कृषि एवं किसान
कल्याण मंत्रालय
MINISTRY OF
AGRICULTURE AND
FARMERS WELFARE

सत्यमेव जयते

भाकृअनुप
ICAR

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CAFRI

Promising Agroforestry Models for Haryana

ICAR-Central Agroforestry Research Institute

Jhansi-284003, Uttar Pradesh, India

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Contribution

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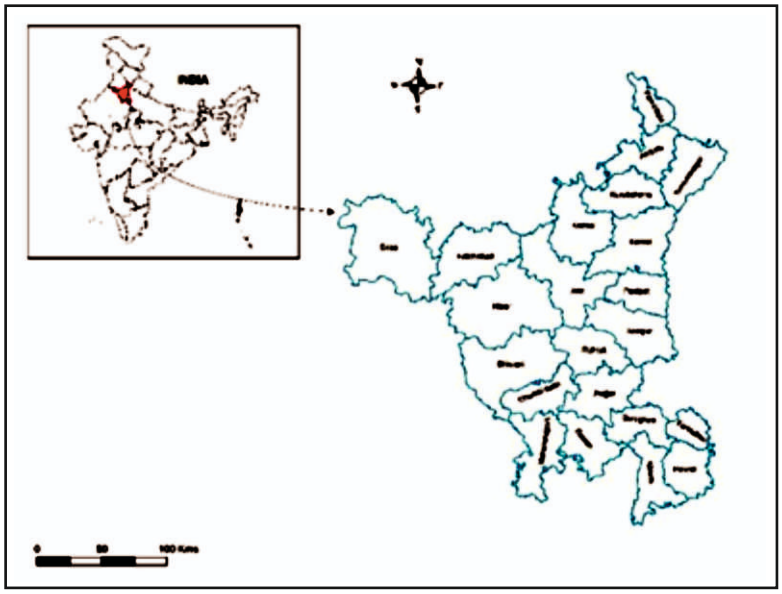
Promising Agroforestry Models for Haryana



Haryana is one of India's most industrialized states in North India. It was formed from the state of Punjab in 1966. It is located between 29° 3' 56.7828'' north latitude and 76° 2' 25.7892'' east longitude. The region has been the scene of many a war because of its being 'A Gateway to North India'. It has borders with Punjab and Himachal Pradesh to the north, as well as Rajasthan to the west and south. The river Yamuna forms the eastern boundary between Uttarakhand and Uttar Pradesh. The state's geographical size is 44212 square kilometres, or 1.3% of India's total geographical area (Government of Haryana, 2024).

Physiography

Haryana has a diverse topography, with four main geographical features

1. The Bagar and the undulating sandy plains-the sand dunes and the tals (230-350 metres)
2. The Alluvial Plain or the Ghaggar-Yamuna Plain comprising Bangar, Khadar, Naili and Bet (below 300 metres)
3. The Aravali outliers (300-600 metres)
4. The Shiwaliks-Hill (over 400 metres)

The Bagar and the undulating sandy plain

Sand dunes of diverse forms and sizes make a dry terrain covered with stoppe flora in Haryana's south-western region. The Bagar is located in sections of Sirsa, Hisar, and Bhiwani districts. This constitutes a continuous strip of considerable concentration of sand dunes close to the Thar desert, covering around 11% of the State's total area. Sand dunes of a vast scale may be seen in this area, which extends from the southeast of Sirsa district along the Rajasthan border with Hisar district, and eventually spreads across the Bhiwani district. Bagar is the native name for the region, which resembles a nearly treeless undulating dry desert. The south-west is characterised by sand dunes of varied magnitudes. The soil moisture deficit is very acute and it persists throughout the year.

The Alluvial Plain

Haryana's alluvial plain is as rich as it always is. It is a socio-economic hinterland in India and contributes significantly to the country's food grain reserves. The districts of Ambala, Yamuna Nagar, Kurukshetra, Karnal, Kaithal, Jind, Sonipat, and the northeastern section of Hisar are known for their flat terrain. The alluvial plain includes the low-lying flood plains known as Khadar of Yamuna, Nali of Ghaggar, and Bet of Markanda. The saucer flat in Sonipat and northern Rohtak districts is part of the plain.

The Aravalli Outliers

The Aravallis are considered one of the world's oldest mountain ranges. They start in Gujarat and Rajasthan and travel through south Haryana before ending in Delhi. The Aravallis are widely spread throughout Haryana's districts, including Mewat, Faridabad, Gurugram, Mahendragarh, and Rewari, and actively mined, resulting in tremendous expansion and building activity.

