कृषि एवं किसान
कल्याण मंत्रालय
MINISTRY OF
AGRICULTURE AND
FARMERS WELFARE

भाकृअनुप
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CAFRI

Promising Agroforestry Models for Karnataka

ICAR-Central Agroforestry Research Institute

Jhansi-284003, Uttar Pradesh, India

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Photo Credit : AICRP on Agroforestry

Promising Agroforestry Models for Karnataka

Karnataka is a state located in the southwestern region of India, specifically on the Deccan Plateau. It is situated between 11.5° North and 18.50° North latitude and 74° East and 78.30° East longitude. The state is bordered by Maharashtra and Goa in the North and Northwest, the Arabian Sea in the West, Kerala and Tamil Nadu in the South, and Andhra Pradesh in the East. It is the 8th largest state in India with an area of approximately 1, 91,796 sq. km, accounting for 5.83% of the total geographical area of India (ENVIS Karnataka, 2024).

Physiography

Karnataka is geographically characterized by two primary regions in India, the Deccan Plateau, and the Coastal Plains and Islands. These regions further divide the state into three major physiographic zones:

1. The Coastal Region
2. The Malnad Region
3. The Bayaluseeme Region

The Coastal Region

The Coastal Region of Karnataka is a narrow strip of land, approximately 400 kms long, situated between the Western Ghats and the Arabian Sea. It varies in width from 25 to 65 kms and stretches from Karwar town in the North to a little beyond Mangalore city in the South. This region is transitional in character, lying between the submerging Bombay coast (Konkana coast) in the North and the emergent Kerala (Malabar) coast in the South. It features numerous sandy bays, such as Karwar Bay, Belekere Bay, and Bhatkal Bay, and lacks large deltas due to the active South West Monsoon. Learmonth A.T.A (1962) divided this coastal belt into three longitudinal and parallel belts.

- Coastal Plain: A low plain of river deposition.
- Coastal Low Plateau: A product of marine denudation, also known as a "Marine Platform."
- Coastal Malnad: The rest of the dissected hill with more forested and less cleared for field of Agriculture.

The Malnad Region

The Malnad Region is a predominantly forested hilly area situated to the east of the Western Ghats and west of the Maidan boundary in Karnataka. It is also known as the "Sahyadris" and extends as a continuous belt from the Northwest to the Southeast, almost close to the Arabian Sea, culminating in the mighty Nilgiris. The region is characterized by numerous peaks, including Mullayyanagiri (1913 m) in the Bababudangiri hills, which is the highest peak in the state, and other significant peaks such as Kalhatgiri (1893 m), Kuduremukh (1872 m), Devirammanagudda (1817 m), Rudragiri (1715 m), Meruti (1641 m), and Puspagiri or Subramanya (1731 m). Semi-Malnadis a long Narrow zone situated between Malnad and Bayaluseeme and running north to south for the whole length of the State.

The Bayaluseeme Region:

The Bayaluseeme Region is a flat and gently rolling open area located to the east of the Semi-Malnad region in Karnataka. Its landscape is characterized by a uniform and monotonous topography,

representing an aged terrain. The region slopes gently towards the east, with its elevation gradually increasing from North to South, for example, from Bidar to Chamarajanagara.

1. The Northern Bayaluseen Region: It is also known as the "lower erosion surface," and its elevation ranges from 1200 to 1500 metres. It is the region north of the Tungabadra River and east of the Western Ghats. The Krishna River basin takes up the vast majority of this territory. The Bhima, Don, Krishna, and Tungabhadra rivers have degraded and dissected it severely. The most famous waterfalls in the region are Gokak Falls in Belgaum. Districts like Bidar, Bijapur, Gulbarga, Yadgiri, Raichur, Koppal, and Gadag are noted for their frequent severe droughts.
2. The Southern Bayaluseeme Region: It is commonly referred to as the "higher erosion surface," has a greater elevation and more rough topography than the Northern Bayalu seeme. It is also known as the "Mysore Plateau." It stretches from the Tungabhadra River in the north to Chamarajanagara. It descends towards the east, with an average height of 1600 to 1200 metres. It's strong, crystalline rocks have proven highly resistant to erosion. Agriculture is performed using irrigation, while rain-fed dry crops are also commonly grown (Prasanna Kumar, 2019).

Climate

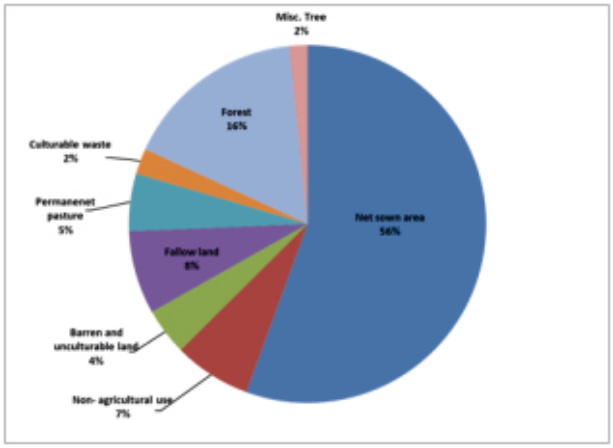
Karnataka has a typical monsoon climate, which have play a decisive role in determining the prospects of agriculture includes hot, rainy, and cold seasons. This climate is classified into three major seasons: (i) summer (March to May), (ii) rainy (June to September), and winter (January to February). The rainfall is usually concentrated in the months of June-September. This helps for the growth of Kharif crops. Karnataka receives majority of its rainfall from south-west monsoon winds. Karnataka receives mean annual rainfall of around 1,355 millimeters. Southern districts of Karnataka also receive rainfall from retreating North-East monsoon winds in the month of October and November which aids the sowing of Rabi crops. The mean maximum average temperature is approximately 34°C in summer and 20°C in winter (WGBIS, 2024).

