International Journal of Environmental Sciences
ISSN: 2229-7359
Vol. 11 No. 1s, 2025
https://www.theaspd.com/ijes.php

TREES OUTSIDE FOREST OF MANIPUR, NORTH EASTERN INDIA

Dr. Khomdram Monalisha Devi [1], Elangbam Monika Devi [2], Rebika Ningombam [3],Loitongbam Bidyarani Devi [4], Dr. Maibam Haripriya Devi [5], Dr. Potsangbam Kumar Singh [6]

[1] Assistant Professor, Department of Botany, Jadonang Memorial College, Longmai Noney-795159, Manipur, India
[2] Research Scholar, Department of Biochemistry, Manipur International University, Ghari Awang Leikai, Manipur -795140, India
[3,4] Research Scholar, Department of Botany, Manipur International University, Ghari Awang Leikai, Manipur -795140, India
[5]Department of Botany, Manipur College, Imphal affiliated to Manipur University, Imphal-795003, India
[6] Professor, Department of Botany, Manipur International University, Ghari Awang Leikai,Manipur -795140, India

Corresponding author: Dr. Khomdram Monalisha Devi
ORCID iD: https://orcid.org/0009-0009-8410-4723

Abstract: Trees Outside Forests (TOF) are essential for maintaining the ecological balance, increasing biodiversity, and providing both economic and environmental benefits. The objective of this study is to analyze the distribution, composition, and ecology of TOF in Manipur across different land-use types, including urban built-up areas, institutional lands, cultivated agricultural land, roadside plantations, and home gardens. The data demonstrated that institutional land possessed the highest proportion of TOF (30%), followed by agricultural land (25%) and urban residential areas (22%). The study showed that TOF maintain important ecosystem benefits such as carbon sequestration, enhancing soil fertility, and regulating climate, while also identifying the current pressures posed by urban encroachment, land-use change, and deforestation. This research emphasizes the need for policy, community involvement, and sustainability in agroforestry systems to protect and expand TOF. Policies should be strengthened, and programs developed to raise awareness of the ecological and socio-economic benefits resulted from TOF.

Keywords: Manipur, Imphal Valley, Trees, Local

1.INTRODUCTION

Manipur is a northeastern state in India, with a variety of geographical features, rich biodiversity, and cultural heritage. The area is 22,327 sq.km in size, with hills making up 90% of the land, while the fertile Imphal Valley occupies the remaining 10%. Manipur lies within the Indo-Burma biodiversity hotspot, which contains a number of unique flora and fauna. Manipur features a subtropical monsoon climate with four distinct seasons: warm summers, torrential monsoons, pleasant autumn seasons, and cold winters. Rainfall ranges between 1,500 and 2,500mm, whereas, temperatures can vary between 0-35°C. The ecosystem relies on the same natural resources, including forests, rivers, and wetlands, in addition to agricultural landscapes.

1.1 Trees Outside Forests (TOFs) in Manipur:

Inthe Imphal Valley, specifically assist in the connection of urban to rural ecosystems. TOFs occur in a variety of land uses, such as home gardens, roadsides, and farmland. Also encourage biodiversity, carbon sequestration, and contribute to livelihoods. However, urban development and land-use change are threatening the existing TOFs and they are losing ecological integrity. In this study we are looking at TOF diversity, density and conservation challenges in the Imphal Valley. The results of this study can be applied to aid sustainable land-use planning that will address TOF conservation for local communities.

1.2 Objectives of the study:

1) To assess the distribution, structure and ecological roles of Trees Outside Forests in different land-use in Manipur.
2) To identify the barriers and opportunities related to conservation of TOF and recommend specific policy measures that support sustainable management of TOF.

2. LITERATURE REVIEW

Trees Outside Forests have a significant role in supporting ecological integrity, improving biodiversity, and providing inputs to agroforestry systems. With study of Manipur (Devi *et al.,* 2024) have identified nine treesofcultural importance in Manipur,whichwerehistorically of relevance and still of spiritual and conservation importanceto the Meitei community:*Konthoujam Lairembi, Khoriphaba, Pureiromba Khongnang, Khongnang Hogaibi, Sati Khongnang, Meikibi Khongnang, Potsangbam Khongnang Lai Ahal, Potsangbam Khongnang Lai Manao,* and *Changing Lairembi, Yurei Pambi*highlights the importanceof connections between the cultural and natural worlds in Manipur and provides insight into how the Meitei community uses trees for spiritual and historical purposes and in conservation efforts to protect the environment. The investigation by (Devi *et al.,* 2024) reveals on the exotic tree species of Manipur Valley, asthesespecies were introduced inthe past as a result of human activity,yet have beendisregardedasanareaof study. The fieldworkforthis research was conducted in remote villages as a means to document and identify exotictree species in Manipur Valley. The study observed a total of 71 exotic tree species belonging to 23 families, with Fabaceae, Myrtaceae, Lythraceae and Annonaceae families being over represented in the exoticspecies identified. Some of these tree species areindigenousto the Indian Subcontinent but not to Manipur, meaningtheyplayedamajorrole in alteringthe natural vegetation in Manipur. The studytakesasignificantfocuson documenting and conservingthe exotic species, notably their multiple uses and ecological role.The paper of (Devi and Singh 2022) isfocusedon Trees Outside Forests in India, with a primary focus on Manipur. TOF is a keyfactorfor timber supply and environmental sustainability andhas an important role to play in agroforestry, pasture adaptation, and urban ecosystems. The study finds that the total growing stock of TOF in India is 1,616 million m^3, with the WesternHimalayas resulting in the greateststock of TOF. In Manipur, the carbon stock recorded in forests differedbased on type, with thegreatestcarbonstocksbeingrecorded in sub-tropical forests. The study also highlights the importance of also conserving trees that are indigenous,as the depletion of these species isnotedtobe growing. Several studies have discussed the significance of TOF as a carbon sink, its soil fertility augmenting capacity, and contribution to climate resilience (Gupta & Das, 2020; Bhatia *et al.,* 2018). Its structural and functional diversity enables it to while thrive in a wide range of ecosystems while supporting local floras and faunas. In Manipur, TOF plays an important role in the livelihoods of rural communities and agroforestry-based land use systems. For instance, Meitei and Devi (2017) study highlights the TOFs in soil conservation and enhancement of microclimatic conditions while also providing key inputs like fodder, fuelwood, and wild medicinal plants. In other words, TOFs provide positive contribution in traditional farming systems and cultivators orient their land use practices along agroforestry principles to ensure sustainable land use systems are developed. However, while empirical studies exist to some degree, rigorous quantitative studies on TOF diversity, density, and structural dimensions are scarce, particularly in urban and peri-urban contexts. Land use changes present one of the most pressing threats to TOF sustainability in the Northeast India region. Future work will involve quantitative and spatial analysis to understand the state of trees outside the forest (TOF) in different land-use categories, their contribution to carbon sequestration, and the threats of urbanization and climate change. These types of studies can be useful for creating conservation strategies, developing agroforestry work, and ensuring the resilience and sustainability of TOF in Manipur and similar ecosystems.

