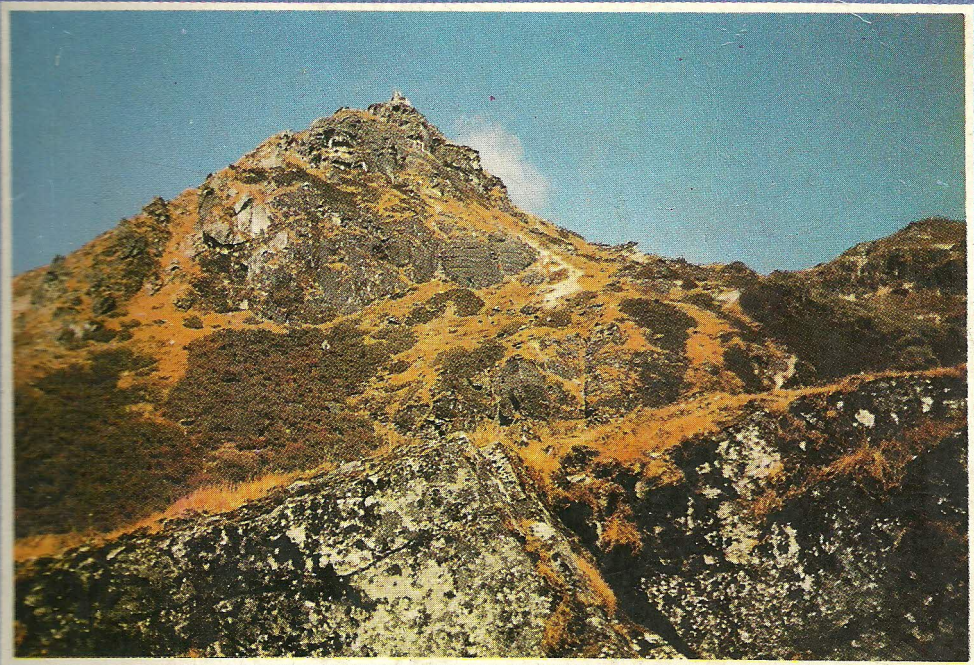


# Ecorestoration of Degraded Hills



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B. K. Tiwari  
and  
Surendra Singh

### About the Book ...

The existence of extremely degraded hills and grassland ecosystems in the tropical and sub-tropical humid areas of the world is an unresolved ecological problem. There is a view of ecologists that the present landscape of these wet areas has emerged as a consequence of deforestation and interference of man. The similar type of situation is prevailing in the degraded hills of the North-Eastern Region of the country specially in Meghalaya plateau which receives the highest rainfall of the world. Denudational forces and processes of degradation accelerating in these areas are to be studied carefully for the restoration of ecosystems.

The practical problems of degradation of the tropical wet lands specially of Meghalaya plateau have been discussed and scientific solutions of these problems are suggested. The present volume '**Ecorestoration of Degraded Hills**' is an outcome of two workshops, namely, '**Environmental Problems of Meghalaya Plateau**' and '**Technologies for Ecorestoration of Cherrapunjee Plateau**' organised by the Centre for Eco-Development, North-Eastern Hill University, Shillong. Fourteen papers have been classified into four broad sections, viz., (a) Eco-Restoration : Concepts and Approaches; (b) Problems of Hill Farming; (c) Geoenvironmental Degradation and (d) Forest and Wild life Protection.

The book, '**Ecorestoration of Degraded Hills**' is very much useful for the researchers who are working on the problems of environmental degradation and is expected to open new dimensions of the facts to the environmental scientists and planners of the country.

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# *Ecorestoration of Degraded Hills*

*Edited By*  
**B.K. Tiwari**  
and  
**Surendra Singh**



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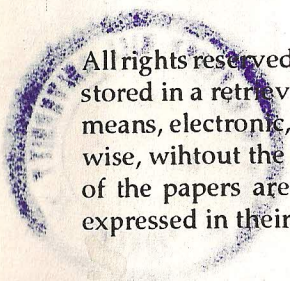
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## Preface

Interaction of man with the environment is inseparable as man derives all his requirements from the biotic and abiotic components of the environment around him. The civilization and cultural traits are important parts of human environment. The modern culture, which is largely based on the materialism of the West and follows limitless principles of economic development, does not fit under the ambit of ecological jurisprudence which impose the limits to development and requires to follow some natural laws that regulate the relationships of organism with environment. The habitat dictates these rules of the environmental limits and defines the *niche* of an organism including man in the system. Thus, there seems to be a conflict between nature, controlled environmental systems and uncontrolled human activities which disturb the interrelationships among animate and inanimate components of a particular ecosystem. The key component of ecorestoration is to prepare an integrated strategy for rehabilitation of an ecosystem which is dynamic and where the equilibrium between regeneration and utilization of resource is maintained. The systems which are studied under ecorestoration of an ecosystem where man is the key component involve the decision-making processes, its social acceptance and also its short and long term effects on the activities of man, the resources and functioning of the system.