Land use pattern

In Karnataka, with a total geographical area of 191,791 km^2, forest cover constitutes only 16.13% of the land. Specifically, during 2021-22, the net sown area in Karnataka was 98,950 km^2, which accounts for 51.94% of the total geographical area. There was a slight decrease of 0.78% in the net sown area compared to the previous year.

Forests and its resources

Karnataka have to four of India's 16 major forest types, which include Evergreen and Semi-evergreen, Moist Deciduous, Dry Deciduous, and Scrub and thorny forests (Envis Karnataka, 2024). Karnataka has a total recorded forest area of 38.9 thousand km^2, which is 20.19% of its total geographical area. The state's forest cover comprises very dense forest (4532.94 km^2), moderately dense forest (20984.85 km^2), and open forest (13212.2 km^2). Kodagu district has the highest forest cover, accounting for 79.42% of its geographical area (ISFR, 2021).



Source: Gairhe *et al.* (2011)

Karnataka has a 22548 km² inside the Recorded Forest Area (RFA) and 16182 km² outside the Recorded Forest Area(RFA). The tree cover in Karnataka has increased from 6257 km² in 2019 to 7494 km² in 2021 assessment. Trees outside Forest (TOF) in Karnataka cover an area of 23676 km², which is the sum of forest cover outside RFA and tree cover. The top five tree species in TOF for rural areas in Karnataka are *Areca catechu* (22.99%), *Cocos nucifera* (12.81%), *Azadirachta indica* (11.66%), *Mangifera indica* (6.11%), and *Acacia auriculiformis* (3.74%). In urban TOF areas, the top five tree species include *Cocos nucifera* (24.80%), *Areca catechu* (21.01%), *Acacia auriculiformis* (4.93%), *Mangifera indica* (4.61%), and *Tectona grandis* (3.55%). The total carbon stock of forests in Karnataka including TOF patches larger than 1 hectare, amounts to 376.40 million tonnes, representing 5.22% of the country's total carbon stock. Major Non-Timber Forest Produce (NTFP) species in Karnataka include *Cymbopogan citrates, Piper spp, Asparagus racemosa, Curcuma aromatica* and *Ocimim spp* (ISFR, 2021).

Forest types

S. No.	Type of Forest	Area (in sq. km)	% of the total mapped area
1.	West Coast tropical evergreen forest	5143.60	11.91
2.	West Coast semi-evergreen forest	4366.52	10.11
3.	West Coast secondary evergreen Dipterocarp Forest	326.31	0.76
4.	Moist bamboo brakes	1.79	0.00
5.	Lateritic semi-evergreen forest	155.60	0.36
6.	Very moist teak forest	84.59	0.20
7.	Moist teak forest	1771.05	4.10
8.	Slightly moist teak forest	942.15	2.18
9.	Southern moist mixed deciduous forest	4718.62	10.93
10.	Southern secondary moist mixed deciduous forest	657.51	1.52
11.	Mangrove scrub	10.04	0.02
12.	Very dry teak forest	20.47	0.05
13.	Dry teak forest	2427.23	5.62
14.	Southern dry mixed deciduous forest	3093.68	7.17
15.	Dry deciduous scrub	2950.85	6.83
16.	Hardwickia forest	409.55	0.95
17.	Laterite thorn forest	122.34	0.28
18.	Secondary dry deciduous forest	37.43	0.09
19.	Southern thorn forest	1891.25	4.39
20.	Southern thorn scrub	3220.54	7.46
21.	Nilgiri subtropical hill forest	364.46	0.84
22.	TOF/Plantation	10343.97	23.96
	Total (Forest cover & Scrub)	**43059.55**	**99.73**

Source: ISFR (2021)

Soil

Karnataka's soil types vary across the state, with red soil (Alfisols) being the dominant soil in the eastern tract, overlying granite. A broad strip of the area between the eastern and western parts of coorg is covered by red loam, while laterite soils occur in the western region. The soils of the valley are dominantly very deep, moderately well to poorly drained, fine textured, and at places stratified, with

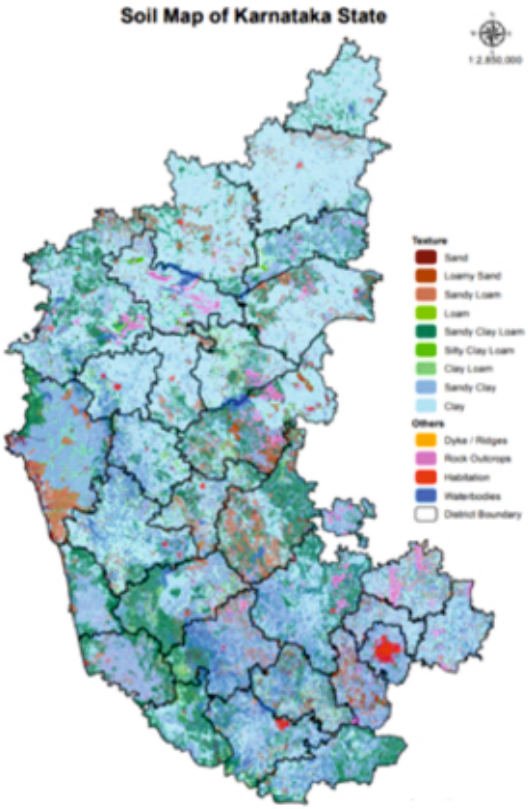
medium to high organic carbon content. The soils of Karnataka can be divided into 7 broad soil order and the state's soils are classified into red soils, laterite soil, black soils, alluvio-colluvial soils, brown forest soils, and coastal laterite and alluvial soils based on agricultural capability. The red soil is shallow to deep, well-drained to excessively drained, and gravelly or non-gravelly, while coastal soils occur in the west coast and are of two types: coastal laterite soils and coastal alluvial soils. The main rock types in Karnataka include gneisses, granites, charnockites, basalt, sandstone, shale, limestone, schist, and quartzites (Ramachanrappa and Thimmegowda, 2016).

