

## **Delineation of Agro Ecological Zones of Tamil Nadu**

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**Abstract:** Tamil Nadu state has 13 million hectare total geographical area with 6 broad land forms. National Bureau of Soil Survey and Land Use Planning, Bangalore identified six soil orders and mapped into 285 mapping units as association of soil families. Rainfall and its distribution varies largely across the regions. Major part of the state receives rainfall from north-east monsoon. The rainfall data of 120 locations was used to arrive at the LGP map of the state. Based on the moisture index, major part of the state comes under semi- arid (dry/moist), coastal tracts of the state (sub-humid) and hilly areas are classified as per-humid. Based on variability of soils and LGP, 17 Agro-Ecological Zones (AEZ) is delineated matching to the taluk boundary in six physiographic regions. The LGP map so prepared was validated by different research stations of TNAU spread over the state. In Nilgiris region LGP varied from 210 to 270 days and the dominant soils are deep to very deep red clayey soils. In South Sahyadri, crop growing period is greater than 270 days and dominant soils are deep to very deep red clayey soils. In Eastern ghats area, LGP is 150 to 180 days with pre-dominantly medium deep red gravelly clay and shallow red loamy soils. In Tamilnadu uplands LGP varied from <90 days to 180 days with pre-dominantly shallow to moderately deep gravelly loam and gravelly clay soils. LGP varied from <90 days to 270 days in Tamilnadu plains and the dominant soils are deep, calcareous black and alluvial clay or loamy soils in riverine landform, deep to very deep gravelly clay in lateritic landform and sandy soils in marine landform.

**Additional key words:** *Bio-climate, landforms, length of growing period, agro-ecological zone*

### **Introduction**

Ever increasing need for food to support growing population necessitates a systematic appraisal of soil and climatic resources for effective land use plan. Crop production in semi- arid regions is largely determined by high evaporative demand during most of the growing season, variations in time and distribution of rainfall are key factors that influence agricultural potential of the region. FAO (1976, 1978) developed the concept of agro-ecological zone with strong emphasis on comparable agro-climatic parameters to delineate agriculturally potential areas suitable for particular crop/genotype so that optimum production potential of the crop/genotype is achieved. This kind of systematic approach may help the

country/state in planning and optimizing land use and preserving soils and environment. Efficient crop planning, therefore, requires proper understanding of agro-climatic conditions. The agro-ecological zoning and resources appraisal linked to GIS have now greatly enhanced the capability to develop alternative land use plan scenarios, management and decision support systems (Velayutham *et al.* 1999). This calls for collection, collation, analysis and interpretation of long-term weather parameters and soils of each region to identify the length of the possible cropping period. Tamil Nadu state has total geographical area of 13 M ha with 31 administrative districts and 162 taluks and exhibit a variety of land scapes and climatic conditions those are reflected in the development of different soils and vegetation.

Tamil Nadu Agricultural University (TNAU) has delineated seven agro-climatic zones (National Agricultural Research Project Zones) in state in late 70s and has been using each zone as one unit for generation and transfer of agro-technologies. Since last four decades package of practices are being recommended to farmers uniformly in each NARP zone. Each NARP zone covers 2-7 districts partly or fully with wide variation in rainfall, length of growing period (LGP) and soils. Hence, there is a limitation in recommending crops and varieties uniformly across the districts and within the NARP zone indicating the need to demarcate areas having similar LGP within the district or zone for site-specific crops and varietal recommendation. However, Mandal *et al.* (1999) attempted to delineate agro-ecological zones of the state using soil information (1: 250,000) and 28 agro meteorological stations data. They demarcated about 16 agro-ecological zones (AEZ's), wherein, the LGP assessment was either less or over estimated. This necessitated re-assessment of LGP and to delineate agro-ecological zones by using more number of rain gauge stations. This paper details the process of integrating soil, landform and climate to delineate agro-ecological zones of Tamil Nadu for better use of natural resources and agro-technology transfer.

### Materials and Methods

Long term weekly rainfall data of 120 locations representing different parts of the state were collected from IMD, Pune. Water balance for each station was calculated using Thornthwaite and Mather (1955). Soil information generated on 1:250,000 scale for the state (Natarajan *et al.* 1997) has been used as a baseline information to use available water supply of soils. For assessing the Length of Growing Period (LGP) FAO model was used (Higgins and Kassam 1981). LGP starts when rainfall exceeds 50 per cent potential evapo-transpiration (PET) and meets crop requirements of different stages till soil moisture storage meets 25 per cent of PET coinciding with the grain maturity and harvesting stage. The prevailing types of crop growing seasons across the state were characterized (Nachtergaele and Pauw 1985).