The Shivaliks

The Shivalik Hills, also known as the Churia Hills, are a mountain range in the outer Himalayas that spans over 2,400 km from the Indus River to the Brahmaputra River. The Shivaliks region in Haryana covers 3,514 square kilometres and includes Ambala, Panchkula, and parts of Yamunanagar districts (Government of Haryana, 2024).

Climate

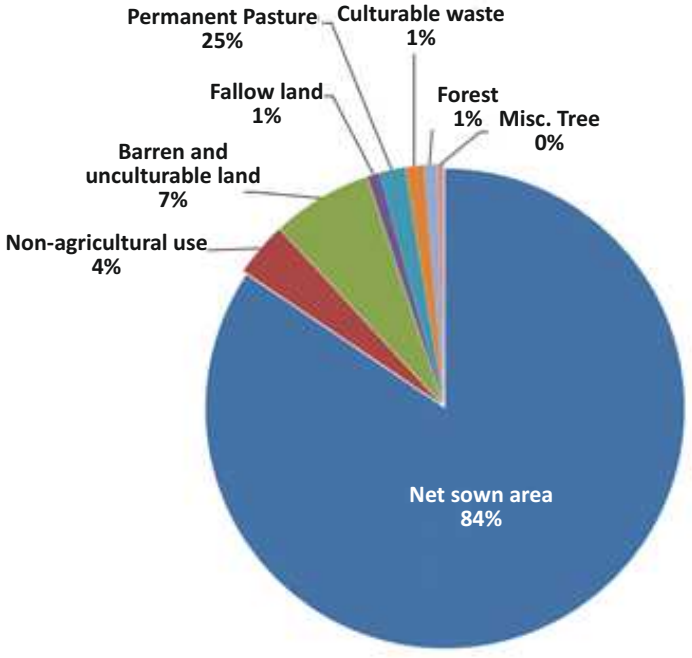
The climate of the Haryana state is subtropical, semi-arid, and subhumid. The districts of Karnal, Ambala, and a section of Kurukshetra that lies between Karnal, Ambala, and Chandigarh have a subtropical monsoon climate with mild winters, dry winters, and scorching summers. Only Sirsa district has the following climatic types: tropical desert, dry, and hot, whereas Hisar district has a climatic type that varies between tropical steppe and semiarid. The warmest months are May and June, while the coldest months are December and January. During the pre-monsoon season (March-May), the state experiences substantial rises in both maximum and lowest temperatures. Maximum temperatures range from +0.04 to 0.08°C every year, while minimum temperatures range from +0.1 to 0.05°C. Significant trends have been observed at Hisar (+0.02°C/year), and Ambala (+0.01°C/year). The monsoon season accounts for 82% of the state's rainfall. The state receives the most rainfall (33%) from the southwest monsoon in August, followed by 32% in July. Southwest monsoon rainfall is concentrated in June and September, accounting for 14% and 21% respectively (DECCH, 2024).

Land use pattern

In Haryana, which covers 44210 km^2 total geographical areaand the forest cover constitutes only 0.81 % of the land. Specifically, during 2023-24, the net sown area in Haryana was 36120 km^2, which accounts for 81.70% of the total geographical area. There was a slight decrease of 1.37 % in the net sown area compared to the previous year.

Forests and its resources

Haryana have to three of India's 16 major forest types, which include Evergreen and Semi-evergreen, Moist Deciduous, Tropical Dry Deciduous Forest, Tropical Thorn Forest and Subtropical Pine Forests (Haryana Forest Department, 2024). Haryana has a total recorded forest area of 1603.48 km^2, which is 3.63% of its total geographical area. The state's forest cover comprises very dense forest (28.00 km^2), moderately dense forest (445.38 km^2), and open forest (1130.10 km^2). Panchkula district has the highest forest cover, accounting for 43.66 % of its geographical area (ISFR, 2021).



Source: (Land use statistics at a glance, 2021)

Haryana covers 374 km² inside the Recorded Forest Area (RFA) and 1229 km² outside the RFA. Haryana's tree cover declined from 1565 km² in 2019 to 1425 km² in the 2021 assessment. Trees outside forest (TOF) occupy 2654 km², which includes both forest cover outside RFA and tree coverage. The top five tree species in TOF for Haryana's rural regions are *Eucalyptus spp*. (29.23%), *Dalbergia sissoo* (11.04%), *Prosopis cineraria* (9.03%), *Azadirachta indica* (6.65%), and *Populus spp*. (5.79) and in the urban TOF regions top five tree species are *Azadirachta indica* (12.69%), *Eucalyptus spp*. (11.69%), *Melia azadirachta* (7.43%), *Morus spp*. (6.82%), and *Prosopis juliflora* (6.30). The total carbon stock of forests in Haryana including TOF patches larger than 1 hectare, amounts to 10.23 million tonnes, representing 0.14% of the country's total carbon stock. Major non-timber forest produce (NTFP) species in Haryana like *Adhatoda vasica, Achyranthes aspera, Abrus precatorius, Cucumis pubescens* and *Asparagus adscendens* (ISFR, 2021).