Soil groups	**District covered**	**% of total geographical area**	**Feature**
Black soil the surface	Belgaum, Bijapur, Gulbarga and Bidhar also part of Raichur, Chitradurga and Bellary	27.77%	The texture of soil is vary from loam to clays and they are neutral to alkaline in reaction and well supplement of Ca, Mg, and K.
Laterite soil	Malnad and Coastal area of Uttara Kannada, Dakshin Kannada and part of Dharwad, Chikkamagalur, Hassan	6.16%	Laterite soil are in the advanced stage of weathering highly leached, poor in bases and very acidic in reaction and it contain adequate amount of organic matter.
Red and red loamy soil	Shimoga, Chikkamagalur, Hassan, Mysore and Coorg.	37.3%	The soil are poor in bases and acidic to neutral in reaction are also has a light textured sandy to loamy.
Coastal alluvials	Dakshin Kannada, Uttara Kannada	3.9%	The surface soil is usually grey, yellow, or light brown, and the colour intensity rises with depth. The soil are acidic in nature, with limited cation exchange capacity and bases.
Dark brown clayey soil	Dakshin Kannada, Uttara Kannada, Coorge, mysore	6%	This soil rich inn organic matter and low bases. The surface receive the decomposition product of the virgin forest.
Mixed red and black soil	Belgaum, Bijapur, Dharwad, Raichur, Bellary and Chitradurg.	15.74	Black soil in lowlands and valleys has qualities similar to medium black soil, which is productive under good management approaches.

Source : Envis Karnataka (2024)

Water Resource

Karnataka, a state in India, experiences two monsoons: the North-East monsoon and the South-West monsoon. The South-West monsoon is particularly significant as it contributes to over 73 percent of the state's mean annual rainfall of approximately 1,355 millimeters. Karnataka possesses seven river basins and approximately 36,753 tanks with a combined capacity of around 6,84,518 hectares. The state's surface water resources are significantly reliant on its rivers and tributaries, with the west flowing rivers contributing about 60 percent of the total surface water, while the east flowing rivers make up the rest. The annual average water yield across the seven river basins in Karnataka is estimated to be approximately 3,475 thousand million cubic feet, with around 1,440 thousand million cubic feet coming from the six basins excluding the west flowing rivers (Balasubramanian, 2017).



***Source*:** KSRSAC (Karnataka State Remote Sensing Applications Centre)

S.	Drainage		Area		District
No.	**Basin**	**Sub Basin**	**Sq.Km**	**%**	
1	Godavari		4405	2	
2	Krishna	Bhima	19345	10	Bidar, Bijapur, Gulbarga
		Malaprabha	19233	10	Belgaum, Bijapur, Dharwad
		Tungabhadra	37786	20	Bellary, Shimoga
		Upper	17685	9	Belgaum, Bijapur, Gulbarga
		Vedavati	19222	10	Bellary, Hassan
3	Cauvery	Arkavati	4500	2	Banglore urban, Banglore
		Hemavati	5006	3	Hassan, Chikmagular
		Kabini	5160	3	Kodagu, Mysore
		Shimsa	7810	4	Bangalore, Mandya, Hassan
		Suvarnavati	4050	2	Mysore
		Upper	7747	4	Kodagu, Mandya, Mysore
4	West Flowing rivers	Kalinadi	9291	5	Belgaum, Dharwad, Uttara Kannada
		Netravati	7057	4	Kodagu, Hassan, Dakshina Kannada
		Sharavati	5540	3	Uttara Kannada, Shimoga
		Sita Swarna	4344	2	Dakshina Kannada, Shimoga
5	Palar	-	2826	1	Kolar
6	Pennar	-	7146	4	Bangalore Rural
7	Ponnaiyar	-	2638	2	Bangalore Urban, Bangalore

Source: Balasubramanian (2017)

Agriculture

Agriculture is a significant sector in Karnataka, with a majority of the rural population engaged in it. The state's agriculture is heavily dependent on the southwest monsoon, with only 26.5% of the sown area subjected to irrigation. Karnataka has three agricultural seasons: Kharif (April to September), Rabi (October to December), and Summer (January to March). The state is the largest producer of coarse cereals, coffee, raw silk, and tomatoes among the states in India. Horticultural crops are grown in an area of 16,300 km^2, with an annual production of about 9.58 million tons. The income generated from horticulture constitutes over 40% of income generated from agriculture and it is about 17% of the state's GDP. Karnataka is also the largest producer of silk in India, with a majority of the thirty-five billion rupee silk industry in the state.

Major crops in Karnataka (in Lakh tonnes)

Crop	**Production**
Rice	43.46
Jowar	9.54
Ragi	12.34
Maize	52.61
Bajra	2.31
Wheat	2.48
Minor millet	0.32
Tur	13.79
Bengal gram	6.87
Horse gram	0.98
Black gram	0.55
Green gram	1.94
Cowpea	0.36
Groundnut	6.78
Sesamum	0.23
Sunflower	1.19
Castor	0.03
Soyabean	4.21
Safflower	0.23
Cotton	18.75
Sugarcane	403.57
Tobacco	0.66
Total	**583.2**

Source: Department of Agriculture, Government of Karnataka (2022-23)

Scheme of Karnataka

Government of Karnataka has implemented several schemes and plans such as *National Food Security Mission (NFSM), Rashtriya Krishi Vikas Yojana (RKVY), National Horticulture Mission, Matsya Ashraya Scheme, Karnataka Seed Mission, and National Medicinal Plants Mission Schemes*. According to the 19th livestock census, livestock population Odisha is 81143.926 million (Ministry of Agriculture, Depertment of Animal Husbandry, Dairying and Fisheries, 2014).

