CHAPTER I

INTRODUCTION

This study is about agricultural land uses in the Amaravathy basin and changes in such land uses over a 22-year period, during 1971-92. The study purports to analyse land uses, land utilisation types and cropping patterns in a variety of ways, in order to provide for land use planning and developing strategies to make such land uses optimal. There is focus both on the physical and the human aspects of agricultural land uses, productivity and the potential for development. There is a direct analysis of land uses and related crops and cropping patterns, in combination, concentration and diversification. Agricultural development in existence and the prospects for further development are the concern of the study throughout.

The present chapter is concerned with introducing the problem of analysis, which is quite simply that of agricultural land uses in the Amaravathy basin, in a space-time perspective. Changes that have occurred in the last two decades of economic development and their spatial manifestations in agricultural land uses form therefore the very basis of the present research. In order to make the problem of analysis, which is briefly elaborated elsewhere in the chapter, orientated to a context of river basin, this chapter provides for a review and appraisal of earlier studies on land uses in river basins and related developments in agricultural land uses research, in the first section. This is followed by a
discussion on the problem of analysis, objectives and methodologies adopted in this research. The organisation of research is also indicated in this chapter.

Land is the most important of the natural resources, inherited by human beings. Land means different things to different people: space, nature, resource, a production factor, commodity, a source of pleasure, location, property and capital. Its utilisation has shown a reciprocal relationship between the prevalent ecological conditions and the human use of such conditions for the benefit of humankind. The potentiality of an area is dependent upon the intensive or extensive use of the land. The increasing pressure of population on land is the main cause for the problems of land utilisation. The optimum utilisation of land resources, by correcting through the traditional trial and error method, would solve the problems of land utilisation.

Agriculture is the main source of income, which is about 45 per cent of our national income. For a study of changes in agricultural land uses, there is no better way to analyse the problem of optimal land utilisation than through a river basin. A river basin is a natural unit that it offers conducive conditions for carrying out agriculture, with its natural cycles of nutrients, soil building, irrigation using surface and groundwaters, in isolation or in conjunction, for several crops, food and commercial, depending upon the nature of socio-economic organisations and cultural practices. The prospects for progress depend upon the levels of human resource development obtainable in the basin, as a consequence of the changing facets of agriculture, industry and infrastructure.
River basins in India, especially in Tamil Nadu, have recently become dispute hotspots, either for reasons of social and environmental damages caused by developmental programmes or for water scarcities primarily as a consequence of inter-state river disputes, causing concern among the agricultural population. The Cauvery Water Dispute is a long time problem still to be resolved amicably among the disputants, who are indeed the four southern States of the Indian Union, namely, Tamil Nadu, Karnataka, Kerala and Pondicherry. The Amaravathy basin is a part of the Cauvery basin, which assumes greater significance in the changed circumstances as there is a need to carefully utilise the waters of the Amaravathy, for a better economic development, without wastage and with the best possible options of use with equity, efficiency and effectiveness.

Water and conflicts are inseparable that water utilisation in any form, importantly irrigation, is wrought with managerial implications. Water resources development in many of the river basins go side by side with water resources management efforts. The Amaravathy basin is already brought under a programme of National Water Management Project (NWMP, 1988-1994) which is now known as the Water Resources Consolidation Project (WRCP). The purpose behind the WRCP is that of increasing productivity of crops, especially localised ones, through an effective and efficient system of equitable distribution of water with farmers' participation, as envisaged in the Water Policy 1987 of India and the Modified Water Policy 1994 of Tamil Nadu (ISPAN-CWR, 1995).
A Review and Appraisal of Literature

Land use studies date as far back as the early eighteenth century. Land and agriculture dominated the themes in the nineteenth century. Adam Smith (1776), David Ricardo (1819), von Thunen (1826) and Alfred Marshall (1890) were the pioneers in economic and geographical researches and writings on agriculture and land uses. von Thunen developed a model of agricultural location from his experiences in his country. His theory provided, for the first time, a comprehensive view of location and differential land uses around the settlements: economic rent declined with distance from the centre of the settlement and hence the agricultural land uses changed accordingly.

In the twentieth century, land use studies began to occupy an important niche in agricultural planning. L.D. Stamp (1934) became the pioneer of land use studies in Britain. With help from academic institutions and students, he carried out the land use survey of the British Isles, in the 1930s. His ideas and methods played an important role in the scientific planning of land uses. His concern was, primarily, the use and misuse of land. Many countries emulated his example. Kostrowicki (1964) did a similar survey of Poland. In India, too, Stamp’s influence was greatly felt in several of the land use studies carried out by individual researchers, particularly geographers. M. Shafi (1960) is the pioneer with his work on Land Utilisation in Eastern Uttar Pradesh. He provided, others apart, the required impetus to the researchers and contributed tremendously in applied agricultural geography. With his efforts and influence, the themes ranged from the spatial distribution of land uses to combinational techniques (C.D. Deshpande, 1959; S.P. Chatterjee, 1945,1952; and V.L.S.P. Rao, 1959).
It was indeed during the 1940s, the land use studies have begun earnestly in India. They were however very general and not specific to land uses. With the country becoming independent and the planning era beginning to fetch a good deal of data, in the 1950s, agricultural geography began to look up. There was the use of precise, quantitative techniques for understanding the patterns and processes in agriculture. There was also a distinct departure in approach, from the regional to the systematic and the statistical.