Types of Forest

S.No	Type of Forest	Area (in sq. km)	% of the total mapped area
1.	Dry Siwalik sal forest	46.15	2.63
2.	Northern dry mixed deciduous forest	518.73	29.53
3.	Dry deciduous scrub	32.07	1.82
4.	*Anogeissus pendula* forest	97.71	5.56
5.	*Anogeissus pendula* scrub	21.46	1.22
6.	Dry bamboo brakes	7.11	0.40
7.	Desert thorn forest	86.71	4.94
8.	Ravine thorn forest	258.61	14.72
9.	Desert dune scrub	102.76	5.85
10.	Lower or Siwalik chir pine forest	12.94	0.74
11.	TOF/Plantation	572.48	32.59
12.	Total (Forest cover & Scrub)	1756.73	100.00

Source: ISFR (2021)

Soil

The state's soil is virtually completely alluvium, and it is located near the Ganges and Indus river valleys. It is a vast flat plain that almost entirely occupies the watershed between the two river basins. It is a large expanse of damp terrain. Except for the Yamuna and Ghaggar flood plains, the alluvium in the area is of the ancient type, with sand, clay, silt, and hard calcareous concentrations the size of nuts called as 'Kankars'. The Khaddar's alluvium deposits are of the most recent kind. They are made up of coarse sand and silt that is deposited on a regular basis by the Indo-Gangetic watershed's rivers and tiny mountain streams. Sand dunes have formed in the south-west region as a result of wind-blown sand accumulation. These dunes can be many metres high and extend for several km. The alluvium is covered in sand, rendering the area as barren and unproductive as a desert.

S.No.	Name of Soil Order	Area (%)	Districts
1.	Inceptisols	58.0	All districts
2.	Entisols	29.0	All districts
3.	Aridisols	9.0	Sirsa, Fatehabad, Hisar and Bhiwani
4.	Alfisols	2.0	Karnal,Kurukshetra
5.	Hills and Rock outcrops	2.0	Mahendragarh, Rewari, Gurgaon and Panchkula