Length of growing period depends on duration of rainy season and moisture retentive characteristics of soil. Using weekly rainfall, PET and soil available water capacity, LGP was assessed. LGP map was super imposed on landform map of the state to delineate Agro-ecological Zones matching to the taluk boundary for administrative/operational convenience. The LGP map so generated was sent to 29 Agricultural Research stations of Tamil Nadu Agricultural University (TNAU) for ground truth validation.

### Results and Discussions

#### Landforms

The major landforms identified in the state are Nilgiris, South Sahyadri, Eastern Ghats, Tamil Nadu Uplands, Inland plains and Coastal plains (Fig.4). These 6 broad physiographic regions are considered as base to differentiate soils and land uses.

#### Rainfall

In Tamil Nadu, analysis of rainfall distribution pattern showed large regional variation (Table 1). Lowest mean annual rainfall (357 mm) is received in Annur (Coimbatore district) and highest (3150 mm) in Devala (Nilgiris district). The districts namely Chennai, Kancheepuram, Vellore, Thiruvanamali, Dharmapuri, Salem and Coimbatore receive rainfall from both South west (SW) and North east (NE) monsoon seasons indicating bi-modal distribution. The proportion of distribution of annual rainfall during different seasons are 15 %, 38.7 % and 46.5 % respectively during pre, SW, NE monsoon seasons. Southern districts namely Dindigal, Nagapattinam, Thanjavur, Pudukottai, Shivganaga, Madurai, Ramanathapuram, Virudhanagar, Tuticorin and Thirunalveli receive rainfall from pre-dominantly from North-east monsoon season (uni-model distribution). The proportion of rainfall distribution varied *i.e.* 23.4 %, 21.3 % and 55.3 % respectively during Pre-monsoon, SW, NE monsoon seasons. Kanniyakumari and Nilgiris districts receive well distributed rainfall during three seasons *i.e.* pre-monsoon (24.3 %), SW-monsoon (41.6 %) and NE-

monsoon seasons (34.3 %). On the whole, Tuticorin district receives lowest rainfall (661 mm) and Kanniyakumari district receives highest amount of rainfall (1423 mm) in the state.

**Table 1.** Rainfall distribution in different districts of Tamil Nadu

District	Pre-Monsoon (mm)	SW-Monsoon	NE-Monsoon	Annual (mm)	PET (mm)
	Jan. - May	June – Sept.	Oct. – Dec.		
Chennai	191.2(8.4)	408.9(33.3)	727.9(59.2)	1228.0	2007.3
Kancheepuram	97.1(8.3)	426.8(36.6)	643.2(55.1)	1167.1	
Vellore	115.7(12.2)	452.5(47.6)	381.6(40.2)	949.8	1686.1
Thiruvannamalai	135.2(12.7)	468.0(43.9)	462.1(43.4)	1065.3	1686.1
Dharmapuri	1774.7(20.5)	369.4(43.3)	308.8(36.2)	852.9	
Salem	178.6(21.0)	352.8(41.4)	320.5(37.6)	851.9	1728.0
Villupuram	132.1(11.8)	391.2(34.9)	596.5(53.3)	1119.8	
Erode	164.2(24.7)	190.5(28.6)	311.3(46.7)	666.0	1728.0
Tiruchirapalli	145.9(18.0)	265.1(32.7)	399.1(49.3)	810.1	
Nilgiris	305.5(23.5)	594.7(45.8)	399.6(30.7)	1300.0	1176.6
Coimbatore	197.0(17.5)	578.7(51.2)	353.9(31.3)	1129.6	1622.2
Dindigal	207.6(22.7)	267.2(29.2)	439.5(48.1)	914.3	
Nagapattinam	168.0(13.4)	281.9(22.5)	803.7(64.1)	1253.6	1776.0
Thanjavur	158.8(15.1)	331.6(31.5)	562.4(53.4)	1052.8	1776.0
Pudukottai	161.9(18.1)	337.3(37.7)	396.0(44.2)	895.2	
Sivagangai	159.1(18.5)	297.1(34.5)	404.3(47.0)	860.5	
Madurai	174.9(21.4)	256.9(31.4)	385.7(47.2)	817.1	1683.6
Ramanathapuram	177.7(21.9)	133.8(16.5)	500.7(61.6)	812.2	
Virudhnagar	212.3(26.1)	171.8(21.1)	429.2(52.8)	813.3	
Tuticorin	163.3(24.7)	57.8(8.7)	440.5(66.6)	661.6	
Thirunalveli	238.1(27.9)	130.2(15.3)	485.3(56.8)	853.6	
Kanniyakumari	358.8(25.2)	533.0(37.5)	531.6(37.4)	1423.4	

