कृषि एवं किसान
कल्याण मंत्रालय
MINISTRY OF
AGRICULTURE AND
FARMERS WELFARE

सत्यमेव जयते

भाकृअनुप
ICAR

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CAFRI

Promising Agroforestry Models for Manipur

ICAR-Central Agroforestry Research Institute

Jhansi-284003, Uttar Pradesh, India

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Citation

CAFRI (2024) Promising Agroforestry Models for Manipur. ICAR-Central Agroforestry Research Institute, Jhansi; 14p.

Contribution

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Acknowledgement

This document has been prepared for spreading awareness and training of stakeholders for agroforestry in different states and is supported by Govt. of India's *Rashtriya Krishi Vikas Yojana* and training grants from the State.

Disclaimer

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Cover Page Design : Suresh Ramanan S. and A. Arunachalam

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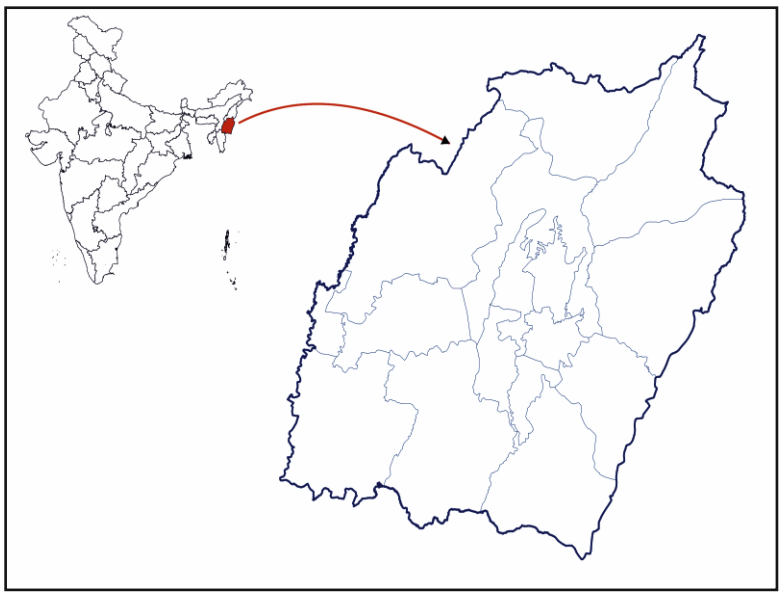
Promising Agroforestry Models for Manipur



Manipur literally meaning *"A jewelled land"* nestle deep within a lush green corner of North East India. The state is known for its abundant greenery and natural beauty. Apart from being endowed with nature's glory Manipur is also a prominent centre of rich art and culture. The state capital is Imphal, located in the centre of Manipur. The state lies in north of the Tropic of Cancer between 23°50' N to 25°42' N and 92°58' E to 94°45' E longitude. It is bordered by Nagaland in the north and northwest, Mizoram in the south and southwest, and Assam in the west. The state also shares international border with Myanmar in south and east. Geographically, Manipur could be divided into two regions: (i) the hill, and (ii) the valley. The valley lies in the central part of the State and the hills surround the valley. The state is among the *Seven Sisters* of India. Manipur became a part of the Indian union and the state achieved its statehood in the year 1972. The state covers an area of 22327km^2, which is 0.68% of the total geographical area of the country (ISFR, 2019).

