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STUDIES ON HUMAN ECOLOGY AND ECO-RESTRATION OF ATTAPADY VALLEY

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SUMMARY

The present study focuses on the change in the interaction between people and land that has occured in a tribal area in the context of increasing influence of economically advanced and politically powerful groups.

The investigations were carried out in Attappady, Palakkad District, Kerala, which is one of the three tribal centres of the state. Social, economic and biophysical features of the area were studied using primary data collected mainly by the participant observation method. Agriculture, landuse, development projects, man-forest interaction, socio-economic relationships were examined so as to arrive at a picture of the human ecology of tribal communities of the region. Specific and general studies were carried out.

Three ethnic groups viz. Kurumba, Irula and Muduga constitute the tribal population, which are sprinkled over 142 hamlets. As a rule, the Kurumbas occupy high, the Mudugas medium and the Irulas low rainfall areas. Irulas are the numerically dominant community and Kurumbas form the smallest group.

The tribal population which constituted 90% of the total population of Attappady in 1951 has been reduced to 33% by 1981, because of high influx of settlers. The tribals of Attappady are educationally backward with a literacy rate of 35% as compared to the 84% literacy of the state.

The tribals who are self-reliant till some decades back depend heavily on settler population and government dole for livelihood. The per capita monthly income of the tribals reveals that they live below the poverty line. Side by side with the tribal economy, there exists a peripheral economy developed by the settlers, and the government agencies in the study area. The tribal economy, which interacts with the peripheral economy, is being destabilised at the hands of latter. Further, the tribals who were mainly cultivators have been transformed to agricultural labourers due to large scale land alienation. Economic profiles of three hamlets belonging to Kurumba, Irula and Muduga revealed that the socio-economic condition of the tribals (Kurumba, for instance) who exercise control over basic resources is far better than that of others.

The landuse of Attappady has changed drastically during the past few decades. Although forests occupy nearly 51% of the geographical area of Attappady, nearly 60% of the forest area has been degraded. Area under habitation and agriculture is increasing.

The forest ecosystem of Attappady known for its past splendour has been totally destroyed except a few intact patches located in the southern and north-western sectors. This, in turn, has had a negative impact on the water availability, agricultural production and microclimate of the area.

The tribal agro-ecosystem is represented by shifting and settled agriculture. Shifting cultivation is practiced by Kurumbas only. Traditional crops like finger millet, little millet, pigeon pea and amaranth are the main crops. Although both the system of cultivation belong to the traditional type, the shifting cultivation is more efficient both in terms of energy and income than settled agriculture.

The major tribal development programmes in the area have been the Integrated Tribal Development Project (ITDP) and also tribal cooperative farms. The ITDP has functioned only as a benficiary oriented programme which is one of the main weaknesses of the system. Unless area development and ecorestoration programmes are launched side by side with beneficiary oriented programmes no breakthrough in tribal development can be achieved, in the study area.

The Attappady Tribal Cooperative Farming Society has established over 1040 ha of cash crop plantions and has enrolled 420 tribal families from different parts of the region. The farming society is facing economic crisis due to crop failure, mismanagement of farms, variation in crop prices, lack of training among the members in farming practices. This venture is a clear example of failure while superimposing modern concepts of development to traditional societies.

Land degradation and marginalisation are interconnected phenomena which are threatening the entire life-support system of tribal communities in Attappady. Massive deforestation, land aquisition by settlers, progressive acculturisation have all played a significant role in this matter. Tribal land alienation for the past three decades has deprived the traditional people of nearly half of the cultivated area. At present tribals are forced to exist on marginal lands on steep slopes while all the fertile lands are under the possession of the settlers.

The traditional forms of local self government have eroded and centralised administration has taken their place. This has played an important role in the disintegration of the social fabric and has led to the demoralisation of the tribal people. In olden days, the tribals lived in harmony with the nature and used what they needed. With the reservation of forests and high deforestation, the accessibility and availability of forest resources such as minor forest products, fire wood etc. have declined significantly, which resulted in change in the man- forest interactions in the study area.

CHAPTER I
Introduction

Genuine development must bring about an improvement of the human condition, encompassing satisfaction of basic needs, reduction of inequalities, elimination of poverty and the attainment of material and human or spiritual wellbeing. Quite often, when development policy is translated into action, what it achieves is just opposite. This happens especially when development concepts are superimposed on traditional societies and structures without examining and understanding how these new forces can work against the interests of the people concerned. Traditional and indigeneous people bear maximum brunt among the different echelons of the society. Development destroys their traditional, social, economic and cultural structures without offering better alternative systems.

Tribals in general and those of Attappady in particular, are most backward among the under privileged groups in Kerala. Tribal economy is a traditional one, characterised by high dependence on agriculture, minimum surplus allocation, and general receprocity within the group. Land, mostly forests, is the important natural resource and is under different uses, ranging from shifting cultivation to sedentary agriculture. Forest is not only a source of food, fuel and fodder, but also a part of their culture. A progressive decline of vegetative cover and loss of top soil due to unscientific management has had a disastrous impact, especially on watersheds and productivity of the soil. Added to this, encroachment by settlers and imposition of their cultivation practices have created a crisis in resource allocation in tribal settlements. Attempts have been made by the government to improve the living condition of the tribals and make them self reliant, but they continue to be poor, due to in-appropriateness of the development plans. Most of these attempts were counter productive due to lack of appreciation of the real needs of people and ignorance of resource base and its

Paucity of information relating to various constituents of human-land system is one of the basic constraints in evolving integrated, ecologically sustainable and economically viable development programmes in tribal areas. The present study attempts to carry out economic and ecological analysis of tribal life support systems, aiming also to develop a data base for future planning.

Objectives

(1) To evaluate different types of human interactions with forests and to identify the important causes of degradation.

(2) To reveal the subtle inter linkages and interdependence among various components (biophysical and socio-economic).

(3) To conduct a land use evaluation of the area.

Methodology

Three distinct geographicial units which are co-terminus with three ecological units have been identified in the study area. Of these, the western part of Attappady predominently consists of reserve forests areas where the rainfall is significantly high and shifting cultivation is the major agro-ecosystem. On the contrary, eastern part is mostly dry and the settled agriculture is widly practiced. The third unit, the south west part, receives medium rainfall where the cropping pattern and ecosystem are totally different from that of west and east. Interestingly enough, each tribal group preferentially inhabits these geographical units. By and large, the Kurumbas are concentrated in western sector, while the Mudugas and Irulas in south west and northern parts of Attappady respectively. The study which examines human interaction with forests as well as inter linkages of biophysical and socio-economic factors, has taken both ethnic and ecological differences into consideration, in the selection of sample hamlets.

The study was conducted in three selected hamlets, one each from three tribes. A list of hamlets of these three tribes belonging to three geographical units was collected from Intergrated Tribal Development Project (ITDP) Office at Agali, which formed the population for drawing the sample hamlets, the ultimate unit of survey. Simple random sampling method was used to select hamlets from each group. The selected hamlets are (1) Lower Thodukki (Kurumba) (2) Karara (Muduga) and (3) Lower Mully (Irula).

Although ITDP office was established during 1975, sufficient data has not been generated on various aspects of tribal life in the project area. Hence, primary information was gathered from the selected hamlets. Data available from the secondary sources is also used in the study.

Apilot survey conducted among the tribals indicated that, due to high illiteracy among the tribals and also due to the fact that the tribals seldom keep account or record on incidents that have occured in the hamlets, more.than one method should be employed to generate good quality data. Consequently, four methods such as direct and participant observation, interview, questionnaire survey and accounting methods were used.

Data collection was begun at Thodukki in 1987-88 and continued in 1988-89 and 1989-90 crop seasons. In Karara and Mully, data were gathered during 1988-89 and 1989-90. Data have been collected mainly on three parameters: economic, social and land use in the hamlets the following aspects were examined in detail.

(1) Economic

(a) Agriculture and animal husbandry
(b) Man-forest interactions
(c) Production relation (land tenure)
(d) Inflow and out flow of resources and distribution
(e) Poverty
(f) Impact of development

(2) Social

(a) Tradition and customs
(b) Social relations
(c) Attitude towards employment, income and development
(d) Literacy and traditional skill

(3) Land use

(a) Forest land use
(b) Watershed management
(c) Land degradation

Methods used to analyse the individual problems are given in the respective chapters.

CHAPTER II

The Setting

Physical features

Attappady is one of the two extensive east sloping plateaus on the Western Ghats of Kerala. It is situated north of the Palghat gap and at the southwestern base of the Nilgiris (Fig. 1). The watershed line of the Western Ghats forms the western boundary of Attappady (Ecosystem Research Group (ESRG) 1989). Descending from an elevation of 2300 m along the southwestern corner of the Nilgiris, this line runs due south to an elevation of 550 m at Mukkali and later climbs to a height of 2000 m at Muthikulam. The northern side of Attappady is demarcated by the southern face of the Nilgiri . The southern and south eastern boundaries are at a height of 1500m extending from Muthikulam. The eastern part is undulating to flat and merges with the plains of Coimbatore. Attappady has an area of 731 km^2.

Two rivers control the drainage of Attappady. The Bhavani river originating from the Nilgiris flows due south up to Mukkali and takes a turn to east. Further, it flows in the west-east direction draining into Tamil Nadu. The Siruvani river descends from the southern portion of the Attappady at Muthikulam and flows south-south west to north-north east and join with Bhavani in the valley itself. Thus Attappady forms the drainage basin of one (Bhavani) of the three east flowing rivers in Kerala (Fig. 2). Between these two major drainage channels there is a rolling landscape with steep hillocks or spur ridges extending from the main ranges and encircling the central plateau (ESRG, 1989).

All the major tributaries of Bhavani and Siruvani originate from very high rainfall receiving upper reaches of Nilgiris and Siruvani hills . Both Bhavani and Siruvani have been dammed and waters diverted to Tamil Nadu. During the summer months, only the 5th and 6th order streams contain water, that too with very sparse flow.

Relief

A relief analysis was carried out for the study area. The elevation classes were 1200 m, 600-1200 m and 600 m. The relief map of Attappady is shown in Fig. 3 and the area under each class is furnished in Table 1.

It is evident from the information given in Table 1 that Attappady area is dominated by medium elevation zones (60.6%). The low elevation part extends from the opening of the hills from Mannarkad on the western side and through the river valleys of Bhavani and Siruvani towards east (Fig. 3). The high elevation areas are in the northern portion, ie. Nilgiri slopes and the southern portion in the Siruvani hills.

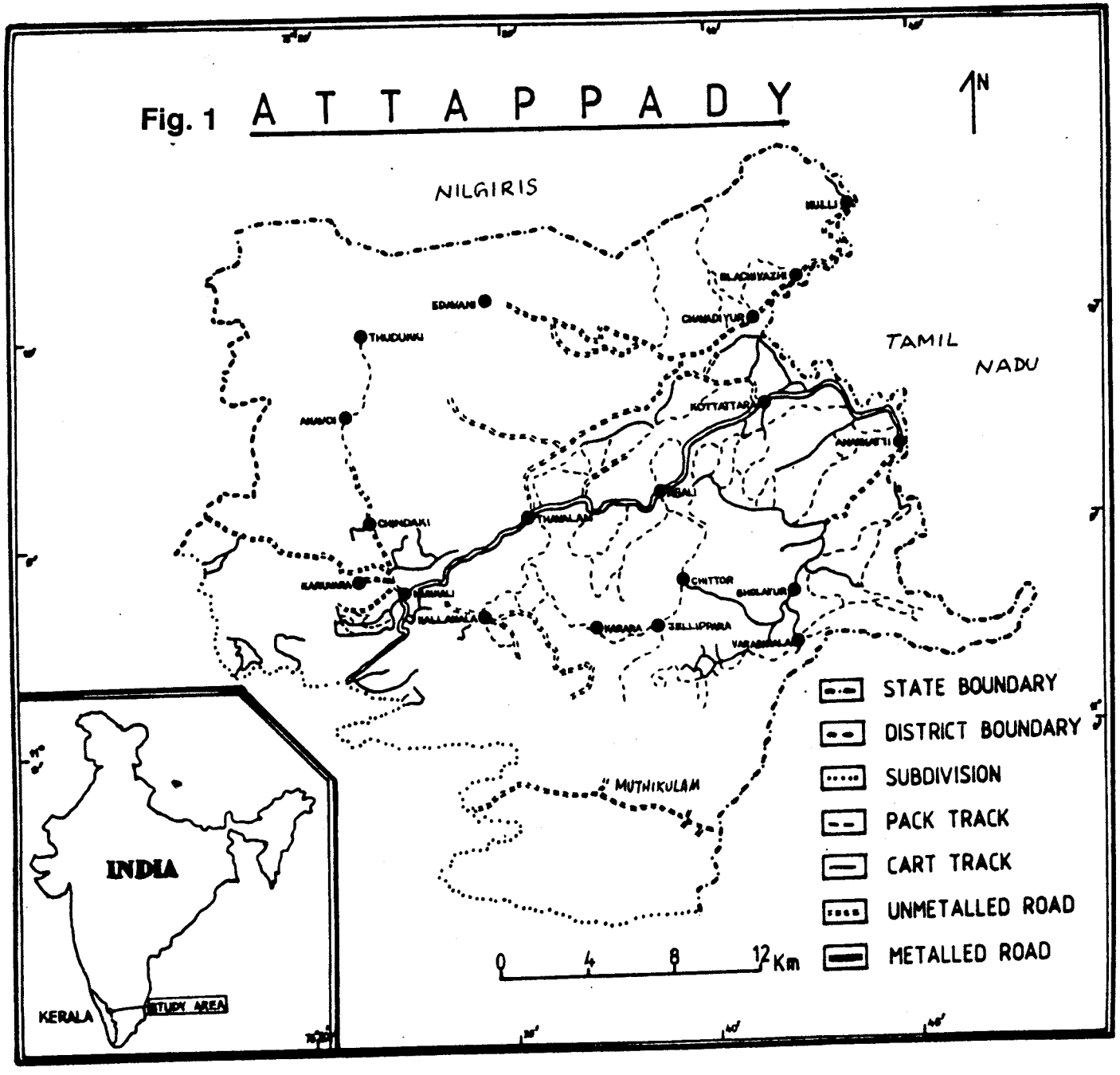


Fig. 1 ATTAPPADY
N
NILGIRIS
TAMIL NADU
MULLI
EDAVANI
THUDUNNU
AGALI
CHINDAKI
KARUMBA
SHOLAYUR
MUTHIKULAM
INDIA
KERALA
STUDY AREA
STATE BOUNDARY
DISTRICT BOUNDARY
SUBDIVISION
PACK TRACK
CART TRACK
UNMETALLED ROAD
METALLED ROAD
0 4 8 12 Km

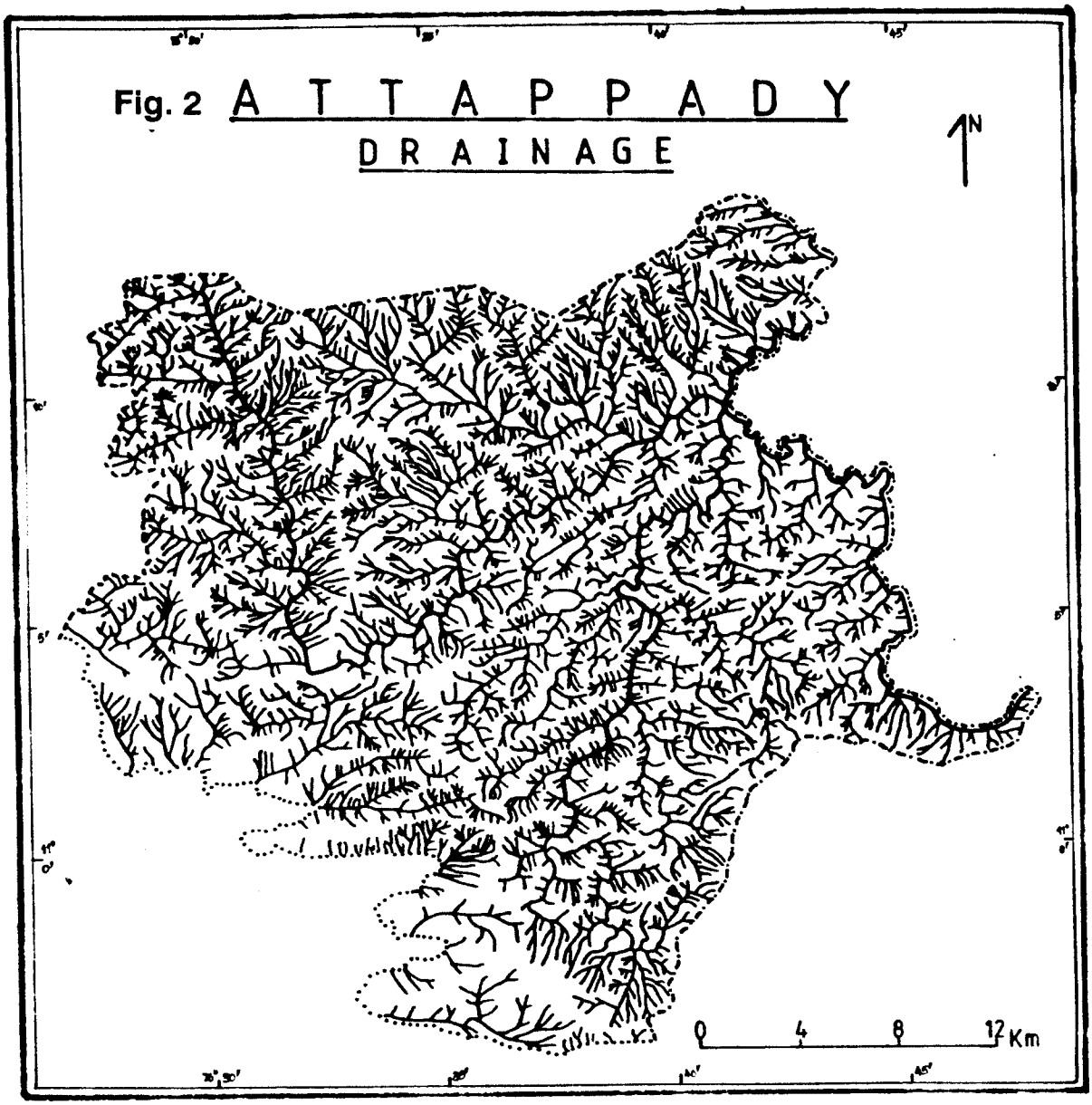


Fig. 2 ATTAPPADY
DRAINAGE
N
0 4 8 12 Km

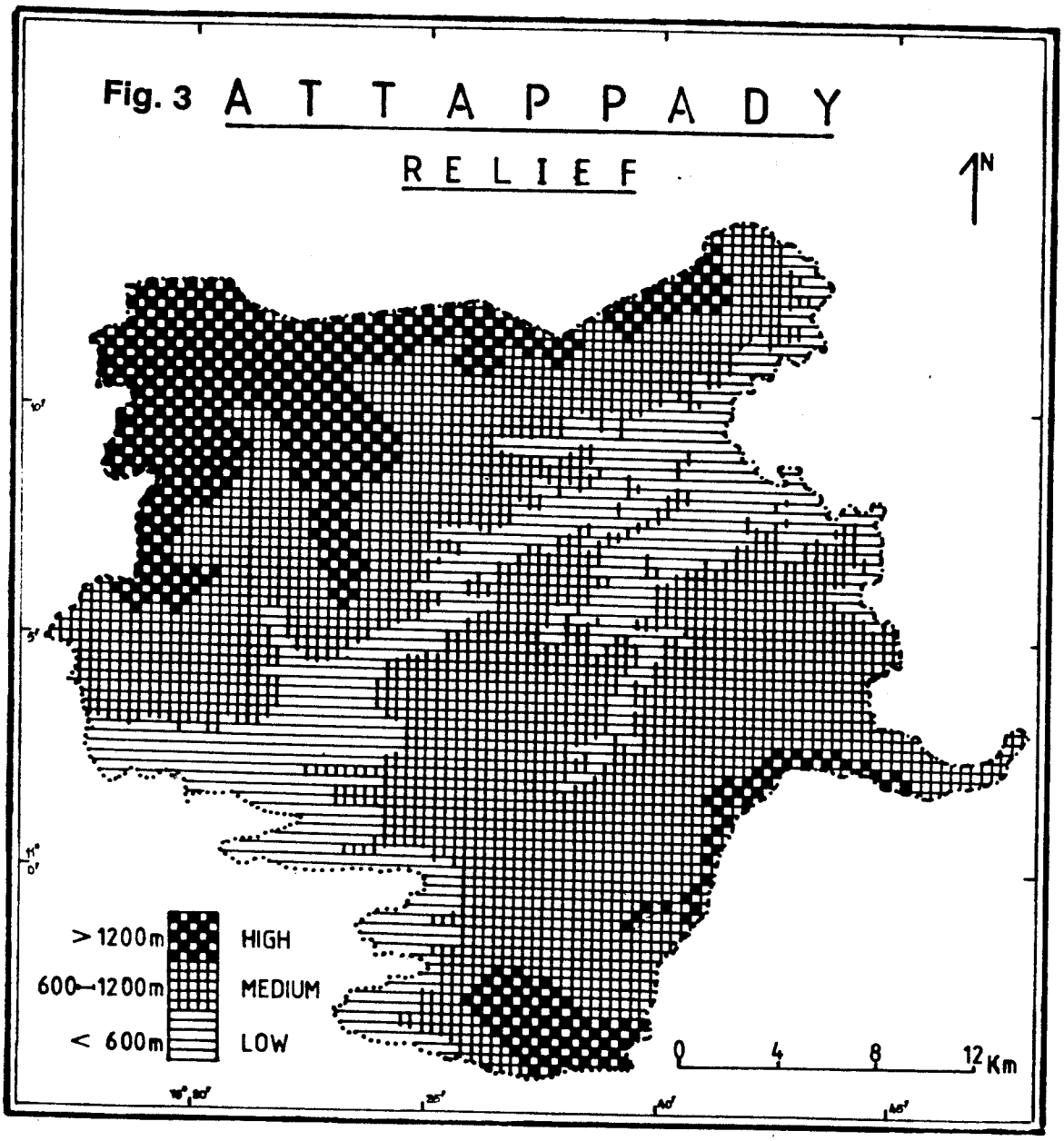


Fig. 3 A T T A P P A D Y
RELIEF
N
> 1200m
HIGH
600—1200m
MEDIUM
< 600m
LOW
0
4
8
12 Km

Table 1. Area under each elevation class

Elevation class	Area (km^2)	Total area
>1200 m (High)	140	19.2
600-1200 m (Medium)	443	60.6
<600 (Low)	148	20.2

Slope

A slope map (Fig. 4) was prepared using average slope and categorised into steep (> 30^o) Medium (15^o-30^o) and low (< 15^o). The area under each category is given in Table 2.

Table 2. Area under different slope categories

Category	Area (km^2)	% to total
>30^o	68	9.3
15^o-30^o (Medium)	523	71.6
<15^o (Low)	140	19.2
Total	731	100

The results indicate that the dominant slope category is medium covering an area of 523 km^2. Areas with steep slopes are few and are located mainly on the northern boundary of the region, which represent the southern face of the Nilgiri range. Further areas with steep slopes are met with in the southern sector covering Siruvani hills. The valley located in the central portion has areas with undulating terrain. These represent the flood plains of the rivers Bhavani and Siruvani. This type of topography extends to the eastern region and merges with Tamil Nadu.

Climate

Attappady is considered to be one among the driest parts of Kerala Western Ghats (ESRG, 1989). The western part is humid and humidity decreases as one traverses from west to east. Rainfall varies from above 3000 mm in the western half to above 900 mm in

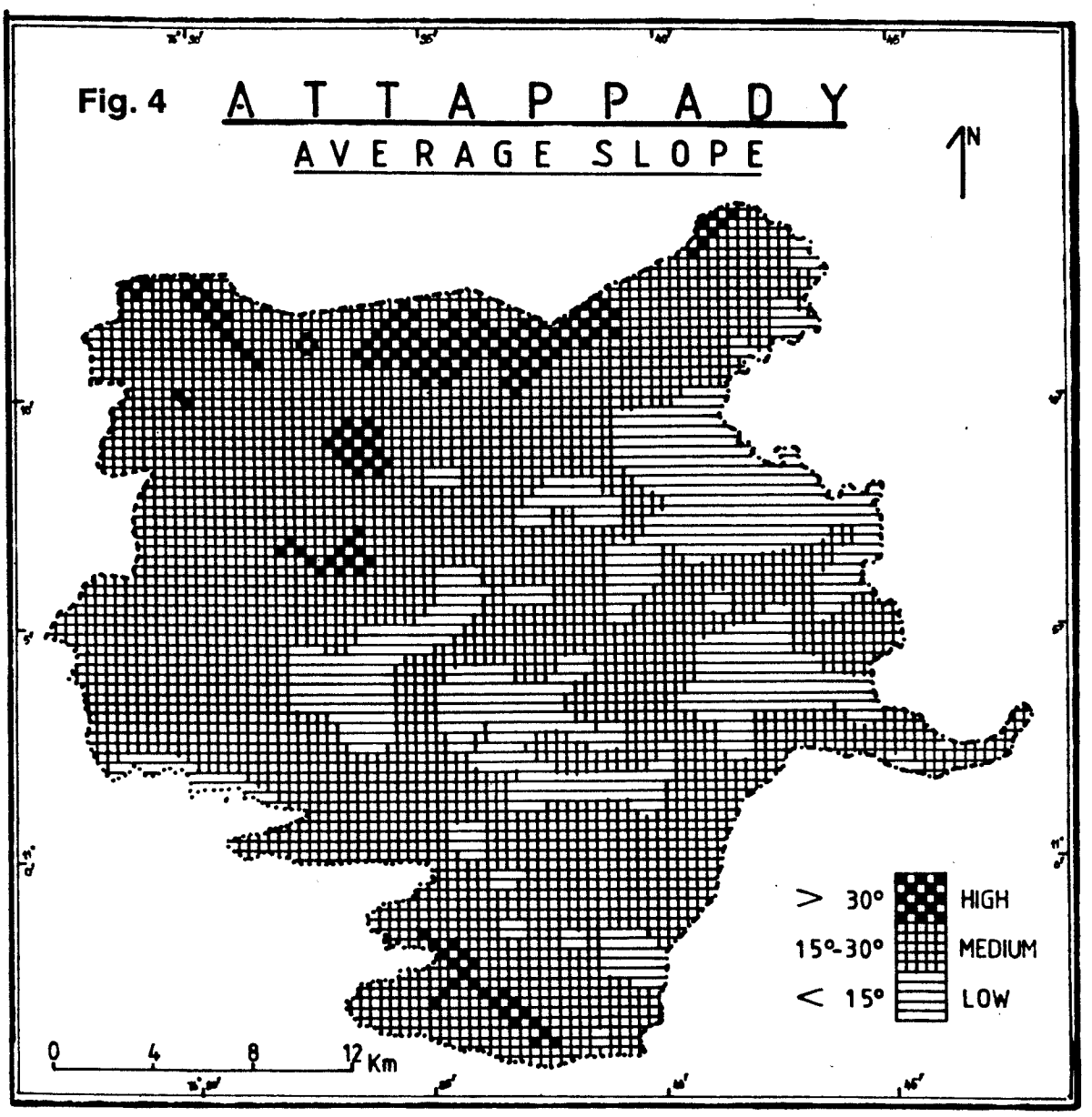


Fig. 4
ATTAPPADY
AVERAGE SLOPE
N
> 30° HIGH
15°-30° MEDIUM
< 15° LOW
0 4 8 12 Km

the eastern boundary. The hills on the western side are higher and steeper and the dryness in the eastern half has been attributed to the rainshadow effect of the mountains. There is a contention that Attappady cannot be treated as a rain shadow area. In the ESRG report (1989) it is stated that a part of the mid western crest line along Mukkali gap never exceeds 1200 m (Fig. 5) and is often much lower and monsoon clouds can enter the plateau from the west. Similarly the eastern edge of the peateau is also formed of hills with many gaps (Fig. 5) and the possibility of adequate north-east monsoon is also high. The eastern border areas receive most of their rain from the north- east monsoon, while the western edge from the south-west monsoon.

It is interesting to note that the south eastern portions receive more rainfall than the central and north-eastern.

The ESRG report (1989) attributes wind as a crucial factor in the area. The area being close to the Palghat gap with discontinuities along the ramparts of ridges to the east and west, the funneling effect of wind takes place. The dry wind has a dessicating influence over the tract.

The average annual atmospheric temperature is always above 17°C. March-May is the hottest period. From November to December a cool dry winter is experienced.

Four regimes of rainfall were identified in the region from the data (5 years) collected from 14 rain gauging stations located in the area.

The regimes are

High rainfall - > 2000 mm
Medium rainfall - 1000 - 2000 mm
(<6 months dry season)
Medium rainfall - 1000 - 2000 mm
(>6 months dry season)
Low rain fall - < 1000 mm

A rainfall distribution map was prepared (Fig. 6) and the area coming under each rainfall regime was calculated (Table 3).

High rainfall areas dominate the region. They are located on the western and southern sectors and receive bulk of the precipetation (70%) during the south-west monsoon (June - September). The northern and the southern part of the zone are forested. The central portion in this zone has undergone severe landuse changes from forest to agroforest, agriculture and monoculture cash crop plantation. The biotope is evergreen forests.

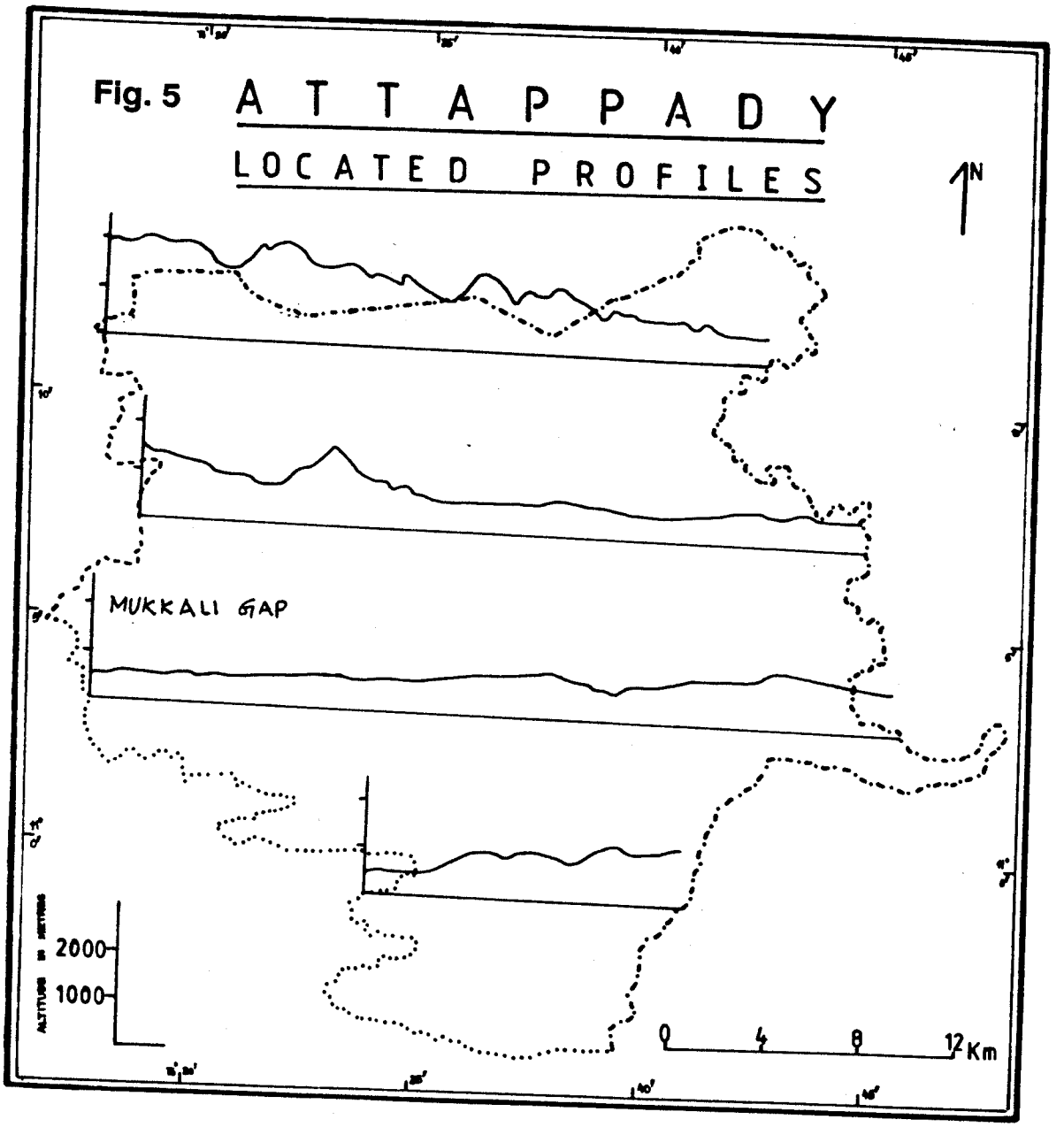


Fig. 5 ATTAPPADY
LOCATED PROFILES
N
MUKKALI GAP
2000
1000
0 4 8 12 Km

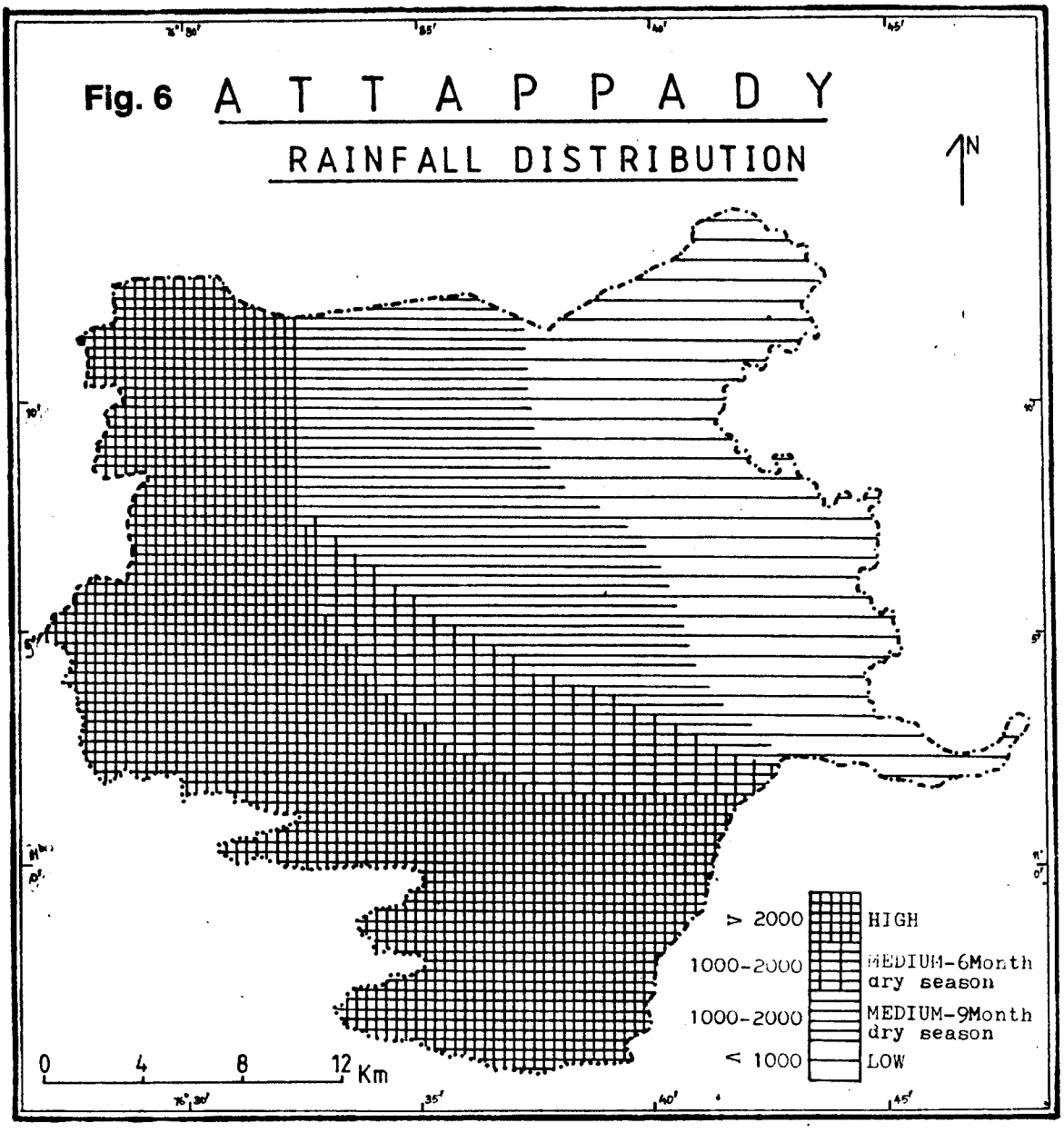


Fig. 6 A T T A P P A D Y
RAINFALL DISTRIBUTION
N
> 2000 HIGH
1000-2000 MEDIUM-6Month dry season
1000-2000 MEDIUM-9Month dry season
< 1000 LOW
0 4 8 12 Km

Table 3. Area under different rainfall regimes

Regime (mm/yr)	Area km^2	% to total
High (> 2000 mm)	334	45.7
Medium (1000-2000 mm < 6 months dry season)	65	8.9
Medium (1000-2000 mm > 6 months dry season)	154	21.0
Low (< 1000 mm)	178	24.4
	731	100

The second rainfall regime (< 6 month dry season 1000-2000 mm) is found close to the heavy rain fall area but towards south east. Here the dry season is 6 months in a year (a month is termed dry if the rain fall is mm). The biotope here is moist deciduous forests. The northern portion of the same tract, although receiving the same amount of rain fall (Fig. 6), the dry season is > 6 months in a year. The biotope changes from drier facies of moist deciduous forests to dry deciduous forests. Bulk of the tribal hamlets are situated in this belt. This zone occupies an area of 154 km2 (21% of the total area).

