

**STUDY ON THE WEED FLORA OF AGRICULTURAL LANDS  
AND FISHERY TANKS OF MEGHALAYA**

*By*

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Submitted in fulfilment of the requirement of the  
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I certify that the thesis entitled "Study on the Weed Flora of Agricultural Lands and Fishery Tanks of Meghalaya" submitted by Bhaskar Neogi for the Degree of Doctor of Philosophy of the North-Eastern Hill University, Shillong, embodies the record of original investigation carried out by him under my supervision. He has been duly registered and the thesis presented is worthy of being considered for the Award of the Ph.D. Degree. This work has not been submitted for any Degree of any other University.

Date: 26.5.80  
Place: Shillong

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*Bhaskar Neogi*  
BHASKAR NEOGI

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Section I

INTRODUCTORY

According to etymological studies the word 'weed' comes from Middle English and has Flemish, Frisian and Anglo-Saxon roots. The word appears in English literature since the beginning of the 9th Century (Harlon and deWet, 1965).

Weeds have been defined variously by different authors and as many as 22 different definitions of weeds have been listed (cf. Harlon and deWet, 1965). The most appropriate definition of weeds, however, seems to be "undesirable, generally obnoxious plants which grow in places where they are not wanted." Weeds are important not only because they are undesirable and obnoxious, but also because some of them act as alternate hosts in carrying various fungal and viral pathogens, which cause diseases in crop plants.

It is seen that all weeds are not unwanted; for example, in rangeland areas many annual grasses, which we consider as weeds, growing among rows of crops, are useful as animal feed. They serve as food and shelter for wild life, reduce erosion in non-crop areas, are useful for medicinal purposes, and have been and continue to be used as food by man. It is quite likely that a weed of today may become a crop plant of tomorrow. An attempt, therefore, is made here to discuss some of the beneficial aspects of weeds.

Meghalaya, one of the richest and most interesting floristic regions of India is still botanically incompletely known. The only regional account of the flora is that of Kanjilal et al (1934-'40) which is, however, incomplete, and dealing mainly with the woody forest species. The monocotyledonous plants of the region (except Poaceae by N.L. Bor, 1940) have not been studied so far. Further, there is a conspicuous lacuna in the knowledge of weed flora of the region.

Moreover, the weed problem in Meghalaya is very much pronounced because of the primitive types of agricultural practices, coupled with the hilly terrain. These factors have greatly influenced the introduction and spreading of many foreign weeds in the region.

Therefore, in the present study an attempt has been made to bring out a comprehensive account of the weed flora of Meghalaya with emphasis on phenology, distribution, local names, habitats, etc., of weed species.

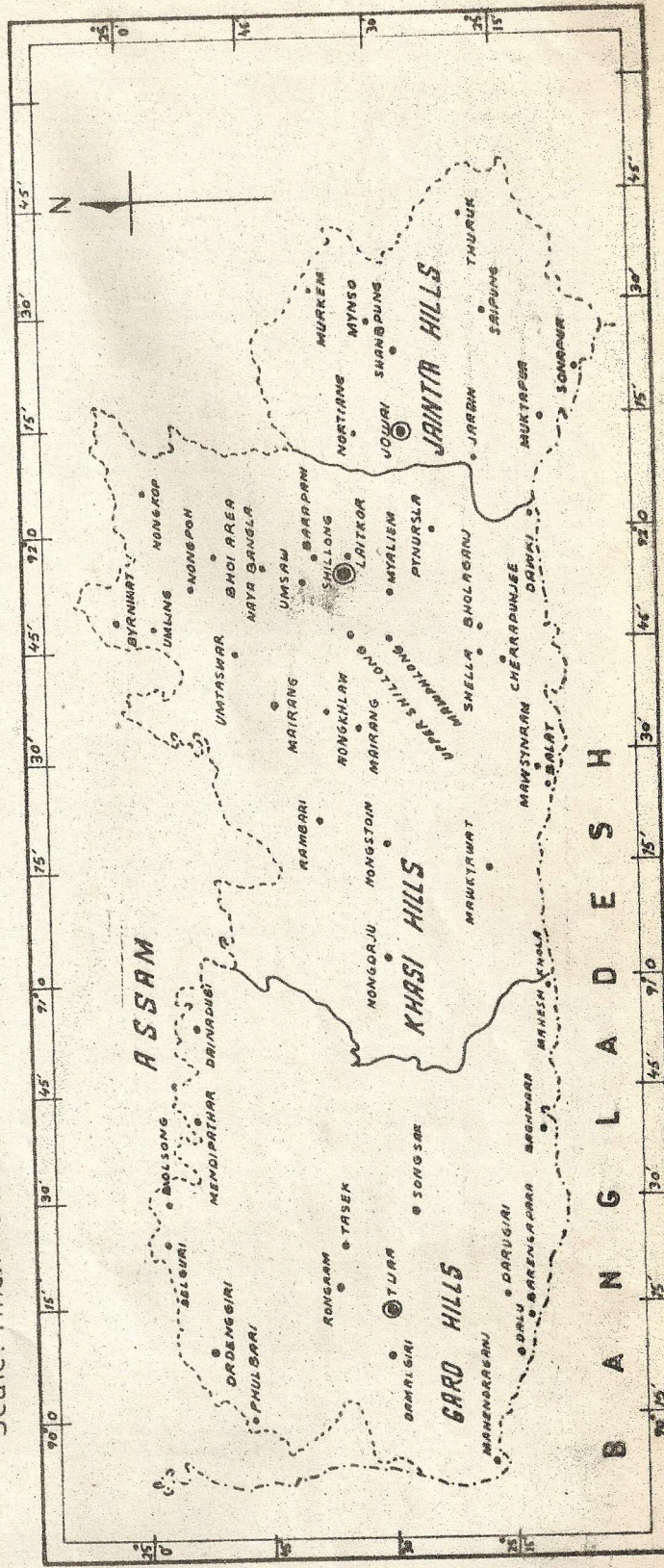
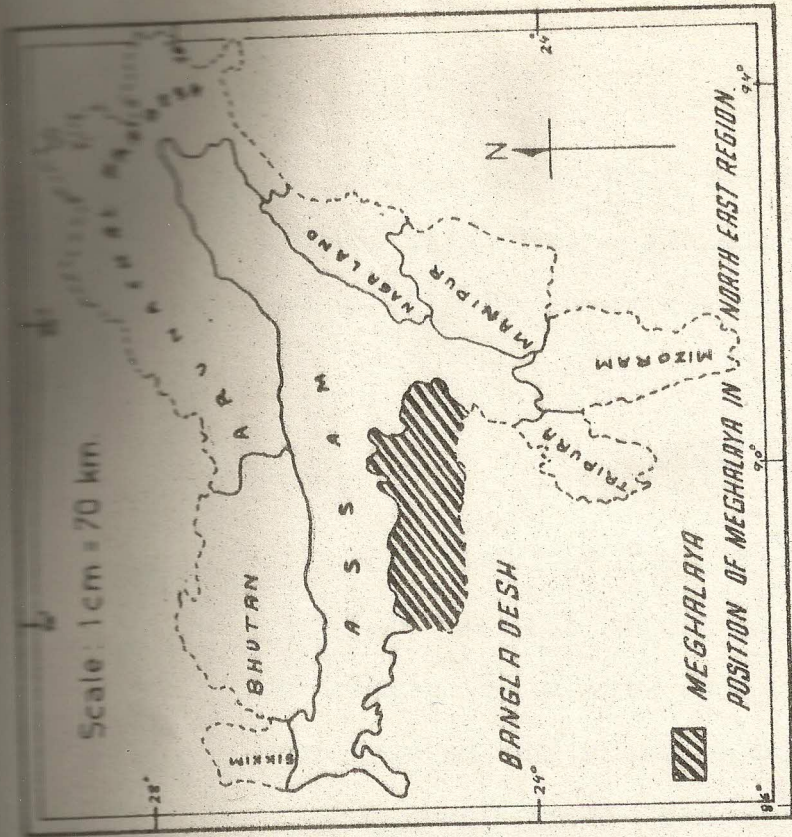
For convenience the thesis has been presented under eight different sections, viz. (i) Introductory, (ii) Review of Literature and Present Study, (iii) General Account of Weeds, (iv) Seasonal Variation and Phenological Pattern, (v) Introduced Weeds, (vi) Useful Weeds, (vii) Taxonomic Treatment, and (viii) Bibliography and Index.