3. RESEARCH METHODOLOGY

The research was carried out in a total of five districts of Manipur (India). These districts are Imphal East, Imphal West, Kakching, Thoubal, and Bishnupur and these districts cover urban, institutional, agricultural, and roadside landscape areas in Manipur. Stratified random sampling technique was used to

select the sites where data was collected both primary (surveys) and secondary (literature review) data. Some of the major parameters determined included tree species, tree density, diameter at the breast height (dbh), canopy cover, and land-use affiliations. Then description statistics were used on the data to understand the diversity of TOF and their conservation status in the Imphal Valley. The time taken to research this study is 6 months from October 2024 to March 2025.

4. FINDINGS AND DISCUSSION

This section provides an overview of the findings associated with species diversity, tree density, diameter at the breast height (dbh), canopy cover, and frequency distribution of trees outside forests in the Imphal Valley of Manipur. Also, discussions about species attributes in different land-use types will be discussed along with their ecological significance in these landscapes.

4.1 Species Diversity and Dominance:

The research recorded a total of 100 tree species under the land use types in the Imphal Valley. The Shannon-Weiner Diversity Index (H'), which accounts for species richness and evenness, was between 2.8 to 3.6 representing moderate to high diversity levels.

Dominant Tree Species

The species represented an abundant of them among the commonly encountered dominant species within agroforestry and home gardens included *Boroi (Ziziphus mauritiana)* for its fruit and medicinal uses. *Heinou (Mangifera indica)* was ubiquitous across institutional lands and roadside plantations, popular for its edible fruit and various ecological services. *Leihao (Magnolia champaca)*, a fragrant flowering tree, was a common resident of both urban and peri-urban areas and was also grown for use in decorative landscaping or religious purposes. *Theibong (Artocarpus heterophyllus)* also supported pollinator species and was viewed as an important part of traditional agroforestry and a source of fodder. *Khongnang Bot (Ficus benghalensis)*, another important ecological species, was also frequently seen in sacred groves for its ecological significance, primarily in providing shade/habitat. Some of the other noteworthy species were *Nashik (Eucalyptus globulus)*, valued for both fruit and medicinal uses, as well as *Yongchak (Parkia timoriana)*, a multipurpose tree with edible fruits, timber resources and nitrogen-fixing benefits. *Heinoujom (Averrhoa carambola)*, was used primarily for providing shade as well as fruit production, and was a frequent resident along roadsides and backyard gardens. *Khagi Leihao Angangba (Plumeria rubra)* and *Khagi Leihao Angouba (Plumeria alba)*, were also part of the traditional & contemporary landscaping purposes and ecosystem services. *Kurao Angangba (Erythrina indica)* was often encountered in a field margin or mixed agroforestry landscape and aided in maintaining good soil health. Neem *(Azadirachta indica)* was often reads as one of the well-known ecological benefits and medicinal tree to many as well, in providing effective pest control or repellent resource. *Nobab (Citrus grandis L Osbeck)*, of special note in the urban green scene as a significant contributor to inclusive green infrastructure and consolidary of a notable species.The species for timber and/or shade, declining native timber species, included; *Pungdon (Psidium guajava)* a tree of high quality timber used from local and region, and *Sanakhonang (Ficus religiosa)* is a native flowering species sought after for its ecological and medicinal uses. *Shitaphal (Passiflora edulis)* was perhaps one of the more common fruit trees while *Awathabi (Carica papaya)* was of traditional significance and was located in sacred groves. Less known plants such as *Champra (Citrus limon)*, contributed to local biodiversity, while *Chigonglei (Vachellia nilotica)* and *Chigonglei Namthibi (Senna siamea)* were commonly used in traditional medicine and agroforestry. *Chumbrei (Prunus persica)* was available in mixed plantings as well as roadsides and *Heibi (Vangueria spinosa)*, a fast-growing timber tree, has many commercial uses.

Ecological Importance of Dominant Tree Species

Trees outside forests are crucial for ecological stability, biodiversity enhancement, and supporting local ecosystems. Theyperform various ecological functions, including carbon storage, enhancing soil fertility, providinghabitats, and climate amelioration.

