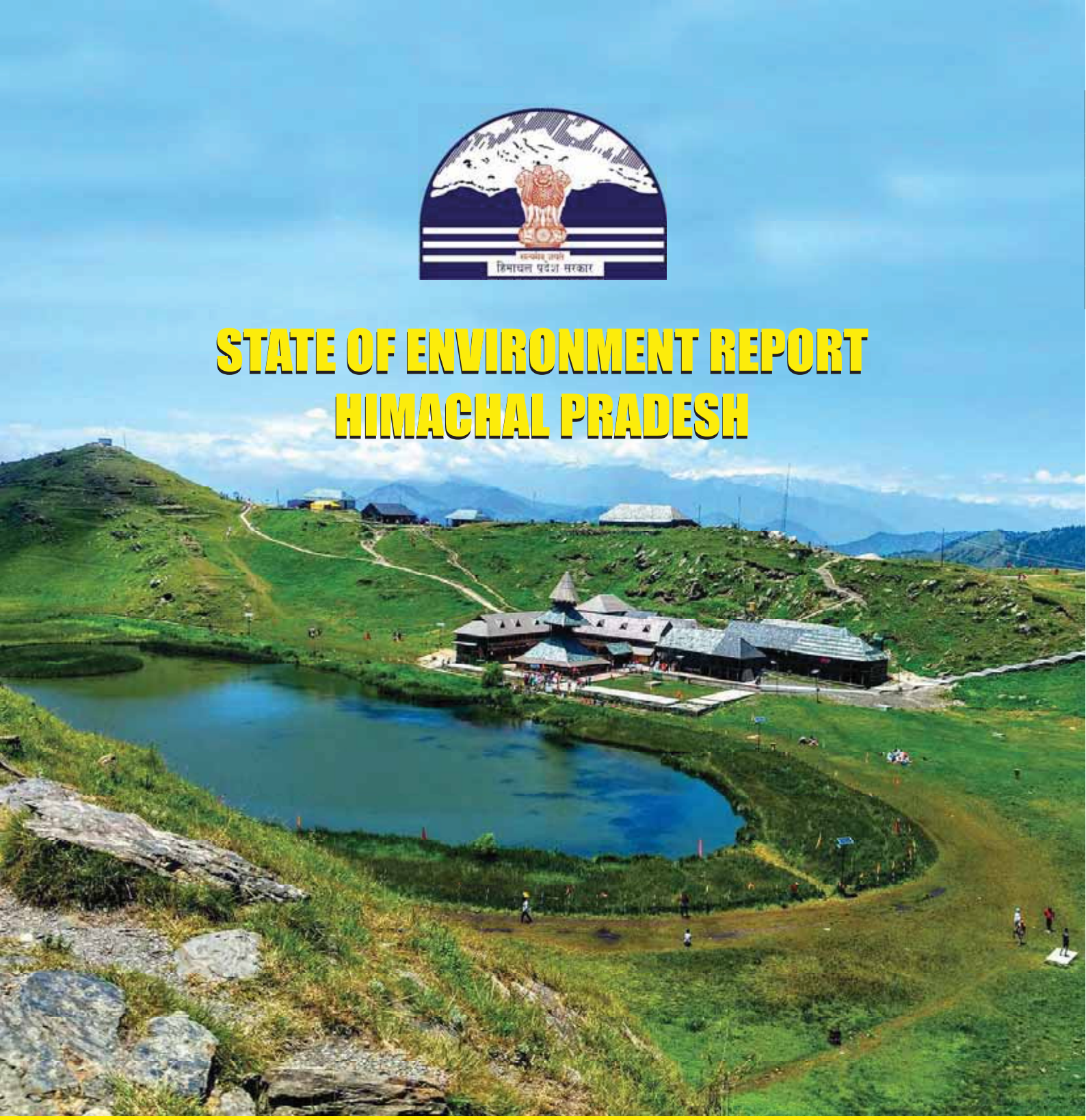

STATE OF ENVIRONMENT REPORT
HIMACHAL PRADESH

Department of Environment, Science & Technology
Government of Himachal Pradesh

2019-20

For further information, please contact:

Director

Department of Environment, Science and Technology

Paryavaran Bhawan, Shimla-171001 (Himachal Pradesh) INDIA

+91 177-2625851, 2620559, Telefax: 2627603

www.himachal.nic.in/environment

State of Environment Report
Himachal Pradesh

2019-2020

Editor-in Chief
Lalit Jain
Editors
Tarun Gupta
Asheesh Gupta
Sharmila Chauhan

Department of Environment, Science & Technology
Government of Himachal Pradesh

Paryavaran Bhawan, Shimla-171 001, H.P.
Phone No. 0177-2627608, 2627604, 2620559
Website: www.himachal.nic.in/environment

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+91 8894440400, 7018888684, email: ingeniousbs@hotmail.com

JAI RAM THAKUR
Chief Minister
Himachal Pradesh

EIIERSLIE
Shimla-171002

MESSAGE

I am pleased to learn that the Department of Environment, Science & Technology, Government of Himachal Pradesh is bringing updated State Of Environment Report for the State. Today, everyone is poised to have better living standards and the Government of Himachal Pradesh is committed to meet the expectations of the people of Himachal Pradesh. To achieve and fulfill people dreams, the Government of Himachal Pradesh is executing different schemes & projects, and is also devoted to protect and conserve pristine Environment of the State.

Our vision is to conserve and improve the environment and natural resources of the State and enhance the capacity of all the stakeholders in development to foster environmental sustainability and human well-being.

I Compliment the Department of Environment, Science & Technology, for updating the State of Environment Report which I am sure will help the Planners to take decisions for better environment management in developmental interventions.

I am given to understand that such updation of the Report shall be taken up periodically which will definitely help in understanding how environmental practices are being integrated in the developmental process to achieve the much cherished goal of sustainable development

(Jai Ram Thakur)

Ellerslie
H.P. Secretariat-171002
Tele. : 0177-2621022
E-mail: cs-hp@nic.in

Ram Subhag Singh,IAS
Chief Secretary

MESSAGE

I am pleased to learn that the Department of Environment, Science & Technology, Government of Himachal Pradesh is bringing out an updated State Of Environment Report for the Himachal Pradesh. The environment supports our existence and the lives of the other species. It is an inter-dependent cycle that enables living possible on the earth. Thus, there is a need for conserving the environment as it forms the basis of all life forms.

There is also a need to strike a fine balance between our quest for faster development and sustain ability of environmental resources. Environment degradation is a global concern. True development necessitates not only delivering economic progress but also making concerted efforts to rejuvenate rivers, water bodies, forests and improving ambient air quality.

Environmental data allows exploring environment issues, engaging in problem solving, taking action to improve the environment and develop a deeper understanding of environment problems. I strongly believe that we have the skills to make informed and responsible decisions. There is a need for spreading awareness about the pivotal role played by the environment in enhancing quality of our life. I hope that the report will be useful in understanding and addressing the environmental issues in a sustainable manner for a holistic development of our State.

Ram Subhag Singh

FOREWORD

Clean environment gives us countless benefits and is a priceless asset. Loss of biodiversity, desertification, climate change and the disruption of a number of natural cycles are among the costs of our disregard for Nature and the integrity of its ecosystems and life-supporting processes.

The solar system reminds us that, just as the earth is not alone in universe, all forms of life have a symbiotic interdependence. We, along with the rest of the natural world, are all interconnected within the larger web of life.

The Department of Environment, Science and Technology had prepared last State of Environment Report (SoER) in the year 2010 which was based on the Pressure, State, Impact & Response (PSIR) Model. The updation of State of Environment Report is an effort to provide insight on the environmental issues and changing environmental concerns in the state and to address them in the context of dynamic environmental circumstances within our available technological options. The updated report is supported in the user friendly form of tables, pictures, graphs rendering the statistical data easy to comprehend.

I am sure that the updated report will help the Policy makers/ planners to take decisions for better environment management. I hope that the report will be equally helpful to the research scholars, students, NGOs and the public at large in understanding the changing environmental concerns of the State.

Prabodh Saxena, IAS
Addl. Chief Secretary (Env.,S&T) to the
Government of Himachal Pradesh

ACKNOWLEDGEMENT

To meet a balance between environment protection and developmental challenges requires a systematic approach and strategy. The world has entered a new era of data-driven environmental policy-making. A more data-driven and empirical approach to environmental protection promises to make it easier to spot problems, track trends, highlight policy successes and failures, identify best practices, and optimize the gains from investments in environmental protection.

As the data advances and the statistical tools of the information age flow more fully into the environmental arena, the potential for even more rigorous environmental decision-making by governments, businesses and the academic community looks significant.

While updating the state of Environment Report, the significance of data in Environmental decisions making and better management of pristine environment of the state was always in the backdrop.

This report contains large amount of data which has been collected and collated from various departments through the Nodal officers appointed within each department. Our sincere thanks is extended to all the Departments / Nodal Officers without whose help it would not have been possible to prepare this document.

I, duly acknowledge the efforts of the Thematic Experts of various sectors in writing and compiling the report. My due thanks to the Proof reader who went to the entire document and suggested corrections. I also wish to put on record the efforts made by the "Team Environment" to bring out the report.

Lalit Jain, IAS
Director
Environment, Science & Technology
Government of Himachal Pradesh

LIST OF CONTRIBUTORS

Sr.No	Name of the chapter	Contributed by
1	Physiography and Environment	Sh. D.C. Thakur, MISO, DEST,Shimla-1 H.P.
2.	Agriculture & Environment	Dr. B.D Sharma, Retired Pr. Scientific officer, NBPGR, Phagli, Shimla, H.P
3.	Horticulture & Environment	Dr. S.K Bhardwaj, Prof. & Head, Deptt. of Environmental Science, Dr. Y.S Parmar, UHF, Nauni, Solan.
4.	Bio-diversity & Environment	Dr. K.S Kapoor, (Retired Scientist, HFRI), Dr. M.L. Thakur, State Biodiversity Board, H.P.
5.	Energy & Environment	Dr. S.S Chandel, Dean, Shoolini University, Bajhol, Solan & Dr. Rajeev Agarwal, Assistant Professor, Dr.Y S Paramar, UHF, Nauni, Solan.
6.	Environment Pollution & Management	Dr. Harish Sharma , Retired Pr. Scientific officer, HPPCB, Shimla.
7.	Forest & Environment	Sh. A.R.M. Reddy, Addl.PCCF, Department of Forest, Shimla.
8.	Health & Environment	Dr. Rakesh Roshan Bhardwaj, OSD, Health and Safety Regulation, Dr. S.N. Joshi, Retired IAS, Shimla
9.	Land use & Environment	Sh. Rajender Thapa, PSO, State Council for Science & Technology, Shimla.
10.	Natural Disasters & Climate Change	Dr. S.S. Randhawa, PSO, HIMCOSTE, Shimla
11.	Society & Environment	Sh. Raja Bhasin, Renowned writer, Shimla, H.P
12.	Water Resources & Environment	Dr. J. C. Sharma, Prof. & Head, Deptt. Of Soil Science & Water Management, Dr. Y.S Parmar UHF, Nauni, Solan.
13.	Industries & Environment	Sh. Lalit Jain, Director, Department of Environment, S&T, Shimla.
14	Tourism Culture & Environment	Sh. Raja Bhasin, Renowned writer, Shimla, H.P
15	Transport & Environment	Dr. R.N. Batta, Secretary (R.D.D).

TABLE OF CONTENTS

PHYSIOGRAPHY OF HIMACHAL PRADESH

CHAPTER-1

1. Introduction

Himachal Pradesh lies between 30° 22' 40" to 33° 12' 40" north latitudes and 75° 45' 55" to 79° 04' 20" east longitudes in the western Himalaya. The altitudinal variation in the State is 350 m to 6,816 m above mean sea level. The terrain is entirely mountainous. The state of Himachal Pradesh encompasses an area 55,673 km² and is bordered by Jammu and Kashmir in the north, Punjab in the southwest, Haryana in the south, Uttarakhand in the southeast and Tibet in the east.

Himachal Pradesh is set amidst majestic mountains famous for its abundant natural beauty. The word Himachal is derived from two Sanskrit words, 'HIMA' (snow) and 'ACHALA' (mountain), meaning 'snowy-mountains' or ‘snowy- range'. Similarly the word Himalaya is derived from 'HIMA' and 'Alaya' (abode), meaning the 'home' or abode of snow'.

After India attained Independence in 1947, 31 princely region of the area were united and Himachal Pradesh was formed on 15th April, 1948. In 1950 Himachal was declared as a Union Territory. With the reorganization of Punjab on 1st November, 1966, certain areas belonging to it were also included in Himachal Pradesh. On 25th January, 1971, Himachal Pradesh attained full statehood.

1. 2 Geographical/ Land Profile

1. 2. 1 Physiography

Himachal Pradesh has a complex and diverse physiography and complex geological structure. Himachal Pradesh can be subdivided into four distinct physiographic regions: 1- Shiwalik or Outer Himalayan Zone. 2- Middle or mid-Himalayan region. 3- Higher or main Himalayan region. 4-Trans-Himalayan region. The Shiwalik jor out Himalayan region occupies the lower belt of the State bordering Haryana and Punjab. It includes the Shiwalik hills and valleys between these hills and the middle-Himalayan region. The middle Himalayan regions consists of relatively higher mountains and valleys. The higher Himalayan region comprises of high mountains and many snow clad peaks. The trans-Himalayan region has across the main Himalayan region and resembles the Tibetan plateau.

Himachal Pradesh is a mountainous state with altitude ranging from 350 m above msl at its boundary along the Punjab plains to 6,816 msl at Reo Purgyal in the Zanskar range in Kinnaur. The altitude increases from west to east and south to north. The general landscape presents an intricate mosaic of mountain ranges, hills and valleys. Important mountain ranges in the State include the Shiwaliks, Dhauladhar, Pir Panjal, Great Himalaya and the Zanskar. Separated by valleys, mountains and hills, distinct physiographic regions run almost parallel to each other throughout the length of the State from west to east.

Major Mountain Ranges of Himachal Pradesh

Pir Panjal Range: To the south of the main Himalayan range lies the Pir Panjal Range at an average height of 5,000 m. This range enters the State in Chamba district and runs in a more or less in north west-south east direction.

Dhauladhar Range: To the south of the Pir Panjal lies the Dhauladhar range. It is in the form of a distinct feature

of the snow-capped ridges, that forms the division between the Ravi and the Beas valleys. In the west it divides the Chenab valley and the Tawi valley. Towards the east it extends across Himachal Pradesh forming the high ridges of the Larji gorge and extending towards the south of the Pin Parvati valley before it forms the ridgeline east of the Sutlej River.

Zanskar Range: It lies to the north of the main Himalaya. In Himachal Pradesh the range extends through Lahaul and Spiti. While on the North it continues across the Kinnaur before extending towards west across Uttarakhand. The Zanskar range is the main mountain feature of the trans-Himalayan region of Himachal Pradesh.

Shiwalik Hills: It lies to the south of the Dhauladhar, with an average height of 1,000 to 1,500 m. The Shiwalik hills occupy a position between the Indo-Ganges plain and the mid-Himalayan region of the State. It includes parts of Sirmour, Solan, Bilaspur, Mandi, Kangra and Chamba districts.

1. 2. 2 Soils

The soils of Himachal Pradesh vary according to aspect, slope and climatic conditions. Major soil types that are scattered throughout the state geology described below:

Alluvial soils: These soils are found in Una, Kangra and Poanta areas where the flood plain is the dominant physiography. Soils are coarse textured, loamy sand and sandy loam. Organic matter content is low and soils are calcareous in nature containing 2 - 4.5% calcium carbonate content.

Brown hill soils: The soils found in parts of Sirmour and Solan districts are brown hill soils with medium to high organic matter content. Texture varies from sandy loam to clay loam. The soils are neutral to slightly acidic in reaction.

