

CHAPTER III
LAND USE AND
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3.1 INTRODUCTION

Land is one of the most important natural resources on which all of man's activities are depended upon, and a thorough knowledge of it, which includes the land use / land cover is very much essential for a number of planning and management activities. The term "land use" (LU) relates to the human activity or economic function associated with a specific piece of land, whereas the term "land cover" (LC) relates to the type of feature present on the surface of the earth. However both the term 'land use' and 'land cover' are synonymous in the scientific community.

The land use / land cover is the result of permanent adjustment between the constraining properties of land and the socio economic attributes whereas the land utilization type defines the technical details about cultivation / form details. Therefore, in order to understand man and his interaction over the land the present chapter deals with the land use/ land cover and the associated properties of land utilization of the study area.

The Land Use / Land Cover of Tuticorin coast has been brought out in the present chapter. The study is based purely on remotely sensed data and field checks. The spatial land uses were classified based on NRSA (*National Remote Sensing Agency, 2003*) guidelines with slight modifications and derived 19 land use classes (Level III), suitable to the local condition. They are **Built-up lands** (Urban, Rural, and Industrial) **Agricultural lands** (Crop land: Kharif, Rabi and Double Cropped area, Fallow land, Energy/Commercial/Shelter Plantations), **Forests** (Scrub forest, Forest blanks), **Wastelands** (Land with Scrub, Land without Scrub, Salt affected land, Sandy area, Tidal flat, Swampy / Marshy and Reef area), **Water bodies** (Rivers/Streams/Tanks) and **Others** (Saltpan, Roads and Railways) in the Tuticorin coastal zone.

3.2 LAND USE CLASSIFICATION SYSTEM

The United States Geological Survey (USGS) devised a land use and land cover classification system to use in the remote sensing data in the mid 1970s

(Anderson et al., 1976). This classification system designed to use four “levels” of information could be drawn from aerial photos and satellite images, depending on the sensor system and image resolution. This classification system also provides more detailed land use/land cover categories in Levels III and IV. Levels I and II are principally of interest to users who desire to get information on a nationwide, interstate, or statewide basis. Levels III and IV can be utilized to provide information on regional (*district*), taluk, or local planning and management activities. In India, the National Remote Sensing Agency (NRSA) has developed a standard classification system for Indian conditions. It is adaptable for both visual and digital interpretation. The present study has adopted this classification system to bring out the various land use classes of the study area.

3.3 ROLE OF GIS IN LAND COVER CLASSIFICATION

The study follows the GIS based land use / land cover database employing remote sensing data. It is a hierarchical structure containing 19 different categories up to the level III and by assemblage of these, the land use/land cover classes are grouped into six major categories at level I. The information is derived manually by visual image interpretation. The hierarchical structure of the land use / land cover classes allows logical class aggregation, and hence abstract mapping. The classification system is extendable by adding classes to level two and three. This operational classification chain enables faster and more frequent update as well as improved class information. The derived land use / land cover classification system builds upon two different themes of datasets such as feature class and shape file (*.shp) format in the GIS environ.

3.4 LAND USE MAPPING

As mentioned earlier, the NRSA’s classification system has been adopted for the present study. The IRS-1D LISS III, FCC geocoded data (2003) have been used in obtaining land use / land cover details for the major seasons of the region viz, Kharif (*summer*) and Rabi (*winter*). By visual image interpretation, land use / land cover was classified into six classes: 1) Built-up lands 2) Agricultural Lands 3) Forests 4) Wastelands 5) Water bodies and 6) Others. They cover 4.6%, 48.6%, 30.7%, 6.8%, and 2.9% respectively.

A preliminary interpretation key is prepared and later finalized after a limited ground-verification. The image interpretation key is developed based on the spectral response of surface features observed on IRS-1D (LISS-III) FCC image with a band combination of 2, 3 & 4.

3.5 SPATIAL DISTRIBUTION OF LAND COVER OF THE STUDY AREA

In a combination of multi-spectral bands, three bands were used to derive land use classes, for which the ground data collected in the field were used as training samples. Supervised classification procedure was used to prepare present land use (*Figure 3.1*) using spectral classes. Table 3.1 shows the classes of present land use / land cover of the study area which is described below:

3.5.1 Built-up land

It is defined as an area of human habitation developed due to non-agricultural lands which cover buildings, industrial structures, transportation network, etc. The physical size or built-up sprawl with transport network can be a surrogate to classify a settlement as urban or rural. It is identifiable on the imagery by its dark bluish green to bluish tone, definite size, shape and texture. Often, built-up lands with high density of buildings appear in dark tone at the centre and lighter on the peripheries, because of being low dense and less developed.

3.5.1.1 Urban: The *Urban* centres in the study area are Tuticorin, Sayalkudi Kilakkarai, Tiruppulani, Mandapam and Rameswaram. They cover an area of 1994 ha which accounts for 1.3 per cent of the total area of the Tuticorin coastal zone.

3.5.1.2 Rural: The *Rural* settlements taken for the study are Muttayapuram, Kulathur, Vembar, Poosanor, Nedungulam, Soorangudi, Kila Arasai, Taruvaikkulam, Veppalodai, Vadanattam, Kuthiraimozhi, Mokkaiyur, Sayalkudi, Peiyakulam, Sikkal, Mariyur, Ervadi, Valinockam, Kalimankundu, Pudumadam, Raghunathapuram, Attangari, Rajasurimadai, Uttarkosaimangai, Pamban and Rameswaram. It covers an area of 3779 ha. It accounts for 2.5 per cent of the total area.

3.5.1.3 Industrial: A region in and around Muttayapuram is under industrial use which occupies an area of 1131ha or 0.8 per cent of the total study area.

Table 3.1. Tuticorin Coastal Zone: Area under various Land use Classes

Sl. No	Land use Classes			Area	
	Level 1	Level 2	Level 3	hectare	Percentage
1	Built up land	Urban		1914	1.3
2		Rural		3779	2.5
3		Industrial		1131	0.8
				6824	4.6
4	Agricultural lands	Crop land	<i>Kharif</i>	19582	13.2
5			<i>Rabi</i>	13741	9.2
6			<i>Double</i>	18670	12.5
7		Commercial / Energy / Shelter Plantations		17441	11.7
8		Fallow land		3002	2.0
				72436	48.6
9	Forests	Scurb Forest		8149	5.5
10		Forest blanks		1452	1.0
				9601	6.5
11	Wasteland	Land with scurb		19223	12.9
12		Land without scurb		16235	10.9
13		Salt affected area		2226	1.5
14		Sandy area		2083	1.4
15		Swampy/Marshy		2047	1.4
16		Tidal Flat		2757	1.9
17		Reef area		1040	0.7
				4511	30.7
18	Water bodies	River/streams/tanks		10054	6.8
19	Others	Salt pan		4339	2.9
	Total			148865	100.0