1) Carbon Storageand Air Quality Improvement: Trees such as Neem *(Azadirachta indica), Theibong (Artocarpus heterophyllus)* and *Sana Khongnang (Ficus religiosa)*plantcontribute to a decrease in atmospheric carbon dioxide concentration, and improve air quality from pollutants,andtheyprovideregulationoftemperatures in urban spaces with extensive canopies.
2) Soil Fertility and Nitrogen Fixation: Some tree species, such as*Yongchak (Parkia timoriana), Kurou Angangba (Erythrina indica),*andothers,aresignificantcontributorsto soil fertility through their nitrogen-fixingproperties. Theybuildup soil structure, prevent soil erosion, and improve productivity in agroforestry systems.
3) Biodiversity ComponentandHabitats: Large canopy trees like*Khongnang bot (Ficus benghalensis), Heinou (Mangifera indica),* and others provide important nesting and foraging space for avians, insects, and small mammals. Thesetreesare keystone species for supporting the community of pollinators and the food chain.
4) Water Cycle Controland Erosion: Specieswithlonger roots such as*Leihao (Magnolia champaca), Pungdon (Psidium Guajava),* and *Heibi (Vangueria spinosa)*stabilize soil to prevent erosion, regulate groundwater, and helptomaintainthe health of the watersheds by reducing surface run off.
5) Medicinal andCulturalValues: Certain trees such as *Boroi (Ziziphus mauritiana), Nashik (Eucalyptus globulus),* and *Chigonglei (Vachellia nilotica)*provide significant potential for traditional medicine bycontaining antimicrobial and therapeutic properties associatedwiththeirleaves, bark, and fruits.
6) Urban Greening and Aesthetic Value: Trees such as*Nobab (Citrus grandis L Osbeck), Sanakhongnang (Ficus religiosa),*andothersbeautifycommunities,enhanceusablegreenspaces,andpromotewellness.Theirsizeprovidesshade,whichhelpstomitigate urban heat.

A B

Fig: A. Photo of Roadside tree plantation, B. Photo of Home garden tree

LIST OF 100 TREES SPECIES FOUND IN IMPHAL VALLEY OUTSIDE FOREST

Local Name (Manipuri)	Common Name	SCIENTIFIC NAME	Family Name	Category of trees	Benefits & Uses
1. **Agor**	Eagle wood tree	AQUILARIA MALACCENSIS	Thymelaeaceae	Timber/Aromatic	Used for making incense, perfumes, and traditional medicines.
2. **Aman**	Indian ash tree	LANNEA COROMANDELICA	Anacardiaceae	Timber	Timber used for furniture, medicinal uses for skin diseases.
3. **Ashi heibong**	Hairy fig	FICUS HISPIDA	Moraceae	Fruit/Medicinal	Edible fruit, used in traditional medicine for digestive issues.
4. **Ashok**	Ashoka tree	SARACA ASOCA	Fabaceae	Ornamental/Medicinal	Used in Ayurveda for treating gynecological disorders, ornamental tree.
5. **Awathabi**	Papaya	CARICA PAPAYA	Caricaceae	Fruit	Edible fruit rich in vitamins, leaves used for dengue fever treatment.
6. **Bokul**	Bullet – wood tree	MIMUSOPS ELENGI	Sapotaceae	Timber/Ornamental	Flowers used in perfumes, wood for making furniture.
7. **Boroi**	Jujube	ZIZIPHUS MAURITIANA	Rhamnaceae	Fruit	Fruits are rich in Vitamin C, used in herbal medicine.
8. **Cha-chadan**	Sandalwood	SANTALUM ALBUM	Santalaceae	Timber/Aromatic	Wood used for carvings, oil for aromatherapy and skincare.
9. **Chahui**	Golden shower	CASSIA FISTULA	Fabaceae	Ornamental/Medicinal	Medicinal uses for constipation and skin diseases, ornamental tree.
10. **Champra**	Lemon	CITRUS LIMON	Rutaceae	Fruit	Rich in Vitamin C, used in food, medicine, and cleaning.
11. **Chigonglei**	Babul tree	VACHELLIA NILOTICA	Fabaceae	Timber/Medicinal	Bark used in dental care, wood used for furniture.
12. **Chigonglei namthibi**	Cassie flower	SENNA SIAMEA	Fabaceae	Ornamental	Used for making perfumes, medicinal properties for skin ailments.
13. **Chingthrao-angangba**	Butterfly tree	BAUHINIA PURPUREA	Fabaceae	Ornamental	Ornamental tree, flowers used in traditional medicine.
14. **Chingthrao-angouba**	White bauhinia twiner	BAUHINIA VAHLII	Fabaceae	Ornamental	Used for treating wounds, ornamental plant.
15. **Chingthrao-ngourunaba**	Camels foot tree	BAUHINIA VARIEGATA	Fabaceae	Ornamental	Used in Ayurveda for treating diabetes and stomach issues.
16. **Chorphon**	Indian olive	OLEA DIOICA	Oleaceae	Timber/Medicinal	Edible fruit, used in traditional medicine.
17. **Chumbrei**	Peach	PRUNUS PERSICA	Rosaceae	Fruit	Edible fruit rich in fiber, used in skincare.
18. **Gulamchat**	Black plum	SYZYGIUM CUMINI	Myrtaceae	Fruit/Medicinal	Fruit used to manage diabetes, rich in antioxidants.
19. **Heibamana/Heibam**	Wild Fig	FICUS SEMICORDATA	Moraceae	Fruit/Wild	Fruits eaten raw, leaves used in traditional medicine.
20. **Heibi**	Vanguria spinosa	VANGUERIA SPINOSA	Rubiaceae	Fruit/Wild	Used in traditional medicine for infections.
21. **Heibong**	Fig	FICUS CARICA	Moraceae	Fruit/Medicinal	Edible fruit, high in fiber, aids digestion.
22. **Heibung**	Himalayan garcinia	GARCINIA COWA	Clusiaceae	Fruit/Medicinal	Used in weight loss supplements, edible fruit.
23. **Heigreng/Heikreng**	Southern nettle	TREMA ORIENTALIS	Cannabaceae	Timber/Medicinal	Used in herbal medicine for treating inflammation.
24. **Hei-gri**	Elephant apple	DILLENIA INDICA	Dilleniaceae	Fruit/Medicinal	Edible fruit, used in traditional medicine for digestion.
25. **Heijugak/Heijuga**	Walnut	JUGLANS REGIA	Juglandaceae	Nut/Timber	Nut rich in omega-3, wood used for furniture.
26. **Heikru/Heigru**	Emblic myrobalan/Gooseberry	PHYLLANTHUS EMBLICA	Phyllanthaceae	Fruit/Medicinal	High in Vitamin C, used in Ayurveda for immunity.
27. **Heimang**	Chinese sumac	RHUS CHINENSIS	Anacardiaceae	Timber/Medicinal	Used in traditional medicine for diarrhea and skin infections.
28. **Heining**	Wild mango	MANGIFERA SYLVATICA	Anacardiaceae	Fruit/Wild	Edible fruit, seeds used in herbal medicine.
29. **Heinou**	Mango	MANGIFERA INDICA	Anacardiaceae	Fruit	Edible fruit, leaves used for diabetes management.

