



कृषि एवं किसान  
कल्याण मंत्रालय  
MINISTRY OF  
AGRICULTURE AND  
FARMERS WELFARE

सत्यमेव जयते



# Promising Agroforestry Models for Sikkim



**ICAR-Central Agroforestry Research Institute**

Jhansi-284003, Uttar Pradesh, India





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### **Contribution**

Agroforestry scientists working in ICAR-Central Agroforestry Research Institute, Jhansi and in the All India Coordinated Research Project on Agroforestry of the Indian Council of Agricultural Research, New Delhi.

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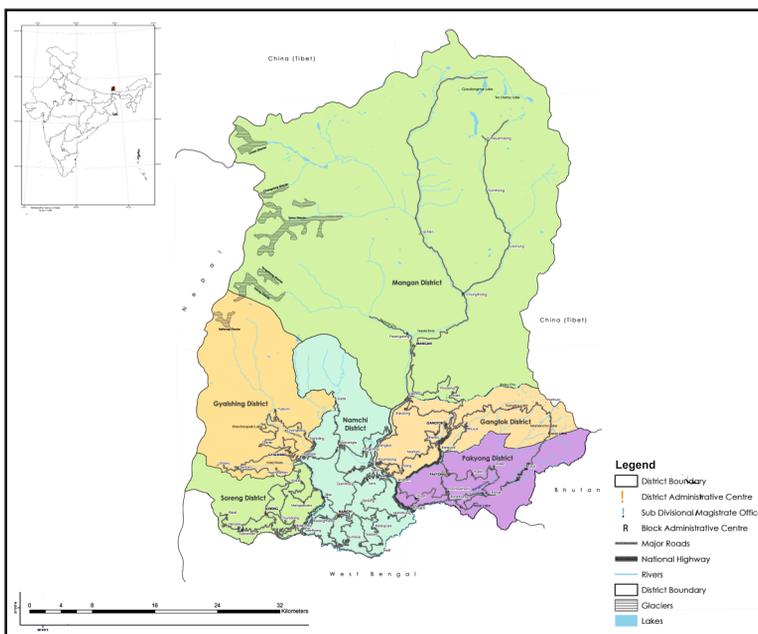
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# Promising Agroforestry Models for Sikkim

Sikkim, literally meaning "new palace" (from the Limbu words su meaning "new" and khyim meaning "palace"), is a picturesque state nestled in the Eastern Himalayas. Known for its snow-capped peaks, lush green valleys, and rich biodiversity, Sikkim is one of the most environmentally conscious states in India and the first to achieve 100% organic farming. Apart from its natural charm, Sikkim is also a cradle of diverse cultures and traditions, showcasing a harmonious blend of Nepali, Bhutia, and Lepcha heritages. The state capital is Gangtok, located in the eastern part of Sikkim. Geographically, Sikkim is situated



between 27°04' N to 28°07' N latitude and 88°00' E to 88°55' E longitude. It is bordered by Tibet (China) in the north and northeast, Bhutan in the east, West Bengal in the south, and Nepal in the west, sharing three international boundaries. Despite being the second smallest state in India, Sikkim holds strategic and ecological significance in the Indian subcontinent. The state became a part of India on 16<sup>th</sup> May 1975, following a referendum that led to the dissolution of its monarchy. Covering an area of 7,096 km<sup>2</sup>, Sikkim accounts for about 0.21% of India's total geographical area. Sikkim has six districts namely Gangtok, Mangan, Namchi, Gyalshing, Pakyong and Soreng. The district capitals are also Gangtok, Mangan, Namchi, Gyalshing, Pakyong and Soreng respectively. These six districts are further divided into 16 subdivisions. Pakyong and Soreng Districts were added after December 2021 (GoS, 2025).

## Physiography

Physiographically, Sikkim is characterized by a rugged terrain with towering mountains, steep ridges, deep gorges, and swift-flowing rivers. The state lies entirely within the Himalayan range and is broadly divided into four districts—East, West, North, and South Sikkim—each varying in elevation and landform features. The northern region is dominated by high-altitude mountains, including Kangchenjunga (8,586 m), the third highest peak in the world and the highest in India, located on the border with Nepal. The Teesta River, the lifeline of Sikkim, flows southward through the state along with its tributary, the Rangeet River, carving beautiful valleys and gorges. While the northern parts are alpine and glaciated, the southern region descends into subtropical valleys. Forests cover a significant portion of the landscape, and the region is part of the Eastern Himalayan biodiversity hotspot. High-altitude lakes such as Tsomgo (Changu) Lake, Gurudongmar Lake, and Khecheopalri Lake are prominent features, adding to Sikkim's charm and spiritual significance (Sikkim Biodiversity Board, 2023).