Non-calcic brown soils: These soils are neutral in reaction which are normally found in parts of Hamirpur, Bilaspur, Mandi and Kangra districts. Organic matter content is low to medium and the texture varies from loamy sand to clay loam.

Brown podzolic soils: The soils are characterized by dark colour indicating high organic matter content. These are sandy loam to clay loam in texture mostly found in some parts of Shimla, Kullu districts and Mandi districts. Soil reaction ranges from slightly to strongly acidic.

Grey brown podzolic soils: These soils occur in parts of Kangra district and Jogindernagar area of Mandi district. The soils are slightly red in colour due to the presence of iron andmanganese concretions. They are acidic in reaction and the texture is either clay loam or silty loam or silty clay.

Planosolic soils: The soils shows iron-manganese concretions and mottlings and mixed grey colours. They are medium to fine textured i.e. sandy loam to sandy clay loam and clay loam and neutral in reaction. The organic matter content is medium to high. As they are fine textured soils, there is a problem of drainage.

Humus and iron podzols: The soils are mainly confined to parts of Shimla, Dalhousie (Chamba) and Manali regions. The soils are acidic in reaction with high organic matter content. Sandy loam to sandy clay loam and clay loam textures are common.

Alpine humus mountainous soils: The soils are found in the higher Himalayan regions in the districts of Kinnaur and Lahaul-Spiti and Pangi tehsil of Chamba district. They are gravelly loamy sand to loam and generally high in organic matter.

Brown forest soils: These soils have high content organic carbon, nitrogen and phosphorus and medium content of potassium. These are acidic in reaction. Found in parts of Chamba, Kullu and Shimla districts.

Soil Types

(a) Udalfs-Ochrepts (20,24): The udalfs-ocherpts are high base status soils of humid regions such as Chamba, Lahaul & Spiti, Kinnaur and the southern part of Sirmaur. A combination of udalfs-ochrepts is found in Mandi, Bilaspur and the eastern part of Shimla as well. The ochrepts are shallow black, brown and alluvial soils.

(b) Orthents-Ochrepts (58): The othents-ochrepts soils represent the combination of shallow black, brown and alluvial soils. These are recently formed soils and are found in lower and mid-Himalayan region such as Sirmaur, Solan, Una, Hamirpur, Kangra and part of Chamba district. They are mainly alluvial soils which were recently formed. They are shallow black as well as red loamy and red sandy in nature. Kullu, parts of Kinnaur and Shimla are characterised by these types of soils. These soils are very good for horticulture.

(c) Ochrepts-Orthents-Ustalfs (70,72,73,74,82): The udolls are found in northern part of Lahaul & Spiti. They represent the characteristics of the Terai soil of humid regions.

(d) Udolls (89): The glaciers and snowcap soils are spread in patches in part of Kullu, Lahaul-Spiti and Kinnaur where glaciers and snow cover is present throughout the year.

1. 2. 3 Land Capability

Land capability is the capacity of the land to put to a specific use. It depends on the soil, slope, aspect, climate and other conditions. Land suitability is basically an interpretation of groupings of different soil units and serves an important role in land use planning to show the relative suitability of soil for cultivation of crops, pastures, forestry and focusing the problems which needs preventive measures. Therefore, the strategy would be to identify the lands according to its natural (environmental) suitability in a way that the use is not adversely affecting its natural condition and/or its natural functions on a sustainable basis. This means the identification of suitable region for different type of development. Land use according to land capability should be such that cultivation be in between I to IV capability classes, horticulture & grazing V on VII and forestry on class VII, leaving class VIII for conservation ecological services and recreation.

In a study undertaken by NBSS &LUP, the soils of the state have been classed into 5 land capability classes. Majority of the soils belong to class VIII (40.6%), class VII (14.7%) and class VI (23.0%). These soils are not suitable for agriculture. Class VI lands can be utilized for growing forests and pastures. Class VII lands are mostly rocky outcrops, which can be utilized as recreational areas. Class VII lands can be marginally utilized for forests and pastures. Class III and IV lands can be utilized for cultivation by adopting suitable soil conservation measures. Class II lands though not mentioned here but exists in small patches and is included in the classes.

LAND CAPABILITY CLASSES IN HIMACHAL PRADESH

Class	Area		Limitations	Potentials
	000 ha	%age		
III	370	6.7	Moderate problems due to moderate depth, gravels, moderate slopes subject to water erosion	Moderately good cultivable land
IV	816	14.7	Moderately steep lands subjects to serious water erosion, shallow depth, gravels and stones.	Fairly good land suited for cultivation
VI	1281	23.1	Steep lands subject to severe erosion if cover	Well suited for grazing, forestry and plantations and limited cultivation
VII	819	14.8	Very steep land subject to erosion, if cover if depleted, very shallow and stony soils.	Fairly well suited for grazing forestry, not arable.
VIII	2260	40.7	Highly erodible gullies, badlands, barren mountain tops and rock outcrops.	Suited only for wildlife, recreation and permanent snow covered as protection of water supplies.

1.2.4 Climate

The climate of the state varies from place to place depending on the altitude and latitude. It varies from hot and sub-humid tropical (450-900 m) in the southern low tracts, warm and temperate (900-1800 m), cool and temperate (1900-2400 m) and cold alpine and glacial (2400-4800 m) in the northern and eastern high mountain ranges.

The climate of the State is influenced by three distinct reasons: winter, summer and monsoon. Most parts of the State receives rainfall from the South West monsoon though precipitation is also from winter rains. There are three marked seasons in Himachal Pradesh. These are:-
(a) Summer Season (April to June)
(b) Rainy Season (July to September)
(c) Winter Season (October to March)

Based upon based on mean annual temperature and mean annual precipitation the state of Himachal Pradesh is divided into six climatic zones given as under:

(i) Sub humid-subtropical zone: This zone covers parts of Una, Sirmaur and Kangra districts with a mean annual temperature of 24°C and mean annual precipitation of 1000 mm.

(ii) Humid subtropical zone: The zone covers whole of Hamirpur and Bilaspur districts, major part of Mandi district, Nahan of Sirmaur district, Bhatiyat valley of Chamba district, Nalagarh, Dehragopipur and Nurpur tehsils of Kangra district. Characteristic features of this zone are mean annual temperature varies from 20-24°C and mean annual precipitation is 1180 to 1900 mm.

(iii) Wet temperate zone: This zone comprises of Palampur, Dharmasala areas of Kangra, Jogindemagar and Dalhousie areas of Chamba and Mandi districts. The mean annual temperature varies from 15-19°C. The mean annual rainfall is 2500-3900 mm.

(iv) Humid temperate zone: Parts of Mandi, Solan, Chamba, Kangra, Sirmaur, Kullu and Shimla districts comes under this zone. The mean annual temperature ranges from a minimum of 13°C to a maximum of 18°C with an average annual rainfall of 1000-2500 mm.

(v) Sub-humid temperate alpine high lands: It includes major parts of Lahaul-Spiti, Pangi and Kinnaur areas. The average annual temperature is 13°C and rainfall is 600 mm. The precipitation mostly received in the form of a snow.

(vi) Frigid aridic zone: This zone covers Spiti sub-division of Lahaul-Spiti district, parts of Chamba and Kinnaur areas. The mean annual temperature is 13°C and the annual rainfall average is about 250 mm. In this zone also snow fall is a common occurrence.

Himachal Pradesh exhibits considerable variation in the distribution of rainfall and temperature due to the varying aspects and altitudes. Precipitation declines from west to east and south to north. The average annual rainfall of Himachal is 149 cm. Kangra district receives the maximum amount of rainfall (185 cm) in a year, whereas Una receives the minimum amount of rainfall (121 cm) in a year. About 70% of this precipitation is received from July to September. Winter precipitation as snow is received at elevations above 1,800 m. An average of 3 m of snow is experienced from December to March at elevations above 3,000 m. The reaches above 4,500 m above msl remain under almost perpetual snow. District-wise figures of rainfall in Himachal Pradesh are given in table. Average rainfall graph of the State shows an increasing trend of rainfall during the year 1999-2011.

Temperatures decrease from west to east. Whereas January is the coldest month, the highest temperature is recorded during the month of June.

1.2.4 Land Use

According to the Survey or General of India, the total geographical area in the State is 55673 thousand hectares, out of which 4543 thousand hectares is cadastrally surveyed and finds place in the land records. Thus, the remaining area of 1024 thousand hectares with a percentage of 18.39 cadastrally surveyed and does not find entry on revenue records. This difference is on account of the far-flung interior areas being iinaccessible which remained unsurveyed, However, this is bound to narrow down as more areas are finding place in revenue records.

The entire land resource in the State is owned by the Government, communities and private individuals.
The major land use of Himachal Pradesh are:

1. Forest
2. Grasslands
3. Cultivated land
4. Wasteland

Total Area and Classification of Area In Each District of HIMACHAL PRADESH for the year ending 2008-09 (in Hectares)

District Name	Reporting area for Land Utilisation Statistics	Forests	Not Available For Cutivation			Other Uncultivated Land Excluding Fallow Land				Fallow Land			Net Area Sown	Total Cropped Area	Area Sown More than Once
			Area Under Non Agricultural Uses	Barren and Un Culturable Land	Total	Permanent Pastures and Other Grazing Lands	Land Under Misc Tree Crops and Groves not included in Net Area	Culturable Waste Land	Total	Fallow Lands Other than Current Fallows	Current Fallow	Total			
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
1. Bilaspur	111776	14013	15252	4296	19548	39433	130	6221	45784	972	1492	2464	29967	56508	26541
2. Chamba	692419	272008	15104	4881	19985	349017	225	6860	356120	935	1583	2518	41806	68443	26637
3. Hamirpur	110224	18232	15254	11700	26954	11545	1	11038	22584	1515	5287	6802	35652	68828	33176
4. Kangra	577681	232520	77669	14848	92517	87865	8274	28204	124343	1097	11456	12553	115748	217672	101924
5. Kinnaur	624215	37612	117794	133335	251129	322344	98	3289	325731	56	1821	1877	7866	9621	1755
6. Kullu	54771	877	5834	2006	7840	1437	1830	2466	5733	293	2792	3085	37236	64254	27018
7. Lahaul & Spiti	911195	135369	135760	415831	551591	220058	126	589	220773	1	102	103	3359	3547	188
8. Mandi	397833	175239	16233	8884	25117	96238	350	4485	101073	331	9478	9809	86595	159191	72596
9. Shimla	508908	130411	16663	15681	32344	228567	11817	21209	261593	3979	15609	19588	64972	86022	21050
10. Sirmaur	224743	48313	10471	8529	19000	56941	37307	12659	106907	5877	4026	9903	40620	74681	34061
11. Solan	180923	20289	12950	11705	24655	77283	550	14877	92710	2375	3285	5660	37609	63713	26104
12. Una	154923	18153	28845	22232	51077	12589	7083	23182	42854	2444	2363	4807	38032	73647	35615
State Total	4549611	1103036	467829	653928	1121757	1503317	67791	135079	1706187	19875	59294	79169	539462	946127	496665

Source: Directorate of Economics & Statistics
Ministry of Agriculture, Govt. of India

Total Geographical area of the State is 5567300 ha

Land use in H.P. (Area in Ha)

Land Use	Area in '000 ha	Percentage
Total geographical area	5,5673	
Reporting area for land utilization	4,549	100.00
Forests	1,101	24.21
Not available for cultivation	1,129	24.82
Permanent pastures and other grazing lands	1,496	32.89
Land under misc. tree crops and groves	65	1.43
Culturable wasteland	138	3.03
Fallow lands other than current fallows	15	0.33
Current fallows	64	1.41
Net area sown	541	11.90

Source: Land Use Statistics, Ministry of Agriculture, GOI, 2008-09.

a) Changes in Land Use Pattern

Land is needed for many different needs and land use changes due to demographic and other processes. In the past decades, land use in the State has changed with land being used for roads, settlements, hydro-electric projects and many other uses. Before 1980, the forest area of the State has reduced.

b) Forest Lands

The Forests of Himachal Pradesh known for their grandeur and majesty are like a green pearl in the Himalayan crown. This life supporting systems are presently under great stress due to impact of modern civilization, economic development and growth in human and cattle population.

According to National Forest Policy, 1988, atleast two third i. e 66% of the geographical area should be under forest in the hilly states like Himachal Pradesh. However, keeping in view that about 20 % of the area is inaccessible and above the tree line, the State Government aims to bring 50% of the geographical area under forest cover.

The forests of the State have been classified on an ecological basis as laid down by Champion and Seth, and can be broadly classified into Coniferous Forests and broad-leaved Forests. Distribution of various species follows fairly regular altitudinal stratification. The vegetation varies from Dry Scrub Forests at lower altitudes to Alpine Pastures at higher altitudes. In between these two extremes, distinct vegetational zones of Mixed Deciduous Forests, Bamboo, Chil, Oaks, Deodar, Kail, Fir and Spruce, are found. The richness and diversity of our flora can be gauged from the fact that, out of total 45,000 species found in the country as many as 3,295 species (7.32%) are reported in the State. More than 95% of the species are endemic to Himachal Pradesh and characteristic of Western Himalayan flora, while about 5% (150 species) are exotic, introduced over the last 150 years. The forests of Himachal Pradesh are rich in vascular flora, which forms the conspicuous vegetation cover.

Forest cover in the State, according to FSI based on interpretation of satellite data of October-December 2008 is 14,679 km² which is 26.37% of the State's geographical area. In terms of forest cover canopy density classes, the State has 3,224 km² area under very dense forest 6,384 km² area under moderately dense forest and 5,074 km² area under open forest.

District Wise Forest Cover in different canopy density classes alongwith the changes compared to 1999 assessment and scrub are given in the following table.

Land use (Area in Ha)

Landuse Classification	1966-67	1994-95	1999-2000	2008-2009
Forests	6,36,096	10,49,039	10,94,209	11,03,036
Barren and Un-cultureable Land	1,09,383	1,49,388	8,56,911	6,53,928
Area put to non-agricultural Uses	1,17,483	1,98,669	30,219	4,67,829
Permanent Pastures and Other Grazing Lands	11,63,402	11,93,602	14,71,536	15,03,317
Land under Miscellaneous Tree Crops and Groves	39,716	48,634	64,161	67,791
Culturable Waste Lands	1,76,760	1,18,126	1,19,413	1,35,079
Other Fallow Lands	2,630	20,695	15,714	19,875
Current Fallow	65,759	55,938	56,233	59,294
Net Area Sown	5,35,107	5,68,338	5,51,457	5,39,462
Total Area	**29,06,336**	**34,02,429**	**45,31,828**	**45,49,611**

c) Cultivated Lands

Himachal Pradesh is primarily an agrarian State with the rural population (61,67,805) accounting for 89.95% of the total population (68,56,509) according to 2011 Census. An area of 8,97,400 hectare is under cultivation as per records of Agriculture Department. However, as per revenue records based on survey and settlement up to 1995-96 (Table above), the total net sown area in the State is only 5.57 lakh hectare. Even after taking into account areas under Culturable Waste Lands, fallows other than current fallows and the fallow lands the total adds up to 7.59 lakh hectare. With the total number of land holdings in the state estimated at 8.44 lakh, the average size of land holding thus works out to a about one hectare. Of these, holdings of less than one hectare account for more than 60% of the total and only about one percent of the holdings are larger than ten hectares. With the increase in population over the years and the change in life style, many joint families have split thus increasing the number of smaller land holdings. Smaller holdings are unable to sustain the needs of the family and this trend is unhealthy. The small farmer has, therefore, to look for other avenues for income generation. There could be cases where cultivators leave the land and look for other opportunities.