Note: Values in parenthesis indicate per cent to annual rainfall

#### *Bio-Climat*

Based on the moisture index major part of the state has been classified under semi- arid (dry/moist). Coastal tracts of the state has sub-humid and hilly areas are classified as per- humid. Some pockets in southern plains qualify as arid.

#### *Potential evapotranspiration*

The atmospheric water demand (PET) is low in hilly tracts *i.e.* 1,135 to 1,177 mm in Coonur and Kodaikanal to as high as 2007 mm at Chennai. The PET demand in Tamil Nadu uplands vary between 1,683 to

1,728 mm and gradually increases to 2,007 mm in coastal region (Table 1).

#### *Characterization of different types of growing periods*

The rainfall distribution pattern indicated that there are four typical growing periods noticed across the state.

*Extended normal growing period:* Prolonged growing period is prevalent in Nilgiris district and hilly tracts of Tamil Nadu, where rainfall distribution is continuously favourable starting from Pre-monsoon (PRM), south west monsoon (SWM) and north east monsoon seasons (NEM). The crop growing period ranges from 210 to >270 days (Fig.2a).

*Extended normal growing period with mild intermediate break:* The long growing period occur in Kanyakumari district and parts of northern coastal plains where PRM and NEM are active with weak SWM during August/September months (bi-model distribution). Crop growing period vary from 180 to 270 days (Fig.2b).

*Normal growing period:* This kind of growing period occur in Tamil Nadu uplands and northern plains, where SWM is weak followed by active NEM season (Fig.2c). LGP in these tracts varies from 120 to 180 days.

*Short growing period:* It is prevalent in southern Tamil Nadu plains, where PRM and SWM are too weak followed by active NEM (Unimodal distribution) which contributes good amount of rainfall for growing rabi crops. In these tracts crop growing season ranges from <90 to 120 days (Fig 2d).

#### *Soils*

National Bureau of Soil Survey and Land Use Planning, Bangalore surveyed and mapped the state into 285 mapping units as association of soil families. These were further classified into six orders, 20 greatgroups, 44 subgroups and 94 soil families. 50 per cent area in the state is covered by Inceptisols, 30 per cent by Alfisols, 7 per cent by Vertisols, 6 per cent by Entisols, 1 per cent by Ultisols and very negligible area by Mollisols. These 285 units were re-interpreted into 29 soil types (Fig.1.)

#### *Agro-Ecological Zones*

The LGP (Fig.3) was super-imposed on land-form map of the state (Fig.4). The state has been demarcated into 17 Agro-Ecological Zones (Fig.5). The brief description of each zone with respect to geographical area showing taluk boundary, major soils and length of growing period and land use are discussed.

