | 1.15 | 3.74 | 0.005 | 5.80 | 2.59 | 0.32 | 0.35 | 0.95 | 0.58 | 3.43 |
| Wells | 16.52 | 11.03 | 3.86 | 0.06 | 7.12 | 9.4 | 5.15 | 2.94 | 0.23 | 0.32 | 1.46 |
| Canals & Tanks | 30.38 | 13.09 | 14.16 | 0.30 | 1.81 | 8.80 | 1.57 | 0.32 | 1.47 | 0.002 | 0.16 |
| Tanks & Wells | 38.80 | 7.81 | 11.84 | 0.56 | 3.47 | 3.74 | 1.32 | 2.39 | 1.16 | 0.02 | 4.21 |
| Wells & Canals | 19.91 | 24.21 | 3.86 | 0.19 | 3.73 | 0.14 | 3.95 | 2.35 | 0.79 | 0.35 | 8.35 |

**Water availability and Index of land productivity (Contd.)**

| Regions with the predominant sources of irrigation | Gingelly | Total Pulses | Groundnut | Castor | Kora | Tobacco | Productivity for (L) |
|---|---|---|---|---|---|---|---|
| Canals | 0.28 | 3.83 | 8.71 | 0.003 | 0.001 | 0.04 | 5.65 |
| Tanks | 1.41 | 1.57 | 9.60 | 0.02 | 0.06 | 0.03 | 3.65 |
| Wells | 1.54 | 11.37 | 20.16 | 0.49 | 0.38 | 0.04 | 5.42 |
| Canals & Tanks | 2.60 | 3.89 | 13.17 | 0.10 | 0.004 | 0.09 | 5.41 |
| Tanks & Wells | 1.61 | 5.23 | 11.91 | 0.01 | 0.07 | 0.05 | 5.54 |
| Wells & Canals | 1.42 | 7.69 | 14.02 | 0.06 | 0.56 | 0.93 | 5.38 |

The above table shows the fact that the higher level of index of land productivity is seen in the region with the canals as the predominant sources of irrigation and the lowest level of productivity is seen in the tank irrigated region which in turn reflects the highest regional agricultural development in the canal irrigated region and the lowest level of development in the tank irrigated region.

## Water Requirements of Crops in Tamil Nadu

Crop consumes large quantities of water in the process of transpiration. In addition considerable volume of water is lost by evaporation from the soil surface in cropped area specially when the crop is still quite young. These losses are collectively termed as evapo-transpiration. This represents the consumptive use of water by the crop and does not include loss due to deep percolation and run-off. The water requirements of crop include evapo-transpiration and economically unavoidable losses in the form of deep percolation and run-off.

A knowledge of the water requirements of different crops is necessary as water supply is the most critical factor governing the choice of crops in any region. Water requirements depend on a number of factors such as (i) the nature of the soil, the sub-soil and the manuring (ii) the crop variety and its duration (iii) the meteorological factors and the length of the growing season. Water requirements of the crop vary within its life span with the stage of crop growth and the weather conditions such as temperature, humidity, wind velocity, etc. prevailing at a particular stage. It is, therefore, not enough to have overall estimates of the seasonal water requirements of each crop under a given set of conditions, but a complete analysis of water needs at successive stages of crop development is also necessary to assess the rates of water use and to locate the peak periods of water requirements. Such knowledge together with information on the effective rainfall and the magnitude of economically unavoidable losses, furnishes estimates of irrigation requirements.

As a result adequate and timely water supply is one of the basic inputs for obtaining potential crop yields. Very often it is the most important limiting factor in crop production on account of three main reasons. Firstly, water is required in huge quantities. Secondly, it needs to be supplied several times at intervals throughout the crop growth because of continuous process of evapo-transpiration and limited water holding capacity of the soil and thirdly it affects yields not only directly but also indirectly by influencing sowing time responses to fertilisers and other management factors.

Tamil Nadu endowed with erratic, inadequate and unevenly distributed rainfall; and hence assumed irrigation is the only way for permanent and profitable farming. Further 3.66 million hectares of irrigated area is seen in Tamil Nadu and the percentage of irrigated area to total cropped area is 48.2%.

As a state having its agricultural economy mainly depending upon irrigation, irrigation water becomes a costly commodity and injudicious use of water results not only in the wastage of water, but also in the development of water logging and salt problems. Economic and efficient utilisation of water therefore becomes a must in water use programme for which precise knowledge of water requirements of crops and its relations with other input factors is imperative.

**Water Requirements of Crops in Tamil Nadu**

| Crops | State/Place | Water needs (mm) | Author |
|---|---|---|---|
| Rice | Bhavanisagar & Pattukottai - Tamil Nadu | 1,300 to 2,500 | Chandra Mohan (1965-67) |
| | Tamil Nadu | 1,295 | Narasinha Rao (1951) |
| Ragi (Crowfoot Millet) | Siruguppa (Mysore) | 450 (in 9 irrigations) | Patil, et al. (1969) |
| Pulses: | | | |
| (i) Redgram | Bhavanisagar | 165 (two irrigations) | Chandra Mohan (1969) |
| (ii) Horsegram | Bhavanisagar-Tamil Nadu | 80 (two irrigations) | Chandra Mohan (1969) |
| Groundnut | Bhavanisagar-Tamil Nadu | 556 to 634 (six to nine irrigations) | Chandra Mohan (1966) |
| Cotton (MCU-1) | Bhavanisagar-Tamil Nádu | 600 to 650 (six to nine irrigations) | Chandra Mohan (1967) |
| Cotton (MCU-3) | Coimbatore-Tamil Nadu | 510, 635 & 765 (three irrigations) | Subbiah & Kaliappa (1968). |

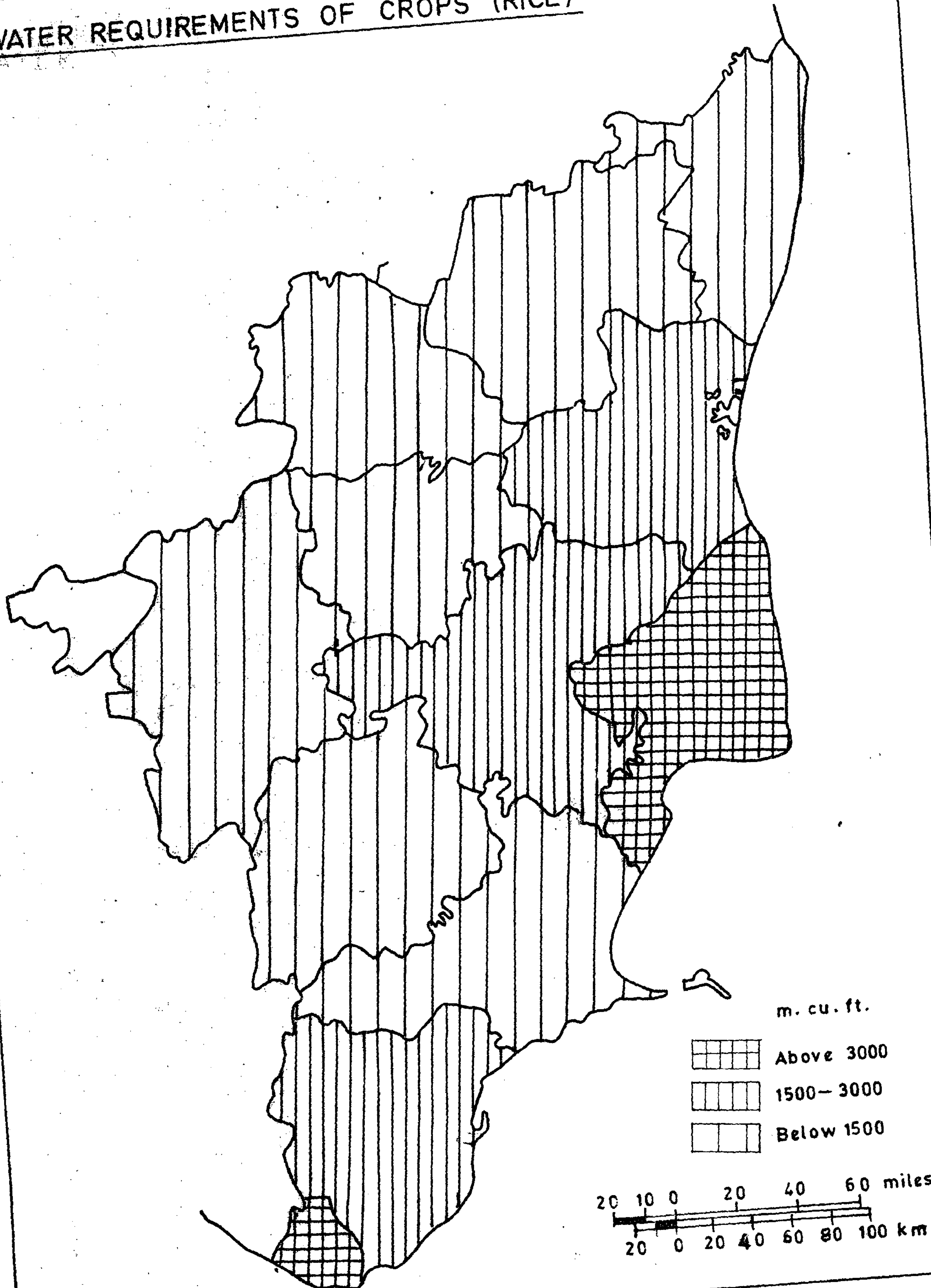
Source: ' Review of work done on water requirements of crops in India by Dastane, Singh, Hukkeri & Vamadevan' 1970.

Based on the above table, mean water requirements of the above mentioned crops are taken (for Rice according to Chandra Mohan's estimate; the mean of 1,900 mm is taken, for groundnut, 595 mm, for Ragi, 450 mm, for cotton, 637 mm, for Redgram 165 mm, and for Horse gram 80 mm respectively) and the water requirements are calculated by multiplying the production of the crops (for 1968-69) with that of the mean water requirements of crops which gives an approximate requirements of water for each region with different sources of water supply and they are as follows.

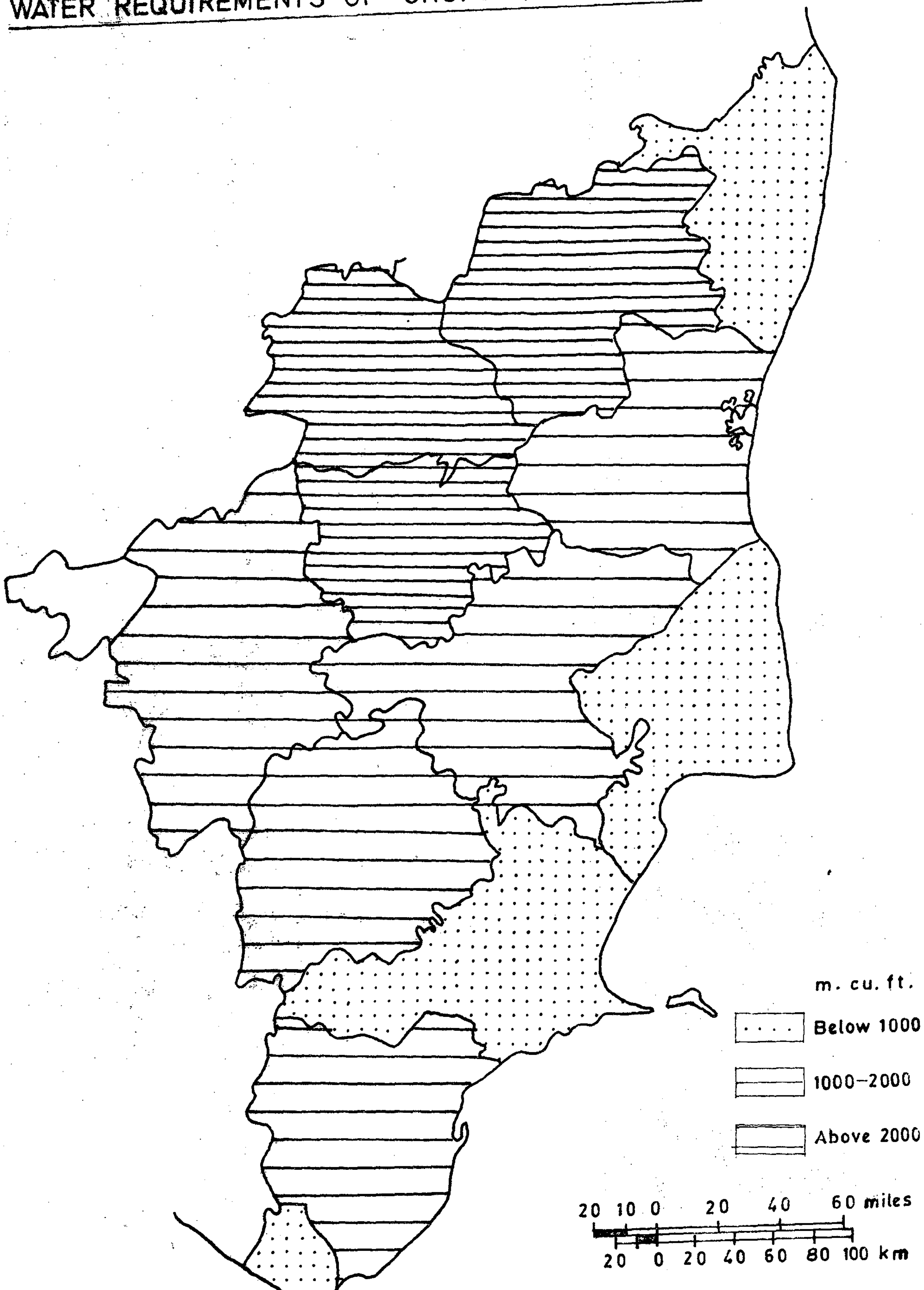
**WATER REQUIREMENTS OF CROPS (Cubic foot per Second)**

| Regions with the predominance of irrigation | Rice | Groundnut | Cotton | Redgram | Horsegram | Ragi |
|---|---|---|---|---|---|---|
| 1. Canal | 61337240000 | 674109330 | 4148700.5 | 1495129.33 | 443158.53 | 22936640.7 |
| 2. Tanks | 11208499000 | 621033650 | 336766234.85 | 1682019.5 | 1597069.95 | 327356800.0 |
| 3. Wells | 10050213950 | 1587781833.33 | 26383306.46 | 16166084.0 | 18371964.66 | 532172566.66 |
| 4. Canals & Tanks | 19676877000 | 1315869500.0 | 200580660.0 | 17567769.0 | 5391527.0 | 171897400.00 |
| 5. Canals & Wells | 11348237000 | 1241651790.0 | 1307201450.0 | 4064882.5 | 17465829.0 | 281037565.00 |
| 6. Tanks & Wells | 19776271000 | 1515440300.0 | 388174075.0 | 7101864.35 | 11513628.55 | 339972025.00 |

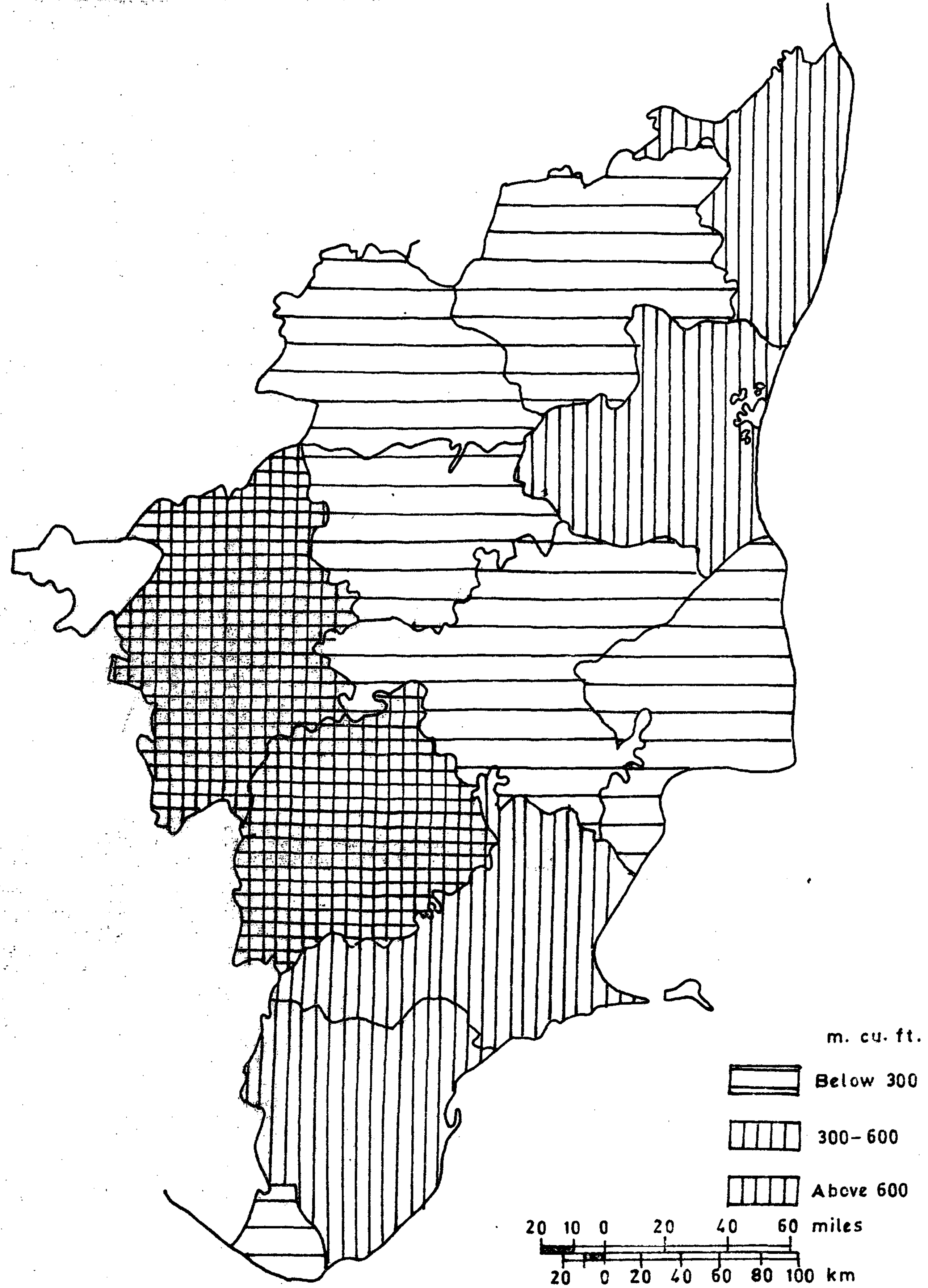
# WATER REQUIREMENTS OF CROPS (RICE)



# WATER REQUIREMENTS OF CROPS (GROUNDNUT)



# WATER REQUIREMENTS OF CROPS (COTTON)



The above table shows the water requirements which is measured by Production x mean water requirements of crops according to the research work done in Tamil Nadu. Hence, the calculated figures are highly approximate.

The above table shows the fact that maximum utilisation of water for rice crop is seen in the canal irrigated tracts, for groundnut, ragi and horse-gram are seen in the well irrigated tracts, for cotton in the tanks and well irrigated tracts and for redgram in the canal and tank-irrigated area respectively.

In all the regions, rice crop utilises maximum water. Hence, further researches in introducing the improved varieties which requires less water and the study of the economic use of water for rice will help in the conservation of water for introducing other commercial crops at least in the water deficit areas like the tank irrigated region.

Yield Response to Water Adequacy

The yield response of crops to irrigation water supplied throughout the season is difficult to establish due to wide variation in the amounts of water percolating into the soil, the distribution of the supplies throughout the season, climatic factors such as evaporative demand and rainfall and many other parameters of plant growth which differ widely from place to place. To assess the impact of water on yields under the circumstances, water requirements of crops (like Rice, Groundnut, Cotton, Pulses like Redgram & Horsegram, & Ragi) (1968-69 approximately calculated) is used for finding out the yield response to water requirements, though crops yield always differ under differ under different management conditions [1 & 2].

*The following table shows the yield response to water requirements or productivity of crops per unit of water.

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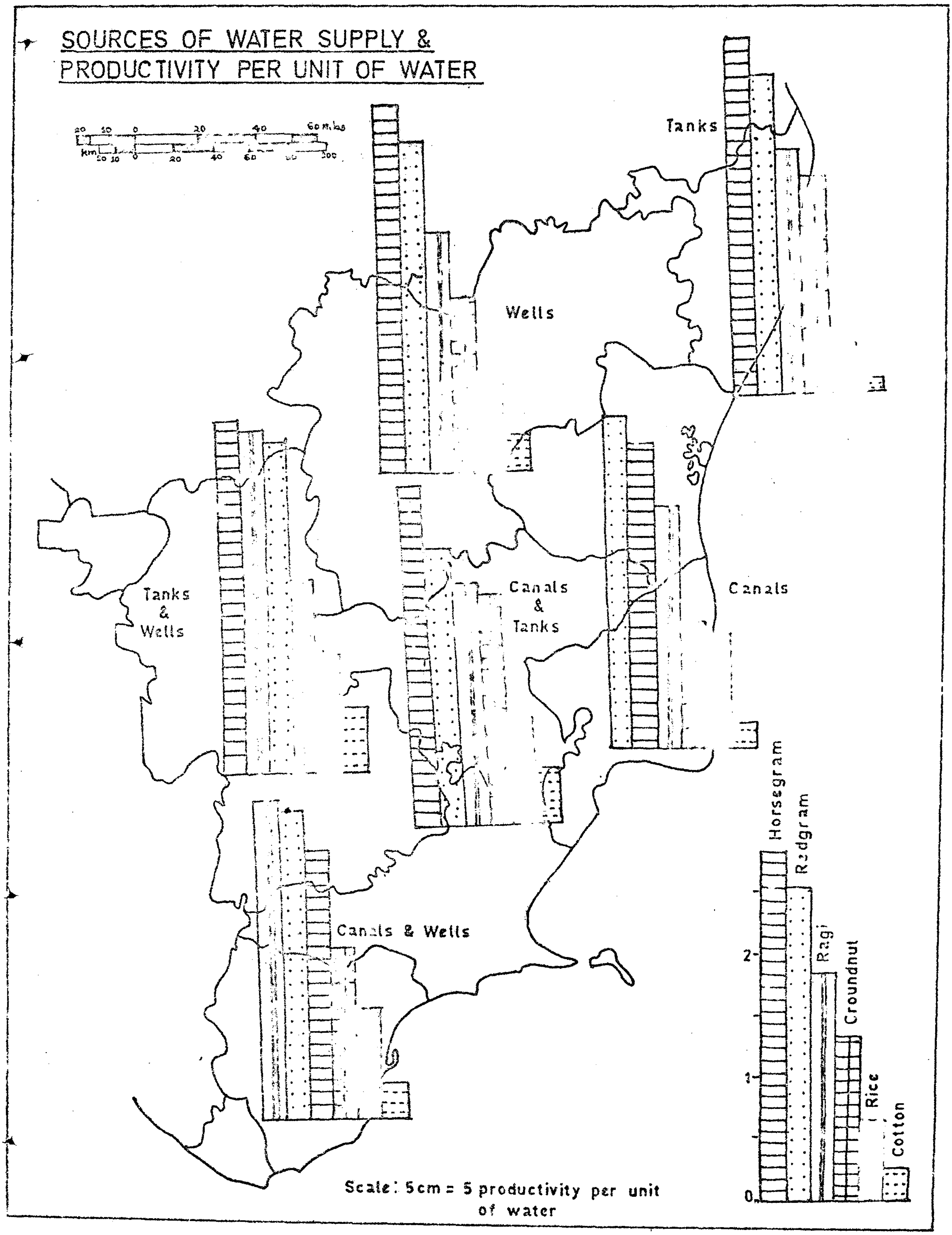
* For finding the productivity per unit of water in different sources of irrigation, the yield of crops are divided by the water requirements of the crops.