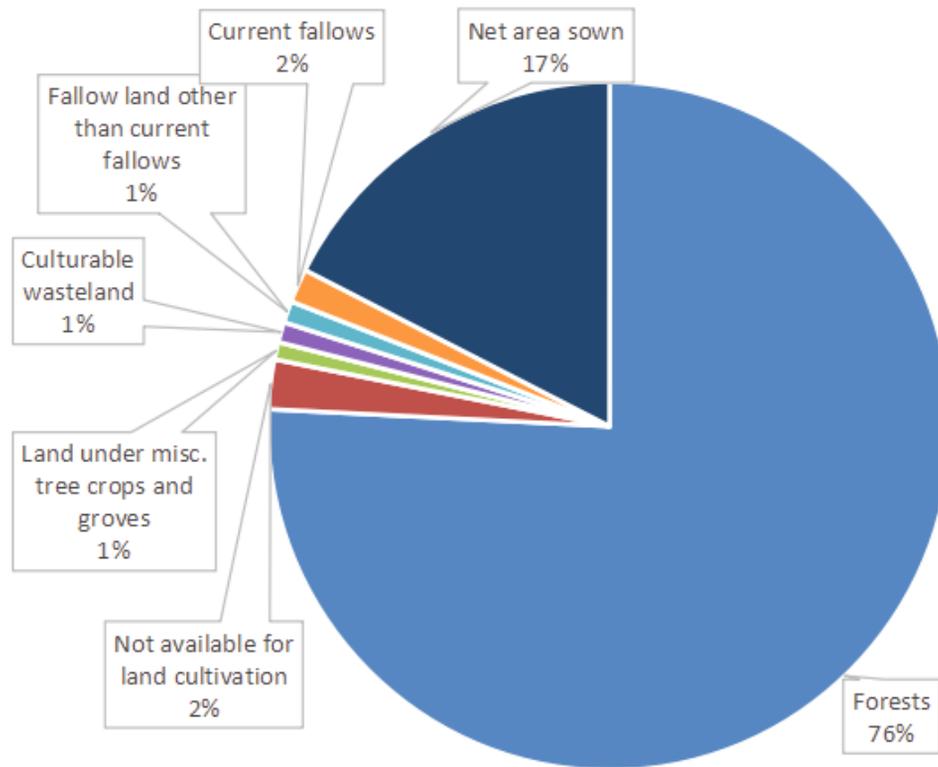
## Climate

Sikkim enjoys a highly diverse climate, ranging from subtropical in the lower altitudes to alpine and tundra in the higher elevations. The climate is largely governed by the topography and altitude, leading to stark variation in weather patterns across the state. Sikkim experiences four distinct seasons—Winter (December to February), Pre-Monsoon (March to May), Monsoon (June to September), and Post-Monsoon (October to November). Winters can be extremely cold, especially in North Sikkim, where

temperatures often drop below -10°C, with regular snowfall. Summers are pleasant, rarely exceeding 25°C. The monsoon season brings heavy rainfall, especially between June and September, due to the southwest monsoon, which leads to frequent landslides and road blockages in hilly terrains. Annual rainfall varies from 2,000 mm to over 5,000 mm, depending on the location, with an average of about 2,500 mm. The state's pristine environment, moderate temperatures in lower altitudes, and snowy peaks make it a year-round destination for tourists and a significant zone for ecological research and conservation (Sikkim State ENVIS Hub, 2018).

**Land use pattern**

Forestry is the dominant land use in Sikkim, with approximately 83% of the state's total geographical area under the administrative control of the State Forest Department—one of the highest proportions in India. A significant portion of this area is protected, including the Khangchendzonga National Park, which spans 1,784 sq. km and covers 25.14% of Sikkim’s geographical area. The park is distributed across the North (78.30%), West (18.32%), and South (3.38%) districts and is a proposed World Heritage Site under both natural and cultural categories. In addition to the national park, Sikkim has seven Wildlife Sanctuaries and one Conservation Reserve. Collectively, these protected areas—along with reserve forests—account for 47.69% of the state's land under forest and tree cover, solidifying Sikkim's status as the greenest state in the country.



*Source:* Land Use Statistics at a Glance (2021-22)

**Forests and its resources**

Sikkim constitutes one of the richest forest zones in India, with diverse forest types and altitudinal vegetation gradients shaped by its unique Himalayan topography. The state has a total forest cover of 3,358.40 km<sup>2</sup>, which accounts for 47.33% of its total geographical area (7,096 km<sup>2</sup>) as per ISFR (2023). The forest cover includes Very Dense Forest (VDF): 1,103.31 km<sup>2</sup>, Moderately Dense Forest (MDF): 1,555.89 km<sup>2</sup>, and Open Forest (OF): 699.20 km<sup>2</sup>. Additionally, Scrub areas constitute another 303.49 km<sup>2</sup> (4.28%). In district-wise analysis before the reorganization in December 2021, North Sikkim has the largest forest area (1,290.33 km<sup>2</sup>) and South Sikkim records the highest percentage of forest cover

relative to its area (75.07%). Forests inside Recorded Forest Area (RFA) cover 2,060.63 km<sup>2</sup>, while forest cover outside RFA is 1,297.77 km<sup>2</sup>.