30. **Heinou-jom**	Carambola	AVERRHOA CARAMBOLA	Oxalidaceae	Fruit	Edible fruit, rich in Vitamin C.
31. **Heirang goi/Heirang khoi**	Rohituka tree	APHANAMIXIS POLYSTACHYA	Meliaceae	Medicinal	Used in Ayurvedic medicine for liver diseases.
32. **Heiri khagok**	Stone apple	AEGLE MARMELOS	Rutaceae	Fruit/Medicinal	Fruit used for digestion, leaves used in Ayurveda.
33. **Heiribob**	Citrus macroptera	CITRUS MACROPTERA	Rutaceae	Fruit	Used for making pickles, rich in antioxidants.
34. **Heirikokthong**	Monkey Jack tree	ARTOCARPUS LAKOOCHA	Moraceae	Fruit/Wild	Fruit used in making desserts, wood for furniture.
35. **Heirit**	Drooping fig	FICUS DRUPACEA	Moraceae	Fruit/Wild	Fruits eaten raw, used in herbal medicine.
36. **Heithum**	Grape fruit	CITRUS × PARADISI	Rutaceae	Fruit	Edible fruit, aids in weight loss and digestion.
37. **Heitroi**	Indian coffee plum	FLACOURTIA JANGOMAS	Salicaceae	Fruit/Wild	Edible fruit, used in local medicines.
38. **Heitup**	Wild apple	MALUS SYLVESTRIS	Rosaceae	Fruit/Wild	Edible fruit, used in traditional medicine.
39. **Heiyen**	Big nay	ZIZYPHUS XYLOPYRUS	Rhamnaceae	Timber/Wild	Used in herbal remedies for treating infections.
40. **Kabrangchak**	White mulbery	MORUS ALBA	Moraceae	Fruit/Medicinal	Leaves used for silkworms, fruit edible.
41. **Kadam**	Wild chinchona	CINCHONA OFFICINALIS	Rubiaceae	Medicinal	Source of quinine, used to treat malaria.
42. **Kaphoi/Kamphoi**	Pomegranate	PUNICA GRANATUM	Lythraceae	Fruit	Edible fruit, used for heart health and digestion.
43. **Karpur pambi**	Camphor tree	CINNAMOMUM CAMPHORA	Lauraceae	Aromatic/Medicinal	Leaves and wood used in medicine and aromatherapy.
44. **Keeyamlei**	Common honey locust	GLEDITSIA TRIACANTHOS	Fabaceae	Timber/Ornamental	Used for soil improvement and herbal medicine.
45. **Kekru**	Soap nut berry	SAPINDUS MUKOROSSI	Sapindaceae	Medicinal	Natural soap alternative, used for hair and skin.
46. **Khagileihao angangba**	Red temple/Pagoda tree	PLUMERIA RUBRA	Apocynaceae	Ornamental	Ornamental tree, used in traditional medicine.
47. **Khagi-leihao angouba**	Temple/Pagoda tree	PLUMERIA ALBA	Apocynaceae	Ornamental	Anti-inflammatory, medicinal, ornamental, religious, and used in perfumes and garlands.
48. **Khok**	Siris tree	ALBIZIA LEBBECK	Fabaceae	Timber	Timber used for furniture, medicinal uses for respiratory issues.
49. **Khongnang bot**	Banyan tree	FICUS BENGHALENSIS	Moraceae	Sacred/Ornamental	Sacred tree, bark used in traditional medicine.
50. **Kihoree**	Star gooseberry	PHYLLANTHUS ACIDUS	Phyllanthaceae	Fruit/Wild	Edible fruit, used in making pickles and jams.
51. **Kokal**	Chinese alangium	ALANGIUM CHINENSE	Alangiaceae	Medicinal	Used in herbal medicine for fever and pain relief.
52. **Kona**	Palmyra palm	BORASSUS FLABELLIFER	Arecaceae	Fruit/Timber	Produces edible fruit, used in sugar production.
53. **Kurao angangba**	Coral tree	ERYTHRINA INDICA	Fabaceae	Ornamental	Used for treating wounds and fever in herbal medicine.
54. **Kurao angouba**	Coral tree	ERYTHRINA VARIEGATA	Fabaceae	Ornamental	Aids in healing, pain relief, liver health, diabetes, soil enrichment, fodder, timber, and dye extraction.
55. **Kwa pambi**	Betel nut	ARECA CATECHU	Arecaceae	Nut/Economic	Used for chewing, medicinal properties for digestion.
56. **Leihao**	Champak	MAGNOLIA CHAMPACA	Magnoliaceae	Ornamental/Aromatic	Flowers used for perfumes, wood used in timber.
57. **Leihao-leisang**	Wild Champa	MAGNOLIA KISOPA	Magnoliaceae	Ornamental/Aromatic	Flower use for making perfumes and wood used as furniture and popular for it color and texture.
58. **Loyum – lei**	Three-leafed capper	CAPPARIS ZEYLANICA	Capparaceae	Medicinal	Used in Ayurveda for digestive issues.
59. **Madhabi**	Clustered hiptage	HIPTAGE BENGHALENSIS	Malpighiaceae	Ornamental	Used in herbal medicine for skin diseases.
60. **Malhei**	:Common apricot	PRUNUS ARMENIACA	Rosaceae	Fruit	Edible fruit, rich in vitamins and antioxidants.