Compiled by author based on IRS 1D LISS III FCC Image, 2003

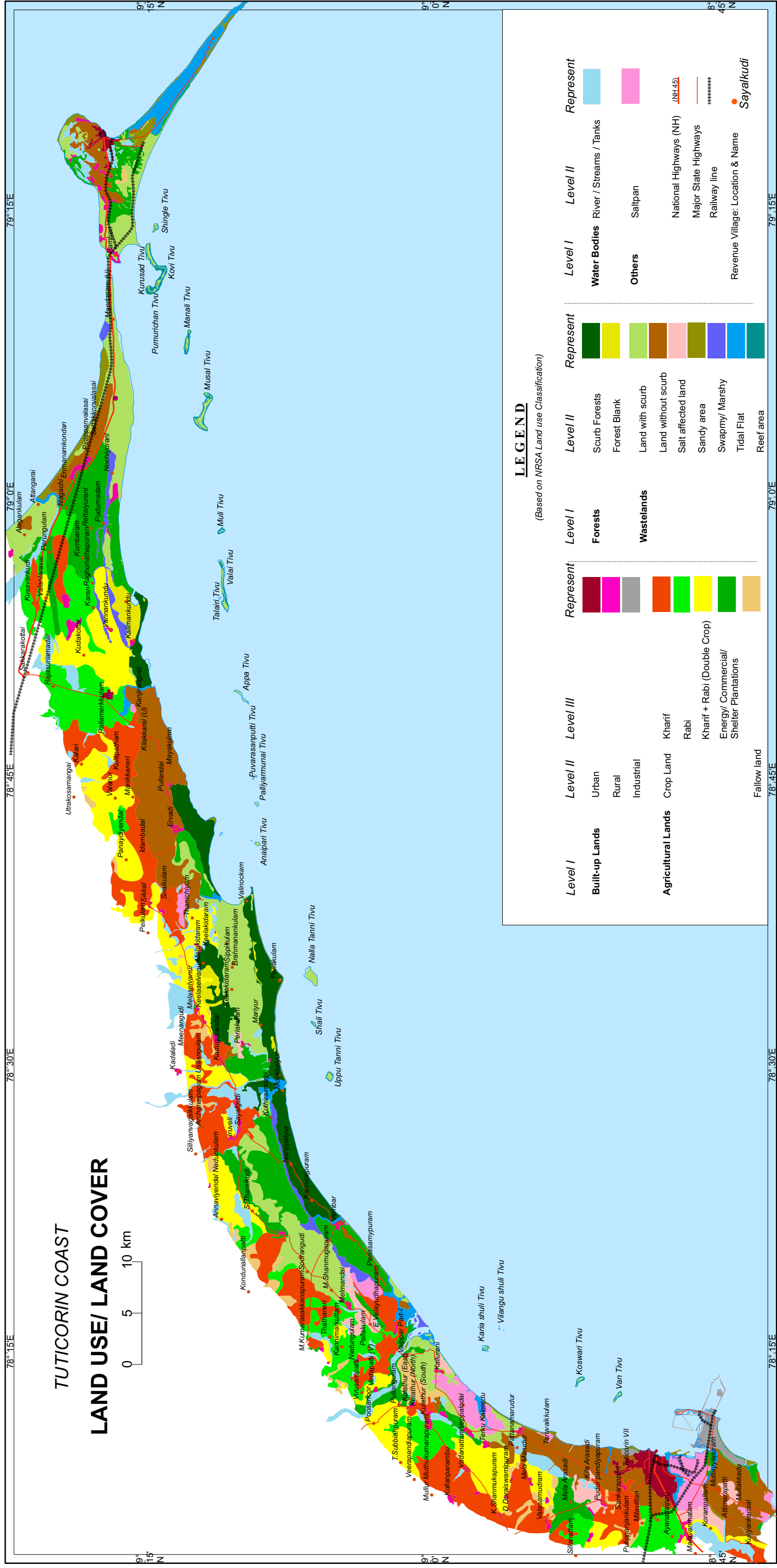


Fig. 3.1

3.5.2 Agricultural lands

It is defined as the land primarily used for farming and for production of food, fibre, commercial and horticultural crops. It includes the land under crops (*irrigated and rainfed*), fallow, plantations etc. It covers about 48.6 per cent of the total study area.

3.5.2.1 Crop land: It includes those lands with bearing crop as on the date of the satellite imagery. The crops may be of either Kharif or Rabi or both seasons. The tonal contrast of crop land varies from bright red to red tone which may signify the greenness of the foliage during different stages of crop growth, phenological condition (*healthy or infected*) besides the nature of soil (*moist or dry*) and the type of terrain. Its spatial extent varies in size and shape, with smooth texture (*when the crop is in full matured stage*) to coarse or mottled (*at the early stages of planning and growth*). It is contiguous under irrigated (*canal, tank, well etc.*) areas and non-contiguous in unirrigated or rainfed areas.

3.5.2.1.1 Kharif: The *Kharif* crops are dominant in Pullipanchankulam, Kulaiyankaraisal, K. Shanmugapuram, Kollamparambu, Mulur Muthukumarapuram, Virusampatti, M. Kumarasakkanpuram, Silliyavagaikulam, Meenangudi, Siraikulam, Sikkal, Kulapatham, Kalari, and Perungulam areas which cover an area of 19,582 ha or 13.2 per cent of the study area.

3.5.2.1.2 Rabi: Rabi crops are mainly distributed about 13741 ha (9.2 per cent) in Milavittan, Silanattam, Mulur-Muthukumarapuram, Kannimarkuttam, Thathaneri, Pallamorekulam, Karan, and Kosavankudi villages.

3.5.2.1.3 Double crop: The area devoted for cultivation both during kharif and rabi seasons come under double cropped area. Such areas are found in Maravanmadam, Pullipanchankulam, Melamarudur, D.Duraisamipuram, T. Subbiahpuram, Poosanoor, Thathaneri, Thangammalpuram. K., Annaviyendal Nedukulam, Melaselvanoor, Keelaselvanoor, Keelakidaram, Peikulam, Panaiyediendal, Valanoor, Kalarai, Tiruppullani, Kudakottai, Vannankundu, and Raghunathapuram. About 12.5 per cent of the study area is being devoted for double cropping which covers an area of 18,670 ha.

3.5.2.2 Plantations: It is described as an area under agricultural tree crops, planted adopting certain agricultural management techniques. It includes tea, coffee, rubber, coconut, areca nut, citrus, orchards, and other horticultural nurseries. These

appear dark red to red in tone, small in size with regular shapes, sharp and smooth edges. The difference in tone may indicate different types of plantations or same plantation in different stages of growth or foliage cover or due to seasons. However, as the area is under the coastal environment, the plantation like coconut, palm, banana, casurina, cashewnut and tamarind are predominant plantation crops. Altogether it covers an area of 17441ha which accounts for 11.7 per cent of the total cropped area. They are distributed in the areas of Maravanmadam, Terku Kalamedu, Kallurani, Mookkaiyur, Thanichyam, Kulapatham, Alagankulam, Dhanuskodi and some pockets of coastal tracts adjacent to the coast line.

3.5.2.3 Fallow land: It is also an agricultural land which is taken up for cultivation but is temporarily allowed to rest, un-cropped for one or more season, but not less than one year. These lands are particularly those which are devoid of crops during both seasons. It appears yellow to greenish blue in the image tone depending on the topography, nature of soil and moisture content of the ground. It appears light in tone in sandy red soils and in coastal soils, and dark in tone in alluvial/black cotton and in soils rich in clay. A total of 3002 ha area comes under fallow land which accounts for 2 per cent of the study area.

3.5.3 Forests

It is an area within notified forest boundary, predominantly with trees and other vegetation capable of producing timber and other forest produce. It occurs on uplands, coastal plains in association with forest trees and other vegetation. It is clearly identifiable from the imagery as it appears light red to red in tone in satellite images depending upon the foliage cover, stage of growth and season etc. There is no very distinct forest cover in the study area except a few patches of scrub forests and forest blanks.