S. No	Scheme	Objective
1.	Karnataka Seed Mission	The Karnataka Seed Mission Scheme, launched in 2008-09 under RKVY, aims to enhance crop productivity through seed replacement rates, identify seed requirements and production, and strengthen certified seed production and distribution programs. The scheme aims to make Karnataka a global destination for seed production by addressing gaps in seed requirement, production, and infrastructure for quality seed production and marketing, and adopting a farmer-centric approach in varietal development, seed production, and marketing. The scheme has resulted in increased awareness of seed replacement in various crops and has been implemented in conjunction with farm mechanization schemes.
2.	National Food Security Mission	The National Food Security Mission (NFSM), a centrally supported project, was initiated in 2007-08. The objective is to significantly increase the production of rice, wheat, and pulses. In Karnataka, NFSM was launched in two components: NFSM (Rice) and NFSM (Pulses). Belagavi, Dakshin Kannada, Hassan, Raichur, Shivamogga, Udupi, and Uttara Kannada come under NFSM (Rice), while NFSM (Pulses) is implemented in all districts..
3.	*Rashtriya Krishi Vikas Yojana* (RKVY)	This scheme was launched in 2007-08 as an important programme of the 11th five-year plan, and the funds were used to implement schemes in Agriculture, Horticulture, Animal Husbandry, Fisheries, Agricultural Marketing, Sericulture, University of Agricultural Science (Bengaluru, Dharwad, and Raichur) and the Karnataka State Seeds Corporation schemes, and RKVY sub-schemes.
4.	Integrated Scheme for Oilseeds, Oil Palm and Maize (ISOPOM)	ISOPOM is a centrally sponsored scheme for the development of oilseeds, pulses, oil palms, and maize that has been in place since 2004-05. ISOPOM's primary goal is to improve crop production and ensure its sustainability. The sharing ratio between the centre and the state is 75:25. In Karnataka, the scheme is being implemented in all 30 districts. This Scheme provides a 50% subsidy for the distribution of certified seeds, inputs required for Block Demonstration, IPM, and FFS Demonstrations (Rhizobium/PSB, NPV, Gypsum/Pyrites, and micronutrients), water convey pipes, Plant Protection chemicals, and Plant Protection equipment.
5.	Bhoochetana	Bhoochetana is an innovative mission style, science-based initiative that has been undertaken by the Government of Karnataka since 2009-10 to raise the yield of chosen rainfed crops by 20% over four years. It was initially introduced in 16 districts and has now been extended to all 30 districts in the state. The consortium partners include ICRISAT, the Watershed Development Department, and three state agriculture universities.

6.	Suvarna Bhoomi Yojane	The Suvarna Bhoomi Yojane Scheme began in 2011-12. The goal of this strategy is to incentivize farmers to shift from low-income crops to high-income crops such as pulses, oil seeds, and Bt cotton. The motivation extends to other activities such as biofuel, horticulture, apiculture, sericulture, and organic farming. Ten lakh small and marginal farmers, including two lakh SC and one lakh ST farmers, will be paid Rs. 10,000 in two equal instalments of Rs. 5,000 each through banks to participate in the planned activity, therefore improving their economic condition.
7.	Initiative for Nutritional Security through Intensive Millets Promotion Programme (INSIMP)	In 2011-12 GOI launched this new effort to enhanced the production of millet in integrated manner. Millet are the principal food crops in Karnataka covering area 23 lakh hain the Kharif season this program implement in 15 district and in Rabi season the programme was implement in 5 district.
8.	Raitha Samparka Kendra (RSK)	Depertment of Agriculture under “Raitha Mitra Yojane” established Raitha Samparka Kendras (RSKs) to provide services and information at single poit required by the farmer. Based on the various Agro climatic zones, the new food production technologies and skills being implement in the Farmer field aiming to increase the state food production level under this scheme. The plan of action comprises bimonthly and fortnightly primary and secondary training sessions to keep extension workers' professional skills up to date.
9.	Karnataka Krishi Mission (KKM)	The Karnataka Agriculture Mission (KKM) was established under the leadership of the Chief Minister to comprehensively develop agriculture and related activities. The KKM aims to introduce new ideas, sensitize and develop new plans, projects, and programs for agriculture and universities and departments related to agriculture. It also focuses on streamlining and coordinating the functions of various departments, including agriculture, horticulture, animal husbandry and veterinary services, sericulture, and fisheries
10.	Agri Business in Karnataka	Karnataka has led the way in creating a sustainable agribusiness sector with the "Integrated Agribusiness Development Policy," which covers both the infrastructure and industrial sectors of agriculture and related industries such as horticulture, fisheries, animal husbandry, sericulture, and food processing. It is anticipated that this policy will address major issues impacting the growth of the agricultural industry and related industries, such as increasing productivity, reducing postharvest losses, strengthening postharvest processing and value addition, improving value realization through improved marketing channels, and using sustainable production, processing, branding, and marketing practices.
11.	Weather based Crop Insurance Scheme	The objective of this scheme is to provide protection against the notified crop loss due to floods, famine, storm, frost, emperature and change in relative humidity which occur due to weather aberations.

12.	National Horticulture Mission (NHM)	It is a centrally sponsored scheme launched during 10th five year plan (2005-06 and 2006-07). It provided cent percent assistance to the State missions. The main objective of implementing the NHM plan was to integrate forward and backward connections in order to achieve the all-around development of horticulture. It takes a "end to end" strategy, beginning with the manufacturing of planting material and concluding with the marketing and export of the output after value addition. The main goals established for the growth of horticulture in the state through NHM included doubling the output and productivity of important horticultural crops, improving the quality of the produce.
13.	Coconut Development Board (CDB)	The Coconut Development Board is giving 100% financial assistance for the state's integrated coconut industry development. The actions that are being implemented are: 1) Setting out and maintaining demonstration plots. 2) Distribution of plant protection chemicals, organic manures, chemical and bio fertilisers to boost coconut production and productivity. 3) Production of Tall x Dwarf hybrid coconut seedlings.
14.	National Medicinal Plants Mission	The National Medicinal Plants Mission has made action to expand the area under various medicinal plants. This system in the state covers medicinal plants such as ashwagandha, tulsi, guggal, coleus, amla, gloriana, asparagus, konch, aloevera and bhumiamlaki.
15.	Comprehensive Horticulture Development	Horticulture development in the state is hindered by numerous issues and weaknesses, such as low value addition, inadequate marketing facilities, and poor crop management practices. To accomplish comprehensive development in the Horticulture sector, a strategy dubbed "Integrated Development of Horticulture".
16.	Mango Development Board	Karnataka is one of the country's leading mango producers. The regional climate has aided the production of several mango kinds throughout the state. Mango Development Board was founded in 2010-11 to promote and streamline the production, processing, marketing, and export of mangoes in the state.