The eastern sector of Attappady is the low rainfall zone. This area receives bulk of rainfall from the north-east monsoon. The biotope is dry deciduous forest with frequent individual trees of the moist deciduous type. At present the area has been thoroughly degraded and is dominated by pioneer euphorbeaceous scrub jungles. Tribal hamlets are in plenty along with settlers from Tamil Nadu in this area. The dry season extends from 6 to 9 months and the annual rainfall is below 800 mm. The coefficient of variation of rainfall for the past 5 years is above 50%.

Landuse

The complex and inter connected social, cultural, economic and ecological factors have influenced the landuse of Attappady. Deforestation, implementation of development projects, and migration of settlers from the plains have all contributed to a typical landuse scenario. The presence of sub-zones with distinct climate characteristics makes the same more complex.

A physical map of Attappady area was prepared using toposheets (l:50,000). The area was delimited using data from records and published material. The map was divided into grids of 1 km^2 and each grid was visited. The dominating landuse in each grid was recorded. The followng types were considered.

1. Forests - Dense
   Degraded
   Grassland
2. Plantation (agricultural)
3. Agriculture and habitations
4. Rock and
5. Water bodies

A landuse map was prepared incorporating these informations and the (Fig. 7) area under each category is given in Table 4.

Menon (1990) has also arrived at more or less the same figures for area under different landuse types in Attappady.

Habitation and agriculture is becoming the most dominating landuse, concentrating in the central and eastern portions of Attappady. In the north-west and southern areas the habitation and agriculture is sparse.

Table4 .Landuse

Category	Area km^2	% to total
Forests		
Dense	131	17.8
Degraded	210	28.7
Grassland	46	6.3
Plantation (agriculture)	78	10.7
Habitation + Agriculture	257	35.2
Rock	5	0.7
Water bodies	4	0.6
Total	731	100

The total forest cover of the area is 387 km^2 of which only 131km^2 is dense. The dense forests are only in Attappady Block I and Block VI, which were reserved in the early 1900. Although 200 km^2 were reserved during this period, a good portion of the same is degraded at present.

Degraded forests cover an area of 210 km^2 and are mostly the erstwhile private forests vested with the government in 1971. The central and eastern portions of the valley do not

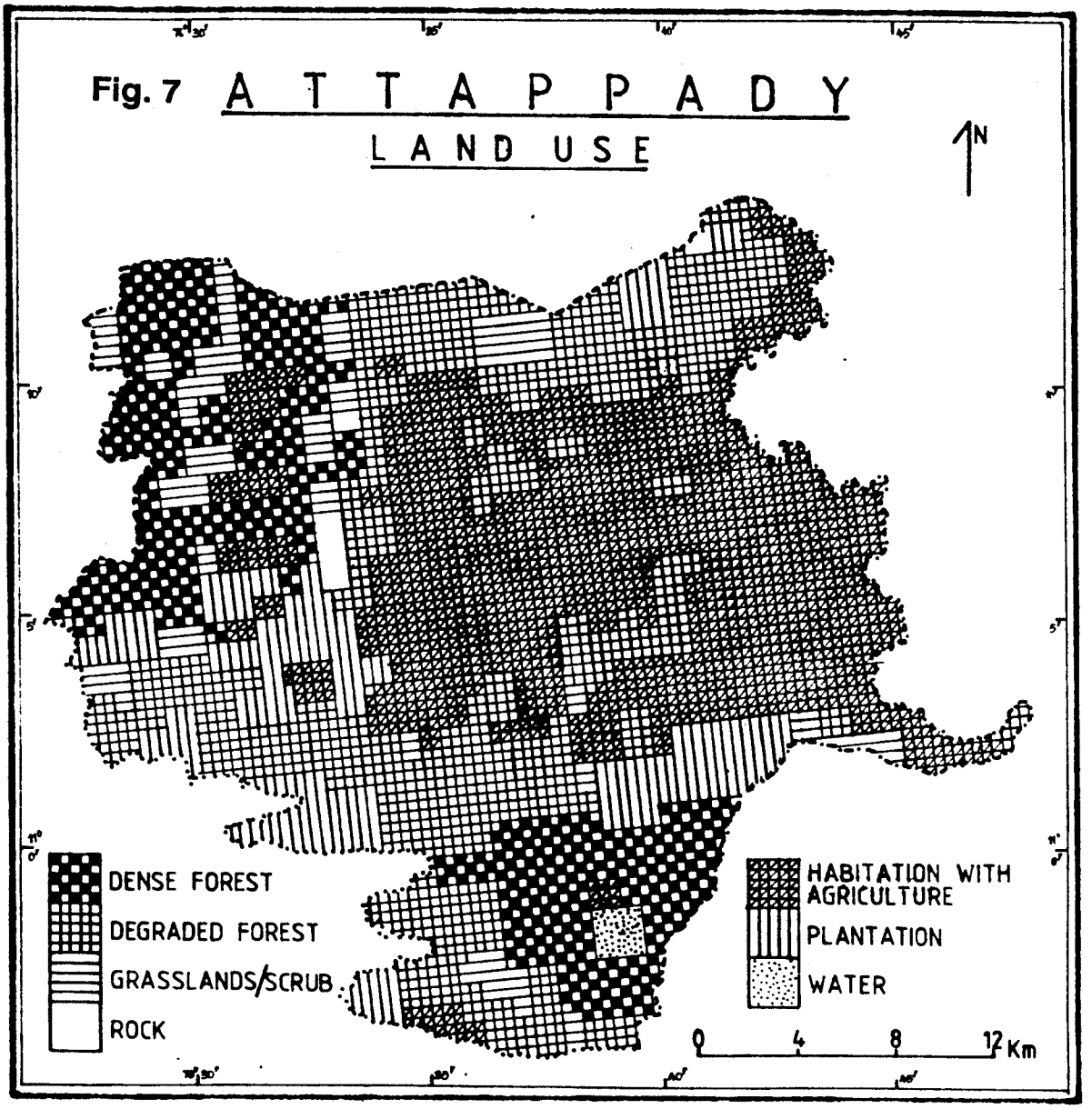


Fig. 7 ATTAPPADY
LAND USE
N
DENSE FOREST
DEGRADED FOREST
GRASSLANDS/SCRUB
ROCK
HABITATION WITH AGRICULTURE
PLANTATION
WATER
0 4 8 12 Km

contain thick forests at all. Grasslands which occupy 46 km^2, include both high level (> 1500 m and climax) and low level (< 1500 m and pyrogenic).

Agriculture plantations are to the tune of 78 km^2. These plantations are mostly rubber,coffee, cardamom and tea. The first three are in the western and south-western sector while tea is found in the south eastern and also in the southern face of Nilgiris in the north-eastern sector. Rocky areas and water bodies occupy an area of 5 and 4 km^2 respectively.

The people

Population in Attappady consists of tribals and non tribals and the latter constitute the settlers from Tamil Nadu and other parts of Kerala. The tribal inhabitants of Attappady are not aborginal population, who have all practically vanished as a result of ingression of population into the hills and annihilation of earliest residents (Nair, 1988). The tribals in Attappady were the early migrants who moved into the thick forests, aiming to escape from persecution in the low lands in the neighbouring states such as Karnataka and Tamil Nadu. The tribal communities identified in the study area are Kurumbas, Mudugas and Irulas who all belong to the broad group of Dravidians.

Tribal hamlets

Attappady block of Mannarkad Taluk, Palakkad District comprises three panchayaths viz. Agali, Pudur and Sholayur . All the panchayats contain tribal hamlets. The distribution of hamlets in the three panchayats is presented in Table 5.

Table 5. Community wise distribution of hamlets in three panchayaths

Panchayath	Irula	Kurumba	Muduga	Mix	Total
Agali	35	-	15	2	52
Pudur	32	16	5	-	53
Sholayur	37	-	-	-	37
Total	104	16	20	2	142

Agali and Pudur panchayaths contain more or less the same number of hamlets. Irulas dominate in all panchayaths. The Kurumbas reside only in Pudur and Sholayur is an exclusively Irula panchayath, an exception being Muthikulam hamlet (Muduga) near Siruvani dam site. Majority of hamlets have non-tribal settlements nearby. For instance, of the total hamlets, about 24 hamlets are situated near Malayalee settlers, 43 Tamils and 28 a mixture of Tamil and Malayalee settlers.

CHAPTER III

Socio-Economic System and Biophysical Conditions

An attempt is made in this chapter to analyse the socio- economic system and biophysical conditions of tribal hamlets in Attappady. This chapter is divided into four sections. Section I describes the social system of the tribal communities. The general framework for economic system and economic conditions of the tribals in the area is analysed in Section II. Because of paucity of data, only some selected variables are examined here. In order to supplement information on the economic condition, an economic profile of the selected hamlets is given in Section III. The biophysical conditions in tribal areas and rating of hamlets based on socio-economic and biophysical conditions are presented in Section IV.

I Social System

Kurumbas

The Kurumbas were perhaps the earliest inhabitants of Attappady. There is a strong case they have moved down from the Nilgiris, with the colonisation of the area by Badugas. After an initial period of nomadic life, they must have taken up shifting cultivation and then organised into hamlets in forest areas.

Kurumba hamlets are located mostly in valleys of river Bhavani and its tributary Varaharpallam, for easy access to water. The houses in a hamlet, made up of grass, bamboo and mud, are generally built in a row. A house is often compartmentalised and each compartment is alloted to one family. Kurumbas maintain a community life by sharing labour and food with others in the hamlet as and when required.

Due to low development and literacy rate, Kurumbas are considered as a primitive tribal group (Govt. of Kerala, 1988). The language spoken by them is a mixture of Canarese, Tamil and Malayalam. Tribals, mostly animists, have their own religion which is different from Hindu religion. They believe in ghosts and spirits. Apart from their own God, the Kurumbas worship many dieties of Hindu pantheon and observe many Hindu festivals (Mathur 1977).

The community is divided into clans (Kula) and marriage within the clan is strictly prohibited. Just like caste status in Hindu relegion, the clan status is hereditary. For instance, Moopan is always selected from a particular clan (Am Moopar) and after his death, the position is passed on to his eldest son.

The tribals of Attappady in general and the Kurumbas in particular, prefer a nuclear family consisting of father, mother and children. Father is the head of the family whose words are final in many family matters. Kurumbas follow a patriarchal system in which the male children share the property of the parents, including farm implements and weapons (Mathur, 1977). Most of the families are monogamous, but polygamy is rarely observed.

In order to strengthen the family ties, the marriages are often arranged with uncle's (mother's brother) or aunt's (father's sister) son or daughter. The custom relating to marriage in Kurumba community is simple and is initiated by the boy himself. He informs his intention to marry a particular girl to the Moopan who intimates this to boy's parents. A group consisting of Moopan, parents of the boy and one member from each clan visits the girl's house to call on her. Similarly, another group from girl's house visits the boy's house. After this visit, the marriage takes place within a few days. A nominal amount is paid to girl's parents as bride price during the marriage which is non refundalbe at any circumstances. After the marriage, the new couple lives together in a separate house. Divorce and remarriages are permitted in the community.

Rituals relating to death of aperson are very simple, but continue till cremation which is carried out at third day of the death. As part of rituals, dance is performed by members of the hamlet, aiming to make the soul of the dead happy. The death anniversary is observed for salvation of the soul in which a feast is given to the relatives of the dead. Relationship with past governs the way of life. Cremational lands and spirits of deceased elders are cherished all along. In this context significance of a spirit called 'Pasathu' is worth mention. Pasathu is a tribal God with no form and represents souls of the dead. It is contained in a closed earthen vessel. Tribals believe that souls of the dead are present in the vessel. This pot is called 'Gurumadam'. On festive and other important occasions prayers and offerings are conducted to this vessel. Names of all elders are chanted and in certain households we have come across over 20 names indicating the link with elders over 20 generations.

Existence of a social council in each hamlet to discuss and solve major problems faced by the members is yet another aspect of the social system of tribals in Attappady. The structure as well as office bearers of this council are same throughout the study area. The office bearers of this council are Moopan, Kuruthalai, Bhandari and Mannukaran. Moopan who is socio- political and religious leader of the hamlet, presides over the meeting of the council. Also, he acts as a link between tribals and government officials. The verdict of the Moopan on many issues is final and unquestionable. Kuruthalai helps Moopan in performing his duties and convenes meeting of the council as and when the latter desires. Bhandari, the cashier, keeps accounts of common properties of the hamlet. Mannukaran, the soil expert, selects land for cultivation and performs rituals related to the farming. Generally,

sowing and harvesting in the hamlet are inaugurated by the Mannukaran. Although the office of the Moopan continues to be powerful in Kurumba community, his position in Muduga and Irula communities has been eroded due to socio- political changes.

Some of the elements of social system such as clans, belief in ghost and spirit, worship of Hindu God, patriarchal system, divorce and remarriage, etc. mentioned earlier are common in all the three tribal communities in Attappady. Thus, only distinct features of the social system of other two communities are given below.

Mudugas

Mudugas are the second largest tribal community in Attappady. There is a belief that they were Kurumbas and subsequently broke away from them to form a separate community, The similarities in their culture and intermarriage between Mudugas and Kurumbas support this view.

Muduga women carry their babies on their back by supporting them in a piece of cloth and this style of carrying babies is said to have earned the tribe their name (Mathur, 1977). Some tribal old men believe that Mudugas established the township of Coimbatore and later moved westward due to persecution and exploitation by more dominant communities. The first Muduga settlement in Attappady was supposed to be established at Karara. Later, they occupied the geographical area between Karara and Mukkali. Even today, the Muduga settlements are mostly distributed between these two places.

Although the language spoken by the tribals is a mixture of Canarase, Tamil and Malayalam, each community has its own dialect which makes communication among the groups difficult. Literacy rate among Mudugas is highest. Due to shortage of land, they practice settled agriculture with many features of shifting cultivation. Land alienation is the major problem faced by this community and encroachment of Muduga lands has been effected mostly by Malayalee settlers. The growing contact between Mudugas and Malayalee settlers has led to acculturisation to this tribe, which often ends up in intermarriage with the latter and erosion of tribal culture.

Polygamy is common among the Mudugas and it is not rare that all wives stay in the same house (Mathur, 1977). But polyandry is not permitted. Mudugas prefer neither joint family nor a community life although their houses in the hamlets are built nearby.

After death, the body is either cremated or buried in a deep grave. They do not observe any particular custom relating to death.

Irulas

Irulas are scattered all over peninsular India with different customs and life styles. Those in Attappady area must have migrated from the east, having been ousted from Shevarorys Javadi, Kolli and Pachamalais (CES. ud) and moved westward, In Tamil Nadu, Irulas are seen in Gobichettipalayam, Coimbatore taluk of Coimbatore district and Nilgiri slopes adjacent to Attappady. Irulas, probaly, have occupied Attappady after Kurumbas and Mudugas.

Numerically dominant and relatively advanced group among the three tribes in the area, Irulas are found residing in 104 hamlets, which are distributed in all the three panchayats of Attappady. Originally, they were shifting cultivators. Because of land alienation that was brought about mainly by the encroachment of the settlers in the area, they have taken to settled agriculture and plough cultivation. They are good artisans and craftsmen.

The traditional Irula houses are made up of bamboo, mud and grass and are built in a row. Recently, a number of tiled and concrete houses were constructed by the ITDP in certain Irula hamlets. The land is under community ownership, but community life does not exist in Irula hamlet. Unlike Kurumbas relationship among the members in Irula hamlet is not very intense and warm. Sharing of products is rarely seen among the Irulas.

Intermarriage with people in other tribal communities is strictly prohibited in Irula community. Since Irulas are more in number, there is wide scope for selection among them for marriage. Marriage within the clan is strictly prohibited. An amount of Rs. l00/- is paid as bride price and is not refundable at the time of divorce.

II Economic System

The frame work

The tribal economy which was self-reliant and self-sustainable till some decades back, depends now heavily up on settler population, Integrated Tribal Development Project office, etc. for livilihood. The transition from self-reliance to dependence which began at the turn of the present century and accelerated since 1950, was brought about by a number of factors that operated in the area.

The tribals who lived in the thick forests of Attappady were content with their environment as it met all their basic needs. Land was a source of livelihood rather than a property to the tribals and they maintained a functional and spiritual relationship with land. The first attempt to change land relation in Attappady was made by the British Govern-

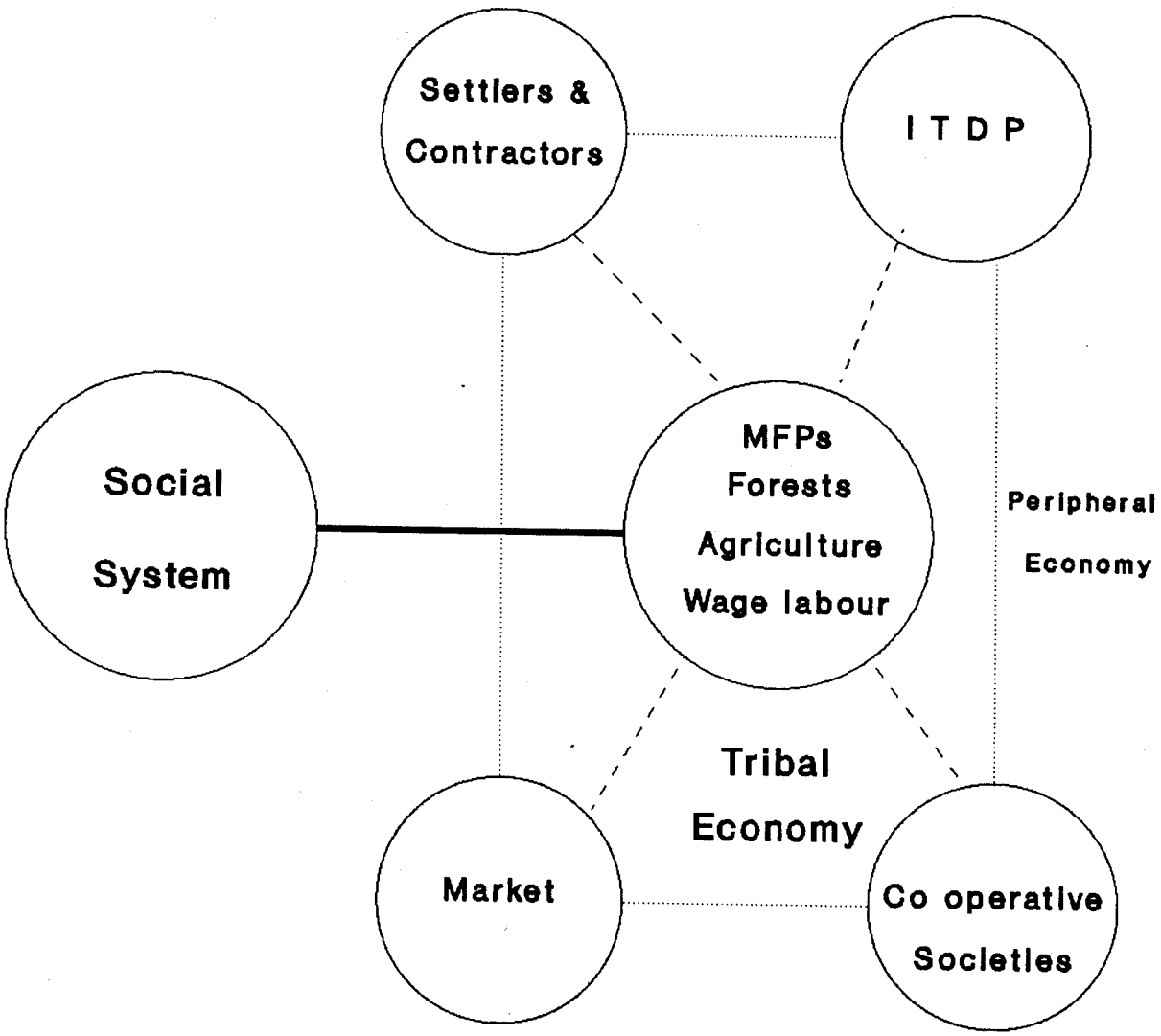
ment, by bringing a part of forests under reservation in 1900. The control exercised by the government over the reserved forests often created dissensation and distress among the tribals, which ultimately led to a section of tribals moving to private forests areas to establish new hamlets. Initially, it helped the tribals to continue shifting cultivation and collection of minor forest products freely in private forest areas. Later, it turned out to be fatal, because of the occurrence of number of incidents in the area such as massive deforestation, high influx of settlers and large scale encroachment of tribal land. The tribals were dispossessed and displaced from their fertile land to hill tops where productivity is less. Since 1962, a number of development programmes have been launched and implemented by the government through agencies such as Tribal Block and ITDP to improve the economic conditions of the tribals. But it neither improved their economic conditions nor brought them to their original condition. Rather, it increased their dependency on government agencies. Large scale investment under tribal development programmes by the government, coupled with emergence of a number of financial institutions and prosperity of settlers gave birth to a market economy which operates in the periphery of tribal economy. Today, these self contained communities are threatended by the larger society and powerful forces which they cannot avoid or control.

The tribal economy is a primitive and subsistence one in which production and exchange are oriented towards meeting the basic needs. The economy consists of agriculture and animal husbandry, wage labour and MFP collection. In addition, the forests supply some basic goods such as thatching material, fuel wood, water, medicinal plants, etc.

The peripheral economy is composed of many components of which ITDP, settlers and contractors, market and co-operative societies are the most important. The development programmes, launched by the ITDP are effected through contractors. The participation of tribals is stipulated as a condition for implementation of any development programme in the project area as it provides employment to them, and thus, the tribals are hired by the contractors. Further, the tribals are employed extensively in the settlers farm as their labour is very cheap. The co-operative societies meet a significant part of the credit and marketing requirements of the tribals. Because of the prosperity of the settlers and emergence of a large number of financial institutions, market has been strengthened in the study area and linked with national and international markets (some of the crops of the settlers are exported to other places).

The tribals lead an integrated way of life, combining the economic, cultural, spiritual and social aspects and consequently, the social system of the tribal interacts with the tribal economy which in turn depends on peripheral economy (Fig. 8).

Fig. 8 Interaction between Social & Economic Systems in Tribal areas



Agriculture is treated not only as an occupation but also as a part of their social life. This is manifested by the fact that different phases of agriculture are closely attached with certain customs and rituals. The rituals pertaining to agriculture is performed by Mannukaran.

In the context of destruction of the life support system of the tribal and growing acculturisation, the tribal economy closely depends on market based peripheral economy for meeting a variety of needs. In the absence of adequate income from agriculture and MFP collection, wage labour has emerged as an important source of livelihood and is given by contractors and settlers belonging to the peripheral economy. Conversely, the development of contractors and settlers depends, to a great extent, on the availability of cheap tribal labour. Our survey indicated that the peripheral economy has made a big stride in Attappady mostly at the cost of tribal economy.

Economic Condition

Population

According to the 1981 census the total population of Attapady was 62246 of which the tribals and settlers were 20659 and 41587 respectively. The tribals of Attappady form 8 percent of the total tribal population in the state (Govt. of Kerala 1988). Total tribal families in Attappady was estimated to be 4636 and average size of family was 4.5 in 1985-86.

Information on population increase in Attappady during the last four decades beginning from 1951 is given in Table 6. The population in Attappady has been increasing annually at the compound rate of 5.71% of which the tribals and settlers increased about 2.36% and 11.8% respectively. A high growth rate of settlers during the reference period is the indication of a large scale influx of settlers. The tribals constituted the majority of the population in 1961 but turned out to be a minority in 1971. In 1981 they formed only one third of the population.

Table 6. Population growth in Attappady during 1951-1981

Year	Tribals	% to Total	Settlers	% to Total	Total
1951	10,200	90.32	1100	9.68	11300
1961	12,972	60.45	8489	39.55	21461
1971	16,536	42.21	22647	57.79	39183
1981	20,659	33.00	41587	67.00	62246

Source: Census Reports.

The break up of tribal population for the periods from 1961 to 1981 is given in Table 7. Of the three tribal communities, Kurumba is the smallest one accounting for 5.22 % while the Irulas form the largest community constituting 82.85 %. Mudugas fall between Kurumbas and Irulas, forming 12.53 %. Annual compound growth rate of Kurumbas during the period was 2.24 % as against 1.61 % in the case of Mudugas, while Irulas registered an increase of 2.41 %.

Table 7. Population growth *of* three tribal communities in Attappady during 1961-1981

Communities	1961	% to total	1971	% to total	1981	% to total
Kurumbas	693	5.30	790	5.00	1079	5.22
Mudugas	1881	14.40	2370	15.00	2590	12.53
Irulas	10559	80.30	12649	80.00	16990	82.25
Total	13133	100.00	15800	100.00	20659	100.00

Source: ITDP Office, Agali.

Education

The tribals of Kerala in general and of Attappady in particular are educationally backward sections in the society. The literacy rate of tribals at state level was estimated to be 35 % as against 84 % in the case of general population. The literacy rate of tribals in Attappady was found to be only 11.8 % in 1985-86. Among the three communities in Attappady, the Kurumbas are the least educated. The level of education is highest among the Mudugas, probably because most of the Muduga hamlets are located near schools.

Large scale investments have been made in the education sector in Attappady, especially since the establishment of ITDP. Consequently, there has been a significant increase in the number of educational institutions and number of students enrolled in the schools in Attappady. For instance, between 1976 and 1989, the number of high schools increased from 1 to 6, lower primary schools from 7 to 18 and the students enrolled in the school from 271 to 5146. Out of 142 hamlets, 68 have some sort of institutions for formal education nearby. For 66 hamlets the schools are located far away and for 7 very far away. Under the Integrated Child Development Scheme, 57 hamlets have Anganvadys within the hamlets and 45 are not having any access to this facility. However, the number of people who received higher education, like graduates and post graduates was less. There were only 5 graduates, 48 matriculates and 32 technically educated person in 1986. The total literacy programme, conducted through out the state during 1990-91, did not encompass the tribal population of Attappady.

Health

One primary health centre at Agali and one co-operative hospital at Chindakky, besides three dispensaries, one pilot scheme dispensary and 10 sub-centres function in ITDP areas. The tribals are entitled to get free medical treatment from government hospitals and dispensaries that are located in the ITDP limit. The existing medical facilities are quite inadequate. For instance, there is only one doctor for 10,000 tribals and stocks of medicines in the health centres have been very poor. Further, only five hamlets have any kind of medical facility within the hamlet, 56 have hospitals / health centres nearby and 61 are far away from the hospitals. About 20 hamlets have no access to any form of health facility. Since most of the hospitals and dispensaries are located in certain important localities, the tribals living in remote areas are not able to get the benefit from this. Consequently, a significant number of tribals still depend upon unqualified indigenous doctors and Moopans for treating the diseases.

Occupation

The tribals in Attappady were shifting cultivators. With the influx of settlers, the agricultural sector in the study areas, witnessed a series of changes of which the following are the most important. (1) Except Kurumbas, all other tribal communities have taken into settled agriculture. (2) Because of dispossession of land, many tribals became agricultural labourers.

Table 8. Percentage distribution of tribal households according to main occupation

Main occupation	%
Cultivators	51.0
Agriculturallabourers	43.1
Government service	0.1
Private employment	0.1
Collection of MFP	1.0
Other labour	4.3
Total	100.00

Source: ITDP Office, Agali.

At present, agriculture is the single largest source of employment for tribals in Attappady, employing 94% of the tribals of which cultivators and agricultural labourers constitute 51% and 43% respectively (Table 8). Collection of minor forest products is another source of employment, engaging 1%of tribal population. About 0.2% of the tribal population are accomodated in private and public sectors. Reservation of employment in

government services has provided only very few job oppurtunites to the tribals of Attap-Pady.

Animal husbandry

Traditionally the tribals have reared the cattle of the plainsmen, especially from TamiI Nadu, for very low remuneration. Even today this practice continues. As an alternative source of income to the tribals, the development of animal husbandry has received prime importance ever since the formation of ITDP. Attappady is endowed with huge animal population, consisting of cattle, goats and poultry. Animals maintained by the tribals, and the settlers and animal arriving from Tamil Nadu to Attappady for rearing constitute the total animal population in the study area. There does not exist any information on total number of animals maintained by the settlers and animals sent to Attappady for rearing. However, the enquiry showed that the cattle population in the project area was about 30,000. There are three veterinary institutions in the project area, but they are poorly staffed.

Industry

Attappady is one of the industrially backward regions in Palakkad district (Govt: of Kerala, 1988). Except a few brick making units and one rattan manufacturing unit, there is no industrial unit in Attappady. With an aim of imparting skill to tribals, three training centres were started in the study area.

Co-operation

The state government has given priority to the development of tribals of Attappady ever since the formation of the state in 1956. One of the ways by which it attempted to tackle their problem was to bring them under co-operative fold. Co-operative credit societies were organised to meet the credit requirements of the tribals. Marketing facilities to the tribals have been extended by a branch of Taluk Co-operative Marketing Society, located at Mannarkad. In addition, one joint farming society at Mukkali, and two co-operative farming societies viz. Attappady

Co-operative Farming Society and Vattalukky Girijan Co-operative Farming Society were also formed for the betterment of the tribals. Now about 50 % of the tribals are under the co-operative fold.

Income

Percentage distribution of households by monthly income is furnished in Table 9. While 4% of the households received income below Rs.100, about 5% earned income above Rs.400/- per month. The rest of the households fall between these two categories,

ie. 38% received income between Rs.100-199,42% between Rs.200 and Rs.299, and 12% received a monthly income between Rs.300 and Rs.399.