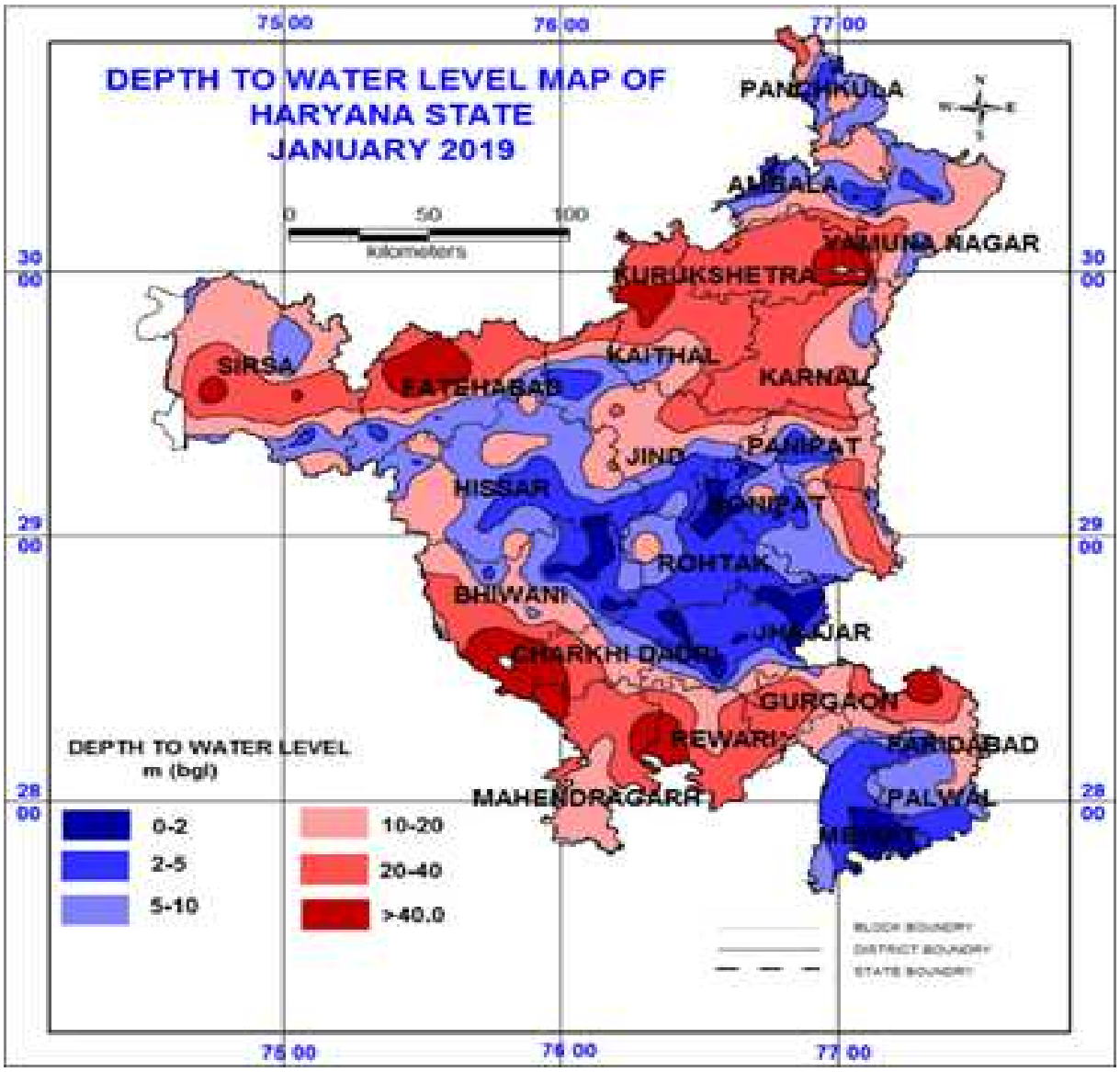
Source: HAU (2018)

Water Resources of Haryana

The major source of water in the state is groundwater. Groundwater supplies are influenced by monsoon 3.24 (in Billion Cubic Meter) and non-monsoon rainfall 0.58 (in BCM), irrigation return flow, recharge from canals, lakes, ponds, and floods. In 2020, the Total Annual Ground Water Recharge fell from 10.15 to 9.53 BCM, Annual Extractable Resources from 9.13 to 8.63 BCM, and Annual Ground Water Extraction from 12.5 to 11.61 BCM, compared to the 2017 assessment. The stage of groundwater extraction has been reduced from 137% to 135%.

Water Profile

Particulars	Details
Annual Precipitation per year (in mm)	536.5
Total Annual Ground Water Recharge (in BCM)	9.53
Annual Extractable Ground Water Resource (in BCM)	8.63
Current Annual Ground Water Extraction (in BCM)	11.61
Net Ground Water Availability for future use (in BCM)	0.97
Stage of Ground Water Extraction (in %)	134.56



Source: Ground Water - Haryana State (2019)

River basins of Haryana

Basin	Name of Rivers	Length (in km Total/ Haryana)	Tributaries	Dam/ Barrages	Status
Indus	Ghaggar	250	Markanda, Saraswati and Kaushalaya	Ottu Barrage in Sirsa	Polluted and dry has turned
	Kaushalaya	20	-	Kaushalya Dam	-
	Markanda/Aruna	90	Tangri, Begna	Barrage at Jalbehra in Kurukshetra	Polluted and dry has turne seasonal
	Tangri/ Dangri	70	Seasonal Shivalik streams	-	Polluted and causes floods
	Saraswati/ Sarsuti	110	-	-	Channel not traceable
	Choutang	-	-	-	Once considered as river Drisdavati an important tributary to Saraswati River, the river has several channels which function as storm water drainage.
	Dohan	50	-	Hamidpur check dam	-
	Krishanvati/Kasunti	20	-	Norana Check dam Rajasthan	-
Ganga	Yamuna	350	Somb, Thapana, Sahibi	Hathini kund barrage	Polluted and has turned seasonal
	Somb	40	Pathrala (Bali Nadi)	Dadupur Barrage	Dry and has turned seasonal
	Thapana	15	Few local strems	-	Perennial but threatened
	Sahibi	120	Sota river, Kotkasim drain an Indori river	Masani	Dry & Heavily Polluted