Physiography

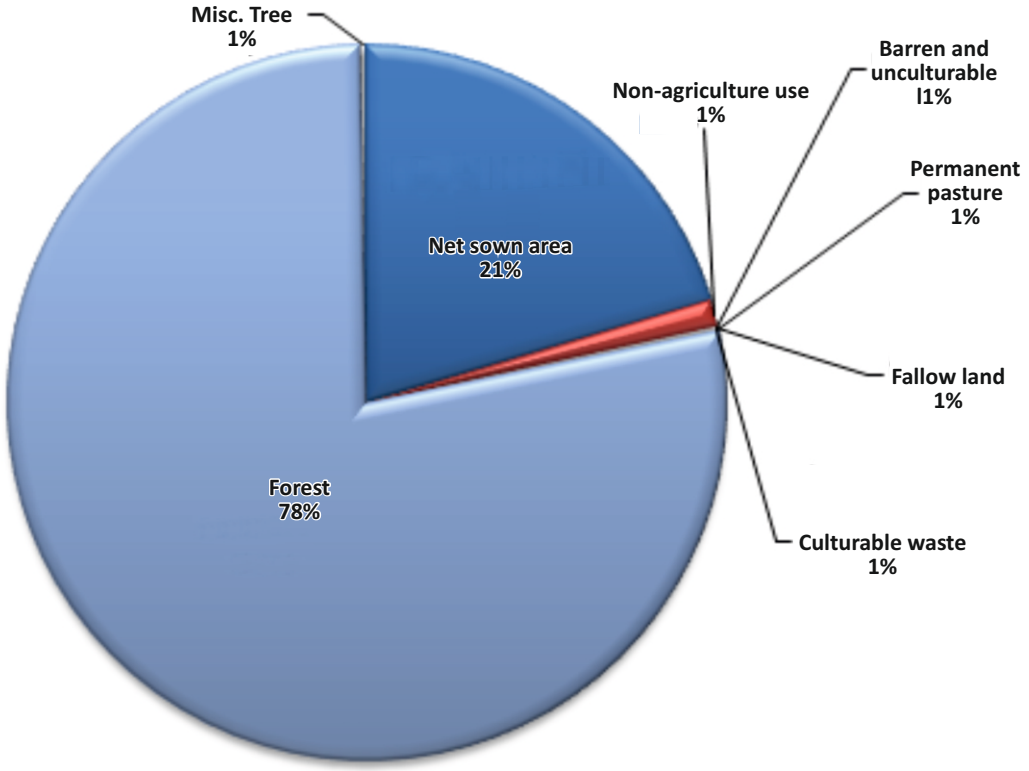
Physiographically, Manipur is characterised by two distinct physical regions-an outlying area of rugged hills and narrow valleys, and the inner area of flat plain, with all associated land forms (Town Planning Department, 2024). These two areas are not only distinct in terms of physical features but are also conspicuous with regard to various plants and animal species. The eastern wing of the Himalayas, particularly its lower hills, constitutes an important feature of the landscape of Manipur. Some of the mountains in Manipur are quite high like a peak on the Nagaland-Manipur border which is more than 3,000 m. Ninety per cent of the total geographical area of Manipur is covered by the hills. The Barak River and its tributaries constituted the plains of the state. The state's capital Imphal is situated on the bank of Barak River. The valley region is monotonous, featureless plain but also constitutes a number of hills and mounds rising above the flat surface. The Loktak lake is an important feature of the central plain in Manipur.

Climate

Manipur is blessed with a clean climate round the year. The state has tropical to temperate climate depending upon elevation. The state has two main seasons separated by two transitions: winter season, pre-monsoon, monsoon, and post-monsoon season. The winter season is from December to February. Pre-Monsoon season in the months of March and April. The monsoon season starts in May and end in September. The post-monsoon season lies between October and November. Temperature ranges from sub-zero to 36°C. In winter the weather remains much cold. The temperature goes down below zero °C. The region also experiences snowfall. Most of the rainfall in the state is occurred in monsoon season due to southwest monsoon. Rainfall in Manipur varies from 1000 mm to 3500 mm and average rainfall is about 1500 mm.

Land use pattern

In Manipur, which covers 22330km^2 total geographical area, the forest cover constitutes only 75.45% of the land. During 2018-19, the net sown area in Manipur was 4410 km^2 which accounts for 19.74% of the total geographical area. There was a slight decrease of 1.12% in the net sown area compared to the previous year (2017-18).