Table 9. Percentage distribution of households by monthly income

Monthly income (Rs.)	% distribution of households
0-99	3.52
100-199	37.58
200-299	42.10
300-399	12.08
400 and above	4.72
Total	100.00

Source: ITDP Office, Agali.

The average monthly income of a tribal household amounted to Rs. 233.33 in 1988-89. The average family size being 4.5, the per capita monthly income amounted to Rs. 50, indicating that the tribals of Attappady live below the poverty line.

Transportation

Road facilities in Attappady are poor and inadequate to meet the requirements of the tribals. Mannarkad-Chinnathadagam road is the main road which links Attappady to Coimbatore and other parts of Kerala. There are four types of roads in the study area: tarred, metalled, unmetalled and pathways. Only some centres in the study area are connected with tarred or metalled road and only 50% of the hamlets in the valley are accessible by road. The road length per 1000 population is 1.02 km which is far below the state average of 2.56 km per 1000 population (Jayan, 1988). Of the total hamlets, only 22 hamlets have the nearest bus stop within one km of walking distance.

III Economic Profile of the Selected Hamlets

(i) Thodukki

Thodukki hamlet is situated at an elevation of 1300 m and surrounded by thick evergreen forests in a remote area of Attappady, about 22 km away from the nearest market. The group 'Kurumba' inhabits the area.

The houses of Kurumbas in the hamlet are of traditional type built of bamboo and thatching grass and walls plastered with mud. There are about 11 houses in the hamlet, comprising 13 families with a total population of 69. The adults and children below 12 years number 40 and 29 respectively and the male: female ratio is 1:0.99. The literacy rate

of the hamlet is 2% as against 11% for Kurumbas in Attappady and no literate in the hamlet has attended school beyond 6th standard.

Agriculture is the main occupation of the people in the hamlet and is followed by collection of minor forest products. The people in the hamlet rarely do wage labour. They are shifting cultivators and the cropping pattern is dominated by subsistence crops. Total income from agriculture, comprising the value of food grain and cash crops amounted to Rs. 2026 per family per year in the hamlet of which the value of latter amounted to Rs. 1150. The income from the sale of minor forest products per family in the hamlet was Rs. 650 per year. Thus, total disposable income of the family is only Rs. 1800. This amount is used to purchase additional food items, clothes, utensils, etc. and also for medical and other purposes.

Since the hamlet is located in the reserve forest areas, land alienation is not a problem. No encroachment is reported in the hamlet. This hamlet has been allotted about 60 ha of land in he midst of forest for agriculture, which has been divided into four blocks and each block is cultivated for three successive years. Thus, one family owns about 1.15 ha of land in a block and totally 4.60 ha. With regard to the area under cultivation, the tribals in Thodukki are better off and consequently, their dependence on wage labour and settlers, has been least.

The average indebtedness of the hamlet amounted to Rs.7150, i.e, each family owes about Rs.550. About 80% of this amount is provided by cooperative societies and the rest by private agencies. Borrowing from society is nothing but an advance against next year's marketable products and therefore, tribals are liable to sell their products, both agricultural as well as minor forest products, to the society. Generally, loan from the society is treated as agricultural credit, for cultivation. But this amount is used for consumption purposes, such as buying clothes and celebrating 'Shiva Rathri', by almost all the families.

(ii) Karara

Mudugas inhabit at Karara hamlet, which is located in the south central part of the study area (Fig. 1). This hamlet is considered to be one of the oldest Muduga hamlets in Attappady.

Karara hamlet consists of 13 families with 59 members of which the adult male and female are 20 and 19 respectively and the rest are children below the age of 12. There were only 2 literate persons in the hamlet in 1982 (Govt. of Kerala, 1982), but the number was found to be 18 during our survey in 1988-89, that is, literacy rate in the hamlet was as high as 30%. Among the literates, about 73% have a level of education between 1st and 5th standards and 27% have between 5th and 10th standards. Land alienation and encroach-

ment are the two main problems faced by the hamlet and thereby most of the families have lost major part of their agricultural land. According to the estimate prepared by the ITDP Office, this hamlet had lost about 68 ha of land by 1982 (Govt. of Kerala, 1982). At present, the hamlet owns only 7.2 ha, i.e. each family owns 0.5 ha. There exists inequalities on land holdings in the hamlet which is brought about by a variety of reasons including encroachment. About 23% of the families have an area of less than 0.4 ha, 47% between 0.4 and 0.8 ha, 24% between 0.8 and 1.2 ha and 6% have an area between 1.2 and 1.6 ha. The encroachment in the hamlet has taken place mostly in the areas attached to their homesteads, which forced the inmates of the hamlet to clear more forest land for cultivation. The present cultivation areas are located 4-5 km away from the residential area.

Since area under cultivation is less, income received from agriculture is quite inadequate to meet their livelihood. Thus, majority of the adults depend on wage labour either in settler farms or co-operative farms, located near the hamlet to supplement their income. Among the adults, about 26% are unemployed of whom 70% are male. The distribution of the employed adults in the hamlet is as follows: about 41% depend upon wage labour, 25% on cultivation and 34% on both cultivation and wage labour for livelihood. On an average, a female worker gets employment about 20 days per month as against 18 days as in the case of a male worker.

Total indebtedness of the hamlet and per family estimated to be Rs. 13,195 and Rs. 1015 respectively. Indebtedness per family accounts for as high as 38% of their annual income. The agency ITDP and cooperative societies are two major sources of credit, constituting 77% while the rest is contributed by the private agencies. The loan from the private agency carries an interest ranging between 24 to 32% per annum.

(iii) Mully

Mully, one of the Irula hamlets, is located in the north eastern part of Attappady, bordering with Tamil Nadu state (Fig. 1). Of the total 149 inhabitants in the hamlet, adult male and female numbered 62 and 61 respectively and the rest are children.

Literacy rate among the Irulas in Attappady is stated to below. Contrary to this, literacy rate in Mully hamlet is found to be high, accounting for 45%. Among the literates 55% have attained a primary level of education (1 to 4th standard), 40% have secondary level of education (5th to 9th standard) and 5% have completed 10th standard or above. The literacy rate in the hamlet is high, probably, because a school is located near the hamlet.

Unlike in Karara and Thodukki, there are landless families in Mully hamlet (20%). The land owning families are, on an average, having an area below 1.6 ha. In addition to landlessness, inequalities on land holding prevail among families in the hamlet. About 27%

of the families in the hamlet have an area less than 0.4 ha, 37% between 0.4 and 0.8 ha, 31% between 0.8 and 1.2 ha and the rest have an area between 1.2 and 1.6 ha.

As Mully is a dry area where prospects of the agriculture depend mostly on rainfall which is erratic, crop failure is a regular phenomenon. Partly because of this and partly due to low income from agriculture, tribals in the hamlet have developed disinterest towards farming. They treat agriculture as secondary and depend mostly on other sources for livilihood. For instance, only 10% of the adult population exclusively depend on cultivation and the rest in addition to cultivation rely on wage labour. It is estimated that about 70% of family income of the second category is obtained from wage labour. Un-employment accounts for about 30% in the hamlet and the same is significantly higher among the women (about 65%) probably because of the low level of agricultural activity.

Generally an adult male gets employment about 18 days per month as against 13 days for an adult female. Similarly, the average wage received by a female worker amounted to Rs. 15 per day and it was less than that of male worker (Rs. 20-30).

Indebtedness is very high among the Irulas in Attappady (Mathur, 1977). This is particularly true among tribals in Mully hamlet because of a variety of reasons such as unemployment, poor performance of agriculture, change in life style due to interaction with settler community, etc. Total indebtedness of the hamlet was estimated to be Rs. 70,000 that is, per family it amounted to Rs. 2187. Private agencies are the major sources of borrowing, followed by the government (ITDP) and society. Among the private agencies, some charge interest of about 32% and some others give interest free loans. But in the latter case, the tribals are insisted to do unlawful activities such as smuggling of sandal wood, cutting timber, etc. However, the loan is used for consuniption purposes. IRDP loans are mostly in the form of cattle, aiming to supplement income.

IV Biophysical Conditions

A proforma for assessing biophysical conditions of the tribal hamlets was prepared and field tested several times and a final format was arrived at (Table 10). Information on 46 parameters listed in the Table 10 was gathered. About 20% of the hamlets were revisited and data corrected and confirmed. The data were analysed using d Base III programme. The general status of biophysical conditions of tribal hamlets is given in Table 11.

Terrain wise, only 10 hamlets are located on tlat riverine areas, 52 hamlets are on moderately steep and yet another 52 on rugged terrain. 11 hamlets are situated on undulating and 17 on steep slopes. Thus most of the arable fertile lands, which belonged to the tribals have been taken over by settlers.

Table 10. Proforma

Parameters	I	II	III	IV	V
1. Tribal group	Irula	Kurumba	Muduga	Mixed	-
2. Terrain	Flat ri.	Undul.	Mod.slp	Steep	Rugged
3. Rainfall	High	Medium	Low	V.low	-
4. Tree cover	V.high	High	Medium	Low	-
5. Forest type	Ever	MD	Dry.d	Scrub	Grass
6. Houses	Trad.	Tile	RCC	Dila	Mixture
7. Land availability	100	75	50	25	Nil
8. Land connection	Total	Wide	Narrow	Nil	Noland
9. Soil condition	Deep	Medium	Shallow	Stoney	Rocky
10. Soil erosion	Nil	Sparse	Medium	High	V.high
11. Soil conservation works	100%	75	50	Sparse	Nil
12. Crops	75	3 - 5	1 - 2	Nil	-
13. Subsistence farming	100%	75	50	25	Nil
14. Commercia1 farming	Nil	25	50	75	100
15. Market	Nil	Nearby	Far	V.far	-
16. Non-tribal %	0	10	25	50	75
17. Livestock	V.high	High	Medium	Low	0
18. Nearness to forest	Near	Far	V.far	Nil	-
19. Non-tribals around	Nil	Mal.	Tamil	Mixture	-
20. Employment-in	100	75	50	25	Nil
21. Employment-out	0	25	50	75	100
22. Water (protected)	Near	Far	V. far	Nil	-
23. Number of pumps	5	3	2	1	Nil
24. Source of water	River	Well	Tubewell	-	-
25. Road head	Main	Metal	Kutcha	Cart track	Nil
26. Health/hospital	Within	Near	Far	V.far	-
27. School	Nearby	Far	V.far	Nil	-
28. Electricity	100	75	25 - 50	25	Nil
29. Electricity (agriculture)	100	50 - 75	25 - 50	25	Nil
30. Solar	5	3	2	1	Nil
31. Provision store	Near	Far	V.far	Nil	-
32. Tea shop	Near	Far	V.far	Nil	-
33. Number of ration cards	100%	75%	50%	25%	Nil
34. Arrack shop	Nil	V.far	Far	Near	Inside
35. Government assistance	100	75	25 - 50	25	Nil
36. Failed schemes	Nil	25	25 - 50	50	100
37. Bank	Near	Far	V.far	Nil	-

38. Society	Near	Far	V. far	Nil	-
39. Money lenders	Nil	Sparse	Medium	Active	-
40. Land alienation	Nil	25	25 - 50	75	100%
41. Post office	Near	Far	V. far	Nil	-
42. Government employees	5	3	2	1	Nil
43. Cemetry	Inside	Near	Far	V.far	Nil
44. Temple	Inside	Near	Far	V.far	Nil
45. Ration shop	Inside	Near	Far	V.far	Nil
46. Anganvady	Inside	Near	Far	V. far	Nil

Table 11. Socio-economic and biophysical conditions of hamlets

Parameters	I	II	III	IV	V
1. Tribal group	104	16	20	2	-
2. Terrain	10	11	52	17	52
3. Rainfall	24	95	23	-	-
4. Tree cover	0	19	20	94	9
5. Forest type	16	80	24	22	-
6. Houses	21	27	10	1	3
7. Land availability	31	58	31	19	3
8. Land connection	42	32	57	8	3
9. Soil condition	-	45	34	61	2
10. Soil erosion	2	64	74	2	-
11. Soil conservation works	38	36	13	22	33
12. Crops	139	-	-	3	-
13. Subsistence farming	-	63	52	23	4
14. Commercial farming	5	60	55	18	4
15. Market	-	33	71	38	-
16. Non-tribal %	48	46	19	17	12
17. Livestock	-	3	88	42	9
18. Nearness to forest	64	32	43	3	-
19. Non-tribals around	47	24	43	28	-
20. Employment-in	29	30	55	28	-
21. Employment-out	29	29	55	29	-
22. Water (protected)	75	4	1	62	-
23. Number of pumps	4	4	13	23	98
24. Source of water	96	35	11	-	-
25. Road head	30	44	20	33	15
26. Health/hospital	5	56	61	20	-
27. School	68	66	7	1	-
28. Electricity	3	6	13	17	103
29. Electricity (agriculture)	2	-	-	6	134
30. Solar	4	3	4	1	130
31. Provision store	103	24	3	12	-
32. Tea shop	118	17	2	5	-
33. Number of ration cards	3	104	20	14	1
34. Arrack shop	4	9	34	93	2
35. Government assistance	9	29	61	40	3
36. Failed schemes	124	17	1	-	-
37. Bank	42	56	43	1	-
38. Society	42	69	30	1	-
39. Money lenders	93	35	11	3	-
40. Land alienation	37	51	29	23	2

41. Post office	69	62	10	1	-
42. Government emp1oyees	10	5	5	23	99
43. Cemetry	37	91	13	1	-
44. Temple	35	101	6	-	
45. Ration shop	8	86	36	8	4
46. Anganvady	57	37	3	-	45

Majority of the hamiets (95) are positioned in the medium rainfall zone (1000-2000 mm yr^{-1}). Only 24 hamlets are in areas which receive high rainfall (> 2000 mm yr^{-1}) and 23 in areas of low rainfall (< 1000 mm yr^{-1}).

The forest type around 16 hamlets is evergreen, around 80 moist deciduous, and 24 and 22 have dry deciduous and scrub forests. The dominating vegetaton type is moist deciduous forest, indicating that most areas of the region receive rainfall between 1000 and 2000 mm yr^{-1}. Data on rainfall distribution (Fig. 6) reveal that over 75% of the area receives above 1000 mm yr^{-1} and that the predominant vegetation type would have been moist deciduous forests.

At present the tree cover around hamlets and also in forest areas is thin. Of the 142 hamlets in Attappady 19 possess high tree cover, 20 medium, 94 low and 9 hamlets are located on barren areas. No hamlet has very dense tree cover around. Thus a major problem in the area is the absence of protective tree cover.

Land availability among tribals is yet another major issue. Most of the original land of the tribals has been alienated. About 31 hamlets have not experienced land alienation. They are mainly in the reserve forest areas or in farms of Attappady Cooperative Farming Socity. 58 hamlets have lost 25% of the land, while 31 have been dispossessed of 50%. About 75% of the land has been alienated in 19 hamlets and 3 hamlets have no land at all. Most of the land with the tribals is marginal and degraded.

Due to the prolonged process of land alienation, at present, certain hamlets have no agricultural land nearby. The original lands around the hamlets have been lost and tribals cultivate areas located far away. 42 hamlets have arable land around the hamlet while 19 have at far away places. Of the total hamlets,32 and 57 hamlets have a wide and or narrow connection respectively with the agricultural land.

As the tribals have been evicted from the original areas, the land condition of the hamlets at present is deplorable. No hamlet has deep and fertle soil. 45 have medium fertile soil, while 34 have shallow and 61 stoney soils. The position is such that over 70% of the hamlets are on degraded land.

Thus, the tribal lands are threatened by soil erosion as they are on steep and rugged terrain. Only two hamlets out of 142 have land free from soil erosion. In 64 hamlets the erosion is sparse, in 74 it is medium while in two the erosion rates are high. Thus majority of the hamlets the soil cover is under threat.

Soil conservation works (under the Kundah Project) have been carried out completely only in the lands of 38 hamlets, in 36 hamlets 75% of the area has been treated, and in

13 hamlets 50% of the area. About 33 hamlets have not benifitted at all from the project and in 16 hamlets the soil conservation works have been sparse.

Agriculture is practiced in 139 hamlets and more than 5 crops are grown. Three hamlets, as stated earlier, have no land at all. Subsistance farming is predominantly seen in most of the hamlets. The commercial farming is observed in five hamlets, where food crops are not cultivated. These hamlets are part of the Attappady Cooperative Farming Society which grow pepper, coffee and cardamom. Wage labour is the main source of income for the tribal in these hamlets.

Water source is available nearby only for 75 hamlets, while 62 hamlets have no access to the same. River is the main source of water for 96 hamlets, well for 35 and tubewell for 11. Only 44 hamlets have tubewells within a radius of 1 km while 98 hamlets have no access to the same. Of the 142 hamlets only 30 are connected by main roads. 15 hamlets have no road access at all.

The ITDP through tribal sub-plan and special component plans has tried to electrify the hamlets in an enormous way. But the results are pitiable. Only 3 hamlets have all the houses with electrical connections and 6 have with 75%. About 13 and 17 hamlets are partialy electrified with 50% and 25% of the houses enjoying this facility respectively. However, 103 hamlets have no access to electrical power.

Solar lights were also introduced in distant tribal areas to provide light and also to minimise the cost of drawing lines through long stretches. So far, twelve hamlets have been provided with solar light.

Rating of hamlets

A weightage from ten to one was accorded for each parameter ($n = 46$) in the proforma sheet for a hamlet. Scorings were given according to the status of the parameter. The overall scores for a hamlet were determined and the score values for each hamlet is presented (Table 12) in the ascending order. On the basis of score value, the hamlets were rated as follows: good (> 250 points), average (200-250) and bad (< 200).

The results lead to the following inference. The good hamlets are those attached to farm (ATCOFARMS) sites (9) and those (6) which belong to Kurumba and Muduga, located in forest areas with good tree cover and high to moderate rainfall. Land alienation has only partially affected these hamlets and they are located away from the main centres. Basic amenities for existence present in farm hamlets, as the infrastructure facilities are provided by the farms.

Table **12**. Rating of hamlets

Hamlet	Total points
1. Narasamukku	**175**
2. Dhundoor	**181**
3. Oothukuzhi	**181**
4. Kathirampathi	**183**
5. Kozhikoodam	**187**
6. Vendhapatty	**188**
7. Dhoddukatty	**190**
8. Bhommiampadi	**191**
9. Boothivazhi	**192**
10. Manthimala	**192**
11. Mele Kandiyoor	**193**
12. Pettikkal (Sholayoor)	**193**
13. Thekumukayoor	**193**
14. Karara	**194**
15. Nallasinga	**196**
16. Kolangadavu	**196**
17. Kottamedu	**196**
18. Guddayoor	**196**
19. Mele Manjikandi	**197**
20. Dhonikundu	**197**
21. Cheerakadavu	**197**
22. Mattathukad	**197**
23. Paloor	**200**
24. Chavadiyoor (Sholayoor)	**200**
25. Chalayoor	**201**
26. Mele Goolikadavu	**201**
27. Pattimalam	**201**
28. Kalkandiyoor	**201**
29. Anakatty (Sholayoor)	**202**
30. North Ommala	**202**
31. South Kadampara	**202**
32. Vattulukky	**203**
33. Vayaloor	**203**
34. Parappanthara	**204**
35. Urianjala	**204**
36. Vellakulam	**207**
37. Kothiyoor	**208**
38. Kulukoor	**208**
39. Nattakal (Kottathara)	**209**
40. Mele Samparkode	**209**
41. Thazhe Goolikadavu	**210**
42. Kunanjala	**210**
43. Vellavatty	**211**
44. Nakkuppathi	**211**

The lowest scores (< 200) have been obtained by Irula hamlets (22 hamlets) located on or close to main centres. Land alienation, loss of traditional resources, water problem and over all absence of self sufficiency are the reasons.

Majority of the hamlets (104) scored 200 but less than 250 points. This is an indication that bulk of the hamlets have not received due attention and partial development has brought them to a transitional stage only.

Tribe-wise Kurumba hamlets scored maximum points ($\bar{X}$ = 240) and Irulas minimum ($\bar{X}$ = 216). Mudugas occupy the second position ($\bar{X}$ = 235). This result, once more, justifies, our conclusion that, hamlets, where traditional command over resources is existent, (for eg. Kurumba) are better off than these where efforts to develop have destroyed localised systems.

Panchayathwise also, hamlets in Pudur score the maximum average score ($\bar{X}$ = 229) followed by Agali (225) and Sholayur (218).

CHAPTER IV

The Forest Ecosystem

The forest ecosystem of Attappady is a classical example of unplanned human settlements which has turned, within a short period, the 'green hell' into a red desert. A portion of the forests in the area alone received the benefit of protection from the beginning of the century (KFRI, 1980), while the rest have been exposed to varying degrees of interferences.

History

The study area belonged to the Zamorin of Calicut (Kozhikode) who in turn vested the right of control to various princely families. Unlike Travancore, Malabar was not an unified state and large numbers of principalities, local rulers etc. existed and specific areas were under their control. Moopil Nayar's family and Elarpad Raja are widely referred to as the owners of Attappady area. Nattamooppan of Oothukuzhi hamlet near Sholayur narrated that the King of Kozhikode had given Attappady to a local ruler as bride price (dowry). Later, he continued; "Mudugas, Kurumbas and Irulas arrived and the rulers permitted them to inhabit the area. The ruler had excercised powers on the tribals and also and set up an administrative system comprising Moopan, Kuruthala and Bhandari among them and collected tax, grain, etc." Minimum damage was incurred to the forest cover.

The tribal inhabitants of the Western Ghats were and continue to be instrumental in moulding its ecosystems in various ways (Nair, 1988). The damage caused by them should have been minimal with shifting cultivation, hunting and gathering being the major activities. The colonial period starting from early 1800 gave rise to the genesis, evolution and consolidation of a forest and land management policy with vested interests.

The first legislation curtailing shifting cultivation was enacted in 1866 (Nair, 1988). The Madras Forest Act was promulgated in 1882. The Voelkar Commission led to the formulation of the first National Forest Policy in 1894. Demarcation of protection and commercial forests, regulation of the rights and restriction of privileges in the reserved forests were the results.

The process of declaring an area as reserved forest under the Madras Forest Act 1882 was more intricate and prolonged in Malabar district than in most other parts of Madras Presidency. According to the Madras District Gazetter Vol. I (Malabar and Anjengo) 1915 (CES u.d),the Attappady valley was inhabited by Tamil and Kanarese Gowndas, Badugas, Irulas, Kurumbas and other hill tribes who practiced shifting cultivation extensively. Twenty one hills' and part of another belonged to the government and the rest were in

dispute among powerful jenmies (landlords). Attappady Blocks I-IV were constituted as reserved forests as per notification No.332 dt. 13July, 1900. As both Attappady Blocks V and VI belonged to private parties they had to be acquired under the land requisition act. It is interesting to note here that instead of claimants rights over forests notified for reservation being in the position of plaintiffs who had to make out their title, as was necessary elsewhere, it was judicially upheld that in Malabar, it rested on the government to prove that the forest in dispute was at their disposal. Attappady Block V was purchased for Rs.11,379-4-0 and Block VI for Rs.91,571-12-0. The two Blocks were notified as reserve forests as per notification No. 314 dt. 22 June, 1912.

The primary idea was to keep the above blocks as protection forests in order to protect the catchment areas of the river Bhavani and its tributaries. During 1920-28 these forests received a great deal of attention, largely owing to post-war activity in the timber trade. A number of rest houses and bridle paths were constructed with a view to developing these forests.

Except for the lease of minor forest produce, none of the reserves had been worked since reservation upto 1932. During this year selection felling was started in Attappady Block I. The Blocks were brought under the regular working plan by T.V. Venkateswara Aiyer for the first time in 1934 (Aiyer, 1935). During subsequent Working Plan periods large areas of shola evergreen forests and moist deciduous forests were put under the selection system. Over 300 ha of forests was clearfelled and planted with teak. Eucalyptus was raised in Block I and Block VI.

All other areas in the Attappady Valley had been considered as private property and the forest belonged to Jenmies. Until World War II, the private forests of the area retained their pristine glory. But by 1945, the area was thoroughly damaged causing concern to the government. The Madras Preservation of Private Forest Act was promulgated in 1949. But unfortunately this Act was never effectively implemented, one of the resons for this was that the winds of political changes were starting to blow (Nair, 1988).

On January 1, 1957, Malabar District was divided into Cannanore, Calicut and Palghat districts and attached to Kerala state. For various reasons such as the formation of Kerala, changing circumstances and legal questions prevented the passing of further legislation to replace the Madras Preservation of Private Forest Act. In 1957, the Kerala Private Forest Act was promulgated but nothing was done. The land hungry people obtained money receipts from owners and destroyed these forests mercilessly. The massive and successful conversion of forests and arable land to cash crops in the hills of Travancore-Cochin, as economically profitable activity, prompted a very large number of land hungry people from

Travancore to migrate to Palghat hills. The owners on the other hand preferred the easy money obtained by felling the timber to the proper management of the areas for which they had neither interest nor incentive (CES u.d).

Consequently in 1971, the Kerala Forests Vesting and Assignment Act was passed. High Court of Kerala struck down the order on 21st May 1972. After a long legal battle, the Supreme Court of India approved the legislation on 19th August 1973. The interim period of one year and four months was a legal vacuum, during which massive, organised forest plunder was carried out (Nair, 1988).

By 1971, most of the desirable and accessible portions of these forests had already been converted to settled areas exempt from the Act, and, while litigation continued in the courts, the forests were thoroughly denuded of all valuable timber. What remained were mostly steep, rocky and remote patches beyond the margins of economic cultivation. Although the Act provided for 33% of the area for assignment, as per direction of the government the committee recasted the list of areas proposed for reservation.

Present status

At present all the erstwhile private forest of Attappady, which were vested with government, and also the Reserve Forests have been organised under the Mannarghat Forest Division (Fig.9). This division comprises two ranges viz. Attappady and Agali. No clearfelling or selection felling is practiced. Management of existing plantations (Teak and Eucalypt) and augmentation works in degraded natural forests are in the agenda. As the reserve forest portion comes under the buffer zone (manipulation forestry) and the erstwhile private forests under the ecorestoration zone of the Nilgiri Biosphere Reserve, appropriate management practices are being evolved.

The area under forest in Attappady at present is 376 km^2 of which 204 km^2 is reserved forest and 172 km^2 private forests, which were vested with the government in 1971. The total geographical area of Attappady (for the purpose of this study) is 731 km^2 indicating that 51% is still under the control of the Forest Department.

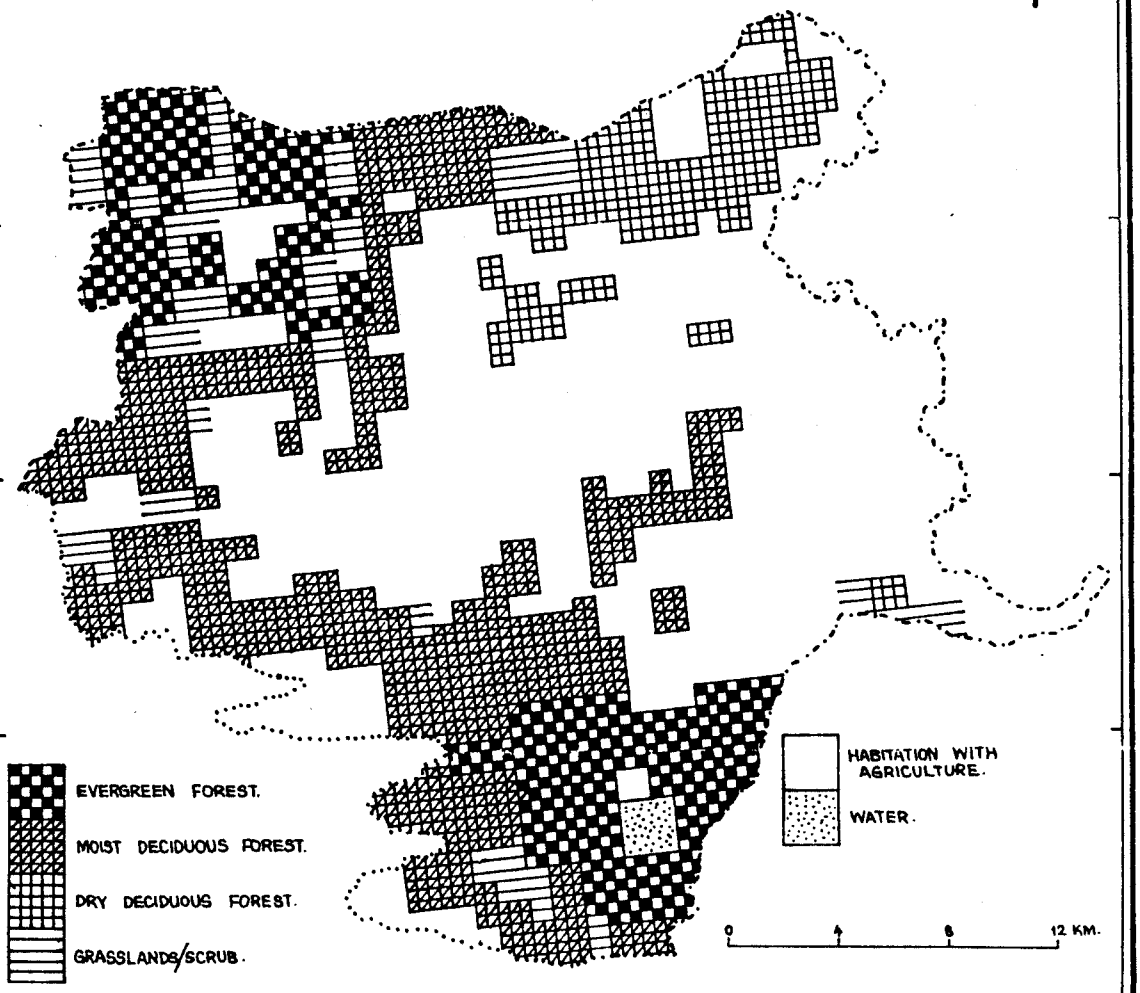
Forest Types

The important forest types found in Attappady area are under the following heads and have been classified by Basha (1977) and Zacharia (1981). A clear line of demarcation between the different types is not always observed and occassionally one type merges with the other

Fig. 9 A T T A P P A D Y

NATURAL VEGETATION

1



1.Tropical wet evergreen forests

These forests occupy humid areas and are found on hills and valleys between 300 and 1100m elevation in Attappady. Tree covered major areas of Attappady in Block I, V and VI.

2.West coast tropical semi-evergreen forest

These forests originally evergreen forests but were retrograded due to fire are found in Attappady Block I and Block VI. Secondary evergreen forests, destroyed by fire from shifting cultivation are located near Thodukki.

3.South Indian moist deciduous forests

This type of forest must have been the most dominant one in Attappady. These forests have been destroyed for their valuable timber. Of this type is found even in the dry belts of Pudur indicating the presence of moist ecosystems in the past.

4.Southern tropical dry deciduous forests

Above 30% of the forest cover of Attappady, at present, belongs to this type. They are understocked in most places due to destruction in the form of removal, fire and grazing.

5.Pioneer euphorbeacus scrub

This is the retrograded form of dry deciduous forests and is located in Mulli and Thoova areas.

6.Subtropical hill forests

This type is found at elevations above 1500m in the upper reaches. They are stunted in physiognomy and with fewer species.

7.Southern montane temperate forests

This type is found at elevations above 1900m along with grasslands in protected hill folds. These are called Shola forest too. The crest of Attappady hills on the Western part, especially, Block I and V bear this type of forests.

8.Grasslands

Grasslands are found at elevations below 1500m are low level grasslands and above 1500m high level grasslands. The low level grasslands are the result of fire and timber removal. Chand Basha (1977) regarded the high level grasslands as a climatic edaphic climax.

CHAPTER V

Agro-Ecosystem

An Agro-ecosystem is a complex of air, water, soil, plants, animals, micro organism and every thing else in a bounded area that people have modified for the purpose of agricultural production (Marten, 1988). Shifting cultivation and settled agriculture are the two types of agro-ecosystemswhich can be identified in the tribal areas of Attapady. While Kurumbas practice shifting cultivation inside the reserve forests, the other two tribal groups, viz. Irulas and Mudugas carry out settled agriculture. An attempt is made in this section to analyse the major features, sustainability and efficiency of both types of agro-ecosystems.

I Shifting cultivation

The shifting or slash and burn agriculture is a primitive system of cultivation, which is generally practiced in the hilly terrain, where gentle slope of land, high rainfall, moderate temperature and good soil favour quick growth of plants (Bose, et al. 1982). The shifting cultivation may be defined as any continuous system in which impermanent clearances are cropped for shorter period in years than they are fallowed (Conklin, 1969). Hardesty (1977) has summarised the major features of the shifting cultivation as follows:

(1) The clearing of forests with slash and burn techniques.
(2) No tillage is carried out for planting.
(3) No use of fertilisers other than ashes deposited during the burning.
(4) Agricultural practices are done mostly with family labour and no draught animal and machine is used at any stage of cultivation.
(5) Fields are shifted frequently.
(6) No use of irrigation.
(7) Traditional annual crops are grown.

This system of farming is prevalent in many places in the world, including some hilly areas in North-East India and Kerala.

History

Till the turn of the present century, the entire forest areas of Attappady were owned by a few persons who acted as absentee landlords having no interest in the management of forests. In September 1900, a part of the forests (Attappady blocks I to IV) was constituted as reserve forests and the tribals residing therein were recognised as tenants of the government. In olden days, the tribals were the only inhabitants in the forests of Attappady and subsisted mainly on shifting cultivation. They practiced an extensive type of shifting cultivation, by shifting the fields annually from one place to another. Although the govern-

ment was concerned about the shifting cultivation, no attempt was made to control it, because the Forest Department needed the services of the tribals.