In the 1960s, there was an academic revolution. Many conceptual researches were conducted. In the 1970s, the quantitative approach to researches enabled the researchers to generate, compile, store, analyse and map voluminous data through computers. This development ushered in precision, coherence and comprehensiveness. Indian geography moved from derivation to enhanced efficiency of analysis and application to prediction. Trend of the 1980s focused on the geographical analysis of socio-economic indicators, with orientation to economic growth, agricultural growth and productivity, diffusion of new technology and the study of food systems (Indian National Science Academy, 1984). In the 1990s, the themes of agricultural research include geography of food (agricultural geography in a new mould), alternative and organic agriculture, environmental protection and restoration, environmental management and sustainable development. On the methodological front, cartographic and statistical methods have become enriched with the satellite remote sensing and geographical information systems analysis.
Studies on General Land Uses

There have been several studies, collaborative and individual, dealing with general land use studies. Being a popular field of research, within the geographical realm, agricultural land use categories have been analysed in most case studies (for example: B.B. Singh, 1975; B.K. Roy, 1973). In one of the studies (B.B. Singh, 1975), dealing with an administrative block, it was found that between 1931 and 1983 there was a decline in the cultivable area while the non-cultivable area increased. Population growth, strangely, was attributed with this change. There was a similar conclusion from a study of West Bengal, which showed such a decline during 1953-61 (B.K. Roy, 1973).

The patterns of general land use distribution (S.A. Khan, 1980) in the Ganga-Yamuna Doab and the spatial variations in land use orientations in Andhra Pradesh (N.B.K. Reddy and Y.V. Ramaiah, 1986) using Kostrowicki’s (1970) methodologies. It was found in the study of general land uses in Andhra Pradesh that there were 44 different combinations of land use orientations. Statistical estimations began to be attempted in researches on the cultivation potential (B.K. Roy, 1969). Time series analyses and spatial variations in land uses were measured in percentiles about the same time (S. Kaur, 1969). Successes and failures in land uses primarily due to the basic factors affecting agriculture was studied in the floating garden region of Kashmir (R.N. Raina, 1962). According
to another study of the Kashmir Valley, the climate and the soils were found to be the most important factors affecting agriculture in the region (Raina, 1963).

In the early 1970s, however, the researchers began to see increases in the cultivated area and declines in the permanent fallows as did I.D. Sharma (1971). Similar increase in cultivated area with a corresponding decline in the forested area was also reported (P. Das, 1973). Another study showed that, in the period between 1921 and 1971, there was a significant, positive correlation between the growth rate of population and the total cropped area, for example in Bhagirathi Churni Interfluve (J. Sen and S. Sen, 1979). Climatic impacts on agricultural land uses were extensively studied by the Indian geographers, because Indian agriculture is a gamble on monsoon. The variability of rainfall had definitive impacts on the net sown area and fallow land (S.N. Prasad, 1979) just as the probability of rainfall reflected upon the distribution of land under various crops, as in Ranchi district. Changing pattern of cultivable waste was researched in a particular study of Uttar Pradesh and this study found that between 1941 and 1971 the cultivable waste declined by 80 per cent (S. Pandey, 1977). Utilisation of soils such as saline and alkaline soils were also studied in the context of land uses in Aligarh district and suggestions were made for reclaiming these soils for effective management (A.L. Singh, 1974).

It has been assessed that the Ghaghara-Rapti doab is endowed with potential agricultural land but it has not been properly coaxed (N. Mohammed, 1981). On the other hand, it has also been concluded from a study of the spatial pattern of land utilisation in the Nalbari district of Assam that the arable land has
reached its limit while the culturable wasteland has shown the promise of increase in the net sown area (A.K. Bhagabati, 1989).

Other recent studies have turned their attention to analysing relationships, for example, between farm size and crop land use, long fallow and current fallow land in Tamil Nadu (S. Subbiah et al, 1990). Such studies have shown that the farm size has a definite bearing on the incidence of fallow land. Also, the net sown area has been seen declining with farm size. Long and current fallows have also been seen to be increasing with the farm sizes (see S. Aruchamy and T.V. Kumaran, 1994).

**Land Use Patterns and Regional Analysis**

With Shafi's pioneering work on land utilisation, various researchers have analysed the land use patterns in regional contexts (M. Shafi, 1965; K.L. Joshi, 1971). It was conclusively proved from a study of land use pattern that the supply of seeds, manures, irrigation facilities and the like alone cannot change the agricultural pattern of an area. For intensive utilisation of the land, it is necessary to assess and adopt rotation (T. Das, 1973).

A number of researchers turned their attention to analysing land use patterns in respect of command areas and subregional contexts (K.M. Pofali, 1975; V.R. Singh, 1975; B.K. Roy 1967). Regionally speaking, current land use practices are not very economical everywhere. It is very much so in the Eastern Himalayan Region (S. Lahiri, 1981) has been borne out in a research here. Other studies have shown that the relative importance of multiple cropping to the net
sown area is surprisingly low in a district of Uttar Pradesh. The distributional patterns have shown variations from less than 23 per cent to more than 104 per cent (J.P. Gupta, 1981). Taking the climatic zones of India, it has been found that there are various options in rotation and that for 38 different soils regions of India, the choices of crop rotation are indeed numerous (O.P. Bishnoi, 1981).