MAP OF MEGHALAYA SHOWING  
LOCALITIES OF PLANT COLLECTION AND  
STUDIES

REFERENCES

- International boundary - - - - -
- State boundary - - - - -
- District boundary ———
- District Hq. ●

Scale: 1 inch = 8 miles.



It is hoped that the information contained in the thesis will form a nucleus for further studies regarding weed crop interactions, control measures, etc.

#### AREA OF STUDY

The State of Meghalaya comprising of Garo, Khasi and Jaintia Hill districts, which earlier formed part of Assam, came into existence on 19th January, 1972. The area of the state as of date is 22,549 sq. km. It lies between 25°47' and 26°10' North latitude and 89°45' and 92°47' East longitude. It is bordered on the north-west, north-east, and south-east by the State of Assam and to the south-west by Bangladesh (Fig. 1). The State presents a picturesque landscape of plateaus, ravines, brooks, rivulets, lakes and waterfalls. The altitude varies from 600 to 1950 m, with the highest peak, known as the Shillong Peak, lying in the Shillong plateau of Khasi Hills.

#### PHYSIOGRAPHY AND DRAINAGE PATTERN

The physiographic characteristic of the region is remarkable due to the highly dissected and irregular terrain in the western and northern faces, in contrast to the regular and steep fall of the southern face to Barrak. The interesting physiographic feature in the

north is that the boundary of the plateau is not well defined.

Physiographically, Meghalaya represents a remnant of an ancient plateau of the precambrian Indian peninsular shield, the block uplifted to its present height. The kernel of the plateau is the exposed Archæangneisses and schists covered in the central and eastern parts by precambrian quartzites and phyllites.

The ancient peneplaned surface of the plateau is still preserved with marks of different cycles of denudation in the central and northern parts; it is hidden beneath the mesozoic traps along the central southern fringe, and cretaceous-tertiary and post-tertiary sediments over the southern, south-eastern and south-western parts. The plateau, standing as a watershed between the Surma valley of Bangladesh on the South and the Brahmaputra valley on the north, is dissected by several rivers and a network of their tributaries and lateral streams.

The western part, i.e. Garo Hills is an extensively dissected tract with an average elevation of 600 m or less. The most important physiographic features of Garo Hills are the Tura range and Simsang valley. The Tura range runs almost through the centre of Garo Hills due to east-west extension from Tura town to Siju.

The drainage pattern in the region represents a most spectacular feature revealing extraordinary straight courses of rivers and streams, evidently along joints and faults. The magnificent gorges scooped out by the rivers in the southern Khasi and Jaintia Hills are the result of massive headward erosion by antecedent streams, along joints and sedimentary rocks over the block experiencing relatively greater uplift. Westward, in the Garo Hills, the consequent streams are mostly controlled by the structural faults and monoclines in the sedimentary rocks. The northern part of the plateau devoid of any sedimentary cover is marked by a long incisive valley, formed due to headward erosion along joints in the gneissic rock and granites. The limestone-covered country over the southern Garo, Khasi and Jaintia Hills represents a typical karst topography. The present physiographic configuration of the plateau was attained through different geological events since the mesozoic period to the present day as indicated by the polycyclic erosional surfaces at various levels.

#### GEOLOGY AND SOIL

The state of Meghalaya comprising three districts viz. Garo Hills, Khasi Hills and Jaintia Hills, is occupied by (a) Archaean gneissic complexes with acid and basic intrusives (b) Shillong Groups of rocks (c) Lower Gondwana rocks (d) Sylhet traps and (e) Cretaceous-tertiary sediments.

The Archaean gneissic complex is exposed in the central and northern parts of Meghalaya. They comprise mainly biotite gneiss, biotite granulite, amphibolite, calc-granulite banded magnetite quartzite, sapphirine-cordierite granulite, magnetite-grunerite, granulite, quartz-demeritierite-tourmaline schist, etc. Some of the schistose rocks comprising bilite-schist, quartz-sillimanite schist, metabasite, biotite-cordierite granulite, red schist, etc., occur as detached remnants over the older gneissic complex around Sonaphar. Possible unconformity has recently been postulated between these two groups of rocks.

The mafic rocks within the Archaean, include (a) orthoamphibolite and (b) meta-dolerite and meta-pyroxenite. They show mostly concordant and partly discordant relationship with the associated gneisses.

The Shillong groups of rocks comprising quartzite, usually friable, with subordinate phyllite, quartz-sericite schist, conglomerate, etc., are exposed in the central and eastern parts of the Meghalaya plateau. Current bedding is commonly noticed in these rocks. Rocks of these groups rest unconformably over the gneissic rocks with a basal thick bed of conglomerate in the western part. These rocks generally occur in a NE-SW direction.

These rocks are intruded by ultramafic and acidic sills and dykes. The basic and ultramafic intrusives are represented by epidiorite, dolerite, amphibolite, pyroxenite, etc., which contain some specks of sulphide minerals. The lower Godwana rocks in the Garo Hills, consist of pebbles, sandstones and carbonaceous shales with streaks and layers of coal.