Agriculture

Haryana, known as the "Bread Basket of India," has been in the forefront of implementing cutting-edge agricultural technologies and is also regarded as one of the country's major agricultural producers. Haryana produces all of its own food and is the second largest contributor to India's central pool of food grains. The state contributes an amazing 14% to the Central Pool and has produced 163.33 lakh MT of food grain. The State primary Kharif crops include rice, jowar, bajra, maize, cotton, jute, sugarcane,

sesame, and groundnut. The land is prepared for these crops in April and May, and the seeds are sowed in June, just before the rains begin. Crops are ready for harvesting by early November. Wheat, tobacco, gramme, linseed, rapeseed, and mustard are the most common Rabi crops. The land is prepared by the end of October or early November, and crops are harvested in March. Approximately 86% of the land is arable, with 96% of it being farmed. Approximately 75% of the land is irrigated using tubewells and a vast network of canals (PNB, 2024).

In the year 1966-67, about 58-hectare pond water area was under fish culture by stocking 1.5 lakh fish seeds, and total annual fish production was only 600 tones, which has been increased by covering 18015-hectare area under fish culture by stocking 7862 lakh fish seed, raising 212042.51 MT of fish during the year 2022-23. It is planned to cultivate around 25100 hectares of land and generate 228000 MT of fish during the financial year 2023-24. The Indian Council of Agricultural Research (ICAR) has recognised Haryana as a disease-free state for fish culture. The Central Sector Scheme on Blue Revolution has increased subsidies from 20% to 60% for pond excavation, renovation, and development in waterlogged and saline areas (Haryana Fisheries Department, 2024).

Major crops in Haryana (in '000' tonnes)

Crop	Production
Rice	5514.2
Jowar	12.32
Maize	15.57
Bajra	1119.7
Kharif Pulses	54.7
Wheat	10447.2
Barley	10.65
Gram	45.37
Rabi Pulses	6.06
Groundnut	6.78
Sugarcane	8822.6
Sunflower	18.14
Cotton (Lint)	1316.3
Kharif Oilseed	16.73
Rabi Oilseed	1685
Total	29091.32

Schemes of Haryana

Government of Haryana has implemented several schemes and plans such as National Food Security Mission (NFSM), Rashtriya Krishi Vikas Yojana (RKVY), National Horticulture Mission and National Mission for a Green India. According to the 20th livestock census, livestock population Haryana is 53.23 million (Ministry of Agriculture, Department of Animal Husbandry, Dairying and Fisheries, 2019).

S.No.	Scheme	Objective
1.	*Haryana Pragatisheel Kisan Yojana*	The scheme provides financial incentives and rewards to chosen farmers for their exceptional efforts in agriculture and related industries. Encourage farmers to use modern technology such as water-saving, crop residue management, sustainable agriculture, organic farming, and integrated farming systems to increase crop yield

2.	Reclamation of Saline soils and Waterlogged Land in the State	Haryana government has announced to 1.00 lakh financial support for reclaim the waterlogged and saline soils by various schemes
3.	*Har Khet Swasth Khet*	In this scheme, Haryana government has announced the "Soil Health Card for every acre of Agricultural Land" where each acre of agricultural landof the state is being sampled, tested. To determine the fertility parameters for designing an effective nutrient management for provide available nutrient status and physio-chemical properties
4.	Crop Diversification Programme – *Mera Pani Meri Virasat*	In 2013-2014, the Government of India initiated the Crop Diversification Programme *(Rashtriya Krishi Vikas Yojana*) with 100% support. From 2015 to 2016, the financial system of 100% has been altered to 60:40 (Centre-State). For reduction in area under high water- intensive crops and grow the alternative crops for sustainable agriculture to incresea the farm income, resource conservation, restore water table and reduce the soil unfertility
5.	Scheme for Subsidize for purchase of high/improved/hybrid seeds and agricultural implements	The scheme would aim at encouraging organic agricultural produce in consultation with Agriculture department and H.S.D.C. (Haryana Seeds Development Corporation) To help farmers adopt superior seeds and generate hybrid seeds, it is suggested to provide subsidies on certified seeds through Haryana Seed Development Corporation
6.	Pandit Deen Dayal Upadhyay *Samuhik Pashudhan Beema Yojna*	This scheme is to be implement by Haryana Livestock Development Board (HLDB) for insured the animals under different categories
7.	Mission on Agriculture Mechanization (SMAM)	This scheme is provided the benefits of subsidy for buying agricultural machinery
8.	Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS)	Raising of employment in rural area for livelihood security to the household. One hundred days of wage employment in financial year to every household volunteer to do the unskilled manual work
9.	*Pradhan Mantri Krishi Sinchayee Yojana* - Watershed Management Programm (IWMP/ Now PMKSY)	In this program mandated to restore the ecological balance by harnessing, conserving and developing degraded natural resources such as oil, vegetative cover and water. There are some outcome from the program is prevention the soil erosion, rain water harvesting, recharging of the ground water table and regeneration of natural vegetation
10.	Green Belt in Urban Areas	It is a state plan scheme for taking up to tree planting activity in urban areas along roads, parks and in blank areas available in various localities for increasing Tree and Green Cover