Use of land for agriculture is not always wrought with benefits. The existing land use patterns in some hills of the Uttar Pradesh have indicated to the disruption and deterioration of the ecosystems (C. Sen, 1986) and that it is necessary to change the land use patterns so that the ecosystems could be restored. There is high magnitude of risk in the cultivation of some crops over the others, especially in terms of land allocation under uncertainty and risk in groundnut cultivation in Tamil Nadu (G. Mythili, 1988). This has however prevented the farmers from allocating land to favoured crops, such as groundnut and sugarcane. Examining the cropping patterns in Haryana, research has concluded that the bulk of the arable land is devoted to the low valued crops such as jowar, bajra, gram and barley and less areas are occupied by the favoured commercial crops (S.L. Gupta, 1971). This has resulted in farmers receiving small returns in money terms. Such cropping patterns have therefore shown lacunae either in the locational decision processes in cropping or in the non-optimal use of lands (J. Singh, 1982; B. Ram and D.C. Joshi, 1984). There is thus need for a complete transformation of the cropping patterns of many areas (P. Reddy, 1983; R.S. Tripathi and J.P. Viswakarma, 1988), the examples being those of Kalahandi district of Orissa (M. Patnaik and C.R. Pathak, 1981), Madhya Pradesh (B.P. Panda, 1979) and Upper Tons basin (B.M.P. Sharma, 1975).
Physical Determinants

Physical environment has its own influence on the land use patterns is proved beyond doubt (Stamp, 1962). There are several physical determinants of agricultural land uses (E. Ahmed, 1959). Soil fertility and crop productivity show positive correlations in respect of Garhwal district (B.S. Negi, 1978). Physiography, soils and crop relationships are seen positive in a semi-arid area of Ahmednagar (C.R. Chowdhury et al, 1981). Landforms bear close relationships with the soils and the cropping patterns, especially according to the physical potentialities (Chowdhury et al, 1986; P.C. Vats, 1981; S.S. Dhillon, 1975). It has been found that the harvest is delayed by a day for every ascent of 50-75 metres in Mahasu district of Himachal Pradesh (Dhillon, 1975; 1977). Hill slopes impact upon the land uses around Sagar in Madhya Pradesh and one can see different possibilities of land uses along the different slopes (R.K. Rai, 1981). Slopes facing sun have shown different land uses than the slopes away from the sun (Dhillon, 1977). Slopes above 5° impose severe limitations on the cultivation of crops while those below 3° are most significant in agricultural development have been shown in a research of V.S. Datye and S.C. Gupte (1979, 1984) in Poona district of Maharashtra.

Water balance and agricultural land uses have been analysed and the immense significance of the two has been determined in many researches (B. Dey, 1978). Notable among the relationships seen so far are between moisture adequacy and the cropping pattern (M.J. Subramaniam and V. Vidyanath, 1984). Low moisture adequacy and diversification studies have shown that the lower the
moisture adequacy, the greater is the diversification. Soil moisture, water availability and crop suitability are so intricately related (M.S. Rao, 1986) that it may be inferred that climate and land uses are positively correlated (B. Hemamalini, 1986) while floods/drought and food production are negatively correlated (K. Ramachandran, 1992). However, there are also evidences to suggest that drought does not affect productivity adversely, though it does the cropped area.

**Cultural Determinants**

In the years before the 1950s, geographers have been preoccupied with the explanations of the distribution patterns derivative of the physical environment alone (W.B. Morgan and R.J.C. Munton, 1971). In the later years however, cultural forces have been given their due importance in the land use studies. Of all the cultural elements, most analysed is the relationship between population and land use, especially, population pressure on land and land uses (R.S. Dube, 1969). There has been a growing emphasis on food crops and food production in India owing primarily to the growing pressure of population. There are exceptions, however. In the cotton belt of Vidarbha, the cropping pattern remains the same despite the population pressure (P. Shastri, 1981).

Cultural forces induce metamorphosis in land uses and settlements. A study of the nature and degree of change in land uses in Bhagirathi-Jalangi interflue over 125 years has shown a decline of the influence of population growth (J. Sen and R. Bhattacharya, 1981). The trend here has been that of a balance between the humans and the land uses, with the depopulated areas
becoming fallow and gradually being encroached upon by the jungles. Land uses in many areas have fostered the agricultural settlements and favoured population expansion. Northern Bihar is a standing testimony to these relationships (K.K.L. Das and K.N. Das, 1981). There are good examples of population pressure and agricultural land use relationships in West Bengal, too (J. Bagchi, 1981; S. Basu, 1989). However, levels of impact could be moderate as deduced from population growth and crop area increases (L.R. Singh and R.N. Dubey, 1990) and population growth and area sown more than once (D.B. Goswami, 1990).

Land consolidation had attracted the attention of geographers in their researches. K.L. Lal (1969) had identified some of the problems arising out of consolidation, in Azamgarh of Uttar Pradesh. There were problems of decline in cultivated area, change in cropping patterns and shortfall in improvement programmes, just as there were some improvements also in extended cultivation and soil management (S.N. Tiwari, 1970). Improvements resulting from land reforms have been analysed by others (for example, R.J. Mishra, 1986) as leading to consolidation and resizing of plots and also improvements in farming systems operations.

Gross cropped area varies inversely with the gradually increasing holding sizes (A. Kundu, 1981). It has also been proved that the variations in agricultural patterns at the micro level can be explained and associated with the size and patterns of land holdings and the process of fragmentation (Datye, V.S. and J. Diddee (1981).
Infrastructures and facilities provide for a discernible change in the cropping patterns and agricultural development is shown through a study of HYVs, double cropping in kharif and rabi seasons and electrification and transportation (S.K. Singh, 1971; W.H. Wake, 1962). Similarly, marketing and storage have been related to new cropping patterns (K. Kanungo, 1968). Irrigation has been analysed as the influence on the cropping pattern (S. Banerjee, 1984) varying with distance and crop productivity (T.C. Sharma and O. Coutinho, 1982). It is conclusively proved that Karnataka's efforts at irrigation have been inadequate to effectively meet the challenges from high yield technology. There have been several studies analysing the relationships between irrigation and agricultural land uses, ending up with conclusions of inadequate efforts and improvements (C. Palanivelu, 1974; V. Vidyanath, 1982; K.N. Udayakumar, 1986). A.L. Singh (1992) has analysed the impact of different sources of irrigation on cropping patterns, yields and farm practices and has found that the private tube well irrigation contributes far more to crop output than the canal irrigation.