The Sylhet traps are of the nature of plateau (flood) Basalts, exposed in a narrow E-W strip of 80 km long and 4 km wide along the southern border of the Shillong plateau. They apparently overlie the eroded Precambrian basement and are themselves covered unconformably by the Upper Cretaceous Eocene sediments. The sediments are the lavas form a monocline, becoming a fixture southwards; and have been subsequently eroded at places exposing the traps as inliers. To the north the traps at Therriaghat are in contact with the gneisses, granites or Shillong Group of rocks along and E-W fault, termed the Raibah fault; immediately south of this fault the traps dip at  $45^{\circ}$  -  $50^{\circ}$  to the south. At the southern-most limit, they again dip at  $10^{\circ}$  -  $30^{\circ}$  along the monocline or at  $50^{\circ}$  against the Dawki fault. Laterally they plunge together with the sediments southwest along the Jadukata river; to the east, the last exposure of the Traps is seen in the Dawki river.

The Cretaceous-Tertiary Sediments occupying the southern part of the Meghalaya Plateau are thick and extensive and are considered to be physically continuous with the Cretaceous-Tertiary Sediments of the Bengal basin. These sediments are affected mostly by basement controlled faults.

The sediments are mainly sandstone and shale (mudstone), except for the three well-defined fossiliferous limestone horizons. They occur as discrete outliers in a continuous narrow belt fringing the southern margin of the state bordering the Bangladesh plains.

The oldest formation of the upper Tertiary-sediments (viz. Garo Group) is represented in Garo Hills by the Simsang formation which conformably overlies the Kopili formation without any break in sedimentation. The Simsang formation consists of cycles of massive festoon cross-bedded sand, alternating with siltstone sandstone units.

The Baghmara formation conformably overlies the Simsang formation in the eastern part of the plateau. It consists of irregular beds of coarse felspathic sand with minor mudstone streaks, pebble conglomerate, massive clay and silty clay beds, and thin alternating beds of mudstone and fine sand. Near Tura-Dalu road in Garo Hills, the entire Simsang formation shows a sharp change in facies and grades into sediments of the Baghmara formation.

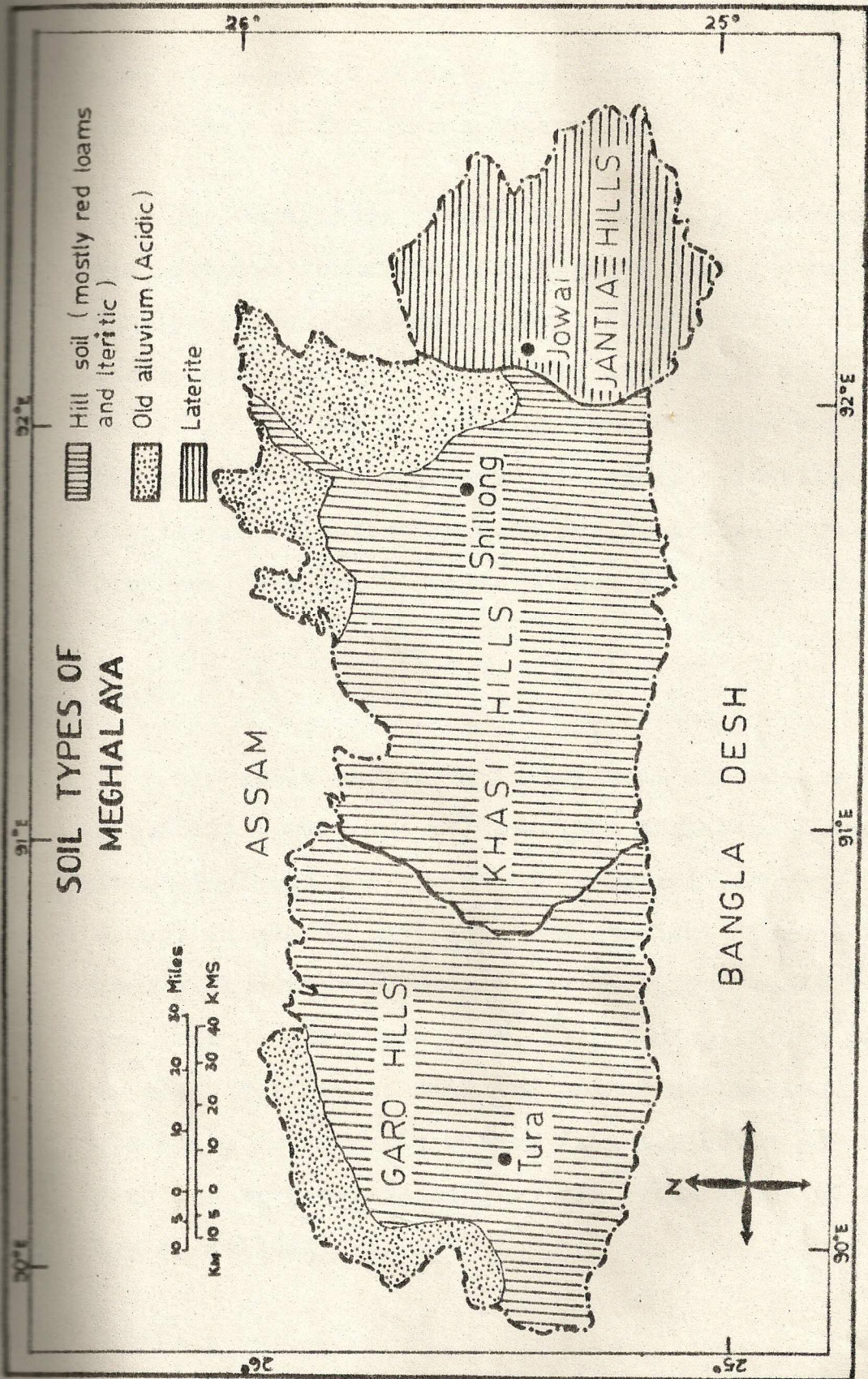


Fig. 2.

Here the Baghmara formation is actually the facies equivalent of the Simsang formation.

The Chengapara formation, overlying conformably the Baghmara formation, consists of poorly-cemented, finely-grained, micaceous sand, blue to brown siltstone and clays with a few thin marly beds at its base. At the top of the Baghmara formation and at the base of the Chengapara formation, a fossiliferous, calcareous siltstone horizon can be traced from near Baghmara to a few kilometers west of Barengapara.