The question arises how to accelerate decision-making processes to restore the degraded environment? Say for example, the questions of resource utilization, environmental degradation, pollution and the qualitative improvement of life and so on deal with ecorestoration and self-sustained growth of the system. The issues and spot-seen-problems of ecodevelopment and ecorestoration of any system are closely related to three major aspects :

- (a) to search for major issues related to environmental degradation,
- (b) to highlight the problems of local inhabitants related to other abiotic and biotic factors of the environment, and
- (c) to provide solution for optimal growth and attainment of balance between use and replenishment of resources.

There is ample need to stress on these issues and problems of ecodevelopment especially with reference to the environmental conditions prevailing in the hill areas of North-East India where human interaction with nature is intensified and is adversely affecting the rich and well-established intricate balance between man and environment. For studying the issues and problems of eco-development, the Meghalaya plateau of the North-Eastern Hill region of the country is chosen as a case study. The plateau is provided with strong geo-processes and harbours rich biological resources required for supporting a sustainable society. Despite of all favorable environmental conditions, the forests, the aquatic bodies, the wildlife, and the landuse system of the region are greatly disturbed. The Meghalaya plateau is a true representative tropical as well as sub-tropical wet forest lands of the world because it receives the highest rainfall of the world with the moderate temperature. The Cherrapunjee area is the most affected part of the plateau which is now called- 'the Tropical Wet Desert'. Denudational forces and processes of degradation accelerating in these areas are to be studied carefully for the restoration of ecosystems.

The present volume is the product of the deliberations in two workshops, namely, '**Environmental Problems of Meghalaya**' and '**Technologies for Eco-restoration for Cherrapunjee Plateau**' organised by the Centre for Eco-Development, North-Eastern Hill University, Shillong, in which the real issues and problems of environmental degradation were discussed involving the local voluntary organisations, villagers and scientists from various research organisations. We are hopeful that, through this volume, the ground realities of the eco-development problems of the hill areas of the region have been highlighted and their solutions are provided for the protection of the environment in an integrated manner. The studies included in this volume have wide applications in understanding the environmental problems and regional developmental planning particularly with reference to the hill areas of the tropical and sub-tropical lands of the world.

Place : Shillong

B.K. Tiwari

Date : 25th January 1995.

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# Landuse Patterns in Meghalaya

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## Introduction

Land is a piece of resources and the study of landuse has great significance for the proper use of land resources. The availability of land resources, natural as well as human and their potentials form the complex nature of interactions between man and nature to satisfy human needs. Land-man relationship is always influenced by various geographical factors which evolve the landuse pattern of an area or a region. Therefore, landuse characteristics are directly related to the physical attributes of land, namely, slope, relief, climatic conditions, geological structure etc. and socio-economic and cultural factors like land tenure system, size of landholdings, applicability of input factors, effects of production prices and traditional systems of farm operations. Landuse practices are also the reflection of the application of modern technology and cultural constraints of the region. For example, the landuse characteristics of the mountain areas of the world are mainly controlled by the physical factors of land, while the agriculturally dominated areas have the strong impact of techno-economic factors and thereby

landuse practices are intensified by these factors. At micro-areal level, the processes of landuse are also operated by the accessibility of market centres and transport costs (Thunen, 1933; Viser 1981, 1982).

Indeed, the term 'Landuse' refers to the use of a 'tract' which is generally defined as specific area full of resources, then question arises how man is utilising these resources. It is a fact that the landuse of Meghalaya state is the result of various physical characteristics of land and socio-economic factors. These attributes and determinents of landuse would be studied in detail.