3.5.3.1 Scrub Forest: An area of 8149 ha or 5.5 per cent of the study area is occupied with scrub forest and distributed over Kannairajapuram to Valinockam coastal stretch and Kadugusandai, Keelakidaram and Melakidaram areas.

3.5.3.2 Forest Blanks: Forest blanks appear distinctly on the imagery in light yellow to light brown tone, small in size, with regular to irregular shapes, coarse to mottled texture, dispersed and scattered amidst forests of all types and sub-types. Forest blanks are the most distinct in the east of Mookaiyur, Periyakulam,

Melakidaram, and Kalimankundu, and altogether they cover 1452ha or 1 per cent of the total study area.

3.5.4 Wastelands

It is described as degraded land which can be brought under vegetative cover with reasonable effort, and which is currently under-utilised and deteriorates due to lack of appropriate water and soil management due to natural causes (*National Wasteland Development Board, NWDB, 1987*).

3.5.4.1 Land with or without scrub: It is the major wasteland type categories which occur throughout the study area in different geographical situations. They appear in light yellow to brown and to greenish blue tone, subject to surface moisture and vegetal cover. Wherever the occurrence of scrub on the elevated land is more, reddish tint appears in dots and patches. They vary in size with irregular and discontinuous shapes, coarse to mottled texture (*subject to surface lithology and vegetation cover on the top*) contiguous and dispersed in patches. An area of 19223 ha or 12.9 per cent is under land with scrub and an area of 16235 ha or 10.9 per cent is under land without scrub. These wastelands are distributed over Kulayankaraisal to Muttayyapuram, Ayanadippu to Mappilaiurani, Kila Arasadi to Pattanamarudu, Terku Kalamedu to Kulathur east, Melmandai to Kuthiraimozhi, Mariyur to Ervadi, Pullandai to Kanjirangudi and Attangarai to Mandapam. It is sparsely distributed in Rameswaram and other islands.

3.5.4.2 Salt affected land: Salt affected land appears in white to light blue tone (*subject to mode of occurrence, site and situation, amount of moisture, etc.*) of Muttayyapuram, Karampallam, Pudur pandiayapuram, Kila Arasadi, Kallurani, E.Velayuthapuram, and Periakulam villages have salt affected lands which covers an area of about 2226 ha which accounts for 1.5 per cent of the total study area.

3.5.4.3 Sandy area: The sandy area which has stabilised due to the accumulation of sand *in situ* or transported by coastal and riverine process occurs either in the form of sand dunes, beaches, channels (river/streams) or islands. It appears in bright white to yellow with bluish to reddish in tone (*subject to surface moisture and spots of vegetation*), vary in size with regular (*sand dunes, beaches, channel islands*) to irregular shapes, smooth to mottled texture (*subject to vegetation cover*), contiguous and linear in pattern. It occurs in coastal onshore associated with shifting sand dunes, coastal beach sands, river sand, and natural levees. These sandy

areas are widely distributed along the coastline in small patches of dune with vegetative covers and occupy an area of 2083 ha or 1.4 per cent of the total study area.

3.5.4.4 Swampy/ Marshy: It is an area such as a marsh or bog, where the ground is saturated with water almost throughout the year, but the surface of the soil is not deeply submerged. It appears bright red to red in tone, small in size with irregular and discontinuous shapes smooth to medium in texture and contiguous to linear and associated with coastal estuaries, tidal creeks/lagoons and near deltaic coasts. The presence of aquatic vegetation is dispersed and non-contiguous water and vegetation together due to depth of sea water level. Mangroves are quite distinct and they cover 2047ha or 1.4 per cent of the study area. The swampy areas of Vaippar, Gundar, Kappal Ar and Vaigai River are very conspicuous.

3.5.4.5 Tidal Flat: A flat, barren and marshy or muddy areas which are either covered or uncovered by the rise and fall of the tide, are called tidal marshes. Normally, these materials have an excess of soluble salt. It appears in light blue to dark blue tone, (*subject to shallow surface water spread, deep and more volume of water, turbidity, etc.*) long and narrow to wide in size with irregular and sinuous shape. The tidal flats are mainly occurring along the coastal line especially, Muttayapuram, Tuticorin (*Karampallam Odai*), Terku Kalamedu, Vaippar, Vembar, Gundar, Palar, Kottakudi Ar, Vaigai River, and Dhanuskodi (*wider area*) and altogether they cover an area of 2,757 ha of land which accounts for 1.9 per cent of the study area.

3.5.4.6 Reef area: It is defined as a flat expanse of dead reef rock which is partly or entirely dry at low tide. Shallow pools and patches of coral debris and sand are the features of the reef area. It is divisible into inner and outer portions. It appears light blue to green in tone, small in size with irregular and discontinuous shapes. These features are very important in environmental point of view. They occupy an area of 1040 ha or 0.7 per cent of the study area. They are seen in areas of islands namely, Van Tivu, Koswari Tivu, Kariasulil Tivu, Uppu Tanni Tivu, Shalli Tivu, Valai Tivu, Taliri Tivu, Mulli Tivu, Musal Tivu, Manali Tivu, Manaliputti Tivu, Kovi Tivu, Pumurichan Tivu, Kursad Tivu, and Shingle Tivu.

3.5.5 Waterbodies

It is a natural course of water distributed over land. It includes ponds, lakes, streams and rivers. It may be perennial or non-perennial. It appears in light blue to dark blue tone subject to shallow surface water spread, deep and more volume of water, turbidity, etc. It is long and narrow to wide in size with irregular and sinuous shapes in satellite images.

3.5.5.1 Rivers/ Streams/ Tanks: The tanks are the important feature among water bodies of which tanks near to village of Kulayankarisal kulam, Mela Arasadi, Thathaneri, Taruvaikulam, S. Taraikudi, Melaselvanur tank and Rajasurimadai are major tanks. The tanks are well distributed over Kadaladi taluk, and are linked to each other. The Vaippar, Gundar, Palar, Kottakudi Ar and Vaigai River are the major rainfed rivers. However, the water body covers an area of 10054 ha of the total study area, which accounts for 6.8 per cent.

3.5.6 Others

It can be treated as miscellaneous because of the nature of occurrence, physical appearance and other characteristics. Saltpans and roads/railways are brought under this category.

3.5.6.1 Saltpan: Any undrained natural depression in which water evaporates and leaves a deposit of salt comes under saltpan. The salt surfaces are formed when a lake in an arid area of internal drainage are dried up. It appears in bright white tone. Saltpans are common phenomena in and around Tuticorin and Valinockam areas. They occupy an area of 4339ha or 2.9 per cent of the total study area.

3.5.6.2 Roads/ Railways: The study area is well connected by the road and railway networks. The National Highways (NH) No.49 connects Madurai and Rameswaram passes through the northern part of the study area. NH (No. 7A) passes through the southern part of the study area and connects Tuticorin to the rest of the country.

3.6 LAND UTILIZATION TYPES (LUT'S)

Land Utilization Type (LUT) is a kind of land use described or defined in a degree of detail greater than that of a major kind of land use (FAO, 32). Therefore, Land Utilization Type is a synthetic process of defining land utilization types, which begins with an analysis of fundamental references and result in an analytical description in terms of key attributes. Beek (1978, 35-37) described a three-step

process of synthesising LUTs, which represent a preliminary form of socio-economic analysis and help to determine the degree of quantification to be reached in the LUTs definition.