#### Soils:

The soils vary both in physical characters and fertility conditions all over the Meghalaya Plateau. In most places the amount of loose soil is very scanty except in places with dense vegetation. The soils are mostly lateritic in origin and vary from sandy loam, red loam to clay loam (Fig. 2). The soils are comparatively more fertile than the upland soils since much of the bases and organic matter from top soils get washed down due to heavy rainfall. The broad types of soils are as follows:

#### Laterite Soils:

This type of soils is derived directly from the residuary basic and intermediate igneous rock produced

by weathering in hot climates. The soils are deficient in potash, phosphoric acid and lime.

This type of soil supports good crops particularly paddy.

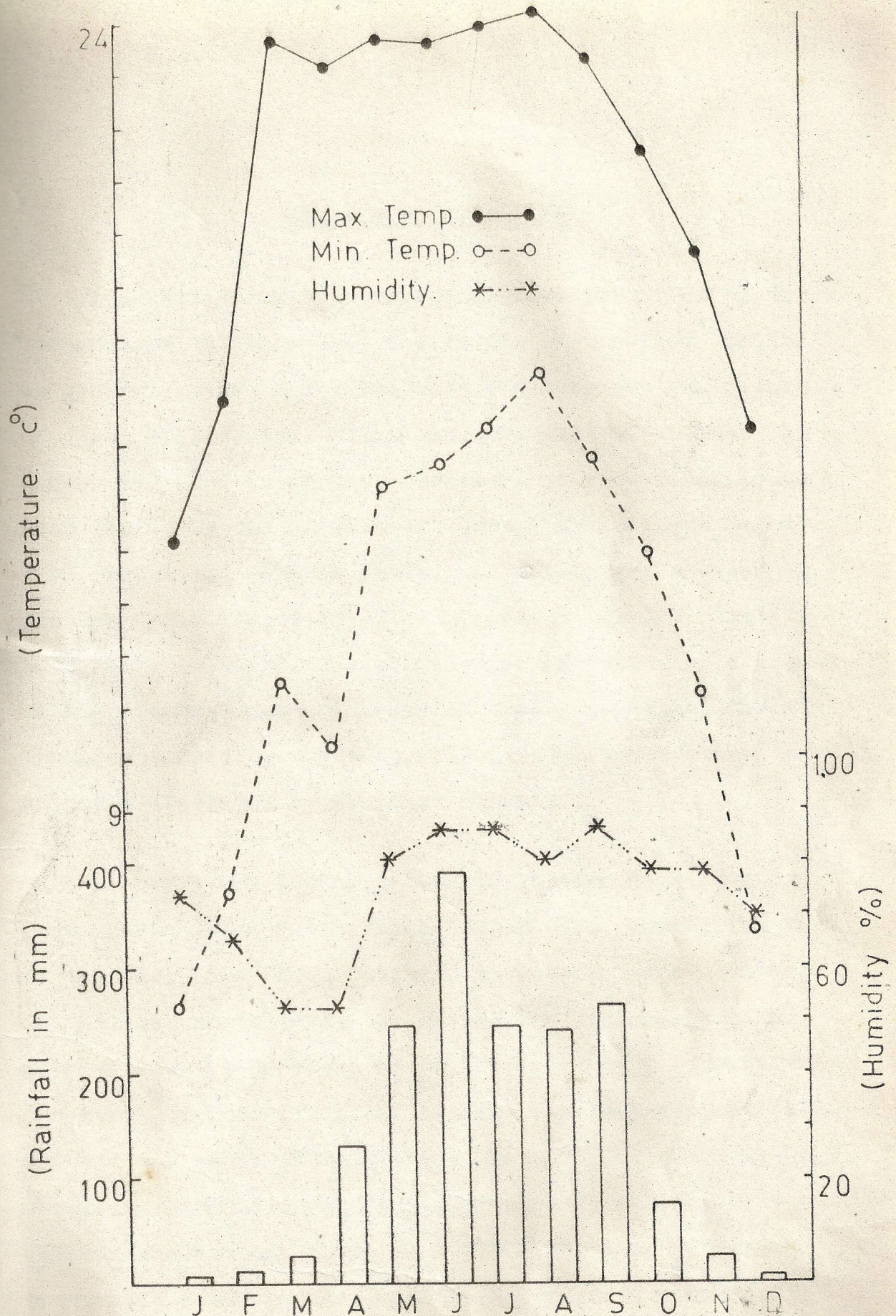
Ferruginous red soil (old or alluvium):

These soils are poor in lime, potash and iron oxide and also uniformly low in phosphorous content. They are generally poorer in nitrogen, phosphorous and humus. Throughout the range the red soils differ greatly in depth and soil fertility, which under irrigation, produce a large variety of crops. The clay portion of the red soils is rich in Kaolinitic type and is suitable for cultivation, specially for paddy, and other crops. Under irrigation a large variety of crops can be grown.

Mountain and Hill soils:

The percentage of organic carbon of the surface soil varies from 1 to 3, and the pH of the surface soil is between 4.5 - 6.5.

After terracing this soil is favourable for other plantation crops.



HYTHERGRAPH FOR MEGHALAYA (Based on averages of 1976-78)

Fig.3

CLIMATE OF MEGHALAYA

The climate of this region differs from that of the Brahmaputra valley mainly due to its high relief which, in general, makes the climate very salubrious while that of the Brahmaputra plain is comparatively warmer in summer and cool in winter. However, it is worthwhile to note that only the climate of Central and Eastern Meghalaya (Khasi and Jaintia Hills) is conducive, whereas in Western Meghalaya (Garo Hills), except for the winter (November-February), the climate is aggressive as a result of high temperature and heavy rainfall, rendering the atmosphere exceedingly steamy although the temperature is slightly moderated by abundant rainfall.

A relatively low elevation of Western Meghalaya is responsible for a fairly high temperature during the part of the year, i.e. from February to October with April as the hottest month (Fig. 3), having the mean maximum and mean minimum temperature as  $24.1^{\circ}\text{C}$  and  $17.3^{\circ}\text{C}$  respectively. The month of June shows the highest average rainfall (393 mm) and the month of July shows the second highest average temperature records for 3 years. The average annual rainfall in western Meghalaya is 2,689 mm of which more than two-thirds occur in four months (May-August). Winter is conspicuously dry with less than 50 mm in four months (November-February). The rainfall decreases from south to

north as the moisture-bearing winds strike the southern part first causing heavy downpour, while the central Tura range obstructs their path to the north. The average annual rainfall in the southeast is above 4,000 mm whereas in the north it is between 2,500 to 3,000 mm.