Source: Government of Karnataka (https://karnataka.gov.in/)

Biodiversity

Karnataka has a complex landscape of species-rich climax forests, secondary forests, pastures, fields, and fallows, with corridors of rivers, streams, gorges, and ridges, as well as a long coastline and marine stretch, which contribute to the state's rich faunal and floral composition. Karnataka has three main geographical regions: coastal or karavali, hilly/mountainous or malenadu, and plains or bayaluseeme. The Karavali region is approximately 320 kms long and 5-65 kms wide, with an average elevation of 70 m. It covers the western border of Dakshina Kannada, Udupi, and Uttara Kannada districts. The Malenadu region is made mostly of the Western Ghats, with the Mullayanagiri hills in Chikkamagaluru district reaching a height of 1,929 metres (6,329 feet). Cauvery, Tungabhadra, Krishna, and Malaprabha are the primary rivers that flow east from the Western Ghats and provide a lifeline for people in Karnataka,

Andhra Pradesh, and Tamil Nadu. Several west-flowing rivers, including the Kali, Aghanashini, and Sharavathi, run for a short distance before meeting the sea. The plains of Bayaluseeme on the Deccan Plateau cover the majority of the state (India's second largest semi-arid region), and they are home to drier habitats. Karnataka has five national parks, 18 wildlife sanctuaries, and nine bird sanctuaries. (ENVIS Centre, 2024).

Group of organisms	Number of species in Karnataka
Birds	508
Mammals	150
Reptiles	156
Amphibians	135
Fishes(marine & brackish water)	405
Fishes (fresh water)	289
Butterflies	330
Medicinal plants	1493
Angiosperms	4946
Gymnosperms	26
Pteridophytes	178
Bryophytes	263
Algae	1761
Fungi	1255
Lichens	438

Source: Karnataka Biodiversity Board

Agro-climatic Zones

Karnataka state can be divided into 10 agro-climatic zones based on the following criteria rainfall pattern, soil types, texture, depth and physico-chemical properties, elevation and topography and major crops and vegetation. The ten agro-climatic regions of Karnataka are: North Eastern Transition Zone, North Eastern Dry Zone, Northern Dry Zone, Central Dry Zone, Eastern Dry Zone, Southern Dry Zone, Southern Transition Zone, Northern Transition Zone, Hilly Zone and Coastal Zone (Government of Karnataka).

Agro-climatic Zones of Karnataka

Name of the Zone	% of Geographical area	Districts (Number of taluks)
North Eastern Transition Zone	5	Bidar, Gulbarga
North Eastern Dry Zone	9	Gulbarga, Yadgir and Raichur
Northern Dry Zone	25	Koppal, Gadag, Dharwad, Belgaum, Bijapur, Bagalkot, Bellary, Davangere and Raichur
Central Dry Zone	10	Chitradurga, Davangere, Tumkur, Chikkamagalur and Hassan
Eastern Dry Zone	9	Bangalore Rural, Ramanagar, Bangalore Urban, Kolar, Chikkaballpur and Tumkur
Southern Dry Zone	9	Mysore, Chamarajnagar, Mandya, Tumkur and Hassan
Southern Transition Zone	6	Hassan, Chikkamagalur, Shimoga, Mysore and Davanagere
Northern Transition Zone	6	Belgaum, Dharwad, Haveri an Gadag
Hilly Zone	13	U.Kannada, Belgaum, Dharwad, Haveri, Shimoga, Chickmangalur, Kodagu and Hassan
Coastal Zone	6	Udupi, Dakshina Kannada and Uttara Kannada

Source: Bakshi (2017)

Source: Water resources, Government of Karnataka

Demography

According to the 2011 Census of India, the total population of Karnataka was 61,095 million, with 30,967 million men and 30,129 million females. This constitutes 4.86% of the nation's overall population of 1,210.855 million. Karnataka's population density is 319 per square kilometre, which is lower than the national average of 382 per square kilometer. The state has a literacy rate of 75.36% and a sex ratio of 973 females to 1,000 men, which is higher than the national average of 943. (Karnataka at a Glance, 2024). The tribal population in Karnataka is reported to be 4,248.978 million (Roy *et al*, 2015).

Administrative profile

Karnataka was formed as Mysore State on 1st November 1956, with the passage of the States Reorganisation Act, and was renamed Karnataka in 1973. The state divided 31 districts into 4 revenue divisions: Bengaluru Division, Mysuru Division, Belagavi Division and Kalburgi Division . The state has a long history with important planning organizations at the district and local levels. Rural self-government entities include, 49 sub division,176 blocks, 9 nagarpalika, 219 Nagar panchayat, 6,006 Gram Panchayats. The state has 10 Municipal Corporations, 59 city Municipal Councils, 116 Town Muncipal Council and 97 Town/Pattana Panchayats (State Profile of Karnataka). The name of 31 district are as follows : Belgaum, Bagalkot, Bijapur, Gulbarga, Bidar, Raichur, Koppal, Gadag, Dharwad, Uttara Kannada, Haveri, Bellary, Chitradurga, Davangere, Shimoga, Udupi, Chikmagalur, Tumkur, Chikkaballapur, Kolar,

Bangalore Rural, Ramanagaram, Mandya, Hassan, Dakshina Kannada, Kodagu, Mysore, Chamarajnagar, Bangalore, Yadgir and Vijayanagar (Government of Karnataka, 2023).