*Source:*Land Use Statistics at a Glance (2021)

Forests and tree resources

Manipur constitutes rich forest resources. The state has a total forest cover of 16598.27km², which is 74.34% of its total geographical area (ISFR, 2021). The state's forest cover includes very dense forest (904.99km²), moderately dense forest (6228.49km²), and open forest (9464.79 km²). Churachandpur (Forest area: 3879.04km^2) and Tamenglong (Forest cover: 86.42% of geographical area) have highest forest cover in terms of total area and percentage of geographical area, respectively. In Manipur, forest cover inside recorded forest area (RFA) is 14833km^2 while forest cover outside RFA is 1765km^2 (ISFR, 2021). Manipur's forest cover decreased from 16846.90km² in 2019 to 16598.27km² in the 2021 assessment. As per the ISFR (2021), tree cover in the state is 169km^2.Trees outside forests (TOF) occupy 1934km², which includes both forest cover outside RFA (1765km^2) and tree cover (169km^2). Dominant tree species in rural TOF of Manipur are *Quercus* spp. (Relative abundance: 15.45%), *Castanopsis* spp. (12.25%), *Pinus kesiya* (10.89%), *Schima wallichii* (10.25%) and *Albizia* spp. (3.09%). In the urban regions dominant TOF species include *Mangifera indica* (Relative abundance: 12.25%), *Eucalyptus* spp.(7.78%), *Areca catechu* (5.92%), *Cedrela toona* (5.82%),and *Syzygium cumini* (5.46%).

The total carbon stock of forests in the state including TOF patches larger than 1 ha, amounts to 176.93 million tones (648.74 million tones of CO_2 equivalent) representing 2.46% of the country's total carbon stock. Major Non-Timber Forest Produce (NTFP) species in Manipur include *Emblica officinalis/ phyllanthus* (Relative abundance: 37.14%), *Parkia javancia/timoriana* (20.00%), Bombax spp./*Bombax ceiba* (20.00%), *Thysanolaena maxima* (17.14%) , and *Acquillaria mallaccensis, Acquillaria agallocha* (5.71%) (ISFR, 2021).

Forest types

S.No.	Type of Forest	Area (in sq.km)	% of the total mapped area
1	Pioneer Euphorbiaceous scrub	1263.20	6.93
2	Cachar semi-evergreen forest	2852.67	15.65
3	Secondary moist bamboo brakes	1324.51	7.27
4	East Himalayan moist mixed deciduous forest	4413.95	24.22
5	East Himalayan subtropical wet hill forest	6199.75	34.02
6	Khasi subtropical wet hill forest	423.94	2.33
7	Assam subtropical pine forest	632.86	3.47
8	Buk oak forest	530.44	2.91
9	Naga hills wet temperate forest	243.92	1.34
10	Montane bamboo brakes	13.49	0.07
11	TOF/Plantation	129.64	0.71
12	Eastern wet alluvial grassland	135.48	0.74
13	Assam sub-tropical pine savannah	60.15	0.34
	Grand Total	18224.00	100.00

Source: ISFR (2021)

Soil

Manipur boasts a diverse range of climates, physiographic settings, geology, and vegetation. The interaction of these factors over time and space results in the formation of various types of soils, each with distinct properties, limitations, and potentials. A field survey was conducted following the physiographic sequences of the terrain features. This survey included profile studies in different geographic situations, the checking and sampling of auger-bore samples at 10 km intervals of grid points, and random soil checks at various sites to generate soil mapping units (soil family associations) that reflect the soil's physiographic and climatic relationships. The map units (soil family associations) are described area-wise in a way that is easily understandable for most land users. Detailed legends describing the mapping units are provided in the report. The taxonomic names of each soil type (following Soil Taxonomy, Soil Survey Staff, 1975) are listed alongside the phases of dominant and subordinate soils in the mapping units, as well as any inclusions. An extended legend is also included on the colored soil map. The soil of Manipur belongs to 4 orders, 8 suborders, 13 great groups and 23 subgroups. It is observed that the Inceptisols are the dominant soils followed by Ultisols, Entisols and Alfisols and occupy 38.4%, 36.4%, 23.1% of the total geographical area of the State, respectively. Lake and marshy land occupy 1.9 percent. The area- wise distribution of soil at order and suborder levels of Taxonomy is given below.