With the total geographical area of the State fixed and total area under forests and unculturable lands known, the shift towards net area sown can only be from fallow lands and Culturable Wastes. However, linking remote areas in the state by network of roads has opened up these areas for cultivation. Small encroachments on forest lands have also taken place in these areas. Land is tilled without constructing terraces, resulting in erosion of topsoil and reduced fertility of the soil. Since the areas still remain undemarcated, only guesses can be made about such encroachments.

Change in land use on another level is in the shape of bringing more areas under intensive agriculture and raising more than one crop per year, raising cash crops as alternative to agricultural crops, or bringing land under orchards or tree farms. These shifts from one type of land use to another are linked to the development of infrastructure – mainly construction of roads linking even the remote localities to the main towns, provision of irrigation and development of modern agricultural technologies. All these trends have been witnessed in the State in the recent past. There is a clear shift from traditional to cash crops.

In Himachal Pradesh traditional agriculture is still practiced over a large part of cultivable area. The area under the major cereal crops in the state viz. wheat, rice, maize and barley, registered an increase from 6.50 lakh hectares during 1966-67 to 7.77 lakh hectares during 1995-96. Production of these food crops also increased from 6.58 mt to 13.18 mt during the same period. These figures reveal that the intensity of agriculture and productivity has also increased over the years. The area under rainfed crops, like pulses, registered a decline from 0.62 lakh hectares during 1966-67 to 0.36 lakh hectares during 1994-95. Similarly the area under minor millets and pseudo cereals has also declined from 0.69 lakh hectares to 0.18 lakh hectares during the same period. This change in land use pattern can be explained by extension of irrigation facilities, availability of improved seeds for major cereal crops and change in food habits of the people, who now have switched over to major cereals from minor cereals and pseudo cereals as their main diet.

The area under fruit trees and vegetables has also increased from 0.92 lakh hectares in 1980-81 to 1.96 lakh hectares in 1995-96 (Department of Horticulture, 1997). This increase in the area under horticulture has been prompted by the suitability land and climate for horticulture and the much higher returns from horticulture produce. An example of changed economy due to switching over to apple cultivation in the higher hills of the state is manifested in recognition of the 'Kiari' village in Kotkhai, Shimla, as the village with the highest per capita income in Asia for the year 1999. Increases in the area under horticulture has been largely at the expense of agriculture. However, private tree lands, particularly in the higher hills, have also been cleared of trees and brought under horticulture.

Conducive climatic conditions make the State ideal for growing off-season vegetables under natural conditions with low irrigation input. Large tracts of land in the lower hills have been diverted from traditional agriculture to growing of vegetables such as tomatoes, capsicum, cucumber and ginger. Similarly, in the high hills, land under vegetables such as cabbage, carrots, cauliflower, peas and potatoes is increasing every year.

In recent years floriculture has also emerged as a cash crop yielding very high returns and a high potential for export. The climate in the state is suitable for growing flowers such as carnations, gladioli, chrysanthemums and lilies. Since this venture needs very high investment and is of a highly intensive nature, the land brought under floriculture is not very large. As per estimates by the Horticulture Department, about 50 ha has already been brought under floriculture and this is increasing at the rate of 10 % per year.

1. 3. Natural Resources

1. 3. 1 Minerals

Himachal Pradesh is the sole holder of country's rock salt resources. Barytes, limestone, salt (rock) and shale are the important minerals produced in the State. **Barytes** occurs in Sirmaur district; **limestone** in Bilaspur, Chamba, Kangra, Kullu, Mandi, Shimla, Sirmaur and Solan districts; and rock salt in Mandi district. Other minerals that occur in the State are **antimony** in Lahaul & Spiti districts; **gypsum** in Chamba, Sirmaur and Solan districts; **magnesite** in Chamba district; pyrite in Shimla district; and **quartz**, **quartzite** and **silica sand** in Una district

Limestone is the most heavily quarried mineral of the state and provides raw material for the three major cement plants and a number of small cement units in the state. Most of the limestone, slate and other quarrying is open cast and causes substantial degradation of the land due to depositing of overburden. River bed quarrying yields increased for building construction.

1.3.2 Water Resources

The State is rich in water resources which owe their existence to good precipitation during the winter and during monsoon season. These resources include glaciers, perennial streams draining into rivers, water bodies including natural lakes and manmade reservoirs, innumerable water springs and large stocks of sub-soil water. Water resources of the state have a major bearing on making the state a very rich repository of biodiversity. The State is in the process of harnessing this vast water resource for the generation of hydropower.

Wild life Sanctuaries and National Parks in Himachal Pradesh

There are 2 National Parks and 33 Wildlife Sanctuaries in Himachal Pradesh. These are listed below:

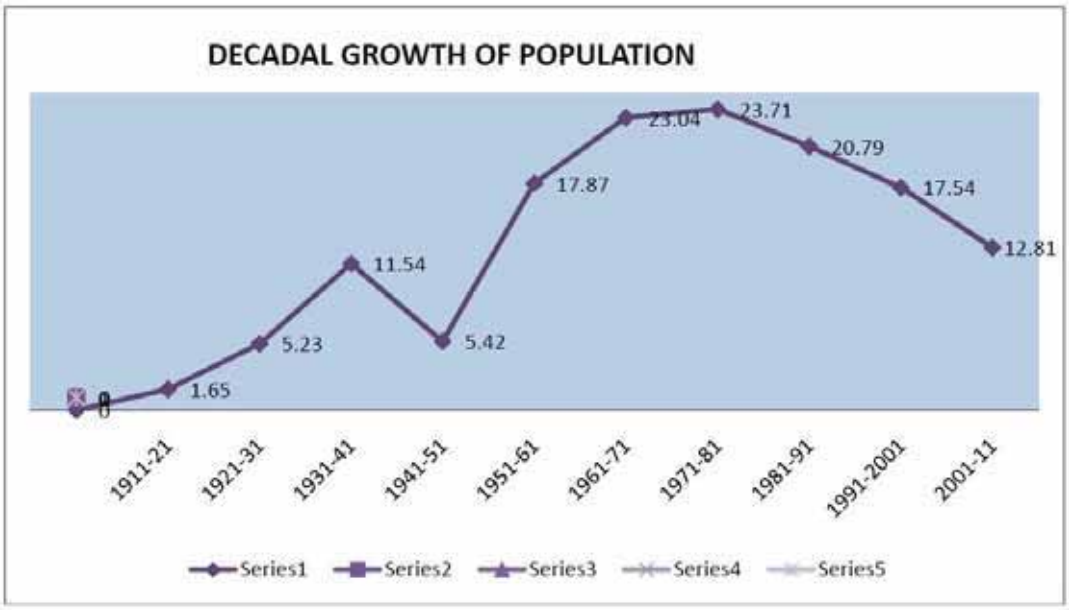
Sr. No.	Name of NPs/Santuaries	Name of District	Area as per Notification (km
1.	Great Himalayan N Park	Kullu	754
2.	Pin Valley National Park	Lahaul Spiti	675
3.	Chail	Solan	109
4.	Simbalbara	Sirmour	19
5.	Renuka Ji	Sirmour	4
6.	Churdhar	Sirmour	66
7.	Majathal	Solan	40
8.	Darlaghat	Solan	6
9.	Talra	Shimla	40
10.	Shilli	Solan	2
11.	Lipa Asrang	Kinnaur	31
12.	Raksham Chhitkul	Kinnaur	304
13.	Rupi Bhaba	Kinnaur	503
14.	Daran Ghati	Shimla	167
15.	Shimla Water Catchment	Shimla	10
16.	Kais	Kullu	14
17.	Bandali	Mandi	41
18.	Shikari Devi	Mandi	214
19.	Khokhan	Mandi	13
20.	Kanawar	Kullu	54
21.	Nargu	Mandi	278
22.	Manali	Kullu	29

Sr. No.	Name of NPs/Santuaries	Name of District	Area as per Notification (km
23.	Naina Devi	Bilaspur	123
24.	Pong Dam	Kangra	307
25.	Govind Sagar	Bilaspur	100
26.	Dhauladhar	Kangra	944
27.	Gamgul Siyabehi	Chamba	109
28.	Kalatop Khajjiar	Chamba	69
29.	Kugti	Chamba	379
30.	Tunda	Chamba	64
31.	Sechu Twan Nala	Chamba	103
32.	Sainj	Kullu	90
33.	Tirthan	Kullu	61
34.	Kibbar	Lahaul Spiti	1400
35.	Chandra Tal	Lahaul Spiti	39
Total			7161

1.3.4 Demography

Population Highlights

The population of Himachal has been increasing continuously over the years. However the growth rate of total population has been a decreasing trend over the last three decades. In 2011 the total population of H.P was 68,56,509 out of which 34,73,892 were males (51%) and 33,82,617 (49%) were females. The rural population was 90% and urban 10% of the total population. The percentage share of urban population has been increasing continuously over the previous years with figures of 7.61% in 1981, 8.69% in 1991, 9.80% in 2001 & 10.00% in 2011 census.



As per the 2011 census report, the human population of the state stood at 68,56,509 showing a decadal growth of 12.81%. Even though the population has increased by 7,79,261 in absolute numbers between 2001 and 2011, the growth rate has shown a definite down trend as compared to the decadal population growth rate of 17.54% between 1991 and 2001. Population figures for the state since 1951 are as per table below:

Population Growth and Density since 1951

Year	Population	Decadal Growth	Density per Km^2
1951	23,85,981	-	43
1961	28,12,463	17.87	51
1971	34,60,434	23.04	62
1981	42,80,818	23.71	77
1991	51,70,877	20.79	93
2001	60,77,248	17.54	109
2011	68,56,509	12.81	123

Himachal Pradesh has the highest percentage of rural population (89.9%) in the country living in more than twenty thousand villages across the state. However, this population is concentrated in the middle and lower regions of the state with Hamirpur district having the highest population density of 406 per km^2 . On the other hand the districts of Lahaul & Spiti and Kinnaur have a population density of a mere 2 and 13 per km^2 respectively. The sex ratio in the State is 974 females per thousand males and the literacy rate stands at 83.78% with the literacy rate for males being 90.83% and for females 76.60%.

District	Population								
	Rural			Urban			total		
	Male	Female	Total	Male	Female	Total	Male	Female	Total
1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
Bilaspur	179726	177204	356930	13101	12025	25126	192827	189229	382056
Chamba	241424	241229	482653	19424	16767	36191	260848	257996	518844
Hamirpur	200450	222430	422880	16292	15121	31413	216742	237551	454293
Kangra	703276	717588	1420864	45283	41076	86359	748559	758664	1507223
Kinnaur	46364	37934	84298	0	0	0	46364	37934	84298
Kullu	202418	193798	396216	21902	19356	41258	224320	213154	437474
Lahaul-Spiti	16455	15073	31528	0	0	0	16455	15073	31528
Mandi	464732	472162	936894	32055	30569	62624	496787	502731	999518
Shimla	313535	298349	611884	110951	90549	201500	424486	388898	813384
Sirmaur	246599	226327	472926	30202	27036	57238	276801	253363	530164
Solan	247195	227397	474592	58967	43111	102078	306162	270508	576670
Una	240088	236052	476149	23453	21464	44917	26354141	257516	521057
H.P.	3102262	3065543	6167805	371630	317074	688704	3473892	3382617	6856509

Source:- Census of India-2011(P)

The major sociological population groups in the state are the 'Rajputs and Brahmins', the 'Scheduled Tribes' and the 'Scheduled Castes'. The Rajputs and Brahmins own most of the agricultural land and form the most affluent and influential social group in the village community. The Scheduled Castes in the state are believed to be 'aborigines of the hills' and have traditionally been dependent upon vocations such as cobblery, carpentry, black smithy, tailoring, basket weaving and so on. Only recently, some of the Scheduled Castes have taken to agriculture after allotment of land to them under the state's 'Nautor' policy. The Scheduled Tribes include the gaddis, the gujjars and the bhots and their main concentration is in the districts of Sirmaur, Chamba, Kinnaur and Lahaul & Spiti. The tribal communities are mainly engaged in animal husbandry with many of them practicing migratory grazing. The very nature of their vocation has contributed to the lower literacy rate in these communities.

1.3.5 Livelihoods

Most of the people in Himachal depend on agriculture for their livelihood. Ninety percent of the people live in villages and small towns. Villages usually have terraced fields and small two storey houses with sloping roofs.

The villages are mostly self-contained with a few shops to take care of basic necessities of life.

PRODUCTION OF PRINCIPAL CROPS

(In '000 tonnes)

Crops	2009-10	2010-11	2011-12	2012-2013(Likely)	2013-14(Target)
1.	2.	3.	4.	5.	6.
FOOD GRAIN					
A.Cereals:					
1. Rice	105.90	128.92	131.63	105.20	130.00
2. Maize	543.19	670.90	715.42	730.18	735.00
3. Ragi	2.21	2.11	2.80	2.91	3.00
4. Small Millets	1.85	3.68	3.31	3.42	5.50
5. Wheat	414.41	614.95	632.95	544.44	635.00
6. Barkey	22.94	32.17	32.68	30.27	34.00
Total-Cereals	**1090.50**	**1452.27**	**1518.79**	**1416.42**	**1542.50**
B. Pulses:					
1. Gram	0.37	0.60	0.66	1.40	2.50
2. Other Pulses	20.29	40.99	34.92	32.14	35.00
Total Pulses	**20.66**	**41.59**	**35.58**	**33.54**	**37.50**
Total-Foodgrains	**1111.16**	**1493.86**	**1554.37**	**1449.96**	**1580.00**
Commercial Crops					
1. Potato	184.43	205.97	152.98	185.00	190.00
2. Vegetables	1206.21	1268.90	1356.60	1385.00	1400.00
3. Ginger (Dry)	3.12	1.56	3.15	4.00	4.00

Source:- Directorate of Agriculture Himachal Pradesh

Almost every family owns land and is engaged in agriculture, horticulture and/ or raising of cash crops like vegetables and flowers. The state has over the years gained prominence as the Orchard State of the country and for growing off-season vegetables and floriculture. However, the average land holding is small, above hectare per family, and the fields are too small to lend themselves to mechanization. Moreover, most of the agriculture is of subsistence type and depends upon the climatic conditions for good yield. All these conditions make the agriculture-based economy inadequate to fulfill the total livelihood requirements of the majority of the families in the State.

FRUIT PRODUCTION

(In '000 tonnes)

Year	Apple	Other temperate fruits	nuts & dry fruits	Citrus	Other Sub-tropical fruits	Total
1.	2.	3.	4.	5.	6.	7.
1996-97	288.54	24.79	3.35	13.83	21.12	351.63
1997-98	234.25	25.12	2.45	11.76	6.11	279.69
1998-99	393.65	17.97	3.07	13.11	19.87	447.67
1999-00	49.13	17.90	1.89	9.26	11.23	89.41
2000-01	376.73	20.45	2.75	11.06	17.04	428.03
2001-02	180.53	29.42	2.91	20.46	30.12	263.44
2002-03	348.26	63.13	3.26	16.03	28.95	459.63
2003-04	459.49	40.93	3.57	28.12	27.86	559.97
2004-05	527.60	60.20	3.73	28.55	71.93	692.01
2005-06	540.35	48.69	3.27	29.16	74.03	695.50
2006-07	268.40	35.65	2.91	12.67	49.47	369.10
2007-08	592.58	53.91	2.92	24.67	38.76	712.84
2008-09	510.16	39.93	3.55	26.01	48.43	628.08
2009-10	280.11	37.08	2.81	28.14	34.10	382.24
2010-11	892.11	61.38	3.62	28.67	42.04	1027.82
2011-12	275.04	31.18	2.49	25.03	39.08	372.82
2012-13up to Dec. 2012	392.10	47.74	1.32	1.79	24.27	467.22

Animal husbandry is another important vocation for the people of the state. Many people derive their income from sheep, goats, and other cattle. Almost every family rears livestock for their day to day requirements, for agricultural purposes and for cash income. The state has a cattle population matching that of the human population. With small land holdings, it is not possible to set aside agriculture land for raising fodder crops and, therefore, the livestock is mainly dependent upon the natural resources, mainly forests, for sustenance. Buffaloes, sheep and goats kept by the tribal communities of the state are traditionally subjected to transhumance every year for sustenance.