State Symbols

Karnataka's state animals and birds include elephants (*Elephas maximus indicus*) and Indian rollers (*Coracias benghalensis*). The state flower is the Sacred Lotus (Nelumbo nucifera), the state trees are Indian Sandalwood (*Santalum album*), and the state fruit is Mango (*Mangifera Indica*). Southern Birdwing, Sahyadri Birdwing (*Troides minos*), and Carnatic Carp (*Hypselo barbuscarnaticus*) are the state butterfly and fish. Kannada is the official language of Karnataka, and a significant number of people in adjacent states such as Andhra Pradesh, Maharashtra, Tamil Nadu, Kerala, Goa, and Daman and Diu speak Kannada as their mother tongue.

Promising Agroforestry Models/Systems for Karnataka

Agri-silviculture System

S.No.	Agroforestry models	Tree component	Crop component	Economic returns/ Benefits Cost Ratio (BCR)
1.	*Simarouba* based agroforestry system	*Simarouba glauca*	*Stylosanthus hamata*, *Stylosanthus scabra* and Dinanath grass	B:C ratio of *Stylosanthus hamate* and *Stylosanthu-sscabra* (1:1.53) performed better and recorded good yield compared to Dinanath grass (1:0.14)
2.	Mango based agroforestry system	Mango (*Mangifera indica*)	*Stylosanthus hamata*, *Stylosanthus scabra,* Horse gram and Anjan grass	*Stylosanthus hamata* based mango agroforestry system is recorded forage yield 46.47 t/ha with net return of Rs. 21382 /ha and B:C ratio is 4.30 followed *Stylosanthus hamata* and *Stylosanthus scabra* based mango agroforestry system recorded forage yield 40.75t/ha with net return of Rs. 17950/ ha and B:C ratio is 3.76
3.	Melia based agroforestry system	Melia (*Melia dubia*)	Finger millet and Soyabean	The grain yield of Soyabean and finger millet yield was higher with wider spacing of 12x5m (18.10 & 29.90 q/ha) as compared to 10x5 m and 8x5 m spacing alley (17.60 & 29.10 q/ha and 17.30 & 28.95 q/ha respectively). Grain yield of finger millet and soyabean decreased with increase in age of *Melia* spaced at 8x5.

4.	Teak based agroforestry system	Teak (*Tectona grandis*)	Finger millet and Soyabean	The grain yield of soybean and finger millet was higher yield with wider spacing of 12x3m (18.35 & 30.25 q/ha) as compared to 10x3m (18.25 & 30.15 q/ha and 8x3 spacing (18.10 & 29.90 q/ha).
5.	Tree based agroforestry system	*Simarouba glauca, Pongamia pinnata, Azadirachta indica, Swetania mahagony* and *Euginea jambolana*	Soyabean	The higher grain yield of soyabean was recorded with *Euginea jambolana* (18.65 q/ha) followed by Swetania mahagony (18.58 q/ha).
6.	*Acacia mangium* based agroforestry system	*Acacia mangium*	Horse gram	The higher grain yield of horse gram in 4m x 1m spacing (151 kg/ha) followed by 4m x 2m spacing (148.1 kg/ha).
7.	Marihal bamboo based agroforestry system	Bamboo (*Oxytene therastocksii*)	Soybean	The soybean yield was higher in 4m x 5m spacing (280 kg/ha) as compared to 4m x 2m spacing (246 kg/ha).
8.	Tamarind based agroforestry system	Imli (*Tamarindus indica*)	Soybean	The higher yield was observed in SMG-12 (338 kg/ha) followed by SMG-4 (335 kg/ha).
9.	Teak legume agroforestry system	*Tectona grandis*	Perennial vegetable (Curry leaf and Drum stick) Soybean and Green gram	The higher grain yield of Grain is in the Teak+Curry leaf + Soybean (768 kg/ha) and Teak +Curry leaf+ green gram(433 kg/ha) followed by Teak+ Drumstick+ Soybean (750 kg/ha) and Teak+ Drumstick+ green gram (398 kg/ha).
10.	Melia based agroforestry system	*Melia azadirach*	Soybean and Safflower	The higher grain yield is Sole Soybean (1870 kg/ha) and Sole Safflower (443 kg/ha) followed by in Soybean 5 x4 m spacing (1643 kg/ha) and in Safflower 5 x 2m spacing (321 kg/ha).
11.	Simarouba based agroforestry system	*Simarouba glauca*	Sunhemp	The higher sunhemp yield of Gouri variety 5m x 3m spacing (202.6 kg/ha) followed by Kali variety 5m x 4m spacing (180.0 kg/ha)

12.	Neem based agroforestry system	Neem (*Azadirachta indica*)	Safflower	Safflower yield higher in the Dharwad neem provenance (702.5 kg/ha) followed by Bijapur neem provenance (690.5 kg/ha)
13.	Bamboo based agroforestry system	*Bambusa bamboos*	Cotton	The cotton yield was maximum in sole cotton (20.58 q/ha) followed by cotton grown with bamboo at 12m x 10m (13.96 q/ha) followed by 10m x 10m (10.94 q/ha) bamboo spacing.
14.	Melia based agroforestry system	*Melia dubia*	Soybean	The growth (height and dbh) of melia and yield of Soybean was higher in 4 x4m (620.4 kg/ha) spacing as compared to 4 x 1m (525.4 kg/ha) spacing.
15.	Teak + Turmeric agrisilviculture system	Teak	Turmeric *var* Alleppi, CLI, Rajpuri, Gujarat selection, Prabha, Selum, Pratibha and Bidar selection	The higher yield was recorded among the different turmeric varieties in CLI (19.92 q/ha), followed by the Rajpuri (19.53 q/ha) and Selum (18.79 q/ha).
16.	Cashew nut clones agroforestry system	Cashew nut	Soybean and Safflower	Sole Soybean grain and haulm (675.6 kg/ha) and (554.5 kg/ha) yield was higher followed by soybean combination with Ullal-3 clone (560.2 kg/ha and 459.2 kg/ha). The yield of Sole Safflower (685.0 kg/ha) higher followed by Ullal-1 clone (525.0 kg/ha).
17.	Fruit based agroforestry system	Amla (*Emblica officinalis*), Cashew (*Anacardium occidentale*), Jamun (*Syzygium cumini*), Mango (*Mangifera indica*) and Imli (*Tamarindus indica*)	Soyabean (*Glycine max*)	Soyabean attained higher yield in *Tamarindus indica* (9.2 q/ha), *Mangifera indica* (9.10 q/ha) followed by *Anacardium occidentale* (9.00 q/ha).