### **Landuse in relation to Physiographic Conditions**

Meghalaya state includes an area of about 22.49 thousand sq.kms. Physiographically, it has its own identity because it is predominantly a plateau land of about 1500 metres height from the mean sea level. The altitudinal variation of the plateau ranges from 500 m to 2000 m approximately. The entire area of the state is rectangular in shape which falls between 25°10' to 26°N. latitude and 88°55' to 93°5' E. longitudes. The Meghalaya state is surrounded by the main plains, namely, the plains of the Brahmaputra valley in the North and in the East and the Bangladesh plains in the South and South-east. Thus, the Assam state is situated in the North and Eastern borders of the Meghalaya state and its Southern and South-western boundaries follow the international boundary of Bangladesh. The contour map of the state which has been prepared by Chatterjee (1968) from one million Topo Sheet, shows that entire state is hilly of which South-eastern parts have steep slope-gradients at higher altitudes of about 2000 m and have less sloppy and undulating land in the central part of the plateau called 'central table land' of Meghalaya. The Jaintia Hills of the East and the Eastern part of Khasi Hills where Shillong is situated are more undulating which follow very high gradients of surface slopes (about 70°) with the varieties of canyons, gorges and caves where natural

vegetation is dominant and most of the share of land is under forests and unproductive categories of landuses. The central table-land of the Meghalaya plateau which covers most of the parts of West Khasi Hills district has smooth topographic features of open river valleys of inter-hill-range plains of gentle slopes where most of the land is under cultivation. In fact, the Westward slopes of the central table-land (i.e. Garo Hills) where eroded hill-tops and wide river valleys can be seen at an average altitude of 1500 m, are used for grazing activity and a significant part of the land is under cultivable waste (Fig. - 8.1).

Intensity and extent of forest land are directly related to topographic features and climatic conditions. In fact, pine forests are mainly found above 1000 m altitudes where the annual temperature ranges from 0°C in winter to 27°C in summer months with the normal rainfall of about 450 mm mostly occurring in summers (Table - 8.1). The central table-land which includes most of the area of East and West Khasi Hills districts is covered by the pine forests. On account of high rainfall with a moderately high temperature in the Southern and Western parts of the Meghalaya, vegetation of these areas comprising most of parts of Garo Hills district and the Southern parts of East and West Khasi Hills districts, is temperate with the mixed forest of hard woods and tall grasses. The area under reserved and protected forests is only 8.5 per cent of the total forest area, however, map of vegetation and forest types also establishes the relationship of forest areas with the altitude of the places. In fact, the reserved forests are situated mostly on the slopes of the main river valleys, while the areas of pine forests are found particularly on the main central table-land which is above 1000 m of altitudes.

The causes of the prevalence of high percentages of cultivable waste and unproductive barren lands are mainly tremendous soil erosion which occurs on the hill-tops and hill-slopes because of deforestation and land clearing for

shifting cultivation (Rai and Panda 1983); these being socio-economic causes of land degradation. But the rate of soil erosion and land degradation is direct result of geomorphic features which are the main attributes of the physical characteristics of land. Another attribute is related to climatic conditions, that is the quantity of water run off. With the help of geomorphic characteristics of the mountain land of Ethiopia, Chandra Bhan (1988) calculated the potential soil erosion risk and asserted that the main faces of hill slopes determine the rate of soil erosion and landuse types. Crusts of hill tops (waxing slopes) which are prominent in the upper parts of

**Table-8.1: Monthly Mean Temperature and Normal Rainfall, Shillong.**

Months	Temperature (°C)		Rainfall (in mm)
	Maxi	Mini	
January	15.5	3.6	25.1
February	17.1	6.4	32.2
March	21.5	10.5	74.0
April	23.8	14.1	179.2
May	23.7	15.5	385.0
June	23.7	17.4	463.1
July	24.1	18.1	416.0
August	24.1	17.8	343.7
September	23.6	16.6	268.2
October	21.8	12.9	135.1
November	18.9	7.7	28.6
December	16.4	4.5	9.9

N.B. : Normal Rainfall figures are the 30 years average for whole of Meghalaya state.

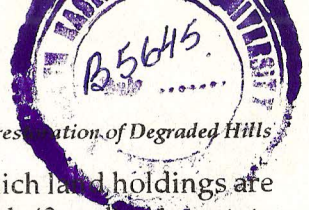
Source : Temperature figures are taken from Rai and Panda (1983).