The first attempt to impose restriction on shifting cultivation in the reserve forests was made in 1917, when the government assigned different areas, free of assessment, to the tribals for cultivation. In the absence of proper enforcement of this by the government, the tribals continued extensive shifting cultivation in the reserve forest areas. In 1927, with an aim of checking the extensive type of shifting cultivation the government brought into effect a scheme with the following provisions:

(1) Each hamlet was allotted three blocks of forest areas, and Moopans in each hamlet were given 2.5 ha separately on a condition that they should supply workers to the Forest Department at the prevailing wages.

(2) Each block was cultivated continuously for 2 years leaving the other blocks fallow and thus a 4 year rotation was introduced in the shifting cultivation areas.

(3) The land was given on lease and the lease would be renewed annually.

The First Working Plan of Palghat Division which was prepared in 1932 (Aiyer, 1935) suggested that the rotation be increased to 10 years instead of 4 years, considering the low recuperation of vegetation in the fallow lands. The government approved the suggestion and introduced 10 year rotation in the shifting cultivation area. Since then, this system has continued. All the three tribal communities inhabited reserve forest areas at the time of imposing restriction on shifting cultivation. But, later two ethnic groups, Irulas and Mudugas moved to adjoining private forest areas where no such restriction existed. Now, only Kurumbas practice shifting cultivation in Attappady.

Ownership of land

The land is allotted by the government on lease. The Moopan, on behalf of members of the hamlet, executes the lease and is supposed to renew it annually. The land is owned by hamlet jointly. However, the power of distribution of land is vested with Moopan who takes decision on the extent and location of land to be distributed to each family. The land in each block is distributed to cultivators at the beginning of the cropping season and they are entitled to cultivate the same land for three years.

Agricultural practices

Thodukki is located at an elevation of 1300 m. and the climate is monsoonic with about 70% of total rainfall of 2432 mm occuring during the period from May to September. The mean maximum temperature during the cropping season is 27 ^{o}C and minimum 17^{o}

C. Thodukki hamlet has been alloted about 60 ha of land in the midst of wet evergreen forests for cultivation. Total area has been divided into four blocks and each block is cultivated for three successive years continuously. The average size of holding in a block is 1.36 ha. The shifting cultivation area which was cropped at the time of data collection was located in a steep slope with angles varying from 40 to 60°.

Preparation of land

The cropping season begins in March. Preparation of land for sowing is the first agricultural operation in shifting cultivation. It begins with slashing down trees and vegetation that occupy the fields. Just before the onset of monsoon, the slash is burned and ash is spread over the field which forms fertiliser for the crops.

Sowing

The soil is disturbed slightly with hoe and pigeon-pea (Cajanus cajan) is sown in rows during April. As seedlings of pigeon-pea stand out (ca. 10cm height), seeds of Finger millet *(Eleusine corocana),* Little millet *(Panicum miliaceum)* and Amaranth *(Amaranthus gangeticum)* are mixed together and broadcasted during the month of May.

Weeding

Since the land is located on steep slopes, intensive weeding would result in soil erosion. The Kurumbas are aware of this and therefore, do minimum weeding. Weeding operation commences with the onset of monsoon in June-July.

Harvesting

Shifting cultivation areas at Thodukki receive less sunshine (photosynthetically active radiation), therefore the crops take more time to mature, ranging from 5 to 11 months. Further, each crop has its own maturity period and harvesting is carried out successively in shifting cultivation areas. Finger millet is the first crop to be harvested (September-November) along with amaranths, and is followed by little millet (December-January). Pigeon-pea is removed during January-February.

Labour

The tribal agriculture in general and shifting cultivation in Attappady in particular, is a subsistence one and is carried out mostly with family labour. The tribals lead an easy life and seldom keep punctuality in doing work on farm. To them, agriculture is a way of life rather than an occupation, therefore, they work on farms as and when they feel to do so.

At the time of seed formation and maturity, the crop is protected from wild animals by male members who generally keep watch at night in a hut constructed in the middle of the farm. Because of easy way of living and working, estimation of labour time spent in a crop season is a difficult task. Table 13 provides data on

Table 13. Labour use in different agricultural operations in Thodukki (mandays ha-1)

Operation	No. of mandays
Preparation of land & sowing	146
Weeding	90
Harvesting	100
Total	336

total man days spent on major agricultural operations, except protection of crop at night. The farmers spend more time on preparation of land and sowing, followed by harvesting and weeding.

Soil properties

The results of soil analyses are given in Table 14. The post burn sample is neutral (pH = 7.2) with low organic matter content and high level of bases. Soils in fallows of three years and above have acidic reaction (pH = 5.3-5.7) and substantially lower base content. A build up of organic carbon in the soil is observed during the fallow period (1.2 to 2.1%).

Table 14. Soil (00-15 cm) properties in fallow plots of varying age

Property	Fallow age (years)			
	a	5	3	0 *
1. pH	5.6	5.7	5.3	7.2
2. Organic carbon %	2.1	1.9	1.6	1.2
3. Exchangeable bases me %	11.0	8.0	9.0	22.0

* Post burn sample
n = 4

Vegetational studies

The status of tree growth ($\geq$ 10 cm gbh) during the recovery phase of 3 to 8 years is given in Table 15. The five year old fallow plot contains more than twice the number of trees (77 trees ha^{-1}) when compared to three year fallow (37 trees ha^{-1}), while the eight

year fallow has nearly double the number of trees (138 trees ha^{-1}) than the five year one. Significant differences in herbaceous and grass growth were not observed in fields with varying fallow periods. Plots in 3, 5 and 8 year fallow had 1.93, 1.68 and 1.9 Kg m^{-2} of herbaceous phytomass respectively.

Table 15. Tree growth (≥10 cm gbh) in plots of varying fallow periods (ha^{-1})

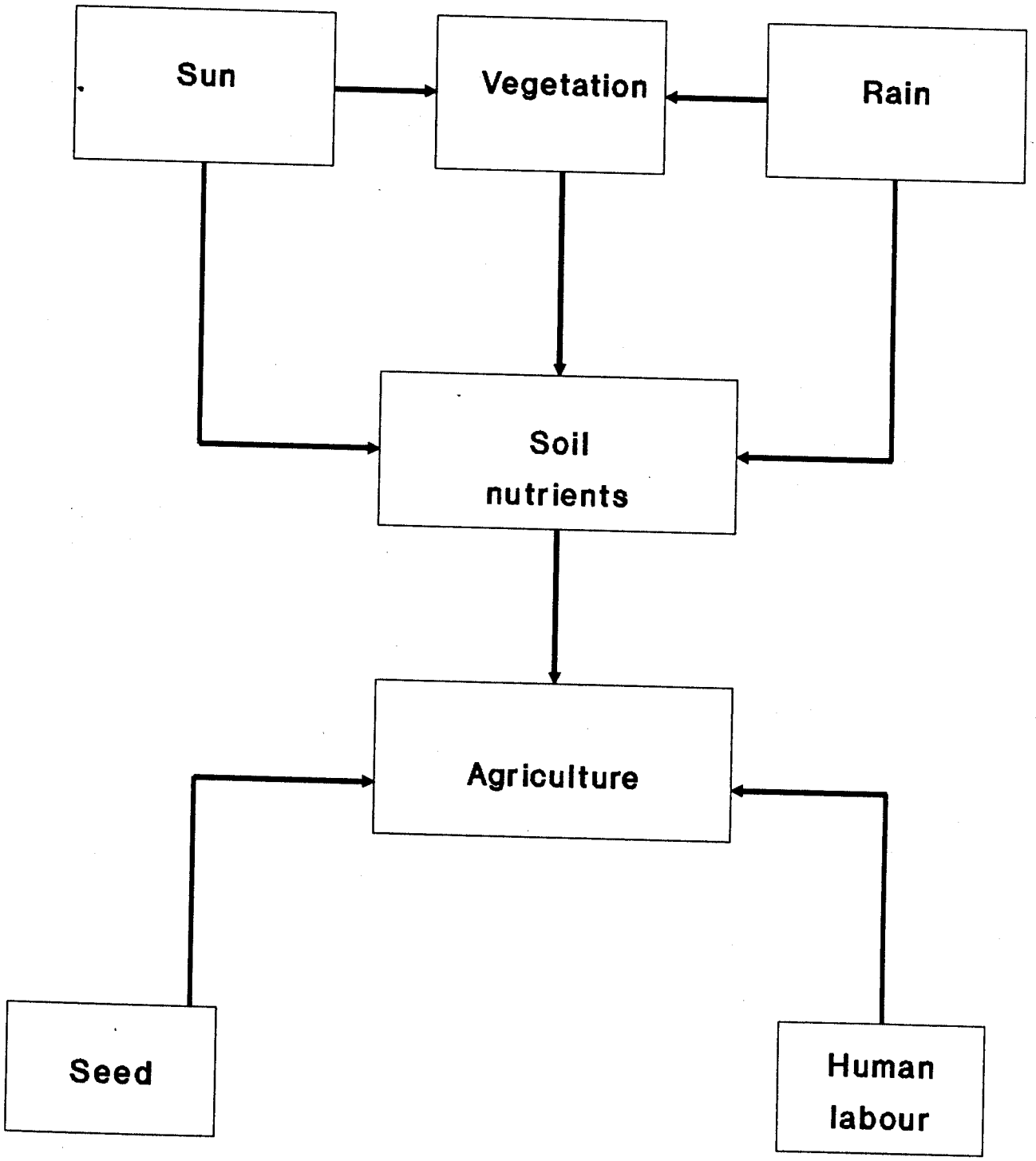
Girth class cm.	Age of fallow (years) 3	5	8
	No. of trees		
10-20	15	4	34
20-30	10	10	29
30-60	10	38	58
60-90	1	23	13
90-120	1	0	4
> 120	0	2	0
Total	37	77	138

Agro-ecosystem structure

An agro-ecosystem structure which includes all elements of the ecosystem indicates how the same is organised to attain its objective (Marten, 1988). Agriculture involves management of biological systems to optimise the flow of solar energy (Jones, 1988). Sun is the basic source of energy in any agro-ecosystem. Solar energy is supplemented by human energy in certain types of agro-ecosystems. In addition to above two sources, external support energy inputs also play an important role in certain other ecosystem like industralised agro-ecosystem. The shifting cultivation, which is based on solar and human energy, uses no external support energy inputs and is carried out by the farmers with resources at their command.

The structure of shifting cultivation system in Attappady is shown in Fig.10. The major components of this system are sun, soil, vegetation, rain, seeds and human labour. Sun and rain help to develop vegetation comprising timber and grasses. The vegetation is slashed down and burnt and ash forms the manure along with soil nutrients for cultivation. Human labour is another source of energy which supplements solar energy in the cultivation.

Fig. 10 Agro Ecosystem Structure (Shifting Agriculture)



Technology

The technology used in shifting cultivation has been developed and perfected with trial and error method by the tribals through generations. Shifting cultivation practices are "scientific" and suitable for the traditional agricultural setting. For instance, slash and burn technique is used not only to clear the land, but to meet the nutritional requirements of the crops (Watters, 1960). The fire is quick and does not produce extreme heat below 2-3 cm beneath the surfaces (Hong, 1987). Burning leads to an improvement in certain properties of soil, such as change in soil reaction from acidic to neutral and an enhancement in bases which are essential plant nutrients.

Mixed cropping is the versatile technique employed in shifting cultivation to maximise production and income and to meet nutritional requirements of the farmers. Mixed cropping has a number of advantages and some of them can be summarised as, "in mixed cropping under jhum, several crop species of diverse growth habit, root system and mineral nutrient requirements enable optimum use of the available space and resources. An extraordinarily large leaf area index is possible because of the storeyed disposition of foliage. The multi-storeyd canopy also protects the land from excessive soil erosion and leaching. Multiple cropping provides an insurance policy to the cultivators because some crops are likely to give a good return even if there is partial or complete failure of other crops. Further, the farmer manages to get all his diverse requirements in cereals, vegetables and tuber crops from the same site. Juxtapositioning of so many crops tends to minimize the incidence of pests and deseases" (Toky & Ramakrishnan 1981).

Since the seeds are sown at different times the crops mature at different periods and therefore, harvesting is carried out successively. For instance, finger millet is the first crop to be harvested (Sept-Nov) along with amaranthus. This is followed by little millet (Dec-Jan). This type of harvesting is scientific in the traditional settings on two accounts. (1) it provides space and nutrients to the remaining crops during its peak period of growth and (2) it enables the farmers to evenly distribute their family labour, so that the use of hired labour can be avoided (Toky & Ramakrishnan, 1981).

Evaluation of system properties

Agro-ecosystem is generally complex, therefore its evaluation is a difficult task. Generally, it is carried out indirectly by identifying the important system properties and then evaluate them. The South East Asian Universities Agro-Ecosystem Net Work (SUAN) has identified 5 system properties for evaluating the agro-ecosystem.

They are:

(1) Productivity - The quantity of food, fuel or fibre an agro-ecosystem produces for human use
(2) Stability - consistency of production
(3) Sustainability - Maintaining a specified level of production over the long period
(4) Equitability - Sharing agricultural production fairly
(5) Autonomy - Agro-ecosystem of self sufficiency

The above properties were adopted for evaluating the agro- eco-system in Attappady.
Productivity and Stability

Time series data relating productivity are required to conduct proper evaluation of the above system properties. No systematic study has so far been carried out regarding the tribal agriculture in Attappady, therefore, there do not exist any data, either published or unpublished on productivity. Thus, the analysis proposed to be carried out here is based on data gathered during the present investigation.

The average yields per hectare of different crops from the cultivation of one block for three years continously (1987--88 to 1989-90) are given in Table 16. Although the productivity of individual crops is low, the total productivity of crop mixture ranges between 1891 Kg^{-1} and 1624 Kg^{-1} which correspond to average yields elsewhere in the state. Another notable trend is that the productivity of different crops in a block declines in successive years, although the variation is not very high indicating that the cultivation is more or less stable. Avariety of reasons may be given for the decline of productivity during the successive years of cultivation in a block. Probably, the most important one is the low availability of biomass for burning in the second and third years.

Table 16. Productivity of Crops Under Shifting Cultivation (kg ha^{-1} (1987-88 to 1989-90

Crops	1987-88	1988-89	1989-90
Finger Millets	670	590	560
Little Millets	409	392	400
Pigeon Pea	812	776	664
Total	1891	1758	1624

Sustainability

As pointed out earlier, there is paucity of adequate time series data to indicate whether the shifting cultivation is sustainable, ie. maintaining a specified level of production over a long period. Figures presented in Table 16 indicate that the cultivation at Thokukki maintains more or less a specified level of production during three years. In the absence of adequate data on productivity, this property is further examined in terms of soil and vegetation status, which are the basic factors determining productivity.

The central concept of shifting cultivation - the dependence on forest fallow periods as the source of nutrients to crops - is applicable at Thodukki. There is a gradual accumulation of soil organic matter during the fallow periods which provides an alternative to fertilization (Table 14). The effects of buring are short-lived and newly burned forest land possesses a nutrient status significantly higher than forest or old plot soil. Although loss in soil fertility and removal of top soil have been reported from many parts of the world due to slash and burn agriculture, the main reason for soil deterioration is attributed to shortening of the fallow period (Sanchez, 1976). A three year successive cropping with a nine year fallow as in Thodukki does not seem to cause irreparable damage to the soil system. It is to be noted further that the nutrient accumulation in the system takes place mainly through the vegetation which builds up as the fallow proceeds.

An analysis of the vegetation in plots of varying fallow length (Table 15) indicates a preponderance of trees in the girth classes of 20 - 30 and 30 - 60 cm. Larger girth classes are represented feebly. Coppice growth is plentiful and can be considered as the main reason for fast reclothing of the land after abandoning. There is a progressive build up of vegetation with increasing fallow length. The redeveloping forest does not at all resemble the primary forest (tropical wet evergreen) as the short forest fallow results only in secondary forest which is species poor. Pyrogenic trees species like Dalbergia latifolia, Grewia tiliafolia and Emblica officinalis constitute more than 60% of the tree cover in the slash and burn sites. Maintenance of a secondary forest may be more useful to the shifting cultivators than primary forests as the former is easy to clear (Clarke, 1976). The absence of significant differences in herbaceous and grass growth among plots of varying fallow length indicates that the area is not yet prone to be converted irreversibly into an unproductive grassland.

Equitability

Equitability is one of the important features of the shifting cultivation and is attained in two ways in Thodukki. First, since the members of the hamlet are relatives, the surplus food grain is often shared among the members of the hamlet, especially during the period

of shortage. Second, the location of fields allotted to each family is changed during each rotation. That is, if one family gets land in slopy area in one block, it will be given land in a good location in the next block, so that the low productivity in the slopy area will be compensated by high productivity in a good location. This is one of the methods by which equity is maintained among the members of the hamlet.

Autonomy

Shifting cultivation at Thodukki is self reliant in the sense that the farmers carry out cultivation with their own resources and family labour. If at all they need additional labour, they depend on their close relatives who reside either in the same hamlet or adjacent Kurumba hamlets. Generally, they are given food and small quantity of grain as wage.

II Settled Agriculture

Mudugas in Karara and Irulas in Mully settlements practice settled agriculture in the forest land alloted by the government. Both the hamlets are located in vested forest (nationalised private forests) areas. In Mully hamlet, a few of the tribals have both revenue land, where they have title deeds and forest land for cultivation. The farmers are free to cultivate and consume the products from the forest lands, but have no right to sell the land. While the Mudugas reside in medium rainfall areas, the Irulas inhabit low rainfall areas in Attappady. However, both the groups practice dryland agriculture, with many features of shifting cultivation mentioned earlier.

Agricultural practices

The agricultural practices in Karara and Mully begin with the preparation of land for sowing which involves cutting and burning of undergrowth and small trees. Revenue land owned by the tribals in Mully are either plain or undulating, where they have taken to plough cultivation. But forest lands in both the settlements are on the hill slopes, where they practice the traditional method of cultivation. In forest land, the slope is not disturbed when the levelling and bunding are carried out. The seeds are sown using hoe or 'kothu' in the forest lands. Just after the first showers of the monsoon, a mixture of millets, such as finger millet and little millet and pigeon pea is sown in both the types of land. The cultivation in both the settlements depends upon the natural fertility of the soil and no manuring except ashes deposited in the burning is used in Karara. The tribals in Mully use manure in their revenue lands. Weeding is carried out in the agricultural land. The farmers depend upon family labour for the cultivation. Harvesting in settled agriculture, as in shifting cultivation, is done, successively, depending upon crop maturity.

Agro-ecosystem structure

Ecosystem structure of settled agriculture in Attuppady is slightly different from shifting cultivation as it receives energy from more diversified sources such as sun, bullock labour, human labour, seeds, etc. The structure of settled agriculture is presented in Fig. 11. This agro-ecosystem receives energy mostly from sun and is further supplemented by energy from bullock labour, human labour, etc. In revenue land, some farmers use cowdung as manure and the land is deeply ploughed. Many farmers in Mully hire bullocks from non-tribals. In addition, some farmers purchase seeds from outside, and hire human labour especially during the peak season for the completion of work. Thus settled agriculture is linked with the market.

Evaluation of System properties

Data on yield have been gathered from Karara for two years (1988-90) and from Mully for one year (1988-89) (as Mully witnessed severe crop failure in 1989-90, the figures relating to that year are not taken for analysis). The average crop production in Karara was estimated to be 1310 Kg/ha in 1988-89 and 1056 Kg/ha in 1989-90, while it was 1206 Kg/ha in Mully in 1988-89 (Table 17). There was not much difference in yield between Karara and Mully in 1988-89, probably because Mully received a good rainfall during the period. In addition, application of manure might have increased the productivity there.

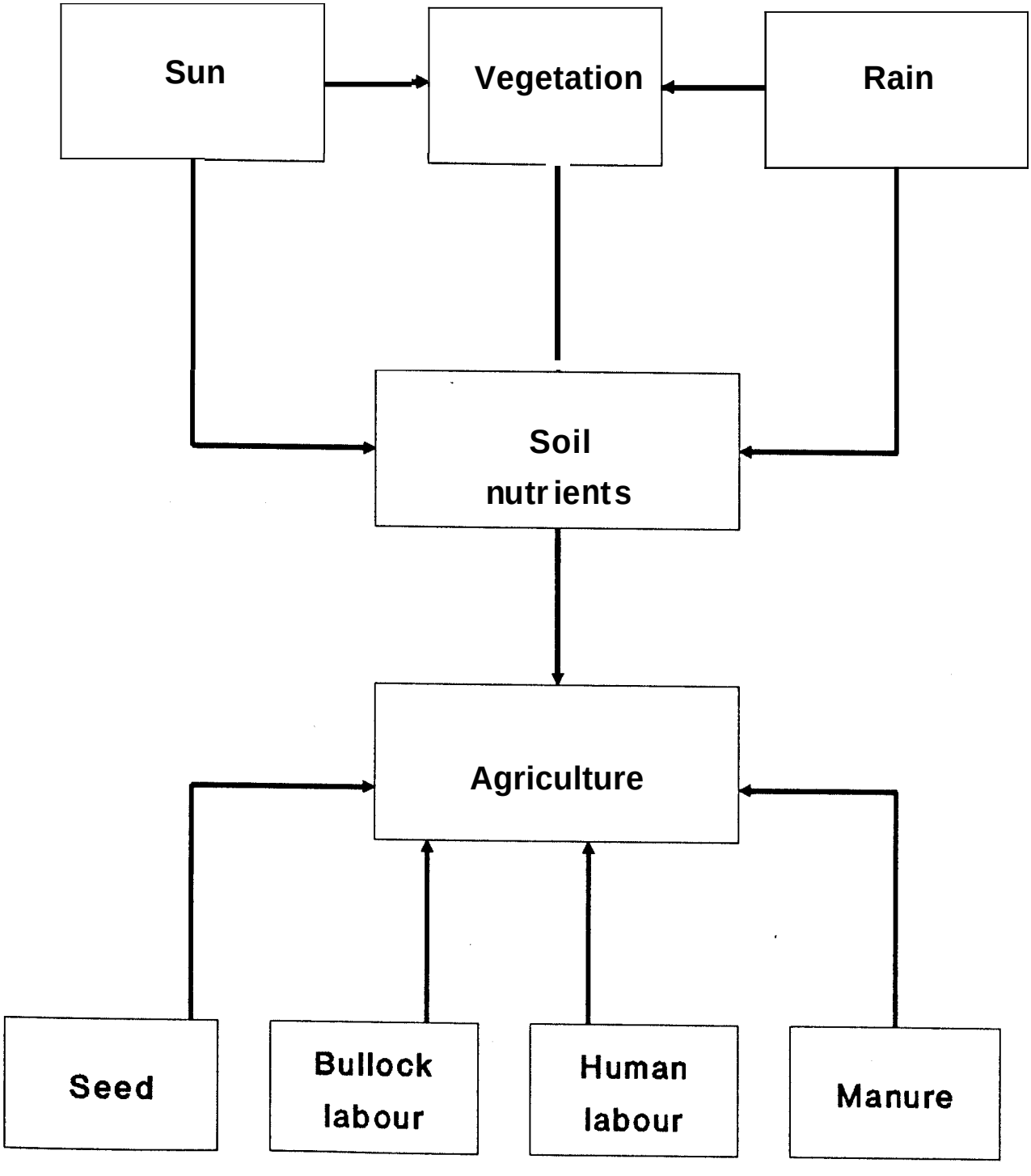
Table 17. Productivity of crops under settled agriculture (kg ha^{-1} during the period 1988-89 to 1989-90

Years	Crops	Karara	Mully
1988-89	Finger Millet	430	401
	Little Millet	335	329
	Pigeon Pea	545	476
	Total	1310	1206
1989-90	Finger Millet	328	-
	Little Millet	318	-
	Pigeon Pea	410	-
	Total	1056	-

The data given above are not adequate to indicate whether the settled agriculture is stable or not. However, it may be pointed out that the productivity is not same for two years in Karara.

Due to lack of time series data on yield, the sustainability of the system cannot be assertained. The cultivation in forest land in both the places depends upon natural fertility

Fig- 11 Agro Ecosystem Structure (Settled Agriculture)



which is very low because of two reasons. First, forest lands are mostly on hill slopes without tree cover and soil erosion is a serious problem. Second, fallowing is not practiced in the settled agricultural fields, therefore there is not much recuperation of fertility. In the revenue land, tribals apply manure but its quantity is inadequate to augment the productivity significantly. Because of low production, the farmers could meet only 40% of the food requirements from agriculture.

Equity, the sharing of agricultural products among the farmers, is not common in Karara and Mully. Major reasons are: **(1)** agricultural production of each family is insufficient even to meet their own consumption and (2) marriages from other hamlets of their tribes located in different parts of Attappady are quite common among Mudugas and Irulas, therefore, the members of individual hamlets are not close as in the case of Kurumbas.

Settled agriculture is not autonomous. Many farmers in Mully hamlet, for instance, depend on market for mobilising the resources (bullock, seed and human labour).

III Efficiency of shifting and settled agriculture

This section is devoted to analyse the efficiency of shifting and settled agriculture that are practiced by the tribal groups in Attappady. Two aspects of the efficiency of the traditional agriculture such as energy and economic efficiencies are examined here. A system is condisered to be efficient in terms of energy when it produces a higher output of energy in comparison with total input (Schahezenski, 1984). This can be assessed from the ratio of energy output to input. Similarly, the economic efficiency denotes the ratio of monetary value of output to input.

Method

Earlier, a number of studies have been carried out to analyse the energy and economic efficiencies of traditional agriculture (Norman, 1978; Toky and Ramakrishnan, 1981). A review of these studies indicates that methodology consists of three components: defining system boundary, measurement of energy input and output and estimation of efficiency. The study is based on the data gathered from three hamlets and ecosystems of these three hamlets constitute the system boundaries.

In energy efficiency studies, generally, energy inputs and output are measured by process method which involves a technique of measuring various inputs used in the process of producing a specific output. The study is based on data collected from three hamlets over aperiod of one year data (1988-89) and is based on the assumption that different inputs and outputs of diverse types (heat of combustion, nutritive value, etc.) are homogeneous (Mishra and Ramakrishnan, 1982).

Major inputs used in the shifting cultivation are seed, and human labour. In addition to the above two, manure and bullock labour are used in the settled agriculture in Mully.

Solar energy is a primary source of energy and plays an important role in agriculture in general and traditional agriculture in particular. But this is excluded from the energy efficiency analysis as the same is considered to be a 'free input'.

Seeds are prepared by the farmers themselves. Generally, it is done just after the harvesting. The energy value of seed was calculated on the basis of the total energy to produce that fraction of crop yield.

Family labour is mostly used in both types of agricultural systems. Total food energy consumed by the farmers apportioned to different activities (Leach, 1976), which are categorised as sedentary, moderate and heavy. Per hour energy expenditure of 0.418 Mega Joules (MJ) for sedentary work, 0.488 MJ for moderate work and 0.679 MJ €or heavy work for an adult male and 0.331 MJ for sedentary work, 0.383 MJ for moderate work and 0.523 MJ heavy work for adult female were used to estimate labour energy input (Gopalan et al, 1978). In the case of bullock labour, per hour energy input was estimated to be 303 MJ per hour (Mitchell, 1979).

The energy value of manure was calculated on the basis of their replacement cost values in terms of fossil fuel (Mishra and Ramakrishnan, 1982). Only cattle dung is used in the settled agriculture (Mully) and its replacement cost value is 1.47 MJ per Kg.

Grains and pulses are the two categories of output in both shifting cultivation and settled agriculture. The standard energy values of grains and pulses are 16.29 MJ per Kg and 16.24 MJ per Kg respectively. The total yields of various crops was converted into Megajoules of energy by multiplying with the above standard values, in order to estimate the energy values of output (Mishra and Ramakrishnan, 1982).

Results

The results of the energy analysis of shifting and settled agriculture of tribal communities in Attappady are presented in Table 18.

In the shifting cultivation site at Thodukki, total energy value of input is estimated to be 1458 MJ ha^{-1} yr^{-1} of which 77% belongs to human labour and 23% to seeds. This type of agriculture uses neither manure nor bullock power. The output is high (28435 MJ ha^{-1} yr^{-1}) with an output/input ratio of 19.5:1.

At Karara, where Mudugas practice settled agriculture, the energy input is 1310 MJ ha^{-1} yr^{-1}. Bullocks are not employed as in the case of Thodukki and less time is spent on

preparation of the land. The output is 21311 MJ ha-1 yr-1, which is lower than that at Thodukki, with an output: input ratio of 16.3:l.

Table 18. Energy (MJ ha^{-1} yr^{-1} and monetary (Rs ha^{-1} yr^{-l}) efficiencies in shifting and settled agriculture

Item	Shifting Cultivation		Settled Agriculture			
	Thodukki		Karara		Mully	
	Energy	Monetary	Energy	Monetary	Energy	Monetary
Human labour	1124	3880	976	4500	851	4020
Seed	334	100	334	100	584	175
Manure	-	-	-	-	42	120
Bullock labour	-	-	-	-	49	240
Total input	1458	4880	1310	4600	1526	4555
Total output	28435	8112	21311	5942	19621	5357
Output input ratio	19.50	1.66	16.26	1.29	12.85	1.17

At Mully, the Irulas attempt to follow certain features of Tamil settled agriculture. Thus the input of energy supplied by manure and bullock is present here, accounting for only 6% of the total input. The output is the lowest among the three cases (19621 MJ ha^{-1} yr^{-1}) and also the output : input ratio of 12.9:l.

Monetarily also, both shifting and settled agriculture are efficient since the output input ratio exceeds one in all the three places (see Table 18).

Discussion

The total number of man days employed per hactare during a crop period was estimated to be 336 in Thodukki, 290 in Karara and 254 in Mully. Preparation of land, comprising clearing, cutting and burning of slash, levelling and sowing accounted for 43% of the total man days and other activities such as, weeding and harvesting shared the rest in Thodukki. More or less the same pattern of employment was observed in settled agriculture also. In Thodukki male and female workers employed more or less equal number of days, while the male workers contributed 35% more days, in Karara and Mully. One possible reason for this is that the distance between the house and the field is less in Thodukki (0.5 km) than Karara and Mully where the distance ranges from 1 to 3 km. In Mully, where the rain fall is low, seed rate used for sowing is more, because of low survival.

Except the land rotation in shifting cultivation, other agricultural practices are more or less same in the three selected hamlets. Probably due to this, the output/input ratios estimated for three hamlets do not show much variation. Of course, the shifting cultivation is more efficient both in terms of energy and income because of the sustainability of the system and favourable biophysical factors operating in Thodukki.

For instance, Thodukki gets less sun shine than Mully, so that the crops mature successively. One advantage is that the family labour can be evenly distributed. Contrary is the condition in Mully, where the crops mature more or less same period, because of warmer conditions. Thus, in order to complete harvesting, the farmers are often forced to hire labour.

One of the advantages of the traditional agricultural systems, whether it is shifting cultivation or settled agriculture is that they command a high energy efficiency compared to industrialised agro-ecosystems which have energy efficiency values of less than one (Spedding, 1975, Leach, 1976).

The efficiency differs even within the traditional system, depending upon whether the system uses hired inputs or not. The differences in energy as well as economic efficiencies between Karara and Mully support this fact. In Mully, the efficiency is less than Karara because: (1) the farmers use more hired inputs or purchase energy from out side and (2) less yield is obtained and (3) wages are comparatively higher.

CHAPTER VI

Tribal Development Programmes

The underlying idea of government policies and programmes that have been launched in Attappady has been to uplift the tribals in par with non-tribals in plainland. The establishment of Integrated Tribal Development Project and Attappady Co- operative Farming Society is aimed at to attain this. A general evaluation of these two institutions is attempted in this chapter.

I Integrated Tribal Development Project (ITDP)

The Integrated Tribal Development Programme which was launched during the Fifth Five Year Plan (1974-79), aimed at overall development of the tribals in the areas where the programme is implemented. All those blocks where more than 50% of the population comprised tribals were selected to implement this programme. A separate tribal sub-plan within the frame work of main Five Year Plan was prepared. The finance for the plan is made available from the state plan outlay and the central government assistance. The allocation of finance to each project area is based on the criteria such as geographical area, population and comparative level of development.

Initially, the programme was conceived and implemented as an area development programme. But it was realised that the benefit of the programme was enjoyed more by non-tribals than the tribals as the former commands more resources in the project area. Thus, in the Sixth Plan it was converted into a target group programme, in which the individual families of the tribals were targeted to receive the benefits. The target group is viewed holistically and economic and non-economic factors responsible for development are integrated, while implementing the programme.

The sub plan strategy of integrated tribal Development was first introduced in the state during 1975-76. The tribal Development programme in Attappady had been implemented by Tribal Development Block since 1962. The ITD Project which replaced the Tribal development block, came into existence on 15th of August, 1975.

Administration

Aproject council, chaired by the District Collector is the supreme policy making body for the project. In addition to a Project Officer, who is the member secretary of the council, it consists of four tribal chiefs, two non officials who are closely associated with tribal welfare activities. Local MLA and MP, the Conservator of Forests, Superintending Engineer (B & R) and Revenue Divisional Officer, The representatives of the Moopans (2 from Irula, and one each from Muduga and Kurumba communities) are nominated by the

Project Officer. The day to day administration in the project office is carried out by the Project Officer (who is generally an IAS Officer), assisted by 2 Assistant Project Officers who are at the grade of Block Development Officer.

It was suggested in the project report that the programmes of the project should be implemented with adequate popular support. In order to attain this, a Moopan's council is formed in each project area, since Moopans are supposed to have control over the members of the hamlet. Each hamlet, irrespective of the communities, has one Moopan and all the Moopans in Attappady are the members in the Council. One head Moopan, among the members is selected democratically. The council is presided over by the Project Officer.

Apart from ITDP, a number of agencies are implementing schemes and programmes in the study area. Thus, it is quite essential to coordinate the activities of these agencies for better utilisation of resources. Attappady Tribal Development Agency, an autonomous body, was constituted for this purpose. The agency is headed by the Project Officer and supported by a team of experts in the various development sectors and the Village Officers. The developmental activities in the area are channelled through this agency.