The climate of central and eastern Meghalaya is bracing due to the high altitude. But at the foot-hills of the southern slopes and sub-montane regions in the north and east the climate is slightly humid and warmer. In the Shillong region the temperature goes down to about 5.2°C, in winter and seldom rises above 26°C in any part of the year. During mid winter (December-January) one usually experiences heavy frost in the Shillong plateau although snowfall is not experienced in the area. The most interesting climatic feature of this region is the very high rainfall with an average annual of 7,196 mm which distinguishes it climatically from the other parts of Meghalaya. However, there is great variation of rainfall within this region from South to North. This is primarily because the higher part, i.e. the central upland zone having an E-W alignment renders a rainshadow effect on the areas lying to the north. Consequently, the rainfall in Cherrapunji which is located in the structural plateau on the south is as high as 12,033 mm, while Shillong being located only 50 km to the north with a rainshadow

effect gets only 2,296 mm. Mawsynram, a village situated on the same plateau as Cherrapunji, about 16 km to the west records the highest rainfall in the world with 13,923 mm (based on the recent average). The highest rainfall in Cherrapunji and Mawsynram region is due to the fact that southwest monsoon laden clouds with great amount of moisture from the Bay of Bengal blows over Bangladesh and is suddenly cut by the cliff of the tableland in the south with an average elevation above 1,200 m and as a result the monsoon having reached the heads of the gorges ascends vertically upwards and causes very heavy rainfall. Jowai which is located on the ridge of the eastern section of the central upland receives greater amount of rainfall than Shillong with 3,077 mm as it does not experience a rainshadow effect. This figure however is much below the average for Khasi and Jaintia Hills mainly due to the high rainfall figures in Mawsynram - Cherrapunji region (12,000 to 13,000 mm). The rainfall decreases further north due to significant rainshadow effect and as such the northern slopes experience 1,270 mm to 2,032 rainfall.

The meteorological data for Meghalaya for the years 1976-78 are produced in the tables 1-3, which gives a clear picture of the climate of the area in general.\*

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\* The climatic data charts have been provided by the Meteorological Office, Shillong, and their use in this study is gratefully acknowledged.

Table - 1

TEMPERATURE (°C) RECORD FOR MEGHALAYA

	1976		1977		1978		AVERAGE	
	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.
JANUARY	14.0	5.0	15.1	5.4	13.4	4.5	14.1	5.2
FEBRUARY	17.0	7.9	17.9	7.8	15.2	6.8	16.8	7.5
MARCH	22.4	11.8	23.4	12.6	21.3	10.3	23.6	11.5
APRIL	24.1	14.5	21.7	12.7	23.8	13.0	23.1	10.06
MAY	22.9	14.8	21.9	14.2	23.1	16.6	23.6	15.2
JUNE	22.1	16.6	23.0	16.6	22.4	13.6	23.5	15.6
JULY	23.5	17.3	24.2	18.1	23.8	13.2	23.8	16.2
AUGUST	23.1	17.1	24.3	17.7	25.0	18.3	24.01	17.3
SEPTEMBER	23.6	13.9	23.0	16.6	23.1	16.6	23.2	15.7
OCTOBER	21.3	13.3	20.7	13.2	22.4	15.2	21.4	13.9
NOVEMBER	18.6	10.9	18.5	12.1	18.5	10.3	18.5	11.1
DECEMBER	15.5	6.5	15.1	6.7	17.8	17.4	16.1	6.8

Table - 2

RAINFALL (mm) DATA FOR MEGHALAYA

	1976	1977	1978	Average
JANUARY	20.9	1.4	00.0	7.4
FEBRUARY	12.2	2.3	17.7	10.7
MARCH	9.2	44.2	34.9	29.4
APRIL	45.2	266.5	84.4	132.02
MAY	211.0	453.4	208.3	290.09
JUNE	408.2	310.7	460.1	393.00
JULY	322.0	270.0	245.2	245.7
AUGUST	215.1	319.8	193.0	242.6
SEPTEMBER	158.5	279.4	246.4	268.15
OCTOBER	53.0	127.4	50.6	77.0
NOVEMBER	3.6	50.3	20.4	24.7
DECEMBER	0.2	25.0	00.0	8.4

Table - 3

MONTHLY MEAN RELATIVE HUMIDITY (%) FOR MEGHALAYA

	1976		1977		1978		AVERAGE
	HOURS		HOURS		HOURS		
	08.30	17.30	08.30	17.30	08.30	17.30	
JANUARY	69	85	60	83	60	88	74.1
FEBRUARY	63	72	57	72	52	79	65.8
MARCH	48	60	51	63	49	52	53.3
APRIL	55	64	77	82	57	37	62.0
MAY	71	81	77	87	79	86	80.1
JUNE	87	89	86	85	84	88	86.5
JULY	85	87	87	88	86	88	86.5
AUGUST	81	88	85	88	82	86	85.0
SEPTEMBER	79	88	76	91	86	91	86.8
OCTOBER	63	87	72	90	70	90	78.5
NOVEMBER	75	88	71	90	64	85	78.5
DECEMBER	60	90	60	88	40	84	73.3

HISTORICAL ACCOUNT OF THE REGIONS

There is no integrated historical account of the Region, since it is occupied by different tribal groups which have till recently lived in physical isolation and have no script of their own. However, there are some references about them in 'Buranjis' of the Ahoms chronicles supplemented particularly on the Khasis, Jaintias, Mikirs and Kacharis, which provide some evidence of occupation of its northern fringe even before the Christian era. There is no evidence of prehistoric settlement of the region except for the recent claim by some scholars that the Rongram Valley of the Garo Hills was inhabited in the paleolithic times, based on their findings in the Daojali excavation site of the said valley.

Historical accounts suggest that there were waves of immigrants into north-eastern India through the north-eastern routes and these immigrants were rather invaders who belonged to the 'Indo-chinese linguistic family' of which two most important sub-families are the 'Mon Khmer' and 'Tibeto Burman'.

The 'Mon Khmer' which constitutes the Khasis and Jaintias was driven by subsequent 'Tibeto Burman' invaders into the Khasi Hills which is the only part of north-eastern India where there were four groups namely Naga,

Kuki, Chin and Bodo. The Nagas and the Kukis were driven into the hills in the north-east and the Bodos dominated the plains, the Garo Hills and the North Cachar Hills. It is said that the Garos and the Kacharis originally belonged to one tribe, and subsequently separated into two - the Kacharis on the north bank, and the Garos over the south bank of the river Brahmaputra.