11.	Herbal Nature Park	It is an ongoing plan scheme started from the year of 2004-05 for general public, especially farmers, aware of the importance, scope and potential of herbal plants. Cultivation and propagation of medicinal plants outside forest is important for conservation and for meeting the demand of medicinal plants, herbs and shrubs
12.	Development of Agroforestry in Community / Farm lands	It is a state plan fully funded to increase the Tree Cover outside forests in consonance with the State and National Forest Policies and to encourage practice of agro-forestry on farmlands for crop diversification and increase in the productivity of farmlands and raise woodlots on Panchayat lands, Institutional lands, Community lands and Private farm lands
13.	Afforestation of Wastelands and Agroforestry	Afforestation of Wastelands and Agro-forestry Project was launched in the state in the year 1991-92 to continue as Social Forestry Project. This project covered wastelands including Alkali lands, Sand Dunes, Other Panchayat Land and Agriculture fields which are generally not covered under traditional forestry programme. The Project paid vital role in harmonizing the regional imbalance of climate and environment in the State and neighboring areas. The project also promoted social, economic and developmental activities
14.	National Mission for a Green India	This is a Centrally Sponsored Scheme of Green India Mission (GIM) is one of the eight Missions identified under the National Action Plan on Climate Change (NAPCC). The GIM aims to address key concerns related to Climate Change in the forest sector, namely: Adaptation, Mitigation, Vulnerability and Ecosystem Services
15.	Integrated Development of Tropical, Temperate and Arid zone fruits	Area Expansion Under this scheme there is a provision of free assistance for planting material and other inputs for the cultivation of fruit crops as per guidelines from GOI from time to time and strengthening of Private Regd. Nurseries scheme Under this scheme there is a provision for assistance for the strengthening of private registered nurseries running in the state under Nurseries Registration Act

Biodiversity

India is a substantially diverse country, home to about 7–8% of all documented plant and animal species on only 2.4% of the world's land area. India is one of the 17 megabiodiversity countries, and it is well-known and recognised for its rich associated traditional knowledge, with biodiversity maintained mostly by local populations. Soil and moisture conservation work in the hills has received special attention in order to preserve water and distribute it to surrounding farmlands, hence improving production and revenue. Herbal Parks have been established in each district to connect people with the natural ecology. Haryana is located on the Indo Gangetic plain, however certain parts are also in the Shiwalik hills. The state's protected area network includes two national parks, eight wildlife sanctuaries, two conservation reserves, and five community reserves, which account for 0.75% of its geographical area (HBSS Annual report, 2022).

Group of organisms	Number of species in Haryana
Birds	509
Mammals	58
Reptiles	38
Amphibians	14
Fishes (fresh water)	74
Arthropoda	1404
Nematoda	197
Annelida	52
Rotifera	42
Coleoptera	370
Lepidoptera	361
Hymenoptera	250
Hemiptera	86
Diptera	100
Orthoptera	82
Plants	1620

Source: ZSI (2020)

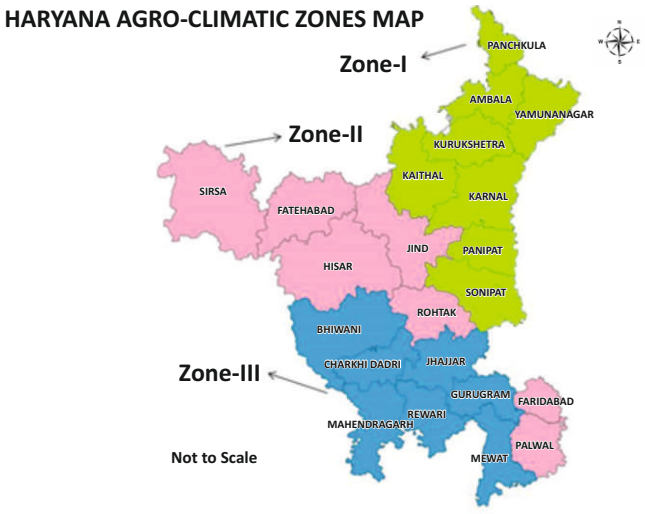
Agro-climatic Zones

Haryana state can be divided into 3 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 three agro-climatic regions of Haryana are: Zone- I, Zone- II, and Zone- III (Atari, Jodhpur).