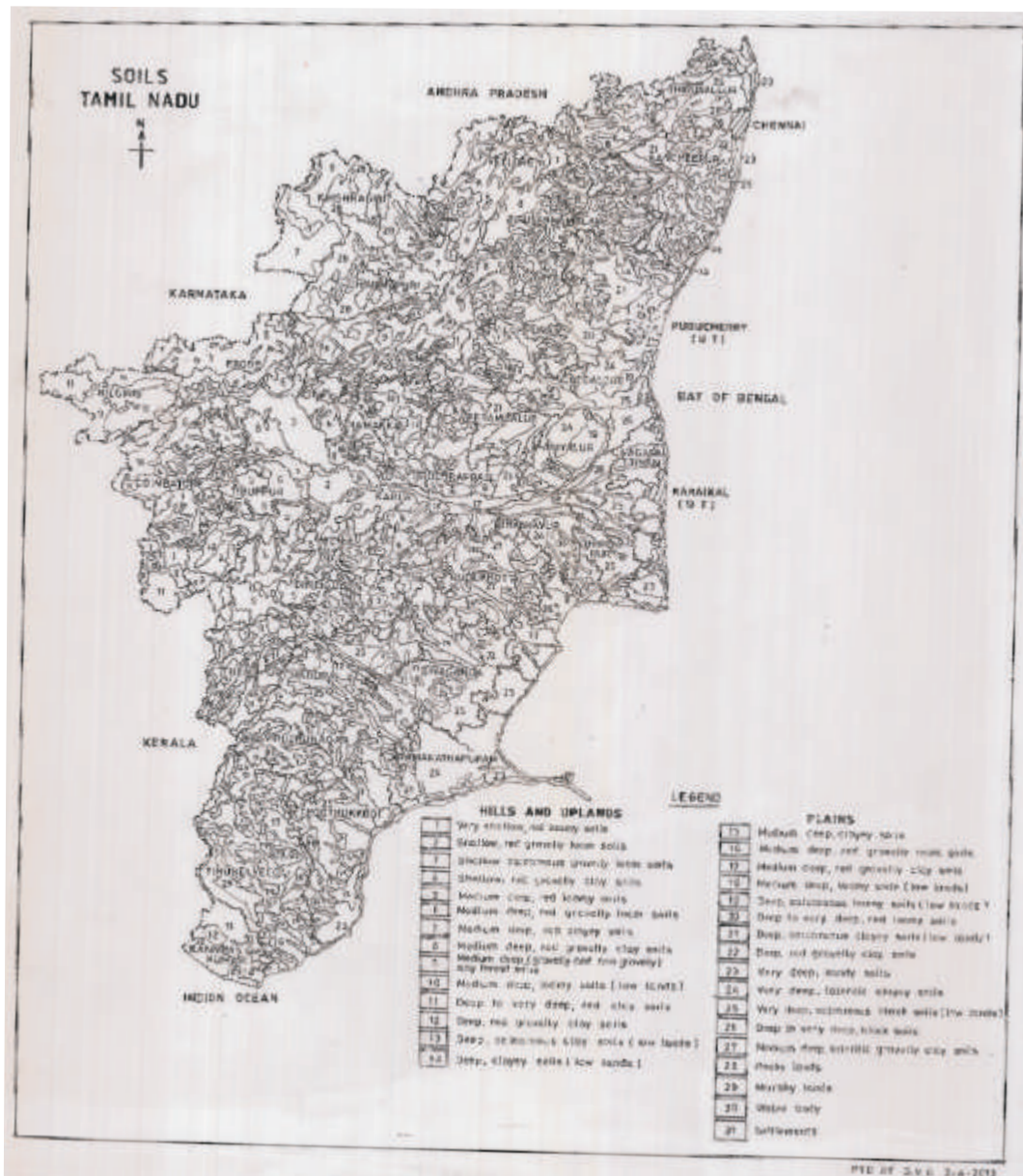


Fig 1. Soil map of Tamil Nadu



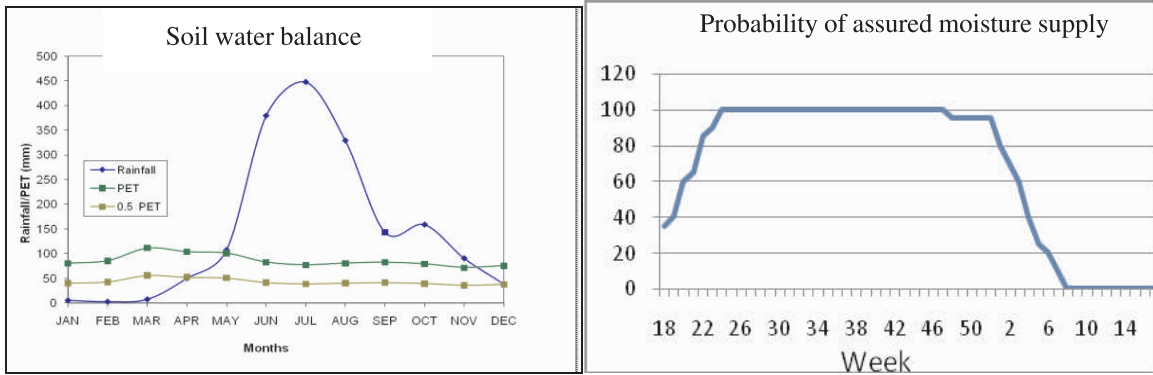


Fig. 2a . Extended normal growing period (Nandavattam, Nilgiris district, LGP : 240-270 days)