A notable contribution applying the von Thunen propositions to Indian agriculture and testing its validity has been made by S.K. Sharma and Archana (1980) with Sagar as a case in point. Modifications on the other hand have been sought to be built keeping in view the changing conditions and interactions between geographical and economic elements (V.R. Singh, 1976). The relevance of von Thunen in a subsistence economy has been tested with Delhi as the background (S. Singh, 1981) and the theory has been found to have validity even while far removed in time and space (see Shafi, 1982).
**Temporal and Spatial Changes**

Weaver's study (1954) of the United States' midwest is perhaps the pioneering study of the volume of change. This study has formed the basis for an Indian study of change in agricultural land uses and crop production in Haranarayanpur and Golghari villages of Aligarh district (M. Shafi, 1965), bringing out the fact that the current patterns are a result of past socio-economic interactions. Input changes over time has also been analysed and found to have changed the spatial patterns of cropping in the deltaic West Bengal (R. Bhattacharya, 1972, 1981). For determining the nature and extent of changes, quantitative analyses have been carried out by C. Palanivelu (1976) and E. Swaminathan (1989). Such changes as temporal and spatial changes in crop patterns have also been noticed through new laws and restrictions by the Government on the land uses (B.B. Dutta, 1986). A slow change has come about from jhum cultivation to terraced cultivation for mixed farming also because of similar interventions (for study of this nature see D. Datt, 1988).

**Crop Combination Regions and Regionalisation**

Agricultural land use planning has been considered essential for agricultural development. Regionalisation on the basis of crop combination analysis has been said to be a step ahead in this direction (B.L. Sharma, 1991). Weaver's contribution in 1954 stood the test of time and proved valuable in researches some long years later (Krishnamurthi, 1982; Somashekar, 1994). The combinations having the smallest sum of deviations could be best suited to combinations formed by the important crops (J. Singh, 1974; K. Doi, 1957).
There have been some instances in which researchers have applied several methods, for combinations based regionalisation. Besides the methods of Weaver and H.J. Nelson (1955), simple percentages and ranking methods have been attempted for determining combination regions (M.M. Das, 1984; R.B. Mandal, 1969; M. Husain, 1972; S.L. Amatya, 1973). Extensions of Weaver's methodology have also been attempted to a whole spectrum of agricultural activity (J.T. Coppock, 1964), including livestock. New methods have been devised as well for the same purpose (N.P. Ayyar, 1969), known as maximum distance method. This method has made possible the determination of the first few crops which could be more important in regionalisation. Doi (1957) is one of the others who devised other methods of regionalisation, which have been used by others. Y.V. Ramanaiah and N.B.K. Reddy (1986) have used Doi's method to identify the basic crop combinations of Andhra Pradesh (also J.P. Gupta, 1978 for Upper Ganga region; J.C. Kuniyal, 1988 for Nainital district and areal differentiation of crops, controlled mainly by the hilly, Bhabar and Terai relief conditions). A temporal analysis by the same authors indicate to a tendency of specialisation.

Crop associations in different altitudinal zones of Garhwal Himalayas have been studied and a number of combinations have been found, although the general conclusion is that the higher the altitude, the smaller is the number of combinations (S. Alam, 1987). Other works of related literature include the study of Trans-Ghaghr plains by W. Mohammed and K.Z. Amani (1973) and Rohilkhand region (A. Khan, 1973). Also see M.F. Siddique (1974), B.S. Negi (1978), P.S. Tiwari (1986), A.C. Athwale (1966) and S.C. Chakraborty (1981).
Crop Concentration and Diversification

In order to measure the regional character of distribution of crops, two measures of intensity of a crop in a region have been devised. They are the methods of crop concentration and diversification. These measures could show up the domination of one crop over the others. Crop concentration is defined as 'the pattern of crop distribution in terms of density of any given crop in a given region at a given point in time'. There are many statistical techniques for the delineation of intensely cropped areas in a given area. Bhatia (1965) suggested a location quotient method to measure the cropping intensity in the following manner:

\[
\text{Index of concentration of crop} = \frac{\text{area of crop in an areal unit}}{\text{total cropped area in the unit}} \div \frac{\text{area of crop in the entire region}}{\text{area of all crops in the entire region}}.
\]

Bhatia's method has been used in the study reported here, with a slight modification: that is, the index derived from Bhatia's method has been multiplied with 100, to express it in percentages. It is said that crop diversification patterns have great relevance for agricultural land use systems analysis, from the point of view of planning. The following is the method of Bhatia.

\[
\text{Index of crop diversification} = \frac{\text{Total percentage of harvested area under } N \text{ crops}}{\text{Number of } N \text{ crops}}
\]

where \(N\) is the number of crops which occupy five or more per cent of the total harvested area in the component areal unit.
Gibbs and Martin (1962) have also proposed an index of diversification which is an effective method of analysis. This model has the form:

\[
ID = \left[1 - \frac{\sum x_i^2}{(\sum x_i)^2}\right] \times 100
\]

Or

\[
ID = \left[1 - \frac{x_1^2 + x_2^2 + \ldots + x_n^2}{(x_1 + x_2 + \ldots + x_n)^2}\right] \times 100
\]

where \(x_1, x_2, \ldots, x_n\) represent the percentages of cropped area by each of the crops.