As regards the history of the Garos, practically nothing is known. They are still primitive. Till recently they have been carrying on raids on the people of neighbouring areas. The history of the Khasis and the Jaintias may be traced from the early part of the 18th Century only, because prior to this, there is no record of the tradition that they owed allegiance to a single prince. After studying the etymological aspect of the name Khasi it gives an idea that 'Kha' means water course in a river or a lake or a spring and 'Chai' also means blood, and 'chai-kha' or 'kha-chai' means bloody water. The people living by the side of the spring from which reddish water oozed out were the 'Kha-chais' and they were later known as Khasias or Khasis. When they first emerged from obscurity, they were split into numerous communities each under its own head. The most well-known in the 16th and 18th Centuries are the Jaintia Raja (Kiang) and to some extent the Raja or Chief (Syiem) of Khyrim in the Khasi Hills. The Khasis previously had been regarded as troublesome plunderers upon the plains of Sylhet. A line

of forts was kept along the hills to check their intrusions. The Khasi Hills came under the British in 1883 with the submission of the last of the important Syiems, Tirot Singh. The Khasis were a religious sect, looking after the holy shrine, while the Jaintias were the ruling class and therefore the chief or headman or Rajah was selected from the Jaintias. The post of headman over a group was elective, whereas the post of Rajah was hereditary.

The people coming from China, the homeland of paddy or 'zuh', introduced the cultivation of paddy for the first time in this part of India. They, however, continued the practice of cultivating ~~arum~~ roots, tumeric, etc., by digging up the land with a pointed iron implement like a hoe called the 'Mohkhiew' and this type of cultivation, known as 'Zuh-Moh' or jhum cultivation, is prevalent even today in most parts of Meghalaya. The rice beer which these people used as an invigorating drink also was known as the Zuh meaning the heavenly drink.

MAP OF MEGHALAYA SHOWING THE CULTIVATED AREAS OF VARIOUS CROPS

0 1 2 miles

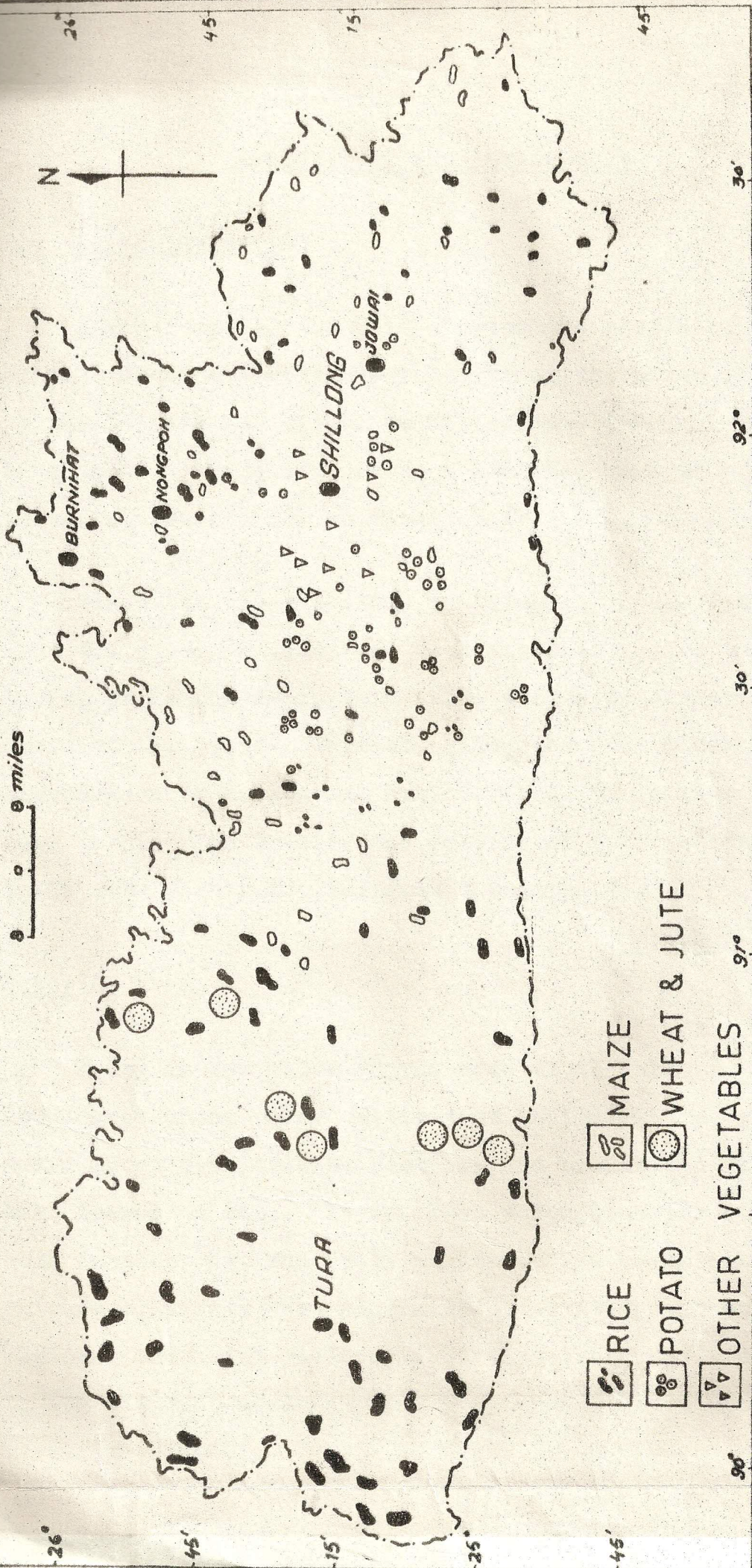


Fig. 4

## AGRICULTURE AND AQUACULTURE

### (i) Agriculture:

Agriculture is the main stay of the people of the state. About 85% of the population of the state live in rural areas and depend on agriculture for their livelihood. Presently, about 2 lakh hectares of land in the state is under cultivation (Fig. 4).

Since the present study is primarily concerned with the study of weeds and weed flora of agricultural lands, it is necessary to outline the major agricultural crops of the state. Further, since the weed flora varies from season to season and crop to crop, it is also necessary to describe briefly the methods of cultivation of these crop plants in different topographies.

#### Paddy:

Paddy is the major staple food of the state. The total area under paddy cultivation in 1969-70 is estimated about 9.5 thousand hectares and production of 1.26 lakh tonnes of rice. It is grown throughout the state both in the plain and hilly regions. The varieties grown therefore, widely vary depending on altitude and climatic regions. The high yielding varieties are successful only in low-altitude areas (upto 700 m) and are more popular among the farmers.

Some of these promising varieties are IR-8, Joya, Pusa 2-21, New IEY-1996 2295, etc. Monohar Sali is a high yielding local, tall variety from Assam, which is grown widely in low lying plain areas. Improved varieties such as Nagoba and Rylow White are found to give much better yield compared to local varieties, and have been recommended by the agriculture department. For areas above 1,300 m a locally selected variety namely, (U.S.I.) is found to perform much better than the other local varieties.