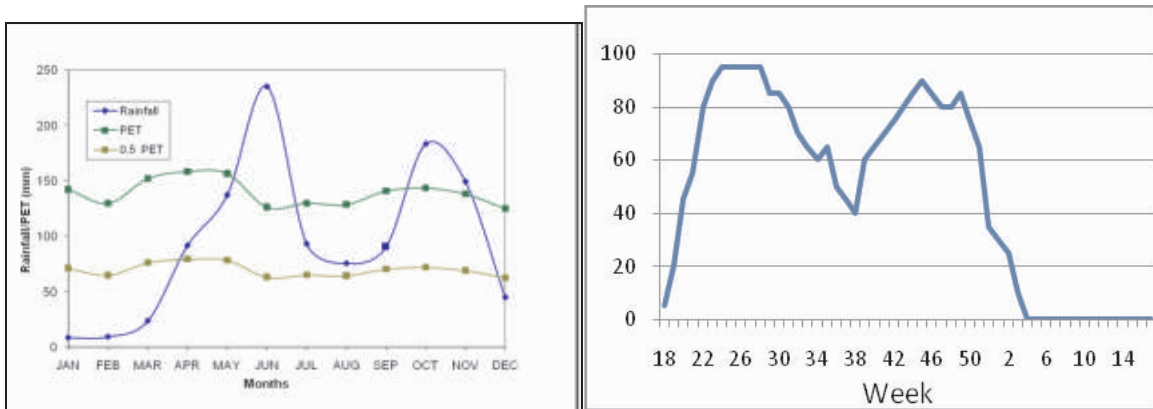


Fig. 2b. Extended growing period with intermediate break (Kuzhithurai, Kanyakumari district, LGP : 240-270)

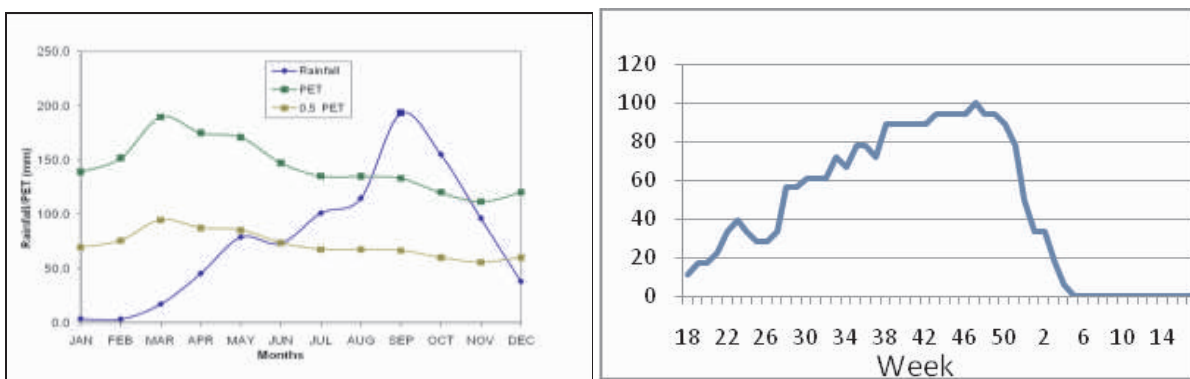


Fig. 2c. Normal growing season (Tamilnadu uplands/Northern plains - Salem, LGP : 150-180 days)