Bhatia's method has been used in several studies, notably M. H. Singh (1963) for the analysis of crop diversification in Malwa region of the Punjab. This study has found that the crop diversification is the maximum under ideal conditions of fine soils, adequate rainfall, irrigation facilities and level land. On the other hand, V.S. Chauhan (1975) in another study has concluded that the diversification is greater in the moderate cropping areas such as the Jammu-Hindon tracts of the western Uttar Pradesh. Yet another study (J. Singh, 1979) has concerned itself with the spatial and temporal variations in crop diversifications in the Punjab and employed the Bhatia method for the years 1951 to 1976. This study has concluded that the region has been losing its diversity and gaining specialisation during the period.

A regional analysis of crop specialisation and diversification in recent years in Andhra Pradesh (Ramanaiah and Reddy, 1986) has categorically concluded that the cropping systems of this state are moving towards

**Agricultural Productivity and Efficiency**

By definition, agricultural productivity refers to the quantum of production per unit area and efficiency denotes the level of existing performance of an unit of land which differentiates one area from another. Production of agriculture as grain equivalent unit (Buck, 1937), output per area and ranking coefficient method (Kendall, 1939), input-output ratio (Khusro, 1965), carrying capacity of land (Stamp, 1959), weightages to the rank order of the output per unit area with the percentage share under crop and total production in monetary terms (Husain, 1976) are all some of the methods that have been in use in measuring the agricultural efficiency.

A significant increase in efficiency has been seen in the agriculture of Uttar Pradesh during 1948-57 in a study by M. Shafi (1962). In another study, the agricultural efficiency of the district of Jaipur has been studied (I. Pal and S.C. Kalwar, 1973) and suggestions for remedial measures towards improving efficiency have been made. Similarly, inter-district variations in agricultural productivity of two major crops in Karnataka have been analysed by T.C. Sharma and O. Coutinho (1976) for the period 1961-72, with the help of a composite index of agricultural productivity. A replication of this study has been made by S.K. Sharma (1980) measuring the variations in productivity in Madhya Pradesh.
Regional variations in productivity have been attributed to irrigation intensity, use of chemical fertilisers and HYVs of seeds. Environmental, technological and institutional factors have been used as determinants of agricultural productivity in a study by S. Subbiah and A. Ahmed (1980) taking Tamil Nadu as a case in point for analysis.

Irrigation efficiency has been found to be good for growing paddy in the Chittar basin of Tirunelveli (G. Soundaravalli, 1983). A seminal study which concluded that the high productivity region forms a core from which the productivity levels decline towards the peripheries has taken the role of the technological factors in increasing the productivity in Azamgarh district, Uttar Pradesh (A. Munir et al, 1989). Stepwise regression has been used in some studies to identify the factors responsible for the levels of productivity, for example, in a Himalayan village by R. Chand and K.C. Joshi (1991), concluding that the productivity could be improved upon by the sustained yield methods of land management.

Refinements to the existing methods have been made in Indian research. Reddy and Ramanaiah (1985) have made a refinement to the method of Kendall, known as the Standard Coefficient Method, for analysing the land use efficiency in Andhra Pradesh. Land use efficiency has been analysed and regionalisation has also been accomplished by using only the positive variables for Royalaseema region of Andhra Pradesh by P.K. Reddy and P. Narayanamma (1992).
Delineating agricultural regions through careful analysis and describing them have long been a major concern of geographers in India and elsewhere. O.E. Baker (1926) delimited the agricultural regions of North America, using variables such as moisture conditions, temperatures, topography and soils. Subsequently, C.F. Jones (1928) classified the agricultural regions of South America and thus made a pioneering contribution to geography. G. Taylor (1930) delimited the agricultural regions of Australia using climatic differences. Agricultural regions of India were outlined by V.S. Valkenberg (1933) in his work on the agricultural regions of the world. However, the monumental work on the world agricultural regions was by Whittlesey (1936) who divided India into two major agricultural regions: (1) Rudimentary sedentary tillage and (2) Intensive tillage (a) with rice or (b) without rice.

Most regionalisation efforts hitherto referred to have been made with qualitative and less rigorous quantitative analysis. First person to delimit the agricultural regions quantitatively was J.C. Weaver (1954). Since his contribution, geographers who were confined themselves to unilateral, single set of variables, had begun multifactor and multilevel analyses in agricultural geography. J. Kostrowicki (1972) has developed an universally acceptable technique to identify agricultural types and regionalisation. In his eminent study on world agricultural typology, he identified 5 first order, 20 second order and 56 third order types of world agriculture.

Contributions by Indian researchers, particularly geographers, are by no
means small. Agricultural regionalisation of India on the basis of territorial differentiation of crop structures and efficiency in their production was made by S.P. Gupta and V. Sdasyuk (1968). Following the example, P.S. Sharma (1971) has attempted agricultural regionalisation of India with six agricultural variables, namely, gross irrigated area, average rainfall, net area sown, intensity of cropping, percapita gross area sown and soil index rating. State level generalisation has been attempted by V.R. Singh (1979) for India based on 22 agricultural attributes. J. Singh (1983) has classified the agriculture of Haryana into 8 types with the help of 25 different variables, using data from 3,000 operational holdings in 142 villages of 42 cropping regions. Two other geographers, B.P.Panda (1979) and B.L. Sharma (1983), have delimited the regions of Madhya Pradesh and Rajasthan, respectively, basing their classification on 20 attributes and computing the maximum class similarity. Cluster and least square methods have been used in delimiting the agricultural regions of Andhra Pradesh by V. Vidyanath (1986). His study has found that irrigation intensity is the most dominant controlling factor when compared to natural factors such as the relief and soils. Monoculture or two-crop combinations have been found in regions where there is a high intensity of irrigation.