LIVESTOCK AND POULTRY

(In Thousands)

Category	1997	2003*	2007*
1.	**2.**	**3.**	**4.**
A. Livestock:			
1. Cattle	2,002	2,196	2,269
2. Buffaloes	652	773	762
3. Sheep	909	906	901
4. Goats	947	1,116	1,241
5. Horses and ponies	22	17	13
6. Mules and donkeys	31	33	26
7. Pigs	5	3	2
8. Other livestock	3	2	2
Total- Livestock	**4571**	**5,046**	**5,216**
B. Poultry	385	764	809

Source:- Directorate of Land Records, Himachal Pradesh.

***Directorate of Animal Husbandry, Himachal Pradesh.**

The economically vulnerable groups including the scheduled tribes and the schedule castes have high dependence on the forest resources. Collection and trade of forest produce, mainly the high value temperate medicinal plants forms an important vocation providing cash income to these rural communities. In many of the rural areas, the entire household is engaged in the collection of medicinal plants. People are also dependent on the forests for their fuel wood, timber and fodder requirements.

AGRICULTURE AND ENVIRONMENT

CHAPTER-2

Agriculture is the largest occupation and source of livelihood to most people in Himachal Pradesh and has an important place in the economy of the State. Himachal Pradesh is the only state in the country who's about 90% of population (Economic Survey 2017-18) lives in rural areas. Therefore dependency on Agriculture/ Horticulture is dominant as it provides direct employment to about 62 % of total workers of the State, whereas it was 66.7% in 2010-11.

Agriculture happens to be the premier source of State Income (GSDP). About 14.9 % of the total GSDP comes from agriculture and its allied sectors which is now 9.4% in 2016-17. Out of the total geographical area of State (55.67 lakh hectare), the area of operational holdings is about 9.55 lakh hectares and is operated by 9.61 lakh farmers. The average holding size is about 1.00 hectare.

Distribution of land holdings according to 2010-11 Agricultural Census shows that 87.95% of the total holdings are of small and Marginal. About 11.71% of holdings are owned by Semi Medium and Medium farmers and only 0.34 percent by large farmers.

About 80 percent of the total cultivated area in the State is rain fed**.** Rice, Wheat and Maize are important cereal crops of the State. Urd, Moong, Rajmash in Kharif season and Gram Lentil in Rabi are the important pulse crops of the State. The agro-climatic conditions in the state are congenial for the production of cash crops like seed potato, off-season vegetables and ginger.

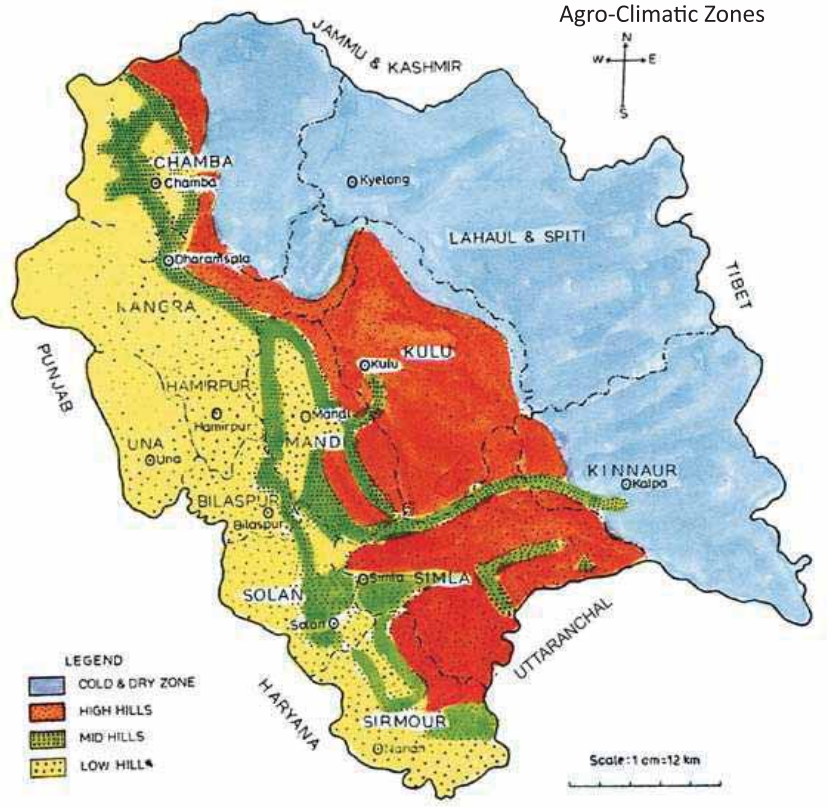
The topography of the state is largely hills where cultivation is mainly done on terraces. The cultivation in hills is subjected to soil erosion since crop cultivation is practiced on 5% to over 30% slopes. This also affects soil fertility status and changes in pH values as well. Cultivation is mainly (80.9%) rain dependent.

Size of Holdings (hect.)	Category (Farmers)	No. of Holdings (lakh)	Area (lakh hect.)	Av. Size of Holdings (hect.)
Below 1.0	Marginal	6.70 (69.78%)	2.73 (28.63%)	0.41
1.0-2.0	Small	1.74 (18.12%)	2.44 (25.55%)	1.40
2.0-4.0	Semi Medium	0.84 (8.83%)	2.30 (24.14%)	2.72
4.0-10.0	Medium	0.28 (2.87%)	1.56 (16.39%)	5.67
10.0-Above	Large	0.03 (0.34%)	0.51 (5.29%)	15.45
	Total	9.61	9.55	1.00

2.1 State

The State of Himachal Pradesh is constituted of ten agro-ecological zones. This indicates a vast potential for growing diverse crop plant species. There are (i) highly fertile valleys intercepting hills and mountains, (ii) subtropical sub mountainous hill areas, (iii) mid hills, (iv) high hills with high rainfall, (v) high hills with scanty rainfall, and (vi) cold desert high mountains. In high hills characterized by temperate climate, the crops are grown mainly in the summer months. This offers opportunities for growing cash crops such as vegetables in off-season for supply to markets in the plains areas. Moreover temperate vegetables and fruits can be other options of growing.

Agro-Climatic Zones



[Source: Department of Agriculture]

Year	Area ('000 hect.)	ProductProduc-tion ('000 M.T.)	Produc- tion per hectare
2011-12	788.05	1549.40	1.97
2012-13	789.52	1544.90	1.96
2013-14	774.70	1585.14	2.05
2014-15	755.21	1546.81	2.05
2015-16 (Ant Ach)	764.85	1634.06	2.14

In Himachal Pradesh, the net cultivated area is only 16.7% of the total area. From the figures in the table it is evident that total area under cultivation is decreasing but production per hectare is increasing**.** The cropping intensity which was 174.5% in 2006-2007 periods increased to 174.70% in the year 2009-10, but in the year 2010-11 dropped down to 172.72% as per the annual season and crop report. New opportunities emerging for cultivation include flowers, medicinal and aromatic plants and new fruits like kiwi and hazel nut.

The trend is towards more substantial efforts of the department for affecting changes in agriculture. It appears that off season vegetables cultivation & better irrigation arrangements the cropping intensity might be on rise side.

In the past, diversity in agriculture had been such that it fitted well in the prevailing agro-ecological conditions. For instance, cultivation, of crops and varieties with good tolerance of drought conditions in the rain fed agriculture ensured minimum production levels. Truly these were low yielding but were tolerant to particular soil conditions, insect-pest incidences, disease epidemics and climatic adversities and thus were rare complete crop failures.

Change in Area Under Traditional Cropping Patterns

Crop	1997-98	1998-99	1999-2000	2000-2001	% Change
Paddy	86,178	82,125	80,221	81,519	-5.41
Wheat	3,77,343	3,79,718	3,70,587	3,62,680	-3.89
Barley	27,693	57,752	25,901	25,643	-7.40
Maize	3,11,861	3,00,976	2,99,906	2,98,052	-4.43
Gram	2,379	1,908	1,691	1,403	-41.02
Green gram	396	362	342	288	-27.27
Masur	1,474	1,168	1,061	993	-32.63
Total Pulses	35,930	33,849	32,556	31,093	-13.47
Fruits	54,504	55,664	56,474	58,458	+7.25
Peas	4,589	4,845	5,046	5,510	+20.07
Dry fruits	1,025	1,124	1,248	1,449	+41.37
Vegetables (aubergine, Tomato, Bhindi)	3,738	4,382	4,546	4,734	+26.64

The cropping intensity has risen to 198.7 percent in the district of Hamirpur closely followed by the district Mandi, Bilaspur and Kangra . It ranged from 103.56% to 194.95% for various districts during the period 2010-11 as shown below.

Cropping Intensity

District	1996-97	1997-98	1998-99	1999-2000	2000-2001
Bilaspur	191.3	192.8	188.9	190.6	191.9
Chamba	140.8	156.5	168.2	152.1	146.5
Hamirpur	190.7	196.7	196.5	195.9	191.7
Kangra	182.7	186.9	187.7	187.3	184.0
Kinnaur	125.8	131.1	124.2	116.1	123.0
Kullu	177.6	172.4	167.0	157.3	179.7
Lahaul-Spiti	104.4	102.4	104.3	102.9	103.1
Mandi	172.6	179.6	187.8	188.3	183.3
Shimla	144.6	150.6	147.5	141.6	129.6
Sirmour	183.1	185.8	184.2	186.1	183.3
Solan	158.8	166.5	165.0	163.1	163.3
Una	179.3	186.7	179.7	176.2	172.3
State Avg.	**170.6**	**176.0**	**176.6**	**173.5**	**170.9**

DISTRICT WISE INTENSITY OF CROPPING FOR THE YEAR 2005-06-VIS 2006-07

Sr. No.	Name of District	Year 2005-06			Year 2006-07		
		Net area Sown	Total Cropped area	Intensity	Net area Sown	Total Cropped area	Intensity
1	2.	3	4	5	6	7	8
1.	Bilaspur	29850	54707	183.2	30998	57829	186.5
2.	Chamba	41886	66728	159.3	42216	67319	159.5
3.	Hamirpur	34047	68714	196.6	34828	69195	198.7
4.	Kangra	115752	217266	187.7	116274	213889	184.0
5.	Kinnaur	7602	9017	118.6	7553	8969	118.7
6.	Kullu	36587	65736	179.6	37000	62004	167.6
7.	Lahaul-Spiti	3291	3464	105.2	3283	3460	105.4
8.	Mandi	86742	156428	180.3	85847	161085	187.6
9.	Shimla	66620	92353	138.6	66197	87163	131.7
10.	Sirmaur	40503	74598	184.1	40756	75605	185.5
11.	Solan	38266	62989	164.6	38389	64028	166.8
12.	Una	36974	71469	193.3	37479	73238	195.4
	Total	539020	943769	175.0	540820	943784	174.5

[Source : annual season and crop report 2006-07.]

DISTRICT WISE INTENSITY OF CROPPING FOR THE YEAR 2009-10-VIS 2010-11

Sr. No.	Name of District	Year 2009-10			Year 2010-11		
		Net area Sown	Total Cropped area	Intensity	Net area Sown	Total Cropped area	Intensity
1	2.	3	4	5	6	7	8
1.	Bilaspur	29133	56009	192.25	29187	56901	194.95
2.	Chamba	41761	67534	161.72	41643	67775	162.75
3.	Hamirpur	35295	68028	192.74	35295	67710	191.84
4.	Kangra	115748	221830	191.65	115748	213162	184.16
5.	Kinnaur	8034	9545	118.81	8310	10646	128.11
6.	Kullu	38429	58540	152.33	38485	59597	154.86
7.	Lahaul-Spiti	3398	3591	105.68	3396	3517	103.56
8.	Mandi	86632	157684	182.02	88775	160610	180.92
9.	Shimla	65579	86915	132.53	65944	86468	131.12
10.	Sirmaur	40347	74347	184.24	40307	75638	187.65
11.	Solan	37366	64240	171.92	37746	62456	165.46
12.	Una	36690	72351	197.20	38529	74025	192.13
	Total	538412	940614	174.70	543364	938505	172.72

[Source : annual season and crop report 2006-07.]

Net Irrigated Area in Himachal Pradesh

Year	Canals	Tanks	Wells &Tube wells	Others Sources	Total
1	2	3	4	5	6
2000-01	3,463	263	14,172	1,05,758	1,23,656
2001-02	3,666	257	12,899	85,284	1,02,106
2002-03	3,510	267	11,764	1,08,377	1,23,918
2003-04	3,379	3	13,569	87,989	1,05,081
2004-05	3,379	28	15,517	85,528	1,04,452
2005-06	4,107	654	16,200	82,776	1,03,640
2006-07	3,979	701	15,744	83,339	1,03,891
2007-08	4,046	526	17,624	86,199	1,08,328
2008-09	4,100	283	17,432	86,091	1,07,852
2009-10	4,100	149	19,357	82,993	1,06,599
2010-11	4,213	33	21,840	83,854	1,09,940
2011-12	4,036	62	25,211	83,440	1,12,749

District wise Net Irrigated Area-2010-11

District	Canals	Tanks	Other wells	Tube Wells	Others	Total
1.	2.	3.	4.	5.	6.	7.
1. Bilaspur	0	0	49	479	3291	3819
2. Chamba	0	0	0	0	4332	4332
3. Hamirpur	0	0	312	82	1560	1954
4. Kangra	4	0	114	4400	31166	35684
5. Kinnaur	0	0	0	0	5286	5286
6. Kullu	0	0	0	0	2553	2553
7. L & S	0	0	0	0	3372	3372
8. Mandi	496	0	95	356	11713	12690
9. Shimla	0	0	0	0	2245	2245
10. Sirmaur	3536	58	45	2432	8306	14377
11. Solan	0	0	783	3455	7722	11960
12. Una	0	4	599	12010	1864	14477
H.P.	**4036**	**62**	**1997**	**23214**	**83440**	**112749**

Source: Directorate of Land Records H.P. 2011)

Net Irrigated Area by source

Year	Canals	Tanks	Wells & Tube Wells	Others Source	Total
1	2	3	4	5	6
2000-01	3,463	263	14,172	1,05758	1,23,656
2001-02	3,666	257	12,899	85,284	1,02,106
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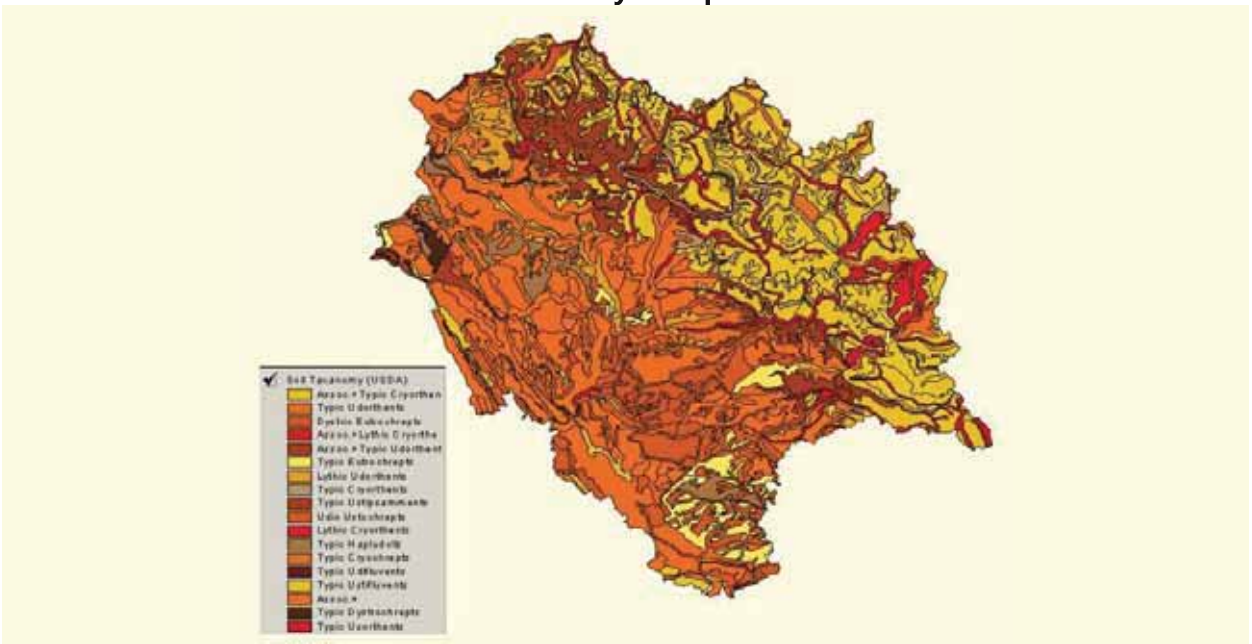
2011-12	4,036	62	25,211	83,440	1,12,749

At presently, high yielding varieties demand high input, better crop protection and good agronomic management to deliver in accordance with their potential. Moreover, some crops or varieties not finding favour with the changed life style of people have gone out of cultivation. The agriculture in hills is and will remain the mainstay of 66.7% of people in the years to come. The challenges in agriculture to meet food demands and increase livelihood scope to people have raised several issues.