Agro-climatic Zones of Haryana

Name of the Zone	Area (Km²)	District name
Zone- I	14118	Panchkula,Ambala,Kurukshetra, Yamunanagar, Karnal, Kaithal, Panipat and Sonipat
Zone- II	17343.82	Sirsa, Fatehbad, Hisar, Jind, Rohtak, and Faridabad including Palwal
Zone- III	12721	Bhiwani, Mahendragarh, Rewari, Jhajjar, Gurgaon, Charkhi dadri and Mewat

Source: ATARI-Jodhpur (2024)



Source: RS & GIS lab ICAR-CAFRI

Demography

According to the 2011 Indian Census, Haryana has a total population of 25.35 million people, with 13.495 million men and 11.857 million women. This accounts for 2.09% of the nation's total population of 1210.19 million. Haryana's population density is 573 per km^2, which exceeds the national average of 382 per km^2. The state's literacy rate is 75.6%, and the sex ratio is 879 females per 1,000 men, which is lower than the national average of 943 (Government of India, 2011).

Administrative profile

Haryana as a state came into existence on 1 November 1966 by the Punjab Reorganisation Act (1966). The Indian government set up the Shah Commission on 23 April 1966 to divide the existing state of Punjab and determine the boundaries of the new state of Haryana after consideration of the languages spoken by the people. The state divided 22 districts into six administrative divisions: Ambala, Faridabad, Gurugram, Hisar, Rohtak, and Karnal Division. The state has a long history of working with important planning groups at the district and municipal levels. Rural self-government entities comprise 73 subdistricts, 93 revenue tehsils, 50 sub-tehsils, 140 community development blocks, 154 cities and towns, 7356 villages, and 6212 village panchayats. The name of 22 district are as follows: Ambala, Bhiwani, Charkhi Dadri, Faridabad, Fatehabad, Gurugram, Hisar, Jhajjar, Jind, Kaithal, Karnal, Kurukshetra , Mahendragarh, Nuh, Palwal, Panchkula, Panipat, Rewari, Rohtak, Sirsa, Sonipat, Yamuna Nagar (FCD, 2023).

State symbols

Haryana state animals and birds include Black Buck (Antelope) (*Antelope cervicapra cervicapra*) and Black Francolin (*Francolinus francolinus*). The state flower is the Sacred Lotus (*Nelumbo nucifera*), the state trees are Pipal tree (*Ficus religiosa*), and the state fruit is Mango (*Mangifera Indica*). Kalbasu (*Labeo calbasu*) is the state fish of Haryana (Haryana Forest Department). Haryana's most widely spoken languages are Hindi and Punjabi. Haryanvi is the state language, and because the majority of Haryana's headquarters are located here, it is critical that a big number of Haryanvi come here on posts or settle. As a result, the Haryanvi language is extensively spoken and understood here. The English language is also widely used (Government of Haryana).

Promising Agroforestry Models for Haryana

Agri-silvicultural system

S.No.	Agroforestry models	Tree component	Crop component	Economic returns/ Benefit Cost Ratio (BCR)
1.	Agri-silvi and agri-horti production	Jamun, Ber, Khejri and Neem	Pearlmillet, Clusterbean, Sorghum and	Crops intercropped with jamun, recorded least yield among all the three species due to dense and wider canopy of jamun.
2.	Eucalyptus based agri-silvicultural system	Eucalyptus	Wheat, Barley, Berseem and Lentil	The winter season crops yet to harvest and threshed.
3.	Agri-horti-silvicultural system	*Eucalyptus tereticornis* (Bhadrachalam clones) and *Emblica officinalis* (Aonla)	Dhaincha and Barley	-