Coefficient of geographical association has been used to regionalise 19 administrative blocks of the Sundarban of the 24 Parganas in West Bengal by R. Gupta (1991). Taking major terrain features S.Singh and N. Rastogi (1992) have delineated morpho-agricultural regions and sub-regions of the eastern Rewa Plateau. Factor approach has been used by S. Santra (1993) for delineating developed agricultural regions, for Haora district of the state of West Bengal, using 14 extracted factors.
Remote Sensing in Land Use Studies

Aerial photographs and satellite images have been used widely in mapping the temporal changes in land uses and forest cover (Anderson, 1976). Textural significance and the structure of images or aerial photographs have been used in correlating them with the land use patterns of sand dunes in Jodhpur and Bikaner districts of Rajasthan by A.K. Sen (1977). S. Thiruvenkadachari et al (1994) have conducted research on irrigated agriculture, after the introduction of National Water Management Project in the Bhadra Project of Karnataka State, developing a paddy yield prediction model, relating satellite derived normalised difference vegetation index (NDVI). Using the NDVI, they have been able to describe the spatial variability in crop varieties such as IR64, Sonna, IR20, Jyothi and Jaya. They have concluded that the difference in variety cultivated is expected to affect the yield prediction model through (a) change in plant characteristics such as chlorophyll content and leaf area index affecting NDVI and (b) varieties having distinctly different yield ranges.

Land Use Studies in Tamil Nadu

Land use studies have been of primary concern in Tamil Nadu for a long time. N. Anandapadmanabhan (1956) identified the close relationships between density of rural population and land uses in Tamil Nadu. M.N.V. Devi (1964) studied in detail the agricultural geography of South India. Changes in cropping patterns have been measured using analysis of variance by C. Palanivelu (1975). Dry farming characteristics in Dharmapuri district have been studied by S. Jayachandran (1978). Components of agricultural growth and levels of
agricultural development have been deeply analysed by G. Parimala and M.H. Qureshi (1981, 1983). The Madurai school of geographers has contributed on various aspects of agriculture and groundwater potential (E. Swaminathan, 1982; 1984), relationships between water balance and cropping pattern (E. Swaminathan and A. Shanthakumari, 1983) and rates of growth of area, yield and production during the sixties and seventies of green revolution (G.S. Subramaniam and S.P. Vasanthi, 1988). Agricultural development of the Kollivills, considering the tribal and cultural ecology of the area, has been analysed by T.V. Kumaran (1983) using factor and cluster approaches.

Land management for rural development taking crops, crop schedules and socio-economic aspects of cultivation has been analysed through factor approach by S. Aruchamy (1986). A similar but an elaborate approach has been followed by R. Jaganathan (1994) for land evaluation for agriculture in the Kambam valley of Madurai district. Land use patterns by districts using linear trend analysis and location coefficient techniques to estimate variations have been studied by M. Thangaraj (1992). S.R. Nagarathinam and N. Sivagnanam (1992) have analysed the water availability during different crop seasons in Coimbatore district and found that moisture deficit is high throughout the district during Chittiraipattam. Crops sown during Adipattam and Purattasi Pattam need one or two supplemental irrigation for better production. R. Jayakumar and M. Siraz (1992) have determined the suitability of groundwater for irrigation in Attur valley and concluded that the suitability of water for agriculture is mostly marginal and is characterised by saline and alkaline hazardous status. Similar study has been carried out by T. Elampooranam and P.H. Anand (1991) in the Cauvery delta of South India.
As for the present study area, there are but a few studies. G. Soundaravalli (1978) has made complete study of morphometry of the basin. Demand-Supply equation of the water resources in the Amaravathy basin has been assessed comprehensively by S. Selvarajan and S.R. Subramaniam (1988). Their analysis indicates that there is an excess of demand of 37.9 per cent over the existing supply and hence they suggest that a rational water use in the existing irrigated area is the only way to extend irrigation facilities to the entire command so as to maximise returns.

Of late, there has been a great concern over the expansion of irrigation facilities in the state and participatory approach to irrigation management for agricultural practices. Experiences in this area have been summarised for the state of Tamil Nadu in a report published jointly by the Centre for Water Resources, Anna University and Irrigation Support Project for Pacific and the Near East (ISPAN) in 1994. A World Bank funded evaluation project of the National Water Management Project (NWMP) in Sathanur Project Command has been carried out by the International Irrigation Management Institute (1995). A project of irrigation management transfer is due to earnestly begin in the Amaravathy basin with the World Bank support.

The Problem of Study

The problem under analysis is to understand how agricultural land uses in the Amaravathy basin have been changing over the 22-year period between 1971 and 1992 as a result of various governmental programmes and also community
and individual efforts at improving productivity. It concerns basically with crops, cropping, production and welfare. By way of definition,

Cropping is a process in which land is put to use in the best way the farmers could, under different utilisation types (crops), often in combinations and intensities (crop, irrigation) through a mix of traditional and modern systems of land and water management, towards the goal of maximising production and, in turn, income and welfare of the family, which is the basic organising unit for farming.