61. **Manahi/Manahei**	Myrobalan	TERMINALIA CHEBULA	Combretaceae	Medicinal	Used in Ayurvedic medicine for digestion and immunity.
62. **Mange**	Tamarind tree	TAMARINDUS INDICA	Fabaceae	Fruit	Edible fruit used in cooking, medicinal properties.
63. **Mayokpha**	Arjuna myrobalan	TERMINALIA ARJUNA	Combretaceae	Medicinal	Used in Ayurveda for heart health.
64. **Motok hei**	Burmese grape	BACCAUREA RAMIFLORA	Phyllanthaceae	Fruit/Wild	Edible fruit, used in herbal medicine.
65. **Nageshwor**	:Iron wood	MESUA FERREA	Calophyllaceae	Timber/Ornamental	Wood used for furniture, medicinal uses.
66. **Naspati**	Chinese pear	PYRUS USSURIENSIS	Rosaceae	Fruit	Edible fruit, used for digestive issues.
67. **Neem**	Neem tree	AZADIRACHTA INDICA	Meliaceae	Medicinal	Used for skin, dental care, and herbal medicine.
68. **Ngang**	Indian ivy-rue	RUTA GRAVEOLENS	Rutaceae	Medicinal	Used in traditional medicine for pain relief.
69. **Nobab**	Pomelo	CITRUS GRANDIS (L) OSBECK	Rutaceae	Fruit	Edible fruit, rich in Vitamin C.
70. **Nongleisang**	Longleaf logwood	XYLOPIA PARVIFLORA	Annonaceae	Timber/Wild	Wood used in timber and herbal medicine.
71. **Nashik**	Eucalyptus	EUCALYPTUS GLOBULUS	Myrtaceae	Timber/Medicinal	Dry leaf can use as medicine to help loosen coughs
72. **Pang-gong**	Flame of the forest	BUTEA MONOSPERMA	Fabaceae	Ornamental	Ornamental tree, used in herbal medicine.
73. **Pungdon**	Guava	PSIDIUM GUAJAVA	Myrtaceae	Fruit	Edible fruit, used in medicine for digestion.
74. **Radhika-nachom/Shitaphal**	Passion fruit	PASSIFLORA EDULIS	Passifloraceae	Fruit	Edible fruit, used in juice and medicine.
75. **Sanakhongnang**	Peepal tree	FICUS RELIGIOSA	Moraceae	Sacred/Medicinal	Sacred tree, used in Ayurveda for respiratory issues.
76. **Sangbrei**	Chinese Albizia	ALBIZIA CHINENSIS	Fabaceae	Ornamental/Medicinal	Used in traditional medicine for treating wounds, inflammation, and skin diseases
77. **Seijrak**	Persian lilac	MELIA AZEDARACH	Meliaceae	Timber/Medicinal	Used in traditional medicine for skin diseases.
78. **Seleima/Sileibi**	:Rose apple	SYZYGIUM JAMBOS	Myrtaceae	Fruit	Edible fruit, used in making juices.
79. **Shamba**	Indian trumpet tree	OROXYLUM INDICUM	Bignoniaceae	Medicinal	Used in Ayurvedic medicine for asthma.
80. **Singga rei**	Night jasmine	NYCTANTHES ARBOR-TRISTIS	Oleaceae	Medicinal/Ornamental	Flowers used for making perfume, medicinal uses.
81. **Tai-ren**	Red cedar	TOONA CILIATA	Meliaceae	Timber	Timber used for furniture, medicinal uses.
82. **Teak /Chingsoo**	Teak	TECTONA GRANDIS	Lamiaceae	Timber	Wood used in high-quality furniture.
83. **Tejbat/Tejpata**	Bay leaf	CINNAMOMUM TAMALA	Lauraceae	Aromatic	Used in cooking, medicinal properties.
84. **Tenawa-machin**	Sparrow beak	RHYNCHOSIA MINIMA	Fabaceae	Wild	Used in traditional medicine.
85. **Tera**	Red silk cotton tree	BOMBAX CEIBA	Malvaceae	Timber/Ornamental	Used for making pillows, medicinal uses.
86. **Thang hidak**	Indian laurel	LITSEA GLUTINOSA	Lauraceae	Timber/Medicinal	Timber used for making boats and furniture.
87. **Thangtup**	:Dwraf date palm	PHOENIX ROEBELENII	Arecaceae	Ornamental	Used for ornamental purposes.
88. **Theibong**	Jack tree /Jack fruit	ARTOCARPUS HETEROPHYLLUS	Moraceae	Fruit	Edible fruit, wood used for furniture.
89. **Tumitla**	Many flowered litsea	LITSEA MONOPETALA	Lauraceae	Timber/Medicinal	Used in traditional medicine.
90. **Uchan**	Long pine /Pine tree	PINUS ROXBURGHII	Pinaceae	Timber	Timber used for construction.
91. **Uningthou**	Wood king	DYSOXYLUM BINECTARIFERUM	Meliaceae	Timber/Medicinal	Used for furniture.
92. **U-khajing**	Wild rhea	BOEHMERIA NIVEA	Urticaceae	Wild/Economic	Used for making fiber.
93. **Ureirom**	Annatto tree	BIXA ORELLANA	Bixaceae	Medicinal/Dye	Seeds used for natural food coloring.
94. **Ureirom laba**	Kamala tree	MALLOTUS PHILIPPENSIS	Euphorbiaceae	Medicinal	Used in herbal medicine for skin diseases.
95. **Ushingsha**	Ceylon Cinnamon	CINNAMOMUM VERUM	Lauraceae	Aromatic	Bark used for spices, medicinal uses.