Distribution of soil order and sub-orders of Manipur

S.No	Soil order	Sub order	Area ('000 ha)	% of TGA
1	Inceptisols		858.3	38.4
		Ocrepts	654.6	29.3
		Acrepts	203.7	9.1
2	Ultisols	811.0	36.4	
		Humults	374.0	16.8
		Udults	436.9	19.6
3	Entisols	Orthents	515.6	23.1

4	Alfisols	Udalfs	3.8	0.2
5	Miscellaneous Marshy landUdalfs	----	42.4	1.9
	Total		2231.0	100.0

Source: Department of Horticulture & Soil Conservation (2024)

Water resources of Manipur

Groundwater is a crucial resource for irrigation, domestic, and industrial use. It is available in the active recharge zone, which is replenished annually, and in the deeper zone below it, which is in-storage. Dynamic groundwater resources are regularly used reflected in water levels fluctuations. There are large groundwater reservoirs in deeper zones below the active recharge zone and confined aquifers in areas covered by alluvial sediments. In-storage groundwater resources can only be developed during extreme drought conditions and for drinking water supply. The state of Manipur's groundwater resources were assessed in March 2017, with a total annual extractable groundwater resource potential of 37787.25-hectare meter (ham). The provision for domestic use was 3629.16 (Hectare meter) ham, and the available groundwater resource for future use was 33688.14 ham. The net draft for irrigation was negligible for the entire state of Manipur. The Central Ground Water Board, North Eastern Region, re-estimated the groundwater resource for the 2019-20 assessment years.

Comparison between groundwater resources of Manipur as on March, 2017 and as on March, 2020

S.No.	Item	Year of Estimation (2017)	Year of Estimation (2020)	Comparison between Dynamic Groundwater Resources Estimated in (2017 & 2020)
1.	Annual Extractable Ground Water Resource (HAM)	37787.25	46296.45	8509.2
2.	Existing Gross Extraction (HAM)	541.65	2368.23	1826.58
3.	Irrigation uses (HAM)	345.95	345	-0.95
4.	Domestic uses (HAM)	171.7	1999.23	1827.53
5.	Industrial uses (HAM)	24	24	0.00
6.	Stage of GW Extraction (%)	1.44	5.12	3.69
7.	Provision for domestic (HAM)	3629.16	2022.18	-1606.98
8.	Provision for future use (HAM)	33788.14	43905.27	10117.13

Source: CGWB, (2020)

Agriculture

Agriculture is the major source of livelihood in Manipur. The state characterized by crested hills and widely spaced valleys, has about 10% area under cultivation. Rice, wheat, maize, oil seeds, potato and sugarcane are the main cash crops in the state. Among these crops, rice cultivation is the largest, both in the plains and hills of Manipur. Area and production of major crops grown in Manipur state are given as follows.

Crops	Year	Area	Production
Groundnut	2022-2023	0.03 lakh ha	0.03 lakh tonne
Rapeseed and mustard	2022-2023	0.32 lakh ha	0.24 lakh tonne
Soyabean	2022-2023	0.04 lakh ha	0.03 lakh tonne
Total oilseeds	2022-2023	0.39 lakh ha	0.30 lakh tonne