Major programmes

The ITDP which receives funds from the state government and some departments in the central government has implemented the following prgrammes.

1. Tribal Development Programme (State Plan and Special Central Assistance)
2. Community Development programme
3. Progrmmes implemented through District Rural Development Agency (DRDA), Palghat
   (a) Integrated Rural Development Programme (IRDP)
   (b) National Rural Employment Programme (NREP)
   (c) Rural Landless Employment Generation Programme (RLEGP)
   (d) TRYSEM
   (e) Development of Women and Children in Rural Areas (DWCRA)
4. Western Ghat Development Programme (Centrally sponsored scheme)
5. Attappady Valley Development (AVD) Scheme

The details of the amount that was expended by both Tribal Development Block and ITD Projects in Attappady under various schemes are available only for the period from 1962-63 to 1984-85 and are furnished in Table 19.

Table 19. Total amount (Rs. in 000) spent for the development of tribals under various schemes in Attappady during the period from 1962-1985

Items	1962-1974	1974-80	1980-1985
Tribal Development Fund	1537.44	5082.75	12,339.99
Community Development Fund	399.47	1754.64	6,147.33
Agricultural funds	-	619.86	137.24
Western Ghat Development fund	-	14829.24	13,503.22
Other Departmental funds	403.05	238.83	990.95
Other schemes (IRDP,NREP,etc.)	-	-	13,461.13
Total	2339.96	22525.32	46579.86

Suggestions

Although a number of development programmes have been launched and implemented by the Tribals Development Block and ITDP since 1962, the economic conditions of the tribals have rather diteriorated. A study on Attappady, prepared by ESRG (1989) observed that "collapse of agriculture, lack of alternative employment, health problem due to ma1 and / under nutrition and contaminated water have created a vicious cycle of poverty, physical weakness, isolation, vulnerability and powerlessness" (pp: 12-13). This indicates that the organised attempt to uplift the tribals made little head way in Attappady and the institutions created for this are partly responsible for this.

The deficiencies of ITDP are numerous and enumeration of them is beyond the scope of this study. In the absence of any other agency, the ITDP has to play a major role in the tribal development in years to come. Thus it should be strengthened for the upliftment of the tribals and in the regard, the following suggestions may be considered.

The ITDP, which was launched as an area development programme was later transformed into a beneficiary oriented programme, aiming to provide more benifits to tribals. This approach is good, especially in areas where the eco-degradation is low. In area like Attappady, where the eco-degradation and distruction of resource base are high, the implementation of beneficiary oriented programmes should be supplemented with area development programme to give a breakthrough in tribal development. In other words, the area development programmes like ecorestoration and beneficiary oriented programmes should be integrated and implemented simultaneously in the tribal areas, under the supervision of ITDP.

During the period between 1962-1989 about Rs. 9.50 crores had been spent through Tribal Development Block and ITDP, for tribal development in the study area, that is, per

head investment amounted to only Rs.4300. Needless to say this is quite inadequate for the development of a downtrodden section in the society. Thus ITDP should be endowed with more resources.

Another interesting fact is that a siginificant part of the total outlay of the ITDP is earmarked for developing infrastructure, espcally construction of roads, houses, etc. It is not that they are unnecessary. But the question is how far it can be carried out as it does not provide direct benefits to the tribals. Further there have been misuse and waste in utilising funds, earmarked for the construction work. There are instances in which one road has been constructed more than once, under different schemes (eg. Chittoor - Ommala road). A number of roads have been constructed on hilltops which are rarely used by the tribals. Whatever be the attraction and justification of undertaking construction work, this should be minimised and waste and misuse of funds avoided.

In addition to ITDP, a substantial amount is invested in Attappady by other government departments such as irrigation, soil conservation, etc. Although the investment is not in the name of tribal development, it has its own impact on tribal economy. But the details of investment made by these departments are seldom passed on to ITDP, therefore ITDP has no control over their investment. The activities of these departments in the project area should be coordinated and the fund should be channelled through ITDP.

Red tapism and corruption are part and parcel of many goverment departments and the ITDP is not fully free from these. These malpractices should be checked in order to strengthen the organization.

II Attappady Co-operative Farming Society (ATCOFARMS)

In terms of magnitude and significance, the formation of Attappady Co-operative Farming Societywas the second largest event in the history of the tribal welfare programme. More than a welfare programme, it was treated as an alternative path of development and thus it evoked much interest among the public.

The society was organised under the Western Ghats Development Programme for settling 420 tribal families. The main philosophy of this farming society was to uplift the downtrodden tribals on par with men of plains without destroying the ecological balance of forests. The society has been allotted about 1080 ha which are uncontiguous and spread over four different places in Attappady viz. Chindakki (230 ha), Pothupaddy (440ha), Karuvara (120 ha) and Varadimala (290 ha). Of the total area, about 1040 ha have been planted up with cash crops such as cardamom, pepper and coffee and 0.50 cent each has

been alotted to each family for cultivation of crops of their own interest within the farm. In addition, each farm provided employment to its members.

The expenditure incurred under this programme can be classified under two broad heads infrastructural and agricultural operations. The infrastructural facilities consist of a variety of items such as labour quarters, roads, consumer stores, hospitals, etc. The Government of India, under the Western Ghat Development Programme, allotted Rs. 2.28 crores for meeting the infrastructural facilities, while the NABARD and Central Land Development Bank have met the plantation raising cost of about Rs. 2 crores. They have been further supplemented from borrowing from different agencies like Perinthalmanna Co-operative Land Mortgage Bank, Marketing Federation, etc.

Undertaking an evaluation study on ATCOFARMS in 1982, KIRTADS stated that the society had not fulfilled its objectives and the benefits had not trickled down to the members. The financial condition of the society has been further deteriorated since 1983 due to mounting debts. At present, the total liability of the society is estimated to be Rs. 153.5 lakhs of which the borrowing from one financial agency (Perinthalmanna Land Mortgage Bank) alone accounted for 90% . Because of the failure to repay the debt, the society is on the verge of liquidation and members facing revenue recovery.

The major reasons stated for failure of the society are summarised as mismanagement and corruption, lack of social planning and poor supervision of agricultural crops (KIR-TADS, 1982). In addition the following points have contributed to the failure of the society.

The success of agricultural crops, especially cash crops, to a great extent, depends upon favourable weather condition. Extensive felling in farms for different agricultural operations coupled with massive deforestation outside the farms are said to have altered the microclimate in the farms, which affected the performance of the crops. The variations in rainfall (Table 20) and droughts of varying intensity reported to have occurred in farm in different years support this view (in 1983, the society lost crops in 80 ha in Varadimala farm due to severe drought).

The tribals who are accustomed with shifting cultivation were forced to cultivate cash crops having different agricultural practices and technology in the farms. The success of cash crops requires more involvement of the workers, intensive management and proper supervision. The tribals are ignorant about the agricultural practices in the farm and no serious attempt has been made to impart training to them. Lack of adequate involvement by the workers and proper supervision and timely management, coupled with change in microclimate significantly affected the yields in farm. This is indicated by the fact that the

coefficient of variation of yield is as high as 57% in cardamom, 89% in coffee and 87% in pepper (Table 21).

Table **20**. Details of rainfall (mm) received area during **1985** to **1989** in four farm area

Name of farm	Years				
	1985	1986	1987	1988	1989
Chindakki	2740	2116	1051	1271	1501
Karuvara	1847	1930	1942	2190	1860
Pothupaddy	1400	1293	1177	1837	1062
Varadimala	1642	1186	1990	2092	1486

Table21. Coefficient of variation of yields of different crops and values received in farm during 1980-81 to 1989-90

Crops	Qty %	Value %
Cardamom	56.52	55.73
Coffee	89.21	94.24
Pepper	87.12	105.05

Table **22**. Details of yield received from the four farms during the period **1980-81** to **1989-90**

Years	Cardamom		Coffee		Pepper		Total
	Q * kg.	Value Rs.	Q kg.	Value Rs.	Q kg.	Value Rs.	Value Rs.
1980-81	**1230**	**92202**	**1250**	**7496**	**100**	**2448**	**102146**
1981-82	**6010**	**728164**	**6298**	**41857**	**9300**	**4367**	**774388**
1982-83	**7080**	**1256498**	**12536**	**73575**	**1076**	**11968**	**1342041**
1983-84	**1706**	**674004**	**11966**	**82828**	**1468**	**35381**	**792213**
1984-85	**2711**	**420424**	**44756**	**174920**	**469**	**18800**	**614144**
1985-86	**3465**	**387611**	**19964**	**214068**	**2174**	**88812**	**690592**
1986-87	**2822**	**610526**	**48840**	**340030**	**7228**	**400050**	**1350607**
1987-88	**2752**	**288109**	**14920**	**87313**	**9152**	**307500**	**682923**
1988-89	**4482**	**684375**	**84200**	**644961**	**6534**	**285984**	**1615322**
1990-91	**1094**	**339910**	**24980**	**242540**	**13700**	**417850**	**10380300**
	33352	**5481823**	**269710**	**1909588**	**51201**	**1573160**	**18344676**

*Q-Quantity
Source: ATCOFARMS, Agali

The price of cash crops are generally determined in the national and international markets which often results in high fluctuations (see Table 22).

The society is left with no option but to accept the price. Because of lack of flexibility in decision making, the variations in price affect the society much more than any individual planter.

The involvement of tribals in this type of cooperative farming did not transform to real participation. They were given the status of wage labourers and were constantly at the mercy of supervisors and Director Board members for day to day existence.

Massive loans taken from Land Mortgage Banks were used mostly for unproductive purposes such as buying pipes for irrigation, conducting the Director Board meetings, etc. One suspicious fact remains as to how the titles deeds were made on land allotted to the society on lease for cultivation by the Forest Department. There was an attempt to auction the land belonging to the farm by the Land Mortgage Bank two years back. Fortunately, the Government of Kerala, intervened and the same stalled. However, the threat to the existence of these farm still lingers and thereby the fate of 400 and odd tribal families.

Protagonists of this venture have long lost all interest in the working of the society. The members have been treated as wage labour and management acts as ruler. The inequity between managers and tribals in the society is bound to continue as long as tribal labour remains alienated from the means of production.

The members of the farm were picked up from different hamlets and were settled in the farm. They did not know each other. They were not adequately informed of the objectives of the society. They were just told that this was for their good and they believed it. Even after 15 years of its formation, they do not feel that the farms belong to them.

Certain suggestions are listed for the improvement of the farms:

1. A detailed review of the activities of the farm may be conducted.

2. The members should be educated properly to get a feeling that they are the rightful owners of the farm.

3. The representation of members may be increased in decision making bodies and appropriate training imparted to them.

4. Cleared but uncultivated portion in each farm may be given to the members for raising food crops.

5. As the departments which control the farm do not appreciate the value of the last chunks of forests within the farm, the farm management may be transferred to the Forest Department.

CHAPTER VII

Socio-Economic Interactions in Tribal Areas

Man-Forest Interaction

The symbiotic relationship between tribals and forests is well recognised. They husbanded the forest as a resource for fulfilling basic needs and optimised its use as a balanced productive ecosystem. Being denizens of forests, they were concerned with preservation of forests and better management so as to get resources for their subsistence. Infact, the forests in Attappady offered a variety of goods to fulfil their basic needs. Thus they lived with nature without exploiting and destroying it much. This condition prevailed in Attappady till the external forces staked their claims on forests. The factors such as reservation of forests, population growth, deforestation, climatic change, etc. which have occurred since the begining of this century, remoulded their attitude towards the forests and utilisation of its resources. Further the conquest of 'civilized living' penetrated deep into the lives of tribals and made them seek new adjustments (Childyal, 1982).

Two aspects of man-forest interaction are analysed here: (1) nature of man-forest interaction and (2) whether basic needs of the tribals are met by the existing forests.

Agriculture

Agriculture, especially shifting cultivation is the major type of man-forest interaction and much has been said about this elsewhere in the report. Although agriculture especially shifting cultivation is efficient, and does not do much harm to forest, it does not provide adequate output to meet their basic needs.

Thatching materials

Majority of the tribal houses are built with bamboo, grass and mud which have been collected from the forests. In addition, a few tiled and concrete houses have been constructed by ITDP which used timber gathered from forests. While the availability of thatching materials is not a problem in reserved forests areas, this has been so in vested forests areas where the deforestation is massive. The maintenance of the houses in the tribal settlements in vested forest areas has been affected by this.

Fuel wood

Fuel wood is the major cooking medium of the tribals and forests are the main source. The average per capita consumption of fuel wood was estimated to be 2.68 kg day^{-1} in Thodukki hamlet, while it was 1.26 kg day^{-1} each in Mully and Karara. In other words, fuel wood consumption in Kurumba hamlet is significantly higher than that of Irula and Muduga hamlets, because the availability of fuel wood is significantly higher in Kurumba areas.

Similarly, the distance travelled in forest areas for collecting fuel wood varies among the tribal communities. For instance, the Kurumbas were able to procure fuel wood within the distance of 1km, where as only 25% Mudugas and 10% Irulas could collect the same within this distance. The problem is more acute in Irula hamlets and even 20% sample Irula households purchased fuel wood from sources out side the hamlet.

Minor forest products

Collection of minor forest products (MFP) is one of the main sources of income to the tribals and is depended upon a variety of factors such as area under dense forests, rainfall, number of people engaged in the collection, etc. In Attappady the MFP are collected mainly from forests areas and by tribals living near the reserve forests. Thus only a small section of the tribal population gets income from MFP in the study area due to depletion of forest cover. For instance, in Karara and Mully, no one was reported to have collected MFP during the period of data collection, because dense forests are located far away from these hamlets.

Details of collection of minor forest products in Attappady for the period 1980-81 to 1988-89 are furnished in Table 23. There had been significant variations in the availability of MFP in the study area during the reference period. This has much implication on income received by the tribals, since income from MFP constitutes a significant proportion of total dispossable income of the gatherers.

Table 23. Minor forest products collection (kg) during the period between 1980-81 to 1988-89

Year	White dammer	Shikakai	Honey	Gooseberry	Medicinal plants
1980-81	12125	1393	-	-	1400
1981-82	-	-	-	346	1435
1982-83	3147	2554	-	805	10727
1983-84	2859	3143	-	254	1239
1984-85	3158	1236	-	70	1061
1985-86	14311	25264	1208	3758	5048
1986-87	10585	8641	1809	11584	948
1987-88	8102	52929	3665	30	18305
1988-89	11518	13223	2281	7071	4792

The minor forest products collected by the tribals are procured by tribal co-operative societies in the study area, aiming partly to eliminate private traders and partly to provide a fair price to the gatherers. The procurement prices of the products are determined by the government and are revised during certain years. But many a times, the price increase

declared by the government is only marginal and significantly lower than the open market price. For instance the procurement price of one bottle of honey (750 gm) amounted to Rs.15 in 1989, which was increased to Rs.16 in 1987 and Rs.19 in 1989. The market price of one bottle of honey was Rs.32 in 1989. Though, the societies could succeed in eliminating private traders, they have failed to give a fair price to the tribals. Considering the factors such as risk involved in the collection and distance to be travelled, new methods may be evolved for fixing the prices of these products.

Grazing

There are pasture land and grazing facilities in some of the forest regions in Attappady. The cattle and goats are concentrated mostly in vested forest areas where growth of vegetation is poor and consequently, the carrying capcity is low. In the absence of alternative method of feeding like stall feeding whatever little vegetation remaining has been eaten away b the animals. This makes Attappady a permanent barren land.

Further it is high time to think over the ITDP's policy of giving animals to the tribals. The tribals do not consume milk. Although, a milk collection unit functions at Agali, it is not able to cater to all tribal centres and the milk is sold to the settlers at low price. Further, when the tribals face with financial stringency, they often sell their animals to the settlers at low price. The settlers who buy the animals give the same to the tribal for rearing for which the latter is paid a nominal amount. Thus the settlers are benifited from the development of animal husbandry in the study area.

Ganja cultivation and sandal wood smuggling

Ganja, a high value, easily transportable and readily marketable crop, is being cultivated by tribals in inaccessable areas on behalf of commercial groups. Illegality of ganja provides more profit to the middlemen than the cultivator. Large scale ganja production would destory the forest and replace the same with grasses. Further it provides substantial harm to watershed and catchment areas.

The tribals, especially those residing border areas are extensively employed by commercial agents for sandal wood smuggling which accelerates further deforestation in the area.

The above discussion closely indicates that there has been a significant change in man-forest interaction in the study area. The tribal who husbanded the forests and co-existed with the nature, has slowly turned into agent of deforestation. A variety of factors may be attributed to this probably socio-economic change and alienation of tribals from the forests are most noteable.

Watershed degradation

Deforestation and unsuitable agricultural practices have left scars on the land. Rains evade the area due to the action of strong winds generated by the heat arising from devegetated land. With the removal of the vegetal cover, the soil has been exposed and eroded and the rainfall dwindled. Desertification is in progress.

In short, the crux of the problem in Attappady is the destabilization of the hydrological cycle due to mismanagement of the soil-vegetation system. Only 5th and 6th order streams bear water thoughout the year. Smaller streams run dry most part of the year. The only remedy is restoration of the ecological balance though regeneration of the normal components of the ecosystem. Ecorestoration of degraded watersheds has to be taken up on a war footing so as to prevent soil erosion, enhance water retaining capacity of the soil, improve soil fertility and to regenerate the disappearing streams and rivulets.

Land degradation and marginalisation

Traditionally, land degradation has been treated as a natural process that may be accelerated as a result of the population growth or bad management. Blame for degradation is placed on the shoulders of land users who are generally portrayed as ignorant of the effects of their action on environment (Black, 1989). The argument proposed to be presented here is slightly different. The tribals are forced to take some management decisions which result in land degradation. This is mainly due to growing marginalisation among the tribals that is brought about by change in the land relation and growing link of tribal economy with peripheral economy, especially with market.

It may be pointed out that land degradation and marginalisation are two different phenomena. The land degradation may be defined as loss of soil quality and fertility, resulting in the decline of productivity where as the marginalisation is the process in which the tribals lose their ability to control their own life due to destruction of sources of livelihood. Since land is the major source of livelihood of the tribals in Attappady, the land degradation is closely linked with the marginalisation.

Attappady was covered with thick forest and the tribals lived in harmony with the forests till the turn of the present century. The British government brought a part of the forests under reservation in 1900, aiming partly to protect the head waters of the Bhavani river and partly to extract timber for railways and defence. In fact, timber extraction in Attappady was inaugurated by the British government in the 1900s and it was the begining of the land degradation in the study area. Reservation of forests followed by restrictions on shifting cultivation, introduced the concept of property right for the first time in the study area, which marked the begining of the dispossession of land by tribals. This is manifested

by the fact that a number of tribals moved out of the reserved forests area and established new hamlets in other part of the Attappady, especially in private forest areas.

Massive deforestation carried out by the land lords and their agents in private forest areas where new tribals settlements sprang up after the reservation, accelerated the momentum of the land degradation. Trees were cut and sold at low price and it continued for many decades, resulting in denudation of private forest areas. Lured by the supply of timber, a number of sawmilling units were established in Kerala and Attappady met a bulk of their raw material requirements. In such a way Attappady was linked with market economy. The tribals were extensively employed for the extraction work, as their labour was cheap. Although they were well aware of the effects of deforestation on environment they were not even in a position to register their protest against this, since the land lords supported by the timber merchants and politicians ruthlessly ruled the area.

Side by side with the deforestation, the sale of forest land, opened by the land lords and their agents at low price attracted many land hungry people from Tamil Nadu and Kerala to the study area. Initially the influx of settlers was slow but later it has been rapid and continuous and subsequently the settlers outnumbered the tribals. The settlers, who were good agriculturists and were socially, politically and economically more advanced than tribals, strengthened their roots at Attappady by enhancing the area under cultivation. This was done either by cheating the tribals and / or encroaching their lands. In the process, the settlers possessed good and fertile land and displaced the tribals to hill tops, where soil is eroded and least fertile. Instead of traditional crops of the tribals, the settlers cultivated mostly cash crops, which not only made them wealthy, but also linked Attappady to national and international markets.

Because of acculturisation and also due to growing interaction with the settlers, the tribals have been forced to change their basic consumption pattern, which force them to interact with market in the peripheral economy. An exchange of goods between a traditional tribal economy and a market economy, will end up with loss to the former due to adverse terms of trade. Thus the tribals have to increase their income to maintain the interaction with market economy and this is made possible only by undertaking unsustainable modes of survival in their land, leading to land degradation. The cultivation of second crop and ploughing by bullock in areas with steep slopes in the study area are the examples of unsustainable practices carried out by tribals to enhance their income. Kurumbas who live in reserved forest areas and are having less interaction with the market economy, are least affected the land degradation.

Land alienation

Land alienation in Attappady took place mostly during the period between 1950 and 1980, although a few cases were reported to have occurred since 1980. The percentage of area alienated to total area, consisting of area cultivated and area alienated, was found to be highest in the case of Mudugas, accounting for 46% and closely followed by Irulas, constituting 43% (Table 24). The data on percentage of area alienated to total area alienated in the study area present a different picture, since the same accounted for 90% in the case Irulas as against only 10% for Mudugas and Kurumbas. The land alienation was reported to be least in Kurumba areas, since their lands are located either in Reserve forest areas or remote areas where the accessability is less. Of the three Panchayats, the land alienation had been highest in Agali (45%) and lowest in Pudur (19%) while Sholayur falls in between (36%).

Table 24. Tribe wise and Panchayat wise details on cultivated and alienated area (1982)

Tribe	No. of houses	No. of families	Population	Cultivated area	Area alienated
Kurumbas	203	216	938	3304.00	26.00
Mudugas	388	417	1691	1266.25	1083.78
Irulas	3152	3310	14958	11580.89	8996.41
Total	3743	3943	17587	16151.14.	10106.19
Panchayat wise					
Aga1i	1391	1461	6367	5112.37	4487.90
Pudur	1110	1178	5187	6841.89	1986.63
Sholayur	1242	1304	6033	4196.88	3631.66
Total	3743	3943	17587	16151.14	10106.19

Source: Government of Kerala 1982

The settlers have used various means such as gift, sale, forcible encroachment and mortgage, either singly or jointly, to alienate the lands of tribals. Infact, the land was sold at very low prices and there does not exist any evidences on land transfer in many cases. Kerala occupies rank No. 2 in atrocities committed against tribals on an all India level (Sharma, 1989). Considering the magnitude of land alienation problem in tribal areas, the state government promulgated an Act, as early as 1975, called Scheduled Tribe (Restriction of Transfer of land and Restoration of Alienated Lands) Act, stipulating the terms and conditions of returning the lands to tribals, which once belonged to them. But the legality of the Act had been questioned in various courts and after the elapse of a long period, the Act was finally upheld by the Supreme Court. The Act became a Law in 1986. However,

no attempt has so far been made to implement the Act in Attappady, partly because a stiff resistence from settlers and partly due to the inertia of the government officials.

Of late, with the propaganda as well as informal education being carried out among the tribals by voluntary organization and social workers, there has been slow awakening among the tribals. Recently, they revitalised their organization - Girijan Sevak Samithi - which was formed in 1975 and organised a number of agitations to implement the Act. But, the settlers, supported by the political parties, formed a settler-farmer association and asserted their right over the land they possessed. A stage has been set for confrontation, between tribal and settlers, over this issue in the study area, thus calling for an urgent solution.

Erosion of power of local self government

Traditional social council in each hamlet with full powers acted as the government for a long time. The Moopan's verdict was unquestionable and most decisions were taken locally. With the immigration of settlers, these conventional governments lost credibility and slowly tribals were attracted to modern centralised systems. Change in land tenure from common lands to private lands played a pivotal role in destabilising the social council.

The knowledge of the people for using the traditional resources and controlling them using traditional wisdom or even religious beliefs were replaced by a western administration system. The attempt of the settlers to impose familiar strategies of exercising control in unfamiliar environment has created only disasters. The disintegration of social fabric led to demoralisation and hence loss of faith in their expertise. The advent of modern education which, without impartially evaluating their skills, superimposes a sense of inferiority upon them and the forces of modernisation which negates their value systems have all led to the degradation of their abilities (Nair, 1988).

At present the state government is the supreme authority of the area and decisions are taken for and on behalf of tribals by plainsmen located at far away places. These decisions lack historical, ecological, cultural and practical comprehension. The tribals have lost faith in their old system but are unable to adapt to the new ones.

Over and above, in Kerala even now the rights of tribals living inside the reserve forests have not been spelt out. Although the government framed the Hillmen Settlement Rules in 1964, the same was struck down by the High Court.

Conclusion and Recommendations

Conclusion

Attappady is one of the east sloping region in the Western Ghats of Kerala. Great variation in rainfall is met within the area. Three geographical units comprising three ecological units can be identified in the study area. The population in Attappady consists of tribals and settlers. The tribal communities residing in the area are Kurumbas, Mudugas and Irulas. Of the 142 tribal hamlets in the region, 104 belong to Irulas, 16 to Kurumbas, 20 to Mudugas and 2 hamlets contain a mixture of Kurumbas and Mudugas. These hamlets are sprinkled over three panchayats of Agali (52), Pudur (53) and Sholayur (37). The settler population consists of migrants from Kerala and Tamil Nadu.

Although the three ethnic communities residing in Attappady belong to the broad group of Dravidian, there is a marginal variation in their social relation, custom, culture and level of economic development. Traditionally, each hamlet was self- sufficient and self-reliant, both politically and economically, and was ruled by a council of their representatives, headed by Moopan. The property, mainly land was owned by the community and distributed by head of the hamlets. The formation of tribal block and then ITDP was an important event in Attappady. The decisions in lTDP are taken for and on behalf of tribals by plainsmen located at far away places. Introduction of political ideologies by different political parties and modern administration by different government departments aiming to modernise the tribals resulted in slow erosion of their traditional systems. Interestingly enough, with all these, they lost their faith in their old system, but are unable to adapt to the new one.

The tribal economy in Attappady has been a primitive and subsistence one, with high dependence on agriculture, minimum surplus generation and fair distribution. Production and exchange were carried out for meeting basic needs. Agriculture and sale of minor forest products were the two traditional sources of income to the tribals. With the decline of area under cultivation and high deforestation, the income from these sources has declined significantly in many hamlets, especially those located in the vested forest areas. This has forced many tribals to depend on wage labour for their livelihood.

Pauperisation of farmers and consequent increase of wage labourers in a traditional economy can be identified as emergence of capitalist development. The origin of this trend could be traced back to the reservation of certain areas in 1900 by British government, which spearheaded the move to exclude the ethnic groups from command over forest resources. This was accelerated by the factors such as high deforestation in private forest

areas and encroachment by the settlers. The development of a peripheral economy super-imposed by the settler population and government agencies further strenghtened this trend.

The efficiency of the agro-ecosystems varies even within the traditional systems in Attappady. The shifting cultivation system at Thodukki stands out with the highest energy efficiency due to reasonable land fertility (rotation) and also very favourable bio-physical conditions. The rainfall at Thodukki is on an average 2000 mm per year and the soil fertility is enhanced by the surrounding evergreen forest ecosystem. In Karara and Mully, where settled agriculture is practiced, the difference in energy efficiency is related to biophysical conditions of the land. Karara is in a medium rainfall area, with average annual rainfall 1000 but less than 1500 mm and biotope is moist deciduous forests with their very efficient nutrient-cycling system. On the contrary, Mully is very low rainfall area (600-900 mm) with high yearly variation. The potential vegetation is dry deciduous forests tending to pioneer euphorbeacious scrub. The fertility of the soil is very low, and the organic productivity in the system is less dynamic both in Karara and mully, since the fields are cultivated continuously.

Tribals living close to dense forests still generate income from minor forest products, although, due to decline of area under forests, majority of population have no access to this resources. Marketing of MFP is carried out by the co-operative societies. But, the prices of these products are not scientifically determined and consequently, the remuneration received by the gatherers does not commensurate with the hardship they take for collection.

The land use of Attappady has changed drastically. Loss of dense forests cover and an increase in degraded areas have created a disastrous condition as regards to basic resources, like soil, water and vegetation.

The Integrated Tribal Development Programme (ITDP) and ATCO Farms are two major tribal development programmes launched in Attappady, aiming to uplift the tribal populaion of the area, on par with the men of plainlands and also to bring them to the national mainstream. These programmes failed to achieve their high sounding objectives due to lack of understanding of traditional culture of the people and existing socio-economic and bio-physical factors. Further this has resulted in the degradation of the traditional sources of livilihood and made the tribal dependent on government dole.

In olden days, the tribals lived in harmony with the nature and exploited what they needed. Infact, the forests met all their basic needs. But now, there has been significant change in man- forest interactions in tribal areas. This is brought about by avariety of factors such as inaccessibility of forest resources, land alienation and annihilation of resource base of the tribals.

Because of high deforestation, certain hamlets do not obtain even firewood and thatching materials sufficiently. In this context, most of the tribals have lost interest in the protection of forest and some have turned into the agents of deforestation.

Recommendations

The tribe consists of well knit cohesive human group, living in forest areas with mutual co-operation and support. It operates as a social system which links with the economic system and environment in which they live. Any change in one of the systems has a pervasive effect on other systems. This interlinkage should be taken into account, while implementing any development programmes in the study area.

The agriculture carried out by the tribals is found to be efficient, but not providing income / output to meet their basic needs. One way of enhancing income is to modernise the agriculture. But, considering the socio-economic and biophysical factors, there is little scope for moderninsing the tribal agriculture. For instance, the tribals are not used to modern agricultural practices and even if they are trained, it is very difficult to practice in tribal areas, where the cultivation is carried out on hill slopes. Deep tilling, for instance, will accentuate the soil erosion and application of fertilisers and pesticides will enahance water pollution.

In this circumstance, one alternative to increase production is to bring more area under cultivation. The Kurumbas may be allotted to one more block near their existing shifting cultivation area so that each block will be cultivated only twice continuously, instead of thrice being practiced now. For the other two communities, steps should be taken to give back atleast a part of their alienated land.

In the shifting cultivation areas, horticultural crops like banana, may be raised in fallow land which, without affecting the fertility, would provide additional income and food to the tribals. The planting of rattan on border areas of each block will not only increase the income of the cultivators, but also solve the raw material problem of the tribal rattan co-operative society functioning in the area.

Land is the basic resource of the tribals without which, their economic condition cannot be improved. The study gives ample evidence that the socio-economic conditions of the tribals who exercise control over basic resources are far better than that of others. Thus, the alienated and dispossessed tribals should be given back their land. The implementation of 1975 scheduled Tribe Act is a ticklish issue, considering the mounting resistance from the settlers. However, this Act should be implemented to uplift the tribals, for which new ways and means may be thought of. In this connection, two suggestions may

be put forth: (1) A cut off period may be fixed up and alienated land after this period may be taken over without any compensation and given to the original owners. (2) A part of the sub plan allocation earmarked for the tribal development can be utilised to buy land from settlers who possessed the same before the cut off period, for distribution.

The accrual of economic benefits of forestry operations to the tribal people has been limited to what could be earned by them as wages. This is wrong. Rights to collect MFPs, and other usufructs should be reinstated.

The traditional institutions of the tribals are being superseded by a powerful formal structure of the modern state whose ways they are unaware. Thus, education is particularly critical for the tribal communities in the new context. The policy makers should pay more attention to this.

The remuneration paid to the gatherers is one of the important components of the price of MFP and a fair wage to the gatherers is essential for better utilisation of the products. Better methods should be used for the determination of prices of MFP and fair wages to the gatherers. The current policy of treating forests as a gift of nature without value and consequently, setting prices of forest products at low level, cannot be justified at least economically. This is particularly true in the case of minor forest products. For determining the fair wages, the following suggestions may be considered. (1) In the context of high deforestation, the hill tribes have to travel into the interior forest areas for the collection and thus, the average time they spent for collection of one unit may be taken as the basis of their remuneration. (2) The collection of minor forest products, especially from interior forest areas is highly risky and they can be given the same wage as one gets in undertaking similar risky job outside the forest areas. A fair wage to minor forest products would enhance the dispossable income of the gatherers, especially Kurumbas.

The development programmes implemented through ITDP are mostly beneficiary oriented programmes aiming to get benefit directly to the tribals. In a degraded area like Attappady, they should be supplemented by area development programmes so as to improve the socio-economic conditions of the target group. Well knit eco-restoration programmes, consisting of afforestation and soil conservation, should be implemented, with the help of tribals.

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Summary

An afforestation trial at Mully in eastern Attappady was conducted during 1988-1990. Mully is a low rainfall area (925 mm) with degraded dry deciduous forests tending to pioneer euphorbiaceous scrub. The experiment consisted of nursery trials, planting method trials, species performance trials and monitoring of natural regeneration under protected condition.

Traditional potting material (red soil, field soil) was found to be practically more effective than the mixtures of soil and soil conditioners (jalsakthi, vermiculite and polyurethane foam). In a dry tract like Mully, where water is a scarce resource, watering of plants in nursery once in alternate days was found to be most effective. The mulching trials revealed that conventional stone packing in combination with stone mulching will suffice. Planting pits of 30 x 30 x 30 cm provide satisfactory growth and survival rates for most species. Species like *Acacia planifrons, Albizia amara, Acacia nilotica* etc., were found to be most suitable for afforestation programmes in the area. *Agave americana, Agave sissalana* and *Agave viracruz* performed extremely well and can be raised as live fences. Protection of natural regeneration can, to a great extent, augment the eco-restoration process while carrying out afforestation programmes.

CHAPTER I

Introduction

Although the two rivers, Bhavani and Siruvani control the drainage in Attappady - one of the two extensive east sloping plateaus -this region is considered to be one among the driest parts of Kerala Western Ghats. Although the western part is humid with rainfall of ca. 3000 mm the eastern half is dry (900 mm). The area has a tribal population of over 20000 and is one of the three tribal centres in the State.