18.	Sapota-Timber species agroforestry system	Sapota, *Pterocarpus marsupium, Tectona grandis, Terminalia paniculata, Lagerstromia lanceolata* and *Terminalia alata*	Safflower and Soybean	Sole Soybean and Sole safflower recorded the highest yield (2316.2 kg/ha) and (1462.5 kg/ha) followed by in soybean with sapota (2225.0 kg/ha) and in Safflower+ *P. marsupium +* field crop (1393.7 kg/ha) agroforestry system.
19.	Silvi-Horti agroforestry system	Sapota, *Eucalyptus tereticornis, Tectona grandis, Acacia auriculiformis, Lagestromia lanceolata* and *dalbergia latifolia*		In the timber tree species total biomass and carbon stocking was higher in *Eucalyptus tereticornis* (138.77 ton/ha and 69.39 ton/ha) followed by *Tectona grandis* (134.12 ton/ha and 67.06 ton/ha). Among the sapota trees, total biomass and carbon stocking is higher in sapota with *Lagestromia lanceolata* (19.22 to/ha and 9.61 ton/ha) followed by sapota with *Eucalyptus tereticornis* (9.92 ton/ha and 4.96 ton/ha).
20.	Biofuel based agroforestry system	Pongamia (*Pongamia pinnata),* Bakain *(Melia azaderach),* Melia *(Melia dubia),* Mahua *(Madhuca latifolia), Callophyllum inophyllum* and *Azadirachta indica*	Finger millet, Soyabean and Redgram	Fingermillet recorded highest yield (17.50 q/ha) under the *Callophyllumi nophyllum* tree and in the Pongamia tree soyabean recorded high yield (11.56 q/ha) and Red gram gave good yield under the Pongamia or *Callophyllum inophyllum* trees.
21.	Tree born oil seeds (TBO's) based agroforestry system	*Simarouba glauca, Pongamia pinnata, Madhucalatifolia, Azadirachta indica, Melia azadirach, Melia dubia,* and *Callophylum inophylum*	Finger millet	The highest B:C ratio was recorded in the Pure crop (4.40) followed by *Callophylum inophylum* with finger millet (4.41) and finger millet with *Madhuca latifolia* (4.03).
22.	Provenance trial on Jatropha in agroforestry system	*Jatropha curcas*	Safflower	The highest yield of safflower in TNMC-5 provenance (850.0 kg/ha) followed by Ratlam provenance (846.6 kg/ha)

23.	Provenance trial on pongamia in agroforestry system	*Pongamia pinnata*	Safflower	In safflower RAK-89+FC provenance attained (874.0 kg/ha) higher yield followed by RAK-5+FC (873.6 kg/ha)
24.	Tree Borne Oil Seeds under agroforestry system	*Pongamia pinnata, Simarouba gluaca, Azadirachta indica, Calophyllum inophyllum, Aphanamixis polystachya* and *Madhuca indica*	Sunhemp	Sunhemp yield observed high in *Simarouba gluaca* (490 kg/ ha) as compared *Calophyllum inophyllum* (485 kg/ha)

Silvipastoral system

S.No.	Agroforestry models	Tree component	Crop component	Economic returns/ Benefits Cost Ratio (BCR)
1.	*Tamarind* based silvi-pastoral system	Tamarind (*Tamarindus indica*)	*Stylosanthus hamata*, *Stylosanthus scabra, Guinea* grass, Green panic grass, Cowpea, Sorghum and Maize	*Stylosanthus hamata* grass recorded higher B: C ratio and forage yield (1.51) (6.50 t/ha) followed *Stylosanthus scabra* (1.40) (5.50 t/ha).
2.	*Pongamia* based silvi-pastoral system	*Pongamia pinnata*	*Stylosanthus hamata*, *Stylosanthus scabra, Guinea* grass, Green panic grass, Cowpea, Sorghum and Maize	*Stylosanthus hamata* grass recorded higher B: C ratio and forage yield (1.47) (12.00 t/ha) followed green panic (1.41) (10.70 t/ha).
3.	Neembased silvi-pastoral system	Neem (*Azadirachta indica*)	*Stylosanthus hamata*, *Stylosanthus scabra, Guinea* grass, Green panic grass, Cowpea, Sorghum and Maize	*Stylosanthus hamata* grass recorded higher B: C ratio and forage yield (1.58) (12.20 t/ha) followed green panic (1.57) (11.55 t/ha).
4.	Agri-Silvi-Horti-Pastoral system	Teak, Papaya, and Subabul	Jowar, Groundnut, Chilli, Ragi and grass	The highest yield of the sole groundnut (2,068 kg/ha) followed by the teak with grass (1,571 kg/ha) in the 20m spacing between two rows. In the 10m spaced teak row also sole groundnut record (1681 kg/ha) followed by Groundnut +teak (1019 kg/ha). Green fodder yield was higher in 10 m spaced teak rows than in 20 m spaced teak row. Higher green grass (9.08 t/ha) and subabul green fodder (2.89 t/ha).