Natural rubber	2019-2020	-----	1920 tonne
Sugarcane	2022-2023	0.05 lakh ha	2.90 lakh tonne
Coarse cereals	2022-2023	0.25 lakh ha	0.57 lakh tonne
Maize	2022-2023	0.25 lakh ha	0.57 lakh tonne
Rice	2022-2023	1.86 lakh ha	3.49 lakh tonne
Total cereals and millets	2022-2023	2.14 lakh ha	1.12 lakh tonne
Wheat	2022-2023	0.02 lakh ha	0.06 lakh tonne
Arhar	2022-2023	0.01 lakh ha	0.01 lakh tonne
Gram/Bengal gram	2022-2023	0.01 lakh ha	0.01 lakh tonne
Masoor	2022-2023	0.01 lakh ha	0.01 lakh tonne
Moong	2022-2023	0.49 thousand ha	0.47 thousand tonne
Peas and beans	2020-2021	18.20 thousand ha	16.86 thousand tonne
Urad	2022-2023	0.01 lakh ha	0.01 lakh tonne
Total pulses	2022-2023	0.32 lakh ha	0.32 lakh tonne
Total foodgrains	2022-2023	2.46 lakh ha	4.43 lakh tonne
Total vegetables	2022-2023	38.35 thousand ha	376.57 thousand tonne
Total spices	2022-2023	8.74 thousand ha	64.41 thousand tonne
Total fruits	2022-2023	43.12 thousand ha	468.16 thousand tonne
Total medicinal and aromatic plants	2022-2023	0.04 thousand ha	0.12 thousand tonne
Total plantation crops	2022-2023	0.90 thousand ha	0.33 thousand tonne
Total flowers	2022-2023	0.24 thousand ha	0.06 thousand tonne

Source: http://www.indiastatmanipur.com

During 2020-21, total milk, meat, fish and egg production in the state were 71000 tonnes, 29000 tonnes, 0.33 lakh tones, and 1142 lakh numbers, respectively. For 2022-23, total honey production in the state was 500 tonne. Manipur is gifted with suitable agro-climatic conditions which support the production of various food and cash crops, fruits and vegetables. During 2022-2023, total fruit and vegetable production in the state were 468.16 thousand tonnes and 376.57 thousand tonnes, respectively.

Schemes of Manipur

The Manipur government has introduced various initiatives and plans, including the National Food Security Mission (NFSM), *Rashtriya Krishi Vikas Yojana* (RKVY), National Mission on Edible Oil-Oilseed (NMEO-OS), and National Mission on Oilseeds and Oil Palm (NMOOP). According to the 20th livestock census, the livestock and poultry population in Manipur is 6.44 million (Ministry of Agriculture, Department of Animal Husbandry, Dairying and Fisheries, 2019).

S.No	Scheme	Objective
1.	National Food Security Mission (NFSM)	This scheme was introduced to boost the production of rice, wheat, pulses, coarse cereals, and nutrient-rich cereals by expanding the cultivated area and enhancing productivity in a sustainable manner within the targeted districts. Additionally, it aims to restore soil fertility and productivity at the individual farm level.
2.	National Mission on Edible Oil-Oilseed (NMEO-OS)	The NMEO-OS scheme aims to enhance oilseed production nationwide. In the state, oilseed cultivation spans approximately 66652 hectares covers 6 districts. Currently, the emphasis is on three main oilseed crops: rapeseed and mustard, soybean, and groundnut.

3.	Fish Fair cum Fish Crop Competition, Promotion of Fisheries Activities	The Fisheries Department organizes an annual event to encourage fish farmers in the state. Farmers with the highest production records are selected and awarded to recognize their achievements.
4.	State Share to NEC Programme for Horticulture Development Activities	Under the scheme state will allocate ₹38.46 lakh for the revival of the progeny orchard, ₹10.85 lakh for strengthening the breeder seed regional potato farm at Mao, and ₹15 lakh for ameliorating acid soil for horticultural crops. Additionally, 160 acres of land will be utilized to produce 461 MT of quality and nucleus potato seeds.
5.	*Rashtriya Krishi Vikas Yojana* (RKVY)	The Yojana aims to develop farming as a primary economic activity. Its objectives include risk mitigation, supporting farmers' efforts, and promoting agri-business entrepreneurship by creating agricultural infrastructure.
6.	Agriculture Technology Management Agency (ATMA)	The Yojana aims to develop farming as a primary economic activity. Its objectives include risk mitigation, supporting farmers' efforts, and promoting agri-business entrepreneurship by creating agricultural infrastructure.
7.	National Mission on Agricultural Extension and Technology	The primary goal is to provide technical training to farmers. ATMA, a society comprising key stakeholders at the district level, focuses on sustainable agricultural development within the district.
8.	*Paramparagat Krishi Vikas Yojna* (PKVY)	*Paramparagat Krishi Vikas Yojna* (PKVY) is a scheme under National Mission for Sustainable Agriculture (NMSA). It aims at development of sustainable models of organic farming through integrating traditional and modern science to ensure long term soil fertility, resource conservation and address climate change.
9.	Per Drop more Crop (PDMC-PMKSY)	The scheme aims to maximize crop yields while using minimal water. The 'Per drop more crop' model is designed to address water-related issues by systematically improving water productivity and conservation, particularly in agriculture, thereby freeing up water for other productive uses.
10.	Mission Organic Value Change Development (MOVCD-Agri)	The "Mission Organic Value Chain Development for North Eastern Region" is a scheme aimed at promoting certified organic production in a value chain mode in states like Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, and Tripura, aiming to link growers with consumers and support the entire value chain from inputs to certification.
11.	Rainfed Area Development Program (RADP)	The initiative aims to enhance the quality of life for farmers, particularly small and marginal farmers, by providing a comprehensive set of activities designed to maximize agricultural returns. The Rural Agricultural Development Program (RADP) emphasizes an Integrated Farming System (IFS) approach to boost productivity and reduce the risks associated with climate variability.