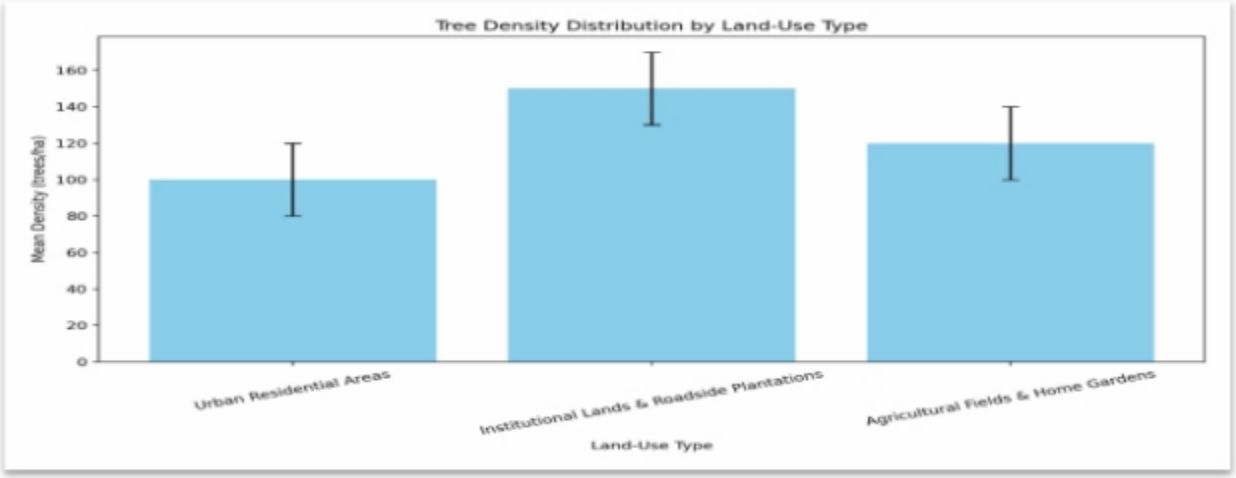
96. **U-thambal**	Bull bay	MAGNOLIA GRANDIFLORA	Magnoliaceae	Ornamental	Ornamental tree, used for perfumes.
97. **Uthum**	Large-leaf magnolia	MAGNOLIA MACROPHYLLA	Magnoliaceae	Ornamental	Ornamental tree, used in traditional medicine.
98. **Utonglei**	Yellow oleander	CASCABELA THEVETIA	Apocynaceae	Poisonous/Ornamental	Used in herbal medicine, but toxic in large amounts.
99. **Yen-dang**	Cycas	CYCAS REVOLUTA	Cycadaceae	Ornamental	Ornamental plant, toxic seeds.
100. **Yongchak**	Tree bean	PARKIA TIMORIANA	Fabaceae	Fruit/Wild	Edible pods, nitrogen-fixing plant.

4.2 Tree Density Distribution:

The mean tree density across surveyed locations was 145 trees per hectare, with a standard deviation of ±15 trees per hectare, indicating moderate variation across sites. The density of TOF varied significantly based on land-use type, reflecting differences in urbanization, conservation efforts, and plantation initiatives.

Tree Density by Land-Use Type

Land-Use Type	Tree Density (trees/ha)	Key Influencing Factors
Urban Residential Areas	80–120	Lower density due to space limitations, construction activities, and reduced planting initiatives.
Institutional Lands & Roadside Plantations	130–170	Higher density attributed to planned afforestation efforts and long-term conservation strategies.
Agricultural Fields & Home Gardens	100–140	Moderate density, with trees integrated into farmlands and private gardens for fruit production and shade.



Key Observations:

- Urban areas have lower tree densities due to land constraints and expansion of infrastructure.
- Institutional lands and roadside plantations have higher densities, demonstrating the effectiveness of afforestation projects.
- Agricultural lands maintain moderate tree density, benefiting from traditional agroforestry practices.

International Journal of Environmental Sciences
ISSN: 2229-7359
Vol. 11 No. 1s, 2025
https://www.theaspd.com/ijes.php

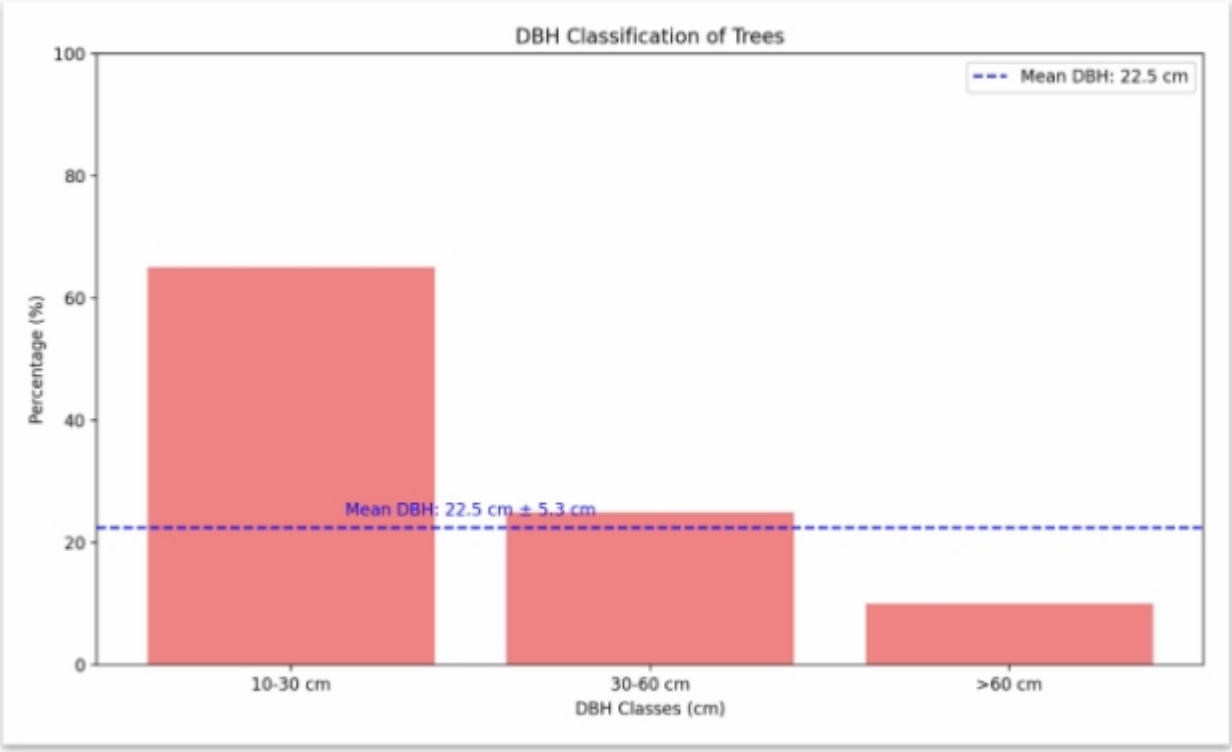
4.3 DBH (Diameter at Breast Height) Analysis:

The DBH distribution provides insights into the age and structural diversity of TOF species.