5.	Agri-Silvi-Horti-Pastoral system	Sapota, *Eucalyptus tereticornis*, *Lagerstroemia lanceolata*, *Casuarina equisetifolia*, *Tectona grandis* and *Dalbergia sissoo*.	Sunhemp and Grass	The highest number of fruit per plant with *Lagerstroemia lanceolata* (13,410) *followed by Eucalyptus* (1,178) *and Control* (952)
6.	Fodder tree species under agroforestry system	*Callianraca lothryus, Albiziale bbeck, Leucaena leucocephala, Sesbanea grandiflora, Gliricidia sepium, Moringa oleifera* and *Cassia siamea*	Soybean and Safflower	Maxium Soybean grain and haulm yield higher in combination of *Glyricidia sepium* (995.0 kg/ha and 866.7 kg/ha) followed by *Cassia siamea* (956.7 kg/ha and 831.3 kg/ha). Safflower yield is significantly in *Moringa oleifera* combination (756.2 kg/ha) followed by *Albizia lebbeck* (694.2 kg/ha).
7.	Fodder Tree species under agroforestry system	*Calliandra calothryus, Albizia lebbeck, Leucaena leucocephala, Sesbanea grandiflora, Gliricidia sepium, Moringa oleifera* and *Bauhinia purpurea*	Soybean and Safflower	Green biomass is higher in *Calliandra calothryus*(1325 kg/ha) followed by *Leucaena leucocephala* (1225.9 kg/ha). The yield of Soybean (533.1 kg/ha) and safflower (482.9 kg/ha) grown solely whereas combination of soybean with *Albizia lebbeck* is higher (530.7 kg/ha and 578.3 kg/ha) and the safflower was higher in *Moringa oleifera* (393.7 kg/ha) followed by *Albizia lebbeck* (368.3 kg/ha)

Melia (*Melia dubia*) based Agri-silviculture system

Scientific name: *Melia dubia*

Suitable Spacing: 5 x 5 m and 6 x 4 m

Suitable Intercrops: Finger millet and Cowpea

Tree productivity : The tree recorded 10 to 12 cubic/ft after 10 years.

Economic Returns: The net return from the melia model is Rs 7,92,000/acre. (Handa *et al*., 2020).

Ailanthus based Agri-silvicultural System

Scientific name: *Ailanthus excelsa* Roxb.

Suitable Spacing: 5 x 5 m under rainfed conditions and as a block and boundary plantation the spacing should be 3 x 3 m.

Suitable Intercrops: Green gram, cluster bean and cowpea

Tree productivity : Timber volume : 944.2 cubic feet/ha; Fuel wood : 10834 kg/ha

Economic Returns: The highest net return from Ardu intercropping with green gram was Rs 76,024/ha, surpassing both sole cropping and other agri-silvi systems. However, the B:C ratio from sole Ardu was greater at 8.53 compared to the Ardu + green gram system (Handa *et al*., 2019).

Teak based Agrisilvicultural System

Scientific name: *Tectona grandis*

Suitable Spacing: 60 x 60 cm and 60 x 20 cm as a block and boundary plantation in field

Suitable Intercrops: Sorghum and Groundnut

Tree productivity : 22 years timber yield obtained was 24.35m3/ha in 10 m alleys and 13.46m3/ha in 20 m alleys. Fodder Yield: 3.42 t/ha at 10 m alley and 1.89 t/ha at 20m alley.

Economic Returns: The highest net returns of Rs. 12,316/ha/yr were realized with field crop+ teak + papaya and the unit cost of Rs 5838/ha/yr. The contribution of income from various components was 39 to 47% by arable crops and 48 to 58% by teak. (Handa *et al*., 2020).

Tamarind based Silvi-horticultural System

Scientific name: *Tamarindus indica*

Suitable Spacing: 12 x 12 m apart on degraded sloping and for the boundary and block plantation land of hilly zone.

Suitable Intercrops: Natural grass

Tree productivity : Eucalyptus: 10–15 t/ha

Economic Returns: The combined net income from tamarind and Eucalyptus cultivation amounted to Rs 6,180/hectare/year, with a B:C Ratio of 1.79:1 in this agricultural practice (Handa *et al*., 2020).

Tamarind + Curry leaf based Agroforestry System

Scientific name: *Tamarindus indica* and *Murrayyakoenigii*

Suitable Spacing: Tamarind is planted at 6 x 6 m spacing and the Curry leaf is planted at 2 x 2 m spacing in between two tamarind trees in Boundary and block plantation.

Economic Returns: The tamarind + curry leaf based agroforestry system net returns obtained amounted to Rs 6125/ha/yr with the Benefit Cost ratio of 1.68:1 (Handa *et al*., 2020).

Fodder Tree Species under Agroforestry System

Scientific name: *Leucaena leucocephala*

Suitable Spacing: 6 m x 4 m spacing for the rainfed condition

Suitable Intercrops: Soybean and Safflower

Fodder yield: The Green Biomass yield of Leucaena is 383 kg/ha with the combination of Soybean and Safflower yield is 938.3 kg/ha and 735.6 kg/ha.

Casuarina + Sandalwood based agroforestry system

Scientific name: *Casuarina equisetifolia and Santalum album*

Suitable Spacing: Sandal block plantation at 4 x 4 m spacing with Casuarina.

Tree productivity :casuarina yield returns to the Rs. 56,000 per ha on extraction of poles in the 15th year

Economic Returns: Sandal block plantation has given the good return Rs. 12.5 lakh, B:C ratio is 3.3 (Viswanath *et al*, 2010).

Bamboo based Agri-silvicultural System

Scientific name:*Bambusa sp.*

Suitable Spacing: 10 m x 10 m or 10 m x 12 m (as block plantation) and 4 m x 4m (as bund plantation)

Suitable Intercrops: Green gram, black gram and sesame during Kharif season and mustard, chickpea and barley during Rabi season.

Economic Returns: The time span of seven years, farmers generated an annual net profit exceeding Rs 26,000.00 from their bamboo cultivation (Handa *et al*., 2020).

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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.

Promoting Agroforestry based Business Opportunities and Creating an Ecosystem for Entrepreneurship

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