The forests of Attappady, which were once luxuriant, have been ruthlessly converted to various types of landuses during the past fifty years. Only a portion of the area received protection in the form of reservation by the British during the early 1900. The rest of the area was under private ownership (Jenmi) and underwent massive conversion. The private landlords preferred easy money obtained by felling timber and selling the land to settlers from Kerala and Tamil Nadu. The private forests were nationalised in 1971 and after continuous litigations in various' courts have, at present, been constituted under the Mannarkad Forest Division.

Deforestation and unsuitable agricultural practices have caused almost irreparable damages to both land and people. There is a reduction in rainfall, water shortage and loss of soil fertility. Thus agriculture which is the mainstay of majority of the population is jeopardised. In short, the crux of the problem in Attappady is the destabilization of the hydrological cycle due to the mismanagement of the soil-vegetation system. Afforestation of degraded areas has to be undertaken to regenerate the dying ecological conditions of the area.

As conventional forestry plantation programmes have not yielded desired results it has become necessary to develop alternate and viable stratagies while taking up such programmes. Local conditions, native species, traditional needs and technology have to be taken care of.

Objectives

The present project was initiated with the following objectives.

(i) To monitor natural restoration process under protected condition.

(ii) To develop techniques for afforestation in degraded areas and to supplement natural restoration process.

(iii) To standardise afforestation techniques under the varied conditions in Attappady.

CHAPTER II

Materials and Methods

Study area

Seven ha of degraded forest land at Mully (Fig. 1) in Attappady Range of Mannarkad Forest Division was selected. The experimental plots were in two bits; one about 5 ha on the left side of the Mully-Melemully road (Pl. 1) and the other, about 2 ha on the right side of the Mully-Chavadiyur road. The area supported degraded vegetation with sparse, shrubby growth of *Dodonaea viscosa, Lantana camara, Eupatorium odoratum, Sida veronicaefolia, Tephrosia maxima,* etc. Scattered trees like *Albizia amara, Hardwickia binata, Sterculia guttata* were observed. The terrain was flat to moderately sloping. Soil was shallow with rocky and bouldry outcrops (Pl. 2). Average annual rainfall was 925 mm during the study period (Table-1).

Table 1. Rainfall (mm) during the study period

Year	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sept	Oct	Nov	Dec	Total
1987	11(1)	10(2)	24(4)	Nil	30(6)	9(3)	Nil	15(6)	91(8)	215(18)	176(12)	417(12)	999(72)
1988	8(3)	20(2)	63(4)	7(9)	121(4)	54(8)	74(15)	40(6)	120(9)	101(10)	171(9)	86(5)	1005(84)
1989	3(1)	Nil	46(3)	47(7)	49(6)	43(4)	76(10)	19(6)	41(6)	154(16)	114(7)	23(3)	615(69)
1990	100(5)	Nil	129(4)	58(5)	56(7)	20(4)	13(2)	10(5)	16(3)	505(14)	157(8)	17(3)	1081(60)

Figures in parentheses indicate number of rainy days Average-925(71)

Nursery experiments

A temporary nursery was established during March-April 1988 in an area of 0.091 ha on the banks of the river Kundah at Mully (Pl. 3). The area was leased out from a tribal farmer for Rs.300/- for a period of two years with an agreement that a member of his family will be involved and trained in various aspects of afforestation programmes at Mully. Fencing was done all along the boundary using brush wood and thorns which were locally available. Thirty mother beds of 10x1 m were prepared using soil from the nursery and without any bamboo split support at the sides. Termite problem was controlled by drenching the beds with a liquid formulation of Aldrin 30 EC. Seeds either procured from Forest Genetics Division, Tamil Nadu Forest Department, Coimbatore or locally collected were put in mother beds for germination. Shade pandal was provided only during initial days of seed germination and seedling emergence. Seedlings were pricked out and potted in polythene bags of 18 x 13 cm and 23 x 18 cm sizes which were arranged over polythene sheets spread over the ground (Pl. 4). Bags were shifted from the original position every

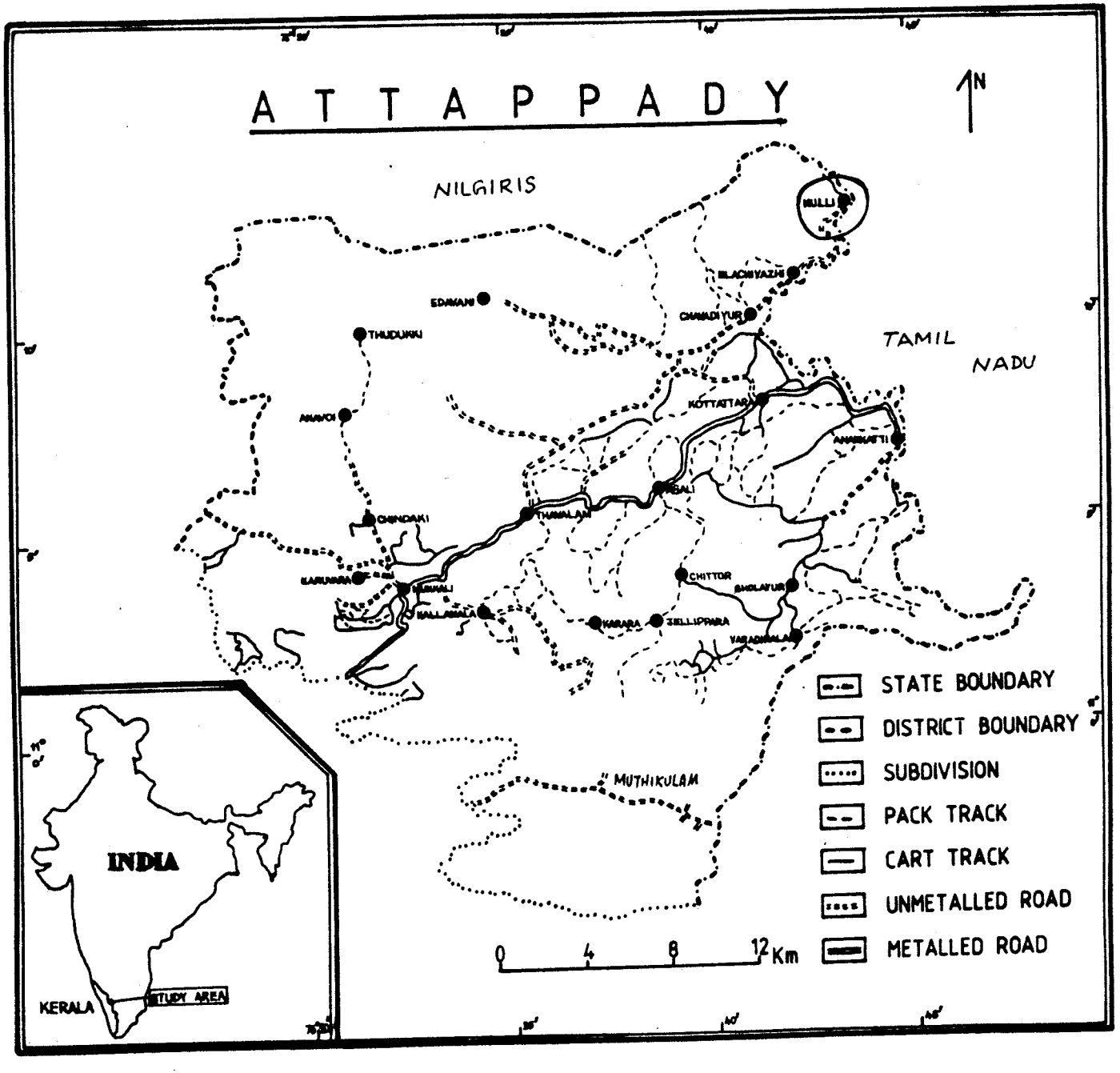


Fig. 1. Map of Attappady showing the study area

Plate 1 - Experimental area

Plate 2 - Experimental area (closer look)

Plate 3. Nursery site

Plate 4. Polypotted seedlings of *Anacardium occidentale*

month to prevent roots striking the ground. Watering was done every day in mother beds and alternate days in polythene bags. After four months of growth in polythene bags watering was discontinued until the seedlings showed tendencies of wilting. Seedlings were outplanted during October-November in 1988 and 89.

Out of two experiments conducted in nursery one was to study the mositure retention capacity of different potting media. Second experiment was to study the effect of different potting media and watering schedules on survival and growth of seedlings of *Acacia planifrons* and *Tamarindus indica.*

Moisture retention capacity of potting media

Different potting media used in the study include jalsakthi, vermiculite and polyurethane foam. In addition, red soil from the nursery site and field soil from the experimental plots at Mully were used as controls.

Jalsakthi is an off-white powder which on absorbing water forms a smooth gel and acts like a water reservoir. Jalsakthi absorbs water 100 times its weight and makes available to the plants during critical periods of moisture stress. It is a product of Indian Organic Chemicals Limited, Bombay.

Vermiculite is a mineral belonging to mica family. On heating, it expands to produce a low density bulky material. Vermiculite has the capacity to hold water 60% of its weight. Dugar Vermiculite Private Limited, Madras produces this mineral material.

Polyurethane foam commonly known as U-foam is a cushioning material, which is very light in weight (0.02 gm/m3) soft, springy and flexible. Its open cell structure allows to accumulate, store and retain air and water freely.

Polythene bags of 200 guage and 7 x 9 cm size were used for the experiment. The experiment had five treatments replicated five times with three polythene bags in each replicate. The treat ments were as follows:

Treatment (T1) : Red soil (Control)
Treatment (T2) : Field soil (Control)
Treatment (T3) : Red soil + Jalsakthi
Treatment (T4) : Red soil + Vermiculite
Treatment (T5) : Red soil + Polyurethane foam bits

Treatments 1 and 2 were red soil and field soil respectively which served as controls. Red soil was collected from adjoining area of the nursery, and field soil, from the plots where species performance trials were to be conducted. Stones, roots and clods were removed before filling the bags.

In the third and fourth treatments bags were half filled with red soil. Remaining portion was filled with a fine mixture of red soil + 10 g of jalsakthi; and red soil + 50 g of vermiculite respectively.

Treatment 5 had polythene bags filled upto 3/4 portion initially with red soil followed by two pieces of 15 mm thick polyurethane foam of 5 x 5 cm. The foam pieces were again covered with another layer of red soil.

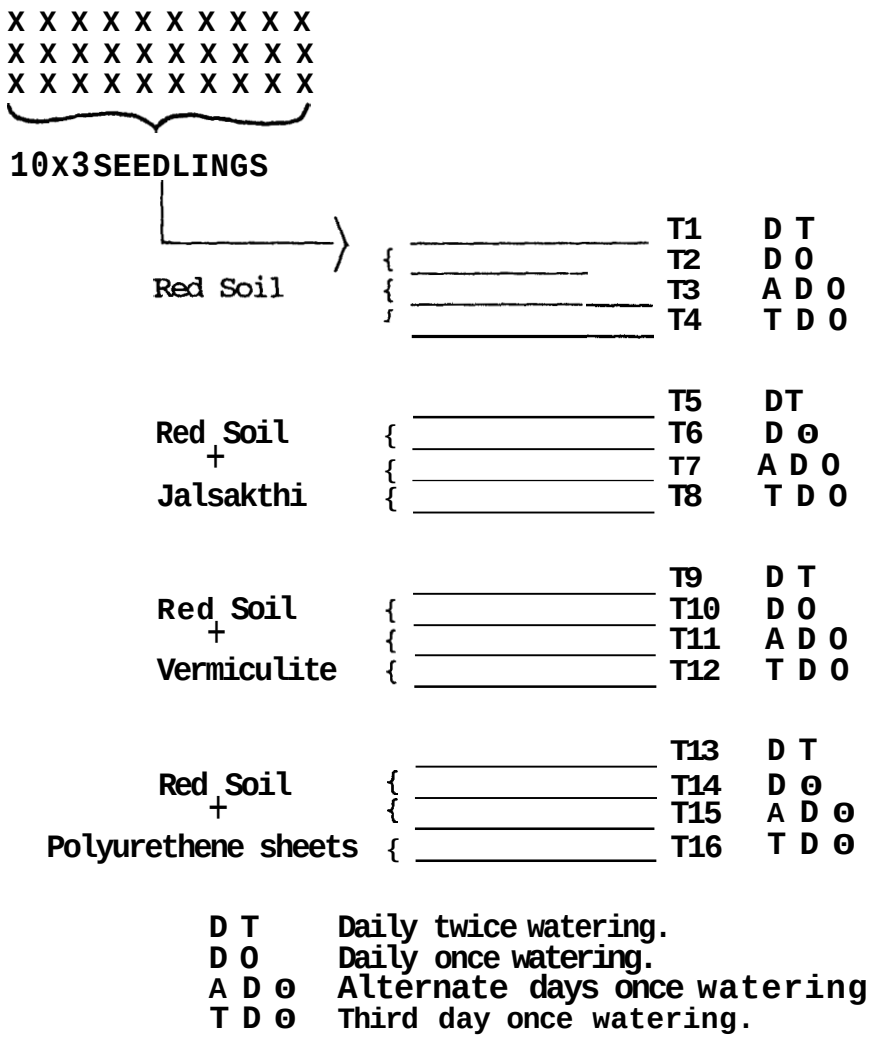
Weighings were made and water was added in each of the bags upto field capacity level. Further weighings were made at an interval of 24 hours up to about 30 days.

Effect of different potting media and watering schedules on the survival and growth of seedlings

As in the previous experiment, all potting media were used except field soil. Polythene bags were filled with potting media as mentioned in the above experiment and planted with seedlings of Acacia planifrons and Tamarindus indica. The watering schedules were as follows:

1. **Daily twice watering.** **DT**
2. **Daily once watering.** **DO**
3. **Alternate days once watering.** **ADO**
4. **Erery third day once watering.** **TDO**

The experiment had 16 treatments with 3 replicates as shown below.



Experimental design used in the study of different potting media and watering schedules on survival and height growth of seedlings

Plantation trials

Mulching trial

Mulching trial was carried out in an area of 0.25 ha with two species *Emblica officinalis* and *Tamarindus indica*. After demarcating, aligning and staking the area, pits of 30 x 30 x 30 cm were dug at a spacing of 2 m x 2 m . The experimental design was Randomised Complete Block Design (RCBD) with five treatments and two replicates.

The treatments were as follows:

Tratment-(1) control.
Treatment-(2) stone packing.
Treatment-(3) stone packing + stone mulching.
Treatment-(4) stone packing + plastic mulching.
Treatment-(5) plastic mulching.

Treatment-1 was control in which conventional planting was done in standard pits of 30 x 30 x 30 cm. In treatment-2, stones available in the locality were arranged in a semi-circular pattern on the downward side of the pit forming a ridge and was called the stone-packing. Treatment-3 was a combination of stone packing and stone mulching. Stone mulching was done by arranging stones loosely on the ground leaving about 3 cm gap from the seedlings in a circular pattern (Pl. 5) to a diameter of around 20 cm. Treatment-4 included stone packing and plastic mulching (Pl. 6). Polythene sheets were cut into 50 x 50 cm pieces. One edge of the sheet was again cut to a length of about 25 cm, so that it could be inserted and the seedlings positioned in centre. The sheets were kept in position using four stones placed at four corners. Treatment-5 had only plastic mulching. Survival and height growth of plants were monitored up to eight months.

Planting method trial

The trial was carried out in 0.50 ha and included 3 species; *Agave sissalana,Acacia nilotica* and *Ceiba pentandra*. Aligning and staking were carried out keeping the spacing at 2 x 2 m. The experimental design was RCBD with five treatments and four replications in Agave sissalana and two replications in the remaining two species. Each treatments comprised 30 seedlings.

The treatments were as follows:

Treatment-(1) ground level planting in 30x30x30 cm pits (Pl.7)
Treatment-(2) ground level planting + stone packing in 30 x 30 x 30 cm pits (Pl. 8)
Treatment-(3) deep planting in 45x45x60 cm pits
Treatment-(4) ground level planting in 45x45x60 cm pits
Treatment-(5) ground level planting in 45x45x45 cm pits

T3, T4 and T5 had larger pits. In T3, pits were only half filled and planting done at a lower level, hence called deep planting (Pl. 9). Height growth and Survival of seedlings were recorded every month for a period of twelve months.

Plate 5 - Stone mulching

Plate 6 - Stone packing and plastic mulching

Plate 7 - Ground level planting

Plate 8 - Ground level planting stone packing

Plate 9 - Deep planting

Species performance trial

Two trials were conducted, one in 1988 with 15 species and the other in 1989 with 33 species. Around 4.5 ha of degraded forest area was demarcated, aligned and staked during September, 1988 and 1989 respectively. The spacing was 2 x 2 m and the pit size was 30 x 30 x 30 cm for the 1988 trial. However, the 1989 trial had larger pits of 45 x 45 x 45 cm for species like *Bambusa arundinacea* and *Dendrocalamus strictus* and 30 x 30 x 30 cm for remaining species. The experimental layout was randomised block design with three replicates in both the trials. The plots were protected against grazing and fire. Observations on survival were recorded every month and height growth every alternate months.

Natural restoration under protected conditions

Plots of 25 X 25 m were demarcated randomly at twelve locations in the degraded forests of Mully. Of these, six plots were fenced with chainlinks (Pl. 10). Remaining six plots (control plots) were marked by wooden pegs. Within each plot a 2.5 m surround was left along the inner boundaries thus retaining a 20 X 20 m treatment plot. This was equally subdivided into 2 X 2 m grids of 100 subplots. Hundred percent enumeration was carried out in the treatment plots during January to March in 1990 and 1991. The plant growth was classified into 3 major groups viz., grasses, herbs and shrubs, and seedlings of tree species.

Statistical analysis

Analysis of variance of survival percentage and mean annual height increment (MAHI) was done after appropriate transformations. The treatments were further grouped (Calinski, 1985).

Plate 10 - Protected plots for natural regeneration

CHAPTER III

Results and Discussion

Nursery experiments

Moisture retention capacity of potting media

The polythene bags with different potting media were watered until they reached field capacity level. The bags containing jalsakthi attained field capacity level much slower than the remaining treatments. This was mainly due to absorption of water and subsequent swelling of the medium. Quantity of water required to bring red soil-jalsakthi mixture to field capacity level was about four times the quantity required by red soil. Though vermiculite did not show much of a swelling as in the case of jalsakthi, slight expansion was noted which made the former more bulky. Red soil-vermiculite mixture consumed about double the quantity of water as that of red soil. There was no appreciable difference in water requirement of red soil-polyurethene foam, and red soil-field soil.

Even though, minor variations were observed in moisture retention capacity of different potting media over time, a general declining trend was common in all treatments (Fig. 2). Moisture loss was rapid in both controls, field soil and red soil. Moisture level in field soil reached wilting point (17%) in around 3 to 4 days while in red soil it took only 5 days to touch the break up point (Fig. 2). Moisture loss was slightly slower in mixtures of red soil-vermiculite and red soil-foam. In the former it took 6 days for moisture level to come down to wilting point whereas moisture was retained up to 7 days in the latter. Bags containing potting media of red soil-jalsakthi retained water for a maximum period of 12 days. Unlike other treatments water loss from this medium was very gradual.

From this experiment it is evident that initially more water was required to bring red soil-jalsakthi mixture to field capacity level. The excess water imbibed by the gel particles of jalsakthi was released in a comparatively slower pace thus making moisture available for longer periods. Hence, initial requirement of water is very much high when jalsakthi is used as a soil conditioner.

Effect of different potting media and watering schedules on the survival and growth of seedlings

In all treatments both *Acacia planifrons* and *Tamarindus indica* 'showed different growth responses (Table 2). Even though, seedlings of *Acacia planifrons* registered maximum survival in red soil-jalsakthi mixture, survival rate in red soil-vermiculite mixture was also comparatively high. Incidentally, in all these cases watering was done once in alternate days. However, with regard to final height, seedlings grown in red soil and watered once

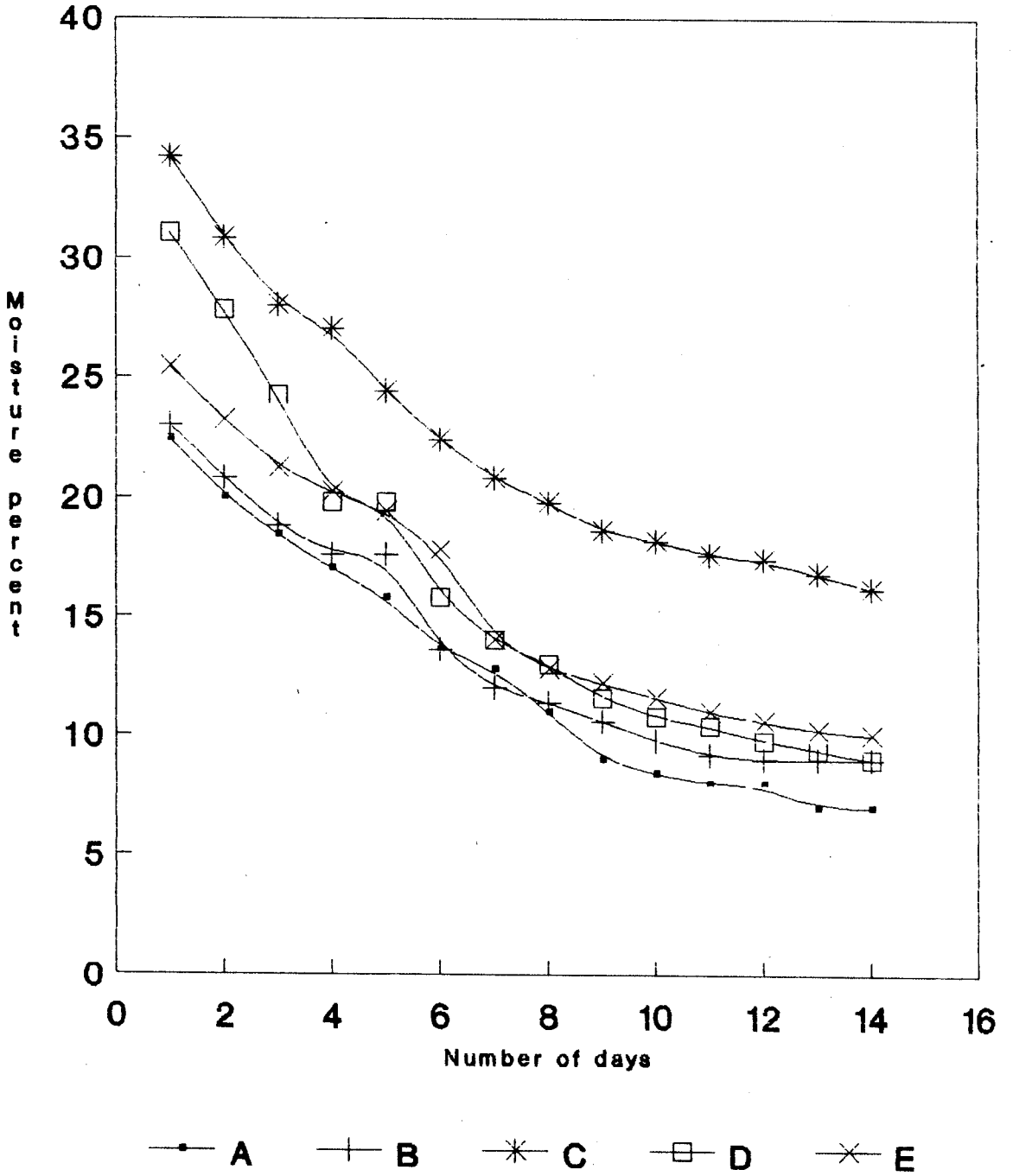


Fig. 2. Moisture retention capacity of different potting media

in a day recorded maximum height. Sheikh (1984) reported best seedling growth in *Pinus roxburghii* when watered twice daily. However, the survival rate in all the watering schedules (once a day, twice a day, on alternate days and on every third day) was low and uniform. Even though, more frequent watering promoted faster height growth, better survival rate and moderately faster height growth could be obtained with watering once in alternate days. This is particularly important when cost of soil conditioners like jalsakthi and vermiculite is taken into consideration. Sparse availability of water in drier tracts like Mully is yet another aspect. Hence, for *Acacia planifrons*, conventional method of raising seedlings in polypots with red soil and watering once every alternate days proved to be ideal.

Table 2. Survival (%) and mean height of seedlings raised in different potting media and watering schedules

Treatments*			Acacia planifrons		Tamarindus indica	
			Survival %	Mean height cm	Survival %	Mean height cm
RS		DT	93	40.4	90	34.7
RS		DO	97	42.5	97	33.9
RS		ADO	97	32.3	93	32.5
RS		TDO	87	33.2	83	30.6
RS	J	DT	87	27.4	83	36.0
RS	J	DO	77	26.0	80	26.6
RS	J	ADO	100	28.8	93	30.5
RS	J	TDO	87	29.9	90	25.3
RS	V	DT	93	31.6	100	30.9
RS	V	DO	87	32.6	97	28.9
RS	V	ADO	97	28.6	97	26.9
RS	V	TDO	93	32.2	83	24.7
RS	F	DT	67	37.8	87	31.9
RS	F	DO	90	35.1	87	29.8
RS	F	ADO	80	34.5	100	32.9
RS	F	TDO	90	28.5	97	27.2

* RS - Red soil
J - Jalsakthi
V - Vermiculite
F - Foam
DT - Daily twice
DO - Daily once
ADO - Alternate days once
TDO - Every third day once

Seedlings of *Tamarindus indica* raised in polypots with red soil- vermiculite and red soil-foam gave highest survival percent (Table 2). However, watering schedule followed in the former was twice a day and in the latter, once in alternate days. Higher and similar

survival rates were obtained in seedlings planted in red soil with once a day watering, red soil-vermiculite with once a day and alternate day watering, and red soil-foam with every third day watering. The survival of seedlings was comparatively higher in red soil-vermiculite followed by red soil alone. It was also observed that in all potting media, like red soil, red soil-jalsakthi, red soil-vermiculite and red soil-foam, seedlings which received water once in alternate days showed better survival percent. Maximum height growth was obtained in seedlings planted in red soil-jalsakthi which received water twice everyday. This again confirms the importance of more frequent watering for faster height growth. However, in three other potting media, like red soil, red soil-jalsakthi, red soil- foam seedlings responded with moderately fast height growth when watering was done once in alternate days. Sheikh et a1 (1985) found that growth and biomass production increased with increasing irrigation in four fodder tree species. However, from the present study on seedlings of *Tamarindus indica* it is observed that watering once in alternate days will be sufficient to get moderately good survival and height growth.

Plantation trials

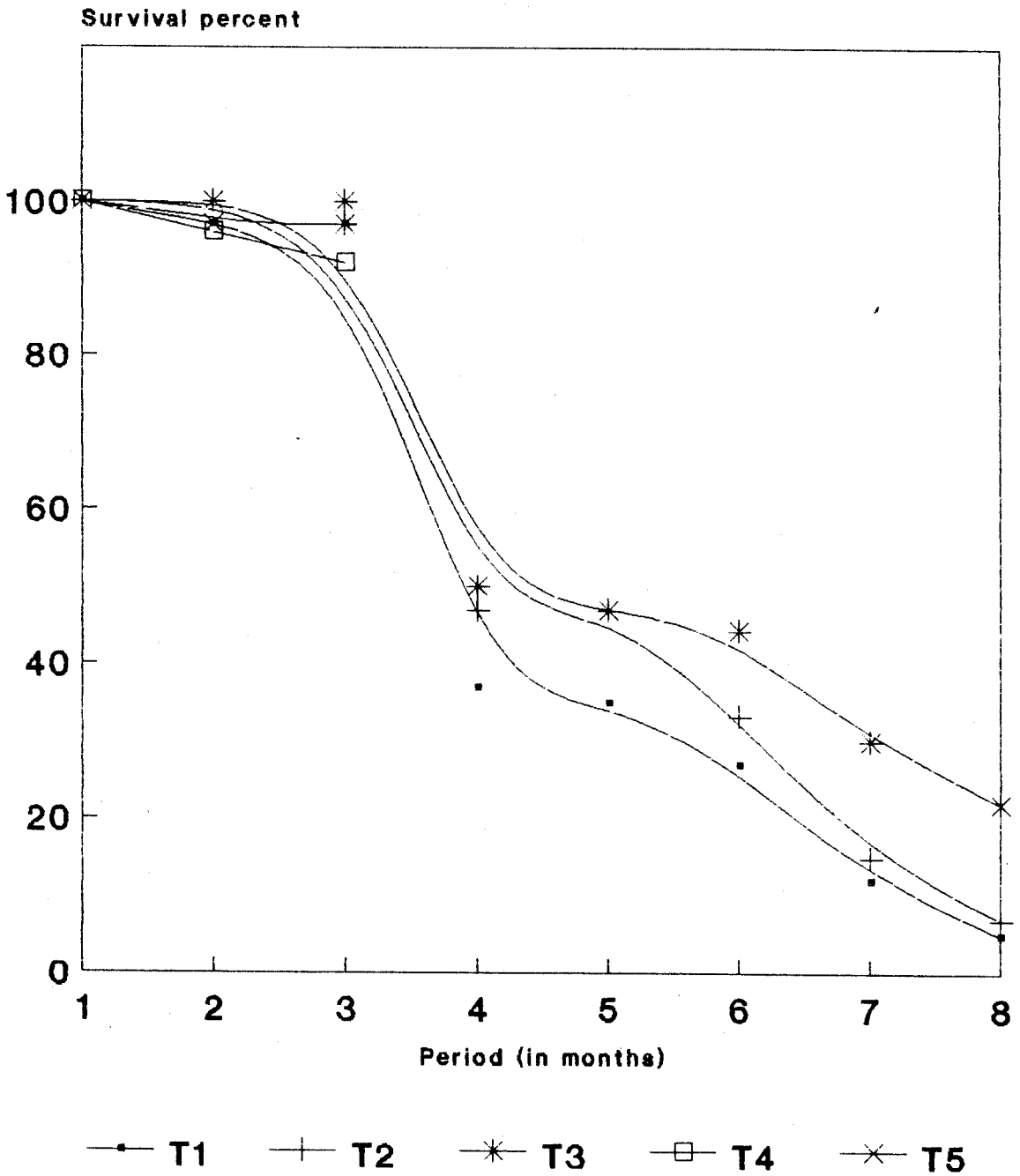
Mulching trial

As mentioned earlier (Table 1), the erratic rains and subsequent drought during the study period resulted in a very hot and dry climate at Mully. Probably due to extreme heat, plastic sheets used as mulches in two of the treatments got crumbled within two months of installation. Hence it is clear that in extremely hot conditions plastic sheets cannot be used as mulches. Contrary to this, Song et al., (1987) confirmed the usefulness of plastic film cover in preserving moisture and thereby promoting seedling growth. Sheikh (1983) mentioned that mulches had no effect on survival of seedlings; however, plastic aprons significantly improved growth in the field.

In the present study, survival percent in both *Emblica officinalis* and *Tamarindus indica* followed a similar pattern (Figs. 3,4). Maximum survival percent was observed for seedlings which had stone packing and stone mulching followed by those with only stone packing (Table 3). Higher survival percent in the former may be due to prevention of abrupt run-off and retention of moisture after erratic rains. However, conservation of soil and reduction in run-off are direct effects of stone mulching. Reduced run-off also leads to greater infiltration.

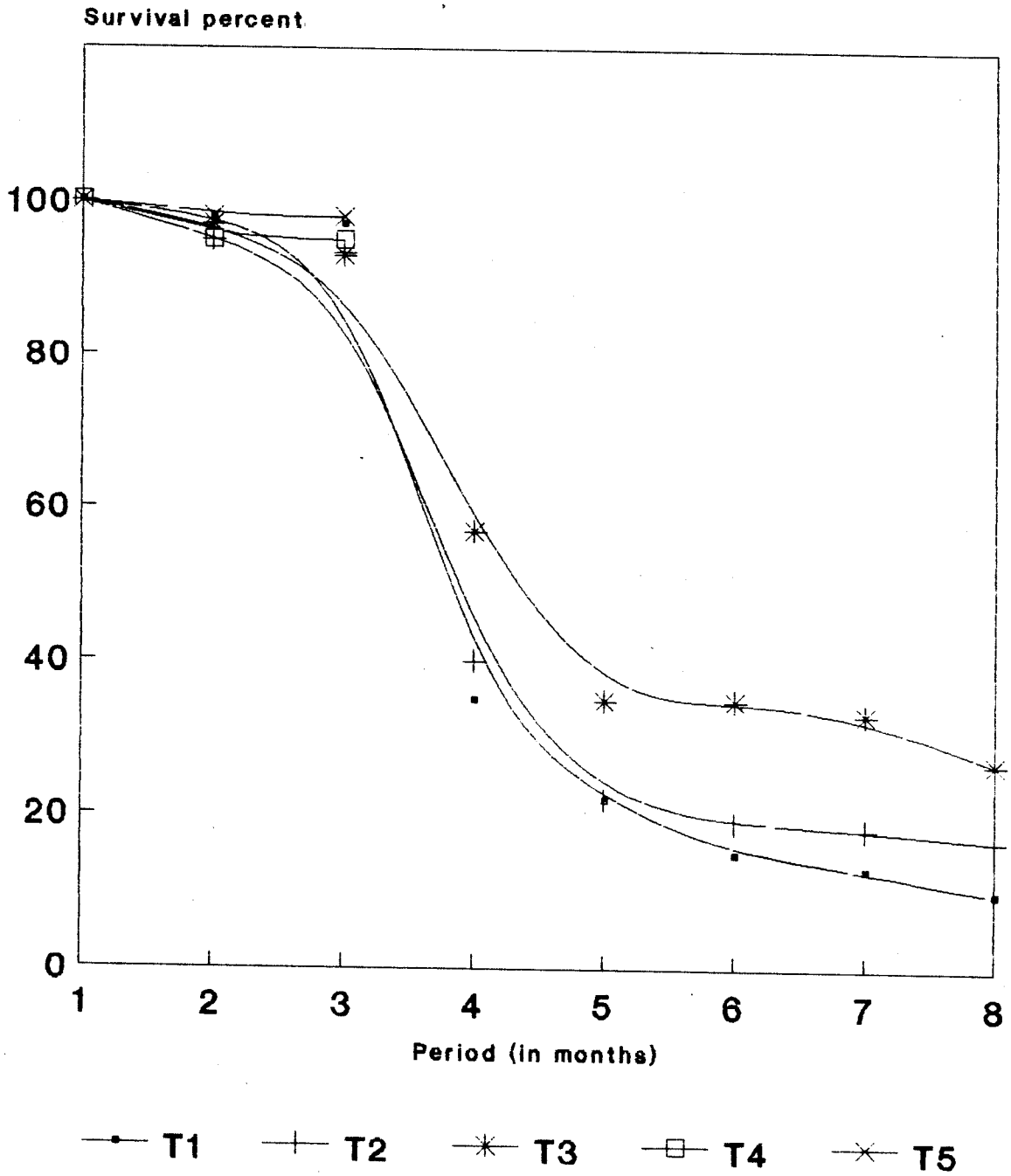
Appreciable effects of stone mulching in afforestation programmes of semi-arid and arid regions have been reported by Seth (1962). According to him, stone mulches have a positive effect in soil moisture conservation. Soils under stones harbour small animals which can improve the soil structure.