Shillong ranges follow the varieties of landuse at different altitudes. Most of the upper parts of the hill-top crust (where convex slopes are markable) is covered by pine forests. While the free-face eroded surface of steep slopes of the Southern parts of Shillong ranges have the major share of its landuse under unproductive barren lands because of the erosion of surface soils. On the debris slopes of the parts of Meghalaya plateau near Shillong which receive the weathered rock material derived from free-face of steep slopes, maize, potato and vegetables are predominantly grown (Rai and Panda 1983). The lower river valleys which have the concave slope called pediments are important for paddy cultivation. The central part of the Meghalaya plateau and the Garo Hills district are the noticeable areas where paddy cultivation is prominent. Rainfall and temperature are also significant factors for the growth of agriculture and the increase of crop-yield. Thus, the cropping pattern of Meghalaya state is dominated by monoculture of paddy. It is also noticeable that in the deep 'V' shape valleys of Upper Shillong Ranges, maize and potato are grown in abundance. It is due to the impact of Shillong city where the potato consumption is higher than the other parts of the state. Details of the landuse characteristics in relation to socio-economic attribute are given separately in the following heads.

### **Landuse in relation to Socio-Economic Conditions**

The social characteristics embrace several sub-variables which have a great impact on the landuse types. These include the system of land tenure, size of land holdings and the level of cultural development (Vink 1975). The systems of land tenure include: (a) common systems which are operated under tribal or traditional communal forms of tenure, (b) tenancy system which is operated by tenants in exchange for services or by the share-cropping, (c) owner-operator under which land is used by land owner, (d) fixed rent tenancy, (e)



co-operative holding system under which land holdings are operated by profit organisations, and (f) collective state holdings which are operated by the group of working people collectively (Kostrowicky 1972). Further, landuse is also influenced by various economic factors. Demand of the goods and prices of production are main factors. For example, in spite of sharp topographic features and steep slopes of the river valleys around Shillong city, the crops like vegetables, potato and even maize are grown on commercial basis because of increasing demand of these crop-products in the Shillong urban area. These factors can be interpreted side-by-side in the study of general landuse of Meghalaya state.

### Landuse Characteristics

According to the standard classification of landuse which is based on the guidelines of the Ministry of Agriculture and Co-operation, Government of India, New Delhi, the total reporting land is broadly categorised into four categories : (i) Forests, (ii) Land not available for cultivation, (iii) Uncultivated land excluding fallow land and (iv) the Net Area Sown. These categories have been divided into 9 sub- categories which give the detail picture of landuse of the area. Land under various categories and its changing patterns for the Meghalaya state are given in Table- 8.2 & Fig.- 8.2. The impact of socio economic factors on the landuse characteristics of the Meghalaya state is visualised by studying the main landuse categories.

**(A) Land Under Forests :** It is the most significant category of landuse which accounts for more than one- third share of the total reporting area of Meghalaya state (Table- 8.2). Land under forests was recorded 740 thousand hectare in 1972-73. It was 32.90 per cent of the total area in 1972-73. It is noticeable that it has increased by 3.10 per cent from 740 to 810 thousand hactare during the last 15 years (1972-73 to 1987-88). The reasons behind an increase of forest area in the Meghalaya are as follows :

Table- 8.2 : Changing Patterns of Landuse in Meghalaya

Landuse Categories	1972-73		1987-88		Change %
	Area	%	Area	%	
1. Forests	740	32.90	810	36.0	3.10
2. Area put to non-agricultural uses	50	2.22	90	4.0	1.78
3. Barren & Uncultivable Land	216	9.60	230	10.0	0.40
4. Permanent Pastures & Grazing Land	54	2.40	20	0.90	-1.50
5. Land Under Misc., Tree, Crops & Groves	76	3.38	150	6.7	3.32
6. Cultivable Waste	650	28.90	450	20.0	-8.90
7. Old Fallow	252	11.20	260	11.6	0.40
8. Current Fallow	49	2.18	50	2.2	0.02
9. Net Area Sown	164	7.29	190	8.4	1.11
Total Reporting Area	2249	100.00		100.00	-

Source : Directorate of Eco. & Stat., M. O. A. & I., GOI, New Delhi.