Soil Layer Map



[Source : Water Resources Management for H.P.]

Soil Unit	Area (ha)	Description
1.	213.9 (3.8)	Rock outcrops covered with glaciers associated with shallow excessively drained sandy - skeletal soils with sandy surface, severe erosion and strong stoniness Lythic Cryorthents.
2.	29.3 (0.5)	Shallow E3 excessively drained sandy - skeletal soils very steep slopes with sandy surface, severe erosion and moderate stoniness; Lythic Cryorthents associated with rock outcrops.
3.	16.0 (0.3)	Shallow excessively drained loamy - skeletal calcareous soils very steep slopes with loamy surface, severe erosion and moderate stoniness; Lythic Cryorthents Associated with Rock outcrops.
4.	24.7 (0.4)	Rock outcrops and valley glaciers associated with shallow excessively drained sandy - skeletal soils very steep slopes with sandy surface, severe erosion and moderate stoniness Lythic Cryorthents.
5.	174.8 (3.1)	Mountain and valley glaciers and rock outcrops associated with medium deep excessively drained sandy - skeletal soils very sleep slopes with sandy surface, severe erosion and moderate stoniness. Typic Cryorthents.
6.	235.6 (4.2)	Rock outcrops associated with medium deep excessively drained loamy - skeletal calcareous soils very steep slopes with loamy surface, severe erosion and moderate stoniness. Typic Cryorthents.
7.	340.1 (6.1)	Rock outcrops associated with shallow excessively drained loamy - skeletal soils very - steep slopes with loamy surface, severe erosion and moderate stoniness. Typic Cryorthents.
8.	450.2 (8.1)	Rock outcrops associated with medium deep excessively drained loamy - skeletal calcareous soil steep slopes with loamy surface, severe erosion and strong stoniness. Typic Cryorthents.
9.	299.8 (5.4)	Rock outcrops associated with deep well drained mesic loamy-skeletal soils very steep slopes with loamy surface, severe erosion and strong stoniness. Typic Udorthents.
10.	97.2 (1.7)	Rock outcrops associated with shallow somewhat excessively drained coarse-loamy calcareous soils steep slopes with loamy surface, severe erosion and strong stoniness. Lythic Cryorthents.

Note: Soil units from sr. No. 1 to 10, not depicting the entire soil taxonomical map of Himachal Pradesh. Which may be referred from soil taxonomy as well soil series map by National Bureaue of Soil Survey and Land Use Planning, Nagpur

2.2 Major Challenge in H.P. Agriculture:

Agriculture in the State of Himachal Pradesh though it has made good headway yet faces several challenges in the absence of scientifically sound policy guidelines since 1948 onwards when the state had its own Department of Agriculture. For instance the workers of the agriculture department laid much stress on using high yielding varieties (HYVs) and use of fertilizers and pesticides resulting in loss of area under crops like gram, mash, bean, moong, horse gram (Kultha) etc. and highly drought resistant crop varieties such

Area Brought Under High Yielding Varieties ('000 hect.)

Year	Maize	Paddy	Wheat
2011-12	279.05	75.08	330.35
2012-13	279.60	76.90	336.56
2013-14	285.05	76.05	341.35
2014-15	288.00	74.00	352.00
2015-16	200.07	62.64	324.00
2016-17	255.00	75.00	354.00
(Target)			

as Rohru dhan, Ridley wheat and there was significant reduction in diversity at crop and variety levels. The major challenges in agriculture are discussed below.

2.2.1 Pressures :

(a) Land Fragmentation and Size of Holdings Leading to Un-remunerative Agriculture:

Agriculture has an important place in the economy of state being the single largest industry, and as main occupation of people. According to the Economic Survey Report it provides direct employment to 69% of the total workers of the state. As per the Economic survey of H.P 2016-17, about 10% of total Gross State Domestic Product (GSDP) comes from agriculture and its allied sectors . The average holding size in the state is 1.00 hectare. The Agricultural Census Report of 2010-11 shows that 87 % of the total holdings are of small and marginal farmers which were 84.5% as per 1995-96 Agriculture Census Report. About 11.71 % of holdings are owned by semi medium/ medium farmers and only 0.34 percent are large farmers.

Distribution of land holdings

Size of Holdings (ha)	Category of Farmers	% of Holdings	% Area of Holdings	Average Size of Holdings (ha)
Below 1.0	Marginal	69.78	28.63	0.41
1.0 to 2.0	Small	18.12	25.58	1.40
2.0 to 4.0	Semi Medium	8.83	24.14	2.72
4.0 to 10.0	Medium	2.87	16.39	5.67
Above 10.0	Large	0.34	5.29	15.45

Distributions of Land Holdings

Size of Holdings(hect.)		Category (Farmers)	No. of Holdings (lakh)	Area (lakh hect.)	Av. Size of Holding (hect.)
	Below 1.0	Marginal	6.70 (69.78%)	2.73 (28.63%)	0.41
1.0-2.0		Small	1.75 (18.17%)	2.44 (25.55%)	1.40
2.0-4.0		Semi Medium	0.85 (8.83%)	2.31 (24.14%)	2.72
4.0-10.0		Medium	0.28 (2.87%)	1.57 (16.39%)	5.67
	10.0-Above	Large	0.03 (0.34%)	0.51 (5.29%)	15.45
		Total	**9.61**	**9.55**	**1.00**

Economic Survey of H.P, 2015-16.

The small holdings have become non-profitable due to high input costs in the present situation. This is because holdings of less than one hectare account for more than half (69.8%) of the total holdings. This is driving away rural people to search for alternate occupations. The problem will be further aggravated owing to progressive fragmentation of holdings on the basis of the law of inheritance in operation

(b) Agriculture as Constrained Source of Livelihood

Hill agriculture is under serious threat as source of livelihood to the rural community until and unless it is backed up by a scientifically designed strategic policy frame work. As stated earlier
69% of the total working force of the state gets direct employment in agriculture; hence there is urgency to give a serious thought to this large chunk of people in order to provide the necessary boost to the economy of the state.

In economic transitional phase, the society is also undergoing changes. Joint family systems are becoming nuclear families and consequently working hands in agriculture are severely reduced. The size of holdings are small and modern high input agricultural technologies create economic stress on cultivators. This is more so when the needs of farming families cross the subsistence boundary and require them to have money to spend on children's education, clothing, health care, and other amenities such as TV, radio, telephone and fridge etc. Furthermore, vagaries of weather sometimes cause lower production, and market un-remunerative prices increase the desperation of farmers. The percentage of people below the poverty level varies from 19 to 61.7 in different districts, the highest being in Chamba and lowest in Una and Kullu.

© No Systematic Resource Survey and Planning Agriculture

The development in the agricultural sector requires a systematic resource survey followed by planning all over the state. This should have been the first step to leap forward. This required knowledge of soil type, soil fertility, slope condition, water availability for irrigation, areas afflicted by severe frosts, floods weather conditions, occurrence of wild relatives of crops, hill aspect, crops well suited and vegetation type. Lacking resource knowledge in a particular area it is difficult to plan for profitable agriculture. Market access or market facilities also become an important factor to fetch better prices of agricultural produce. In a certain year, a good tomato crop was raised in Mandi in and around Rewalsar, but they could not find a market for the produce. There was no proper planning, hence farmers ultimately suffered losses.

(d) Crop damage by stray and wild animals

Main damage to crops is from wild pigs, monkey, birds & stray animals like Cows & Nilgai, these wild & straw animals cause a huge losses. Traditional crops like Til, Black grams, Cotton, pulses, Kathi, Kodra and desi masur etc. were grown in the region but now these are not grown in the region. The traditional variety of wheat, maize and paddy is being replaced by hybrid varieties. It was pointed out that the traditional varieties of the crops were tolerant to the diseases as well as to pests. The hybrid varieties are not tolerant to the diseases and require a massive amount of pesticides to grow healthy crops. The black paddy which was grown earlier was very tolerant to the diseases whereas the hybrid replacement needs a good amount of pesticides. The modern system of macro & micro-irrigation is need to be promoted to encourage cash crops (vegetables, flowers, medicinal & aromatic plants)

2.2.2 Impacts:

2.2.2.1 Loss of Agro-biodiversity and Narrow Crop base:

The transition of traditional agriculture to modern in the absence of suitable policy guidelines has caused severe erosion of genetic resources in the past couple of years. Some crops have become rare or even completely gone out of cultivation. Similarly a large number of crop land races(ha) been lost on account of their replacement by high yielding varieties (HYVs). Some crop plant species are under threat of becoming lost. The major features of these crops and varieties were their adaptation to soil, weather adversities and

incidences of diseases and pests. The HYVs produce a good crop under favourable conditions but fail miserably if there are adversities of above mentioned types. Crops that have disappeared from the farmers' fields include Eleusine coracana (Marua, Mandal), Setaria italica (Kangani), Panicum miliaceum (Cheena) and other crops such as grain amaranth, grain chenopods, buckwheat, barley (Hulled and hull less) Kinnauri Matar, Kulth are under severe threat. Pulse production in the state has gone down (27% to 41%) to a great extent in recent past. The narrowing down of the crop base in agriculture may be suitable for commercial crops but it never insures human food and nutrition.

2.2.2.2 Shift in Cropping Patterns:

According to a report published in the year 2000, the field studies in districts of Bilaspur, Hamirpur, Kangra, Sirmour, Shimla and Solan reported that, with the provision of irrigation, there are clear cut shifts in the cropping pattern. The major shift is from cereal crops to vegetable crops. In addition to this, multiple cropping has been introduced in irrigated areas The replacing crops are generally cash crops and have become a predominant factor in small farm management to earn cash in order to meet their input requirements and family money needs. However in certain situations this trend may be detrimental to meet food demands.

2.2.2.3 Heavy Reliance on Higher Energy Input:

The advanced countries are already facing uneconomical energy input in agriculture. Something similar is happening here. There is an increase in the crossbred bull population to the extent of 84.6%, whereas the indigenous bull population declined by 22%. The crossbred bulls are unsuitable for use as draught animals for ploughing. There is evidently little preference for the use of draught cattle where it is possible to hire and to use tractor for land preparation and crop sowing. The use of higher energy in agriculture is on the rise. It is mainly in the form of tractors; diesel pumping sets electric pumping sets and threshers. Table 2.9 depicts the situation about rise in the number of energy input implements.

Energy based Agricultural Implements

S.No.	Implement Type	Number				
		1997	2001	2006-07	2011-12	2017-18 (Estimated)
1	Bullock carts	1807	2,404	886	-	-
2	Cane Crushers	1213	1135	1654	10,203	11,640
3	Tractors	4205	6966	5711	15,363	22,250
4	Oil engines	1295	3,664	1558	4,321	5,220
5	Electric Pump sets	2530	7325	1275	5008	6308
6	Threshers	14048	19458	15,443	46,891	48,190
7	Ploughs	462439	631470	1,14409	1,062698	1,070720
8	Electric motors	-	-	-	-	26,500
9	Power tillers	-	-	-	-	3890
10	Power weeders	-	-	-	-	24,650

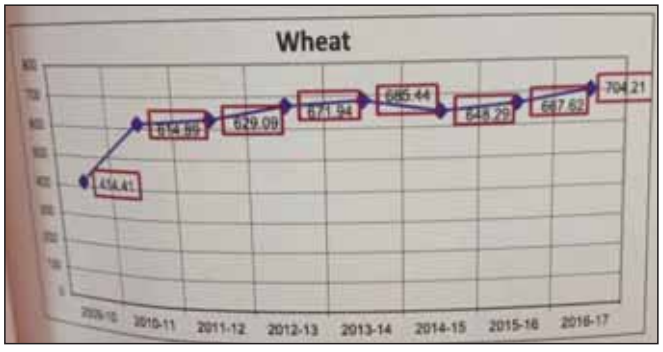
The data in table 2.9 reveals that the population of bullocks used for various work has continuously declined which is almost nil in 2017-18 as compared to 886 in 2006-07. On the other hand the number of tractors has increased from 15,363 in 2011-12 to 22,250 in 2017-18. Similarly the uses of other agricultural implements i.e. cane crushers, oil engines, electric pump sets, threshers, plough, electric motors, power tillers, power weeders etc. have been increased continuously since 1997.

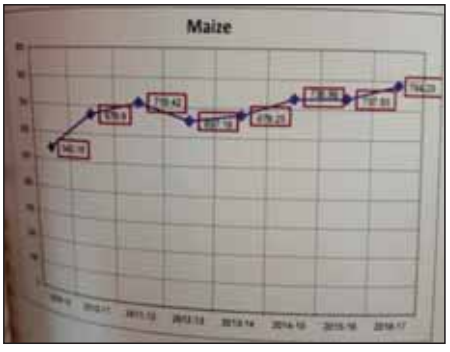
2.2.2.4 Rainfed Nature of Agriculture:

Rainfall is a crucial factor for the success of crop production. As per economic survey of India 2017-18. In Himachal Pradesh 80 % of the area is still not irrigated and is totally rain dependent. The abnormal pattern of rainfall over the past few years has caused great fluctuations in crop production.

Food grain Production

Crop	2012-13	2013-14	2014-15	2015-16
Rice	125.28	128.49	125.22	129.88
Maize	657.16	678.25	677.79	737.65
Ragi	2.51	1.97	1.91	1.93
Wheat	671.94	685.45	646.46	667.62
Barley	34.83	35.18	37.78	34.33
Gram	0.46	0.40	0.38	0.38
Other Pulses	47.87	51.82	53.88	59.17
Millets and other Cereals	4.84	3.59	3.59	3.09
Total	1544.89	1585.15	1546.81	1634.05





Food grain Production('000 Tonnes)

The performance of crops is directly related to rainfall received during the crop season. The rainfall has shown variation in different districts, in some it was in excess whereas in others deficient.

The cultivated area in HP is 5.51 lakh hectares of which 98000 hectares are irrigated which is about 22.6%. Of this 7.14% is irrigated by canals, 7.14% by tube wells and 85.71% by other sources like kuhls, check dams and lift irrigation. The change from rainfall to irrigated conditions is required to insure employment, livelihood and food security in the state.