Compared to ISFR 2021, there has been a net increase of 5.19 km<sup>2</sup> in total forest cover. The state's tree cover outside forests is relatively lower compared to the forest cover i.e 48.33 km<sup>2</sup>. Major TOF species in rural areas include *Schima wallichii*, *Ficus spp.*, *Alnus nepalensis*, *Alnus spp.*, and *Macaranga spp.* In urban areas, *Schima wallichii*, *Pinus kesiya*, *Ficus spp.*, *Cryptomeria japonica*, and *Macaranga spp.* are dominant. As per ISFR 2023, the total carbon stock of forests in Sikkim is 56.83 million tonnes, and with a per hectare carbon density of 169.20 tonnes/ha, the state contributes significantly on a per unit area basis—reflecting its dense vegetation and substantial forest cover.

Major Non-Timber Forest Produce (NTFP) species include *Thysanolaena maxima*, *Rubia cordifolia*, *Diplazium spp.*, *Nephrolepis spp.*, *Urtica dioica*, and *Aconitum ferox*. The top tree species by volume inside RFAs are *Castanopsis spp.* (5.63 Mm<sup>3</sup>), *Shorea robusta* (3.61 Mm<sup>3</sup>), and *Schima wallichii* (2.03 Mm<sup>3</sup>).

#### Forest types

S.No.	Forest type (Champion & Seth classification)	Area (km <sup>2</sup> )	% of total mapped area
1	East Himalayan Sal (3C/C1a(I))	69.80	1.84%
2	East Himalayan Moist Mixed Deciduous Forest (3C/C3b)	190.98	5.03%
3	East Himalayan Subtropical Wet Hill Forest (8B/C1)	889.35	23.42%
4	Buk Oak Forest (11B/C1b)	877.86	23.11%
5	East Himalayan Mixed Coniferous Forest (12/C3a)	223.74	5.89%
6	Montane Bamboo Brakes (12/DS1)	7.08	0.18%
7	East Himalayan Sub-Alpine Birch/Fir Forest (14/C2)	903.18	23.78%
8	Birch/Rhododendron Scrub Forest (15/C1)	145.60	3.83%
9	Dwarf Rhododendron Scrub (15/E1)	11.50	0.30%
10	Dwarf Juniper Scrub (15/E2)	208.76	5.50%
	<b>Subtotal (Forest Cover + Scrub)</b>	<b>3,527.85</b>	<b>92.88%</b>
11	TOF / Plantation	134.04	3.53%
	<b>Total Forest Cover &amp; Scrub</b>	<b>3,661.89</b>	<b>96.41%</b>
12	Alpine Pastures (15/C3, outside forest cover)	136.28	3.59%
	<b>Grand Total (Forest + Scrub + Alpine Pasture)</b>	<b>3,798.17</b>	<b>100.00%</b>

Source: FSI (2023)

#### Soil

The soils of Sikkim belong to 3 orders namely, Inceptisol (42.84%), Entisol (42.52%) and Mollisol (14.64%), 7 suborders, 12 great groups and 26 subgroups. The soils are mostly of light texture, well drained, therefore its water holding capacity is poor. Texture of soil varies from loamy sand to silty clay loam. The depth of soil varies from few inches and in some places practically nil to several meters. With respect to soil fertility, soils in Sikkim are high in organic carbon content, potassium, zinc, copper, iron and manganese contents, medium in available phosphorus and nitrogen and deficient in boron and molybdenum. The soils are having high phosphorus fixation capacity due to high amount of active iron and aluminium oxides. In many soils, the total amount of native phosphorus is high but present in unavailable forms to plants. The soil of Sikkim developed under the influence of heavy rainfall has the acidic reaction throughout the State. The soil reaction varies from moderately acidic to strongly acidic (pH range from 4.3 to 6.4; mean is 5.37) and low

exchangeable bases. Of the four Districts of Sikkim, the frequency of soil having pH < 5.0 are 50 per cent in North Sikkim while in the others it is about 12 per cent. Such soils pose aluminium and manganese toxicities to the crops. Soil remains wet from March to October. Thereafter due to paucity of rainfall post monsoon/winter moisture stress occurs. During winter (Oct to Feb) natural springs serves as the main source of water for feeding cattle and as life saving irrigation to winter crops.