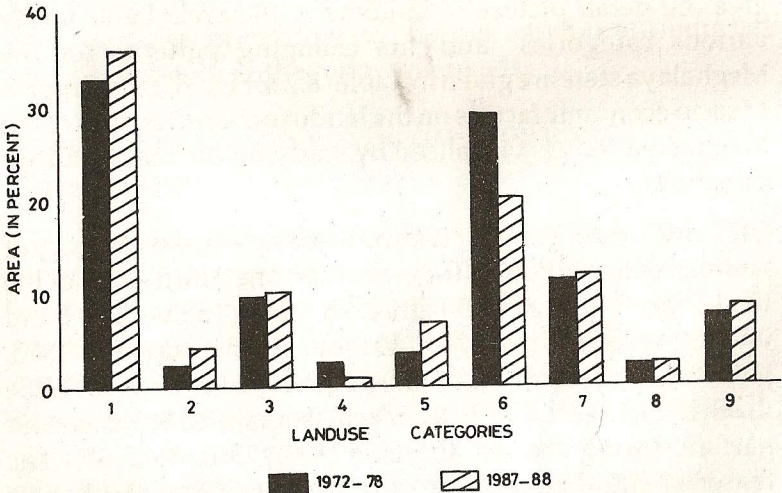


Fig.-8.2 : Changing Landuse Patterns in Meghalaya.

(1) In spite of more than 90 per cent forest area being under individual tenancy system as recorded unclassified category according to legal status of forests (Table-8.3), the forest area has been increased by 3.1 per cent during 1972-73 to 1987-88. It can be because of general awareness regarding the importance and utility of the forests which is persuaded by the government under the national forest policies. People of the state are aware of the programmes related to social forestry and hence, land under tree crops and groves has also been increased by 3.3 per cent over the last 15 years.

**Table- 8.3 : Area Under Forest According to their Legal Status (1984-85).**

	Area (000 ha)	%
Reserved Forests	70.6	8.29
Protected Forests	1.6	0.19
Unclassified Forests	779.2	91.52
<b>Total Forest</b>	<b>851.4</b>	<b>100.00</b>

Source : Basic Statistics of N.E. Region 1987, Published by NEC, Shillong.

(2) Indeed, the tribal people are very much fond of the Orchards and Greenaries. They generally maintain kitchen-gardens and tiny plants. As a result, the land under vegetables and groves has increased in the last few years. One of the most important reasons behind increasing land under tree-crops is the increasing demand of the fruits and vegetables. It is a fact that, in the Meghalaya state, the flat land available for cultivation is very less because of hilly topography. Therefore, tree-crops are predominant on the sloppy terrain on which the farmers are practising terrace cultivation.

(3) The decrease in area under shifting cultivation also has a direct impact on the increase of forest land in the Meghalaya

plateau. It is interesting to note that the relief features have a positive relationship with the distribution of the types of forest areas. For example, the areas above 1000 m altitude from mean sea level have pine forests. Therefore, entire parts of the central plateau which includes most of the parts of East and West Khasi Hills districts have pine dominated forests. In the valleys of the main rivers, generally in the upper valley areas of Someswari, Dudhnain Umkhri, Umiam and Kopili rivers, the reserved forest areas are markable, although they have only 8.29 per cent share (70.6 thousand hectare) to the total forest area of the state. On the steep slopes of the main rivers, mainly mixed temperate forests are found.

**(B) Area Put to No-Agricultural Uses :** On account of increasing land under settlements, the area under this category has increased from 50 to 90 thousand hectare in the state during the last 15 years of period. The processes of settlement expansion specially in the urban areas increase the land under non-agricultural uses. In fact, the townships like Tura, Nongstoin, Cherrapunjee, Jowai and even larger villages are in the process of fast population growth and areal expansion. Thus, the area under this category of landuse has increased by 2 per cent.

**(C) Land Under Cultivable Waste :** General landuse table shows that area under cultivable waste and barren land has decreased by 8.0 per cent from 650 to 450 thousand hectare during the last 15 years. It is noticeable that a significant share of land i.e., 29.0 per cent, is under this category. However, it has reduced significantly. It is due to conversion of waste land into forest area ; in some parts of the state, it has been converted into terrace-cultivation.

**(D) Cultivated Land :** It includes Net Area Sown and fallow land (other than current and current fallow). Marginal increase of 1.11 per cent may be observed in Net Area Sown. It was only 164 thousand hectare in 1972-73 which has increased upto 190 thousand hectares during the last 15 years. The percentage share of cultivated land is very less on

account of physiographic constraints. Going through Table-8.4 which shows the changing cropping patterns, it can be said that paddy is the dominant crop of the state which occupies more than 54 per cent share of the total Gross Cropped Area. The intensive paddy cultivation is practised twice even thrice in a year in the river valleys and on the hill slope terraces. Coarse cereals have the second place in the cropping pattern. There is a marginal decrease in the paddy crop area. In general, it can be said that the cropping patterns of Meghalaya state have not undergone significant changes in its character.