[1 & 2] Review of work done on water requirement of crops in India -ICAR Technical Bulletin (AGRIC) No. 8 by B. K. Mukerji & S. S. Chatterjee. Review of work done on water requirements of crops in India by Dastane, Singh, Hekkeri & Vamadevan.

## Productivity of Crops Per Unit of Water (1968-69)

| Region with the predominant sources of water supply | | Rice | Ragi | Redgram | Horsegram | Groundnut | Cotton |
|---|---|---|---|---|---|---|---|
| 1. | Canal | 1.00 | 1.90 | 2.49 | 2.65 | 0.93 | 0.25 |
| 2. | Tanks | 0.43 | 1.96 | 2.76 | 2.54 | 1.74 | 0.15 |
| 3. | Wells | 0.71 | 1.96 | 2.92 | 2.65 | 1.48 | 0.36 |
| 4. | Canals & Tanks | 0.88 | 1.96 | 2.27 | 2.66 | 1.85 | 0.41 |
| 5. | Canals & Wells | 0.99 | 2.67 | 2.27 | 2.57 | 1.48 | 0.35 |
| 6. | Tanks & Wells | 0.91 | 2.78 | 2.81 | 2.65 | 1.52 | 0.58 |

(Since the researches are going on in this field and the water requirements of crops always differ from each author, the above table represents only approximate answers).



SOURCES OF WATER SUPPLY &
PRODUCTIVITY PER UNIT OF WATER
Tanks
Wells
Tanks & Wells
Canals & Tanks
Canals
Canals & Wells
Horsegram
Redgram
Ragi
Groundnut
Rice
Cotton
0
1
2
Scale: 5cm = 5 productivity per unit of water

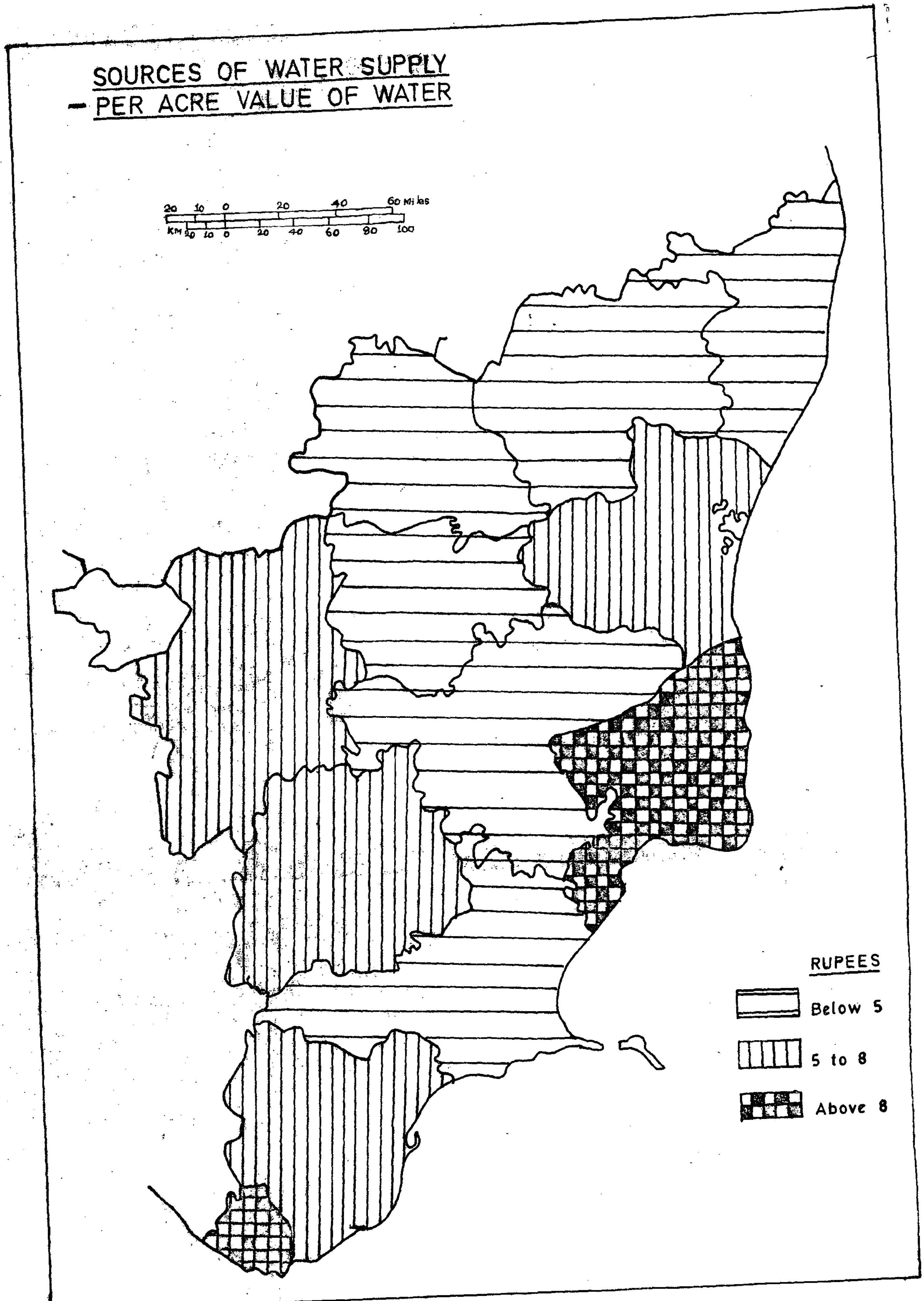
The water requirements of crops always shows the fact that most of the irrigation water is always diverted to rice or to other commercial crops. This is due to the fact that among the crops rice requires much more water than do the rest. But productivity per unit of water is much lower in rice than in other crops as can be seen from the Table. In this circumstances, it becomes advisable to increase area under other crops other than rice and to spread water extensively and dispense its benefits among the larger masses to avoid development of economic disparity.

Economic farm value of Water - as a part of Monetisation of Agriculture for Development

Improved water management implies are integrated agricultural development which involved adoption of improved cultural practices. Financial analysis of individual farm businesses should indicate the profitability of new practices to increase production. Likewise, the increased cost of better managing irrigation water must be reflected to indicate the farm value of water, which in turn is a part of monetisation of agriculture.

The determination of payment capacity which is taken to be the same as the farm value of water helps to delimit the irrigable area, provides an appraisal of land productivity and development and governs the projected landuse pattern. Payment capacity varies with land classes and provides a direct means for arriving at reasonable estimates of the total payment capacity of a given irrigation project area.

97A


SOURCES OF WATER SUPPLY
– PER ACRE VALUE OF WATER
20 10 0 20 40 60 Miles
KM 20 10 0 20 40 60 80 100
RUPEES
Below 5
5 to 8
Above 8

Further the per acre value of water helps in knowing the econimic viability and financial soundness of the irrigation project.

The following table shows the per acre value of water in the regions of different sources of water supply in Tamil Nadu [1].

PER ACRE VALUE OF WATER (1966-67)

| Regions with the Predominance of Irrigation | | Per Acre Value of Water |
|---|---|---|
| 1. | Canals | Rs. 8.79 |
| 2. | Tanks | Rs. 3.62 |
| 3. | Wells | Rs. 3.48 |
| 4. | Canals & Tanks | Rs. 4.39 |
| 5. | Canals & Wells | Rs. 7.37 |
| 6. | Tanks & Wells | Rs. 7.36 |

The maximum value is seen in the canal irrigated area and the minimum value is seen in the tanks and wells irrigated area. This in turn reflects the high amount of water used for the crops in the canal irrigated area. The dominance of rice in the canal irrigated area is the main reason for this. On the contrary to this, the dry farming in the tank and well irrigated areas shows the less need for water hence the cost is also less.

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[1] The per acre value of water has been determined by dividing the irrigation expenditure (in each district 1966-67) by the total cropped area (1966-67).

Further, the profitable double cropping makes the farmer to afford for the increasing cost of water while in the tank irrigated area being six months idle, without the water supply in the summer season, the farmer in this region is not able to afford even for the scheduled water supply during the monsoons. [1] Hence this results in the lower cost of water in the tank and well irrigated regions. This in turn reflects the economic disparities seen among these two different regions. that the additional water will always bring more field. Further the marketable surplus seen in this tract with reference to rice crop has tempted the farmer him to give more water which has resulted in the higher cost of water in this region.

## Water Spread

It has been observed that in most cases the command area is much bigger than what can be served by the available water. This has led to the difficulty of meeting the demands of water when the crop needs it the most. This difficulty has further enhanced because of the policy of distributing water to as many areas as possible in the command area. If the water spread in each region has been calculated accurately it will solve the problem of many irrigation projects which are facing the problem of meeting large command areas.

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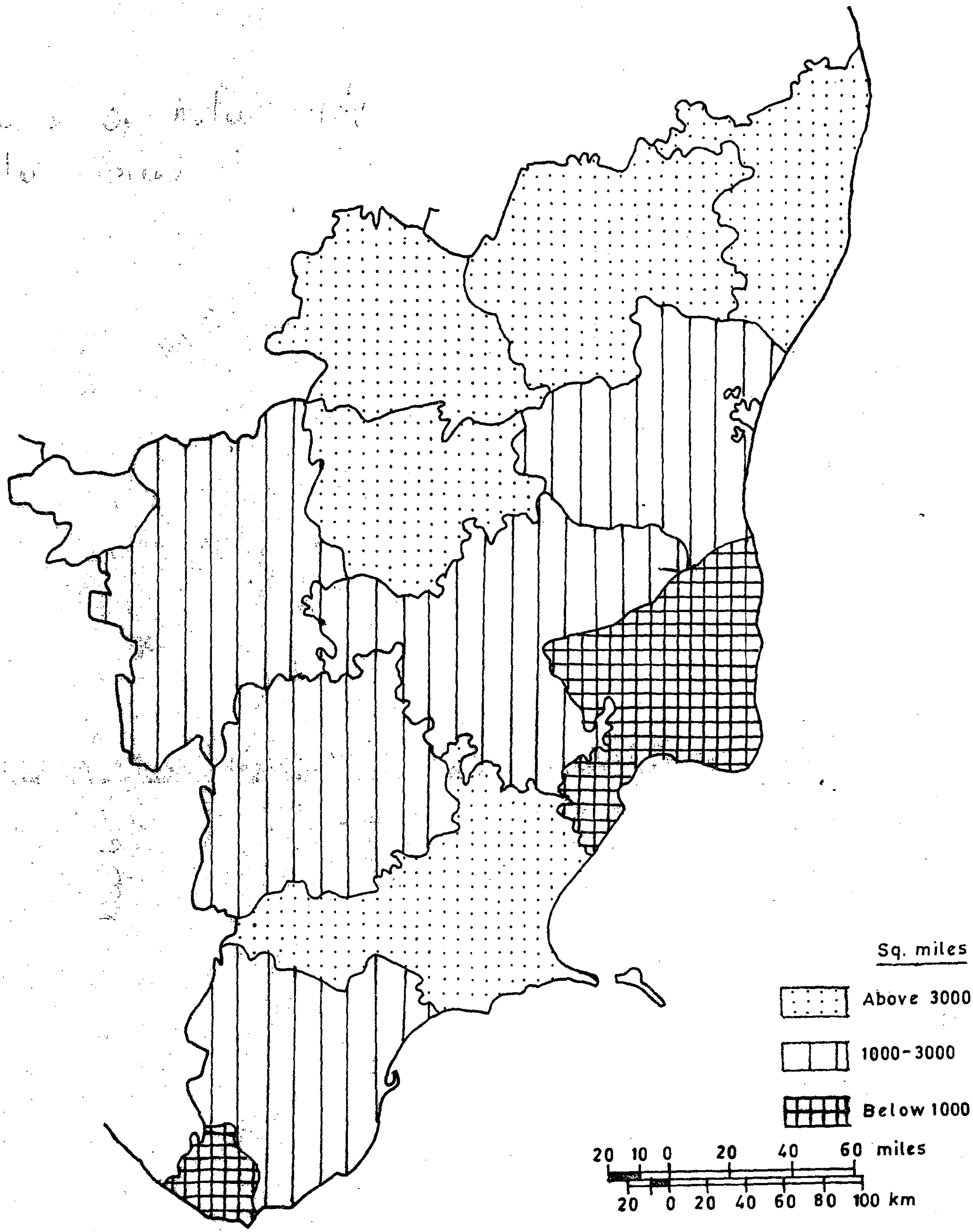
[1] The author belongs to Thanjavur district where there is the dominance of canal irrigation is able to find out the psychological factor that the erratic unequal distribution of rainfall in time and quantity has made the farmer to think in such a way. That the additional water will always bring more yield.

# WATER SPREAD IN TAMILNADU



The following table shows the approximate water spread calculated for the regions with the different sources of irrigation.

| | Regions with the predominance of irrigation[1] | Water Spread (Square miles) |
|---|---|---|
| 1. | Canal Irrigated region | 3,468.37 |
| 2. | Tanks | 379.86 |
| 3. | Wells | 440.12 |
| 4. | Canals & Tanks | 1,321.29 |
| 5. | Tanks & Wells | 1,415.87 |
| 6. | Canals & Wells | 1,255.44 |

The above table clearly shows that the canal irrigated region enjoys the maximum water availability and the water spread seen in the tank irrigated region in turn reflects the water scarcity and the need for the installation of more irrigation facilities.

## Conclusion

The highest level of regional agricultural development is seen in the canal irrigated region and the main reason for this is the natural endowment of abundant water resources which has made the farmer to the extent of wasting water lavishly, but at the same time it has made him to attain marketable surplus in food grains especially in rice in this region. In fact, it should be

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[1] The above figures are calculated with the help of a planimeter and hence, the figures are highly approximate.

noted, though rice requires more water, the productivity of rice per cubic foot of water is the least compared to other crops. Further, the attitude seen among the farmers (as his tradition has taught time from the past). "More water will gives more yield in rice crop" in this region has resulted in the higher cost of water per hectare.

On the contrary, that lowest agricultural development is seen in the tank irrigated region and all aspects of agricultural development clearly shows the fact that it is due to water scarcity. It further depicts that unless the tanks are provided with water at least in future during the deficit periods, it will be difficult for this region to cope up with other regions in the agricultural development which is a great menace in the economic prosperity of the State.

# CHAPTER IV

# THE STRATEGIC ROLE OF WATER IN AGRICULTURE

## The Strategic role of water resources in agriculture

1. Water is one of the most important inputs in agriculture and its strategic role in crop production is a complex phenomenon. Further it is needless to emphasise the factor that efficient water management in agriculture will give the optimum or profitable returns. Hence, the development of an agrarian system heavily depends upon irrigation which is the availability of and access to sufficient quantity and quality of water.

To analyse the role of water in agriculture some of the variables associated with agriculture are taken and their degree of dependency in water is analysed quantitatively by doing chi-square tests.

1. Per-centage of rice acreage to total crops acreage (1968-69).
2. Percentage of rice acreage and groundnut acreage to total crops acre (1968-69).
3. Percentage of agricultural workers (cultivators & agricultural labourers) to total workers (1971).
4. Rural population density (1961).
5. Rural population growth rate (1961-71).
6. Percentage of cultivated holdings over 15 acres to total cultivated holdings (1961).
7. Percentage of pure and mixed tenancy holdings to total holdings (1961).

## Methodology

The Chi-square test is adopted to find out the dependency of districtwise rainfall index and also the weighted water resources index on the above mentioned variables. The 2 x 2 contingency tables are prepared for rainfall index as well as for water resources index and the details of the methodology are given below:

Rainfall index

The districtwise normal rainfall for 1968-69 is taken as the basis. The 27" of rainfall limit is taken to divide Tamil Nadu into two groups viz. (a) Districts which are receiving less than 27" of rainfall (6 districts), (b) districts which are receiving 27" and above (7 districts).

Weighted water resource index

Since rainfall alone is not the main factor of water resources of any region (This is mainly because of the fact that rainfall represents only the run-off and the seepage or the loss due to percolation is not taken into consideration). A synthetic index namely weighted water resource index is computed to examine its relationship with the variables mentioned above.

For finding the water resource index the districtwise normal rainfall is multiplied by the percentage of gross irrigated area to the total cropped area (1968-69).

The weighted water resource index has been chosen so that one could see whether irrigation facilities in the districts are playing a "Balancing Role" with that of the erratic nature of the rainfall conditions.

The number of districts are bifurcated as (a) districts which are having less than 1000 index of weighted water resources (6 districts) and districts which are having 1000 or more than 1000 index of water resources (7 districts).

Results and relationships

After forming 2 x 2 contingency table on the above lines, chi-square test formula was applied to arrive at the observed values of the distribution of the districts in each of the categories. These observed values of chi-square distribution are tabulated in the Appendix for rainfall index and the weighted water resource index separately. Against the observed values, the theoretical values of chi-square distribution (with one degree of freedom) at 1%, 5% and 10% level of significance are noted down. The 5% level of significance is chosen either to reject or accept the null hypothesis. If observed value is less than the theoretical value at 5% level of significance, the null hypothesis is accepted. On the other hand if the observed value is more than the theoretical value or 5% of level of significance the null hypothesis is rejected.

The results of the chi-square tests in respect of the various phenomena are analysed in Appendix No. 24.

The main conclusions that emerge out are summarised below:

I. Rainfall and water resources exert significant influence on:

1. Rural population density.

2. Rainfall has influence on the following phenomenon whereas water resources does not have.

   (a) proportion of pure and mixed tenancy holdings to total cultivation holdings.

   (b) proportion of cultivation holdings of over 15 acres to total cultivation holdings.

3. Water resources alone has the influence on the following whereas rainfall do not have:

   (a) proportion of acreage under rice to total average under crops (1968-69).

   (b) proportion of acreage under rice and groundnut to total acreage under crops (1968-69).

   (c) proportion of agricultural workers to total workers.

4. Neither rainfall nor water resources have any significant influence on:

   (a) Rural population growth rate.

(i) The irrigation facilities in Tamil Nadu are playing the major role in neutralising the regional disparities in rainfall especially it is seen in some of the district like Coimbatore which shows the maximum development only due to irrigation.

(ii) Rice, the aquatic plant requires more water than what have been obtained from rainfall in most of the districts of Tamil Nadu. Hence it is not showing dependency on rainfall. Since 75% of the rice crop sown in the state is irrigated, its dependency on water resources index is more significant.

(iii) Next to rice, groundnut which is occupying more acreage in Tamil Nadu is highly dependent on irrigation. As a result rice and groundnut the two important major irrigated crops in the State does not show dependency on rainfall. On the otherhand it shows more dependency on water resource index.

(iv) As it is the fact, there is no dependency of agricultural workers to rainfall. But it has dependency with water resources since there is always a possibility of labour force irrigation wherever irrigation facilities are available. Further it indirectly reflects the Employment structure in the agriculture sector since it has been felt from the beginning that availability of water is the main criterian for unemployment in the agricultural sector.

(v) The rural population density has dependency both on rainfall as well as on water resources. This shows the characteristics of the wide spread "wet point settlements" mostly seen in Tamil Nadu.

(vi) The population growth rate is not dependent on rainfall or water resources index mainly because the growth rate is dependent upon other economic and sociological factors like health, nutrition etc. If further depends upon demographic factor also.

(vii) The percentage of cultivated holdings over 15 acres to total cultivated holdings is depending on rainfall index but not on water resource index. This depicts the fragmentation and scattering of holdings of

Tamil Nadu which in turn highly affects the economy of the state. Secondly it reveals the fact that the larger the farms, the lesser will be the technological applications seen in the state.

(viii) There appears to be very little relationship of the tenancy holdings with that of water resource index but its dependency is significant with regard to rainfall index, which is due to the fact that the farmers always give preferences of tenancy holdings in the regions where the rainfall is more and vice-versa. This may be due to the reason that the draughts that frequently occurs in the State might have cultivated this psychological feelings among the farmers though irrigation facilities are also considered as the main criterian.

# CONCLUSION

**In this study, the water resources of Tamil Nadu and its role in the agricultural development of this region is vividly dealt with which enabled to bring out the following observations.**

**Availability of Water Resources**

**1. At the outset, when the literature survey in this area was started, the first impediment noticed was the inadequacy of water resources data. Unless the accurate, complete data of this precious resource is available, it is very difficult to arrive at right conclusions and the implementation of projects based on inadequate and unreliable data will be fruit-less and futile. Hence, necessary steps should be taken to conduct field surveys on sound, scientific methods to collect the accurate data regarding availability and utilisation of water resources in the entire state.**

**2. The physical features and the physical forces are mainly responsible for the disparities in the distribution of this resource. This in turn has become a great challenge on the part of man which helped him to adapt and invent new ingenious engineering practices. The astonishing achievement of the Periyar channels in the state exemplifies as an example of excellence or paragon. It also gives scope for further attempts in this direction.**

**3. From the beginning the unequal distribution of rainfall is considered as a menace to water resource development. Though it is the important fact which affects this state (since it receives rainfall from both the south-west**

and north-east monsoons), it is also important to know how much run-off can be expected from precipitation under certain available soil conditions.

4. Proper and well organised coordination between the surface water and underground water departments is necessary for further water resource development of the state.