DBH Classification

DBH Range (cm)	Percentage of Trees	Age Group
10–30 cm	65%	Young and medium-aged trees
30–60 cm	25%	Mature trees
>60 cm	10%	Old-growth trees

The mean DBH value was 22.5 cm ± 5.3 cm, suggesting a predominance of young and medium-aged trees in TOF landscapes.



Key Observations:

- 65% of trees fall in the 10–30 cm range, indicating a dynamic and regenerating TOF ecosystem.
- Mature and old-growth trees (DBH >30 cm) make up 35%, playing a crucial role in carbon storage, shade provision, and habitat support.
- The presence of old trees is limited in urban areas, as these trees are often removed for development projects.

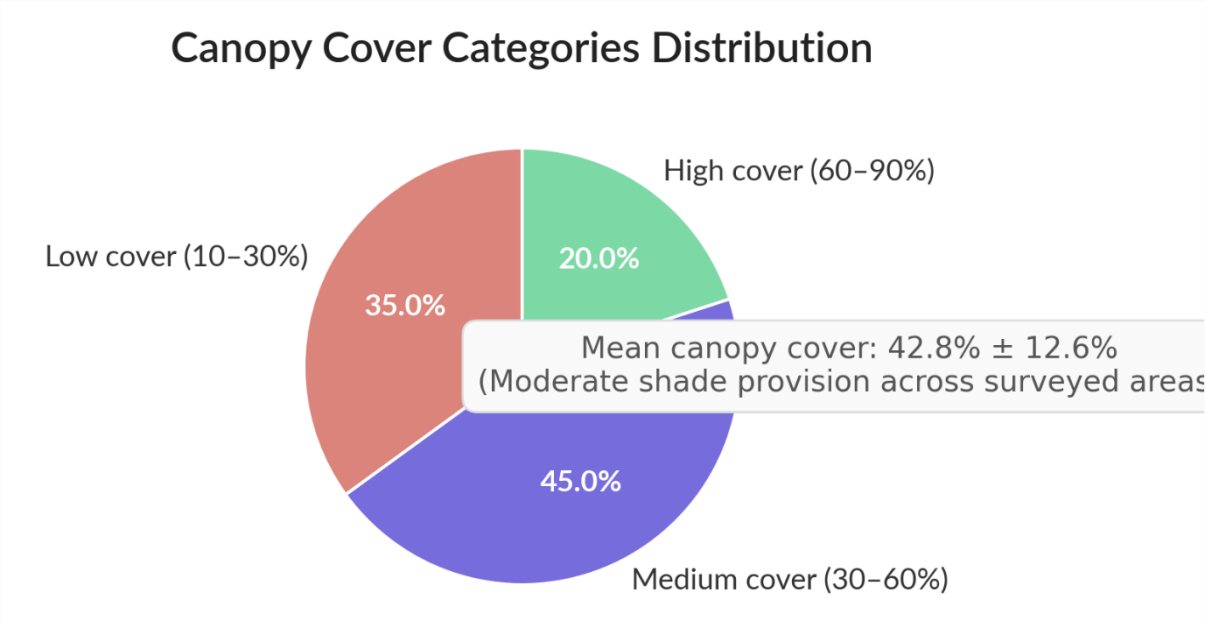
4.4 Canopy Cover Analysis

Canopy cover plays a vital role in microclimate regulation, soil protection, and biodiversity conservation. The findings highlight the distribution of TOF canopy cover across different land-use types.

Canopy Cover Categories

Canopy Cover Percentage	Percentage of TOF Trees	Impact on Environment
Low cover (10–30%)	35%	Limited shade, lower contribution to cooling and air purification.
Medium cover (30–60%)	45%	Moderate shade provision, important for urban microclimate regulation.
High cover (60–90%)	20%	Significant ecological benefits, including reduced heat island effects and improved biodiversity.

The mean canopy cover was 42.8% ± 12.6%, reflecting a moderate shade provision across the surveyed areas.



Key Observations:

- Urban residential areas and agricultural fields had a higher proportion of low-canopy trees, mainly due to space constraints and pruning practices.
- Institutional lands and roadside plantations had a higher proportion of medium to high-canopy trees, contributing to shade, air quality improvement, and ecosystem stability.
- Increasing high-canopy trees in urban landscapes is essential for reducing temperature extremes and enhancing biodiversity.

4.5 Frequency Distribution of TOF in Land-Use Categories

TOF distribution varies across different land-use types, influenced by management practices, conservation strategies, and human activities.

TOF Distribution by Land-Use Type

LAND-USE TYPE	TREE COUNT (%)	DOMINANT SPECIES
URBAN RESIDENTIAL	22%	Peepal tree, Indian Jujube
INSTITUTIONAL LANDS	30%	Red temple/pagoda tree
AGRICULTURAL FIELDS	25%	Tree bean, Papaya
ROADSIDE PLANTATIONS	15%	Babul tree, Eucalyptus
HOME GARDENS	8%	Pomela, Mango

Key Observations:

Institutional sites hold the largest proportion of Trees Outside Forest (TOF) at 30%, which likely occurred due tree planting and conservation initiatives.

- Urban residential/settlement areas are a reasonable tree-proportioned, (22%), but there is opportunity for increased green cover in these settings, which provides biodiversity and air quality benefits.

- Agricultural lands (25%) indicate that there is a strong role for agroforestry that would place trees strategically where potential for improving soil health, providing crop shade and crop protection is possible.

- Roadside tree planting (15%) play a role in urban beautification, pollution abatement and soil erosion mitigation. -

- Home gardens (8%) contribute towards biodiversity conservation and food security for residents, with species Pomela, mango fall within the most common species for home activities.