By field observation in the study area, the study considers three main LUTs such as cropping of Coconut, Palm, Sugarcane and Paddy with subsistence (LUT-1) cropping of Fodder, Bajira, Gram and Cotton by small to marginal farmers, with low capital resources, using mostly cattle drawn farm implements with high labour intensity on free hold farms of 2-5 ha mostly, in an area of good infrastructure from the market for produce and availability of inputs, farm advisory service. Hence, the three main LUTs are irrigated cultivation of LUT-I (Coconut), LUT-II (Groundnut) and LUT-III (Paddy).

3.6.1 Key Attributes of LUT'S

Land Utilization Types (LUTs) is a specific way of using the land as actual or alternative, consisting of a combination of key attributes, such as production, labour, capital, management, technology and scale of operations. Due to close relationships, the key attributes are identified simultaneously and described at the appropriate aggregation level, in accordance with the purpose and detail of land evaluation (Beek, 1974, 34 series). As LUTs are technical, organisational unit in specific socio-economic setting, it is also related to other similar selected LUT's of the particular area. In the every identification of land use requirements, *descriptions of key attributes should be sufficiently informative.*

The FAO framework distinguishes between single, multiple and compound Land Utilization Types (LUT's).

A Single Land Utilization Type: It specifies only one kind of use undertaken on an area of land (*example: Rainfed, groundnut farming area*).

A Multiple Land Utilization Type: It consists of more than one kind of use simultaneously undertaken on the same area of land and different use having its own inputs, requirements and production (*example: turmeric grown in between rows of young coconut trees under irrigated farming*).

A Compound Land Utilization Type: It comprises of more than one kind of uses, sequentially undertaken on the same land. The different kinds of use may occur in time sequence (*example: crop rotation*) or simultaneously in different areas of land within the same organization unit (*example: mixed farming system*), involving

relations between arable crops and livestock production form of grasslands. It refers to four or more uses undertaken on areas that are treated as single unit for the evaluation purpose.

3.6.2 Requirements of LUT'S

The methodology or scheme requires that crop requirements are to be known in order to select important land qualities from soil survey data. In addition, some requirements pertaining to the management aspects of the land utilization types are also to be known.

3.6.3 Identification and Analysis of Land Utilization Types

As stated earlier, Land Utilization Type is a kind of land-use described or defined in a degree of detail greater than that of a major kind of land use, like production, management, and socio economic characteristics.

Generally, land use data (maps) and collateral data including precise material regarding the study area are the baseline information used to identify and describe the land utilization types. The crops already under practice have also been taken into account for identifying the LUTs. Based on village-wise crop strategies and the primary survey of the socio-economic conditions such as crop conditions, labour intensity, technical knowledge and attitudes of farmers, mechanization of the farms, size and shape of the farms, cropping characteristics, material inputs, cultivation practices, management, yields and market orientation of the farmers, LUTs have been described according to the FAO procedures (FAO, 1983: Rainfed Agriculture). In all the descriptions that follow the cropping systems, the sequence in the presentation is as follows; the setting, crop(s) grown, capital and labour intensities, technical knowledge and attitudes, power mechanisation, size and shape of farms, land tenure, infrastructure requirements, cropping characteristics, material inputs, cultivation practices, yields and crop production. From the questionnaire surveys, field visits during the research period and local knowledge of the study-area, it has been possible to identify that the study area has eight land utilization types of which the major three land cropping systems are discussed in the following paragraphs along with LUT's key attributes. There are two different types of agricultural activities, being practiced in the study area.

1. Irrigated agricultural activities
2. Rainfed agricultural activities

treatment with Agrosan at the rate of 100g per 50 kg of seeds is generally recommended to prevent seed-borne diseases. The untreated seeds of high-yielding varieties should be soaked for 12 hours in a solution of wet table Ceresan (0.1 per cent, i.e. 1gm in one litre of water). Then the seeds should be thoroughly dried under shade and used for sowing.

The nursery area required to provide seedling for transplanting one hectare seed rate is 40-50 kg/ha. To ensure rapid and uniform germination, selected seeds should be soaked for 24 hours in clean water, which should be drained away and then the seeds should be incubated in a warm, moist place for 36-48 hours to let them sprout for sowing in the nursery. The general practice of the study area is to go in for wet nurseries. Another system of nursery raising is known as the “*dapog*” method that has been recently suggested for areas where the seedling area is to be obtained within a fortnight for immediate transplanting.

Transplanting: The seedling area ready for transplanting in kharif season (July-November) takes 20-25 days (4-5 leaf stage) whereas in rabi season (October-February), it may take 30-40 days. Two to three seedlings are planted at 20x10 cm or 20x15 cm spacing in leveled fields. In regions of low fertility, and for late planting, *closer planting* is advised.

Water Management: The water requirement for paddy is higher than that of other cereal crops of similar duration due to various soil and environmental settings. It ranges from 37 to 75 acre per inches of water which has been reported from various locations in the study-area.

Fertilizer Management: The new short-statured varieties have a high fertilizer response and give high yields of grain. The major nutrients required for paddy are nitrogen, phosphorus and potassium. Among the micro nutrients, zinc is important. About one third of the total fertilizer is used for the paddy crop. However, the rice-growing conditions are equally conducive to rapid losses of applied nutrients like nitrogen, which is usually deficient in most of the paddy areas. Paddy being a poor utilizer of applied nutrients, there is a need to improve the use of fertilizer efficiency.

Harvesting: Timely harvesting prevents losses in the yield because of the shedding of grains. The later stage of grain ripening is a dehydration process and maturity is hastened when water is withdrawn from the field at the hardening stage of the grains. The timely draining away of water makes the field hard to facilitate mechanical harvesting wherever this system is practiced. The temporal requirements

for the harvesting of early and medium varieties are 25-30 days after flowering and 35-40 days in the case of late varieties. Field paddy should be harvested when the moisture content is to be reduced to 13-14 per cent before milling. Direct drying under the sun leads to an increased breakage of the grains during milling. Gradual drying in the shade is essential for better recovery of grains in the mills.

The produce after harvesting is known as rough rice, paddy or grain. The rough rice is milled before it is consumed. The husk or hull, bran and germ are separated. Shelling or hulling refers to the same process of graining by which the hull is removed. After milling, the highly milled rice is white, translucent or opaque and is classified as head rice, broken, and screenings or brewers rice, according to the size of the kernels.

Storage: Proper storage of the produce is necessary. If moist paddy is stored, fungal attack sets in and this would lead to grain discolouration. Bad odour and bitter taste would also develop. For avoiding such defects, controlled mechanical drying of paddy is a necessary. In advanced countries, mechanical devices and large scale storage units are available and these facilities can be availed on customer-service basis. Such a system can be adopted in this study area. Alternatively, economical and effective storage structures can be established at block or district levels.

Productivity: In the study area, most of the cultivators possess ownership over the cropland. Small and marginal farmers, who are an over whelming majority in the paddy cultivation of the study area. Paddy is subsistence farming and provides food security for the population. As paddy is a labour intensive crop, it deserves human capital (5 farmers per ha), annual capital (Rs. 5000/ha) and mechanical capital (Rs. 2000/ha). It is so much cultivated in the study area that an average of 5 men per month is required per hectare of the paddy cultivate land.