2.2.2.5 Indiscriminate Use of Chemicals in Agriculture

Widely used chemicals in agriculture include chemical fertilizers (NPK), chemical pesticides, fungicides, and herbicides or weedicides. These are playing havoc because of their indiscriminate use, excessive quantities and substandard quality or quantity. For pesticides, toxicity level is hardly taken care of. Substandard fungicides and pesticides are on sale because of their cheap rates and are used by farmers in large amounts.

The use of fertilizers has increased production in the state to a great extent since the late fifties and early sixties when fertilizer use was introduced to Himachal Pradesh. Then onwards the use of fertilizers has been constantly increasing. As per the Annual administrative report of agriculture Department the consumption of fertilizers in 1985-86 was 23,664 metric tonnes increased to 46,808 metric tonnes in 2003-04 and further increased to 57560 metric tonnes in 2017-18 . That is, the consumption has increased to more than doubled.

Regarding the use of fertilizers, three serious concerns have been brought out. These are (i) imbalanced use, (ii) excessive use of urea or other nitrogenous fertilizers, and (iii) reduced application of FYM. Report on input survey 1991-92 revealed that urea was the most widely used nitrogenous fertilizer in respect of non -irrigated areas in the state and it is same situation in irrigated lands. Thus, urea is used to the maximum by all types of farmers irrespective of their holding sizes. Super Phosphate is used in small area and potash sources are rarely used, though fertilizer mixture (15N:15P:15k) is used on about 20% of the area yet the users were mainly marginal and small farmers under both irrigated and rain fed conditions of farming. Use of nitrogenous fertilizers being almost three times than more phosphorus and potash fertilizers.
In comparison to fertilizers, the use of FYM or compost organic manures is progressively decreasing because of the fact that service class farmers having nucleus families are hardly engaged in rearing cattle or domestic animals.
The use of pesticides has shown a sharp rise particularly in vegetable crops. There is also more use of herbicides or weedicides. The use of pesticides brings in two concerns (i) Sub standard or outdated pesticides act as booster and not as killer and (ii) Toxic residual effects remain unnoticed.

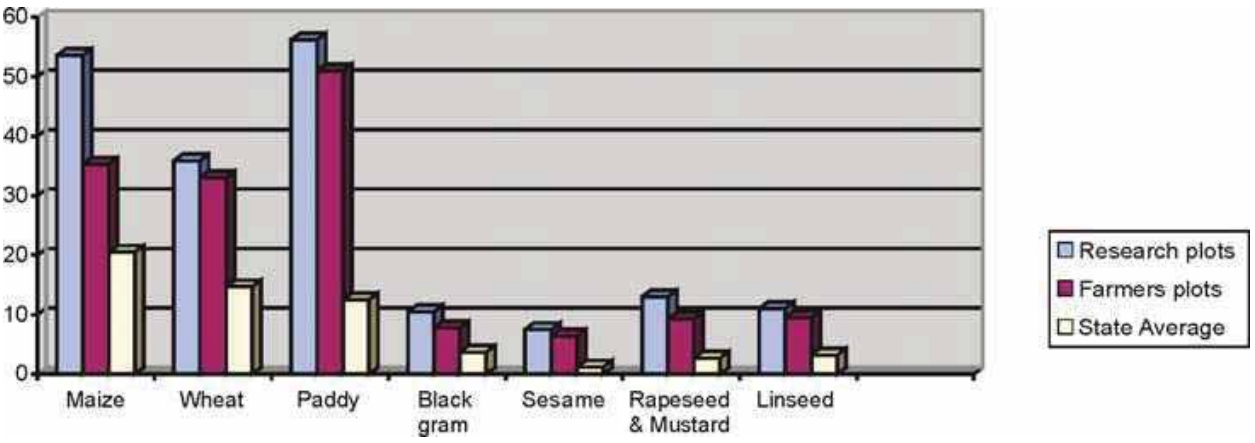
2.2.2.6 Threat from Rogue Plants and Animals Damaging Crops:

In recent years, crop growing has faced a serious, threat from rogues. These are *Ageratum conyzoides* (Neela Phulnu), *Parthenium hysterophorus* (Congress Grass) among plants and wild boar, monkeys among animals. Their populations have increased tremendously but no data has been available on them. Their control is at present difficult.

Another important point to be noted is that the research farms use high inputs and there are hardly any serious attempts to evolve crop varieties suited to rain fed or drought prone areas which is at present not less than 80%. Moreover there is a need to regulate the seed supply of high yielding varieties and the quality standards must be strictly enforced so that farmers do not suffer, Research thrusts have since been confined to major crops, thus millet and pseudo-cereals are under threat of loss.

Yield Gap Analysis

Crop	Yield in q		
	Research Plots	Farmers Plots	State Average
Maize	53.6	35.3	20.5
Wheat	35.9	33.0	14.7
Paddy	56.2	51.0	12.5
Black gram	10.5	7.8	3.7
Sesame	7.5	6.4	1.2
Rapeseed & Mustard	13.0	9.3	2.7
Linseed	11.0	9.5	3.2



Yield Gap Analysis

2.2.2.7 Problematic Market Access:

The hill farmers are generally very hard working and can achieve results if given correct training. However, the biggest deterrent has been the problems of access to the market for getting remunerative prices for their farm produce. The farmers are exploited by wholesale traders who take advantage of their limited capacity to hold small quantities of produce and their pressing need for cash soon after the farm harvest. There remains a large gap between the produce procurement price and the consumer price.

2.2.2.8 Lopsided Policy Issues:

Policy framework of a state act is the major guiding factor to affect necessary infrastructure changes leading to the prosperity of people. Agriculture in the state of Himachal Pradesh has been subjected to lopsided policy issues since the inception of an independent agriculture department. This is reflected in laying more stress on use of chemical fertilizers without making substantial efforts in developing irrigation means. Many subsistence crops are today facing the threat of extinction. These are Kangani, Mandua, Cheena, grain

amaranth, grain chenopod, buckwheat, naked barley, indigenous dal matar, gram, black gram and kultha. This is because neither were efforts made to support them price were not nor could their supply be regulated through a public distribution system (PDS). Moreover unlike other states where these do not grow, the research support to their production and consumption is still poor. From sustainable food production and livelihood point of view, the mixed farming and mixed cropping is advantageous in comparison with the raising of pure crop stands. However, the recent trend from the government is in favour of pure crop stands which may be useful to the commercial crop growing but not to a sustainable food supply.

2.2.2.9 Inadequacy of Soil and Water Conservation Programmes:

Agriculture in the Himachal hills is practiced on 5% to over 30% slopes coupled with heavy rainfall resulting in severe soil erosion. Almost all areas in the state are subject to sheet erosion but the foothills and valleys are subject to the formation of severe gullies. The upper fertile soil is drained away and the underlying layers slowly become unfit for cultivation. The intensity of soil erosion ranges from 14.7% to 24%.

The least effort has been made so far to conserve of water in streams, rivers or rivulets. Inundation of forest areas and lack of vegetation cover in catchment areas is increasing the problems of low productivity of soils as well as observation of natural water sources.

2.2.2.10 Environmental Issues in Agriculture:

Ecological imbalance caused by faulty human interventions leads directly to the destruction of the production base and living environment. The environmental concerns in the field of agriculture are mainly due to conversion of forest lands to agricultural lands; rivers, rivulets and streams erode the adjoining agricultural lands; on sloping lands runoff water, if unchecked, causes shortage of ground water sources; application of chemical pesticides pollutes water and fresh harvests, and there occurs inadvertent introduction of new weeds as admixtures which may be harmful to animal or human health.

Pesticides cause pollution at two levels, firstly during handling, storage and application in the field, secondly at the stage of produce processing. One major source of pollution is the residual effect in vegetables and grains. Some pesticides are washed by rainwater and then enter subsurface water. If milch or meat animals are fed by the polluted fodder it may gain entry into the human body when their milk or meat is consumed.

2.3 Emerging Trends in Agriculture:

Indian agriculture in general and hill agriculture in particular has undergone a big transformation in over the past five decades. Conspicuous changes have occurred in cropping patterns, fruit orchards have replaced traditional cereal farming and the cultivation of cash crops gained lot of significance and so on. The bullock cultivation is being replaced by the use of tractor cultivation. Threshing of crop harvests, in traditional agriculture, was a tedious job involving several days hard work, now it has been much facilitated and the duration reduced. Usage of chemical fertilizers, pesticides, herbicides, hormones etc. has gone very high. Many old crops and traditional varieties have been replaced. New crops are being used to diversity crop cultivation. Mixed farming is also changing in character. Mixed cropping is fading away. Inputs have increased to a great extent which are causing a financial burden on small and marginal farmers. Farmers have become more conscious about using the available water resources of which earlier they were ignorant. It is, therefore, pertinent to look into them critically.

2.3.1 Replacement of Traditional Crop Germplasm by High Yielding Varieties:

Modernization of agriculture has changed the crop wealth. Crop Germplasm diversity is comprised of:

(I) Obsolete varieties, land races and phased out varieties, and
(ii) Crop plant species in cereals, pulses, oil seeds, pseudo cereals, millets, vegetables, spices and condiments and diversity in agro-ecological zones and subzones.

Traditional cultivation was rich in Germplasm because food and nutritional security in agriculture is directly related to diversity of crops and varieties. However, the modernization process in agriculture has changed the nature of traditional agriculture. For the past many years, there has been emphasis on the use of high yielding varieties (HYVs) only in cereal crops, and drought hardy but less palatable crops have been ignored. In many areas these are no longer found in cultivation and the new generation is unaware of their utility in cultivation for food. The HYVs in general, are designed to respond to good agronomic packages and high input whereas the traditional crop varieties had the ability to adapt to poor agronomic condition and low input. The latter always produced harvestable crops in spite of all adversities. The HYVs produce high yields under favourable conditions but fail miserably under unfavourable conditions.

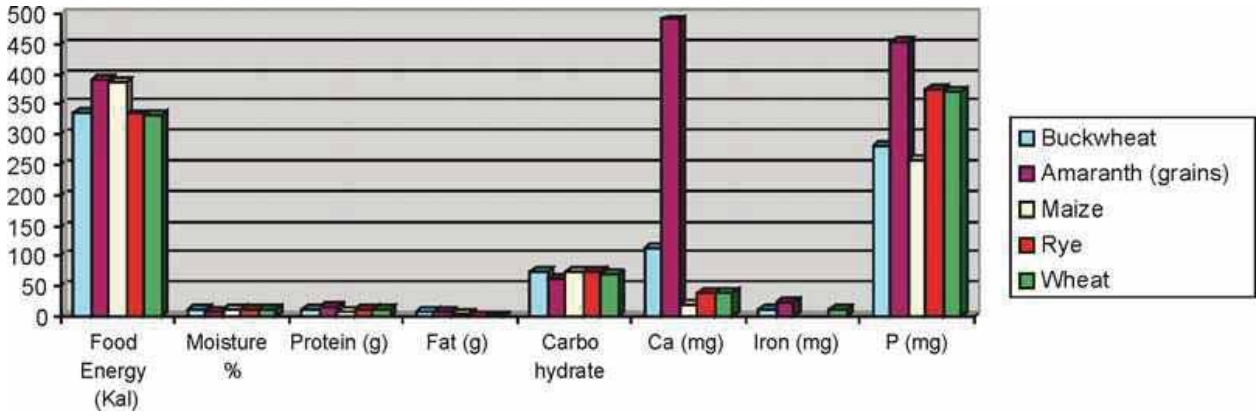
2.3.2 Research Thrusts and Government Support Confined to Major Food Crops:

A wide food base is the key to food and nutritional security. This principle is not being followed in planning research programmes. Moreover, the government policy on providing the support price is limited to major food crop. Crops adapted to poor fertile soils and tolerant to moisture stress were widely prevalent in hilly areas of the Himalaya. These include millet such as Eleusine coracana (ragi, Mandua), Setaria italica (Koni, Kangani), Panicum miliaceum (cheena), Paspalum scorbiculatum (Kodo, Kodra) and pseudo-cereals like grain chenopod, grain amaranth, buckwheat (phaphra, ogal). These crops were consumed largely in the hills. Grain amaranth is rich in the essential amino acid Lysine which in maize is causing deficiency disease in high maize consuming areas. These crops have usually received less attention of the research scientists as well as having government's apathy; consequently they are fading away in modern agriculture. Their nutritional significance is given in the table below.

Amaranths
Courtesy: NBPGR Phagli, Shimla

Average Composition of Pseudo-Cereals in Composition to Major Cereals(1100g) Source USDA Data

Name of crop	Food energy (kcal)	Moisture %	Protein (g)	Carbohydrate (mg)	Fat (g)	Ca (mg)	Iron	P (mg)
Buckwheat	335	11.0	13.5	7.4	72.9	114	13.2	282
Amaranth (grains)	391	9.3	15.3	7.1	63.1	490	22.4	453
Maize	385	12.0	9.2	3.9	73.7	20	-	256
Rye	334	11.0	12.1	1.7	73.4	38	-	376
Wheat	333	12.0	13.3	2.0	71.0	41	10.5	372



Average Composition of Pseudo-Cereals

For balanced human growth and health, at least 45 chemical compounds and elements are believed to be needed. Each of these essential nutrients is believed to be needed to be present in diets. The absence of any of these leads to illness and eventually to death. No single food offers all 45 nutrients.

2.3.3 High Input Modern Agriculture:

The practices of modern agriculture related to crop growing are becoming increasingly high input. The cost of crop production has risen tremendously in recent years. These inputs include cost of seed, cost of pesticides, cost of fertilizers and herbicides or weedicides, wages for labourers, cost for use of tractor for field preparation if bullocks are not used, and cost of crop threshing by threshers. In traditional agriculture, own seed was used but in the modern agriculture, hybrid seeds have to be purchased, also new crop varieties are being introduced at short intervals and farmers incur high costs on them.

For instance the cost of a daily paid labourer increased from Rs. 34.78 in 1993-94 to Rs. 93.92 in 2007-08 and further increased to Rs 225/-in 2018-19.

2.3.4 Energy Inputs Rising in Crop Growing:

The modernization of agriculture has increased the energy input to a great extent. This has happened mainly because the joint family system in rural areas is fast breaking into the nucleus family system. Consequently the working hands from the family are much reduced. This has two repercussions, firstly rearing of bullocks for agriculture is becoming increasingly difficult and secondly, the land holding size is being reduced to uneconomic levels, that is, it is reduced to small marginal farm lands. It is also resulting in using tractors for cultivation. Over the last five decades, the energy input in the form of tractor cultivation, tube well irrigation,

use of crop threshers, diesel engines or electric engines and power sprayer's seed sowing drills. has increased manifold.

2.3.5 Awareness on Cash Crop Growing:

Recently it is frequently found in almost all districts that awareness about the inclusion of cash crops in the prevalent cropping systems is rising. This is natural as the cash money has attracted the attention of most farmers in order to meet their liabilities for the family. The children's education, medical and health care, entertainment means (e.g. radio, TV, cassette player), Phone/Mobile, vehicles, clothes require cash money. Important cash crops in the Himachal hills are potato, tomato, capsicum, green pea, cabbage, cauliflower, ginger, red chillies, hops, tea, onion, garlic, taro, radish. In certain areas flower cultivation, especially for supply as cut flowers, is picking up fast. The growing of off season vegetables in certain areas is an attractive option. The cultivation of medicinal and aromatic plants is also receiving the attention of some farmers. Some of such plants are kuth, pushkarmul, mentha, scented geranium, scented rose and stevia. Data on few cash crops are shown below.