Biodiversity

India is a mega-biodiversity country known for its rich diversity of plant and animal species, housing about7-8% of the recorded species of the world (CBD, 2024) and representing 4 of the 36 globally identified biodiversity hotspots (Himalayas, Indo-Burma, Western Ghats, and Sundaland). The state of Manipur is known for its rich biodiversity and is part of Indo-Burma biodiversity hotspots of the world. Its abundance in forests and resources is due to its location at the junction of two world's hotspots, the Indo-Myanmar and Himalayan hotspots. Manipur has two of these hotspots, the Himalayan and Indo-Burma hotspots. The Protected Area Network, which includes 2 National Parks, 6 Wildlife sanctuaries, and 3 Community Reserves, plays a crucial role in biodiversity conservation and the Loktak Lake of the state is known for its floating vegetation (Forest Department of Manipur, 2024).

Groups	Number of species in Manipur
Angiosperms	4000
Gymnosperms	20
Pteridophytic	300
Mammals	120
Reptiles & Amphibians	100
Medicinal plants	1200
Edible Fungi	34
Algae	121
Orchid	500
Bamboo	55
Birds	695
Fish	160
Migratory aquatic birds	55

Source: (ENVIS Manipur)

Agro-climatic zones

Manipur can be divided into four distinct agroclimatic zones: (i) subtropical plain zone, (ii) subtropical hill zone, (iii) temperate sub-Alpine zone, and (iv) midtropical hill zone, which differ in their geographic location, altitude, and climate (Kamala *et al.*, 2015). Subtropical plain zone encompasses Imphal West (711 m above sea level; average rainfall-1259.5 mm), Imphal East (790; 1413.0 mm), Thoubal (790 m; 1318.39 mm); Bishnupur (828 m; 1204.2 mm), and some area of Senapati district (2500 m; 671-1454 mm). Subtropical hill zone constitutes Churachandpur (1764 m; 3080 mm) and Chandel district (787 m; 1650.00 to 3430.85 mm). Temperate sub-Alpine zone includes Senapati and Ukhrul district (1338 m; 1763.7 mm); while midtropical hill zone comprises Ukhrul and some area of Imphal and Tamenglong district (1260 m; 3135 mm).

Demography

According to the 2011 Indian Census, Manipur had a population of approximately 28.56 lakh people. The state's population distribution reveals that 70.79% of the residents live in rural areas, while 29.21% reside in urban regions. Additionally, 58.9% of the total population is concentrated in the valley, with the remaining 41.1% living in the hilly areas. Manipur represents about 0.24% of India's total population, which was 1,210.19 million in 2011. The population density of Manipur is 121 people per square kilometer, which is notably lower than the national average density of 382 people per square kilometer. Despite this lower density, Manipur stands out for several demographic characteristics. The state has a commendable literacy rate of 79.85%, indicating a relatively high level of education among its inhabitants. However, the sex ratio in Manipur is 931 females for every 1,000 males, which is slightly below the national average of 987 females per 1,000 males (Manipur State Profile, 2023).