Fig. 3. Survival percent of Emblica officinalis in different treatments of Mulching trial



T1-Control
T2-Stone packing
T3-Stone packing + Stone mulching
T4-Stone packing + Plastic mulching
T5-Plastic mulching

Fig. 4. Survival percent of Tamarindus indica in different treatments of Mulching trial



T1-Control
T2-Stone packing
T3-Stone packing + Stone mulching
T4-Stone packing + Plastic mulching
T5-Plastic mulching

Seedlings planted without any mulching gave lowest survival percent. Statistical analysis of the data did not show any significant difference between treatments (Table 3).

Table 3. Survival (%) of different species in mulching trial after eight months growth in filed

Treatments	Emblica officinalis	Tamarindus indica
	Survival %	Survival %
Conventional planting	5^{a}	10^{b}
Without mulching	7^{a}	17^{b}
stone Packing	22^{a}	27^{b}
Stone packing and stone mulching		

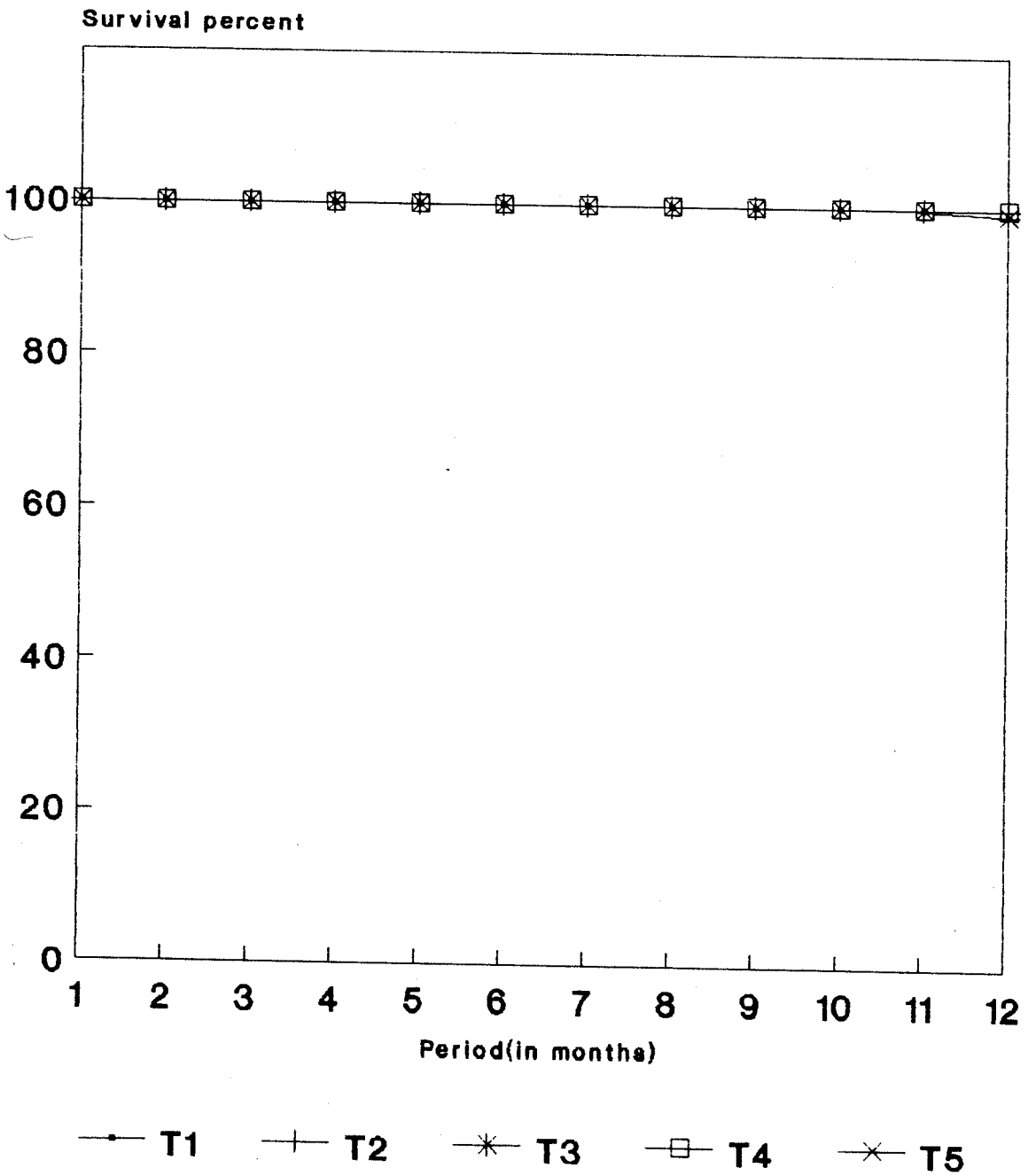
Figures superscribed by same letter under each column are not significantly different at P = 0.05.

Planting method trial

Out of the three species, *Agave sissalana, Acacia nilotica* and *Ceiba pentandra, Agave sissalana* showed high survival rate of 99- 100% and uniform height growth in all treatments up to 12 months after outplanting (Fig. 5). However, height increment during this period showed only minor variations. Maximum height increment of 11 cm was obtained for seedlings planted in larger pits of 45 x 45 x 45 cm followed by those in 45 x 45 x 60 cm ground levelplanting. However, the additional depth of pits in the second category had no marked influence on survial or growth of seedlings. Seeldings planted in conventional pits of 30 x 30 x 30 cm recorded 9 cm height increment, while lowest increment of 6 cm was registered by those planted deep in 45 x 45 x 60 cm pits. Here again, the method of planting seedlings deep in larger pits of 45 x 45 x 60 cm did not have any pronounced effect on growth parameters (survival and height growth).

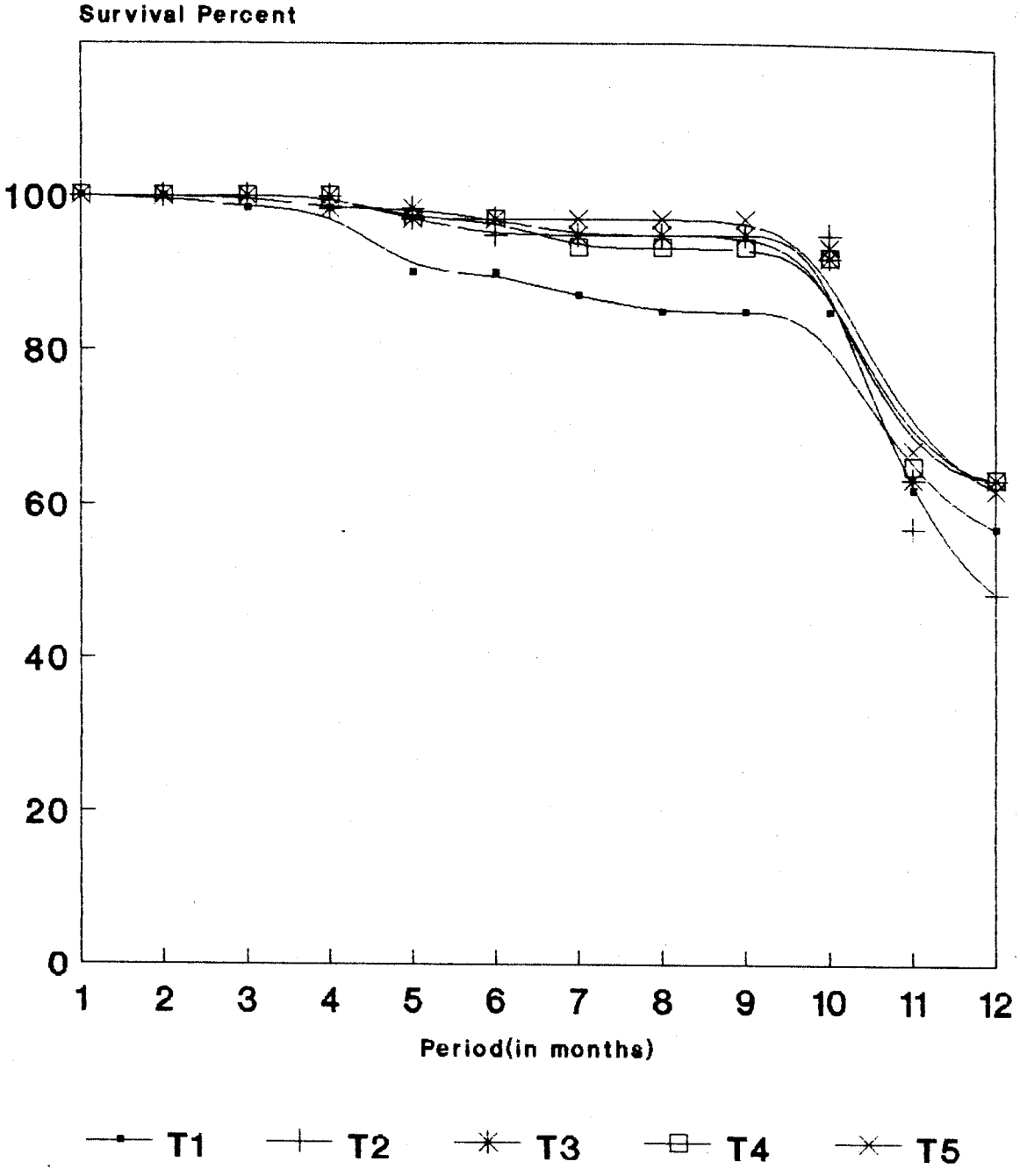
Compared to *Agave sissalana,* the remaining species *Acacia nilotica* and *Ceiba pentandra* showed fluctuating survival rates up to ten months after outplanting followed by a sharp decline (Fig. 6,7). This was probably due to failure of South-West monsoon during study period and lesser suitably of species to the area. Even though *Acacia nilotica registered higher survival percent, faster growth was observed in Ceiba pentandra.*

Fig. 5. Survival percent of *Agave sisalana* in different treatments of Planting method trial



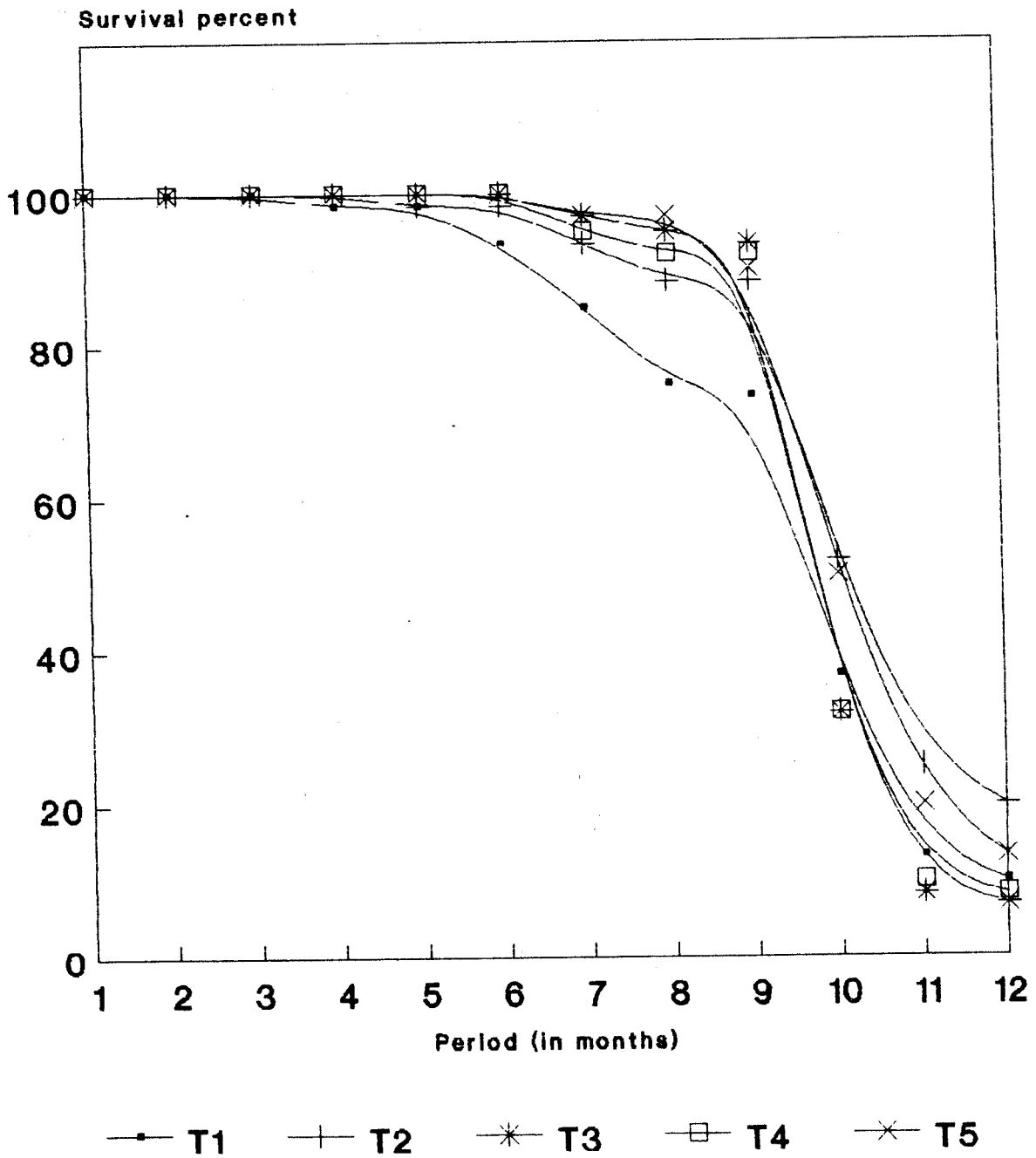
T1-30 x 30 x 30 cm Ground level planting
T2-30 x 30 x 30 cm Stone packing
T3-45 x 45 x 60 cm Deep planting
T4-45 x 45 x 60 cm Ground level planting
T5-45 x 45 x 45 cm Ground level planting

Fig. 6. Survival percent of *Acacia nilotica* in different treatments of Planting method trial



T1-30 x 30 x 30 cm Ground level planting
T2-30 x 30 x 30 cm Stone packing
T3-45 x 45 x 60 cm Deep planting
T4-45 x 45 x 60 cm Ground level planting
T5-45 x 45 x 45 cm Ground level planting

Fig. 7. Survival percent of Ceiba pentandra in different treatments of Planting method trial



T1-30 x 30 x 30 cm Ground level planting
T2-30 x 30 x 30 cm Stone packing
T3-45 x 45 x 60 cm Deep planting
T4-45 x 45 x 60 cm Ground level planting
T5-45 x 45 x 45 cm Ground level planting

Table 4. Survival (%) and mean annual height increment of different species in planting method trial after 12 months growth in field

Treatments	Agave sissalana		Acacia planifrons		Ceiba pentandra	
	Survival	MAHI	Survival	MAHI	Survival	MAHI
30x30x30cmGroundlevel planting	99^{a}	9^{b}	57^{c}	20^{d}	10^{e}	30^{f}
30x30x30cmStonepacking	100^{a}	8^{b}	48^{c}	17^{d}	20^{e}	28^{f}
45x45x60 cm Deep planting	99^{a}	6^{b}	63^{c}	16^{d}	7^{e}	63^{f}
45x45x60cmGroundlevel planting	100^{a}	10^{b}	63^{c}	9^{d}	8^{e}	32^{f}
45x45x45cmGroundlevel planting	99^{a}	11^{b}	62^{c}	16^{d}	13^{e}	28^{f}

Figures superscribed by the same letter under each column are not significantly different at P = 0.05

In *Acacia nilotica* higher survival and better height increment was observed in seedlings planted in pits of 45 x 45 x 45 cm. A similar result was obtained in deep planted seedlings in larger pits of 45 x 45 x 60 cm, but preparation of deeper pits was more expensive. Conventional planting in 30 x 30 x 30 cm pits had the advantage of faster height increment but had lower survival percent. Stone packing in conventional planting method also did not improve survival rate. Survival percent in *Ceiba pentandra* was very low and was in the range of 7-20 when observations were taken after twelve months growth in the filed. Maximum survival percent was recorded by seedlings planted in conventional pits (30 x 30 x 30 cm) with stone packing followed by those in 45 x 45 x 45 cm pits. However, in both these cases, height increment was lowest. Larger pits of 45 x 45 x 60 cm with deep and ground level planting enabled seedlings to have faster growth but with very low survival percent. However, statistical analysis of the data after 12 months growth in field did not show any significant difference between treatments in any of the species (Table 4).

From the results, indication is that, in drier areas like Mully either conventional pits (30x30x30 cm) or slightly larger pits (45x45x45 cm) will ensure better survival and faster height growth of seedlings depending upon the species. Even though deeper pits in certain cases may encourage faster height growth, final choice has to be made after taking into consideration the higher costs involved in preparing deeper pits.

Species performance trial-1988

Survival

Considering the adverse site factors at Mully like shallow skeletal soil and erratic rainfall, a survival of 30 and above can be taken as moderately satisfactory. According to Jeyadev, (1963) a survival of about 60-70% in the second or third year is a really encouraging situation in drier areas. Observations on survival percent for a period of 24 months showed that only 3 species out of 15 satisfied the minimum survival standards of 30 (Table 5).

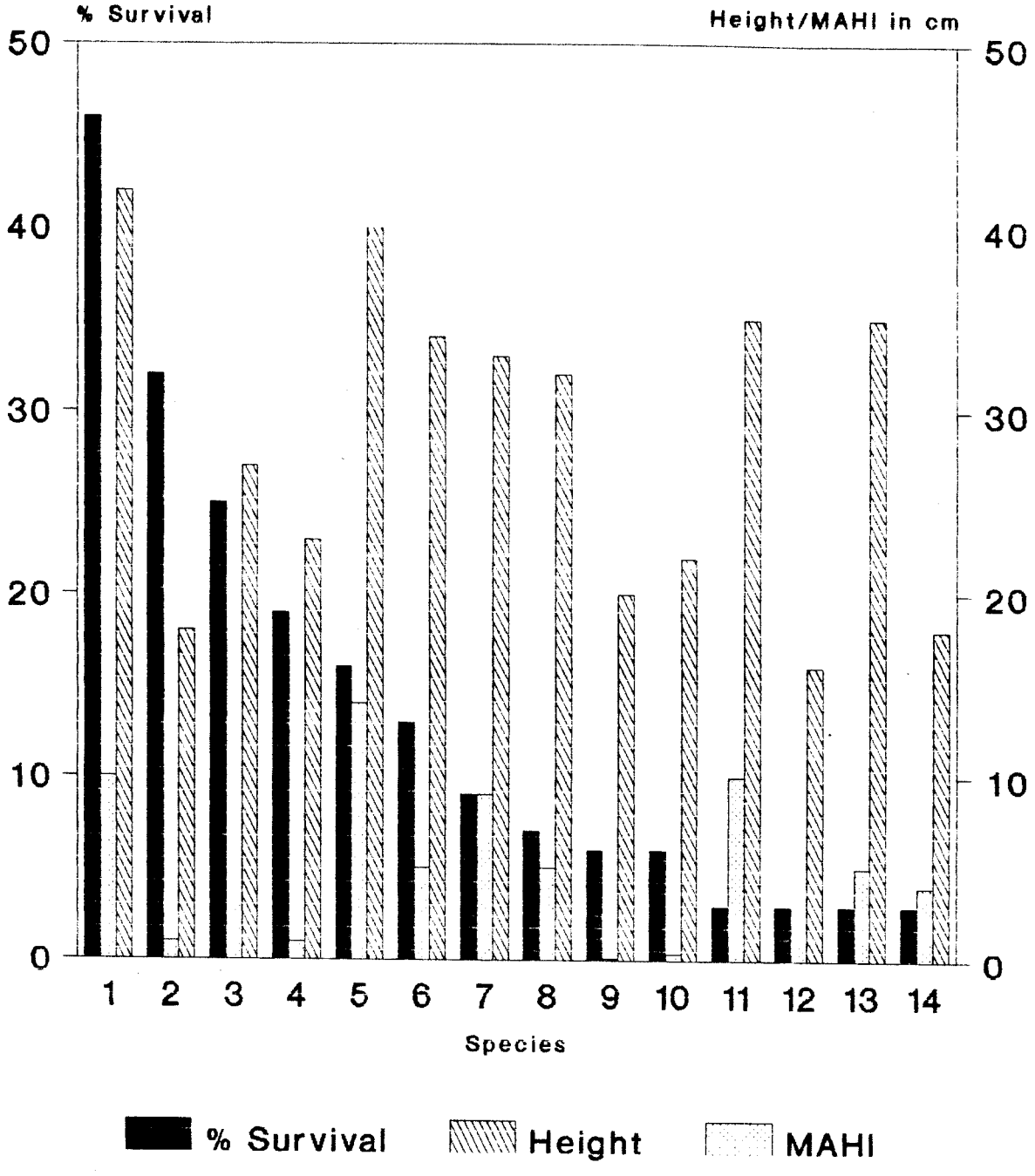
Table 5. Mean survival percent of different species of species performance trial at various periods after planting (1988)

Sl.No.	Species	Mean survival percent at different periods (months)									
		0	1	4	7	10	13	16	19	22	23
1	Albizia lebbeck	100	97	61	21	29*	28*	28*	25*	21	19
2	Acacia planifrons	100	93	68	63	62	49	48	48	46	46
3	Albizia amara	100	94	31	11	10	9	9	9	8	9
4	Anacardium occidentale	100	90	32	11	10	5	6*	7*	6*	6*
5	Ailanthus excelsa	100	93	53	20	18	15	16*	14	14	13
6	Bambusa arundinacea	100	87	38	13	14*	13	13	11	9	7
7	Dendrocalamus strictus	100	97	40	54*	42*	43*	44*	40	37	25
8	Hardwickia binata	100	94	72	48	47	38	41*	39*	36	32
9	Holoptelia integrifolial	00	91	41	15	12	5	4	5*	4	3
10	Tamarindus indica	100	87	40	13	10	10	10	7	7	6
11	Pongamia pinnata	100	77	15	6	5	3	0	3*	0	0
12	Cassia siamea	100	38	9	5	4	4	4	4	4	3
13	Ceiba pentandra	100	98	71	27	21	8	8	5	3	3
14	Azadirachta indica	100	80	36	20	19	18	17	16	15	16
15	Psidium guajava	100	93	43	16	9	11*	ll*	9	6	3

* The increase is due to emergence of new sprouts from the seedlings recorded as casualities earlier

The fluctuation in survival percent was common for all species and was due to drying up of main shoot and subsequent development of new sprouts from the shoot portion. After six months growth in the field, survival trend shown by *Acacia planifrons, Dendrocalamus strictus* (Fig. 8) and *Hardwickia binata* was encouraging which continued up to the 24th month when final observations were taken. Even though *Albizia lebbeck, Ceiba pentandra* and *Azadirachta indica* showed better performance at commencement of trial, later they exhibited a very poor trend. Statistical analysis of the data showed significant differences between different species at the end of 24 months (Table 6).

Fig. 8. Survival percent, Final height and Mean Annual Height Increment of different species after 24 months growth in the field



1. Acacia planifons
2. Hardwickia binata
3. Dendrocalamus strictus
4. Albizia lebbeck
5. Azadirachta indica
6. Ailanthus excelsa
7. Albizia amara
8. Bambusa arundinacea
9. Anacardium occidentale
10. Tamarindus indica
11. Holoptelia integrifolia
12. Cassia siamea
13. Ceiba pentandra
14. Psidium guajava

Table 6. Analysis of variance of survival in species performance trial after 24 months growth in field (1988)

Source	Df	Mean square	F. Value
Species	13	356.093	28.338 **
Replication	2	60.776	4.837
Residual	26	12.566	
Total	41	123.841	

** Significant at P = 0.01

Further tests on mean survival revealed that *Acacia planifrons, Dendrocalamus strictus* and *Hardwickia binata* were the most successful species of the 1988 plantation trial.

Final height and mean annual height increment

Table 7 shows mean height of various species at different periods after planting. Final height after 24 months growth in the field arid MAHI is given in (Fig. 8). Seven species, *Acacia planifrons* (PI. 11), *Azadirachta indica* (Pl. I2), *Holoptelia integrifolia, Ceiba pentandra, Ailanthus excelsa* (PI. 13), *Albizia amara* and *Bambusa arundinacea* (PI. 14) recorded an average height of 30 to 42 cm by the end of study period.

However, MAHI was considerably low for these species. Maximum MAHI of 14.4 cm was recorded by *Azadirachta indica* while *Acacia planifrons* and *Holoptelia integrifolia* recorded only 10 cm each. Remaining species in 1988 species performance trial registered onlyvery low MAHI of less than 10cm (Fig. 8). Statistical analysis of MAHI1 of these species after 24 months growth in field showed significant differences (Table 8).

Second category of species with mean height range of 20-30 cm included *Dendrocalamus strictus* (PI. IS), *Albizia lebbeck, Tamarindus indica* and *Anacardium occidentale* (PI. 16). Three other species, viz., *Psidium guajava, Hardwickia binata* and *Cassia siamea* (PI. 17) recorded a mean height of less than 20 cm by the end of the study period (Fig. 8). *Pongamia pinnata* exhibited very poor growth and was completely dried up after 18 months growth in field.

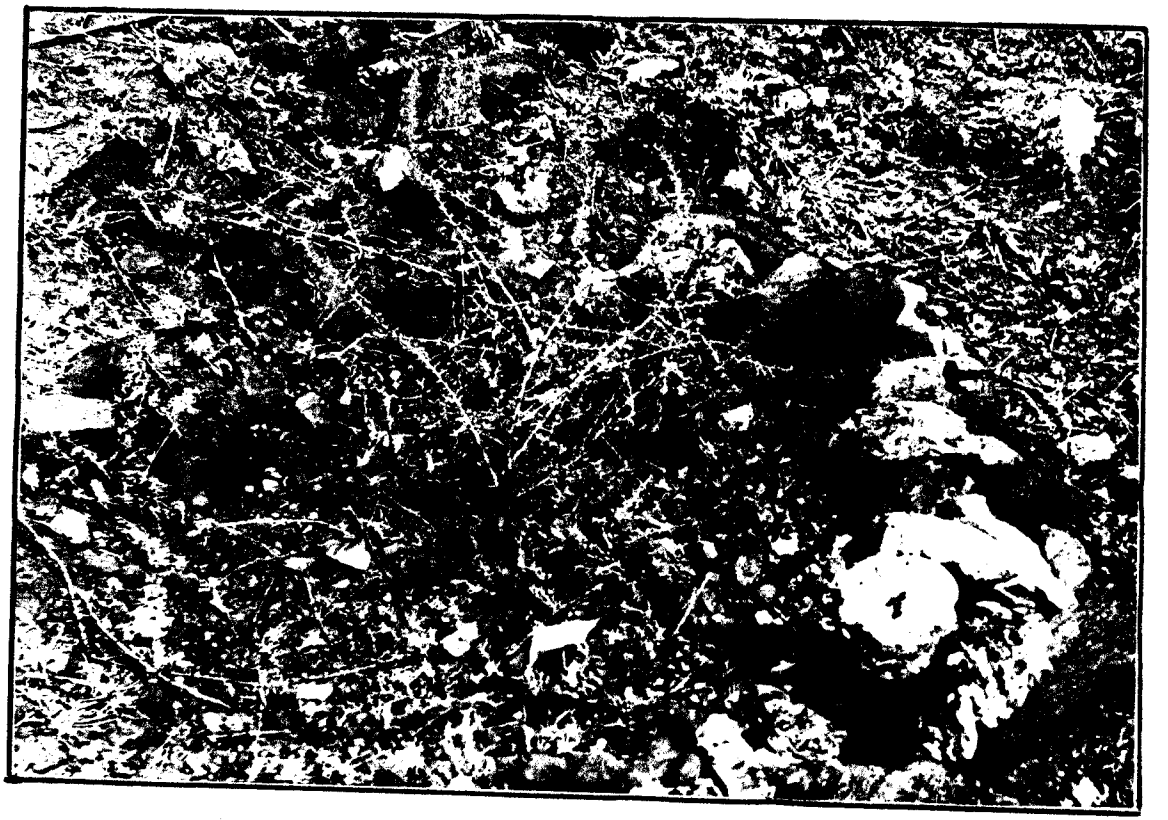


Plate 11 - Acacia planifrons

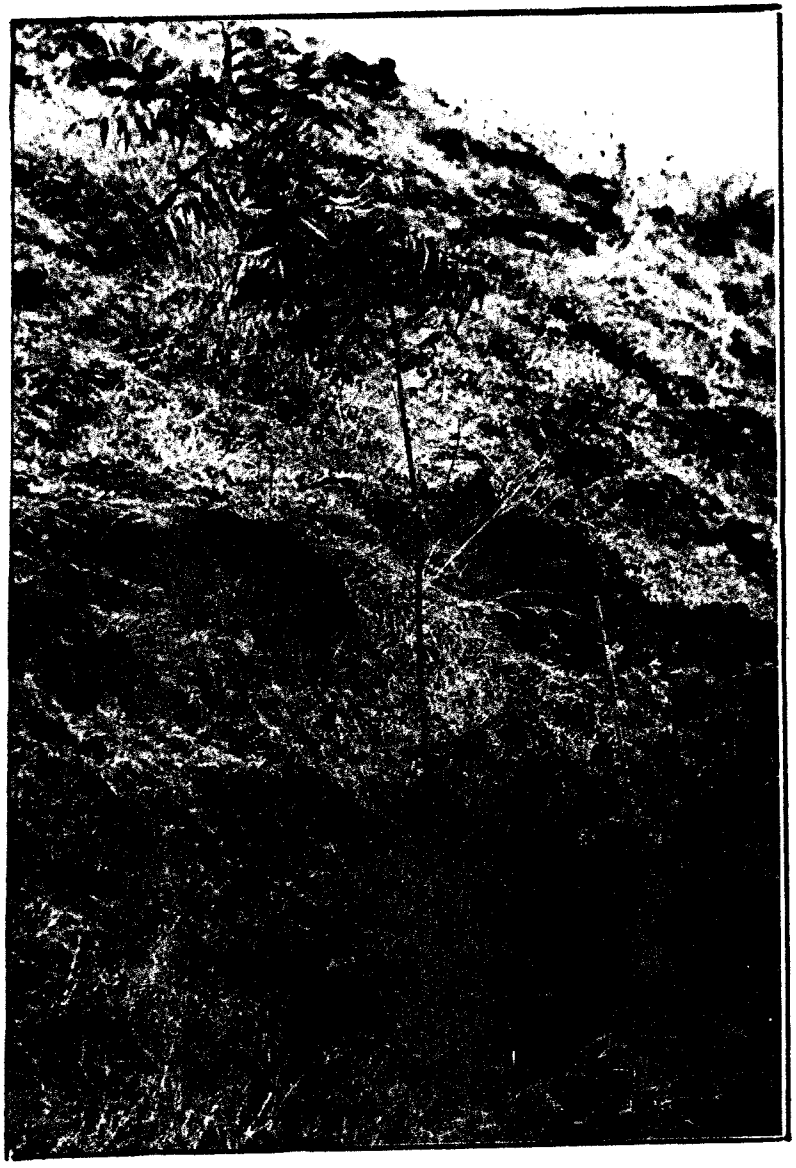


Plate 12 - Azadirachta indica

Plate 13 - Ailanthus excelsa

Plate 14 - Bambusa arundinacea

Plate 15 - Dendrocalamus strictus

Plate 16 - Anacardium occidentale

Plate 17 - Cassia siamea

Table 7. Mean height of different species of species performance trial at various periods after planting (1988)

Species	Mean height (cm) at different periods (months)							
	2	4	7	10	13	16	19	24
Albizia lebbeck	20.3	18.2	21.2	16.5	15.5	17.1	21.3	22.5
Acacia planifrons	22.1	21.8	23.6	24.2	24.1	30.6	38.7	41.7
Albizia amara	15.8	15.8	19.9	20.0	21.6	26.3	32.6	32.5
Anacardium occidentale	20.0	19.6	19.3	23.5	22.0	22.7	23.0	20.1
Ailanthus excelsa	23.6	23.0	27.9	26.3	24.0	28.7	34.0	33.5
Bambusa arundinacea	21.7	21.2	18.0	16.2	19.7	32.1	29.6	32.2
Dendrocalamus strictus	21.1	21.7	15.5	14.9	28.7	31.0	31.7	27.0
Hardwickia binata	16.0	14.4	16.9	14.2	13.9	16.2	18.5	17.6
Holoptelia integrifolial	6.5	16.0	20.3	20.4	24.3	31.4	37.1	35.0
Tamarindus indica	21.5	20.9	21.3	21.5	20.4	21.6	23.4	22.2
Pongamia pinnata	15.2	14.5	19.0	19.5	24.0	25.0	8.0	0.0
Cassia siamea	10.9	11.7	16.9	13.8	14.9	16.5	16.3	16.4
Ceiba pentandra	25.4	27.5	33.9	32.9	37.1	36.4	52.2	35.0
Azadirachta indica	12.2	7.8	11.6	15.2	18.8	23.1	35.2	39.9
Psidium guajava	10.3	10.7	13.7	19.4	13.4	17.0	15.9	18.0

Table 8. Analysis of variance of mean annual height increment in species performance trial after 24 months growth in field (1988)

Source	Df	Mean square	F. Value
Species	13	87.618	3.874 **
Replication	2	105.007	4.643 *
Residual	26	22.614	
Total	41	47.244	

** Significant at P = 0.01
* Significant at P = 0.05

Species Performance Trial-1989

Survival

The species performance trial-1989 revealed a higher survival percent after 13 months growth in the field. Out of 33 species, only 5 species recorded a survival of more

than 60%. This included two tree species *Acacia planifrons, Albizia amara* and three shrubby species *Agave sissalana, Agave viracruz and Agave americana.*

Table 9. Mean survival percent of different species in species performance trial at various periods after planting (1989)

Species	Mean survival percent at different periods (months)					
	0	1	4	7	10	13
1. Albizia amara	100	99	89	75	69	67
2. Albizia lebbeck	100	100	97	66	62	33
3. Acacia nilotica	100	100	100	87	81	43
4. Acacia leucophloea	100	100	99	40	29	8
5. Anona squamosa	100	100	97	36	24	15
6. Anogeissus latifolia	100	100	97	79	73	26
7. Azadirachta indica	100	100	96	64	59	39
8. Cassia siamea	100	100	100	45	25	15
9. Cassia spectabilis	100	98	80	40	32	20
10. Chloroxylon swietenia	100	98	98	50	44	57
11. Ceiba pentandra	100	98	95	65	36	0
12. Citrus aurantifolia	100	99	88	22	15	9
13. Zizyphus sp.	100	99	97	46	33	14
14. Pongamia pinnata	100	100	99	29	20	3
15. Pterocarpus santalinus	100	100	96	72	56	23
16. Wrightia tinctoria	100	100	100	89	65	34
17. Bauhinia sp.	100	100	100	83	64	25
18. Emblica officinalis	100	99	92	69	24	5
19. Holoptelia integrifolia	100	100	98	79	56	23
20. Bambusa arundinacea	100	100	99	90	79	49
21. Dendrocalamus strictus	100	97	93	64	28	17
22. Santalum album	100	70	34	6	6	3
23. Sapindus emarginatus	100	90	78	45	37	25
24. Tamarindus indica	100	99	97	42	26	12
25. Acacia planifrons	100	100	98	94	93	92
26. Enterolobium cyclocarpum	100	100	94	49	36	0
27. Alstonia scholaris	100	98	98	20	7	0
28. Bauhinia purpurea	100	100	90	52	0	0
29. Citrus limon	100	100	100	20	12	12
30. Agave sissalana	100	100	100	100	100	99
31. Agave americana	100	100	100	95	91	81
32. Agave viracruz	100	100	100	100	100	95
33. Sterculia urens	100	97	92	71	79	37

Second category of species with moderately successful performance included seven species, *Chloroxylon swietenia*, *Bambusa arundinacea*, *Acacia nilotica*, *Azadirachta indica*, *Sterculia urens*, *Wrightia tinctoria* and *Albizia lebbeck*. Species which were locally available and exhibited good survival rate in the 1989 species performance trial were *Anogeissus latifolia*, *Azadirachta indica*, *Chloroxylon swietenia*, *Sapindus emarginatus* and a *Bauhinia* species. Few species showed very poor survival percent and four species, i.e., *Ceiba pentandra*, *Enterolobium cyclocarpum*, *Alstonia scholaris* and *Bauhinia purpurea* dried up during the course of study (Table 9). Analysis of variance showed significant differences among the survival percent of species at the end of 13 months growth in the field (Table 10).