2.3.6 Vanishing Traditional Mixed Cropping and Mixed Farming:

In traditional agriculture the predominance of mixed cropping and mixed farming was based on the principles of sustenance. Sustainable agriculture involved all features of mixed cropping and mixed farming. Mixed cropping may not be a suitable option for commercial farms but otherwise it is the use of resources to the best extent. For example, wheat plus gram was the common trend in the rabi season. Gram, being a legume, fixed nitrogen and benefited the wheat crop as well. Similarly maize and beans or cow pea enjoyed symbiotic relationships. Mixed farming denotes the inclusion of animal husbandry with crop husbandry, that is, crop growing farmers invariably reared domestic cattle, sheep, goats, pigs, poultry birds, honey bees and fish. This provided organic manure for fields and crop residues were utilized as feed. In recent years, farmers are adapting the components of mixed farming such as mushroom culture, apiculture and dairying to supplement the farm income. To promote the tradition mixed cropping and mixed farming , the new progamme i.e. Rainfed Area Development (RAD) of National Mission for Sustainable Agriculture (NMSA) is being implemented in the State since 2014-15.

2.3.7 Increasing Adoption of High Yielding Varieties (HYVs) and Hybrid (F1) Seeds:

The adoption of high yielding varieties has ushered in an era of food self sufficiency in the Himachal hills where earlier farmers suffered frequent food shortages. People are now well aware of HYVs seeds and generally keep track of new arrivals that are newly released varieties. Similarly F1 hybrid seeds are also attracting the attention of farmers. The hybrid of seeds several crops such as maize, aubergine, Capsicum annuum, cucumber and tomato are becoming popular. These hybrid seeds produce higher yields, and the quality of produce is far superior. Table 2.17 shows the trend of adoption of high yielding varieties in Himachal.

Area under High Yielding Varieties ('000 ha.)

Year	Maize	Paddy	Wheat
1998-99	191.69	80.55	378.26
1999-2000	193.74	74.31	366.52
2000-01	219.68	73.83	329.77
2001-02	212.33	62.68	376.72
2002-03	192.10	64.73	313.23
2003-04	222.19	78.90	364.07
2004-05	242.76	75.21	353.29
2005-06	273.14	70.94	346.15
2006-07	280.61	72.65	349.60
2007-08	280.31	73.56	332.09
2008-09	280.51	74.61	325.22
2009-10	286.50	75.00	328.00
2010-11	278.65	75.20	327.00
2011-12	279.05	75.08	330.35
2012-13	335.35	75.70	288.15
2013-14	341.35	76.50	285.05
2014-15	352.00	74.00	288.00
2015-16	324.00	62.64	200.07
2016-17	354.00	65.00	255.00
2017-18	342.00	65.00	206.00

There are 20 seed multiplication farms where foundation seed is produced for further multiplication. In addition there are 3 vegetable development stations, 12 potato development stations and one Ginger development station in the State.

2.3.8 Change in Traditional Cropping Patterns:

Traditional cropping patterns in Himachal comprised of a large number of crops, some of which were grown as pure stands whereas others were grown mixed with other crops. Besides main cereals (wheat, maize and paddy), these included small millets such as mandua, Kangani, cheena, Kodon, pseudocereals (grainamaranth, grain chenopod, buckwheat (ogal and phaphra), grain cannabis), among pulses (Kultha, spiti local pea) and naked barley. However, due to modernization of agriculture these crops are depleting fast from the cultivation and are being replaced by high value crops like green pod pea, cabbage, cauliflower, capsicum, tomato and potato.

French Beans Courtesy: NBPGR Phagli, Shimla

Recently some European temperate vegetables such as broccoli, celery, asparagus and red cabbage also have been introduced in the hills. The area under traditional crops has registered a change in which they are being replaced by high value crop species such as vegetables (off season) , cut flowers (e.g. gladioli, carnation, alistomeria) medicinal and aromatic plants (kuth, Pushkarmul, Mentha, Scented geranium, Tagetis minima).

2.3.9 Organic Farming viz-à-viz Traditional Hill Agriculture:

Organic farming has become the talk of the day especially in European and American countries having experienced the ills of chemicals in agriculture. Organic farming refers to agricultural production systems used to produce food and fibre organically. The system does not use chemical pesticides, weedicides and fertilizers. Traditionally hill agriculture was entirely organic in nature. It was only during the modernization phase of agriculture that farmers learnt the use of chemical fertilizers, pesticides and weedicides. In recent years, there is wide interest in organically produced foods in India. The hills of Himachal have become an important feeder of markets in the plains especially in respect of vegetables (Seasonal and off Season) and fruits. There is thus a need to revive the organic nature of farming in the hills.

2.3.10 Threatened Agro-forestry Components:

The agro-forestry systems traditionally were maintained in the hills for the supply of green fodder for domestic animals in lean winter months, fuel wood, fruits and timber wood as well. However in recent years in order to boost crop production to replace the cut trees the farming lands are becoming naked. There is a need to have a fresh look at this issue when the greenery of the Himachal hills is already in the red. A very common species, Grewia optiva (Biuhal) is thought a very useful agro forestry species in lower and mid hill elevations, as it is considered to cause allelopathic effects on crops growing underneath it.

2.3.11 Conversion of Agricultural Lands to Fruit Orchards:

During the early phase of development in Himachal Pradesh, much government level effort has gone into planting of fruit orchards at elevations beyond 2500 m. The main fruits grown in Himachal hills include apple, pear, peach, apricot, plum, walnut, almond, mango, orange, Kiwi, pecan nut. The land under agricultural crops has been used to plant the orchards and so much so that in certain areas the crop cultivation is reduced to an insignificant level. This process has caused replacement of certain crops, namely grain amaranth, buckwheat, beans. There has been a continuous increase in the area under all kinds of fruits.. The area 2,30,852Ha in 2017-18.

2.4 Major Causes of Decline in Agro-Eco Environment:

Recent years have witnessed wide protests about the decline of environment in the agro- ecological condition the world over. This has much significance with regard to human and animal health, because it has direct influence on life.

These influences may be noticed in terms of food and nutritional scarcity, residual toxicity in fruits, vegetables and grains, loss of certain widely adopted crop species and varieties, decline of organic matter in the soil, accumulation of harmful substances in the soil, entry of invasive weed species harmful to health decline in useful soil micro flora, destruction of useful pollution of surface and groundwater and presence of toxic substances in milk and other produce. All these concerns may generally be ascribed to the following major causes.

2.4.1 Defective Policy Perceptions In Agriculture:

The process of modernization and development has proceeded in the absence of appropriate policy perceptions at least in the field of agriculture. The glaring example of this is the blind pursuance of the introduction of high yielding varieties (Ms) for replacing well adapted land races and traditional crops which had and inbuilt mechanism for growing on marginal and poor fertile soils, drought conditions due to the rainfed nature of agriculture and resistance to diseases and pests. Furthermore, the indiscriminate and excessive use of chemical fertilizers, such as urea, has made soil unfit for growing legumes for their detrimental effect on nodulation bacteria. Applications ignored the long-term effects accruing from the immediate gains of fertilizers and pesticides.

2.4.2 Unskilled Traditional Farmers:

Lack of education and understanding of farmers has been instrumental in wrong and imbalanced applications lack of chemical fertilizers and lack of farm yard manure (FYM). They did not have adequate knowledge about the use and preparation of compost manure. The use of inferior quality or low dosage pesticides resulted in the evolution of new strains of crop insect-pests and diseases. The small and marginal farmers reveal that traditional varieties or crops coulddo better under adverse conditions than high yielding varieties or crops bred for better conditions. In certain pockets in the hills pulses were of high quality and could have generated good income to farmers under prevailing conditions when pulse prices are soaring.

2.4.3 Poor Vision of Research Planners:

Research planning for the hills of Himachal Pradesh needed prior considerations such as resource crunch to small and marginal farmers, rainfed nature of crop growing, agro-climatic or agro- ecological potentials, communication systems in the hills, and market access. The research outcomes are hardly able to fulfil these criteria. In other words, the research results must show feasibility from farmers field and should be within the reach of overage farmers who constitute the majority. The package of practices for crops has generally been designed for optimum conditions only. The cost of cultivation has been largely ignored and no published information is available. The promotion of new crops such as kiwi has been faulty in the sense people have not been informed about its use or market avenues and consequently manyenthusiastic farmers end in despair when face with queries on useand wise marketing.

2.4.4 Resource Poverty and Access:

As pointed out earlier 6996 of the population is directly employed in agriculture with 84.5% farmers having holding sizes ranging from 0.4ha to 1.4 ha and are termed as marginal small farmers. Furthermore, another category of medium farmers, with holdings of 2.0 to 4.0 ha constitute 11.0% of the population. Keeping this in view, the majority of people in Himachal suffer scarcity of resources and that too when about 80%of the total cultivated area in the state is rainfed. Resource scarcity prevents their investing liberally in agriculture and taking full advantage of modern agriculture. The access of farmers to various resource centres is also poor because of the corrupt bureaucratic system in government offices. As a result only a few clever people able to take theadvantage of various schemes and programmes.

2.4.5 Indiscriminate and wide spread use of Chemicals:

The advancement in agriculture has no doubt been due to the adoption of new varieties, chemicals, and agronomic practices by the farmers. The problem has arisen recently because of extensive and wrong application of chemical pesticides which leave residual toxic effects on food articles. Besides which the chemicals are washed by rainwater and taken to water sources as well as absorbed by fodder and feed sources. From all these sources the residues enters the body of animals and human beings when they are fed with contaminated food items. The consumption of chemical fertilizers has gone up from 2000 metric tons in 1966-1967 to 34000 metric tons in 1995-96 and further increased to 57560 metric tonnes in 2017-18. It has been found that 70% of the vegetables sold in the market today are contaminated with pesticides and the toxic residues contained in them are higher than the safe limits. For instance onion contained toxic residues in over 92% samples, lady's finger (8hindi) contained in 78% samples, potato and tomato had residues in over 51% samples, and 74% samples of aubergine, 62% samples of cabbage, 58% samples of cauliflower and 48% samples of spinach contained toxic residues in the market which enter in our bodies every day. In one study even it was found that sixteen sample of flour from the branded companies contained toxic residues of DDT, Aldrin and lindane beyond safe limits. The chemical load in fruits may also be found, as fruits like apple receive a heavy schedule of sprays in the orchards.

2.4.6 Reduction of Working Hands In Nucleus Farming Families:

The joint family system in India had ensured require the labour to work in agriculture. In recent years, when western influences began dominating the scene of Indian society, the joint family system is breaking fast into nucleus families (parents plus one or two children) and in this situation, children, unlike earlier times, are engaged in school education and for agricultural work only one or two adults are available. The hired labour costs are high and it could only be possible 225.00/- per day. This single factor compels farming families to change their agricultural land to some long-term usage such as a fruit orchard, timber tree cultivation or to grow some high value crops such as flowers, medicine and aromatic plants and vegetable crops so as to earn immediate larger profits to pay the hired labour for better resource inputs.

2.4.7 Destruction (Non scientific) of Agro-forestry Component and Surrounding Green Cover:

The agro forestry has been practiced in the hills since time immemorial. This is because it meets the daily requirements of fuel wood, fodder, timber and fibre. Besides it keeps the surrounding atmosphere clean. The non scientific use of surrounding forests has created new environmental problems such as shift in weather conditions, low rainfall, drying of perennial water sources, gully erosion, lowering of soil organic matter which used to come to farm fields through runoff water. Due to non availability of wild fruits to wildlife these have become aggressive to nearby village life and farm crops.

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2.4.8Timidity of Extension Workers:

As has been said earlier the unskilled farming community does not understand the significance of long-term investment in agriculture. That is why they are fascinated by quick gains which may otherwise be harmful in the long run. This was to be overcome by an extension workforce engaged in community blocks which needs further strengthening so as to discharge their duties more diligently in the interest of farming community development . The very spirit of service for the upliftment of the rural masses was never reflected over five decades which carried the huge plan budgets. Farmers are now becoming aware of the ill effects of chemical fertilizers, pesticides and herbicides. People have lost hold of their best produce in times before transition. For example, in certain areas the blackgram crop had the highest quality and now it is not even grown in those areas. In certain areas, bullock cultivation is replaced by tractor. As a consequence the availability of FYM or compost manure is much reduced and green manuring has not been practised, causing serious damage from chemical fertilizers on the soil and plantsgrowing there.

2.5 Responses:

2.5.1 Technologies/Alternatives Available:

Eco-friendly agricultural practices are necessary in order to protect our environment and to keep it safe for the health of farming families and for millions of others who daily consume the produce. Such practices were traditionally inherited in the hill agriculture. However, due to recent trends in modernization of agriculture, some practices have become alarming to the environment. These are the application of chemical pesticides, fungicides, antibiotics, acaricides, nematicides, herbicides, NPK fertilizers, use of dust powders such as DDT, BHC, Sevin for treating stored grains or cellphos fumigation. The other pollutants are tractors replacing bullock cultivation, diesel pumps or gensets. Removal of many tree species from agro-forestry systems was another damaging factor because these tree species had great influence on the environment. For example mango trees in rural areas purify the environment through their leaves which contain antibacterial and antiviral substances. Similarly winds from pine trees and deodars also purify environment whereas network of roads connecting villages and the growing number of vehicles is also increasing pollution. The following technologies/alternatives will be useful to protect the environment in rural areas.

2.5.2 Zero Budget Natural Farming Agriculture:

The advanced western countries have already experienced the ill effects of using chemicals in agriculture and are now advocating the concept of natural farming. But natural farming is not new to India especially in the hills of Himalaya. They followed bio-dynamic agriculture concept. This is done through the steps given below:

1. No dependence on Market. All inputs required in farming are either available in the village or can be prepared on farm.
2. No chemical based inputs. It protects our environment, soil and water from pollution and conserve natural flora and fauna.
3. Restoration of Soil fertility, soil organic matter and soil carbon. The ZBNF increases soil microbes and promotes the soil food web through indigenous cow dung and urine based formulations-is the key to ZBNF. It is seen as an microbial culture to promote soil microbial populations.
4. Low Cost of cultivation through natural means of Pest management and botanical preparations, on farm input generations.
5. It promotes use of local seeds which are hardier and well adapted.
6. Inter cropping and multi cropping. The income from the short duration intercrops provides the working capital for the farmers for the main crop and that is the rationale for calling it " Zero Budget"
7. Multi crop models and incorporation of trees in Agriculture-provides year ling income and reduces risks. More important , the continuous green cover improves soil fertility, yields lot of mulch and reduces water losses.
8. Less water required under ZBNF: due to mulching and 'waphasa'. ZBNF offers an indigenous way of maximizing the usage of condensation of water vapour present in the atmosphere for plant growth, thereby significantly reducing the groundwater requirements.
9. Under ZBNF, crops can withstand dry spells better and longer. They also revive much better-when they get irrigation. Similarly, crops can withstand heavy rains.
10. From a climate change perspective, ZBNF is the most climate friendly agriculture system.
11. Consumers get healthy food. There is a huge increase in domestic demand for chemical free food.

2.5.3 Increasing Green Cover on Hills:

According to the National Forest Policy of 1988, at least two-thirds (i.e. 66%) of geographical area should be under forest greenery in hill states like Himachal Pradesh, but there exists only 22% of the geographical area under forest cover. The decline in forest cover has been responsible for low and erratic rain and snow, floods, heavy rains and land slides, gully formation. Good grass cover on hill slopes prevents soil erosion. The thick forests and snow glaciers are responsible for the slow release of water to the rivers and streams in the hills perennially.

2.5.4 Significance of Agro-forestry in Hill Agriculture:

The agro-forestry systems have been an essential component in the traditional farming systems. However in the present time without realizing its significance farmers are removing fast the tree components from their farming lands because of small damage done by birds, shade etc. This has encouraged the damage by rodents, wild beasts and insect- pests. Birds were also feeding on insect-pests.

2.5.5 Use of Bullocks as Draught Animals:

The use of bullocks for ploughing and other purposes in agriculture has distinct advantages. It is a renewable energy source, provides manure, consumes grass and crop wastes and has no damaging influence on environment.