#### Distribution of soil sub-groups across the physiographic units

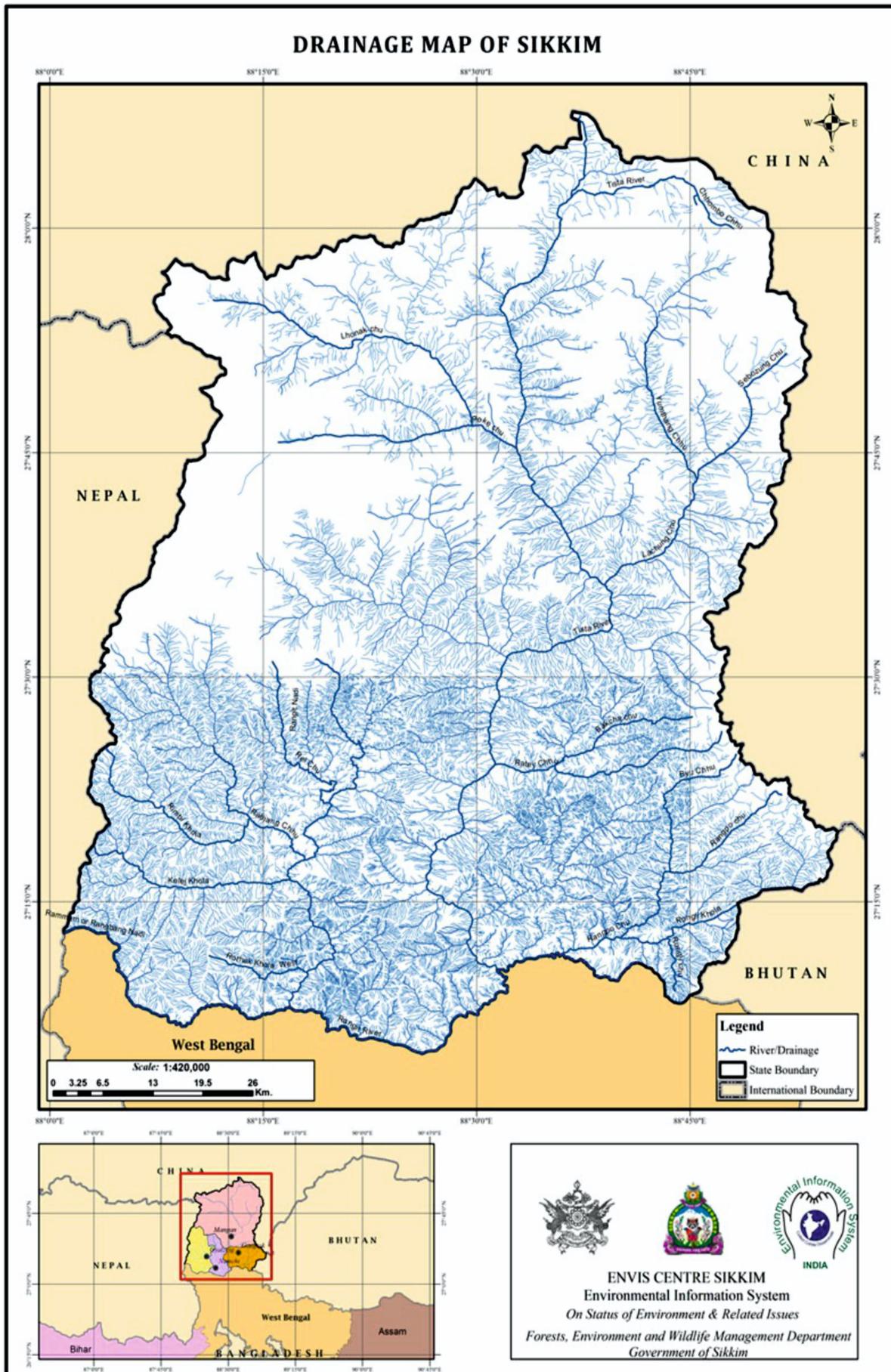
S.No.	Physiographic Units	Dominant Soils Subgroup
1	Summit and ridge (<30% slope)	Typic Haplumbrepts, Typic Hapludolls, Pachic Haplumbrepts, Typic Udorthents
2	Side slope of hills	
2.1	Very steeply sloping (>50%)	Typic Haplohumults, Entic Hapludolls, Dystric Eutrochrepts, Lithic Cryorthents
2.2	Escarpments (>50%)	Typic Udorthents, Entic Hapludolls, Umbric Dystrochrepts
2.3	Steeply sloping (30–50%)	Umbric Dystrochrepts, Typic Hapludolls, Typic Argiudolls, Cumuli Haplumbrepts, Entic Cryumbrepts
2.4	Moderately steep sloping (15–30%)	Fluventic Eutrochrepts, Mollic Udarents, Typic Argiudolls, Cumuli Argiudolls
3	Valleys (15–30%)	Typic Haplumbrepts, Aquic Udorthents, Cumuli Hapludolls
4	Rocky cliffs and Precipitous slope	Lithic Udorthents, Lithic Haplumbrepts