Mode of cultivation:

In lower altitudes like Byrnihat, Garo Hills, etc. mainly two types of paddy cultivation, namely, Ahu and Halipaddy are grown. Ahu paddy is sown in the months of February-April and harvested in the month of May-June.

Halipaddy is sown in the month of June-July and harvested in the month of November-December. Thus throughout the year the field remains under paddy cultivation. Many of the aquatic and marshy weeds specially belonging to Cyperaceae, Poaceae and Eriocaulaceae, are reported from these fields. At this stage quite a large number of other dicotyledonous weeds make their appearance and thus reduce the soil fertility. But around Nongpoh, only one type of paddy is cultivated. It is sown in the month of May-June and harvested in November-December. For the

remaining part of the year, the land remains fallow.

In higher altitudes like Shillong and Upper Shillong also only one cultivation is done in a year. Sowing is done from June onwards and harvested in the month of October-November.

But according to recommended procedure, transplanting of the seedlings should be done from the middle of April to the beginning of May ( $\pm 1,500$  m); May to June ( $\pm 600$  m); June to first week of July ( $\pm 100$  m). But in other type of cultivation where the paddy is broadcasted, it should be done between April to May ( $\pm 1,500$  m); May to June ( $\pm 500$  m) and June to July ( $\pm 100$  m).

It is observed that most of the weeds are reported in the month of August-September around Byrnihat ( $\pm 100$  m). They do the weeding by hand pulling only when there is a maximum growth of weeds. A variety of weeds like Setaria glauca, Ageratum conyzoides, Polygonum Spp., Paspalum dilatatum, Digitaria ciliaris, etc, are commonly noticed.

Approximately 30% to 40% of paddy area is still under jhum cultivation, which is one of the main causes of average low yield. The weeds in the jhum fallows are quite different from those of other fields. The paddy growing areas in the state are shown in Fig. 4.

Maize:

Maize is the next important cereal crop of the state. It yields approximately 11,000 tonnes. Some of the composite varieties like 'Vijoy' and 'Kissan' are found to grow well in medium and low altitudes while in the higher altitudes improved varieties are found to grow better than the available hybrids or composites. In many localities it is grown as mixed crops, which again results in low average yield.

Maize is also cultivated as a mixed crop in the jhum lands (Plates 95B, 96B). Here the crop is normally cultivated along with the potato during summer season. In lower altitudes it is usually sown in the month of June-July, whereas in higher altitudes sowing is done between April and May.

The weeds of maize fields are quite distinct from that of paddy fields and most of the macrophytic weeds come up in these fields. Weeding is rarely done in these crops and hence weeds appear in dense populations. Common weeds are: Ageratum conyzoides, Amaranthus spinosus, Amaranthus gracilis, Eleusine indica, Fagopyrum esculentum, Galinsoga parviflora, Galinsoga ciliata, Oxalis corniculata, Oxalis corymbosa, etc.

Wheat:

Wheat is a comparatively new crop in the state. About 1,650 hectares of high yielding wheat varieties like 'Sonalika' are grown in the plain areas of West Garo Hills District. Experiments have indicated that wheat can also be grown successfully in the higher altitudes upto 1,200 m. More areas are therefore likely to be brought under wheat cultivation in the near future. The weed flora here is quite similar to that of maize fields.

Potato:

Potato is the major cash crop in the high altitudinal region of the state, specially in the central plateau of East and West Khasi Hills District (Fig. 4). The total area of potato cultivation in the state is about 17,500 hectares with production of approximately 85,000 tonnes. The main drawback of the potato variety grown so far is that, these are highly susceptible to late blight diseases. Improved, blight-resistant varieties like 'Kufri' 'Jyoti' have been recommended and are getting popular with the farmers.

*see main*

Mode of cultivation:

There are mainly two methods of potato cultivation:

- i. Wetland Potato Cultivation (Summer potato).
- ii. Highland Potato Cultivation (Winter potato).

In the former method the crop is sown in the month of February-March and is harvested in the month of June-July after the paddy crop is harvested. In the latter method the crop is sown in the month of July-August and harvested in the month of November-December. This method is practised in hill slopes at higher altitudes either by terracing or just on slopes (Plate 96A).

Many weeds like Chenopodium album, Oxalis corymbosa, Galinsoga parviflora, Spergula arvensis, etc., are commonly associated with highland potato crop, whereas in the wetland potato cultivation Gnaphalium luteo-album, Drymaria cordata, Anaphalis spp., etc. are more predominant.

#### Vegetables:

In many places along with potato cultivation various other vegetable crops like cabbage, cauliflower, carrot, etc., are also grown. Weeds belonging to Galinsoga, Polygonum, Digitaria, etc., are very prominent in these fields (Plate 103B).

Jhuming or Shifting Cultivation:

This is rather a primitive type of agriculture, most prevalent among the tribals in Meghalaya. This involves the selection of some forested area, cutting down and burning of the forest growth before the onset of the monsoon for cultivation (Plate 95). But the tragedy here is that after cultivating the area for 2-3 years and when the yield decreases considerably, the field is left fallow and the tribal family favours some other forested area for this purpose. The area of the fallow depends on the amount of land available, pressure of population, level of fertility, rapidity of regeneration of the fallow and various other factors. This has got a strong deleterious effect on native vegetation and today much of the original forest has been cleared off from this area. When the field remains a fallow large number of introduced weeds colonise the area. Thus Eupatorium is one group which has become abundant in practically all areas in Meghalaya.

Almost all the crops required for livelihood are grown in these Jhums. The mixed crops that are grown are paddy, maize, tapioca, potato, curcubits, bananas, chillies, etc.

These jhums also support quite a large number of weeds, many of which are utilized by tribal families for their various needs. Hence, keeping in view the uses of weeds, in

many places, the weeding is not done and hence a profuse growth of weeds can be observed in these jhums. Sometimes, these weeds are uprooted and burnt for organic manure, since they do not apply any other artificial fertilizers. Some of the common weeds are Imperata cylindrica, Eupatorium spp., Ageratum conyzoides, Digitaria ciliaris, Fagopyrum esculentum, Oxalis corymbosa, etc.

Jhumming being a part of the socio-religious function of the people, it has not been possible to prevent this practice effectively in the state. Added to this, much of the forests are owned by private individuals or groups. An alternate suggestion to this shifting cultivation is Terracing on hills (Plate 96A). Terracing the land prevents soil erosion and loss of soil fertility. Shifting cultivation cannot be checked unless the farmers are instructed and made to understand the evil effects of jhum<sup>m</sup>ing.

(ii) Aquaculture (Fish farming):

Next in importance to agriculture in Meghalaya comes the fish farming. These fish farms also support quite a large number of aquatic weeds. Hence, the present study has been extended to weeds of fishery tanks or ponds also.