Varieties: In the study area paddy varieties such as Thaladi or Pishnam is being cultivated depending on the monsoon seasons. During non-monsoon season, salt tolerant varieties such as Ponni (*Mahsuri*) and ADT 32; long duration varieties such as CO30, CO25, ASD11 (*late planting*), CO40 (*Rajarajan*), PVR 1 and SR 26B are cultivated especially in saline areas.

Distribution: Such varieties of LUTs are predominant in the deep buried pediment ecosystem. It is found in Tuticorin sector and meagerly in the Mandapam sector. The productivity area is almost 30,809.04 ha (*20 per cent*) of the total study area.

3.7.2 Cropping System in Fluvio-marine land

The cropping system of fluvio-marine land is generally practiced Sorghum and other small grains.

3.7.2.1 Millets Cropping System (LUT2: Sorgham): The Sorghum (*Sorghum Vulgare Pers.*), popularly known as jowar or *Cholam* (vernacular) is the most important food and fodder crop of dry land / rain fed agriculture. The area under Cholam ranges between 17 and 18 million hectares and the annual production is between 8 and 10 million tones. Jowar is mainly grown in Ottapidaram and Vilathikulam sectors in the study area. In other sectors, it grows for fodder for small areas. The sorghum grain is used as human food such as *roti or bhakri (unleavened bread)*, or it is cooked like rice. Sorghum is also malted, popped and several local preparations are made. Green and dried fodder is the most important roughage for feeding the cattle throughout the study area.

Climate: The sorghum belt receives an annual rainfall ranging from 400-800 mm per annum, usually grown between the last weeks of June and the first weeks of October in most part of the study area. Within this season there is a fluctuation in the temperature but it rarely handicaps the crop growth, except when the rabi sowings of the crop are unduly delayed in the study area. Medium and deep black soils are predominantly suitable for growing sorghums, whereas the rabi sorghums are wholly confined to black cotton soils. The kharif sorghums are grown on lighter soils on limited scale.

Sorghums are grown during both kharif (*July-November*) and rabi (*October-February*) seasons. The area under rabi sorghum is concentrated in Tuticorin sector which accounts for 9145ha or 6.13 per cent of the agricultural land which is more or less a contiguous belt. In the Vilathikulam and Kadaladi sectors, rabi Jowar occupies very little areas, whereas in Tuticorin sector, the distribution is 5-6 per cent in both seasons. In other sectors, the kharif season is more important. About 1-5per cent Jowar is grown under irrigation condition usually during summer.

Cultivation practices: Sorghum cultivation still remains traditional in most parts of the study area. The preparation of land with ploughs or blade harrows with least application of farmyard manure, line sowing with a seed-drill in rows of 12-18 inch apart, and inter culturing with bullock-drawn implements is continued to be

practiced even today. The rainfall years are abnormal, the low crop stands and in absence of the use of fertilizers. The factors which stand in the way of its production are the traditional late varieties which are drought-prone. Weed control may not be serious in black soils, but weeds are a limiting factor in kharif crops in red soils.

Traditional Varieties: Natural selection and domestication over thousands of years have resulted in the development of numerous varieties of crops highly local in their adaptation. Indian sorghums exhibit a wide range of variability in respect to duration and grain quality cultured under different seasonal, soil and climatic conditions. At present, improved varieties of crops are the result of pure line selection practiced among the principal local varieties. Notable varieties developed during the early period and are continuing under cultivation or co-series all over in state; the Nandyal and Guntur (CSV-1, CSV-5) is traditional varieties in the study area.

3.7.2.2 Pulses Cropping System (LUT3: Grams): Pulses form an important source of protein and are essential adjuncts to a predominantly cereal-based diet and enhance the biological value of the protein consumed. Being leguminous crops possessing root nodules, they fix and utilize atmospheric nitrogen, a process requiring energy, but add up to 30 kg of N/ per ha to the soil and improve its fertility. **Black-gram** (*Phaseolus mungo* Roxb.): Black gram (*urd*, *mash*) is a highly prized pulse, very rich in phosphoric acid. It is used, more or less, in the same way as green-gram (*mung*). It is also used in preparing papad (*a kind of wafer*) and barian (*spiced balls of ground dal*) and together with rice in preparing dosa and idli, popular breakfast dishes of the south India.

Soil and Climate: Mash prefers water-retentive, stiff loamy or heavy soils, and does well on both black cotton soils and brown alluviums. It is grown as a rainfed crop in the warm plains as well as in the elevated lands upto an altitude of 26 metres. The cooking quality of black-gram produced in the highlands or in moist climate is claimed to be better.

Rotation: This pulse is most commonly grown as a mixed crop, subsidiary to cotton, maize, jowar and other millets. In Tuticorin sector, it is sometimes grown separately for manuring the paddy. In the Vaippar River it is often grown on bunds around terraced paddy fields.

Cultivation: Preparatory tillage, manuring, the method of sowing, inter culture, harvesting, threshing and storage are similar to those described in the case of green gram. However, the sowing may be done either in February (early spring) or

June-July (rainy season) or October-November (autumn), depending on climatic and agricultural conditions and the variety grown. The seed amount is 10-15 kg ha and the out-turn is 10-12 quintals of grain and about 2 tonnes of straw per hectare.

The commonest types have black seeds, but types with green seeds are also known. Appreciable varietal differences exist in the plant habit and the time taken to mature.

3.7.2.3 Oil Seeds Cropping System (LUT4: Ground nut, LUT5: Sunflower, LUT6: Gingelly):

Groundnut: Oil seed crops have been the back bone of the agricultural economy of India from time immemorial. The Groundnut (*Arachis hypogaea* L.) is believed to be a native of Brazil (*South America*), as many closely related species are found there.

Productivity and distribution: About 2938ha of land is utilized for growing groundnut, of which 19.7 per cent occupies Tuticorin, Villathikulam and Mandapam which are the major groundnut products areas. Tuticorin occupies the first position.

Climate and soil: The crop can be grown successfully in places receiving a minimum rainfall of 500 mm and the maximum rainfall of 1250mm. The rainfall should be distributed well during the flowering and pegging of the crop. The total amount of rainfall required for pre-sowing operations (*preparatory cultivation*) is 100mm; 150mm for sowing and evenly distributed rainfall of 400 to 500mm for the flowering pod development. The groundnut crop, however, cannot stand in frost, long and severe drought or in water stagnation. Groundnut is grown on a wide variety of soil types. However, the crop grows well on sandy loam and loamy soils and in black soils with good drainage. Heavy and stiff clays are unsuitable for groundnut cultivation, whereas soil pod development is supporting to grown.

Rotation and mixed cropping: Generally, as a *kharif* crop, groundnut is grown yearly once. In certain places of the study area, it is rotated with gram, paddy and cotton, and in some areas with garden crops, such as chillies, vegetables and millets. The yields of cereal crops following groundnut usually increases about 20 per cent. Pulses and millets are being grown mixed with groundnut.

Season: Groundnut is raised mostly as a rain fed *kharif* crop. It is sown from May to June depending on the monsoon rains. In the areas, where the monsoon is delayed, it is sown in August or early September. As an irrigated crop, it is grown to limited extent between January and March and between May and July.

Yield: Under rain fed conditions, the average yield of semi-spreading and spreading varieties is 1200 - 1400kg of unshelled pods per hectare and most of the other varieties have the yield of 800 - 1000kg. The crops grown with supplemental irrigations produce 3000kg pods per hectare.