5. 94 per cent of the surface water in the state has been fully utilised and the underground water is the only alternative; hence an increase in the efficiency of underground water development is expected to solve the future problems of the state.

6. The Ground Water Directorate should undertake collection of lithologic and hydraulic data of all bore holes drilled irrespective of agency and be responsible for comprehensive compilation and inclusion of all relevant data on hydrology and geology of this area.

7. More efficient use of groundwater and wells should be cultivated by means of field demonstrations by extension workers followed by suitable legislation.

8. A comprehensive survey should be carried out to study the water level fluctuations in the wells to optimise increased groundwater development on seasonal lowering of water level.

9. A detailed record should be maintained for total groundwater extraction by basin and by well and they should be studied particularly in the light of changing the cropping patterns.

10. Further, the utilisation of groundwater enhances the hope of raising the third crop in a year. It will, certainly, provide assured water supply for advanced growing of rice independently of the present impredictable delivery of surface water and will provide security against times of surface water shortage.

Finally a "Water Resource Institute" is an imperative necessity for all manifestations like collection, intrepretation, feasibility studies, and management and implementation of the various projects, etc. Hence, early steps should be taken to organise the "Water Resources Institute" to augment the resources and to carry out various Research and Development studies in these areas.

Water Resources and Agricultural Development

1. The disparities sean in the agricultural development between the canal irrigated region and the tank irrigated region should be minimised by increasing the efficiency of irrigation facilities in the tank irrigated region.

2. A detailed land use survey using maps of appropriate scale should be made to enable the determination of cropped area and various lands particularly with reference to water utilisation characteristics.

3. With the uncertainity of rainfall and its maldistribution, it has become necessary to change the cropping patterns according to water availability.

4. The index of land productivity or the yield index, when considered shows the vast disparities between the canal and tank irrigated regions which can be changed with the increase of agricultural inputs.

5. The critical stage of crop development at which shortage of water supply may cause major yield reductions in the tank irrigated region should be identified so that necessary adjustments may be made in irrigation practices to augment the supply during the critical stages of crop growth as well as reducing the supply during the least water requirement periods of the crop.

6. Though maximum water in the state is utilised only for rice crop, the productivity per unit of water is the lowest in this crop compared to anyother crop. Hence it is necessary to increase the area under other crops which can avoid development of economic disparity in the state.

7. A comprehensive study should be undertaken about the advantages and disadvantages of collecting revenues for water on the basis of the quantity of utilisation of water rather than on the basis of acreage which will induce the cultivators to use water more economically.

Finally the problems that are arising out the imbalances seen in the availability, utilisation and agricultural development are expected to be solved by inter-transfer of river basins or the "water grid". Since this is a time consuming one and also a large scale capital oriented venture, it is advisable for the state to augment the inter-transfer of river basins at the state level as suggested by the experts in the field. Further it has been felt that it is possible for the state to adjust with the small projects at present though rejuvenation of so many perennial problems are expected in the near future.

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# APPENDICES

## Appendix No. 1

**Open Pan Evaporimeters Stations in Tamil Nadu**

| District | Station | Lati. | Long. | Year of Installation |
|---|---|---|---|---|
| | **Catchment No. 301** | | | |
| Madurai | Kodaikanal | 10° 14' | 77° 28' | 1959 |
| Tirunelveli | Koilpatti (A) | 09° 12' | 77° 53' | 1955 |
| | **Catchment No. 302** | | | |
| Thanjavur | Aduthurai (A) | 11° 01' | 79° 32' | 1955 |
| Coimbatore | Coimbatore (A) | 11° 00' | 77° 00' | 1955 |
| Nilgiris | Ootacamund (A) | 11° 24' | 76° 41' | 1958 |
| S. Arcot | Annamalainagar(A) | 11°24' | 79° 44' | 1968 |
| | **Catchment No. 303** | | | |
| Chingleput | Madras (Meena) | 13°00' | 80° 11' | 1955 |

(A) = Agricultural Meteorological Observatory.

Source: Catchmentwise list of Open Pan Evaporimeter Stations in India as on 1st August 1972.

## Appendix No. 2

### List of Groundwater Stations in Tamil Nadu

| Station | Latitude | Longitude |
|---|---|---|
| 1. Kodiyur | 12° 34' | 78° 33' |
| 2. Wandiwash | 12° 30' | 79° 38' |
| 3. Puttur | 12° 26' | 79° 35' |
| 4. Pavalangudi | 11° 38' | 79° 28' |
| 5. Kottarakuppam | 11° 38' | 79° 22' |
| 6. Tammampatti | 11° 24' | 78° 29' |
| 7. Gopichettipalayam | | |
| 8. Gudalur | 11° 30' | 76° 30' |
| 9. Palani | 10° 26' | 77° 30' |
| 10. Maraneri | 9° 25' | 77° 45' |
| 11. Tirunelveli | 8° 44' | 77° 44' |
| 12. Kundal | 8° 05' | 77° 88' |
| 13. Erasanayakkampatti | 10° 86' | 78° 33' |
| 14. Alangottai | 10° 35' | 79° 25' |
| 15. Ullikottai | 10° 37' | 79° 25' |
| 16. Puduvayal | 13° 20' | 80° 09' |
| 17. Gummidipundi | 13° 24' | 80° 08' |
| 18. Paramaguid | 9° 32' | 78° 38' |
| 19. Mandapam | 9° 17' | 79° 10' |
| 20. Tiruchendur | 8° 29' | 78° 12' |
| 21. Tirukalikundram | 12° 08' | 80° 03' |

Appendix No. 3

## CALCULATION OF "DRY, DAMP, WET METHOD IN SATTUR STAION"

Rainfall Station - Sattur - 1950 June to 1951 January

| Date | Rainfall in Inches | Condition | Yield in Inches | Remarks |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |
| May | | | Nil | |
| June 15 | 0.06 | Dry | - | Below 1.00 inch. No yield |
| July | Nil | Nil | - | — |
| August 3 | 0.10 | Dry | - | Below 1.00 inch. No yield |
| August 20 | 1.27 | Dry | 0.062 | As there is no rainfall in the previous days, the 1.27" rain treated is on dry condition. |
| August 30 | 0.09 | Dry | - | There is only 1.27" in the previous 10 days i.e. less than 1 1/2". This can be treated as dry only. |
| September 28 | 1.19 | Dry | 0.053 | No rainfall in the previous day. Hence treated as dry. |
| October 3 | 0.98 | Damp | 0.106 | As there is above 1" rainfall in the previous 7 days, the previous dry condition becomes damp. |
| October 11 | 1.45 | Damp | 0.226 | As there is more than 3/4" rain in the previous 10 days the damp condition is continued. |
| October 13 | 0.58 | Wet | 0.079 | There is 2" rainfall in the previous 3 days. Hence the previous damp condition becomes wet. |
| October 15 | 0.02 | Wet | | There is 0.58" of rainfall in the previous 2 days. Hence the wet condition is continue |
| October 16 | 0.22 | Wet | 0.047 | -do- |

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| October 18 | 0.42 | Damp | 0.047 | As there is more than 3/4" rainfall in the previous 5 days the wet condition becomes damp. |
| October 22 | 0.81 | Damp | 0.072 | As there is above 1/3" rainfall in the previous day, the damp becomes wet. |
| November 6 | 0.10 | Dry | Nil | Below 1.00 inch. No useful rainfall. |
| November 11 | 0.02 | Dry | Nil | -do- |
| November 17 | 0.14 | Dry | Nil | -do- |
| November 23 | 0.05 | Dry | Nil | -do- |
| November 7 | 0.14 | Dry | Nil | -do- |
| December 13 | 0.29 | Dry | Nil | -do- |
| December 14 | 0.22 | Damp | Nil | As there is above 1/4" rainfall in the previous day, the day becomes damp. |
| December 22 | 0.07 | Dry | Nil | As there is no 3/4" rainfall in the previous 10 days the damp becomes dry. |
| December 23 | 0 13 | Dry | Nil | Below 1.00 inch. No useful rainfall |
| January 15 | 0.33 | Dry | Nil | |
| January 16 | 0.78 | Damp | 0.066 | As there is above 1/4" rainfall in the previous day, the dry becomes damp. |
| | 11.22 | | 1.237 | Yield per sq. mile |

$$\frac{1.237 \times 5280 \times 5280}{1000000 \times 12} \text{ M.Cft.} = 2.873$$

Note: I) Sample working sheet for Sattur rainfall station for one year.
II) Col.4 figures works to be obtained from Appendix 'A'
III) Catchment is treated as 'Average'.

## Appendix No. 4

### Self Recording Raingauges in Tamil Nadu

| District/Station | Co-ordinates Lati | Longi | Year of Installation |
|---|---|---|---|
| Kanyakumari Dt. | | | |
| Kanyakumari | 08° 05' | 77° 30' | 1972 |
| Madurai Dt. | | | |
| Kodaikanal | 10° 14' | 77° 28' | 1930 |
| Madurai | 09° 55' | 78° 07' | 1968 |
| Tirunelveli Dt. | | | |
| Tuticorin Harbour | 08° 45' | 78° 11' | 1966 |
| Tuticorin | 08° 48' | 78° 09' | 1968 |
| Koilpatti | 09° 10' | 77° 52' | 1970 |
| Ramanathapuram Dt. | | | |
| Pamban | 09° 16' | 79° 18' | 1968 |
| Thanjavur Dt. | | | |
| Nagapattinam | 10° 46' | 79° 51' | 1968 |
| Tiruchirapalli Dt. | | | |
| Tiruchirapalli | 10° 46' | 78° 43' | 1953 |
| Coimbatore Dt. | | | |
| Coimbatore Airfield | 11° 02' | 77° 03' | 1962 |
| The Nilgiris Dt. | | | |
| Ootacamund | 11° 24' | 76° 44 | 1968 |
| Chingleput Dt. | | | |
| Madras (Meenumbakkam) | 13° 00' | 80° 11' | 1943 |
| Madras Dt. | | | |
| Madras (Nungambakkam) | 13° 04' | 80° 15' | 1949 |
| North Arcot Dt. | | | |
| Vellore | 12° 55' | 79° 09' | 1969 |
| South Arcot Dt. | | | |
| Cuddalore | 11° 46' | 79° 46' | 1967 |

Source: List of Stations equipped with self Recording Raingauges as on 1.7.1972.

Issued by India Meteorological Department, 1972.

Appendix No. 5

**Yield Tables**
**Dry-Damp-Wet-Method**

**Classification of Catchment average**

| Rainfall | Dry | Damp | Wet | Rainfall | Dry | Damp | Wet |
|---|---|---|---|---|---|---|---|
| 0.25 | | | 0.020 | 0.71 | | 0.055 | 0.110 |
| 0.26 | | | 0.022 | 0.72 | | 0.056 | 0.113 |
| 0.27 | | | 0.023 | 0.73 | | 0.058 | 0.115 |
| 0.28 | | | 0.025 | 0.74 | | 0.059 | 0.118 |
| 0.29 | | | 0.026 | 0.75 | | 0.060 | 0.120 |
| 0.30 | | | 0.028 | 0.76 | | 0.062 | 0.122 |
| 0.31 | | | 0.030 | 0.77 | | 0.064 | 0.125 |
| 0.32 | | | 0.031 | 0.78 | | 0.066 | 0.127 |
| 0.33 | | | 0.033 | 0.79 | | 0.068 | 0.130 |
| 0.34 | | | 0.034 | 0.80 | | 0.070 | 0.132 |
| 0.35 | | | 0.036 | 0.81 | | 0.072 | 0.134 |
| 0.35 | | | 0.038 | 0.82 | | 0.074 | 0.137 |
| 0.36 | | | 0.039 | 0.83 | | 0.076 | 0.139 |
| 0.37 | | | 0.041 | 0.84 | | 0.078 | 0.142 |
| 0.38 | | | 0.042 | 0.85 | | 0.080 | 0.144 |
| 0.39 | | | 0.044 | 0.86 | | 0.082 | 0.146 |
| 0.40 | | | 0.046 | 0.87 | | 0.084 | 0.149 |
| 0.41 | | | 0.047 | 0.88 | | 0.086 | 0.151 |
| 0.42 | | | 0.049 | 0.89 | | 0.088 | 0.154 |
| 0.43 | | | 0.050 | 0.90 | | 0.090 | 0.156 |
| 0.44 | | | 0.052 | 0.91 | | 0.092 | 0.158 |
| 0.45 | | | 0.054 | 0.92 | | 0.094 | 0.161 |
| 0.46 | | | 0.055 | 0.93 | | 0.096 | 0.163 |
| 0.47 | | | 0.057 | 0.94 | | 0.098 | 0.166 |
| 0.48 | | | 0.058 | 0.95 | | 0.100 | 0.168 |
| 0.49 | | | 0.060 | 0.96 | | 0.102 | 0.170 |
| 0.50 | | 0.030 | 0.062 | 0.97 | | 0.104 | 0.173 |
| 0.51 | | 0.031 | 0.065 | 0.98 | | 0.106 | 0.175 |
| 0.52 | | 0.032 | 0.067 | 0.99 | | 0.108 | 0.178 |
| 0.53 | | 0.034 | 0.070 | 1.00 | | 0.110 | 0.180 |
| 0.54 | | 0.035 | 0.072 | 1.01 | | 0.112 | 0.184 |
| 0.55 | | 0.036 | 0.074 | 1.02 | | 0.115 | 0.188 |
| 0.56 | | 0.037 | 0.077 | 1.03 | | 0.117 | 0.192 |
| 0.57 | | 0.038 | 0.079 | 1.04 | | 0.120 | 0.196 |
| 0.58 | | 0.040 | 0.082 | 1.05 | | 0.122 | 0.200 |
| 0.59 | | 0.041 | 0.084 | | | | |
| 0.60 | | 0.042 | 0.086 | | | | |

| Rainfall | Dry | Damp | Wet | Rainfall | Dry | Damp | Wet |
|---|---|---|---|---|---|---|---|
| 0.61 | | 0.043 | 0.089 | | | | |
| 0.62 | | 0.044 | 0.091 | | | | |
| 0.63 | | 0.046 | 0.094 | | | | |
| 0.64 | | 0.047 | 0.096 | | | | |
| 0.65 | | 0.048 | | | | | |
| | | 0.049 | 0.098 | | | | |
| 0.66 | | 0.049 | 0.101 | | | | |
| 0.67 | | 0.050 | 0.103 | | | | |
| 0.68 | | 0.052 | 0.106 | | | | |
| 0.69 | | 0.053 | 0.108 | | | | |
| 0.70 | | 0.054 | 0.110 | | | | |
| 1.06 | 0.037 | 0.124 | 0.204 | 1.46 | 0.085 | 0.229 | 0.364 |
| 1.07 | 0.038 | 0.127 | 0.208 | 1.47 | 0.086 | 0.232 | 0.368 |
| 1.08 | 0.040 | 0.129 | 0.212 | 1.48 | 0.088 | 0.234 | 0.372 |
| 1.09 | 0.041 | 0.132 | 0.216 | 1.49 | 0.089 | 0.237 | 0.376 |
| 1.10 | 0.042 | 0.134 | 0.220 | 1.50 | 0.090 | 0.240 | 0.380 |
| 1.11 | 0.043 | 0.136 | 0.224 | 1.51 | 0.092 | 0.244 | 0.386 |
| 1.12 | 0.044 | 0.136 | 0.228 | 1.52 | 0.095 | 0.247 | 0.391 |
| 1.13 | 0.046 | 0.141 | 0.232 | 1.53 | 0.097 | 0.251 | 0.397 |
| 1.14 | 0.047 | 0.144 | 0.236 | 1.54 | 0.100 | 0.254 | 0.402 |
| 1.15 | 0.048 | 0.146 | 0.240 | 1.55 | 0.102 | 0.258 | 0.408 |
| 1.16 | 0.049 | 0.148 | 0.244 | 1.56 | 0.104 | 0.262 | 0.414 |
| 1.17 | 0.050 | 0.151 | 0.248 | 1.57 | 0.107 | 0.265 | 0.419 |
| 1.18 | 0.052 | 0.153 | 0.252 | 1.58 | 0.109 | 0.269 | 0.425 |
| 1.19 | 0.053 | 0.156 | 0.256 | 1.59 | 0.112 | 0.272 | 0.430 |
| 1.20 | 0.054 | 0.158 | 0.260 | 1.60 | 0.114 | 0.276 | 0.436 |
| 1.21 | 0.055 | 0.160 | 0.264 | 1.61 | 0.116 | 0.280 | 0.442 |
| 1.22 | 0.056 | 0.163 | 0.268 | 1.62 | 0.119 | 0.283 | 0.447 |
| 1.23 | 0.058 | 0.165 | 0.272 | 1.63 | 0.121 | 0.287 | 0.453 |
| 1.24 | 0.059 | 0.168 | 0.276 | 1.64 | 0.124 | 0.290 | 0.458 |
| 1.25 | 0.060 | 0.170 | 0.280 | 1.65 | 0.126 | 0.294 | 0.464 |
| 1.26 | 0.061 | 0.173 | 0.284 | 1.66 | 0.128 | 0.298 | 0.470 |
| 1.27 | 0.062 | 0.176 | 0.288 | 1.67 | 0.131 | 0.301 | 0.475 |
| 1.28 | 0.064 | 0.178 | 0.292 | 1.68 | 0.133 | 0.305 | 0.481 |
| 1.29 | 0.065 | 0.181 | 0.296 | 1.69 | 0.136 | 0.308 | 0.486 |
| 1.30 | 0.066 | 0.184 | 0.300 | 1.70 | 0.138 | 0.312 | 0.492 |
| 1.31 | 0.067 | 0.187 | 0.304 | 1.71 | 0.140 | 0.316 | 0.498 |
| 1.32 | 0.068 | 0.190 | 0.308 | 1.72 | 0.143 | 0.319 | 0.503 |
| 1.33 | 0.070 | 0.192 | 0.312 | 1.73 | 0.145 | 0.323 | 0.509 |
| 1.34 | 0.071 | 0.195 | 0.316 | 1.74 | 0.148 | 0.326 | 0.514 |
| 1.35 | 0.072 | 0.198 | 0.320 | 1.75 | 0.150 | 0.330 | 0.520 |

| Rainfall | Dry | Damp | Wet | Rainfall | Dry | Damp | Wet |
|---|---|---|---|---|---|---|---|
| 1.36 | 0.073 | 0.301 | 0.324 | 1.76 | 0.152 | 0.334 | 0.526 |
| 1.37 | 0.074 | 0.204 | 0.328 | 1.77 | 0.155 | 0.339 | 0.532 |
| 1.38 | 0.076 | 0.206 | 0.332 | 1.78 | 0.157 | 0.343 | 0.538 |
| 1.39 | 0.077 | 0.209 | 0.336 | 1.79 | 0.160 | 0.348 | 0.544 |
| 1.40 | 0.078 | 0.212 | 0.340 | 1.80 | 0.162 | 0.352 | 0.550 |
| 1.41 | 0.079 | 0.215 | 0.344 | 1.81 | 0.164 | 0.356 | 0.556 |
| 1.42 | 0.080 | 0.218 | 0.348 | 1.82 | 0.167 | 0.361 | 0.562 |
| 1.43 | 0.082 | 0.220 | 0.352 | 1.83 | 0.169 | 0.365 | 0.568 |
| 1.44 | 0.083 | 0.223 | 0.356 | 1.84 | 0.172 | 0.370 | 0.574 |
| 1.45 | 0.084 | 0.226 | 0.360 | 1.85 | 0.174 | 0.374 | 0.580 |
| 1.86 | 0.176 | 0.378 | 0.586 | 2.26 | 0.298 | 0.591 | 0.883 |
| 1.87 | 0.179 | 0.383 | 0.592 | 2.27 | 0.302 | 0.597 | 0.891 |
| 1.88 | 0.181 | 0.387 | 0.598 | 2.28 | 0.305 | 0.602 | 0.900 |
| 1.89 | 0.184 | 0.392 | 0.604 | 2.29 | 0.309 | 0.608 | 0.908 |
| 1.90 | 0.186 | 0.396 | 0.610 | 2.30 | 0.312 | 0.614 | 0.916 |
| 1.91 | 0.188 | 0.400 | 0.616 | 2.31 | 0.315 | 0.620 | 0.924 |
| 1.92 | 0.191 | 0.405 | 0.622 | 2.32 | 0.319 | 0.626 | 0.932 |
| 1.93 | 0.193 | 0.409 | 0.628 | 2.33 | 0.322 | 0.631 | 0.941 |
| 1.94 | 0.196 | 0.413 | 0.634 | 2.34 | 0.323 | 0.637 | 0.949 |
| 1.95 | 0.198 | 0.418 | 0.640 | 2.35 | 0.329 | 0.643 | 0.957 |
| 1.96 | 0.200 | 0.422 | 0.646 | 2.36 | 0.332 | 0.649 | 0.965 |
| 1.97 | 0.203 | 0.427 | 0.652 | 2.37 | 0.336 | 0.655 | 0.973 |
| 1.98 | 0.205 | 0.431 | 0.658 | 2.38 | 0.339 | 0.660 | 0.982 |
| 1.99 | 0.208 | 0.436 | 0.664 | 2.39 | 0.343 | 0.666 | 0.990 |
| 2.00 | 0.210 | 0.440 | 0.670 | 2.40 | 0.343 | 0.672 | 0.998 |
| 2.01 | 0.213 | 0.446 | 0.678 | 2.41 | 0.349 | 0.678 | 1.006 |
| 2.02 | 0.217 | 0.452 | 0.686 | 2.42 | 0.353 | 0.684 | 1.014 |
| 2.03 | 0.220 | 0.457 | 0.695 | 2.43 | 0.356 | 0.689 | 1.023 |
| 2.04 | 0.224 | 0.463 | 0.703 | 2.44 | 0.360 | 0.695 | 1.031 |
| 2.05 | 0.227 | 0.469 | 0.711 | 2.45 | 0.363 | 0.701 | 1.039 |
| 2.06 | 0.230 | 0.475 | 0.719 | 2.46 | 0.366 | 0.707 | 1.047 |
| 2.07 | 0.234 | 0.481 | 0.727 | 2.47 | 0.370 | 0.713 | 1.055 |
| 2.08 | 0.241 | 0.492 | 0.744 | 2.49 | 0.377 | 0.724 | 1.072 |
| 2.09 | 0.241 | 0.492 | 0.744 | 2.49 | 0.377 | 0.724 | 1.072 |
| 2.10 | 0.244 | 0.498 | 0.752 | 2.50 | 0.380 | 0.730 | 1.080 |
| 2.11 | 0.247 | 0.504 | 0.760 | 2.51 | | | 1.091 |
| 2.12 | 0.251 | 0.510 | 0.768 | 2.52 | | | 1.103 |
| 2.13 | 0.254 | 0.515 | 0.777 | 2.53 | | | 1.114 |
| 2.14 | 0.258 | 0.521 | 0.785 | 2.54 | Since more | | 1.126 |
| 2.15 | 0.261 | 0.527 | 0.793 | 2.55 | than 2 1/2" | | 1.137 |
| 2.16 | 0.264 | 0.533 | 0.801 | 2.56 | rainfall | | 1.142 |
| 2.17 | 0.268 | 0.539 | 0.809 | 2.57 | | | 1.160 |