Administrative profile

In 1947, Manipur regained its political status as a sovereign independent Kingdom through the Manipur Constitution Act, 1947. This democratic government had the Maharaja as the Executive Head and an elected legislative assembly. On 15th October 1949, Manipur was merged into India through a merger agreement, ending the independent kingdom era. The state became part of the Indian Union in 1972 and achieved statehood. Imphal, the capital city of Manipur, is at the heart of the state's administrative and political activities. Manipur's rural governance structure includes 28 municipalities, 3,172 gram panchayats, 70 blocks, and 3,690 villages. Politically, the state is represented by 2 Lok Sabha constituencies and 60 Assembly constituencies. Administratively, Manipur is divided into 16 districts: Bishnupur, Chandel, Churachandpur, Imphal East, Imphal West, Jiribam, Kakching, Kamjong, Kangpokpi, Noney, Pherzawl, Senapati, Tamenglong, Tengnoupal, Thoubal, and Ukhrul. These districts are crucial for local governance and the implementation of state policies across both the hilly and valley regions of Manipur. (Ministry of Rural Development, 2024).

State symbols

Manipur's state symbols highlight its rich biodiversity. The state animal is the Manipur Brow Antlered Deer, also known as the Dancing Deer (*Panolia eldii eldii*). The state bird is Mrs. Hume's pheasant, or bar-tailed pheasant (*Syrmaticus humiae*). The Siroy Lily, known locally as Shirui Lily (*Lilium mackliniae*), is the state flower. The state tree is the Bonsum, referred to as Uningthou in Manipuri and Angare in Nepali (*Phoebe hainesiana*). The Belengee puti (*Osteobrama belangeri*) is recognized as the state fish. The State official language of Manipur is Meitei, also known as Manipuri. Beyond Meitei, Manipur is characterized by significant linguistic diversity, similar to much of Northeast India.

Promising Agroforestry Models for Manipur

S.No.	Agroforestry models	Tree component	Crop component	Economic returns/ Benefit Cost Ratio (BCR)
1.	*Eucalyptus*-based silvihorticultural agroforestry	*Eucalyptus citriodora, Eucalyptus tereticornis*	Pineapple	48.80 qha^{-1} yr^{-1} (Bhatt *et al.*, 2001) 47.6 qha^{-1} yr^{-1} (Bhatt *et al.*, 2001)
2.	*Parkia*-based silvihorticultural agroforestry	*Parkia roxburghii*	Pineapple	64.0 qha^{-1} yr^{-1} (Bhatt *et al.*, 2001)
3.	*Subabul*-based silvihorticultural agroforestry	*Leucaena leucocephala*	Pineapple	108.20 qha^{-1} yr^{-1} (Bhatt *et al.*, 2001)
4.	Bamboo-based Agroforestry Model	Bamboo spp.	Wheat, mustard, pulses, ginger and turmeric	Net income of Rs. 95,000 to 2,00,000 ha^{-1} yr^{-1} after 4 years under irrigated conditions(Handa *et al.*, 2020)
5.	Mulberry-based Agroforestry Model	*Morus alba*	Napier-Bajra hybrid or *Setaria anceps* grass pulses, beans, soybean and wheat	Net income of Rs. 14 000 ha^{-1} yr^{-1} in the initial years to Rs. 50000 ha^{-1} yr^{-1}after establishment of the system (Handa *et al.*, 2020)
6.	Agar based Agroforestry	*Aquilaria malaccensis*	Patchouli, Sugandh mantra, Kalmegh, Gathion pineapple, Ginger, turmeric, Sarpagandha Pipali	From an established plantation, a net income of Rs. 25-30 lakh ha^{-1} after 15 years may be generated giving an average of Rs. 1, 96,400 $year^{-1}$ ha^{-1} (Handa *et al.*, 2019).

Agroforestry Models for Manipur

Agar-*based* Agroforestry Model

Scientific name: *Aquilaria malaccensis*

Suitable spacing: For mono crop, spacing is 2.5mx2.5m. However, after 10 years of growth 50% of trees may be harvested.