Varieties: The varieties under cultivation fall into three groups with respect to the habit of growth, namely bunch (*Spanish*), semi-spreading (*Virginia bunch*) and spreading (*Virginia runner*).

LUT5: Sunflower (*Helianthus annuus*, L.): Sunflower is a common name for annual and perennial herbs of a genus of the daisy family. The genus, which contains about 67 species, is thought to be native to South America. Sunflower is a hardy crop, superior to sorghum in drought tolerance. Under dry land conditions, sunflower extracts water from deeper soil profile to enable the crop tolerate prolonged dry periods. In the tropics, sunflower cultivation is becoming widespread in the different ecological zones and seasons of the year. Sunflower offers a special opportunity for crop production in the post monsoon season in the Mandapam sector of the study area, because few other crops may be produced during this period. Soil water reserve is a valuable resource important to the exploitation of the post monsoon season cropping period. This period is characterised by concurrent stresses due to extremely high soil and air temperatures, high solar intensity, strong vapour pressure deficits (atmospheric dryness), and severe soil moisture deficits.

Climate and Soil: This crop requires a cool climate during germination and seedling growth, warm weather from the seedling stage up to flowering, and non-cloudy, sunny days during flowering to maturity. The crop can thrive well in a variety of soils in the study area. The optimum pH of the soils for this crop is 6.5 to 8.5.

Agronomic characters: Sunflower is one crop in the case of which, the season of planting, the photoperiod and within limits the altitude are not the limiting factors. Hence it is possible to cultivate throughout the year. At the time of sowing, the soil should be friable and free from weeds. Three to four ploughings and disking are sufficient for preparing land. Soil should be moist at least at a depth of about 10cm before sowing.

Eight to ten kg of well-filled plump seeds is required to cover one hectare. The pre-soaking of seed for 12-24 hours ensures a rapid and high percentage of germination, an early emergence and establishment of the crop. The seed is drilled at

a depth of 5 cm by adopting a spacing of 45 cm between rows and 30 cm between plants in the row.

Generally, two hoeing, 15 days and 30 days after sowing, are sufficient for the successful cultivation of this crop. The yields can be doubled by irrigating the crop. In general, for light soils, 9-10 and for heavy soils 5-6 irrigations are sufficient. The critical stages of moisture requirements are germination, capitulum initiation, flowering and grain-filling.

The sunflower crop matures in 90-100 days. The crop has to be harvested when the lower side of the head turns yellow and some of the bracts dry up. The mature heads are cut with a sickle and the area is dried by exposing the upper side of the seeds to the Sun. The well-dried heads area is beaten with sticks to separate the seeds.

Pests and Diseases: Grasshopper (*Atractomorpha cremlata* F.) and the capitulum-border capitulum-borer (*Heliothis armigera* Hb.) are the important pests of sunflower. Dusting with BHC 10 per cent is effective against these pests. The major disease caused by these pests on sunflower is leaf-rust (*Puccinia Helianthi*).

Soil and water: The sandy loam soil of the study area is an alfisol. The soil is characterised by 24.6 % clay, 46.7 % sand, 27.7 % silt. In this soil, soil water storage is related more to water infiltration than water retention properties.

Varieties: The sunflower varieties grown in the study area at present are the E. C.68413 (Vniimk 8931) and E. C. 68414 (Peredovick). Recently, a short duration variety, E. C. 101495 (Cernianka), maturing about 75 days is becoming popular.

Yield: In the study area the sunflower crop gives a grain yield of 300-500 kg per ha under rainfed conditions and 800-1200 kg per ha when grown under irrigation.

Productivity: Annual sunflowers are cultivated for their seeds. Refined sunflower-seed oil is edible and considered by many as equal in quality to olive oil. Crude sunflower oil is used for making soap and candles. The oil cakes (*solid residues after oil is pressed*) are used as cattle feed. The raw seeds are used in poultry mixes and are consumed by human beings as well. The roots of a perennial species, also called Jerusalem artichoke, may be eaten boiled, stewed, or baked in pies.

LUT6: Gingelly: Sesamum (*Sesamum indicum* L.), also known as sesame, til and gingelly, is an important and ancient oil-yielding crop. Africa is considered to be the primary centre of origin of this crop. India is the secondary centre of origin and another secondary centre is Japan. The economic importance of this crop seed is its

rich source of edible oil. Its oil content varies from 46 to 52 per cent. Sesamum oil is used as a cooking-oil in South India especially, Tamil Nadu. It is also used for anointing the body, for manufacturing perfumed oils and for medicinal purpose. The cake is a nutritious feed for milch cattle.

Climate and soil: It cannot stand frost, continued heavy rain or prolonged drought. It is grown in sandy loam to heavy black soils. Most of the crop is confined to lighter soils and its cultivation in heavy soils is limited to certain places in the study area. In the study area Sesamum grows in the alluvial plain of Mandapam sector. Ottapidaram and Vilathikulam taluks are deep soil distributed.

Cropping system: *kharif* sesamum is grown both as main and mixed with other crops, whereas the semi-rabi and summer crops are taken as pure. The common component crops are cotton and groundnut in the Tuticorin and Vilathikulam Taluks.

Cultivation: In Tuticorin coast, sesamum is grown in three seasons, viz, *kharif*, semi-rabi and summer. The *kharif* crop occupies over 60 per cent of the study area, whereas the semi-rabi and summer crops occupy 30 per cent and 10 per cent area respectively. The *kharif* sesamum is sown in June-July with the onset of the monsoon and is harvested in December-January. The semi-rabi crops are entirely rainfed, whereas the summer crops are grown under irrigation. The yield of the *kharif* crop is poor, whereas the semi-rabi and summer crops are high, as they are grown in rich soils under better management.

The preparatory cultivation for the *kharif* crop is usually not thorough. For the semi-rabi and summer crops, the land is ploughed and harrowed repeatedly to secure a clean and fine seed-bed. The recommended spacing for the line-sown crop in different places, however, ranges from 25 to 35cm between the rows and 10 to 20cm between the plants in the row. The seed being small, it is often mixed with sand to ensure its even distribution and the drill is operated rather shallow to avoid deep sowing. After sowing, the seed is covered lightly with a brush harrow. The seed-rate varies from 3 to 5kg per hectare. The rainfed crop is weeded and hoed once or twice and the irrigated crop is weeded often.

Yield: The average grain yield of the *kharif* crop grown unmixed is 200 to 500kg per hectare and the average yields of the semi-rabi crop and of the irrigated summer crop is 300 to 600kg per hectare.

3.7.2.4 Fiber Cropping System (LUT7: Cotton): Cotton is one of the most important commercial crop. India develops on a commercial scale. The predominant species is *G. hirsutum*. It is cultivated for an area of 17423ha or 11.7 per cent.

Climate and Soils: Cotton is a tropical and sub tropical crop. For the successful germination of its seeds, a minimum temperature of 15°C is required. The optimum temperature for vegetative growth ranges from 21° C to 27° C. It can tolerate temperature as high as 43°C, but cotton does not grow well if the temperature falls below 21°C. During the period of fruiting, warm days and cool nights, with large diurnal variations are conducive to good boll and fiber development.