Source: Rahman and Karuppaiyan (2011)

#### Water resources of Manipur

Sikkim is abundantly endowed with diverse water resources, encompassing rivers, glaciers, lakes, and natural springs, playing a vital role in the state's ecological and socio-economic fabric. The two principal river systems are the Teesta and Rangit rivers. Teesta, originating from the Teesta Khangse Glacier in the Mangan District, is the major river of the state, fed by tributaries such as Dikchu, Rangyong, Bakchachu, Rongpochu, Zemu Chu, and Lachung Chu. Rangit, another significant river, has tributaries like Rangbhang, Relli, Rathong, and Kalej. These rivers are sustained by numerous glaciers predominantly located in Mangan District, such as Zemu, Lhonak (North and South), Hidden, Talung, and Teesta Khangse. The Rathong Glacier, situated in Gyalshing District, is the origin of the Rangit river. Sikkim is also home to over 500 lakes, many of which are glacial in origin. Prominent lakes include Gurudongmar and Chalamu in Mangan District, Tsomgo (Changu), Menmecho, and Bidang Cho in Gangtok District, and Khecheopalri, Samiti, Laxmi Pokhari, and Ram-Laxman Twin Lakes in Gyalshing District. These water bodies serve not only as ecological hotspots but also hold immense religious, cultural, and touristic value. (State of Environment Report, 2016). The major tributaries of Teesta river are listed below. For better understanding of Teesta river system, it has been divided into a number of river sub-systems which are described in the succeeding paragraphs. These sub-systems are: i) Chhombho Chhu/ Teesta river upstream of Zemu Chhu-Teesta confluence, ii) Zemu Chhu, iii) Teesta river between Lachen and Chungthang, iv) Lachung Chhu, v) Chungthang-Mangan and Chakung Chhu sub-system, vi) Rangyong (Talung) Chhu, vii) Dik Chhu, viii) Teesta river between Mangan and Singtam, ix) Rani Khola, x) Teesta river between Teesta-Rani Khola confluence and Teesta-Rangpo Chhu confluence, xi) Rangpo Chhu, xii) Rangit River, and xiii) Jaldhaka River.

S.No.	Left-bank Tributaries	Right-bank Tributaries
1	Lachung Chhu	Zemu Chhu
2	Chakung Chhu	Rangyong Chhu
3	Dik Chhu	Rangit River
4	Rani Khola	
5	Rangpo Chhu	



Source: Sikkim ENVIS Hub (2025)

## Agriculture

Agriculture plays a pivotal role in the economy of Sikkim, serving as the primary source of livelihood and economic security for a significant portion of the population. With over 80% of the rural population dependent on agriculture and allied sectors, the state's agricultural framework underpins food and nutritional security for its people. Despite challenges posed by various biotic and abiotic factors, Sikkimese farmers have nurtured an integrated farming system that reflects generations of indigenous knowledge and experimentation.

In recent years, the adoption of modern agricultural technologies has contributed to marginal improvements in the lifestyle of farmers. However, it is the state's organic transformation that has positioned Sikkim as a national and global model. Leveraging its natural advantages and favourable agro-climatic conditions, Sikkim has embraced policies and programmes aligned with sustainable, organic agriculture. The state's visionary initiative, the Sikkim Organic Mission, has led to comprehensive departmental interventions, particularly by the Agriculture and Horticulture Departments, to promote chemical-free and environmentally responsible farming practices.

### Crop Production Statistics as on 2020-21

Crop	Area (000' ha)	Production (000' tonnes)	Productivity (kg/ha)
Rice	8.70	16.19	1860.61
Wheat	0.10	0.12	1153.85
Maize	38.39	67.94	1769.68
Finger Millet	2.05	2.13	1037.98
Barley	0.35	0.40	1167.63
Buckwheat	3.11	3.07	986.83
Pulses	5.14	4.95	961.76
Oilseeds	6.13	5.67	925.09

Source: Sikkim ENVIS Hub (2022)

## Biodiversity

India is a mega-biodiversity country known for its rich diversity of plant and animal species, housing about 7-8% 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 Sikkim is renowned for its extraordinary biological richness and forms a part of the Eastern Himalaya, one of the world's 18 recognized biodiversity hotspots. Although covering only 0.2% of India's geographical area, Sikkim hosts a remarkable diversity of flora and fauna due to its altitudinal range (300 m to 8,586 m), varied climate zones, and ecological niches. The state falls under the Himalayan (2) Biogeographic Zone and the Central Himalaya (2c) Biotic Province, encompassing around 9 major forest types. Its Protected Area Network includes several Wildlife Sanctuaries and a National Park, such as the Khangchendzonga National Park, a UNESCO World Heritage Site known for its high-altitude biodiversity. The state is home to many rare and endangered species, and the high-altitude wetlands, rivers, and lakes contribute significantly to its ecological value. The forests of Sikkim are not only rich in timber but are also a vital source of medicinal plants and other non-timber forest products used by local communities for traditional healing practices (Forest Department of Sikkim, 2024)