4.	Agri-silvicultural system	Poplar and Eucalyptus	Sorghum, Wheat, Dhaincha and Barley	The gross income from agroforestry in three year old poplar bund plantation (East-West) Rs. 272213 was found higher than growing of sorghum Rs. 21935 and wheat Rs. 54042.
5.	Poplar based agroforestry system	Poplar	Cowpea, Wheat, Sorghum and Berseem	The gross income received from crops intercropped with poplar was found to be 7.4 % higher at 10 x 2 Poplar + Sorghum - Berseem Rs. 61884 and Poplar + cowpea - wheat Rs. 81780 spacing of poplar and 2.7 % higher at 18x2x2 spacing of poplar as compared to sole crops of sorghum-Berseem or cowpea-wheat.
6.	Agri-silvicultural system	*Prosopis cineraria, Azadirachta indica* and *Ailanthus excesla*	*Cenchrus ciliaris,* Moongbean, Mustard, Clusterbean, Pearlmillet and Gram	Nine month old seedlings of neem, Ailanthus and khejri planted at spacing of 10 x 4m. Survival percent ranged from 63.1 (Ailanthus) to 81.3 (khejri) and the maximum average plant heiaght (90.4 cm) and basal diameter (10.71 mm) was recorded of Ailanthus followed by Neem.
7.	Poplar based agroforestry system	Poplar	Moongbean-wheat	Maximum grain (5.22 t/ha) and straw (6.22 t/ha) yield were recorded in WH-1105 being statistically at par with HD-2967 but significantly higher than DPW-621-50.
8.	Agri-silvi-horti system	Kinnow and Eucalyptus	Wheat	The grain higher in control 4.57 t/ha followed by Kinnow+Wheat 1.88 t/ha. The kinnow fruit yield is recorded higher in the kinnow + agricultural crops 4.2t/ha followed by kinnow + eucalyptus + agricultural crops 2.7t/ha.
9.	Agri-silvicultural system	*Casuarina junghuhniana* and *Casuarina*	Moong, wheat and berseem	The maximum wheat grain yield in comtrol of *Casuarina junghuhniana* and *Casuarina equisetifolia* is similar (4.34 t/ha). The berseem fodder yield is higher in control (48.4 t/ha) in both species of Casuarina.

Agroforestry Systems for Haryana

Poplar (*Populous deltoides*) based agri-silvicultural system

Scientific Name: *Populous deltoides*

Suitable Spacing: 8 x 2.5 m

Suitable Intercrops: Poplar with intercrops such as wheat, mustard and turmeric

Tree Productivity : Timber yield from 6-year poplar block plantation varies from 20 to 25 t/ha/year

Economic Returns: the returns from poplar based agroforestry system vary from Rs. 1,75,000 to Rs. 2,00,000/ha/year (including income from crops)

Source: Handa *et al.* (2020)

Casuarina based agri-silvicultural system

Scientific Name: *Casuarina junghuhniana* and *Casuarina equisetifolia*

Suitable Spacing: 4 x 3 m, 5 x 3 m and 6 x 3 m.

Suitable Intercrops: Wheat and Berseem

Yield: The maximum Wheat grain yield (4.34 t/ha) was recorded in under control/sole crop and in the Berseem fodder highest yield (48.4 t/ha) achieve in control/sole crop

Source: CCSHAU, AICRP Annual Report (2020-21)

Eucalyptus + Kinnow based agri-silvi-horti system

Scientific Name: *Eucalyptus spp* and *Citrus reticulata* (Kinnow)

Suitable Spacing: 6 x 6 m

Suitable Intercrops: Wheat

Yield: The Fruit yield varied from 2.7 t/ha in agri-silvi-horti system (kinnow+eucalyptus+agricultural crops) to 4.2 t/ha in agri-horti system (kinnow+agricultural crops)

Source: CCSHAU, AICRP Annual Report (2017-18)

Khejri based agri-silvicultural system

Scientific Name: *Prosopis cineraria*

Suitable Intercrops: Mustard , Wheat, Barley and Pearlmillet

Economics/Yield: The B:C ratio of Khejri + pearlmillet is 2.02 and the yield of the Mustard Wheat and barley is 1.18 t/ha, 2.98 t/ha and 4.00 t/ha

Source: Kaushik *et al*. (2021)

Melia (*Melia dubia*) based agri-silvicultural system

Scientific Name: *Melia dubia*

Suitable Spacing: 3 x 3 m

Suitable Intercrops: Wheat

Yield: The highest biological yield of wheat under tree plantation HD 3086 (11.7 t/ha) followed by WH 711 (9.18 t/ha)

Source: Arya *et al*. (2023)

Neem based agri-silvicultural system

Scientific Name: *Azadirachta indica*

Suitable Spacing: 10 x 10 m

Suitable Intercrops: Sorghum, Clusterbean, Pearlmillet and Moongbean**.**

Yield: The highest Fodder yield of Sorghum in the Neem agroforestry models is 15 t/ha and the grain is higher in clusterbean 0.17 t/ha followed by Pealmillet 0.12 t/ha

Source: CCSHAU, AICRP Annual Report (2004-05)

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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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