| Rainfall | Dry | Damp | Wet | Rainfall | Dry | Damp | Wet |
|---|---|---|---|---|---|---|---|
| 2.18 | 0.271 | 0.544 | 0.818 | 2.58 | | | 1.171 |
| 2.19 | 0.275 | 0.550 | 0.826 | 2.59 | | | 1.183 |
| 2.20 | 0.278 | 0.556 | 0.834 | 2.60 | | | 1.194 |
| 2.21 | 0.281 | 0.562 | 0.842 | 2.61 | | | 1.205 |
| 2.22 | 0.285 | 0.568 | 0.850 | 2.62 | | | 1.217 |
| 2.23 | 0.288 | 0.573 | 0.859 | 2.63 | | | 1.228 |
| 2.24 | 0.292 | 0.579 | 0.867 | 2.64 | | | 1.240 |
| 2.25 | 0.295 | 0.585 | 0.875 | 2.65 | | | 1.251 |
| 2.66 | | | 1.262 | 3.06 | | | 1.719 |
| 2.67 | | | 1.274 | 3.07 | | | 1.731 |
| 2.68 | Since | | 1.285 | 3.08 | Since | | 1.742 |
| 2.69 | more | | 1.297 | 3.09 | more | | 1.754 |
| 2.70 | than | | 1.308 | 3.10 | than | | 1.765 |
| 2.71 | 3 1/2" | | 1.319 | 3.11 | 3 1/2" | | 1.777 |
| 2.72 | rainfall | | 1.331 | 3.12 | rainfall | | 1.788 |
| 2.73 | | | 1.342 | 3.18 | | | 1.800 |
| 2.74 | | | 1.354 | 3.14 | | | 1.811 |
| 2.75 | | | 1.365 | 3.15 | | | 1.823 |
| 2.76 | | | 1.376 | 3.16 | | | 1.834 |
| 2.77 | | | 1.388 | 3.17 | | | 1.846 |
| 2.78 | | | 1.399 | 3.18 | | | 1.857 |
| 2.79 | | | 1.411 | 3.19 | | | 1.869 |
| 2.80 | | | 1.422 | 3.20 | | | 1.880 |
| 2.81 | | | 1.433 | 3.21 | | | 1.892 |
| 2.82 | | | 1.445 | 3.22 | | | 1.903 |
| 2.83 | | | 1.456 | 3.23 | | | 1.915 |
| 2.84 | | | 1.468 | 3.24 | | | 1.926 |
| 2.85 | | | 1.469 | 3.25 | | | 1.938 |
| 2.86 | | | 1.490 | 3.26 | | | 1.949 |
| 2.87 | | | 1.502 | 3.27 | | | 1.961 |
| 2.88 | | | 1.512 | 3.28 | | | 1.972 |
| 2.89 | | | 1.525 | 3.29 | | | 1.984 |
| 2.90 | | | 1.536 | 3.30 | | | 1.995 |
| 2.91 | | | 1.547 | 3.31 | | | 2.007 |
| 2.92 | | | 1.559 | 3.32 | | | 2.018 |
| 2.93 | | | 1.570 | 3.33 | | | 2.030 |
| 2.94 | | | 1.582 | 3.34 | | | 2.041 |
| 2.95 | | | 1.593 | 3.35 | | | 2.053 |
| 2.96 | | | 1.604 | 3.36 | | | 2.064 |
| 2.97 | | | 1.616 | 3.37 | | | 2.076 |
| 2.98 | | | 1.627 | 3.38 | | | 2.087 |
| 2.99 | | | 1.639 | 3.39 | | | 2.099 |
| 3.00 | | | 1.650 | 3.40 | | | 2.110 |

| Rainfall | Dry | Damp | Wet | Rainfall | Dry | Damp | Wet |
|---|---|---|---|---|---|---|---|
| 3.01 | | | 1.662 | 3.41 | | | 2.122 |
| 3.02 | | | 1.673 | 3.42 | | | 2.133 |
| 3.03 | | | 1.685 | 3.43 | | | 2.145 |
| 3.04 | | | 1.696 | 3.44 | | | 2.156 |
| 3.05 | | | 1.708 | 3.45 | | | 2.168 |
| 3.46 | | | 2.179 | 3.74 | | | 2.501 |
| 3.47 | | | 2.191 | 3.75 | | | 2.513 |
| 3.48 | | | 2.202 | 3.76 | | | 2.524 |
| 3.49 | | | 2.214 | 3.77 | | | 2.536 |
| 3.50 | | | 2.225 | 3.78 | | | 2.547 |
| 3.51 | | | 2.237 | 3.79 | | | 2.559 |
| 3.52 | | | 2.248 | 3.80 | | | 2.570 |
| 3.53 | | | 2.260 | 3.81 | | | 2.582 |
| 3.54 | | | 2.271 | 3.82 | | | 2.593 |
| 3.55 | | | 2.283 | 3.83 | | | 2.605 |
| 3.56 | | | 2.294 | 3.84 | | | 2.616 |
| 3.57 | | | 2.306 | 3.85 | | | 2.628 |
| 3.58 | | | 2.317 | 3.86 | | | 2.639 |
| 3.59 | | | 2.329 | 3.87 | | | 2.651 |
| 3.60 | | | 2.340 | 3.88 | | | 2.662 |
| 3.61 | | | 2.352 | 3.89 | | | 2.674 |
| 3.62 | | | 2.363 | 3.90 | | | 2.685 |
| 3.63 | | | 2.375 | 3.91 | | | 2.697 |
| 3.64 | | | 2.386 | 3.92 | | | 2.708 |
| 3.65 | | | 2.398 | 3.93 | | | 2.720 |
| 3.66 | | | 2.409 | 3.94 | | | 2.731 |
| 3.67 | | | 2.421 | 3.95 | | | 2.743 |
| 3.68 | | | 2.432 | 3.96 | | | 2.754 |
| 3.69 | | | 2.445 | 3.97 | | | 2.766 |
| 3.70 | | | 2.455 | 3.98 | | | 2.777 |
| 3.71 | | | 2.462 | 3.99 | | | 2.789 |
| 3.72 | | | 2.478 | 4.00 | | | 2.800 |
| 3.73 | | | 2.490 | | | | |

Note: (For good or bad catchments add or deduct upto 25% of yield)

Appendix No. 6

The Rainfall and Run Off Data for Aliabad Anicut for 1963-64

| MONTH | 1963 | | | | | | | | | | | | | | | | | | 1964 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | April | | May | | June | | July | | August | | September | | October | | November | | December | | January | | February | | March | |
| DATE | Rain fall in m.m. | Flow in C/S. days | Rain fall in m.m. | Flow in C/S. days | Rain fall in m.m. | Flow in C/S. days | Rain fall in m.m. | Flow in C/S. days | Rain fall in m.m. | Flow in C/S. days | Rain fall in m.m. | Flow in C/S. days | Rain fall in m.m. | Flow in C/S. days | Rain fall in m.m. | Flow in C/S. days | Rain fall in m.m. | Flow in C/S. days | Rain fall in m.m. | Flow in C/S. days | Rain fall in m.m. | Flow in C/S. days | Rain fall in m.m. | Flow in C/S. days |
| 1 | - | - | - | - | - | 9 | - | - | - | 77 | 55.30 | 143 | - | 141 | - | 118 | - | 107 | - | 83 | - | 9 | - | - |
| 2 | - | - | - | - | - | - | - | - | 42.30 | 90 | - | 60 | - | 70 | 14.20 | 114 | - | 117 | - | 83 | - | 9 | - | - |
| 3 | - | - | - | - | - | - | - | - | - | 100 | 6.20 | 46 | - | 70 | - | 114 | 31.20 | 151 | - | 83 | - | 9 | - | - |
| 4 | - | - | - | - | - | - | - | - | 64.00 | 110 | 3.20 | 1 | - | 70 | 9.00 | 104 | 23.10 | 138 | - | 78 | - | 9 | - | - |
| 5 | - | - | - | - | - | - | - | - | - | 98 | - | - | - | 67 | - | 85 | - | 111 | - | 63 | - | 9 | - | - |
| 6 | - | - | - | - | - | - | - | - | - | 76 | - | - | - | 67 | - | 70 | - | 104 | - | 63 | - | 9 | - | - |
| 7 | - | - | - | - | 9.20 | - | - | - | 12.20 | 76 | - | - | - | 70 | - | 70 | 9.20 | 107 | - | 63 | - | 9 | - | - |
| 8 | - | - | - | - | - | - | - | - | - | 76 | - | - | - | 56 | - | 70 | 18.10 | 117 | - | 61 | - | 9 | - | - |
| 9 | - | - | - | - | - | - | - | - | - | 72 | - | - | 16.20 | 56 | - | 70 | - | 117 | - | 56 | - | 9 | - | - |
| 10 | - | - | - | - | - | - | - | - | - | 65 | - | - | 9.10 | 67 | - | 70 | 11.20 | 114 | - | 56 | - | - | - | - |
| 11 | - | - | - | - | - | - | - | - | - | 49 | - | - | - | 128 | - | 70 | - | 104 | - | 56 | - | - | - | - |
| 12 | - | - | - | - | - | 11 | - | - | - | 49 | - | - | 69.10 | 148 | - | 70 | - | 104 | - | 56 | - | - | - | - |
| 13 | - | - | - | - | 29.10 | 46 | - | - | - | 26 | - | - | 25.10 | 199 | - | 70 | - | 104 | - | 56 | - | - | - | - |
| 14 | - | - | - | - | - | - | - | - | - | - | - | - | - | 117 | - | 70 | - | 104 | - | 56 | - | - | - | - |
| 15 | 20.10 | - | - | - | - | - | 20.40 | - | - | - | - | - | - | 107 | - | 70 | - | 104 | - | 56 | - | - | - | - |
| 16 | - | - | - | - | - | - | 44.20 | - | - | - | 53.10 | - | 16.10 | 104 | - | 70 | - | 104 | - | 51 | - | - | - | - |
| 17 | - | - | - | - | - | - | 30.20 | 76 | - | - | 8.20 | - | - | 104 | 20.10 | 99 | - | 102 | - | 36 | - | - | - | - |
| 18 | - | - | - | 206 | - | - | 31.10 | 83 | - | - | 10.00 | 62 | - | 121 | 10.20 | 657 | - | 97 | - | 36 | - | - | - | - |
| 19 | - | - | 50.20 | 50 | - | - | 24.10 | 92 | - | - | 15.00 | 63 | - | 70 | 83.20 | 178 | - | 97 | - | 36 | - | - | - | - |
| 20 | - | - | - | - | - | - | 9.20 | 68 | - | - | - | 89 | - | 78 | - | 124 | - | 97 | - | 36 | - | - | - | - |
| 21 | - | - | - | - | - | - | - | 104 | 11.20 | - | 10.20 | 63 | 75.20 | 417 | 20.10 | 140 | - | 99 | - | 36 | - | - | - | - |
| 22 | - | - | - | - | - | - | 51.00 | 91 | - | - | - | 33 | 32.10 | 247 | 20.10 | 149 | - | 99 | - | 13 | - | - | - | - |
| 23 | - | 3 | - | - | - | - | - | 70 | - | - | - | 29 | - | 146 | - | 133 | - | 85 | - | 13 | - | - | - | - |
| 24 | - | 19 | - | - | - | - | - | 63 | - | - | - | 52 | - | 139 | - | 104 | - | 85 | - | 13 | - | - | - | - |
| 25 | - | - | - | - | - | - | 5.00 | 63 | - | - | 9.20 | 115 | - | 128 | - | 104 | - | 90 | - | 13 | - | - | - | - |
| 26 | - | - | 12.10 | - | - | - | - | 63 | - | - | 25.00 | 56 | - | 107 | - | 104 | - | 104 | - | 13 | - | - | - | - |
| 27 | - | - | - | 44 | - | - | - | 63 | - | - | 10.20 | 100 | - | 107 | - | 104 | - | 101 | - | 12 | - | - | - | |
| 28 | - | - | 58.20 | 90 | - | - | - | 63 | - | - | - | 60 | 10.20 | 114 | - | 104 | - | 90 | - | 9 | - | - | - | |
| 29 | - | - | - | 51 | - | - | - | 63 | - | - | - | 67 | 9.20 | 104 | - | 107 | - | 90 | - | 9 | - | - | - | |
| 30 | - | - | - | 18 | - | - | - | 63 | - | - | 9.20 | 100 | - | 104 | 27.20 | 117 | - | 90 | - | 9 | - | - | - | - |
| 31 | - | - | - | 18 | - | - | - | 63 | - | 285 | - | - | 9.10 | 104 | - | - | - | 88 | - | 9 | - | - | | - |

Source: Informations Collected from Public Works Department, Tamil Nadu.

## Appendix No. 7

### The Rainfall and Runn Off Data for Bhavani Reservoir for 1963-64

| MONTH | 1963 April | | May | | June | | July | | August | | September | | October | | November | | December | | January | | 1964 February | | March | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DATE | Rain fall in m.m. | Inflow in m.cu.ft. | Rain fall in m.m. | Inflow in m.cu.ft. | Rain fall in m.m. | Inflow in m.cu.ft. | Rain fall in m.m. | Inflow in m.cu.ft. | Rain fall in m.m. | Inflow in m.cu.ft. | Rain fall in m.m. | Inflow in m.cu.ft. | Rain fall in m.m. | Inflow in m.cu.ft. | Rain fall in m.m. | Inflow in m.cu.ft. | Rain fall in m.m. | Inflow in m.cu.ft. | Rain fall in m.m. | Inflow in m.cu.ft. | Rain fall in m.m. | Inflow in m.cu.ft. | Rain fall in m.m. | Inflow in m.cu.ft. |
| 1 | - | 99 | - | 86 | 1.39 | 110 | 0.76 | 138 | 1.41 | 286 | 1.23 | 189 | 0.29 | 117 | 3.83 | 164 | 19.23 | 374 | - | 106 | - | 78 | - | 58 |
| 2 | 1.41 | 109 | - | 92 | 2.90 | 51 | 3.83 | 189 | 1.46 | 285 | 6.37 | 187 | 1.21 | 95 | 4.43 | 202 | 4.03 | 229 | - | 96 | - | 88 | - | 51 |
| 3 | 0.07 | 118 | 0.70 | 97 | 0.68 | 74 | 16.49 | 550 | 5.16 | 223 | 1.02 | 203 | 5.51 | 146 | 2.91 | 135 | 10.10 | 271 | - | 105 | - | 71 | - | 56 |
| 4 | 0.74 | 117 | 1.58 | 97 | 2.46 | 87 | 15.54 | 707 | 3.17 | 249 | 2.93 | 229 | 1.74 | 143 | 6.26 | 243 | 4.93 | 329 | - | 121 | - | 93 | - | 55 |
| 5 | 0.02 | 110 | 4.82 | 112 | 5.59 | 104 | 16.64 | 880 | 2.51 | 214 | 1.47 | 226 | 0.09 | 135 | 27.56 | 480 | 9.18 | 240 | - | 97 | - | 83 | - | 67 |
| 6 | 1.33 | 113 | 8.38 | 103 | 9.31 | 176 | 22.06 | 1547 | 1.34 | 203 | 0.90 | 185 | 2.82 | 125 | 1.32 | 218 | 7.41 | 239 | - | 112 | - | 72 | - | 74 |
| 7 | 1.33 | 79 | 3.79 | 116 | 8.03 | 271 | 19.54 | 1885 | 1.44 | 190 | 1.78 | 194 | 1.37 | 138 | - | 173 | 4.21 | 373 | - | 100 | - | 73 | - | 78 |
| 8 | - | 92 | 3.50 | 104 | 11.32 | 313 | 23.00 | 1812 | 0.07 | 189 | 0.40 | 162 | 3.37 | 143 | - | 147 | 17.53 | 426 | - | 110 | - | 64 | - | 63 |
| 9 | - | 86 | 2.59 | 115 | 1.03 | 164 | 4.99 | 878 | 0.07 | 159 | - | 163 | 7.74 | 169 | - | 142 | 4.73 | 451 | - | 101 | - | 52 | - | 51 |
| 10 | - | 70 | 4.02 | 138 | 1.30 | 135 | 6.18 | 775 | 0.44 | 175 | 0.33 | 161 | 13.40 | 168 | - | 132 | 5.19 | 395 | - | 98 | - | 50 | - | 42 |
| 11 | - | 110 | 3.43 | 114 | 4.40 | 135 | 2.14 | 505 | 0.81 | 180 | 1.27 | 174 | 4.61 | 304 | - | 107 | 1.54 | 280 | - | 94 | - | 69 | - | 55 |
| 12 | 2.92 | 219 | 7.62 | 77 | 8.23 | 123 | 2.12 | 392 | 4.44 | 211 | 8.12 | 187 | 1.73 | 201 | - | 117 | - | - | - | 94 | - | 66 | - | 60 |
| 13 | 14.59 | 179 | 1.58 | 124 | 5.67 | 117 | 1.16 | 270 | 3.10 | 314 | - | 178 | 0.84 | 141 | - | 113 | - | 183 | - | 103 | - | 54 | - | 73 |
| 14 | - | 30 | 4.16 | 118 | 3.54 | 105 | 0.93 | 229 | 4.30 | 242 | 0.11 | 170 | 13.69 | 511 | 0.42 | 100 | - | 149 | - | 96 | - | 55 | - | 72 |
| 15 | 17.49 | 82 | - | 76 | 0.14 | 105 | 0.07 | 209 | 5.40 | 185 | - | 141 | 10.67 | 359 | 7.49 | 195 | - | 149 | - | 68 | - | 65 | - | 57 |
| 16 | 0.18 | 82 | 0.14 | 106 | 0.07 | 99 | 1.36 | 189 | 4.13 | 256 | - | 137 | 9.72 | 358 | 14.23 | 197 | - | 147 | - | 55 | - | 55 | - | 43 |
| 17 | - | 88 | 0.29 | 94 | 0.06 | 87 | 3.96 | 201 | 6.70 | 256 | 0.28 | 126 | 16.97 | 432 | 6.10 | 132 | - | 136 | - | 83 | - | 62 | - | 65 |
| 18 | - | 82 | 6.82 | 137 | - | 98 | 5.57 | 167 | 3.11 | 267 | 2.22 | 137 | 2.43 | 323 | 10.22 | 166 | - | 149 | - | 90 | - | 83 | - | 68 |
| 19 | 2.47 | 99 | 5.30 | 82 | - | 92 | 4.86 | 167 | 0.52 | 224 | 2.29 | 128 | 7.52 | 283 | 25.22 | 405 | - | 142 | - | 90 | - | 82 | - | 64 |
| 20 | 3.24 | 153 | 6.58 | 106 | 0.10 | 86 | 2.79 | 155 | 2.62 | 214 | 8.72 | 165 | 4.90 | 235 | 8.86 | 266 | - | 132 | - | 89 | - | 63 | 0.48 | 68 |
| 21 | 2.24 | 83 | 6.18 | 110 | 0.76 | 68 | 0.18 | 132 | 8.09 | 183 | 14.14 | 106 | 19.57 | 591 | 6.69 | 267 | - | 131 | - | 90 | - | 48 | 2.57 | 74 |
| 22 | 2.58 | 89 | 0.20 | 110 | 1.08 | 65 | 0.24 | 132 | 2.12 | 177 | 10.47 | 115 | 39.26 | 754 | 5.23 | 275 | 0.18 | 127 | - | 87 | - | 50 | 0.87 | 106 |
| 23 | 8.01 | 194 | 0.24 | 104 | 1.68 | 71 | 7.70 | 161 | 2.64 | 192 | 5.60 | 677 | 4.36 | 282 | 4.36 | 282 | - | 135 | - | 87 | - | 55 | 0.44 | 61 |
| 24 | 22.64 | 142 | 7.13 | 156 | 0.78 | 65 | 5.29 | 156 | 1.29 | 150 | 4.20 | 201 | 2.00 | 407 | 0.11 | 182 | - | 129 | - | 87 | - | 53 | 0.37 | 63 |
| 25 | 0.90 | 112 | 10.91 | 115 | 3.17 | 59 | 1.61 | 138 | 5.47 | 167 | 5.10 | 131 | 0.49 | 300 | - | 158 | - | 122 | - | 99 | - | 48 | - | 65 |
| 26 | 9.27 | 124 | 1.82 | 85 | 0.94 | 60 | 2.81 | 371 | 10.60 | 179 | 1.66 | 176 | 0.69 | 262 | - | 153 | - | 124 | - | 78 | - | 51 | - | 64 |
| 27 | 0.36 | 107 | - | 79 | 3.57 | 48 | 1.44 | 250 | 18.44 | 465 | 2.44 | 150 | 0.82 | 228 | - | 134 | - | 130 | - | 67 | 5.60 | 67 | - | 62 |
| 28 | 3.11 | 102 | 0.67 | 91 | 0.92 | 89 | 1.76 | 238 | 4.92 | 456 | 4.06 | 156 | 0.92 | 210 | - | 124 | - | 120 | - | 67 | - | 50 | - | 59 |
| 29 | 1.76 | 107 | 0.22 | 109 | 0.64 | 181 | 9.18 | 357 | 2.90 | 358 | 0.57 | 135 | 4.18 | 238 | 8.37 | 121 | - | 103 | - | 88 | - | 55 | 11.88 | 79 |
| 30 | 0.04 | 114 | 8.18 | 103 | 0.08 | 146 | 4.49 | 494 | 2.01 | 269 | 2.51 | 117 | 3.77 | 190 | 13.53 | 286 | - | 103 | - | 71 | - | - | - | 40 |
| 31 | | | 10.21 | 132 | | | 4.23 | 347 | 3.62 | 222 | | | 2.78 | 210 | | | | 107 | | 65 | | | | 47 |

Source: Informations Collected from Public Works Department, Tamil Nadu.