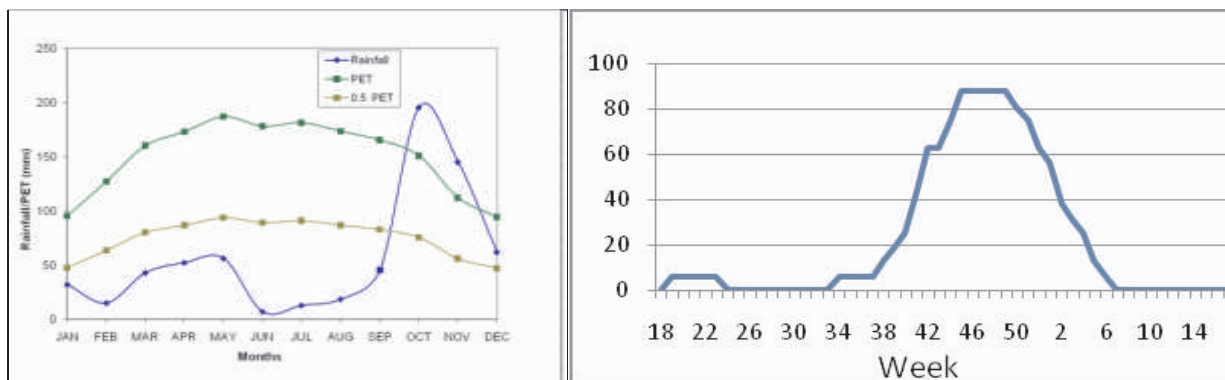


Fig. 2d. Short growing season (Tamilnadu - Southern plains - Ottapidaram, LGP : <90 days)