Table 10. Analysis of variance of survival in species performance trial after 13 months growth in field (1989)

Species	Df	Mean square	F. Value
Species	28	1402.473	23.908 **
Replication	2	1431.347	24.400 **
Residual	56	58.662	
Total	86	528.105	

** Significant at P = 0.01

Final height and mean annual height increment

Mean height of species during different periods after planting is given in Table 11. Final height and MAHI of these species during 13 months of the study period are shown in Fig. 9. Towards the close of study, only three tree species, *Acacia nilotica*, *Holoptelia integrifolia*, *Acacia planifrons* and a shrubby species *Agave sissalana* registered mean heights in the range of 30 to 45 cm.

Ten species, *Citrus aurantifolia*, *Cassia siamea*, *Bambusa arundinacea*, *Azadirachta indica*, *Anogeissus latifolia*, *Tamarindus indica*, *Citrus limon*, *Albizia amara*, *Pongamia pinnata* and *Santalum album* came in the second category of species with a mean height range of 20 to 30 cm and the remaining species exhibited poor height growths.

All the species registered comparatively low MAHI during the study period (Fig. 9). Statistical analysis also showed significant differences among the MAHI of the species after

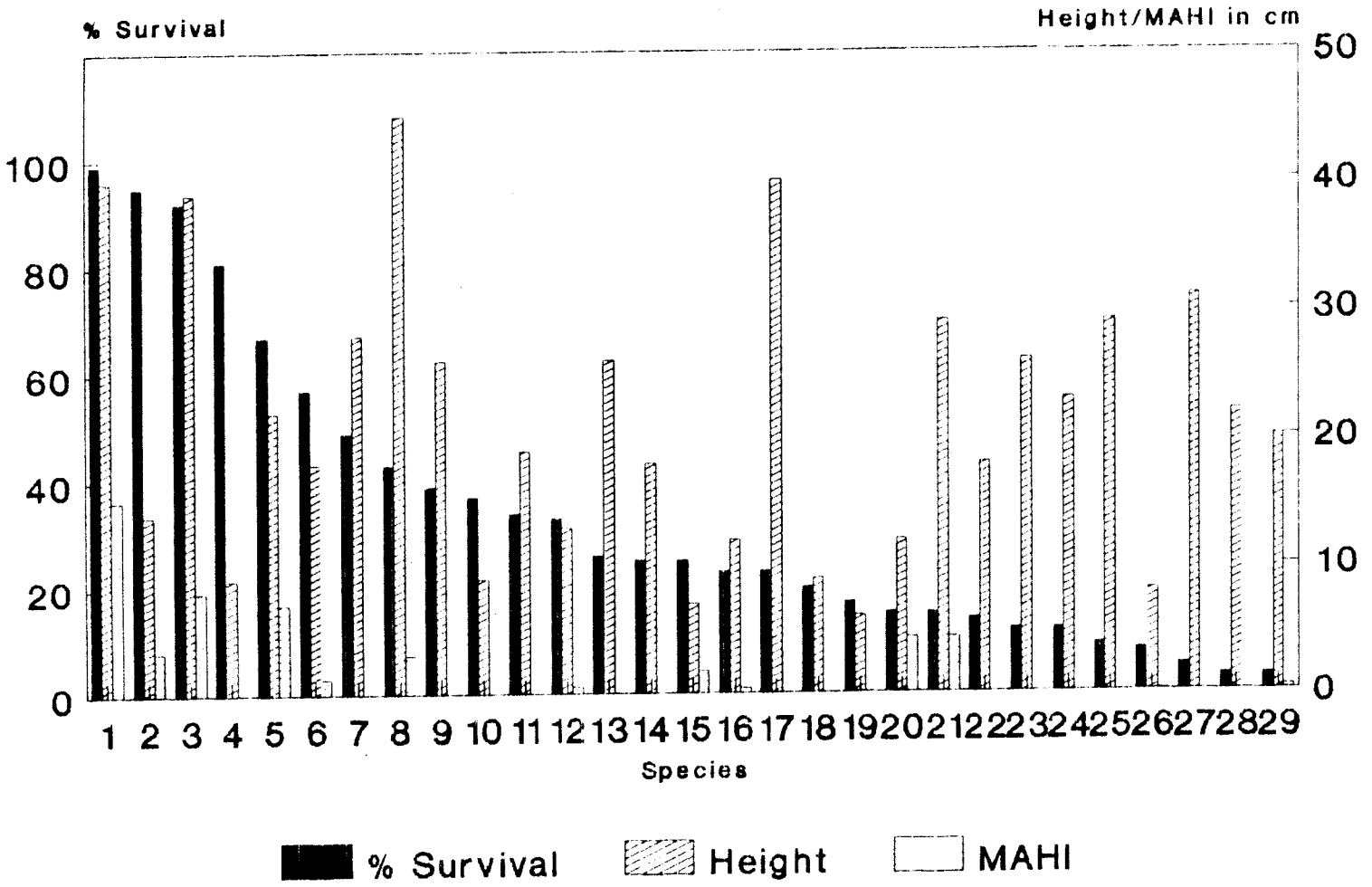


Fig. 9. Survival percent, Final height and Mean Annual Height Increment of different species after 13 months growth in the field

Legend for Fig. 9

1. *Agave sissalana*
2. *Agave viracruz*
3. *Acacia planifrons*
4. *Agave americana*
5. *Albizia amara*
6. *Chloroxylon swietenia*
7. *Bambusa arundinacea*
8. *Acacia nilotica*
9. *Azadirachta indica*
10. *Sterculia urens*
11. *Wrightia tinctoria*
12. *Albizia lebbeck*
13. *Anogeissus latifolia*
14. *Bauhinia sps.*
15. *Sapindus emarginatus*
16. *Pterocarpus santalinus*
17. *Holoptelia integrifolia*
18. *Cassia spectabilis*
19. *Dendrocalamus strictus*
20. *Anona squamosa*
21. *Cassia siamea*
22. *Zizyphus sps.*
23. *Tamarindus indica*
24. *Citrus limon*
25. *Citrus aurantifolia*
26. *Acacia leucophloea*
27. *Emblica*
28. *Pongamia pinnata*
29. *Santalum album*

Table 11. Mean height of different spccics in specics performance trial at various periods after planting (1989)

Species	Mean height (cm) at different periods (months)				
	1	3	5	8	13
1 Albizia amara	14.7	17	19.2	24.5	22.1
2 Albizia lebbeck	12.7	15.6	16.7	16.2	13.2
3 Acacia nilotica	41.6	47.8	49.2	47.9	45.2
4 Acacia leucophloea	8.3	10.9	11.9	10.8	8.3
5 Anona squamosa	7.4	9.3	10.9	14	12
6 Anogeissus latifolia	41.7	38.8	41.4	32.3	25.7
7 Azadirachta indica	30.2	30.3	31	27	26.3
8 Cassia siamea	14.9	19.8	23.5	23.2	29.3
9 Cassia spectabilis	19.6	22	25	27.6	9
10 Chloroxylon swietenia	17	18.2	19.1	18.4	18.3
11 Ceiba pentandra	33.4	39.2	40.8	52.3	0
12 Citrus aurantifolia	24	23.8	25.6	23.1	29.3
13 Zizyphus sp.	20.3	25.6	26.9	13.9	18
14 Pongamia pinnata	4.5	15.8	17.6	18.6	22
15 Pterocarpus santalinus	11.4	12.2'	13	11.5	11.8
16 Wrightia tinctoria	29.4	29.2	31.7	26.3	18.7
17 Bauhinia sp	23.2	31.9	32	21.4	17.5
18 Emblica officinalis	32.4	33.2	33.8	31.6	31
19 Holoptelia integrifolia	44.2	48.4	49.1	44.6	39.9
20 Bambusa arundinacea	72.9	68.8	65	45.9	27.8
21 Dendrocalamus strictus	19	18	17.2	13	6.2
22 Santalum album	6.4	7.7	11.3	16	20
23 Sapindus emarginatus	4.6	7	8.1	7	6.5
24 Tamarindus indica	26.1	26.6	27.2	28	25.7
25 Acacia planifrons	30.2	33.4	35.2	38.7	38.7
26 Enterolobium cyclocarpum	91.6	89.8	80.8	86.3	0
27 Alstonia scholaris	23.2	31.6	34.3	35.5	0
28 Bauhinia purpurea	47.9	52	46.9	36	0
29 Citrus limon	24.8	26.6	27	25	22.8
30 Agave sissalana	23.9	29	32.6	34.7	40.4
31 Agave americana	13.1	26.7	16.9	12.3	8.8
32 Agave viracruz	10.7	17.8	16.5	13	14.3
33 Sterculia urens	11.3	11.6	12.4	8.4	8.5

13 months growth in the field (Table 12). Maximum MAHI was only 15 cm for *Agave sissalana*. The tree speceis which recorded maximum MAHI of I3 cm were *Santalum album* and *Cassia siamea*. However, survival percent of both these species was extremely low (3 and 13 respectively) in the filed. Species which registered higher survival percent and comparatively higher MAHI were Acacia planifrons and *Albizia amara*. Even though *Pongamia pinnata* recorded a MAHI of 7 cm equal to *Albizia amara*, its survival was only 3, Two other species Chloroxylon swietenia and *Acacia nilotica* recorded higher survival percent of 57 and 43 respectively but with a considerable low MAHl of 1 and 3 cm. Albizia *lebbeck* also showed a survival percent of 33 but without any appreciable growth increments during the study period.

Table 12. Analysis of variance of mean annual height increment in spccics performance trial after 13 months growth in field (1989)

Source	Df	Mean square	F. Value
species	28	345.700	5.206 **
Replication	2	191.159	2.879 ns
Residual	56	66.406	
Total	86	160.240	

** Significant at P = 0.01
ns Not significant

Few species showed negative increments mainly because of the drying up of the leading shoot and subsequent development of new sprouts from the lower portions of the shoot. This phenomenon was probably due to very erratic rains and subsequent droughts and was very common among the species like *Bambusa arundinacea*, *Wrightia tinctoria*, *Azadirachta indica* and *Sterculia urens* which registered satisfactory survival percent of 49, 34, 39 and 37% respectively. This was the reason lor the wide fluctuations in growth parameters like survival and height growth monitored periodically from the study area.

Natural restoration under protected conditions

Tribals living in and around Mully possess large number of livestock. They also depend on the degraded vegetation for their fuelwood needs.

A reconnaissance survey in and around Mully soon after the onset of North-East monsoon showed abundant regeneration of grasses, herbs, shrubs and even tree seedlings. The uncontrolled grazing (Pl. 18) coupled with the rigorous climate, extremely shallow and poor, if not infertile soil wipes off the new recruits within a short span of time. Hence an

Plate 18 - Goats in the area

attempt was made to study the effect of protecting regeneration through fencing small portions of the area and observing natural restoration process.

Though a period of one year is too short for getting conclusive evidences of the effect of protection on regeneration the general trend could be easily understood. Since the first enumeration was carried out soon after the chainlink fencing in 1990 species combination was very much similar in control and fenced plots. However, after 12 months of fencing, evidences of initiation of natural restoration process were very much clear in fenced plots (Fig. 10, 11, 12). Grass growth in fenced and control plots were similar and was around 35% during first enumerations in 1990 (Fig. 10). Profuse natural regeneration brought about considerable increase (78%) in grass growth in fenced plots by second enumerations in 1991. This, probably, was the direct and immediate effect of protection. Grass growth showed a gradual reduction (29%) in control plots during the above period presumably due to increased biotic interferences including grazing.

Number of species belonging to the category of herbs and shrubs was lesser in control plots than in fenced plots during 1990 (Fig. 11). Probable reason can only be intense grazing in these open plots which might have considerably reduced the number of countable plants. The number of herbs and shrubs was 76% more in fenced plots during the first enumerations in 1990. Fencing had only meagre effect on regeneration of this category of plants. There was a 22% increase in the number of plants belonging to herbs and shrubs category in fenced plots. However, in control plots the number got reduced by 4.5%. The profuse regeneration of grasses in fenced plots due to protection might have had smothering effect on regeneration of small shrubby species.

The percentage increase of tree seedlings in control plots were comparatively lesser than fenced plots (Fig. 12). When there was a 10% increase in the number of tree seedlings in control plots, the increase was 29% in the fenced plots (Fig. 12). The difference of 19% - a direct effect of fencing - confirms the importance of protection in natural regeneration of various species especially the tree species in a degraded area like Mully.

A list of species identified during the enumarations are given in Appendix.

Fig. 10 - Abundance of grass growth during 12 months in control and fenced plots

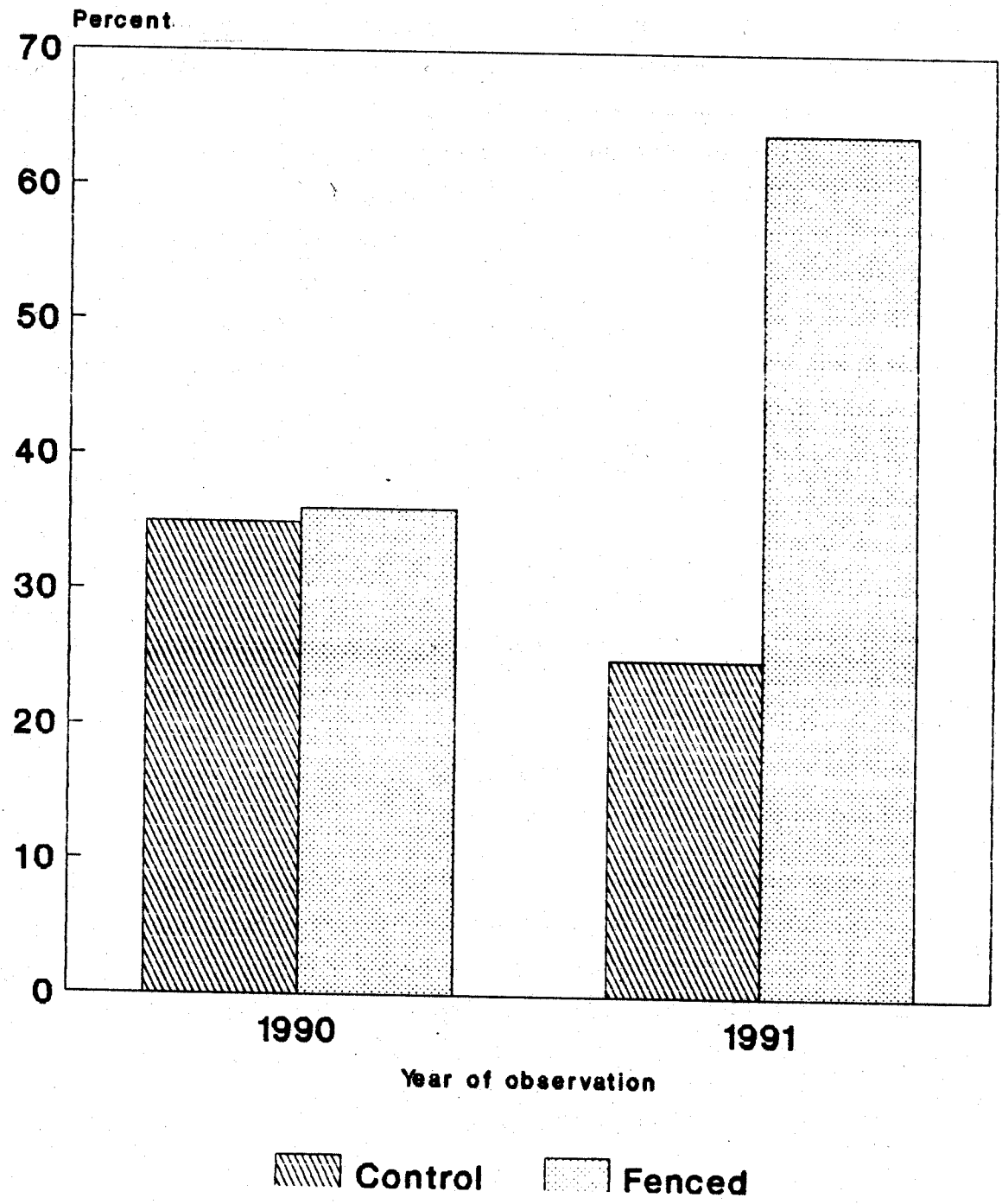


Fig. 11 - Abundance of herbs and shrubs during 12 months in control and fenced plots

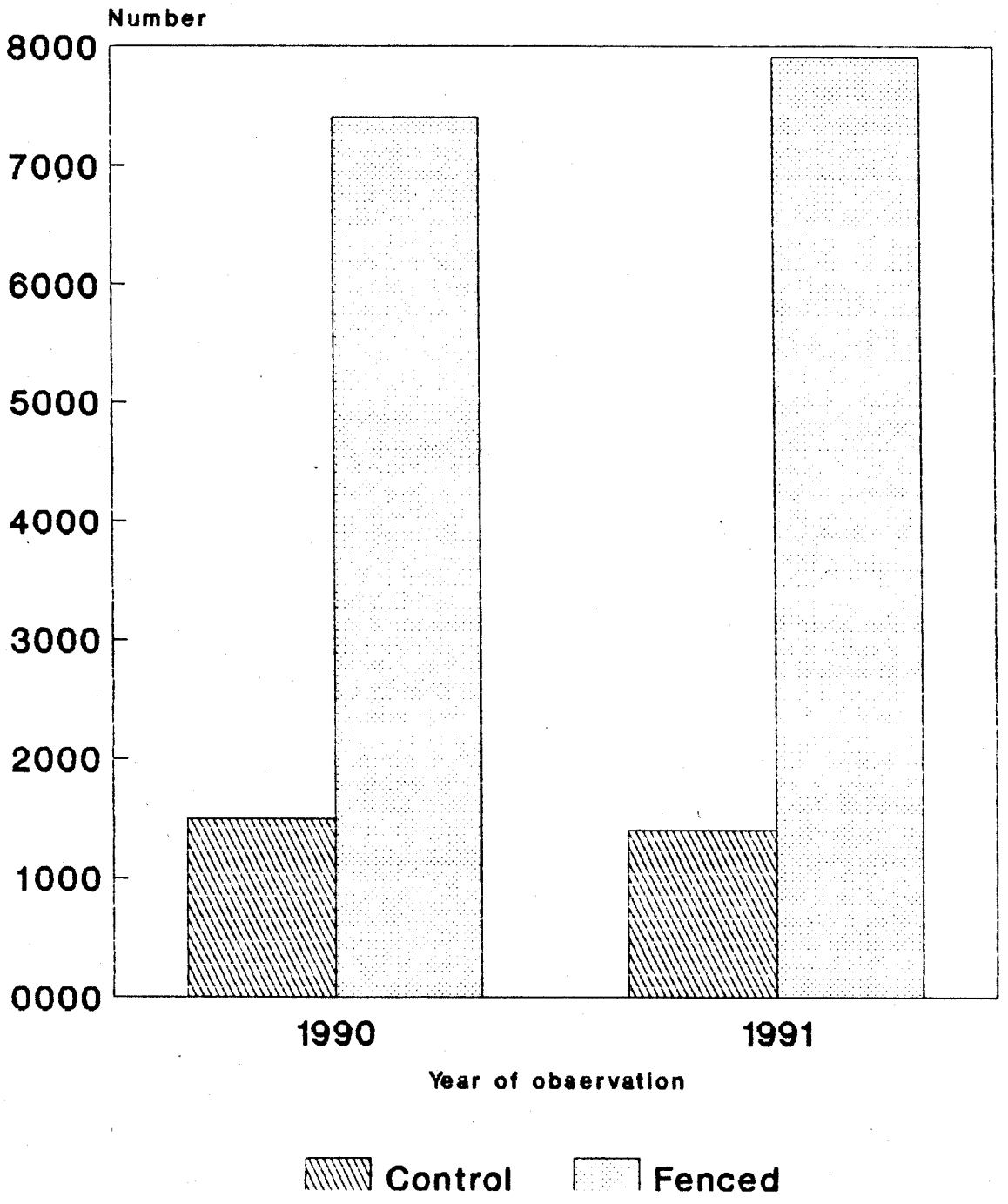
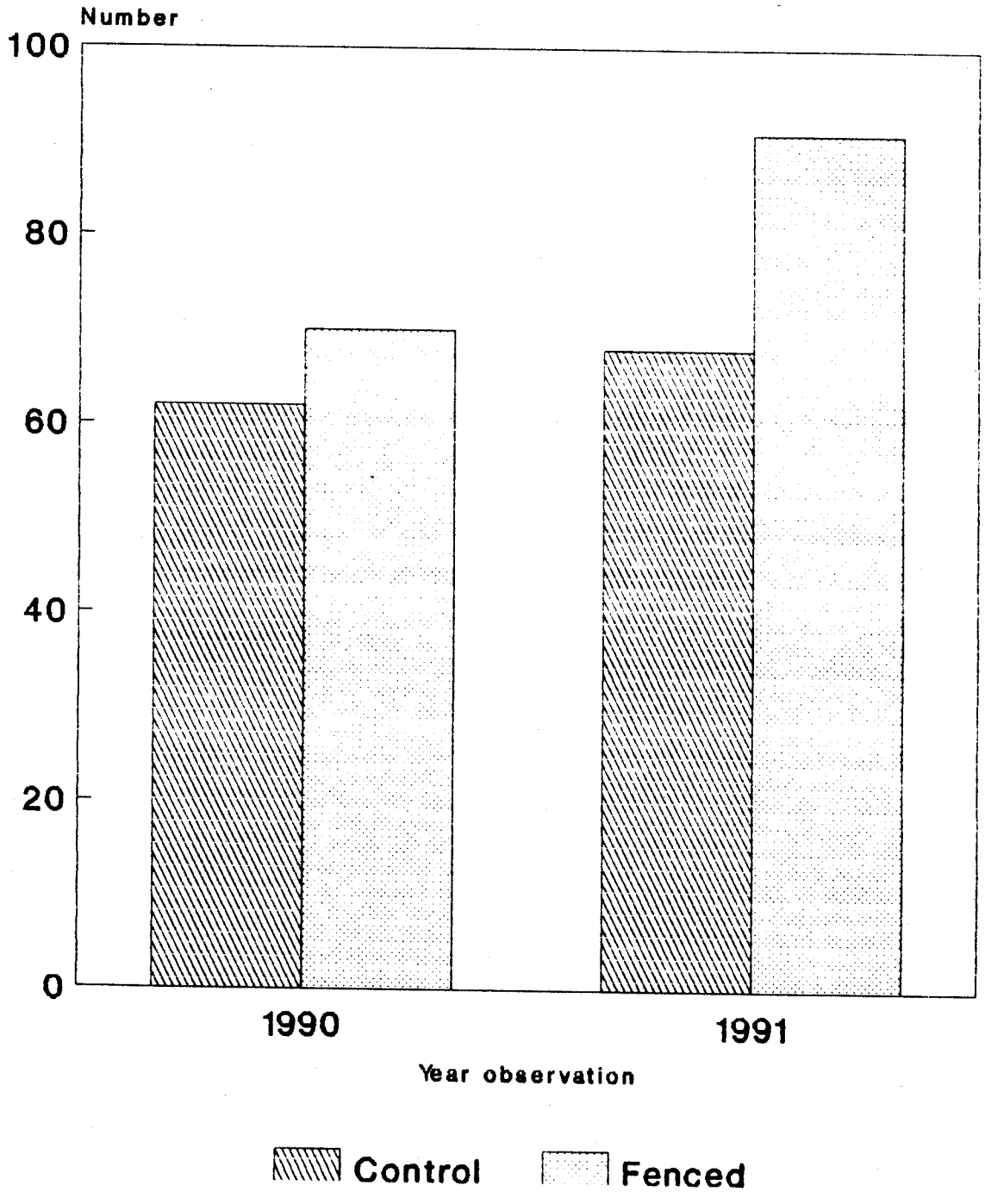


Fig. 12 - Abundance of tree seedlings during 12 months in control and fenced plots



Conclusions and Recommendations

Even though soil conditioners like jalsakthi, vermiculite and polyurethane foam retain moisture for more number of days than red soil, it is yet to be understood whether the moisture is in an available form to the plants. Soil conditioners had very little effect on the survival and growth of *Acacia planifrons* and *Tamarindus indica* seedlings during their nursery stages. Seedlings grown in red soil gave very much comparable results in the nursery. Hence the additional expenditure on soil conditioners can be saved in similar situations involving forestry species like *Acacia planifrons* and *Tamarindus indica*.

Similarly both the species showed almost uniform survival and height growth when watered twice a day and on alternate days. Even though more frequent watering ensured faster height growth, survival was independent of this. Survival was equal or even better in lesser frequencies of watering. Hence in drier locations like Mully watering the plants once in alternate days will not only reduce the nursery cost but will also ensure lesser demand for water.

From the Mulching trials it was observed that ploy urethane sheets cannot be used as mulches in plantations of drier areas especially when the rains are erratic. The best method would be a combination of stone mulching and stone packing. In these methods only the locally available loose stones are made use of, thus minimising the plantation maintanance cost.

In the planting method trial it was observed that seedlings when outplanted in pits of 30 x 30 x 30 cm and 45 x 45 x 45 cm size gave better survival and height growth, very much comparable to those planted in larger and deeper pits. In certain cases the seedlings planted indeeper pitsgave faster height growth but survival rate was similar to those in conventional pits. Hence in drier and degraded areas conventional pits will reduce the plantation cost without affecting the plant growth.

From species performance trial it was clear that atleast few species have good potential to be considered for afforestation programmes in similar areas. Species that showed good to moderately good survival percentage includes *Acacia planifrons, Albizia amara, Chloroxylon swietenia, Dendrocalamus strictus, Bambusa arundinacea, Hardwickia binata, Acacia nilotica, Azadirachta indica, Sterculia urens, Wrightia tinctoria and Albizia lebbeck.*

Species like *Agave sissalana, Agave viracruz* and *Agave americana* showed very good survival and comparatively good height growth and can be raised as live fences. An added advantage *of Agave* species is that they are attaining popularity for their fibers in and around Attappady.

Observations on protected natural regeneration have revealed appreciable growth and survival of seedlings belonging to native tree species. Thus ecorestoration processes can be augmented by imparting protection of concerned area from grazing and fire.

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Appendix

List of species observed in the enumeration and control plots at Mully

1. *Abutilon hertum*
2. *Achyranthus bidentata*
3. *Albizia amara*
4. *Anogeissus latifolia*
5. *Argyreia sps.*
6. *Atlantia monophylla*
7. *Azadirachta indica*
8. *Barleria buxifolia*
9. *Barleria prionitis*
10. *Bauhinia sps.*
11. *Blepharis maderspatensis*
12. *Boerhaavia diffusa*
13. *Bombax sps.*
14. *Borreria articularis*
15. *Capparis grandiflora*
16. *Caralumma adscedens*
17. *Cardiospermum halicacabum*
18. *Carissa spinarum*
19. *Cassia auriculata*
20. *Cassine glauca*
21. *Chloroxylon swietenia*
22. *Chordia obliqua*
23. *Cissus quandrangularis*
24. *Commelina sps.*
25. *Commiphora berryi*
26. *Corchorus sps.*
27. *Crotalaria sps.*
28. *Croton bonplandianus*
29. *Cyanotis crystata*
30. *Dalbergia paniculata*
31. *Desmodium triflorum*
32. *Dichrostachys cinerea*
33. *Diospyros sylvatica*
34. *Dodonaea viscosa*
35. *Ehretia microphylla*
36. *Erythroxylon monogynum*
37. *Eupatorium odoratum*
38. *Euphorbia antiquorum*
39. *Euphorbia hirta*
40. *Flacourtia sps.*
41. *Gardenia latifolia*
42. *Grewia rotundifolia*
43. *Grewia sps.*
44. *Hardiwickia binata*
45. *Hemionitis arifolia*
46. *Hemidesmus indicus*
47. *Hybanthus enneaspermis*
48. *Indigofera ennaephylla*
49. *Ipomea sps.*
50. *Ixora brachyata*
51. *Jasminum sps.*
52. *Jatropha sps.*
53. *Justicia tranquebarensis*
54. *Lantana camara*
55. *Leucas aspera*
56. *Morinda tinctoria*
57. *Mullugo pentaphylla*
58. *Mundulea sericea*
59. *Murraya koenigii*
60. *Ocimum canum*
61. *Opuntia dillenii*
62. *Oxalis corniculata*
63. *Pavetta indica*
64. *Pavonia odorata*
65. *Pergularia extensa*
66. *Phyllanthus niruri*
67. *Phyllanthus reticulata*
68. *Plectronia didyma*
69. *Portulaca quadrifida*
70. *Premna tomentosa*
71. *Prosopis juliflora*
72. *Pterolobium indicum*
73. *Putranjiva roxburghii*
74. *Randia candolleana*
75. *Sapindus emarginatus*
76. *Securinega virosa*
77. *Sida acuta*
78. *Sida rhombifolia*
79. *Sida veronicaefolia*
80. *Solanum sps.*
81. *Sterculia guttata*
82. *Sterculia urens*
83. *Strebulus asper*
84. *Strychnos potatorum*
85. *Tephrosia maxima*
86. *Terenna asiatica*
87. *Toddalia asiatica*
88. *Tribulus terrestris*
89. *Tridax procumbens*
90. *Trychodesma zeylanicum*
91. *Urgenia indica*
92. *Vernonia cinera*
93. *Vinca rosea*
94. *Xeromphis spinosa*
95. *Zizyphus sps.*