# Appendix No. 8

## Monthly & Annual Distribution of Successive Tropical Disturbances along Tamil Nadu Coast during 1891 to 1960

| Month | Coastal Sections & Latitude Range Particulars of Disturbances | Tamil Nadu 8°N to 13°N |
|---|---|---|
| 1 | 2 | 3 |
| | a | 94 |
| January | b | 215 |
| | c | 4 |
| | a | 216 |
| April | b | 216 |
| | c | 1 |
| | a | 145 |
| May | b | 172 |
| | c | 4 |
| | a | - |
| June | b | - |
| | c | - |
| | a | - |
| July | b | - |
| | c | - |
| | a | - |
| August | b | - |
| | c | - |
| | a | - |
| September | b | - |
| | c | - |
| | a | 25 |
| October | b | 38 |
| | c | 5 |

| 1 | 2 | 3 |
|---|---|---|
| | a | 7 |
| November | b | 44 |
| | c | 8 |
| | a | 142 |
| December | b | 142 |
| | c | 1 |
| | a | 7 |
| Annual | b | 106 |
| | c | 23 |

| | |
|---|---|
| Dates of successive disturbances which caused minimum duration | 30.11.'52 & 7.12.'52 |

a) Minimum duration in days between any two successive disturbances

b) Average duration between any two successive disturbances

c) Total No. of successive disturbances.

Source: Dhar O.N. & Ghose G.C. "Spatial & sequential distribution of depressions/storms over Peninsular India" Seventh Symposium, the Civil & Hydraulic Engineering Department "Water Resources" May 11 to 16, 1971. Indian Institute of Science, Bangalore, 1971. pp.A10-12.

## Appendix No. 9

### Districtwise Geological Formations

| Sl. No. | District | Total Area in sq. Km. | Formation area in sq. Km. | | | | |
|---|---|---|---|---|---|---|---|
| | | | Archaeans | Gondwanas | Cretacious | Tertiary | Quarternary & Alluvium |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| 1. | Madras | | 21 | - | - | - | 106 |
| 2. | Chingleput | 7,350 | 3,190 | 2,041 | - | 362 | 2,261 |
| 3. | North Arcot | 12,799 | 12,400 | 150 | - | - | 248 |
| 4. | South Arcot | 10,888 | 6,231 | - | 282 | 1,130 | 3,247 |
| 5. | Tanjavur | 9,686 | - | - | 414 | 3,580 | 5,695 |
| 6. | Tiruchirappalli | 14,281 | 9,608 | 36 | 816 | 1,909 | 1,916 |
| 7. | Salem | 18,203 | 18,202 | - | - | - | - |
| 8. | Dharmapuri | | | | | | |
| 9. | Coimbatore | 15,587 | 15,586 | - | - | - | - |
| 10. | Nilgiris | 2,549 | 2,458 | - | - | - | - |

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|
| 11. | Madurai | 12,717 | 12,535 | - | - | - | - |
| 12. | Ramanathapuram | 12,559 | 4,273 | 285 | - | 1,624 | 6,381 |
| 13. | Tirunelveli | 1,445 | 7,290 | - | - | - | 1,564 |
| 14. | Kanya Kumari | 1,665 | 1,269 | - | - | 140 | 261 |
| | Total | 130,357 | 95,677 | 2,513 | 1,513 | 8,746 | 21,908 |
| | | 100% | 73.4% | 1.9% | 1.2% | 6.7% | 16.8% |

Note: These figures are planimetered figures and hence or approximate only.

Source: Working paper prepared by Thiru S. Panchanathan for State Planning Commission.

## Appendix No. 10

### Strange's Table of Run-off due to Monsoon Rainfall

Table of total monsoon rainfall and estimated run-off and yield per square mile from catchment areas

| Total monsoon rainfall | Good Catchment | | | Average Catchment | | | Bad Catchment | | |
|---|---|---|---|---|---|---|---|---|---|
| | Percentage of run-off to rainfall | Depth of run-off due to rainfall in Inches | Yield of run-off from catchment per sq. mile in m.c.ft. | Percentage of run-off to rainfall | Depth of run-off due to rainfall in Inches | Yield of run-off from catchment per sq. mile in m.c.ft. | Percentage of run-off due to rainfall | Depth of run-off due to rainfall in Inches | Yield of run-off from catchment per sq. mile in m.c.ft. |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 1 | 0.1 | 0.001 | 0.002 | 0.1 | 0.001 | 0.001 | 0.05 | 0.0005 | 0.001 |
| 2 | 0.2 | 0.004 | 0.009 | 0.15 | 0.003 | 0.006 | 0.1 | 0.002 | 0.004 |
| 3 | 0.4 | 0.012 | 0.029 | 0.3 | 0.009 | 0.021 | 0.2 | 0.006 | 0.014 |
| 4 | 0.7 | 0.028 | 00065 | 0.5 | 0.021 | 0.048 | 0.3 | 0.014 | 0.032 |
| 5 | [illegible].0 | 0.050 | 0.116 | 0.7 | 0.037 | 0.087 | 0.5 | 0.025 | 0.058 |
| 6 | 1.5 | 0.090 | 0.209 | 1.1 | 0.067 | 0.156 | 0.7 | 0.045 | 0.104 |
| 7 | 2.1 | 0.147 | 0.341 | 1.5 | 0.110 | 0.255 | 1.0 | 0.073 | 0.170 |
| 8 | 2.8 | 0.224 | 0.520 | 2.1 | 0.168 | 0.390 | 1.4 | 0.112 | 0.260 |
| 9 | 3.5 | 0.315 | 0.732 | 2.6 | 0.236 | 0.549 | 1.7 | 0.157 | 0.366 |
| 10 | 4.3 | 0.430 | 0.999 | 3.2 | 0.322 | 0.749 | 2.1 | 0.215 | 0.499 |
| 11 | 5.2 | 0.572 | 1.329 | 3.9 | 0.429 | 0.996 | 2.6 | 0.286 | 0.664 |
| 12 | 6.2 | 0.744 | 1.728 | 4.6 | 0.558 | 1.296 | 3.1 | 0.372 | 0.864 |
| 13 | 7.2 | 0.936 | 2.174 | 5.4 | 0.702 | 1.630 | 3.6 | 0.468 | 1.087 |

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|
| 14 | 8.3 | 1.162 | 2.699 | 6.2 | 0.871 | 2.024 | 4.1 | 0.581 | 1.349 |
| 15 | 9.4 | 1.410 | 3.276 | 7.0 | 1.057 | 2.457 | 4.7 | 0.705 | 1.638 |
| 16 | 10.5 | 1.680 | 3.903 | 7.8 | 1.260 | 2.927 | 5.2 | 0.840 | 1.951 |
| 17 | 11.6 | 1.972 | 4.581 | 8.7 | 1.479 | 3.435 | 5.8 | 0.986 | 0.290 |
| 18 | 12.8 | 2.304 | 5.353 | 9.6 | 1.728 | 4.014 | 6.4 | 1.152 | 0.676 |
| 19 | 13.9 | 2.641 | 6.135 | 10.4 | 1.980 | 4.601 | 6.9 | 1.320 | 0.067 |
| 20 | 15.0 | 3.000 | 6.970 | 11.25 | 2.250 | 5.227 | 7.5 | 1.500 | 0.485 |
| 21 | 16.1 | 3.381 | 7.855 | 12.0 | 2.535 | 5.891 | 8.0 | 1.690 | 0.927 |
| 22 | 17.3 | 3.806 | 8.842 | 12.9 | 2.854 | 6.631 | 8.6 | 1.903 | 0.421 |
| 23 | 18.4 | 4.232 | 9.832 | 13.8 | 3.174 | 7.374 | 9.2 | 2.116 | 4.916 |
| 24 | 19.5 | 4.680 | 10.873 | 14.6 | 3.510 | 8.154 | 9.7 | 2.340 | 5.436 |
| 25 | 20.6 | 5.150 | 11.964 | 15.4 | 3.862 | 8.973 | 10.3 | 2.515 | 5.982 |
| 26 | 21.8 | 5.668 | 13.168 | 16.3 | 4.251 | 9.876 | 10.9 | 2.834 | 4.916 |
| 27 | 22.9 | 6.183 | 14.364 | 17.1 | 4.637 | 10.773 | 11.4 | 3.091 | 5.436 |
| 28 | 24.0 | 6.720 | 15.612 | 18.0 | 50.040 | 11.709 | 12.0 | 3.360 | 5.982 |
| 29 | 25.1 | 7.279 | 16.911 | 18.8 | 5.459 | 12.683 | 12.5 | 3.639 | 6.584 |
| 30 | 26.3 | 7.890 | 18.830 | 19.7 | 5.917 | 13.747 | 13.1 | 3.945 | 7.182 |
| 31 | 27.4 | 8.494 | 19.733 | 20.5 | 6.370 | 14.799 | 13.7 | 4.247 | 7.806 |
| 32 | 28.5 | 9.120 | 21.188 | 21.3 | 6.840 | 15.891 | 14.2 | 4.560 | 8.455 |
| 33 | 29.6 | 9.768 | 22.693 | 22.2 | 7.326 | 17.019 | 14.8 | 4.884 | 9.165 |
| 34 | 30.8 | 10.472 | 24.329 | 23.1 | 7.854 | 18.246 | 15.4 | 5.236 | 9.866 |
| 35 | 31.9 | 11.165 | 25.939 | 23.9 | 8.373 | 19.454 | 15.9 | 5.582 | 10.594 |
| 36 | 33.0 | 11.880 | 27.600 | 24.7 | 8.910 | 20.700 | 16.5 | 5.940 | 11.346 |
| 37 | 34.1 | 12.617 | 29.312 | 25.5 | 9.462 | 21.984 | 17.0 | 6.308 | 12.164 |
| 38 | 35.3 | 13.414 | 31.163 | 26.4 | 10.060 | 23.372 | 17.6 | 6.707 | 12.969 |
| 39 | 36.4 | 14.196 | 32.980 | 27.3 | 10.647 | 24.735 | 18.2 | 7.098 | 13.800 |
| 40 | 37.5 | 15.000 | 34.848 | 28.1 | 11.250 | 26.136 | 18.7 | 7.500 | 14.656 |
| 41 | 38.6 | 15.826 | 36.767 | 28.9 | 11.869 | 27.575 | 19.3 | 7.913 | 15.581 |

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|
| 42 | 39.8 | 16.716 | 38.835 | 29.8 | 12.537 | 29.126 | 19.9 | 8.358 | 16.490 |
| 43 | 40.9 | 17.587 | 40.858 | 30.6 | 13.190 | 30.643 | 20.4 | 8.793 | 17.424 |
| 44 | 42.0 | 18.480 | 42.933 | 31.5 | 13.860 | 22.199 | 21.0 | 9.240 | 18.388 |
| 45 | 43.1 | 19.395 | 45.058 | 32.3 | 14.546 | 33.793 | 21.5 | 9.697 | 19.417 |
| 46 | 44.3 | 20.378 | 47.342 | 33.2 | 15.283 | 35.506 | 22.1 | 10.189 | 20.429 |
| 47 | 45.4 | 21.338 | 49.572 | 34.0 | 16.003 | 31.179 | 22.7 | 10.669 | 21.466 |
| 48 | 46.5 | 22.320 | 51.854 | 34.8 | 17.740 | 38.890 | 23.2 | 11.160 | 22.529 |
| 49 | 47.6 | 23.324 | 54.186 | 35.7 | 18.493 | 40.639 | 23.8 | 11.662 | 23.671 |
| 50 | 48.8 | 24.400 | 56.686 | 36.6 | 18.300 | 42.514 | 24.4 | 12.200 | 24.786 |
| 51 | 49.9 | 25.449 | 59.123 | 37.4 | 19.086 | 44.342 | 24.9 | 12.724 | 25.927 |
| 52 | 51.0 | 26.520 | 61.611 | 38.2 | 19.880 | 46.208 | 25.5 | 13.260 | 27.092 |
| 53 | 52.1 | 27.713 | 64.151 | 39.0 | 20.709 | 48.113 | 26.0 | 13.806 | 28.343 |
| 54 | 53.3 | 28.782 | 66.866 | 39.9 | 21.586 | 50.149 | 26.6 | 14.391 | 29.561 |
| 55 | 54.4 | 29.920 | 69.510 | 40.8 | 22.440 | 52.132 | 27.2 | 14.960 | 30.805 |
| 56 | 55.5 | 31.080 | 72.205 | 41.6 | 43.310 | 514.53 | 27.7 | 15.540 | 32.075 |
| 57 | 56.6 | 32.262 | 74.951 | 42.4 | 24.196 | 56.213 | 28.3 | 16.131 | 37.475 |
| 58 | 57.8 | 33.524 | 77.883 | 43.3 | 25.143 | 58.412 | 28.9 | 16.762 | 38.941 |
| 59 | 58.9 | 34.751 | 80.734 | 44.4 | 26.063 | 60.550 | 29.4 | 17.375 | 40.367 |
| 60 | 60.0 | 36.000 | 83.635 | 45.0 | 27.000 | 62.726 | 30.0 | 18.000 | 41.814 |

Source: Ellis W.M. "College of Engineering Manual "Irrigation" Govt. of Madras, 1963. pp.21-22.

## Appendix No.11

### Medium Projects Under Construction (Tamil Nadu)

| Sl. No. | Name of the Project | Name of the River | Total area to be benefitted hectares (acres) | River Supply to be diverted m.cu.m. (TMC) | Proposed withdrawal m.cu.m. (TMC) |
|---|---|---|---|---|---|
| 1. | Parappalar | Parappalar | 900 (2312) | 9 (0.320) | 10 (0.339) |
| 2. | Palar-Porandalar | Palar-Porandalar | 6100 (14981) | 59 (2.100) | 63 (2.230) |
| 3. | Chinnar (Dharmapuri) | Chinnar | 1800 (4500) | 21 (0.780) | 24 (0.840) |
| 4. | Ponnanlar | Ponnanlar | 900 (2101) | 10 (0.350) | 10 (0.362) |

Source: Cauvery Basin Report of Tamil Nadu Performa, Part I Vol.III.

1. Report of the Cauvery Fact Finding Committee, Ministry of Irrigation & Power, New Delhi. 15th December 1972.

# Appendix No. 12

## Medium Projects to be taken up in Tamil Nadu

| Sl. No. | Name of the Project | Name of the River | Total Area to be benefitted hectares | River Supply to be diverted m.cu.m. | Proposed Utilisation m.cu.m. |
|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 |
| 1. | Doddahalla | Doddahalla | 753 | 11 | 13 |
| 2. | Reservoir across Ayyar Kollis Hills | Ayyar | 2833 | 16 | 18 |
| 3. | Gunderipallam | Gunderipallam | 460 | 5 | 6 |
| 4. | Varattapallam | Varattapallam | 677 | 8 | 9 |
| 5. | Varadamanadhi | Varadamanadhi | 2105 | 5 | 5 |
| 6. | Sastramutulu | Jungle stream | 180 | 2 | 2 |
| 7. | Maniarpallam | Maniapallam | 850 | 10 | 11 |
| 8. | Nagavathi | Nagavathi or Palar | 520 | 7 | 8 |
| 9. | Thoppiar | Thoppiar | 1153 | 14 | 17 |
| 10. | Dhonimaguder | Dinnapattipallam | 486 | 7 | 7 |
| 11. | Bellahalla | Bellahalla | 527 | 6 | 7 |
| 12. | Thannirpallam | Thannirpallam | 440 | 4 | 5 |
| 13. | Kombupallam | Kombupallam | 142 | 1 | 2 |
| 14. | Valukkuparai-pallam | Valukkuparai-pallam | 753 | 5 | 6 |
| 15. | Mannarai | Noyyil | 893 | 9 | 9 |
| 16. | Noyyil (Vellaiya) | Noyyil | 971 | 11 | 12 |
| 17. | Noyyil (Thopparpatti) | Noyyil | 3642 | 42 | 47 |

| 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|
| 18. | Kudiraiyar | Kudiraiyar | 1498 | 10 | 11 |
| 19. | Nellathangal Odai | Nellathangal | 625 | 9 | 9 |
| 20. | Vettamalaikarai Odai | Vettamalaikarai | 1200 | 13 | 14 |
| 21. | Sanmugachittar | Sanmugachittar | 465 | 6 | 6 |
| 22. | Kodaganar | Kodaganar | 2313 | 23 | 25 |

Source: Cauvery Basin Report of Tamil Nadu, Part 6.

1. Report of the Cauvery Fact Finding Committee, Ministry of Irrigation & Power, New Delhi. 15th December 1972.

## Appendix No. 13

**Sources of Water Supply and Area Irrigated there from in each District of Tamil Nadu.**

| Districts | Canals | | | | Wells | | | | | | | | No. of wells used for domestic purposes only |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Government | | Private | | No. of tube wells | | | No. of other wells used for irrigation purposes only | | | | | |
| | | | | | | | | Governtmnt | | Private | | | |
| | No. | Km. | No. | Km. | Govt. | Private | Total | Masoury | Non-Masoury | Masoury | Non-Masoury | Total | |
| Madras | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Chingleput | 94 | 378 | - | - | 4 | 5 | 9 | 107 | 2 | 54,741 | 8,977 | 63,827 | 49,000 |
| South Arcot | 500 | 12,855 | - | - | 147 | 2,207 | 2,354 | 2,350 | 250 | 89,925 | 20,548 | 113,073 | 36,801 |
| North Arcot | 748 | 1,908 | - | - | - | 222 | 222 | 127 | 157 | 155,364 | 41,102 | 196,750 | 39,066 |
| Salem | 86 | 695 | 7 | 15 | - | - | - | 62 | - | 141,651 | 864 | 142,677 | 16,723 |
| Dharmapuri | 234 | 674 | 8 | 6 | - | - | - | 5,711 | 5 | 59,993 | 3,451 | 69,160 | 10,205 |
| Coimbatore | 72 | 1,273 | 2 | 19 | - | 27 | 27 | 78 | 2 | 129,774 | 1,122 | 130,976 | 19,916 |
| Tiruchirapalli | 48 | 1,151 | - | - | 19 | 741 | 741 | 230 | 606 | 111,827 | 46,972 | 159,635 | 16,575 |
| Thanjavur | 134 | 2,688 | 7 | 9 | 2 | 637 | 637 | 2 | - | 7,148 | 31,243 | 38,393 | 69,478 |
| Madurai | 414 | 991 | - | - | - | 224 | 224 | 4 | 9 | 69,513 | 22,391 | 91,917 | 4,121 |
| Ramanathapuram | 11 | 40 | - | - | 2 | 28 | 28 | 66 | 33 | 31,474 | 6,894 | 38,467 | 19,709 |
| Tirunelveli | 3 | 874 | 1 | 2 | - | - | - | 239 | 7 | 61,174 | 7,012 | 68,432 | 18,201 |
| The Nilgiris | - | - | - | - | - | - | - | - | - | - | 27 | 27 | 193 |
| Kanyakumari | 36 | 465 | - | - | - | 7 | 7 | - | - | 292 | 266 | 558 | 7,416 |
| State | 3,211 | 23,992 | 25 | 51 | 174 | 4,075 | 4,249 | 8,976 | 1,071 | 912,876 | 190,969 | 1,113,892 | 307,404 |

Source: Season and Crop Report of Tamil Nadu, 1968-69.

Appendix No. 13 (Contd.)

| Districts | No. of wells not in use | Resu-voirs | No. of Tanks: with ayacuts of 100 acres of more | No. of Tanks: with ayacuts of less than 100 acres | No. of Tanks: Total | No. of oil engines | Net area irrigated by: Govt. Canls | Net area irrigated by: Private Canals | Net area irrigated by: Tanks | Net area irrigated by: Tube wells | Net area irrigated by: Sole irrigation | Net area irrigated by: Supplementing other sources of irrigation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Madras | - | - | - | - | - | - | - | - | - | - | - | - |
| Chingleput | 4,025 | 1 | 1,483 | 1,714 | 3,197 | 10,239 | 3,704 | - | 107,681 | 108 | 40,357 | 12,118 |
| South Arcot | 1,167 | 5 | 1,254 | 1,646 | 2,900 | 11,014 | 77,824 | - | 97,813 | 5,079 | 72,333 | 26,104 |
| North Arcot | 18,275 | 1 | 927 | 2,262 | 3,189 | 3,599 | 11,515 | - | 65,670 | - | 106,276 | 21,158 |
| Salem | 3,042 | 1 | 137 | 498 | 635 | 10,403 | 21,596 | 119 | 12,601 | - | 91,808 | 1,830 |
| Dharmapuri | 2,625 | 1 | 838 | 1,294 | 2,132 | 2,130 | 12,195 | 17 | 16,850 | - | 30,120 | 4,943 |
| Coimbatore | 6,369 | 5 | 57 | 57 | 114 | 3,133 | 106,602 | 563 | 4,059 | 59 | 125,407 | 8,611 |
| Tiruchirapalli | 14,211 | 1 | 354 | 7,502 | 7,856 | 19,805 | 81,243 | - | 79,012 | 4,438 | 64,647 | 16,893 |
| Thanjavur | 2,643 | - | 146 | 737 | 883 | 472 | 470,842 | 566 | 30,485 | 170 | 8,451 | 4,889 |
| Madurai | 5,264 | 2 | 348 | 5,147 | 5,495 | 2,464 | 64,014 | - | 52,011 | 204 | 89,453 | 7,969 |
| Ramanathapuram | 1,658 | - | 2,365 | 3,001 | 5,366 | 1,824 | 132 | - | 198,461 | - | 41,015 | 2,390 |
| Tirunelveli | 4,529 | 8 | 477 | 1,940 | 2,417 | 1,583 | 21,956 | - | 74,684 | - | 63,950 | 1,662 |
| The Nilgiris | 5 | - | 1 | 1 | 2 | 6 | - | - | - | - | - | - |
| Kanyakumari | 742 | 2 | 55 | 2,394 | 2,449 | - | 18,999 | - | 11,203 | 12 | 97 | 37 |
| State | 64,555 | 27 | 8,442 | 28,193 | 36,665 | 66,672 | 890,622 | 1,265 | 750,530 | 10,102 | 733,914 | 108,604 |

Appendix No. 13 (Contd.)