The analytical framework envisaged for this study is shown in Figure 1.1. It is seen from the figure that the land use changes are considered as the impacts of development programmes and community and individual efforts at increasing productivity. The problem under consideration therefore is of the land use changes that can be measured through productivity, crop combinations, concentration and diversification of crops in the basin and their socio-economic and welfare impacts at both the blocks (administrative, spatial units) and farmers (social, individual) levels. The benefits accruing from these measures and findings and their implications would be in the understanding of agricultural change as it has occurred in the basin, given the conditions that have been existing in more than several decades of agriculture. There is also an attempt in this study to regionalise land uses, in a general way, using blocks as the basic units of regionalisation. The study, it is envisaged, would also provide insights into the nature and extent of agricultural change in the near future and the organisational (social, economic, spatial) and managerial strategies that would be needed to make it most rewarding and less damaging to socio-cultural milieus and the physical and human environment.
Changing patterns of agricultural land use in Amaravathy basin

Agriculture in the basin Scenario - 1971-91

Basin Irrigation development

Agricultural land uses in Amaravathy basin

Impacts / Changes -
- Land use types
- Productivity
- Combination Concentration and Diversification
- Socio-economic and welfare impacts
  - Block level
  - Farmer's level

Implications for agricultural change
- Uses
- Patterns
- Changes
- Proposals

Agricultural development
- Land uses
- Crop processes
- Crop and Irrigation intensities
- Irrigation water management

Organisational / Managerial Strategies

Feed back

Fig. 1.1 An analytical framework for the study
Aims and Objectives of the Study

The main aim of the present study is to analyse the temporal and spatial aspects of agricultural land uses in the Amaravathy basin and to evolve a strategy for optimum land use practices. To achieve the aim above, the following objectives are set forth:

1. A study of general agricultural land uses and utilisation types and patterns for a select period of 1971-1992 in order to bring out temporal as well as spatial changes that have occurred during the period considered;

2. An examination of crop concentration, diversification and combinations towards understanding changing land management practices; and

3. An analysis of socio-economic dimensions of farmers, their farming practices and prospects and a consideration of implications for agricultural change and development in the basin under study.

Amaravathy Basin: The Study Area

Selection of the Study Area. A river basin, with a defined watershed boundary, is a natural unit for selection. It is also a suitable unit for planning. The Amaravathy basin has been selected as there have not been any concerted attempts at land use planning in the basin, so far.

The Amaravathy basin (Figure 1.2) forms a part of the Cauvery basin and comprises of the catchment of the Amaravathy and its tributaries of Shanmuganathi, Nallathangal Odai, Nanganjar and Kodaganar. This basin falls
in four districts of the state of Tamil Nadu, namely, Dindigul-Anna, Coimbatore, Periyar and Tiruchirappalli districts. There are in all 25 blocks as shown in Table 1.1. As can be seen from the table, the basin includes four taluks from Dindigul-Anna district, three taluks from Coimbatore district, two taluks from Periyar district and one taluk from Tiruchirappalli district. The four taluks of Dindigul-Anna district have between themselves a total of eleven blocks, three taluks of Coimbatore district a total of five blocks, two taluks of Periyar district a total of five blocks and one taluk of Tiruchirappalli district a total of four blocks. In all, there are 25 blocks. Kodaikanal taluk is a block by itself and being a hill resort is characterised by activities other than agriculture, especially tourism. Hence, this block is not considered in many analysis in the present study.

The elevation varies from 150 metres in the northeast to more than 2,000 metres in the south. The command areas of the Amaravathy and its tributaries are economically well developed than the catchment areas.

The Methodology

Database. In the present study, primary as well as secondary data are used. Blockwise data covering general land uses, crop areas, rainfall and all related items have been collected from various sources, importantly from those of the Directorate of Statistics, Madras and the local offices at the taluk and district headquarters and agricultural offices at the district headquarters. Data on
Table 1.1: The Amaravathy Basin: Administrative Units

<table>
<thead>
<tr>
<th>District</th>
<th>Taluk</th>
<th>Block</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Dindigul-Anna</td>
<td>Dindigul</td>
<td>Athoor</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Dindigul</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Reddiarchatram</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Shanarpatti</td>
</tr>
<tr>
<td></td>
<td>Vedasandur</td>
<td>Gujiliamparai</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Vedasandur</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Vadamadurai</td>
</tr>
<tr>
<td></td>
<td>Kodaikanal</td>
<td>Kodaikanal</td>
</tr>
<tr>
<td></td>
<td>Palani</td>
<td>Oddanchatram</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Palani</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Thoppampalli</td>
</tr>
<tr>
<td>2. Coimbatore</td>
<td>Udumalpet</td>
<td>Madathukulam</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Udumalpet</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Gudimangalam</td>
</tr>
<tr>
<td></td>
<td>Palladam</td>
<td>Sultanpet</td>
</tr>
<tr>
<td></td>
<td>Tiruppur</td>
<td>Pongalur</td>
</tr>
<tr>
<td>3. Periyar</td>
<td>Kangayam</td>
<td>Kangayam</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Vellakoil</td>
</tr>
<tr>
<td></td>
<td>Dharapuram</td>
<td>Kundadam</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Dharapuram</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mulanur</td>
</tr>
<tr>
<td>4. Tiruchirappalli</td>
<td>Karur</td>
<td>K.Paramathy</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Aravakurichi</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Karur</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Thanthoni</td>
</tr>
</tbody>
</table>

Source: Census of India.

sourcewise irrigation have been collected from the Irrigation Department, on-going irrigation projects and the Public Works Department offices at the local divisions. Controlled well data have been collected from the Groundwater Division of the Irrigation Department, Madras.
Data from secondary and documentary sources cover different periods and features. Rainfall statistics relate to a period of 1957-1992. Land use statistics relate to a period of about 22 years, that is, 1971 to 1992. Land use changes have been examined for the same period, with a 10-year interval. Thus, the study draws inferences relating to three time periods, namely, 1971, 1981 and 1991. The year 1992 is the terminal period of investigation in all other respects.

Population data have been taken from the Census Reports. Data regarding various aspects of the socio-economic conditions and crop and land details have been gathered from the published and unpublished records maintained by various Government Departments. As the data from Government Departments have some discrepancies, they have been improved upon by various checks in the field, as part of the field study. Primary data have been collected from a sample survey, conducted in 21 villages (Table 1.2) with 295 sample farmers. Sample farmers have been chosen on a systematic area sampling method.