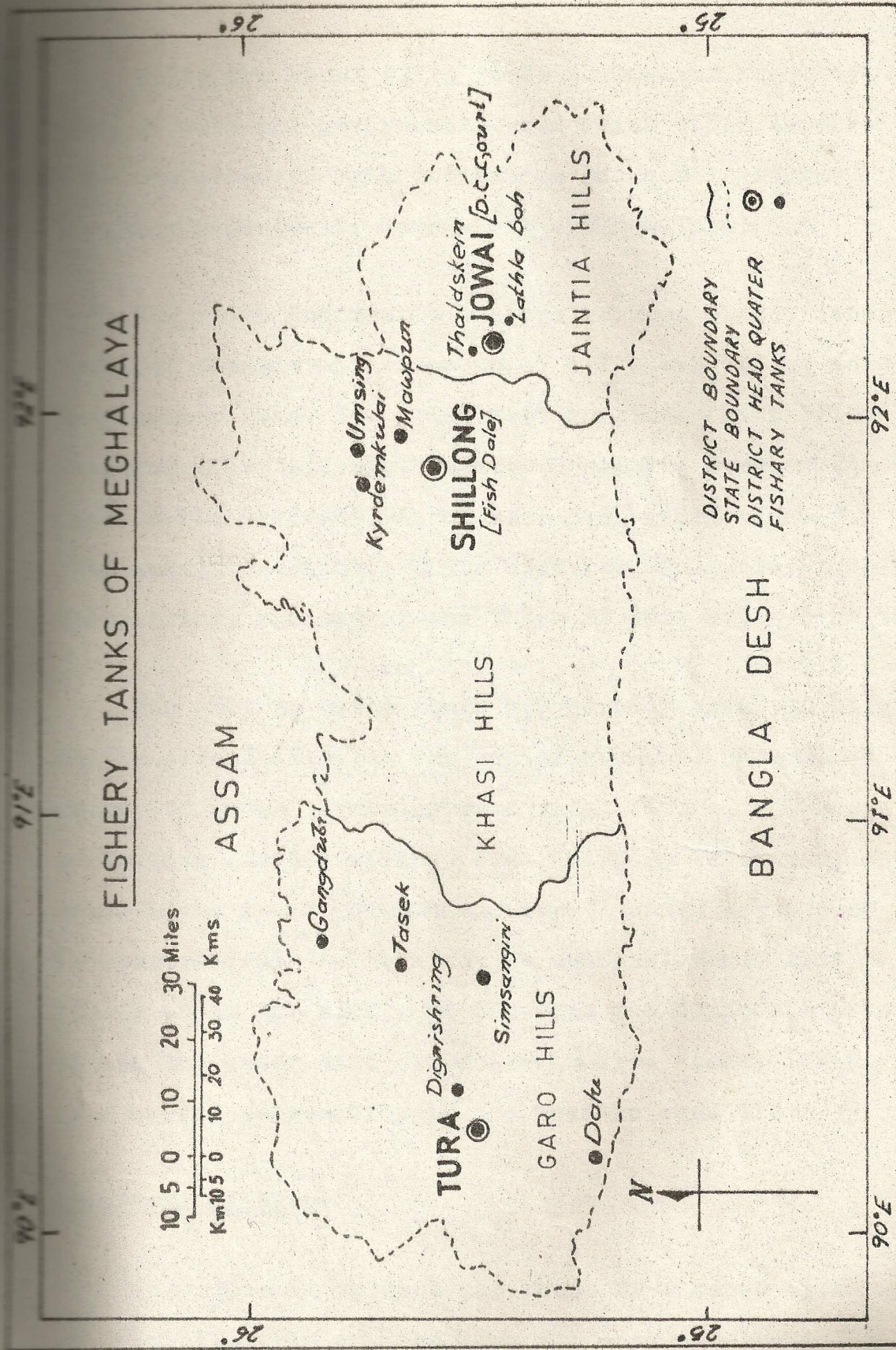


Fig.5

There are about 1,133 ponds throughout Meghalaya both private and government owned which offer excellent resources of both indigenous and exotic fishes (Fishery Department, Government of Meghalaya).

The state department has twelve recognized fishery tanks of considerable area which are shown in the accompanying map (Fig. 5). They are: Shillong (Fish Dale), Barapani (Mawpun), Nayabunglow (Umsning), Kyrdenkulai of Khasi Hills district; Larhlaboh, D.C. Court (Jowai), Thadlaskein of Jaintia Hills district, and Dala, Gangdubi, Digrisiring, Simsangiri and Tasek of Garo Hills district.

The private owned ponds are usually small in size, mostly perennial but a few are of seasonal nature. The source of water is mostly from rain, rivers, streams, irrigation canals, spring, etc. Usually in winter, the water level is at the minimum due to heavy seepage as well as evaporation. As regards the seasonal ponds they get filled up in the middle of May when the monsoon starts and retain the water till December-January. Accordingly, there is a marked seasonality in the aquatic weed flora.

#### Reservoir Fishery:

The state at present has about five reservoirs and ten more flexible sausage dams and many more on the way of

completion of various hydro-electric projects. They are the Uman reservoir, Kyrdemkulai reservoir, Umtham reservoir, Uatra reservoir, Myntdu reservoir, But none of these are used scientifically for fishery development programmes. The Barapani reservoir has about 400 hectares of water and will prove suitable for fishery development.

The water area used for pisciculture at present are those of the ponds, lakes and reservoirs. The state of Meghalaya is estimated to have about 105.7 hectares or more of culturable water, of which the water used at present for fish culture is estimated to be about 67.7 hectares. But of this only about 6.7 hectares are under proper management. This constitutes nearly 6-7% of the available water. The remaining 9.9 hectares is not properly utilized for pisciculture.

In general the following species of fishes are cultured in various regions of Meghalaya. These are as follows:

1. Accrossocheilus hexagenolepis
2. Labeo rohita
3. Labeo pangusia
4. Labeo calbasu
5. Cirrhinua mrigala
6. Catla catla
7. Channa punctatus
8. Cyprinus carpio

3. Stenopharyngodon idella  
4. Hypophthalmichthys molitrix, etc.

These ponds while supporting a large number of Aquatic weeds (Table 5), also support a good Planktonic growth which form the staple food for fishes. These species belong to Calanymonas, Pandorina, Cosmarium, Pediastrum, Closterium, Euglena, Pinnularia, Oscillatoria, Spirogyra, Zygnema, etc. Dense planktonic flora is noticed in waters where it is acidic.

REVIEW OF LITERATURE  
AND PRESENT STUDY