Crop Season and rotation: The sowing season of cotton varies considerably from place to place. It is generally earlier (*April-May*) in Tuticorin, Ottapidaram and Vilathikulam sectors and is delayed as one goes down the north. Cotton is essentially grown as a *kharif* crop in many parts of the study area. Intercropping and mixed cropping under rain-fed conditions serve as an insurance against crop failures.

Preparation of Land: The black-soil areas of the study area are prepared for sowing the rain-fed cotton by harrowing the field 3 to 4 times with the blade harrow. The land is ploughed deeply only once in 4-5 years to remove weeds. As the red and lateritic soils of the study area are poor in retaining soil moistures, the field is usually ploughed lightly two or three times or harrowed and irrigated once so that the land is prepared well for sowing the irrigated winter crop.

Harvesting and yield: The rainfall of 500 mm is the minimum requirement for the growth a favourable distribution of rainfall than the actual rainfall of the crop is the deciding factor in obtaining good yields from the rainfed cotton crops.

Cotton is grown on a variety of soils. It requires a soil amenable to good drainage. It does not tolerate water logging. In the study area it is grown mainly as a dry crop in the black cotton and medium black soils and as an irrigated crop in the alluvial soils. The rainfed cotton predominates nearly 5-7 per cent of the area. In the study area, cotton is entirely hand-picked. The entire crop cannot be harvested at one stretch and the picking of the opened bolls is carried out at suitable intervals and will continue for several weeks. It is better to remove the dry stalks as soon as possible after the picking is completed. The yields vary widely from tract to tract and from season to season, depending upon the agro-climatic conditions.

3.7.2.5 Commercial Cropping System (LUT8: Sugarcane): The commercial crop of Sugarcane (*Saccharum officinarum* L) contributes approximately 6 per cent of

the total study area. The sugarcane distribution mainly depends on sugar mills of Tamil Nadu State.

Soil and Climate: Sugarcane grows best on medium and heavy soils, but can also be raised on lighter soils and heavy clays. There is adequate irrigation available in the former type of soils and the drainage is good in the latter type of soils. In the study area, it is cultivated largely on the loams and clay loams and it is grown on brown reddish loams, laterites and black cotton soils. Sugarcane is able to grow over a prolonged season. Under warm humid condition, it can continue its growth unless terminated by flowering. However, its height is strongly influenced by the age of the crop and season. Temperatures above 50°C arrest its growth; those below 20°C slow it down markedly and severe frost proves fatal. The crop should receive the rainfall ranging from 750 to 1200 mm. The yields tend to be distinctly lower than the interior land.

Planting: Sugarcane planting is usually done with the onset of the warm weather and is completed well before the onset of summer. Hence, it is cultivated in the western part of the coastal tract of Mandapam sector. Cane planting is done between December and February in the study area.

Seed: Healthy seed material, free from pests and diseases, and having high viability are essential for establishing the crop in the first instance. The top one third to half portion of a cane, being comparatively immature, has buds of good viability and is the best to be used as seed. The bottom portion is usually richer in sugar than the top portion, and it is best to utilize for sowing. It is taken from well manured, erect and healthy canes.

Yield and Varieties: The average yield of 11 to 12 month old plant crop under commercial cultivation is about 40 to 45 tonnes per hectare in the study area. Generally, the early season varieties are Co.526, and Co.658 and late season varieties are Co.853 and Co.6304.

Distribution and Productivity: This LUT's is practiced only in the western portion of the Tuticorin sector as the area is mainly with the black cotton soils, which is suitable for this LUT. Sugarcane is distributed for an area of 8877ha or 6per cent of the total study area.

3.7.2.6 Condiments and Species Cropping System (LUT9: Chilly): The Chilly (*Capsicum annuum L.*; *Capsicum frutescens L.*) also called 'red pepper', is an important cash crop in the study area and is grown for its pungent fruits, both green

According to the kind of product and the management, five agricultural land use (*LUT1 through LUT16*) have been distinguished, which are feasible and the major crops in the study area.

3.7 LAND UTILIZATION TYPES IN TUTICORIN COASTAL ZONE

The land use pattern of the study area at any particular time is determined by the physical, economic and institutional framework taken together. In other words, the existing land use pattern in different parts of the study area has been evolved as the result of the action and interaction of various factors such as, the physical characteristics of the land, the institutional framework, the structure of other available resources (*Capital, labour, etc.,*) and the location of the region in relation to other aspects of economic development, e.g. those relating to transport as well as to industry and trade. The present pattern can, therefore, be considered to be in some sort of static harmony and adjustment with the other main characteristics of the economy of the study area. In the dynamic context, keeping in view of the natural endowments and the recent advances in technology, the overall interests are considered. A close study of the present land use patterns and the trends during recent years will help to suggest the scope for planned modified in the patterns of the study area.

3.7.1 Cropping System in Fluvial Land

Fluvial land is formed by the deposition of fluvial sediments. Paddy is the suitable crop for the fluvial land because it grows along the river channel.

3.7.1.1 Irrigated Cereals Cropping System (*LUT1: Paddy*): *Paddy (Oryza Sativa)* belongs to the genus *Oryza*. *LUT1* is mainly practiced in the deep buried pediment areas close to the river. Tractor is used to plough the land, seeding is done by hand and harvesting is done either by hand (*in most case*) or by machines. Paddy is a favourable cereal crop. It is generally grown in wetland conditions and it needs good groundwater availability. It is sown once and harvested using traditional methods.

Seeds and Sowing: The seed rate for direct sowing by broadcasting is 80 to 100kg/ha and by dibbling it is 60-70 kg/ ha. Only well-filled viable seeds should be used for sowing. Lighter seeds that float on the solution of common salt (*1.06 specific gravity*) should be rejected. The choice of suitable variety of seeds based on toposequence, soil type and duration is a prerequisite for obtaining high yield. Seed

and ripe are used (*the latter in the dried form*) to impart pungency to the food. As a condiment, it has become indispensable in every Indian home. It is used as medicinal, and also in *chutnies* and pickles. The pungency is due to the active principle ‘capsicin’ contained in the skin and the septa of the fruit.

Climate and Soil: In the study area this crop is being grown where annual rainfall receives from 600 to 1500mm. A very high rainfall during its growth is harmful. In the hot weather or in lower-rainfall tracts, it is cultivated as an irrigated crop. The rain fed has grown crop well on deep, fertile and well drained black cotton soils in the study area. If there is good manuring with irrigation, excellent chilly crops can be raised in sandy and light alluvial loams as well as in red loamy soils.

Rotation: Under rain fed conditions, the crop is rotated with ragi, cotton, sorghum and groundnut. As an irrigated crop, it is grown in rotation with sugarcane. The irrigated chilly crop is sometimes grown mixed with millets, groundnut, cotton or other vegetables.

Cultivation: The land is ploughed and harrowed 3 or 4 times to obtain a fine tilt. About 100 cart loads of farmyard manure or compost per hectare is applied at the final ploughing. Some farmers also do sheep-penning with pen of about 500 sheep per hectare, in addition to the application of manures. The land for irrigated chilly is laid out into beds, 2-3 squaremetres, or is made into ridges $\frac{1}{2}$ to 1metre apart. The winter crop is planted from July to September and the summer crop in February and March. While these are the two important seasons for its cultivation, a third crop, known as the mid-season (*May-June*) crop, is also taken in certain parts of Kadalai and Ottapidaram sectors of the study area.