Fig. 2. Types of growing periods in Tamilnadu

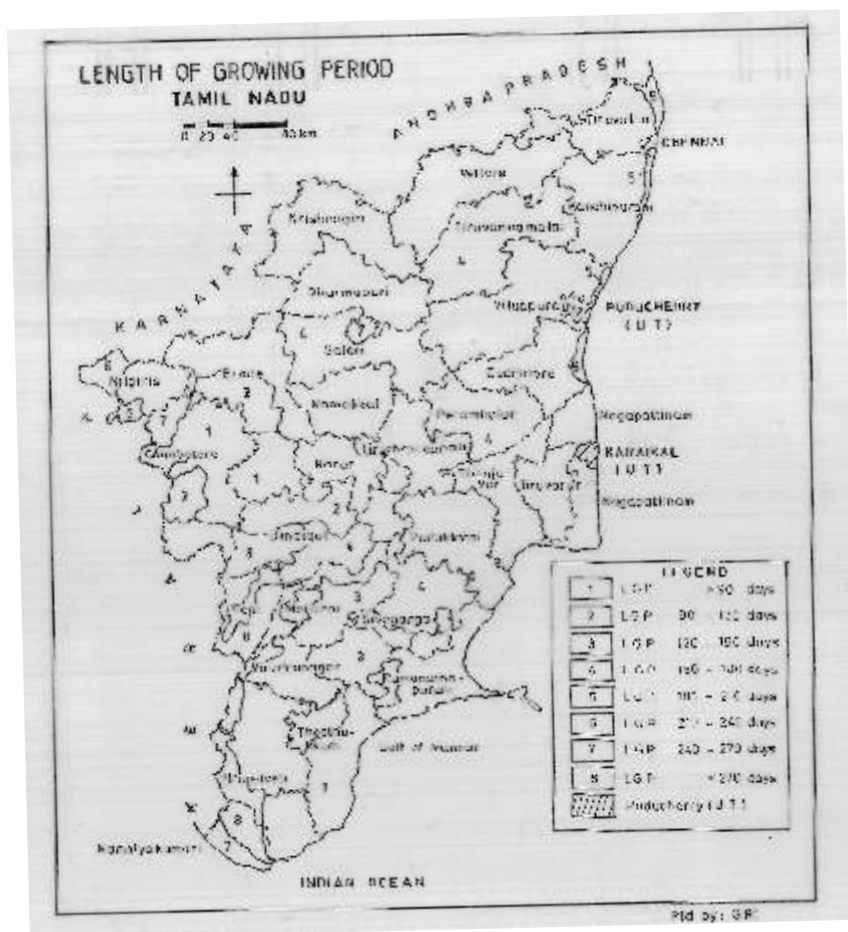


Fig 3. Length of Growing Period in Tamil Nadu





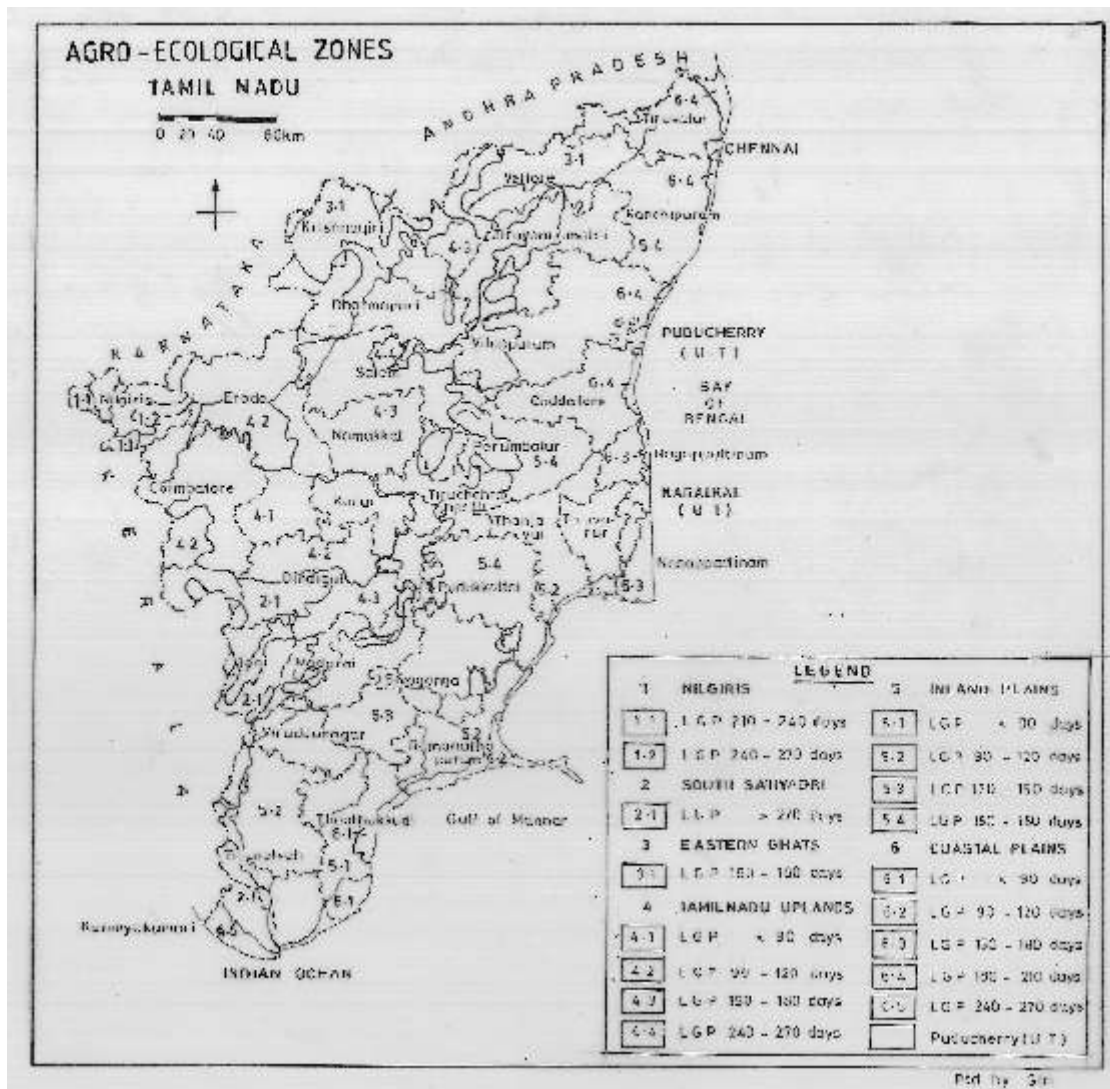


Fig 5. Agro-ecological Zones of Tamil Nadu

### *Agro-Ecological Zones*

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The 17 Agro-ecological Zones map generated was sent to 29 agricultural research stations spread over the state for revalidation. The suggestions received were incorporated in refining the boundaries. The final AEZ map was released in July, 2012. The agricultural research stations of Tamil Nadu Agricultural University have adopted the revised map for crop/variety recommendations in their zones.

The present study thus concludes that Tamil Nadu state has been demarcated into 17 agro-ecological zones based on rainfall data obtained from 120 locations, soils and broad physiographic regions. The LGP varied from less than 90 days in Tamil Nadu uplands and southern plains to 270 days in hilly tracts. In general, length of growing period decreased from north to south direction both in Tamil Nadu plains and uplands except Kanyakumari district. The revised map is now available in public domain for use by different agencies.

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