The villages have been chosen for their representative characteristics (Figure 1.3). Farmers have however been chosen randomly in the 21 sample villages of the basin. The sample consists of 10 farmers each from 4 sample villages and 15 farmers each from 17 other villages. Two adjacent villages have been selected from Madathukulam block, to represent the new command of the Amaravathy (A.K. Pudur) and the old command of the basin (S.K. Pudur). Two villages from the block of K. Paramathy have been chosen, as their names indicate, to represent dryland agriculture (Punjakalakurichi) and wetland agriculture (Nanjakalakurichi). Chettinaickenpatti of Dindigul block and Andankoil East of Thanthoni block have been chosen to represent urban
influence, Dindigul and Karur towns respectively, on the agricultural land uses. Data collected from them, using a pretested schedule (Appendix 1.1), orally administered, in a free associational fashion, are reasonably good.

**Techniques Used**

Various statistical and cartographic techniques have been used in drawing inferences which are described in the thesis. Rainfall variability, general land use and crop areas and crop combinations have all been analysed using relevant

<table>
<thead>
<tr>
<th>No.</th>
<th>Block</th>
<th>Villages</th>
</tr>
</thead>
<tbody>
<tr>
<td>01.</td>
<td>Athoor</td>
<td>N. Panjampatti</td>
</tr>
<tr>
<td>02.</td>
<td>Dindigul</td>
<td>Chettinaickenpatti</td>
</tr>
<tr>
<td>03.</td>
<td>Shanarpatti</td>
<td>Kambilampatti</td>
</tr>
<tr>
<td>04.</td>
<td>Gujiliamparai</td>
<td>Ullikottai</td>
</tr>
<tr>
<td>05.</td>
<td>Vedasandur</td>
<td>Eriyodu</td>
</tr>
<tr>
<td>06.</td>
<td>Vadamadurai</td>
<td>Kulathur</td>
</tr>
<tr>
<td>07.</td>
<td>Oddanchatram</td>
<td>Virupakshi</td>
</tr>
<tr>
<td>08.</td>
<td>Palani</td>
<td>Balasamudram</td>
</tr>
<tr>
<td>09.</td>
<td>Thoppampatti</td>
<td>Poosaripatti</td>
</tr>
<tr>
<td>10.</td>
<td>Madathukulam</td>
<td>A.K. Pudur</td>
</tr>
<tr>
<td></td>
<td></td>
<td>S.K. Pudur</td>
</tr>
<tr>
<td>11.</td>
<td>Udumalpet</td>
<td>Thenboothinatham</td>
</tr>
<tr>
<td>12.</td>
<td>Gudimangalam</td>
<td>Eluppanagaram</td>
</tr>
<tr>
<td>13.</td>
<td>Pongalur</td>
<td>Koduvay</td>
</tr>
<tr>
<td>14.</td>
<td>Kundadam</td>
<td>Gethelrev</td>
</tr>
<tr>
<td>15.</td>
<td>Dharapuram</td>
<td>Kongur</td>
</tr>
<tr>
<td>16.</td>
<td>Mulanur</td>
<td>Kannivadi</td>
</tr>
<tr>
<td>17.</td>
<td>K. Paramathy</td>
<td>Punjakalakurichi</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Nanjakalakurichi</td>
</tr>
<tr>
<td>18.</td>
<td>Aravakurichi</td>
<td>Zamin Alamathupatti</td>
</tr>
<tr>
<td>19.</td>
<td>Thanthoni</td>
<td>Andankoil East</td>
</tr>
</tbody>
</table>

Source: Sample Selection.
statistical techniques. General land use pattern is analysed by simple percentage method. Rafiullah’s method has been used to delimit the crop combination regions in the Amaravathy basin. For regionalisation and for socio-economic analysis, the principal axis components analysis has been used as it is both a mapping and classificatory tool. Summary statistics have been used wherever necessary for describing the variables involved in the analyses. In certain cases, one-way tables have been generated to facilitate the interpretation of the data. Detailed account of various techniques used in the study is given in the respective chapters where the results from these applications are dealt with.

The Organisation of the Thesis

The present thesis is composed into seven chapters. The first chapter is introductory and serves to introduce the problem of analysis and the framework for such analysis, the objectives, the methodology and the organisation. There is also a brief review of earlier research to focus upon the components of analysis here so that the problem of analysis may be confined within appropriate limits. The second chapter deals with the physical infrastructure of the study area, which is the Amaravathy River Basin, in terms of its physiography, geology, relief, climate, soils, natural vegetation, irrigation and related aspects. The third chapter includes the general land use of the study area, with a pointed focus on the agricultural land uses. The patterns are described, their distribution is analysed and the trends of the present and the future are given due consideration. Agricultural technology, institutional infrastructure, marketing and transportation are also examined in some detail.
The fourth chapter deals with cropping patterns, intensities, land use efficiency and the changing cropping patterns over the two decades. In the fifth chapter is a critical and descriptive account of the crop combination regions, ranking of crops and the patterns of crop concentration cropping diversities and specialisation. Trends in these have also been analysed to be included in this chapter. Ranking of crops and changes in the cropping intensities and areas have been analysed also in this chapter. The sixth chapter analyses the primary data in order to derive a comprehensive account of the socio-economic characteristics of the land uses from the field survey using a schedule. Inferences from the analyses are given and implications are drawn for formulating the strategies for optimum land uses in the basin. The final chapter provides a summary of the study and concludes the thesis with a nutshell of findings and their implications. Strategies for land use optimisation are discussed towards the end of the chapter. References and input data and output from the analyses are appended to the thesis.