Yield: The average yield of the rain-fed crop is about 500 kg of dry chillies per ha and that of irrigated crop varies from 1000-2000 kg per ha. The recovery of dry chillies is 25-30 per cent of the fresh weight.

Productivity and Distribution: Chillies are practiced as inter crops in areas like Tuticorin, Ottapidaram, Villathikulam (*along the Vaippar River*) and sparsely distributed in the Mandapam Sectors. About 26 per cent of the study area cultivates chillies which covers an area of 39392 ha. It is a major crop of the present study area.

3.7.2.7 Fruit Cropping System (LUT10: Banana): Banana (*Musa paradisiacal L.*) occupies an area of 23525 ha of the study area. Broadly speaking, banana cultivation is widely practiced in 1200 mm rainfall and a temperature of more

than 15.5° C. The banana cultivation is practiced only in the “*Effective rainfall*” and “*Effective temperature*” climatic zones of the present study area.

Planting: The Banana is usually planted just before the beginning of the rainy season so that adequate moisture is available for the longest possible time. Water requirements for banana cultivation vary according to the topography, soil, climate, type of variety, and type of culture. On the basis of traditional field experience and generally remained empirical in nature, it practices mostly followed in different places in India. In general, irrigation should be done at intervals of 15-20 days during the beginning of the monsoon (*June*). During the active monsoon period (*July and August*) irrigation is not practiced. This plantation needs irrigation once or twice in the month of September and at an interval of 10-12 days during October and February, and at the interval of 4-7 days from March to May months.

Varieties: Povan, Basrai, Pacha Nadan, Robusta and Pahca Montha Bathis are the leading commercial varieties that are being cultivated in the study area.

Productivity and Distribution: In the study area banana cultivation is being carried out along the river course and in the places of alluvium soil, notably in Tuticorin, Vilathikulam and the northwestern part of the Mandapam sectors.

3.7.3 Cropping System in Marine Land

This cropping system purely depends on the coastal environment. Mainly it is a salt tolerant cropping system, easily grown along the tract of coast. There is very gentle plain to support the growth. Horticulture crops are mostly practiced in this land.

3.7.3.1 Horticultural Cropping System (LUT11: Cashewnut)

Cashew (*Anacardium occidentale L.*) is grown more for its nuts than for its fruit (*cashew apple*). In the study area, it is grown chiefly in the coastal sector of Kadaladi. These crops are regularly practiced in various lands of this sector. Cashew cannot tolerate severe summers or winters. It can survive in any soil, as it grows even in very gravel soils. However, it needs a free-draining soil. It grows in areas having rainfall varying from 400-550 mm. Continued adequate soil moisture is, however, necessary for the success of a cashew plantation.

Varieties: There are no distinct varieties of cashew and it exhibits a marked variation in fruit and nut characters while growing from seed. Some of the superior varieties can be multiplied or perpetuated through vegetative propagation.

Propagation and Planning: Sowing the seeds in situ is the usual practice, but it is also possible to transplant one-month-old seedlings by cutting them in to one-third. This plant can also be propagated by air-layering, inarching and side-grafting. The planting distance varies from 6 metres in lateritic and rocky soils to 12 metres in deep loamy soils.

After Care: No attention is paid to cultivation, irrigation or manuring. An occasional clearing of under growth and the pruning of dead and diseased branches is necessary to maintain the health and vigour of trees.

Harvesting and Yield: The fruits ripen between the months of March and May. The season is prolonged during the years, when heavy rainfall is experienced in November-December. Even though the first bearing is normally secured in about three years after planting, the fully satisfactory cashews can only be gathered after about eight years. The yield of nuts varies from 110 to 220 kg per hectare.

Curing and Processing: The nuts are separated from the cashew apples immediately after harvest. The dried nuts are roasted either in open pans over a furnace or in rotary cylinders and in oil baths. Shelling is done by hand soon after roasting. The kernels, so obtained, are dried in the sun or in hot-air chambers. Then they are kept in sweating chambers for some time. The nuts are then ready for grading and packing. For the export trade, the kernels are packed in tins under vacuum or in carbon dioxide. For internal markets, the kernels are sometimes packed in the tins of different sizes and they may or may not be hermetically sealed.

Productivity and Distribution: It is being cultivated only in Kadaladi sector, as the area is highly suitable owing to the soil and the topography especially, the area under swale-ridge complex eco-system such as Ervadi-Sevalpatti tract, practices for long time for an area of 7357 ha or 4.93 per cent of the study area.

3.7.3.2 Plantation Cropping System (LUT12: Coconut, LUT13: Palm, LUT14: Casurina)

LUT12: Coconut (*Cocos nucifera* L.) is a majestic perennial palm. It is extensively grown in all islands and also in the coastal tracts of the study area. The

coconut-palm, rightly known as the '*Kalpa Vriksha*' or the '*tree of heaven*' provides many necessities of life like food and shelter. Of all the palms, coconut provides numerous useful products. Every part of the coconut palm is useful in one way or another.

Climate: Coconut is essentially a crop of the humid tropics. The evenly distributed rainfall throughout the year is congenial. Regions with long dry spell are not suited for its growth. Coconut palm requires an equable climate, neither very hot nor very cold. The optimum mean annual temperature required for best growth is about 27° C with a diurnal variation of 6° C to 7° C. Frost and low humidity adversely affect the growth. Persistent high humidity is also harmful. The coconut requires bright sunshine of about 2000 hours a year.

Soil: The coconut palm adapts and thrives in all types of well-drained soils, such as coastal sand, red loam, laterite, alluvial soils and the reclaimed soil of the marshy low land. A water table that is too high and remains static for long periods is harmful for cultivation.

Planting: Since coconut is a cross-pollinated perennial crop which can be propagated only through seeds, selection has to be made at the mother-palm level and at the seedling stage. The mother-palms should be healthy, high-yielding and regular in bearing. The seedlings should be healthy and should have a minimum of six leaves when they are one year old. The early splitting of leaves is a desirable character. Nine-month-old seedlings, having a minimum of four leaves, can also be planted. The suitable land for this crop cultivation is sandy loam soil with a low water table and the planting pits of the size, 1 m x 1 m x 1 m is generally recommended. The spacing of coconut requires careful consideration. In general, a spacing of 7.5 m to 9 m, accommodating 124 to 177 coconut trees per hectare is adopted under the square system of planting.

Harvest and Yield: The coconut-palm is unique in nature, its life extending over 50 or 60 years. The nuts mature nearly one year after fertilization. Generally, harvesting is done once in 45 or 50 days. The Tender nuts are in great demand, as a delicious soft drink is cultivated particularly in Mandapam, Rameswaram, and Nallatanni Tivu. Nuts for culinary purposes, for making cup copra and good quality fiber are harvested at the age of about 11 months, whereas coconut cultivated for ball copra and coarse coir are harvested only when they are fully ripened.

The average yield per hectare varies from 10000 to 14000 nuts per annum. From a well-maintained garden, an annual yield of 25000 nuts per hectare can also be obtained. Nearly one-third of the annual yield is harvested during the months of March, April and May. It has the east coast conditions.

Productivity and Distribution: In the study area, coconut plantations are distributed along the coastline having 4 to 12m altitude for a distance of 4 to 8 km along the shore. But it is intensively cultivated in Ottapidaram, Vilathikulam, and Mandapam sectors due to coastal sandy. It is distributed for 47768ha which occupies 32 per cent of the total study area.