Size of operational land holdings and the system of land tenancy are the main reasons behind the crop dominance and constant cropping patterns. According to Agriculture Census 1970-71 and also 1980-81, the area under various size land holdings was 252.8 thousand hectares (11.24 per cent) in 1970-71 which has increased upto 296.0 thousand hectare in the 1970's. It might be because of increasing area under cultivated land. It is interesting to note that more than 57 per cent of the total land under various size of land holdings was under 1.0 to 3.0 hectare of operational land holding size in 1970-71 which has been reduced to 45 percent during 1970-71 to 1980-81 (Table-8.5, Fig.-8.3). It indicates that concentration of the land holding was towards medium size of 1-3 hectare in 1970-71 which has been diversified towards small sizes (below 1 ha.) and towards larger sizes (above 4.0 ha.). It means that the socio-economic gaps among the Meghalaya farmers are also widening because farming is the main activity of the rural people and land size variations diversify it. The second social characteristic of land use is associated with tenancy status of land. It is obvious from the Agricultural Statistics 1970-71 that more than two-third area of the various land holding sizes are being operated by the wholly owned and self-operated tenancy system. Only 17.44 per cent area of the various operational land holding sizes is under operation of rent tenancy system (Table-8.6).

Table- 8.4 : Changes in Cropping Patterns in Meghalaya.

(Area in 000 ha)

Crops	1971-72		1979-80		1987-88	
	Area	%	Area	%	Area	%
Autumn Rice	37.7	-	30.5	-	-	-
Winter Rice	59.9	-	70.1	-	-	-
Summer Rice	0.9	-	1.6	-	-	-
Total Rice	98.5	54.12	102.2	50.34	110.0	50.0
Wheat	0.3	0.16	2.0	0.98	10.0	4.5
Coarse Cereals (Maize & Small Millets)	16.6	9.12	18.4	9.06	20.1	9.1
Pulses	1.4	0.77	2.5	1.23	NA	NA
Oilseeds	5.5	3.02	7.9	3.89	10.0	4.6
Fibres (Cotton, Mesta & Jute)	7.47	13.2	6.50	20.1	9.1	
Other Crops (Including Potato)	14.9	8.19	22.3	10.98	50.2	22.7
Gross Cropped Cereals	182.0	-	203.0	-	220.0	-
<b>Crop Intensity</b>	<b>110.97</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>115.80</b>	

N.B. : NA - data not available

Source : Directorate of Economics and Statistics, Ministry of Agriculture &amp; Irrigation (now Co-operation), Govt. of India, New Delhi.

**Table-8.5 : Area Under Various Operational Size of Land Holdings (1970-71 and 1980-81).**

(Area in ha)