5.CONCLUSION:

Trees Outside Forest (TOF) in Manipur contribute towards ecological stability, agricultural sustainability and urban greening, from findings in this study. TOF provide most prominently through biodiversity conservation, carbon capture dynamics, and soil fertility functions. Despite being important, TOF are under threat from urban expansion, agricultural intensification and ad hoc land-use change scenarios should be acknowledged. This study underscores the value of a long-term perspective to TOF conservation and management, supporting a policy intervention, participatory endorsement from community members; for rural and urban communities, as well as sustainable land-use practices within life-cycle considerations. Once the material value and socio-economic benefits can be demonstrated to TOF, then the related interventions can begin, towards to working for the sustainability beyond your generation.

6. SUGGESTIONS:

The following strategies should be adopted to strengthen sustainable management and conservation of Tree Outside Forest in Manipur:

6.1 Strengthening the Policies and Legal Framework: Formulate possible policies that may embed conservation of TOF into land-use planning policies, urban development policies, and agricultural policies. Create legal tools for conservation of native and ecologically significant tree species. Develop policies for regeneration, harvesting, and re-planting of TOF.

6.2 Community Consultation and Awareness: Enhance community engagement with education, planting and other conservation programs. Increase educational programs pertaining to the ecological and economic significance of TOF to Manipur and local communities. Develop incentives for private land owners and farmers that will promote their sustainability or increase cover of TOF.

6.3 Sustainable Land-Use and Agroforestry: Explore agroforestry systems that integrate TOF with agricultural activities to enhance production and ecological sustainability possibilities. Train and engage

farmers in sustainable management and harvesting of tree species. Explore tree planting substituting priority trees with native and climate resilient species as first choices.

6.4 Institutional Support and Research: Initiatives Encourage governance structures, working in district health and environment programs, where local communities, government agencies, and research institutions may work in partnership. Provide budgets for research on both climate resilience and TOF; as well as TOF supporting biodiversity and sustainable actions in urban settings. Implement monitoring mechanisms to assess the status and trends of TOF across a variety of landscapes.

6.5 Urban Greening and Roadside Tree Planting: Integrate tree planting initiatives into urban planning to expand green areas. Establish roadside afforestation initiatives to improve air quality and carbon sequestration areas. Develop and implement regulations and bylaws to address indiscriminate harvest on tree cover, as well as compensatory tree planting.

6.6 Climate Adaptation and Environmental Stewardship: Design restoration projects to stabilize degraded land, wetlands and to restore the riparian forest communities that developed along riverbanks. Develop biodiversity parks and conservation areas to promote the long-term viability of native tree species. Encourage research on the role of TOF to respond to climate change.

6.7 Sustainable Economic Use of TOF: Promote ecological-based industries aligned with the TOF, e.g., sustainability-derived timber and herbal medicines. Facilitate access to markets for farmers engaged in TOF-based enterprises. Support community nurseries, which enable afforestation and rural livelihoods.

REFERENCES

1. Devi, K. M., Devi, M. H., & Singh, P. K. (2024). Trees Outside Forest Having Historical Background in Manipur, Northeastern India. Cuestiones de fisioterapia, 50(2),549-562.
2. Devi, K. M., Devi, K. B., Devi, M. H., & Singh, P. K. (2024). Trees outside forests of Manipur Valley districts of Manipur state with special reference to exotic trees. International Journal of Emerging Technologies and Innovative Research, 11(3), h674-h685.
3. Devi, K. M., & Singh, P. K. (2022). Evaluation of Trees Outside Forests in India with special reference to Manipur State: A Review, 09 (11),54-66
4. Bhatia, R., Sharma, A., & Singh, P. (2018). Agroforestry and its impact on biodiversity conservation: A review. Indian Journal of Agroforestry, 20(1), 45-53.
5. Devi, M., & Sharma, K. (2019). Role of Trees Outside Forests in the ecological sustainability of Northeast India. Environmental Conservation Journal, 40(2), 112-126.
6. Gupta, R., & Das, P. (2020). Carbon sequestration potential of Trees Outside Forests: A case study from India. Journal of Forestry Research, 31(3), 567-580.
7. Meitei, L., & Devi, T. (2017). Traditional agroforestry systems and their contributions to rural livelihoods in Manipur, India. Asian Journal of Environmental Science, 12(1), 77-89.
8. Singh, N., Yumnam, K., & Sinha, R. (2021). Challenges in conserving Trees Outside Forests amidst rapid urbanization in Northeast India. Ecological Research, 36(4), 889-902.
9. FAO. (2010). Global Forest Resources Assessment 2010: Main Report. Food and Agriculture Organization of the United Nations.
10. Champion, H. G., & Seth, S. K. (1968). A Revised Survey of the Forest Types of India. Government of India.
11. Singh, N. P., Singh, D. K., & Hajra, P. K. (2000). Flora of Manipur, Vol. I & II. Botanical Survey of India.
12. Tiwari, B. K., Barik, S. K., & Tripathi, R. S. (1998). Biodiversity value, status, and strategies for conservation of sacred groves of Meghalaya, India. Ecosystem Health, 4(1), 20–32.
13. FSI. (2021). India State of Forest Report 2021. Forest Survey of India, Ministry of Environment, Forest, and Climate Change.
14. Kumar, A., & Khumbongmayum, A. D. (2008). Community forests in Manipur: Their traditional practices and biodiversity conservation. Indian Journal of Traditional Knowledge, 7(2), 236–239.

15. Pandey, R. (2018). Urban forestry in Northeast India: Status, challenges, and future prospects. Journal of Forestry Research, 29(3), 555–567.
16. Shankar, U. (2001). A case study of tree species diversity and distribution in a tropical dry deciduous forest of Manipur. Current Science, 80(8), 938–942.
17. Singh, R. K., & Singh, P. K. (2013). Agroforestry practices and their role in rural livelihood in Manipur. Indian Journal of Agroforestry, 15(2), 89–95.
18. Upadhaya, K., Pandey, H. N., & Law, P. S. (2003). Tree diversity in sacred groves of Meghalaya and its significance in biodiversity conservation. Biodiversity and Conservation, 12(2), 399–412.
19. List of Medicinal plants. Retrived from https://medicinalplants.co.in/list-medicinal-plants/