Groups	Number of Species in Sikkim
Flowering Plants (Angiosperms)	4,500
Orchids	550
Rhododendrons	36
Conifers	16

Bamboos	28
Ferns & Fern Allies	362
Tree Ferns	9
Primulas	30
Oaks	11
Medicinal Plants	424
Mammals	>144
Birds	552
Butterflies	600
Fishes	48

**Source:** Forest & Environment Department-GoS (2025)

### Demography

Sikkim, the least populous state in India, had a total population of 6,10,577 in 2011, marking a decadal growth of 12.89% from 5.41 lakh in 2001. Despite being the second smallest state in terms of area (7,096 km<sup>2</sup>), its population density rose from 76 to 86 persons per km<sup>2</sup> over the decade. The sex ratio improved from 875 to 890 females per 1000 males, while the child sex ratio increased from 938 to 957, reflecting gradual progress in gender balance. The literacy rate saw a significant rise from 68.81% in 2001 to 81.42% in 2011, with male literacy at 86.55% and female literacy at 75.64%, indicating a notable improvement in educational access, particularly for women. The child population (0–6 years) declined from 78,195 to 64,111, suggesting a slowing population growth trend. Urbanization in Sikkim has been rapid, with the urban population growing by over 156%, accounting for 25.15% of the total, while the rural population declined by nearly 5%, though it still comprises 74.85% of the state's total population. Literacy levels are higher in urban areas (88.71%) compared to rural areas (78.95%), and the gender gap in literacy is narrower in towns.

### Administrative profile

Sikkim, formerly an independent monarchy, became the 22<sup>nd</sup> state of India in 1975, with Gangtok as its capital and administrative hub. The state is administratively divided into six districts—Gangtok, Mangan, Namchi, Pakyong, Gyalshing, and Soreng—each managed by a District Collector. These districts are further subdivided into 16 subdivisions and approximately 34 block administrative centres. Rural governance in Sikkim operates under the Sikkim Panchayat Act, 1993, with around 1,149 Gram Panchayat Wards functioning under Gram Panchayat Units (GPUs). Urban governance is managed through one Municipal Corporation in Gangtok and several Nagar Panchayats, including those in Namchi, Mangan, Gyalshing, and Rangpo. The state is represented politically by one Lok Sabha seat and has 32 Assembly constituencies. The Rural Development Department oversees the implementation of key central and state schemes such as MGNREGA, PMGSY, and rural housing initiatives, ensuring development across both rural and urban regions of the state.

### State symbols

Sikkim's state symbols reflect its unique ecological diversity and cultural richness. The state animal is the Red Panda (*Ailurus fulgens*), a rare and charismatic species found in the temperate forests of the Himalayas. The state bird is the Blood Pheasant (*Ithaginis cruentus*), known for its striking coloration and association with high-altitude forests. The Noble Dendrobium (*Dendrobium nobile*), a beautiful orchid species, has been designated as the state flower. The Rhododendron (*Rhododendron niveum*), found in the upper reaches of the Eastern Himalayas, is the state tree. The Common Mahseer (*Neolissochilus hexagonolepis*), a freshwater fish species found in mountain streams, is recognized as the state fish. The state butterfly is Blue Duke (*Bassarona durga*). The official language of Sikkim is Nepali, although other languages such as Bhutia, Lepcha, and Limbu are also widely spoken, reflecting the state's rich ethnic and linguistic mosaic (Forest & Environment Department-GoS, 2025).



**Agroforestry Systems  
for  
Sikkim**



## Himalayan Alder-based Agroforestry Model

**Scientific Name:** *Alnus nepalensis* (Himalayan alder)

**Rotation:** 30–40 years

**Suitable intercrops:** Large cardamom (*Amomum subulatum*) cultivated as an understory perennial crop in Himalayan alder as the shade tree.

**Tree productivity:** Alder: 80 t ha<sup>-1</sup> bole biomass at 30-year rotation, 2.5–3.5 t ha<sup>-1</sup> yr<sup>-1</sup> fuelwood and 150–200 kg ha<sup>-1</sup> yr<sup>-1</sup> fodder production.