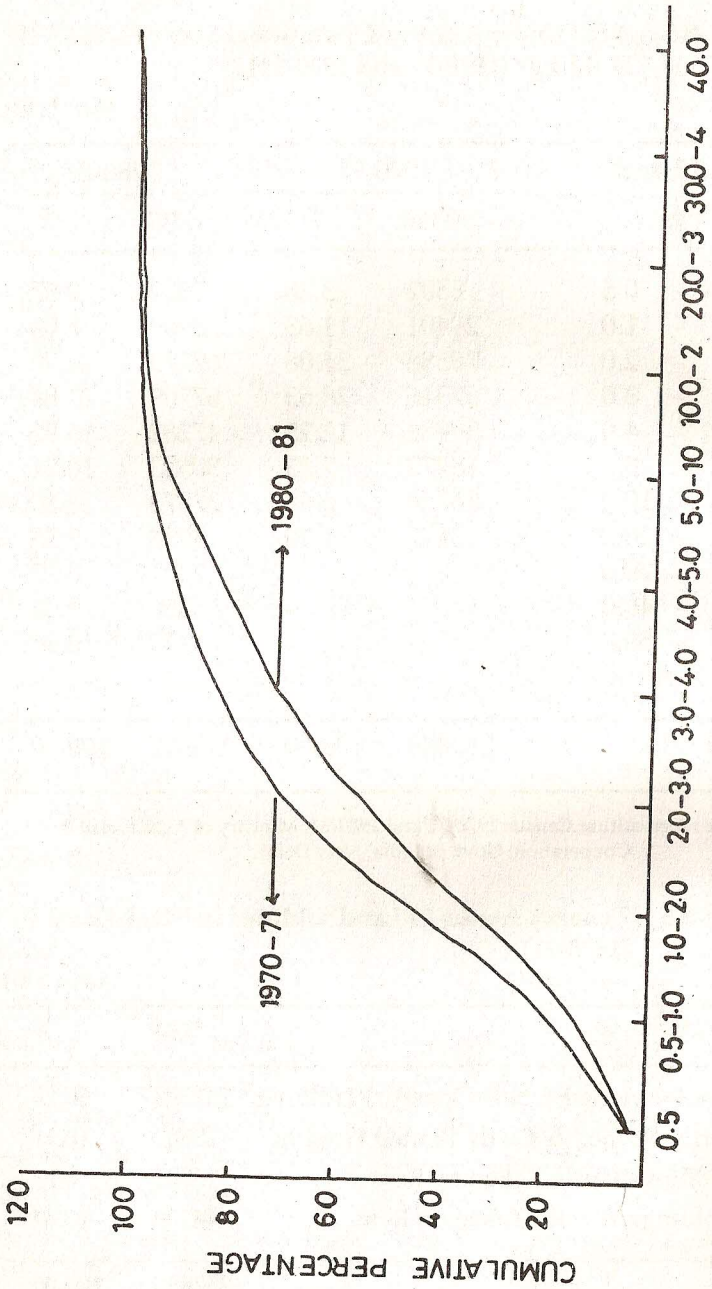
Size of Land Holding	1970-71		1980-81	
	Area	%	Area	%
below - 0.5	8302	3.28	7622	2.57
0.5 - 1.0	29401	11.63	23909	8.08
1.0 - 2.0	78588	31.08	67773	22.90
2.0 - 3.0	67346	26.63	67709	22.88
3.0 - 4.0	30986	12.25	47282	15.97
4.0 - 5.0	18272	7.23	30523	10.31
5.0 - 10.0	16764	6.63	37873	12.80
10.0 - 20.0	3197	1.26	9998	3.38
20.0 - 30.0	-	-	2291	0.77
30.0 - 40.0	-	-	256	0.08
40.0 - 50.0	-	-	725	0.24
50.0 -Above	-	-	-	-
<b>Total</b>	<b>252856</b>	<b>100.00</b>	<b>295961</b>	<b>100.00</b>

Source : Agriculture Census 1970-71 and 1980-81, Ministry of Agriculture & Cooperation, Govt. of India, New Delhi.

**Table-8.6 : Tenancy Status of Landholdings in Meghalaya (1970-71).**

(Area in ha)

Tenancy Status	Area	%
1. Wholly owned & Self-Operated Holding	167393	66.20
2. Partly Owned & Partly Rented Holding	25562	10.11
3. Holdings Partly Taken on Rent	15801	6.25
4. Holdings Wholly Taken on Rent	44100	17.44
<b>Total</b>	<b>252856</b>	<b>100.00</b>



SIZE OF LAND HOLDINGS (Hectare)

Fig. - 8.3 : Size of Operational Landholdings in Meghalaya.

The rental payment system of these land holdings is traditional; rent is paid in the form of giving share of land products (Table-8.7). On account of traditional tenancy system of land operation, the crop intensity is low. It was only 1110.93 per cent in Meghalaya in 1972-73. The fixed money of land rent payments may be the effective tradition for raising crop yield and farm efficiency of landuse, because the farmers who will occupy land on fixed money rent-lease would use the land in efficient manner.

**Table- 8.7 : Terms on Which Holdings are Wholly Taken on Rent (1970-71)**

Rent Terms	(Area in ha)	
	Area	%
1. Fixed Money	2253	5.11
2. Fixed Produce	2343	5.31
3. Share of Produce	6519	14.78
4. Other Terms	32985	74.80
<b>Total</b>	<b>44100</b>	<b>100.00</b>

In the end, it can be concluded from the above discussion that the landuse of the Meghalaya state is being directly influenced by various physical characteristics of land. But at micro areal processes, the social traditions and economic factors like increasing demands for agricultural products and production prices also play significant role in determining the landuse characteristics.

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