| Districts | Other sources i.e. spring chauvels etc. | Total net area irrigated excluding wells supplementing other sources | Percentage of net area irrigated to net area sown | Area irrigated more than once in the same year | Total gross area of crops irrigated | Percentage of total gross irrigated area to the total area sown | No. of wells having independent ayacuts | No. of wells supplementing recognised sources of irrigation | Percentage of area irrigated by wells having independent ayacuts to total area irrigated |
|---|---|---|---|---|---|---|---|---|---|
| Madras | - | - | - | - | - | - | - | - | - |
| Chingleput | 4,583 | 156,433 | 55.5 | 58,034 | 214,467 | 88.0 | 36,458 | 27,378 | 25.8 |
| South Arcot | 10,429 | 263,478 | 47.2 | 112,876 | 376,354 | 55.6 | 42,624 | 72,803 | 27.5 |
| North Arcot | 891 | 184,352 | 40.1 | 64,477 | 250,829 | 44.9 | 95,390 | 101,582 | 57.6 |
| Salem | 1,020 | 127,144 | 31.8 | 26,701 | 153,845 | 34.6 | 113,886 | 28,791 | 72.2 |
| Dharmapuri | 61 | 59,243 | 15.0 | 9,276 | 68,519 | 15.5 | 40,637 | 28,523 | 50.8 |
| Coimbatore | 3,650 | 240,340 | 34.8 | 60,509 | 300,839 | 37.6 | 124,571 | 6,432 | 52.2 |
| Tiruchirapalli | 4,407 | 233,747 | 32.3 | 57,635 | 291,382 | 36.6 | 112,290 | 48,086 | 27.7 |
| Thanjavur | 1,251 | 511,765 | 84.4 | 26,088 | 637,858 | 74.9 | 35,478 | 3,552 | 1.7 |
| Madurai | 2,188 | 207,870 | 37.2 | 53,706 | 261,576 | 41.2 | 78,640 | 13,501 | 43.0 |
| Ramanathapuram | 31 | 239,671 | 39.2 | 5,016 | 244,687 | 39.1 | 27,002 | 11,496 | 17.1 |
| Tirunelveli | 1,201 | 161,791 | 34.2 | 69,450 | 231,241 | 41.8 | 66,020 | 2,412 | 39.5 |
| The Nilgiris | 424 | 424 | 0.8 | - | 424 | 0.8 | - | 27 | - |
| Kanyakumari | 693 | 31,004 | 38.8 | 28,838 | 59,842 | 53.5 | 72 | 493 | 0.32 |
| State | 30,829 | 2,417,262 | 41.0 | 674,606 | 3,091,868 | 44.7 | 773,068 | 345,073 | 30.4 |

## Appendix No. 14

### Levels of Development of Irrigation

| Sl. No. | Districts | Canals | Tanks | Wells | Other Sources | Levels of development of irrigation |
|---|---|---|---|---|---|---|
| 1. | Chingleput | 0.09 | 2.46 | 0.11 | 2.61 | 5.27 |
| 2. | South Arcot | 1.05 | 1.24 | 1.11 | 3.33 | 6.73 |
| 3. | North Arcot | 0.18 | 1.01 | 1.97 | 0.04 | 3.20 |
| 4. | Salem | 0.44 | 0.24 | 2.14 | 0.44 | 3.26 |
| 5. | Dharmapuri | 0.24 | 0.32 | 0.71 | 0.002 | 1.272 |
| 6. | Coimbatore | 1.21 | 0.04 | 1.62 | 1.55 | 4.42 |
| 7. | Tiruchirapalli | 0.92 | 0.85 | 0.84 | 1.11 | 3.72 |
| 8. | Thanjavur | 5.03 | 0.30 | 0.09 | 0.31 | 5.73 |
| 9. | Madurai | 0.91 | 0.69 | 1.46 | 0.75 | 3.81 |
| 10. | Ramnadapuram | 0.03 | 2.74 | 0.67 | 0.008 | 3.45 |
| 11. | Tirunelveli | 0.38 | 1.16 | 1.19 | 0.46 | 3.19 |
| 12. | Nilgiris | - | - | - | - | - |
| 13. | Kanyakumari | 1.53 | 0.86 | 0.01 | 1.33 | 3.73 |

Source: Season and Crop Report 1968-69.

# Appendix No. 15

**Regions with Predominant Sources of Irrigation (Weavers Formula)**

| | Chingleput | | | South Arcot | | |
|---|---|---|---|---|---|---|
| | Tanks | Wells | Canals | Tanks | Wells | Canals |
| 1) Percentage of crops to the total cropped area | 46.67<br>46.67 | 2.08<br>46.67<br>2.08 | 1.70<br>46.67<br>2.08<br>1.70 | 18.42 | 18.42<br>16.49 | 18.42<br>16.49<br>15.60 |
| 2) Percentage of theoritical base curve | 100 | 50,50 | 33.33 | 100 | 50,50 | 33.33 |
| 3) Difference | 53.33 | 3.33<br>47.92 | 13.34<br>31.25<br>31.63 | 81.58 | 31.58<br>33.51 | 14.91<br>16.84<br>17.78 |
| 4) Difference squared | 2844.08 | 11.08<br>2296.32 | 177.96<br>976.56<br>1000.46 | 6655.29 | 997.29<br>1122.92 | 222.30<br>283.59<br>314.35 |
| 5) Sum of squared difference | 2844.08 / 1 | 2307.40 / 2 | 2154.98 / 3 | 6655.29 / 1 | 2120.21 / 2 | 824.20 / 3 |
| 6) No. of divided by number of crops | 2844.08 | 1153.70 | 718.32 | 6655.29 | 1060.10 | 274.73 |
| | | (Tanks) | | | (Tanks & Wells) | |

## Appendix No. 15 (Contd.)

| | North Arcot | | | Salem | | |
|---|---|---|---|---|---|---|
| | Wells | Tanks | Canals | Wells | Canals | Tanks |
| 1) Percentage of crops to the total cropped area | 61.56 | 61.56 | 61.56 | 65.64 | 65.64 | 65.64 |
| | | 31.56 | 31.56 | | 13.50 | 13.50 |
| | | | 5.63 | | | 7.36 |
| 2) Percentage of theoritical base curve | 100 | 50 | 33.33 | 100 | 50 | 33.33 |
| 3) Difference | 38.44 | 11.56 | 28.23 | 34.36 | 15.64 | 32.31 |
| | | 18.44 | 1.77 | | 36.50 | 19.83 |
| | | | 27.70 | | | |
| 4) Difference squared | 1477.63 | 133.63 | 796.93 | 1180.60 | 244.60 | 1043.94 |
| | | | 3.13 | | 1332.25 | 393.23 |
| | | 340.03 | 767.29 | | | |
| 5) Sum of squared difference | 1477.63 | 473.66 / 2 | 1567.35 / 3 | 1180.60 | 1576.85 / 2 | 1437.17 / 3 |
| 6) No. of divided by number of crops | 1477.63 | 236.83 | 522.45 | 1180.60 | 788.42 | 479.56 |
| | | (Wells) | | | (Wells) | |

## Appendix No. 15 (Contd.)

| | Dharmapuri | | | Coimbatore | | |
|---|---|---|---|---|---|---|
| | Wells | Tanks | Canals | Wells | Canals | Tanks |
| 1) Percentage of crops to the total cropped area | 55.91 | 55.91<br>25.19 | 55.91<br>25.19<br>18.89 | 36.65 | 36.65<br>27.38 | 36.65<br>27.38<br>0.90 |
| 2) Percentage of theoritical base curve | 100 | 50 | 33.33 | 100 | 50 | 33.333 |
| 3) Difference | 44.09 | 5.91<br>24.81 | 22.58<br>8.14<br>14.44 | 63.35 | 13.35<br>22.62 | 3.32<br>5.95<br>32.43 |
| 4) Difference squared | 1943.93 | 34.92<br>615.54 | 509.86<br>66.26<br>208.51 | 4013.22 | 178.22<br>511.66 | 11.02<br>35.40<br>1051.70 |
| 5) Sum of squared difference | 1943.93 | 650.46 / 2 | 784.63 / 3 | 4013.22 | 689.88 / 2 | 1098.12 / 3 |
| 6) No. of divided by number of crops | 1943.93 | 325.23 | 261.54 | 4013.22 | 689.88 | 1098.12 |
| | | (Wells) | | | (Wells & Canals) | |

## Appendix No. 15 (Contd.)

| | Tiruchirapalli | | | Thanjavur | | |
|---|---|---|---|---|---|---|
| | Canals | Tanks | Wells | Canals | Tanks | Wells |
| 1) Percentage of crops to the total cropped area | 24.73 | 24.73<br>22.85 | 24.73<br>22.85<br>22.58 | 87.78 | 87.78<br>5.24 | 87.78<br>5.24<br>1.57 |
| 2) Percentage of theoritical based curve | 100 | 50 | 33.33 | 100 | 50 | 33.33 |
| 3) Difference | 75.27 | 25.27<br>27.15 | 8.60<br>27.15<br>27.42 | 12.22 | 37.78<br>44.76 | 54.45<br>28.09<br>31.76 |
| 4) Difference squared | 5665.57 | 638.57<br>737.12 | 73.96<br>737.12<br>751.86 | 149.33 | 1427.33<br>2003.46 | 2964.80<br>789.05<br>1008.69 |
| 5) Sum of squared difference | 5665.57 | 1375.69 / 2 | 1562.94 / 3 | 149.33 | 3430.79 / 2 | 4762.54 / 3 |
| 6) No. of divided by number of crops | 5665.57 | 687.845 | 520.98 | 149.33 | 1715.39 | 1587.51 |
| | | (Canals & Tanks) | | | (Canals) | |

## Appendix No. 15 (Contd.)

| | Madurai | | | Ramanathapuram | | |
|---|---|---|---|---|---|---|
| | Wells | Canals | Tanks | Tanks | Wells | Canals |
| 1) Percentage of crops to the total cropped area | 38.32 | 38.32<br>23.88 | 38.32<br>23.88<br>18.11 | 79.42 | 79.42<br>19.42 | 79.42<br>19.42<br>0.87 |
| 2) Percentage of theoritical based curve | 100 | 50 | 33.33 | 100 | 50 | 33.33 |
| 3) Difference | 61.68 | 11.68<br>26.12 | 4.99<br>9.45<br>15.22 | 20.58 | 29.42<br>30.58 | 46.09<br>13.91<br>32.46 |
| 4) Difference squared | 3804.42 | 136.42<br>682.25 | 24.90<br>89.30<br>231.65 | 516.15 | 865.54<br>935.14 | 2124.29<br>193.48<br>1053.65 |
| 5) Sum of squared difference | 3804.42 / 1 | 818.65 / 2 | 345.85 / 3 | 516.15 / 1 | 1800.68 / 2 | 3371.42 / 3 |
| 6) No. of divided by number of crops | 3804.42 | 409.325 | 115.28 | 516.15 | 900.34 | 1123.80 |
| | | (Wells & Canals) | | | (Tanks) | |

## Appendix No. 15 (Contd.)

| | Tirunelveli | | | Kanyakumari | | |
|---|---|---|---|---|---|---|
| | Wells | Tanks | Canals | Canals | Tanks | Wells |
| 1) Percentage of crops to the total cropped area | 37.30 | 37.30<br>36.36 | 37.30<br>36.36<br>11.91 | 41.02 | 41.02<br>23.06 | 41.02<br>23.06<br>0.27 |
| 2) Percentage of theoritical based curve | 100 | 50 | 33.33 | 100 | 50 | 33.33 |
| 3) Difference | 62.70 | 12.70<br>13.64 | 3.97<br>3.03<br>21.42 | 58.98 | 8.98<br>26.94 | 7.69<br>10.27<br>33.06 |
| 4) Difference squared | 3931.29 | 161.29<br>186.05 | 15.76<br>9.18<br>458.82 | 3478.64 | 80.64<br>725.76 | 59.14<br>105.47<br>1092.96 |
| 5) Sum of squared difference | 3931.29 / 1 | 347.34 / 2 | 483.76 / 3 | 3478.64 / 1 | 806.40 / 2 | 1257.57 / 3 |
| 6) No. of divided by number of crops | 3931.29 | 173.67 | 164.58 | 3478.64 | 403.20 | 419.19 |
| | | (Wells & Tanks) | | | (Canals) | |

Appendix No. 16

Classification of Area in each District of Tamil Nadu in 1968-69

| District | Total Geographical Area By Professional survey Hectares | Total Geographical Area By Village papers Hectares | Forests Hectares | Percentage to the total area | Banen and unculturable land Hectares | Percentage to the total area | Land put to non-agricul. uses Hectares | Percentage to the total area | Culturable waste Hectares | Percentage to the total area | Permanent pastures and other grazing lands Hectares | Percentage to the total area |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Madras | 12,800 | 12,800 | - | 4.1 | - | - | 12,800 | - | - | - | - | - |
| Chingleput | 791,800 | 824,799 | 33,734 | 5.9 | 50,958 | 6.2 | 164,048 | 19.9 | 59,607 | 7.2 | 48,024 | 5.8 |
| South Arcot | 1,089,800 | 1,089,884 | 64,179 | 25.9 | 160,818 | 14.7 | 100,641 | 9.2 | 43,466 | 4.0 | 9,361 | 0.9 |
| North Arcot | 1,226,700 | 1,230,223 | 318,887 | 19.4 | 76,136 | 6.2 | 118,461 | 9.6 | 62,799 | 5.1 | 19,709 | 1.6 |
| Salem | 864,300 | 862,006 | 166,906 | 33.0 | 88,387 | 10.2 | 50,984 | 5.9 | 21,842 | 2.5 | 15,689 | 1.8 |
| Dharmapuri | 962,700 | 962,914 | 317,295 | 29.9 | 78,961 | 8.2 | 80,380 | 8.3 | 19,279 | 2.0 | 11,641 | 1.2 |
| Coimbatore | 1,567,900 | 1,560,374 | 404,558 | 7.0 | 50,239 | 3.2 | 73,027 | 4.7 | 48,375 | 3.1 | 18,733 | 1.2 |
| Tiruchirapalli | 1,427,800 | 1,425,851 | 99,533 | 1.5 | 67,644 | 4.8 | 217,126 | 15.2 | 97,140 | 6.8 | 36,911 | 2.6 |
| Thanjavur | 968,700 | 968,245 | 14,111 | 13.2 | 31,781 | 3.3 | 193,927 | 20.0 | 30,714 | 3.2 | 6,369 | 0.6 |
| Madurai | 1,264,600 | 1,261,244 | 166,309 | 4.3 | 76,871 | 6.1 | 100,608 | 8.0 | 26,397 | 2.1 | 113,846 | 9.0 |
| Ramanathapuram | 1,255,900 | 1,249,749 | 53,978 | 11.2 | 87,494 | 7.0 | 137,529 | 11.0 | 124,194 | 0.9 | 10,615 | 0.8 |
| Tirunelveli | 1,142,300 | 1,141,622 | 127,772 | 42.8 | 55,461 | 4.9 | 106,385 | 9.3 | 70,770 | 6.2 | 34,829 | 3.0 |
| The Nilgiris | 254,800 | 254,474 | 108,831 | 29.1 | 33,824 | 13.3 | 11,798 | 4.6 | 22,423 | 8.8 | 8,792 | 3.5 |
| Kanyakumari | 166,500 | 166,828 | 46,633 | - | 21,467 | 12.9 | 10,637 | 6.3 | 2,636 | 1.6 | - | - |
| State | 12,996,600 | 13,011,013 | 1,924,726 | 14.8 | 879,541 | 6.8 | 1,378,351 | 10.5 | 629,642 | 4.8 | 334,519 | 2.6 |

Appendix No. 16 (Contd.)

| District | Land under miscellaneous the tree crops and groves not included in the net area sown Hectares | Percentage to the total area | Current follows Hectares | Percentage to the total area | Other follow lands Hectares | Percentage to the total area | Net area sown Hectares | Percentage to the total area | Area sown more than once Hectares | Percentage to the total area | Total cropped area Hectare | Percentage to the area |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Madras | - | - | - | - | - | - | - | - | - | - | - | - |
| Chingleput | 46,887 | 5.7 | 103,282 | 12.5 | 36,226 | 4.4 | 282,033 | 34.2 | 87,162 | 10.6 | 369,195 | 44.8 |
| South Arcot | 52,416 | 4.8 | 51,799 | 4.7 | 48,949 | 4.5 | 558,755 | 51.3 | 177,951 | 10.8 | 676,706 | 62.1 |
| North Arcout | 13,453 | 1.0 | 84,657 | 6.9 | 76,521 | 6.2 | 459,600 | 37.4 | 98,521 | 8.0 | 558,121 | 45.4 |
| Salem | 3,255 | 0.4 | 80,015 | 9.3 | 35,303 | 4.1 | 399,625 | 46.4 | 44,727 | 5.2 | 444,352 | 51.6 |
| Dharmapuri | 5,909 | 0.6 | 40,881 | 4.3 | 12,940 | 1.3 | 395,628 | 41.1 | 46,840 | 4.9 | 442,468 | 46.0 |
| Coimbatore | 6,080 | 0.4 | 198,492 | 12.7 | 70,318 | 4.5 | 690,552 | 44.3 | 108,924 | 7.0 | 799,476 | 51.3 |
| Tiruchirapalli | 24,813 | 1.8 | 93,035 | 6.5 | 64,885 | 4.5 | 724,764 | 50.8 | 70,853 | 5.0 | 795,617 | 55.8 |
| Thanjavur | 33,563 | 3.5 | 22,848 | 2.3 | 28,638 | 3.0 | 606,294 | 62.6 | 245,702 | 25.4 | 851,996 | 88.0 |
| Madurai | 25,824 | 2.1 | 129,239 | 10.6 | 62,804 | 5.0 | 559,346 | 44.3 | 75,281 | 6.0 | 634,627 | 50.3 |
| Ramanathapuram | 27,064 | 2.2 | 139,367 | 11.2 | 58,244 | 4.7 | 611,244 | 48.9 | 14,542 | 1.2 | 625,786 | 50.1 |
| Tirunelveli | 10,367 | 1.0 | 137,283 | 12.0 | 125,363 | 11.0 | 472,892 | 41.4 | 79,927 | 7.0 | 552,819 | 48.4 |
| The Nilgiris | 7,837 | 3.1 | 6,874 | 2.7 | 3,784 | 1.5 | 50,311 | 19.7 | 733 | 0.4 | 51,044 | 20.1 |
| Kanyakumari | 12 | - | 2,070 | 1.2 | 1,496 | 1.0 | 79,877 | 47.9 | 32,022 | 19.2 | 111,899 | 67.1 |
| State | 257,980 | 2.0 | 1,089,862 | 8.4 | 625,471 | 4.8 | 5,390,921 | 45.3 | 1,023,185 | 7.9 | 6,914,106 | 53.2 |

Source: Season and Crop Report of Tamil Nadu, 1968-69.

## Appendix No. 17

### The Area in Hectare Under Crops in each District of Tamil Nadu in 1968-69

| Districts | Paddy | | Wheat | | Cholam | | Cumbu | |
|---|---|---|---|---|---|---|---|---|
| | Current | Normal | Current | Normal | Current | Normal | Current | Normal |
| Chingleput | 250,643 | 341,750 | - | - | 2,495 | 1,240 | 6,061 | 3,420 |
| South Arcot | 284,998 | 307,850 | - | - | 36,347 | 41,420 | 52,765 | 49,090 |
| North Arcot | 170,414 | 292,740 | 3 | - | 28,183 | 38,400 | 11,912 | 14,820 |
| Salem | 68,698 | 94,540 | 209 | 220 | 71,227 | 105,470 | 46,779 | 73,280 |
| Dharmapuri | 41,530 | 46,020 | 2 | 10 | 46,988 | 51,990 | 13,277 | 12,630 |
| Coimbatore | 89,357 | 94,040 | 117 | 160 | 208,800 | 207,020 | 53,757 | 56,770 |
| Tiruchirapalli | 218,497 | 228,750 | - | - | 122,232 | 134,410 | 106,441 | 98,070 |
| Thanjavur | 657,522 | 611,690 | 448 | - | 573 | 1,340 | 872 | 1,240 |
| Madurai | 146,787 | 154,920 | - | 420 | 129,678 | 127,850 | 31,687 | 19,070 |
| Ramanathapuram | 263,507 | 258,550 | - | - | 13,298 | 18,920 | 54,607 | 48,620 |
| Tirunelveli | 140,536 | 148,440 | 265 | - | 40,117 | 35,830 | 79,088 | 68,710 |
| The Nilgiris | 2,984 | 3,380 | 265 | 370 | 49 | 40 | 3 | 10 |
| Kanyakumari | 57,425 | 56,840 | - | - | 187 | 100 | 165 | 50 |
| | 2,362,898 | 2,639,510 | 1,044 | 1,180 | 700,174 | 764,030 | 457,414 | 445,280 |

Appendix No. 17 (Contd.)

| Districts | Barley | | Maize | | Ragi | | Korra | |
|---|---|---|---|---|---|---|---|---|
| | Current | Normal | Current | Normal | Current | Normal | Current | Normal |
| Chingaleput | - | - | 35 | 30 | 29,129 | 25,010 | 143 | 270 |
| South Arcot | - | - | 15 | 10 | 25,535 | 22,210 | 728 | 1,010 |
| North Arcot | - | - | 398 | 360 | 28,454 | 28,320 | 262 | 430 |
| Salem | - | - | 94 | 320 | 28,946 | 74,960 | 3,658 | 4,160 |
| Dharmapuri | - | - | 576 | 910 | 83,280 | 93,690 | 904 | 930 |
| Coimbatore | - | - | 2,161 | 170 | 28,591 | 40,060 | 6,957 | 6,640 |
| Tiruchirapalli | - | - | 2,321 | 2,030 | 15,330 | 16,410 | 1,298 | 400 |
| Thanjavur | - | - | 4,374 | 1,860 | 3,583 | 3,660 | 4 | 20 |
| Madurai | - | 40 | 888 | 170 | 15,321 | 14,170 | 2,443 | 4,350 |
| Ramanathapuram | - | - | 5 | - | 28,912 | 27,630 | 808 | 460 |
| Tirunelveli | - | - | 9 | 40 | 11,928 | 9,090 | 145 | 170 |
| The Nilgiris | 22 | 230 | 7 | - | 1,756 | 1,350 | 43 | 40 |
| Kanyakumari | - | - | - | - | 25 | 10 | - | - |
| State | 22 | 270 | 10,883 | 5,900 | 300,788 | 356,570 | 16,033 | 18,880 |

Source: Season and Crop Report of Tamil Nadu, 1968-69.