**Cardamom capsule:** 250–350 kg ha<sup>-1</sup> yr<sup>-1</sup> up to 30 years rotation.

**Uses:** Alder provides shade, fodder, fuelwood and timber. The tree helps to fix 50–150 kg per ha amount of nitrogen.

**Cardamom:** Used in food preparations, confectionaries, perfumes, and seeds contain about 3% essential oil rich in cineole which is used as flavouring agent and spice.

**Economics:** Cardamom starts yield after 3 years and yields until 30 years with a B:C ratio ranging from 1.04 (3<sup>rd</sup> year) to 5.94 (30<sup>th</sup> year). It improves landslide-affected sites through nitrogen fixing and reducing soil loss. Cardamom-alder system stores about 150–160 t ha<sup>-1</sup> total carbon stocks over 20 years (Arunachalam *et al.*, 2019).

## Agar-based Agroforestry Model

**Scientific name:** *Aquilaria malaccensis*

**Suitable Spacing:** For mono crop, spacing is 2.5 m x 2.5 m. However, after 10 years of growth 50 % of trees may be harvested. 6m×3m, 8m×2m and 3m×3m, 2.5m×2.5 m (400-1600 tree ha<sup>-1</sup>) in block plantation. For boundary planting, 150-200 tree ha<sup>-1</sup> at 2-5 m apart.

**Suitable Intercrops:**

- Vegetables/pulses/fruits or medicinal and aromatic crops such as Patchouli (*Pogostemon cablin*), Sugandh mantra (*Homalomena aromatica*), Kalmegh (*Andrographis paniculata*), Gathion (*Kaempferia galanga*), pineapple, 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 (*Rauvolfia serpentina*), 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<sup>-1</sup> after 15 years may be generated giving an average of Rs 1, 96,400 year<sup>-1</sup> ha<sup>-1</sup>. Intercropping in the early stages of growth can generate extra income (Arunachalam *et al.*, 2019; 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<sup>-1</sup> yr<sup>-1</sup> of green tree fodder and 24 t ha<sup>-1</sup> yr<sup>-1</sup> of green grass forage over only 6 t ha<sup>-1</sup> yr<sup>-1</sup> green fodder yield from degraded grassland

**Economic Returns:** Net income of Rs. 14 000 ha<sup>-1</sup> yr<sup>-1</sup> in the initial years to Rs. 50 000 ha<sup>-1</sup> yr<sup>-1</sup> after establishment of the system (Handa *et al.*, 2020)

## Bamboo-based Agroforestry Model

**Scientific name:** *Bambusa ballooon*, *B. bambos*, *B. tulda*, *B. nutan*, *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<sup>-1</sup> yr<sup>-1</sup>

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

### Bamboo species of Sikkim

S.No.	Scientific Name	Common Name	Altitude Zone (m)
1	<i>Arundinaria maling</i> Gamble ( <i>A. racemosa</i> )	Malingo, Dave malingo	1800–2700
2	<i>Arundinaria suberecta</i> Munro	Sanu Maling	1500–2000
3	<i>Bambusa nutans</i> Wall	Mala Bans	600–1500
4	<i>Bambusa pallida</i> Munro	Kalinga	1500
5	<i>Bambusa tulda</i> Roxb	Karanti bans	600
6	<i>Bambusa vulgaris</i> Schard	Bongshingh	1500
7	<i>Cephalostachyum capitatum</i> var. <i>decomposita</i>	Gope bans	600–1800
8	<i>Cephalostachyum fushsianum</i> Gamble	Palom	1800–2400
9	<i>Cephalostachyum latiforum</i> Gamble	Gopa bans	1800–2400
10	<i>Cephalostachyum hookernia</i> Gamble	Pareng/Singhana	1800
11	<i>Cephalostachyum intermedia</i>	Tita Nigalo	2000
12	<i>Cephalostachyum polystachya</i>	—	900–1500
13	<i>Dendrocalamus hamiltonii</i> Nees	Choya bans (Sal forests)	900
14	<i>Dendrocalamus hookeri</i> Munro	Tile bans	900
15	<i>Dendrocalamus patellaris</i> Gamble	Pajiok pao	1800
16	<i>Dendrocalamus sikkimensis</i> Gamble	Bhalu bans	1800
17	<i>Neohouzeaua dullooa</i> ( <i>Teinostachyum dullooa</i> )	Tokri bans	1500
18	<i>Pseudostachyum polymorphum</i> Munro	Pheling	1200
19	<i>Semiarundinaria patlingii</i>	Maling	3000
20	<i>Thanocalamus aristatus</i>	Rato Nigalo	2700–3400
21	<i>Teinostachyum falconeri</i>	Phurse Nigalo	2250–2700
22	<i>Phyllostachys pubescens</i>	Gyansi bans	—
23	<i>Chimonobambusa intermedia</i>	Nigala bans	—
24	<i>Chimonobambusa hookeriana</i>	Singhani bans	—
25	<i>Thanocalamus goostratus</i>	Tshi/Kishome bans	—
26	<i>Pseudostachyum polymorphum</i>	Filling bans	—
27	<i>Cephalostachyum capitatum</i>	Mukali bans	—
28	<i>Phyllostachys edulis</i>	Kata bans	4000–6000