Suitable intercrops:

- Vegetables/pulses/fruits or medicinal and aromatic crops such as Patchouli (*Pogostemon cablin*), Sugandh mantra (*Homalomena aromatica*), Kalmegh (*Andrographis paniculata*), Gathion pineapple (*Kaempferia galanga*), etc. can be cultivated during first 3-5 years of plantation.
- Ginger/turmeric may also be planted during initial 2-3 years In later stages shade-tolerant medicinal plants like Sarpagandha (*Rouvolfia serpentine*), Pipali (*Piper longum*) and Kalmegh can be grown successfully depending on tree population and land situation.

Yield: The yield of commercial product of agar tree varies greatly and is almost unpredictable. After 10 years of planting with intensive management each infected tree may yield about 30-40 kg.

Economic returns: From an established plantation, thus, a net income of Rs. 25-30 lakh ha^{-1}after 15 years may be generated giving an average of Rs. 1, 96,400 $year^{-1}$ ha^{-1}. Intercropping in the early stages of growth can generate extra income (Handa *et al.*, 2019).

Mulberry-*based* Agroforestry Model

Scientific name: *Morus alba*

Suitable spacing: 3m×3m for fodder and 2-3m between trees on Boundary/bunds.

Suitable intercrops: Napier-Bajra hybrid or *Setaria anceps* grass pulses, beans, soybean and wheat can be cultivated.

Tree productivity: 8t ha^{-1} yr^{-1} of green tree fodder and 24 t ha^{-1} yr^{-1} of green grass forage over only 6 t ha^{-1} yr^{-1} green fodder yield from degraded grassland.

Economic returns: Net income of Rs. 14 000 ha^{-1} yr^{-1} in the initial years to Rs. 50 000 ha^{-1} yr^{-1} after establishment of the system (Handa *et al.*, 2020).

Bamboo-*based* Agroforestry Model

Scientific name: *Bambusa balloon, B. bambos, B. tulda, B. nutans, Dendrocalamus hamiltonii, D. strictus* and *D. stocksii*

Suitable spacing: 10m×8m or 12m×10m in agroforestry and 3-4m between clumps on boundary.

Suitable intercrops: Wheat, mustard, pulses, etc. during the establishment phase with normal yield and shade-loving crops *i.e.* ginger and turmeric from the second year onwards.

Productivity: 500-750 culms ha^{-1} yr^{-1}.

Economics: Net income of Rs. 95,000 to 2,00,000 ha^{-1} yr^{-1} after 4 years under irrigated conditions (Handa *et al.*, 2020).

Parkia based Agroforestry

Scientific name: *Parkia roxburghii*

Suitable spacing: 24-30 ft x 24-30 ft..

Suitable intercrops: Vegetables or small fruit crops.

Yield: Fresh pods are harvested from mid-October, with maturation occurring in March. Each tree bean plant produces between 500 to 1,500 pods (equivalent to 90-260 kg. per plant), and the rate Rs. 80-100 per kg. A farmer can earn between Rs. 6,000 and Rs. 8,000 annually from a single immature tree and between Rs. 10,000 and Rs. 15,000 from a single mature tree during the fruiting period from November to March, solely from the sale of the pods.

Source: Kharshi-ing *et al.*, (2004) and Roy *et al.*, (2016).

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Agroforestry Business Incubation Centre

ABiC

Institute Technology Management Unit (ITMU) of CAFRI facilitates incubation of new startup/entrepreneurs and enterprises for innovation technologies by providing need based physical, technical, business and networking support, facilities and services to test and validate business ventures of the incubates in agroforestry-based enterprises. Also, the IP/deemed IP are commercialized for creating an ecosystem for entrepreneurship. ABiC activities includes thematic areas like are plant nursery; semi-processed items like juice, jam, pulp, gum & resin, etc.; tree seed marketing; timber and wood-based products; fibre and flosses; biofuels and briquettes; essential oils; mini-clonal technology and agroforestry models.

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