Appendix No. 17 (Contd.)

| Districts | Varagu | | Samai | | Other Cereals | | Bengal gram | |
|---|---|---|---|---|---|---|---|---|
| | Current | Normal | Current | Normal | Current | Normal | Current | Normal |
| Chingleput | 24,390 | 4,330 | 46 | 40 | 162 | 160 | - | 70 |
| South Arcot | 33,555 | 39,960 | 651 | 1,090 | 165 | 240 | 7 | 30 |
| North Arcot | 6,784 | 10,890 | 16,720 | 18,430 | 1,455 | 730 | 54 | 80 |
| Salem | 8,199 | 18,160 | 12,146 | 33,070 | 589 | 1,380 | 38 | 410 |
| Dharmapuri | 13,482 | 38,390 | 49,506 | 50,080 | 314 | 570 | 346 | 140 |
| Coimbatore | 1,139 | 1,730 | 24,289 | 27,590 | 4 | 370 | 2,687 | 1,250 |
| Tiruchirapalli | 68,875 | 71,150 | 11,649 | 9,180 | 38 | 220 | 15 | 90 |
| Thanjavur | 10,270 | 12,610 | 13 | 40 | 208 | 150 | 5 | 10 |
| Madurai | 14,763 | 17,160 | 35,708 | 38,670 | 4,364 | 610 | 527 | 250 |
| Ramanathapuram | 33,166 | 43,110 | 4,780 | 4,090 | 7,001 | 3,130 | 45 | 40 |
| Tirunelveli | 648 | 1,500 | 10,432 | 11,270 | 206 | 8,150 | 20 | 110 |
| The Nilgiris | - | 20 | 1,307 | 1,450 | 192 | 160 | 20 | 10 |
| Kanyakumari | - | - | - | 40 | - | - | - | - |
| State | 193,320 | 256,010 | 167,247 | 200,040 | 14,698 | 15,870 | 3,764 | 2,490 |

Appendix No. 17 (Contd.)

Pulses

| Districts | Green gram | | Red gram | | Black gram | | Horse gram | |
|---|---|---|---|---|---|---|---|---|
| | Current | Normal | Current | Normal | Current | Normal | Current | Normal |
| Chingalepu | 267 | 120 | 471 | 560 | 981 | 920 | 2,452 | 2,130 |
| South Arcot | 1,705 | 1,940 | 5,091 | 4,820 | 5,495 | 4,360 | 3,552 | 2,900 |
| North Arcot | 920 | 1,290 | 14,515 | 14,840 | 2,396 | 2,180 | 13,888 | 12,410 |
| Salem | 1,319 | 1,820 | 1,904 | 3,820 | 1,281 | 2,200 | 17,437 | 46,720 |
| Dharmapuri | 1,213 | 810 | 3,972 | 3,740 | 2,536 | 1,220 | 81,660 | 74,780 |
| Coimbatore | 4,441 | 4,590 | 2,942 | 3,600 | 1,307 | 2,000 | 52,699 | 53,350 |
| Tiruchirapalli | 1,619 | 1,800 | 10,052 | 16,260 | 4,044 | 2,980 | 11,169 | 7,510 |
| Thanjavur | 31,018 | 24,120 | 1,350 | 1,520 | 13,145 | 10,530 | 98 | 70 |
| Madurai | 558 | 530 | 1,806 | 1,690 | 3,859 | 3,650 | 22,427 | 17,750 |
| Ramanathapuram | 3,532 | 3,860 | 1,201 | 2,380 | 5,846 | 5,050 | 4,517 | 5,620 |
| Tirunelveli | 6,186 | 6,330 | 763 | 1,250 | 7,011 | 9,910 | 22,044 | 18,680 |
| The Nilgiris | - | - | 4 | - | - | 320 | 13 | 10 |
| Kanyakumari | 27 | 40 | 119 | 790 | 755 | 550 | 845 | 1,300 |
| State | 52,805 | 47,250 | 44,190 | 55,270 | 48,656 | 45,870 | 232,801 | 243,230 |

Appendix No. 17 (Contd.)

Condimants of spices

| Districts | Other pulses | | Total pulses | | Cardamom | | Chillies | |
|---|---|---|---|---|---|---|---|---|
| | Current | Normal | Current | Normal | Current | Normal | Current | Normal |
| Chingaleput | 168 | 140 | 4,339 | 3,940 | - | - | 1,791 | 2,290 |
| South Arcot | 698 | 1,140 | 16,548 | 15,190 | - | - | 1,020 | 1,240 |
| North Arcot | 1,361 | 3,210 | 33,134 | 34,010 | - | 10 | 1,354 | 1,520 |
| Salem | 2,895 | 7,710 | 24,874 | 62,680 | 238 | 150 | 638 | 2,370 |
| Dharmapuri | 6,281 | 7,730 | 96,008 | 88,420 | - | - | 1,137 | 1,380 |
| Coimbatore | 24,945 | 28,460 | 89,021 | 93,250 | 758 | 940 | 3,472 | 4,740 |
| Tiruchirapalli | 3,966 | 4,730 | 30,865 | 33,370 | - | - | 9,076 | 11,220 |
| Thanjavur | 969 | 470 | 4,658,500 | 36,720 | - | - | 1,442 | 1,860 |
| Madurai | 5,282 | 4,840 | 34,459 | 28,760 | 2,981 | 3,270 | 5,065 | 6,840 |
| Ramanathapuram | 3,221 | 2,230 | 18,362 | 19,180 | 222 | - | 13,263 | 19,500 |
| Tirunelveli | 6,097 | 5,060 | 42,121 | 41,340 | 8 | 100 | 13,010 | 15,830 |
| The Nilgiris | 221 | 260 | 258 | 600 | 227 | 200 | 52 | 60 |
| Kanyakumari | 1,146 | 1,310 | 2,892 | 3,990 | - | - | 51 | 30 |
| State | 57,250 | 67,340 | 439,466 | 461,450 | 4,434 | 4,620 | 51,371 | 68,900 |

Appendix No. 17 (Contd.)

| Districts | Ginger | | Pepper | | Turmeric | | Garlic | |
|---|---|---|---|---|---|---|---|---|
| | Current | Normal | Current | Normal | Current | Normal | Current | Normal |
| Chingaleput | - | - | - | - | 1 | 20 | - | 10 |
| South Arcot | - | - | - | - | 360 | 400 | - | 10 |
| North Arcot | - | 20 | - | - | 134 | 190 | 17 | 10 |
| Salem | 5 | - | 10 | 5 | 244 | 490 | 7 | 60 |
| Dharmapuri | 1 | - | - | - | 73 | 90 | 47 | 40 |
| Coimbatore | - | - | - | - | 3,147 | 4,110 | 39 | 80 |
| Tiruchirapalli | - | - | - | - | 716 | 860 | 10 | 20 |
| Thanjavur | 3 | - | - | - | 101 | 160 | - | - |
| Madurai | 17 | 20 | - | 6 | 25 | 40 | 765 | 680 |
| Ramanathapuram | - | - | - | - | 1 | 10 | 6 | - |
| Tirunelveli | - | - | 10 | - | 19 | 30 | 1 | 10 |
| The Nilgiris | 376 | 290 | 100 | 75 | 12 | 10 | 53 | 50 |
| Kanyakumari | 20 | 50 | 120 | 1,157 | 1 | - | - | - |
| State | 422 | 380 | 240 | 203 | 4,834 | 6,410 | 945 | 970 |

Appendix No. 17 (Contd.)

| Districts | Coriander | | Tamarind | | Other Condiments & spices | | Sugarcane | |
|---|---|---|---|---|---|---|---|---|
| | Current | Normal | Current | Normal | Current | Normal | Current | Normal |
| Chingaleput | 44 | 100 | 89 | 80 | - | 60 | 2,748 | 1,510 |
| South Arcot | 1,539 | 2,090 | 393 | 380 | 6 | 20 | 30,312 | 14,430 |
| North Arcot | 244 | 160 | 725 | 760 | 15 | 370 | 34,298 | 17,450 |
| Salem | 221 | 1,040 | 28 | 380 | 77 | 110 | 11,563 | 8,190 |
| Dharmapuri | 760 | 1,480 | 872 | 900 | 6 | 180 | 7,080 | 3,450 |
| Coimbatore | 1,185 | 1,530 | 67 | 50 | 42 | - | 33,534 | 22,780 |
| Tiruchirapalli | 7,845 | 8,720 | 781 | 720 | - | - | 24,060 | 14,360 |
| Thanjavur | 98 | 130 | 656 | 620 | 92 | 30 | 8,797 | 4,150 |
| Madurai | 153 | 180 | 1,959 | 1,920 | - | 20 | 11,049 | 5,120 |
| Ramanathapuram | 5,281 | 4,930 | 595 | 580 | 12 | 20 | 6,722 | 3,040 |
| Tirunelveli | 7,748 | 8,880 | 316 | 330 | 1 | 80 | 1,600 | 800 |
| The Nilgiris | 14 | 20 | - | - | - | 40 | 2 | - |
| Kanyakumari | - | - | 1,544 | 1,500 | - | - | 1 | - |
| State | 25,132 | 29,260 | 8,025 | 8,220 | 251 | 930 | 171,766 | 95,280 |

Appendix No. 17 (Contd.)

| Districts | Palmyrah | | Other Sugar Crops | | Total fruits & vegetables includg. root crops | | Total food crops | |
|---|---|---|---|---|---|---|---|---|
| | Current | Normal | Current | Normal | Current | Normal | Current | Normal |
| Chingaleput | 436 | 440 | 71 | - | 6,874 | 7,690 | 307,633 | 392,680 |
| South Arcot | 509 | 460 | 1 | - | 25,517 | 22,100 | 511,033 | 516,450 |
| North Arcot | 356 | 500 | 41 | 30 | 9,244 | 9,190 | 344,147 | 469,500 |
| Salem | 50 | 150 | - | 10 | 34,109 | 25,610 | 313,685 | 514,100 |
| Dharmapuri | 205 | 170 | 16 | 10 | 13,286 | 9,480 | 370,188 | 401,990 |
| Coimbatore | 483 | 460 | - | - | 8,993 | 9,600 | 556,499 | 573,050 |
| Tiruchirapolli | 221 | 210 | - | - | 36,975 | 30,080 | 656,328 | 660,280 |
| Thanjavur | 1,064 | 1,000 | 2 | 10 | 17,049 | 15,700 | 723,374 | 693,350 |
| Madurai | 413 | 440 | - | 70 | 35,914 | 29,440 | 432,158 | 462,450 |
| Ramanathapuram | 2,644 | 2,310 | 2 | 80 | 8,631 | 8,280 | 480,791 | 484,080 |
| Tirunelveli | 12,853 | 13,470 | - | 890 | 17,759 | 13,230 | 398,190 | 391,020 |
| The Nilgiris | - | - | - | - | 10,417 | 9,770 | 18,120 | 18,190 |
| Kanyakumari | 2,078 | 2,070 | - | - | 24,890 | 24,660 | 89,852 | 89,860 |
| State | 21,312 | 21,680 | 131 | 1,100 | 249,658 | 214,770 | 5,251,998 | 5,667,000 |

Appendix No. 17 (Contd.)

| Districts | Cotton | | Oil Seeds Groundnut | | Coconut | | Edible Gingelly | |
|---|---|---|---|---|---|---|---|---|
| | Current | Normal | Current | Normal | Current | Normal | Current | Normal |
| Chingaleput | 49 | 220 | 48,062 | 56,080 | 2,210 | 2,580 | 8,138 | 6,900 |
| South Arcot | 2,197 | 2,830 | 140,532 | 149,210 | 1,946 | 1,430 | 17,497 | 16,300 |
| North Arcot | 251 | 670 | 201,276 | 204,010 | 5,364 | 4,830 | 4,754 | 3,620 |
| Salem | 9,536 | 15,420 | 103,449 | 116,820 | 2,425 | 3,440 | 4,997 | 9,480 |
| Dharmapuri | 1,757 | 1,930 | 47,655 | 42,990 | 3,607 | 3,110 | 12,810 | 11,070 |
| Coimbatore | 72,870 | 106,590 | 118,980 | 121,010 | 8,642 | 6,860 | 14,128 | 14,120 |
| Tiruchirapalli | 7,885 | 9,490 | 98,664 | 106,430 | 3,482 | 3,310 | 21,503 | 29,300 |
| Thanjavur | 207 | 160 | 36,154 | 30,230 | 17,311 | 16,580 | 4,088 | 4,840 |
| Madurai | 34,527 | 40,700 | 85,548 | 102,450 | 5,759 | 4,650 | 7,460 | 9,990 |
| Ramanathapuram | 68,180 | 76,550 | 35,357 | 37,910 | 8,067 | 6,450 | 5,245 | 6,570 |
| Tirunelveli | 81,155 | 90,170 | 12,429 | 13,520 | 4,051 | 3,080 | 7,701 | 7,050 |
| The Nilgiris | 13 | 10 | 5 | 10 | 2 | - | 3 | 10 |
| Kanyakumari | 9 | 30 | 2,422 | 2,360 | 12,116 | 10,920 | 67 | 140 |
| State | 278,636 | 344,770 | 930,536 | 983,030 | 74,982 | 67,240 | 108,391 | 119,330 |

Appendix No. 17 (Contd.)

| Districts | Rape & mustard | | Others | | Linseed | | Castor | |
|---|---|---|---|---|---|---|---|---|
| | Current | Normal | Current | Normal | Current | Normal | Current | Normal |
| Chingaleput | 1 | - | - | 120 | - | - | 2 | 50 |
| South Arcot | 5 | - | 86 | 70 | - | - | 91 | 100 |
| North Arcot | 40 | 50 | 3 | 50 | 16 | - | 733 | 950 |
| Salem | 100 | 310 | - | 130 | - | 870 | 2,619 | 3,980 |
| Dharmapuri | 174 | 360 | 8 | 90 | - | - | 3,336 | 3,390 |
| Coimbatore | 45 | 80 | - | 120 | 1 | - | 861 | 1,010 |
| Tiruchirapalli | 18 | 10 | 4 | - | 1 | - | 550 | 770 |
| Thanjavur | 1 | - | 202 | 450 | - | - | 33 | 40 |
| Madurai | 2 | - | 1 | 50 | - | - | 135 | 140 |
| Ramanathapuram | - | - | 1 | - | - | - | 213 | 340 |
| Tirunelveli | - | 10 | 2 | 10 | 2 | 10 | 129 | 300 |
| The Nilgiris | 11 | 20 | - | - | - | - | 1 | - |
| Kanyakumari | - | - | - | - | - | - | 3 | - |
| State | 397 | 840 | 307 | 1,090 | 20 | 880 | 8,706 | 11,070 |

Appendix No. 17 (Contd.)

Drugs & Narcotics

| Districts | Coffee | | Tea | | Total Tobacco | | Total Drugs & Narcotics | |
|---|---|---|---|---|---|---|---|---|
| | Current | Normal | Current | Normal | Current | Normal | Current | Normal |
| Chingalepet | - | - | - | - | - | - | 338 | 330 |
| South Arcot | - | - | - | - | 286 | 210 | 772 | 700 |
| North Arcot | - | - | - | - | 151 | 170 | 431 | 540 |
| Salem | 4,646 | 4,040 | - | - | 331 | 1,070 | 6,078 | 6,910 |
| Dharmapuri | - | - | - | 10,190 | 92 | 200 | 467 | 880 |
| Coimbatore | 1,443 | 1,140 | 10,131 | - | 10,893 | 7,910 | 25,105 | 21,130 |
| Tiruchirapalli | 1 | - | - | - | 472 | 2,070 | 994 | 2,680 |
| Thanjavur | - | - | - | 950 | 672 | 510 | 1,407 | 1,220 |
| Madurai | 9,063 | 8,380 | 1,151 | - | 2,324 | 1,310 | 13,496 | 11,580 |
| Ramanathapuram | - | - | - | 280 | 43 | 220 | 413 | 610 |
| Tirunelveli | 113 | 230 | 20,722 | 18,920 | 273 | 290 | 962 | 1,720 |
| The Nilgiris | 8,659 | 7,100 | 532 | 510 | 3 | 90 | 29,904 | 26,680 |
| Kanyakumari | 66 | 80 | - | - | - | - | 659 | 810 |
| State | 23,991 | 21,370 | 32,536 | 30,850 | 15,540 | 14,050 | 81,026 | 75,790 |

Appendix No. 17 (Contd.)

Green manure crops

| Districts | Fodder Crops | | Sun Hemp | | Indigo | | Total Green Manure Crops | |
|---|---|---|---|---|---|---|---|---|
| | Current | Normal | Current | Normal | Current | Normal | Current | Normal |
| Chingalepu | 17 | 10 | 253 | 250 | 542 | 380 | 1,000 | 980 |
| South Arcot | 62 | 300 | 667 | 110 | 792 | 510 | 2,310 | 2,390 |
| North Arcot | 60 | 190 | 36 | 80 | 261 | 480 | 373 | 720 |
| Salem | 40 | 1,860 | 10 | 860 | - | - | 403 | 3,300 |
| Dharmapuri | 1,271 | 470 | 305 | 160 | - | - | 315 | 270 |
| Coimbatore | 1,288 | 1,520 | 125 | 150 | - | - | 200 | 410 |
| Tiruchirapalli | 2,096 | 350 | - | 10 | 9 | 30 | 3,458 | 3,430 |
| Thanjavur | - | 40 | 983 | 820 | 203 | 170 | 67,925 | 48,640 |
| Madurai | 662 | 1,860 | 166 | 290 | 30 | 20 | 1,862 | 3,220 |
| Ramanathapuram | 13,946 | 22,230 | 276 | 1,550 | - | 1,010 | 10,608 | 7,610 |
| Tirunelveli | 42,607 | 34,730 | 77 | 100 | 76 | 60 | 649 | 850 |
| The Nilgiris | - | - | - | - | - | - | - | 10 |
| Kanyakumari | - | - | - | 1,060 | - | - | 1,116 | 1,950 |
| State | 62,049 | 63,560 | 2,898 | 5,440 | 1,913 | 2,660 | 90,214 | 73,780 |

## Appendix No. 17 (Contd.)

| Districts | Misc. Non-food Crops | | Total Non-food Crops | | Food Crops | | Non-food Crops | | Total Food & Non-food Crops | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Current | Normal | Current | Normal | Current | Normal | Current | Normal | Current | Normal |
| Chingaleput | 1,703 | 2,200 | 61,562 | 69,520 | 307,633 | 392,680 | 61,562 | 69,520 | 369,195 | 462,200 |
| South Arcot | 107 | 880 | 165,673 | 174,840 | 511,033 | 516,450 | 165,673 | 174,840 | 676,706 | 691,290 |
| North Arcot | 595 | 1,290 | 213,974 | 217,860 | 344,147 | 469,500 | 213,974 | 217,860 | 558,121 | 687,360 |
| Salem | 363 | 1,250 | 130,667 | 164,380 | 313,685 | 514,100 | 130,667 | 164,380 | 444,352 | 678,480 |
| Dharmapuri | 322 | 490 | 72,280 | 65,300 | 370,188 | 401,990 | 72,280 | 65,300 | 442,468 | 467,290 |
| Coimbatore | 843 | 470 | 242,977 | 273,450 | 556,499 | 573,050 | 242,977 | 273,450 | 799,476 | 846,500 |
| Tiruchirapalli | 413 | 450 | 139,289 | 156,650 | 656,328 | 660,280 | 139,284 | 156,650 | 795,617 | 816,930 |
| Thanjavur | 732<br>2,914 | 970 | 128,622 | 103,620 | 723,374 | 693,350 | 128,622 | 103,620 | 851,996 | 756,970 |
| Madurai | 1,506 | 1,890 | 152,469 | 176,740 | 482,158 | 462,450 | 152,469 | 176,740 | 634,637 | 639,190 |
| Ramanathapuram | 3,460 | 1,720 | 144,995 | 161,220 | 480,791 | 484,030 | 144,995 | 161,220 | 625,786 | 645,300 |
| Tirunelveli | 2,345 | 9,380 | 154,629 | 161,200 | 398,190 | 391,020 | 154,629 | 161,700 | 552,819 | 552,720 |
| The Nilgiris[1] | 531 | 2,870 | 32,924 | 30,420 | 18,120 | 18,190 | 32,924 | 30,420 | 51,044 | 48,160 |
| Kanyakumari | - | 960 | 22,047 | 22,900 | 89,852 | 89,860 | 22,047 | 22,900 | 111,849 | 112,760 |
| State | 15,864 | 24,820 | 1,662,108 | 1,778,600 | 5,251,998 | 5,667,000 | 1,662,108 | 1,778,600 | 6,914,106 | 7,445,600 |

Appendix No. 18

Index of Land Productivity of Crops
or
(The Yield Index)

| Districts | Rice | Cholam | Cumbu | Maize | Ragi | Varagu | Samai | Sugar-cane | Chillies | Other Cereals | Cotton | Gingelly | Total Pulses | Ground-nut | Castor | Kora | Tobacco |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Chingleput | 41.86 | 0.50 | 1.27 | 0.009 | 7.7183 | 0.4986 | .011 | 0.60 | 0.30 | .001 | 0.25 | 2.07 | 0.08 | 13.75 | 0.006 | 0.05 | - |
| South Arcot | 48.86 | 5.4 | 8.92 | 0.019 | 4.10 | 6.39 | 0.99 | 4.78 | 0.12 | .009 | 0.45 | 2.48 | 2.47 | 21.71 | 0.001 | 0.14 | 0.06 |
| North Arcot | 24.83 | 5.0 | 1.50 | 0.071 | 5.24 | 1.56 | 3.29 | 5.20 | 0.16 | 0.91 | 6.04 | 0.83 | 6.14 | 30.63 | 0.006 | 0.33 | 0.03 |
| Salem | 17.82 | 16.0 | 9.83 | 0.02 | 6.01 | 1.10 | 2.44 | 2.25 | 0.14 | 0.04 | 2.69 | 1.05 | 5.81 | 19.93 | 0.63 | 0.81 | 0.07 |
| Dharmapuri | 6.92 | 12.11 | 0.2385 | 0.10 | 10.13 | 0.18 | 10.02 | 1.38 | 0.41 | 0.02 | 0.41 | 2.76 | 22.81 | 9.93 | 0.84 | 0.20 | 0.03 |
| Coimbatore | 17.48 | 24.29 | 7.14 | 0.29 | 4.63 | 0.09 | 2.63 | 4.51 | 0.54 | 0.002 | 16.24 | 1.66 | 10.23 | 14.13 | 0.10 | 0.78 | 1.52 |
| Tiruchirapalli | 30.38 | 13.09 | 14.16 | 0.30 | 1.81 | 8.80 | 1.57 | 0.32 | 1.47 | 0.002 | 0.16 | 2.60 | 3.89 | 13.17 | 0.10 | 0.004 | 0.09 |
| Thanjavur | 87.27 | 0.14 | 0.11 | 0.60 | 0.41 | 1.11 | 0.009 | 0.12 | 0.13 | 0.01 | 1.35 | 0.48 | 5.28 | 15.72 | 0.003 | 0.001 | 0.08 |
| Madurai | 22.34 | 23.43 | 0.58 | 0.10 | 2.84 | 0.19 | 5.28 | 0.10 | 1.04 | 0.69 | 0.48 | 1.18 | 5.15 | 13.92 | 0.021 | 0.35 | 0.34 |
| Ramanathapuram | 19.29 | 1.80 | 6.22 | 0.0009 | 3.88 | 4.69 | 0.63 | 0.10 | 1.57 | 1.07 | 6.61 | 0.76 | 3.07 | 5.45 | 0.031 | 0.08 | 0.05 |
| Tirunelveli | 28.75 | 10.32 | 14.77 | 1.1 | 2.84 | 1.101 | 1.66 | 0.004 | 2.20 | 0.03 | 7.97 | 0.75 | 7.99 | 2.11 | 0.02 | 0.004 | 0.04 |
| The Nilgiris | 5.86 | 0.09 | 1.03 | - | 3.88 | - | - | - | 0.15 | - | - | - | 0.55 | - | - | 0.07 | - |
| Kanyakumari | 68.89 | 0.23 | .00046 | - | 3.28 | - | - | - | - | - | - | 0.09 | 2.38 | 1.70 | - | - | - |
| State | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |

Source: Season and Crop Report of Tamil Nadu, 1968-69 and "The Macro Regional Survey of South India by The Indian Statistical Institute".