Source: Forest & Environment Department-GoS (2025)

## References

- Agricultural Statistics at a Glance, (2022). Government of India, Ministry of Agriculture & Farmers Welfare Department of Agriculture & Farmers Welfare Economics & Statistics Division. <https://desagri.gov.in/wp-content/uploads/2023/05/Agricultural-Statistics-at-a-Glance-2022>. Accessed on 5 July 2024.
- CBD (Convention on Biological Diversity), (2024). India - Country Profile: Biodiversity Facts Status and trends of biodiversity, including benefits from biodiversity and ecosystem services. <https://www.cbd.int/countries/profile?country=in>. Accessed on 27 June 2024.
- Forest & Environment Department-GoS (2025) Forest & Environment Department. Last updated: 7 July 2025. Available at: <http://sikkimforest.gov.in/> (Accessed: 8 July 2025).
- Forest Survey of India (2024) India State of Forest Report 2023. Dehradun: Forest Survey of India, Ministry of Environment, Forest and Climate Change. Available at: [https://fsi.nic.in/uploads/isfr2023/isfr\\_book\\_eng-vol-1\\_2023.pdf](https://fsi.nic.in/uploads/isfr2023/isfr_book_eng-vol-1_2023.pdf) (Accessed: 8 July 2025).
- GoS (Government of Sikkim) (2025) Official web portal of Government of Sikkim. Available at: <https://www.sikkim.gov.in/> (Accessed: 8 July 2025).
- Handa, A. K., Dev, Inder., Rizvi, R H., Kumar, Naresh., Ram, Asha., Kumar, Dheeraj., Kumar, Anil., Bhaskar, S., Dhyani, S K. and Rizvi, Javed (eds). 2019. Successful Agroforestry Models for Different Agro-Ecological Regions in India. Jointly published by the Central Agroforestry Research Institute (CAFRI), Jhansi, and the South Asia Regional Programme (based in New Delhi) of World Agroforestry (ICRAF).
- Handa, A.K., Chavan, S.B., Kumar, V., Vishnu, R., Suresh Ramanan S., Tewari, R.K., Arunachalam, A., Bhaskar, S., Chaudhari, S. K., & Mohapatra, T. (2020). Agroforestry for Income Enhancement, Climate Resilience and Ecosystem Services. Indian Council of Agricultural Research, New Delhi.
- Land Use Statistics at a Glance, (2021). Government of India Ministry of Agriculture and Farmers Welfare Department of Agriculture & Farmers Welfare Directorate of Economics & Statistics November 2021. <https://desagri.gov.in/wp-content/uploads/2022/01/LAND-USE-STATISTICS-AT-A-GLANCE-2009-10-to-2018-19-1.pdf>. Accessed on 6 July 2024.
- Rahman, H. and Karuppaiyan, R. (2011) 'Agrobiodiversity of Sikkim', in Arrawatia, M.L. and Tambe, S. (eds.) Biodiversity of Sikkim: Exploring and Conserving a Global Hotspot, Gangtok: Government of Sikkim, pp. 403–426. Available at: [http://www.sikkimforest.gov.in/.../22%20Agrobiodiversity\\_403-426%20web.pdf#page=5.08](http://www.sikkimforest.gov.in/.../22%20Agrobiodiversity_403-426%20web.pdf#page=5.08) (Accessed: 8 July 2025).
- Sikkim Biodiversity Board (2023) About Sikkim. Available at: <https://sbbsikkim.nic.in/sikkim.html> (Accessed: 8 July 2025).
- Sikkim ENVIS Hub (2022) Agriculture. Last updated: 19 December 2022. Available at: [http://sikennis.nic.in/Database/Agriculture\\_777.aspx](http://sikennis.nic.in/Database/Agriculture_777.aspx) (Accessed: 8 July 2025).
- Sikkim ENVIS Hub (2025) Rivers. Available at: [http://sikennis.nic.in/Database/Rivers\\_781.aspx](http://sikennis.nic.in/Database/Rivers_781.aspx) (Accessed: 8 July 2025).
- Sikkim State ENVIS Hub (2018) State of Environment Report Sikkim 2016. Gangtok: Sikkim State ENVIS Hub. Available at: <http://sikennis.nic.in/WriteReadData/Publication/State%20of%20Environment%20Report%20Sikkim%202016.pdf> (Accessed: 8 July 2025).



# 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.

**Promoting Agroforestry based Business Opportunities and Creating an Ecosystem for Entrepreneurship**



*Published by*

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