## Appendix No. 19

### Water Requirements of Crops - 1968-69
### (Production x Mean Water Requirements of Crops)

| Districts | Rice (cu.mm.) | Groundnut (cu.mm.) | Cotton (cu.mm.) | Ragi (cu.mm.) | Redgram (cu.mm.) | Horsegram (cu.mm.) |
|---|---|---|---|---|---|---|
| Chingleput | 44,04,77,000 | 2,88,21,800 | 38,220 | 1,24,51,500 | 41,250 | 40,000 |
| South Arcot | 92,24,76,000 | 8,13,30,550 | 18,91,890 | 1,20,64,500 | 4,52,100 | 60,800 |
| North Arcot | 39,58,60,000 | 9,51,04,800 | 95,550 | 1,28,02,500 | 12,73,800 | 2,36,800 |
| Salem | 2,26,70,80,000 | 5,02,29,900 | 70,57,960 | 1,17,22,500 | 1,45,200 | 3,00,800 |
| Dharmapuri | 8,71,72,000 | 2,28,77,750 | 11,38,860 | 3,18,55,500 | 2,93,700 | 14,08,800 |
| Coimbatore | 39,80,12,000 | 6,98,53,000 | 7,48,85,720 | 1,60,83,000 | 1,78,200 | 8,62,400 |
| Tiruchirapalli | 69,38,23,000 | 4,64,69,500 | 70,83,440 | 60,70,500 | 6,20,400 | 1,90,400 |
| Thanjavur | 2,12,99,19,000 | 2,03,07,350 | 2,93,020 | 16,11,000 | 97,350 | 1,600 |
| Madurai | 40,35,03,000 | 3,71,81,550 | 1,74,41,060 | 79,29,000 | 1,08,900 | 3,71,200 |
| Ramanathapuram | 34,41,09,000 | 1,50,41,600 | 2,37,47,360 | 1,06,69,500 | 77,550 | 72,800 |
| Tirunelveli | 45,43,09,000 | 63,66,500 | 2,55,24,590 | 77,85,000 | 49,500 | 7,52,400 |
| The Nilgiris | 81,89,000 | - | - | 5,62,500 | - | - |
| Kanyakumari | 22,02,29,000 | 11,42,400 | - | 9,000 | 8,250 | 29,700 |

Source: Season and Crop Report of Tamil Nadu, 1968-69 and Review of work done on Water Requirements of Crops in India by Dastane, Singh, Hukkeri and Vamadevan 1970.

**Appendix No.** 20

**Productivity Per Unit of Water (1968-1969) [1]**

| Districts | Rice | Ragi | Red-gram | Horse-gram | Groundnut | Cotton |
|---|---|---|---|---|---|---|
| Chingleput | 0.49 | 2.11 | 3.16 | 2.56 | 1.82 | 0.50 |
| South Arcot | 0.92 | 2.33 | 3.26 | 2.66 | 1.82 | 0.39 |
| North Arcot | 0.64 | 2.22 | 3.22 | 2.66 | 1.46 | 0.38 |
| Salem | 0.91 | 2.00 | 2.79 | 2.70 | 1.49 | 0.35 |
| Dharmapuri | 0.58 | 1.89 | 2.76 | 2.70 | 1.49 | 0.35 |
| Coimbatore | 1.23 | 2.78 | 2.22 | 2.56 | 1.64 | 0.46 |
| Tiruchirapalli | 0.88 | 1.96 | 2.27 | 2.66 | 1.85 | 0.41 |
| Thanjavur | 0.94 | 2.22 | 2.65 | 2.64 | 1.85 | 0.65 |
| Madurai | 0.76 | 2.56 | 2.22 | 2.59 | 1.78 | 0.24 |
| Ramanathapuram | 0.36 | 1.82 | 2.37 | 2.53 | 1.66 | 0.14 |
| Tirunelveli | 0.90 | 3.22 | 2.37 | 2.59 | 1.66 | 0.14 |
| The Nilgiris | 0.76 | 1.58 | 2.37 | 2.64 | 1.33 | - |
| Kanyakumari | 1.06 | 1.58 | 2.34 | 2.66 | 1.33 | - |

[1] This has been calculated by dividing the yield per hectare by mean requirements of water for crops. Hence these are highly approximate.

Source:- Season & Crop Report 1968-69 & Review of the work done on water requirements of Crops in India by Dastane, Singh, Hukkeri & Vamadevan 1970.

## Appendix No. 21

### Per Acre Value of Water 1966-67

| Districts | Total cropped area (in hectares) | Total irrigation expenditure (in rupees) | Per acre value of water (in rupees) |
|---|---|---|---|
| Chingleput | 471,820 | 28,25,790 | 5.99 |
| South Arcot | 702,160 | 52,45,547 | 7.47 |
| North Arcot | 696,667 | 20,89,060 | 2.99 |
| Salem | 487,428 | 10,15,407 | 2.08 |
| Dharmapuri | 454.767 | 24,42,842 | 5.37 |
| Coimbatore | 848,687 | 36,23,907 | 4.28 |
| Tiruchirapalli | 834,697 | 36,65,271 | 4.39 |
| Thanjavur | 794.822 | 70,83,498 | 8.91 |
| Madurai | 642,337 | 67,17,995 | 10.45 |
| Ramanathapuram | 658,174 | 8,23,360 | 1.25 |
| Tirunelveli | 550,473 | 38,29,861 | 7.14 |
| Kanyakumari | 51,045 | 96,88,658 | 8.67 |
| The Nilgiris | 111,696 | - | - |

Source:- Annual Statistical Abstract for Tamil Nadu 1966-67
Govt. of Tamil Nadu 1971.

## Appendix No. 22

### Water Spread in Tamil Nadu

| Districts | Water spread [1] sq. miles. |
|---|---|
| Chingleput | 693.67 |
| S. Arcot | 2444.39 |
| N. Arcot | 1057.03 |
| Salem | 264.25 |
| Dharmapuri | 99.09 |
| Coimbatore | 2312.25 |
| Tiruchirapalli | 1321.29 |
| Thanjavur | 6375.20 |
| Madurai | 198.19 |
| Ramanathapuram | 66.06 |
| Tirunelveli | 1387.35 |
| The Nilgiris | - |
| Kanyakumari | 561.54 |

[1] The above figures are planimetered figures from the Irrigation Atlas of India 1972.

## Appendix No. 23

Standard Yield in 1968-69 of the Principal Crops in each District of Tamil Nadu.

| Districts | Rice | Wheat | Cholam | Cumbu | Barley | Maize | Ragi | Korra | Varagu | Samai | Other Cereals |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Chingleput | 925 | - | 600 | 500 | - | 1064 | 950 | 855 | 855 | 532 | 532 |
| South Arcot | 1740 | - | 700 | 720 | - | 1030 | 1050 | 1030 | 1343 | 515 | 515 |
| North Arcot | 1223 | 371 | 700 | 450 | - | 1064 | 1000 | 960 | 1064 | 532 | 532 |
| Salem | 1737 | 367 | 700 | 590 | - | 1053 | 900 | 743 | 630 | 423 | 526 |
| Dharmapuri | 1105 | 367 | 800 | 500 | - | 1053 | 850 | 743 | 630 | 423 | 526 |
| Coimbatore | 2344 | 355 | 650 | 670 | - | 1019 | 1250 | 719 | 1019 | 410 | 510 |
| Tiruchirapalli | 1671 | - | 600 | 670 | - | 1053 | 880 | 743 | 4053 | 526 | 526 |
| Thanjavur | 1786 | - | 1000 | 670 | - | 1053 | 1000 | 743 | 949 | - | 526 |
| Madurai | 1447 | 374 | 800 | 730 | - | 1075 | 1150 | 643 | 970 | 538 | 538 |
| Ramanathapuram | 687 | - | 600 | 450 | - | 1030 | 820 | 616 | 929 | 515 | 515 |
| Tirunelveli | 1701 | - | 990 | 650 | - | 1053 | 1450 | 526 | 949 | 423 | 526 |
| The Nilgiris | 1444 | 371 | 600 | 650 | 96 | 1064 | 710 | 538 | - | 637 | 532 |
| Kanyakumari | 2018 | - | 800 | 650 | - | - | 710 | - | - | - | - |
| State | 1502 | 371 | 700 | 629 | 96 | 1053 | 972 | 737 | 1029 | 468 | 526 |

Appendix No.2.3 (Contd.)

| Districts | Green gram | Bengal gram | Red gram | Black gram | Horse gram | Other Pulses | Sugar-cane | Chillies | Pepper | Ginger | Potatoes |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Chinglepút | 269 | – | 521 | 260 | 205 | 186 | 69.79 | 1109 | – | – | – |
| South Arcot | 272 | 526 | 538 | 272 | 213 | 243 | 88.22 | 1636 | – | – | – |
| North Arcot | 272 | 521 | 532 | 269 | 213 | 194 | 69.79 | 1053 | – | – | – |
| Salem | 274 | 532 | 461 | 333 | 216 | 216 | 70.02 | 1838 | 202 | 768 | – |
| Dharmapuri | 274 | 532 | 456 | 333 | 216 | 216 | 70.02 | 1838 | – | 768 | 6987 |
| Coimbatore | 186 | 515 | 367 | 298 | 205 | 205 | 89.68 | 1818 | – | – | – |
| Tiruchirapalli | 378 | 526 | 374 | 330 | 213 | 155 | 87.76 | 1795 | – | – | – |
| Thanjavur | 211 | 526 | 437 | 211 | 211 | 288 | 87.76 | 864 | – | 768 | – |
| Madurai | 235 | 521 | 367 | 320 | 207 | 188 | 81.99 | 1757 | 202 | 768 | 6561 |
| Ramanathapuram | 285 | 510 | 391 | 470 | 202 | 184 | 81.99 | 918 | – | – | – |
| Tirunelveli | 291 | 526 | 391 | 423 | 207 | 188 | 81.64 | 1134 | 202 | – | 8703 |
| The Nilgiris | – | 526 | 391 | – | 211 | 291 | – | 1959 | – | 768 | 7065 |
| Kanyakumari | 295 | – | 386 | 437 | 213 | 194 | 81.64 | 1086 | 204 | 752 | – |
| State | 234 | 515 | 457 | 304 | 209 | 202 | 81.27 | 1346 | 204 | 776 | 6808 |

Appendix No. 23 (Contd.)

| Districts | Onions | Tapioca | Cotton | Mesla | Gingelly | Castor | Tobacco | Indigo | Groundnut | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Irrigated | Unirrigated | |
| Chingleput | 9384 | 12730 | 318 | 798 | 295 | 269 | - | - | 1347 | 812 | 1080 |
| South Arcot | 16138 | 7566 | 247 | 798 | 298 | 272 | 1150 | - | 1347 | 812 | 1080 |
| North Arcot | 9244 | 9898 | 239 | 798 | 289 | 272 | 1507 | 29 | 961 | 781 | 871 |
| Salem | 10762 | 9797 | 220 | 815 | 298 | 435 | 931 | - | 961 | 806 | 884 |
| Dharmapuri | 10762 | 9797 | 224 | 798 | 298 | 435 | 931 | - | 961 | 806 | 884 |
| Coimbatore | 11839 | 9494 | 291 | 798 | 289 | 417 | 1546 | - | 961 | 990 | 976 |
| Tiruchirapalli | 10537 | 9696 | 252 | 798 | 301 | 435 | 1250 | - | 1474 | 729 | 1102 |
| Thanjavur | 8074 | 9898 | 414 | - | 308 | 435 | 1098 | - | 1474 | 729 | 1102 |
| Madurai | 15633 | 9595 | 150 | 798 | 298 | 426 | 1226 | - | 1474 | 648 | 1061 |
| Ramanathapuram | 6124 | 9494 | 98 | - | 295 | 426 | 1187 | 28 | 1283 | 686 | 985 |
| Tirunelveli | 11590 | 9595 | 89 | 798 | 298 | 421 | 1141 | 28 | 1283 | 686 | 985 |
| The Nilgiris | 3158 | 8051 | - | - | - | - | 1166 | - | - | 793 | 793 |
| Kanyakumari | - | - | - | - | 301 | - | - | - | - | 793 | 793 |
| State | - | 9720 | 163 | 798 | 313 | 415 | 1425 | 28 | 12165 | 793 | 1029 |

Source: Season and Crop Report of Tamil Nadu, 1968-69.

## Appendix No. 24

### Rainfall Index: - Rural Population Density (1961)

| Rainfall index | Rural population density | Districts in which rural population density is less than 300 | Districts in which rural population density is more than 300 |
|---|---|---|---|
| Districts with less than 27" of rainfall | | 4 | 2 |
| Districts with more than 27" of rainfall | | 2 | 5 |

$$x^2 = \frac{[(4x5) - (2x2)]^2 \, 13}{(7x6) \quad (7x6)}$$

$$x^2 = \underline{1.3}$$

## Appendix No. 24

**Water Resource Index:- Rural Population Density (1961)**

| Weighted water resource Index | Rural Population Density (1961) | Districts in which the rural population density is less than 300 | Districts in which the rural population density is more than 300 |
|---|---|---|---|
| Districts with less than 1000 index | | 4 | 2 |
| Districts with more than 1000 index | | 2 | 5 |

$$x^2 = \frac{[(4x5) - (2x2)]^2\ 13}{(7x6)\quad(7x6)}$$

$$x^2 = \underline{1.3}$$

## Appendix No. 24

**Rainfall index:- Rural Population Growth Rate (1961-71)**

| Rainfall index | Rural population growth rate (1961-71) | Districts in which rural population growth rate was less than 17% | Districts in which rural population growth rate was 17% or more than that |
|---|---|---|---|
| Districts with less than 27" of rainfall | | 3 | 3 |
| Districts with 27" or more rainfall | | 4 | 3 |

$$x^2 = \frac{[(3x3) - (4x3)]^2\ 13}{(7x6)\ \ (7x6)}$$

$$x^2 = \underline{0.07}$$

Appendix No.24

**Water Resource Index:- Rural Population Growth Rate (1961-71)**

| Weighted water resource index / Rural Population growth rate 1961-71 | Districts in which rural population growth rate is less than 17% | Districts in which rural population growth rate is 17% or more than that |
|---|---|---|
| Districts with less than 1000 index | 4 | 2 |
| Districts with more than 1000 index | 3 | 4 |

$$x^2 = \frac{[(4x4) - (3x2)]^2 \, 13}{(7x6) \quad (7x6)}$$

$$x^2 = \underline{0.73}$$

## Appendix No. 24

**Rainfall Index :- Proportion of acreage under rice to total acreage under rice crops (1968-69)**

| Rainfall Index | Ratio of rice acreage to total acreage under crops | Districts in which acreage under rice was less than 25% of total acreage under crops | Districts in which acreage under rice was 25% or more of total acreage under crops |
|---|---|---|---|
| Districts with less than 27" of rainfall | | 4 | 3 |
| Districts with more than 27" or more rainfall | | 4 | 2 |

$$x^2 = \frac{[(4x2) - (4x3)]^2\ 13}{(7x6) \quad (8x5)}$$

$$x^2 = \underline{0.12}$$

## Appendix No. 24

**Water Resource Index :- Proportion of acreage under rice to total acreage under crops (1968-69)**

| Weighted water resource Index | Ratio of rice acreage to total acreage under crops | Districts in which acreage under rice was less than 25% of total acreage under crops | Districts in which acreage under rice was 25% or more of total acreage under crops |
|---|---|---|---|
| Districts with less than 1000 index | | 2 | 4 |
| Districts with more than 1000 index | | 5 | 2 |

$$x^2 = \frac{[(2x2) - (4x5)]^2 \, 13}{(7x6) \quad (7x6)}$$

$$x^2 = \underline{1.88}$$

## Appendix No. 24

**Rainfall Index:- Proportion of acreage under rice & groundnut to total acreage under crops (1968-69)**

| Rainfall Index | Ratio of rice & groundnut acreage to total acreage under crops | Districts in which acreage under rice & groundnut are less than 40% of total acreage under crops | Districts in which acreage under rice & groundnut are more than 40% of total acreage under crops |
|---|---|---|---|
| Districts with less than 27" of rainfall | | 2 | 4 |
| Districts with more than 27" of rainfall | | 4 | 3 |

$$X^2 = \frac{[(2x3) - (4x4)]^2 \; 13}{(6x7)\;(7x6)}$$

$$X^2 = \underline{0.7}$$

## Appendix No. 24

**Water Resource Index:- Proportion of acreage under rice & groundnut to total acreage under crops (1968-69)**

| Weighted water resource index | Ratio of rice & groundnut acreage to total acreage under crops | Districts in which acreage under rice & groundnut are less than 40% of total acreage under crops | Districts in which acreage under rice & groundnut are 40% or more of total acreage under crops |
|---|---|---|---|
| Districts with less than 1000 index | | 5 | 1 |
| Districts with more than 1000 index | | 2 | 5 |

$$x^2 = \frac{[(5x5) - (2x1)]^2\, 13}{(6x7)\ (7x6)}$$

$$x^2 = \underline{3.89}$$

## Appendix No. 24

**Rainfall index:- Proportion of cultivation holdings of over 15 acres to total cultivation holdings (1961)**

| Rainfall index | Proportion of cultivation holdings of over 15 acres to total cultivation holdings | Districts in which the proportion of cultivation holdings of over 15 acres are less than 2.9% | Districts in which the proportion of cultivation holdings of over 15 acres are more than 2.9% |
|---|---|---|---|
| Districts with less than 27" of rainfall | | 2 | 4 |
| Districts with more than 27" of rainfall | | 4 | 2 |

$$X^2 = \frac{[(4x4) - (2x2)]^2 \; 12^*}{(6x6) \; (6x6)}$$

$$X^2 = \underline{1.3}$$

*The Dharmapuri District is not included.

## Appendix No. 24

**Water Resource Index:- Proportion of Cultivation holdings of over 15 acres to total cultivation holdings (1961)**

| Weighted water resource index | Proportion of cultivation holdings of over 15 acres to total cultivation holdings | Districts in which the proportion of cultivation holdings of over 15 acres to total cultivated holdings are less than 2.9% | Districts in which the proportion of cultivation holdings of over 15 acres to total cultivated holdings are more than 2.9% |
|---|---|---|---|
| Districts with less than 1000 index | | 2 | 4 |
| Districts with more than 1000 index | | 3 | 3 |

$$X^2 = \frac{[(2x3) - (3x4)]^2 \; 12*}{(6x6) \; (5x7)}$$

$$X^2 = \underline{0.3}$$

* The district, Dharmapuri is not included.

## Appendix No. 24

**Rainfall index:- Proportion of Agricultural Workers to total workers (1971)**

| Rainfall index | Ratio of agricultural workers to total workers (1971) | Districts in which the proportion of agricultural workers to total workers are less than 63% | Districts in which the proportion of agricultural workers to total workers are more than 63% |
|---|---|---|---|
| Districts with less than 27" of rainfall | | 2 | 4 |
| Districts with more than 27" of rainfall | | 4 | 3 |

$$x^2 = \frac{[(4x4) - (3x2)]^2 \, 13}{(7x6)\ (7x6)}$$

$$x^2 = \underline{0.7}$$

## Appendix No. 24

**Water Resource Index:- Proportion of Agricultural Workers to total workers (1971)**

| Weighted water resource index | Ratio of agricultural workers to total workers | Districts in which the proportion of Agricultural workers to total workers are less than 63% | Districts in which the proportion of Agricultural workers to total workers are more than 63% |
|---|---|---|---|
| Districts with less than 1000 index | | 4 | 2 |
| Districts with more than 1000 index | | 2 | 5 |

$$x^2 = \frac{[(4x5) - (2x2)]^2 \, 13}{(7x6) \ (7x6)}$$

$$x^2 = \underline{2.5}$$

## Appendix No. 24

**Rainfall Index:- Proportion of Pure & Mixed Tenancy Holdings to total cultivation holdings (1961)**

| Rainfall Index | Ratio of pure & mixed tenancy holdings (1961) | Districts in which proportion of pure & mixed tenancy holdings to total holdings are less than 91% | Districts in which proportion of pure & mixed tenancy holdings to total holdings are more than 91% |
|---|---|---|---|
| Districts with less than 27" of rainfall | | 2 | 4 |
| Districts with more than 27" of rainfall | | 4 | 2 |

$$X^2 = \frac{[(4x4) - (2x2)]^2 \; 12^*}{(6x6) \; (6x6)}$$

$$X^2 = \underline{1.3}$$

*Dharmapuri district is not included.

## Appendix No. 24

**Water Resource Index:- Proportion of Pure & Mixed Tenancy Holdings to total cultivation holdings (1961)**

| Water resource index | Ratio of pure & mixed tenancy holdings | Districts in which proportion of pure & mixed tenancy holdings to total holdings are less than 91% | Districts in which proportion of pure & mixed tenancy holdings to total holdings are more than 91% |
|---|---|---|---|
| Districts with less than 1000 index | | 3 | 2 |
| Districts with more than 1000 index | | 3 | 4 |

$$X^2 = \frac{[(3x4)\ \ (3x2)^2\ 12^*}{(6x6)\ \ (6x6)}$$

$$X^2 = \underline{0.03}$$

*Dharmapuri district is excluded.