2.5.6 Rain Water Harvesting for Agriculture:

Sloping lands in the hills make the provision of irrigation difficult. The best possible way to bring a greater area

under irrigation is to resort to rain water harvesting by constructing irrigation ponds which should be lined with thick polythene sheeting to check the seepage water losses. The water from these ponds is usable during winter or the rabi season. For the cultivation of high value crops like vegetables, flowers they will be highly desirable.

2.5.7 Enhancing Crop and Varietal Diversity for Sustainable Crop Harvests:

It is widely realized now that the loss of biodiversity in agriculture in the hills is responsible for crop failures in adverse years. The sustainability in crop production was attained in the hills through diversification of crop species and growing a large number of varieties of each crop. The small millets tolerate drought much better than cereal crops. In rice there were varieties, e.g. Rahru, Rohda, which were growing mixed with the maize crop without any standing water. More varieties provide the chance for at least a few to do well under bad weather conditions.

2.5.8 Mixed Farming and Mixed Cropping - Better Choice:

Mixed farming offers much scope to earn a good income through agriculture at least on small and marginal farms. Mixed farming involves animal husbandry, dairy, apiculture (bee-keeping), pisciculture, sericulture, floriculture, olericulture mushroom growing stet the cultivation of medicinal and aromatic plants. Mixed cropping utilizes the available farm resources to the maximum possible level and provides good returns to the grower.

2.6 Recommendations for Sustainable and Eco-Friendly Food Harvests:

1. Protection of natural resources:- Soil, water and plant genetic resources constitute the foundation upon which agriculture and food security are based. Of these, the least understood and the most undervalued are plant genetic resources (PGR). They are also the resources most dependent upon the care of human beings and they are more threatened today than any time previously. Plant genetic resources for food and agriculture consist of the diversity of the genetic material contained in traditional varieties, land races, obsolete varieties, modern cultivars as well as the wild relatives of crops and other related wild species that can be used for food, feed for domestic animals, fibre, clothing, shelter, wood, timber and energy.

Historically, plant genetic resources have contributed to stability in agro-ecosystems and provided the crucial raw material for the development of modern varieties. They remain the foundation of evolution in crops which has allowed crops to adapt to a myriad environments and uses and which will allow them to respond to the new challenges of the time ahead. Therefore the conservation of plant genetic resources should receive priority attention of planners. The chief cause of the loss of genetic diversity has been the spread of modern commercial agriculture.

2. Maintenance of soil health:- Soil health is basic to human health as it provides the variety of foods that we eat. The worldwide experience now teaches us to use organic culture for healthy foods from the soil. More appropriately biodynamic agriculture is the need of the hour. The energies from the cosmos, mother earth, mother cow and plants must be systematically and synergistically harnessed.

3. Maintenance of community seed bank:- Genetic diversity in agriculture minimizes the losses to farmers and provides the foundation to sustainability in production. Moreover, cereal crops provide a large proportion of our total food requirements. However, when food energy supplies are analysed, a much greater number and

types of crops emerge as significant. These include millets, sorghum, potato, pseudo cereals (grain amaranth, grain chenopod, buckwheat), beans and soybean. In any case, they receive much less attention or investment in terms of research and development. These crops are also important suppliers of dietary constituents such as proteins, fats, vitamins and minerals. These, therefore, need to be given a Place in the public Distribution System (PDS) by the state or central government.

4. Use of renewable energy resources:- The use of renewable energy sources should receive top priority in agriculture. There should be adequate investment for the design and development of implements and equipment using renewable energy. For example, panchakkis (Gharats), water lifting pumps, bullock drawn implements, solar cookers, gobergas cooking, water heaters with solar panels and solar crop driers.

5. Encourage research & development of bio product useful for agriculture:- The state government must invest in the research and development of bio pesticides, bio fungicides, bio compost, and better production of bone meal. Simultaneously, the extension workers must be trained adequately to teach farmers the benefits and use of such newly developed products. This must be done immediately, since the organic produce market is expanding and the hills supply large quantities of off-season vegetables fruits and which should find a remunerative price market.

6. Enhancing of crop intensity:- For economic growth and the prosperity of the people of Himachal Pradesh, there is tremendous scope to enhance the cropping intensity beyond 170 percent by introducing new crop plant species, such as exotic temperate vegetables, flowers, medicinal and aromatic plants either for fresh supply or for quality seed production. The other important areas which need attention are reviving the concept of mixed farming and mixed cropping in order to make best use of the available resources. The districts showing low cropping intensity need to be stepped up.

7. Increase rain water harvesting:- Irrigation and Rainwater Harvesting in the hills, the use of canals is not possible because the slope of cultivatable land varies from 5% to 30%. The Kuhals are the most popular mode of irrigation. However these need government's intervention for efficient management and use. Only 23.5% of the total available groundwater potential has been need in the low hills and valleys, and only 1.5% of the total water resource potential is being used in the high land regions at present. So far only 18.4% of the net area is irrigated in the state. The total geographical area of Himachal is 55.67 lakh hectares, of which only 5.83 lakh hectares are under cultivation and only 98000 hectares are the net irrigated area. That means still 80% or more of the area is rainfed and, if the state economy has to be strengthened, irrigation must be given top priority in planning. The rain harvesting would be an excellent option for the hills which will provide cheap irrigation water for growing rabi crops and will also reduce soil erosion through runoff water. Only solution is water management committee regularization & penalty provision if someone break the waterpipelines, kulahas & oter water source in the village. Till March, 2019, an area of 25856.22 ha has been brought under Micro-irrigation Systems and 36940 farmers were benefitted. A budget provision of Rs.25.00 crore has been proposed for this component during 2019-20.

8. Develop Vision for Research:- Crop Diversification for ten Agro-ecological sub zones in order to harness their potential in the correct perspective of genetic resources, soil and water resources. To save rural farming from untoward circumstances, it is urgently required that the new technologies/alternatives are immediately put into operation. Some of these include adoption of organic or biodynamic agriculture, increasing green cover, adding more irrigated areas or adopting rain harvest technology, saving biodiversity character in crops, and laying due emphasis on mixed farming and mixed cropping. There is no scope for neglecting the issues raised earlier in the context of agriculture if the state has to forge ahead in development as a strong viable economy. The action and will power of governance must be visible to earn credibility.

2.7 Environment Management Practices at Agriculture Marketing Complex.

H.P State Agriculture Marketing Board is implementing World Bank funded H.P Horticulture Development Project to support market access to farmers and also identifying the major environmental and social impacts in early stages of planning of new and upgradation of existing market yards. Under this project HPSAMB has proposed two new market yard at Mehandli, Rohru&Bandrol, Kullu and upgradation of 14 market yards as per PIP (only 7 market yards are feasible and additional 3 new sites proposed).

M/s Ramky Enviro Solution Pvt. Ltd. has been hired for the assessment of Environment and Social Impact in and around the project area, During the impact assessment following components were monitored:

- **Meteorology: -** Meteorological data (Wind speed, wind direction, temperature and relative humidity) were recorded on hourly basis in study area of 2 Km radial distance from the project site.
- **Ambient Air Quality: -** AAQ was monitored to find out the concentration levels of Particulate matter (PM10 and PM 2.5), SO2 and NOx for 24 hours.
- **Water quality: -** Water samples from Surface water, ground water and tap water were collected to assess physical and chemical parameters. the samples were analyzes and analytical result were compared with IS: 10500-2012 drinking water standards.
  (PM10 and PM 2.5), SO2 and NOx for 24 hours.
- **Soil quality:-** The physico-chemical parameters value of soil samples was compared with standards of Indian Council of Agriculture Research (ICAR), New Delhi.
- **Land use and Land cover:-** The status of land around the project area and people depend on that land were analyzed.
- **Ambient noise quality:-**The noise levels at residential and commercial area were compared with noise standard SO 123 € dated 14 Feb, 2000 and its subsequent amendments.
- **Traffic study:-** The detailed traffic survey was conducted.
- **Ecological environment:-** The fauna and flora around the project area was studied.
- **Social Economic Study:-** Social-economic aspects of people inhabiting villages in the study area was studied.

The Environment and Social Management Plan (ESMP) is prepared on basis of Environment and social Impact Assessment (ESIA). The ESMP consist of a set of mitigation, monitoring and institutional measures to be taken during the design, construction and operation stages of the project to eliminate adverse environmental and social impacts, to offset them, or to reduce them to acceptable levels. The plan also includes the actions needed for the implementation of these measures. The ESMP will be integrated with the bid document for contractor for construction and the implementation of ESMP will become contractual obligation for the contractor.

For the protection of environment following equipment's has been proposed to install in market yards

Environmental Control Equipment	Description	Remarks
Air Pollution control equipment	Stack Equipment/air filters/air scrubbers	An air scrubber is a portable filtration system that seizes airborne particles and improves the air quality.
	Odor control	To eliminate the foul odor generated.
Water Pollution control equipment	Rainwater Collection Tank/ ground water recharge pits	
	Packaged sewage treatment plant	Use to treat the waste water.
Noise Pollution	DG set sound proof room	
Solid Waste equipment	Organic waste converter	Use to convert organic waste in manure.
	Waste collection bins	
	Muck management	
Energy Saving equipment	LED Street lighting	
Environmental Health and Safety Equipment	Personal Protective equipment (helmets, hand gloves, ear plugs, nose mask, glasses, safety belts)	
	Fire extinguishers (6x9 kg Class A type, 4x9 Kg Class B type and 4x9 Kg Class C type)	
	Safety siren/ alarm	
	Sand buckets	
	Sign boards for equipment, passages	

Moreover, green belt will also be developed in project area where treated water shall be reused. For the implementation of mitigation measures and above proposed equipment's budgetary provision s has also been made. The mitigation measure proposed during construction and operation activities, information on their feasibility, effectiveness, timeframe and institutional responsibilities will be supervised by the Environment and Social Management Cell at APMC and HPSAMB.

Due to the expansion and up-gradation with advanced infrastructure and better facilities, the product quality enhances and the overall environmental aspects related to market yard will improve significantly. The people who are involved in the project will get benefited in terms of EHS improvements made within the project activities.The project may likely increase quality of life of the workers, improved sanitation, transportation and recreation facilities in work place and will improve to meet the prevailing standards and economy; the region will get benefitted with the proposed developmental activities of Kangni market yard.

The environmental management plan provided to the processing unit will reduce significantly the emission levels and meet the prevailing regulatory standards of local pollution control boards and other agencies. This would also increase awareness among project workers regarding terms and conditions of employment, gender inclusivity, and also generate more employment opportunities to the indigenous/local people. It may trigger rapid growth of service sector and increase of household income in the project area. The study also highlighted certain risk mitigation measures to enhance awareness among workers and contractors through training programs on issues like child labor, safety and worker participation. There will be increased revenue to the state in the form of taxes.

Data of crop production of Cash Crops:

Crops	**Area ('000 hect.)**					
	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
Sugarcane	1.87	1.54	1.63	1.94		
Ginger	2.41	2.19	2.14	2.28	2.27	2.50
Potato	-	-	14.68	18.02	21.08	15.88

Crops	**Production (M.T.)**					
	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
Ginger	16872	15042	14715	15389	-	15947
Potato	-	-	181380	183252	202440	198660

Pesticide Consumption in respect of Department of Agriculture Himachal Pradesh (in qt):

Sr. No	Name of the District	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Bilaspur	105.65	112.04	101.24	114.04	106.39	112.26
2	Chamba	29.06	66.22	162.65	58.32	71.49	57.17
3	Hamirpur	208.51	224.55	258.72	167.65	222.52	163.30
4	Kangra	339.87	339.87	391.55	441.02	306.6	366.75
5	Kinnaur	35	7.35	14	12.94	105.6	19.78
6	Kullu	117.83	138.17	163.73	77.51	164.41	130.97
7	Lahul Sapiti	31.25	33.95	13.2	31.2	115.5	9.71
8	Mandi	294.11	294.79	272.95	303.85	350.89	384.96
9	Shimla	139.91	136.72	65.2	66.9	92.36	94.77
10	Sirmour	184.08	276.44	134.8	190.72	161.98	93.33
11	Solan	262.73	127.69	112.41	174.2	188.56	232.12
12	Una	143.71	220.68	185.38	93.25	173.35	141.99
Total		**1891.71**	**1978.47**	**1875.83**	**1731.60**	**2059.65**	**1807.11**

District wise consumption of fertilizer (in nutrients) 2017-18:

Sr. No	Name of the District	N	P	K	Consumption in kg/ha			Total
					N	P	K	
1	Bilaspur	1915	107	2076	33.46	1.87	0.94	36.27
2	Chamba	1134	88	1285	17.11	1.33	0.95	19.39
3	Hamirpur	2068	186	2351	29.61	2.66	1.39	33.66
4	Kangra	6298	1478	8526	28.68	6.73	3.42	38.82
5	Kinnaur	111	64	264	12.69	7.32	10.18	30.19
6	Kullu	2786	1384	6052	42.80	21.26	28.92	92.98
7	Lahul Sapiti	182	183	474	57.34	57.66	34.34	149.34
8	Mandi	4378	1152	6422	27.28	7.18	5.56	40.02
9	Shimla	6111	2888	15050	63.77	30.14	63.15	157.06
10	Sirmour	3375	665	4427	52.80	10.40	6.05	69.26
11	Solan	2429	474	3156	32.52	6.35	3.39	42.25
12	Una	5813	1102	7477	82.15	15.57	7.94	105.67
	Total	**36600**	**9771**	**57560**	**38.30**	**10.22**	**11.71**	**60.23**

2.8 Seed Certification

Seed is a basic input for Agriculture which plays a big role in production and productivity of the crops. Realizing the importance of good, healthy and genetically pure seed, Government of India Enacted "The Seed Act" during the year 1966 and recommended the State Governments for setting-up Seed Certification Agencies in the State under Section 8 of the Seeds Act.

The National Commission of Agriculture reviewed the Indian Seed Industry from different angles and made some of the following important recommendation in its final report.

1. Seed industry to be expended on commercial lines.
2. Rigorous enforcement of the Seeds Act.
3. Compulsory certification for seeds of hybrids and vegetatively propagated crops.
4. Grow out tests to form integral part of seed testing.
5. Seed processing to be made compulsory.

The Government of India recommended for setting up the State Seed Certification Agencies under Section 8 of the Seeds Act, 1966. The Certification Agencies have been established as autonomous bodies in different states.

The Government of Himachal Pradesh established the H.P. State Certification Agency vide Notification No. Agr. F-12-3/76-Vol-II dated 27.12.1978. The Himachal Pradesh State Seed Certification Agency is registered under the Societies Registration Act, 1860 (Act, XXI of 1860). The agency adopted Memorandum of association and rules based on the model pattern circulated by the Government of India. The Agency was entrusted the Job Certification of organic farms and their produce and consequently its name was changed to H.P. State Seed and Organic Produce Certification Agency vide Notification No. Agr. F (10)-16/2003, dated 19.02.2004.

Aims and Objectives:

Seed Certification is a particular prescribed procedure through which genetic identity, physical and physiological purity and seed health is maintained in seeds and propagating materials of notified kinds and varieties. As a result, the certifies seed is of known pedigree, high varietal purity and good seedling value which confirm to the prescribed field as well as laboratory standards in respect of genetical and physical purity, germination, moisture percentage and seed health.

The main objective of the H.P. State Seed & Organic Produce Certification Agency is to maintain, provide and make available to the Public high quality seeds of notified varieties and propagating materials to ensure their genetic identity, known pedigree, high varietal purity and good seedling value. Certified Seed has to meet the field as laboratory minimum standards in respect of genetic and physical purity, health and germination etc.

Functions:

The main functions of the H.P. State Seed & Organic Produce Certification as under:-

- To act as the Certification Agency established under section 8 of the Seeds Act, 1966 (54 of 1966).
- To discharge the functions entrusted to the certification Agency under section 9 & 10 of the Seeds Act, 1966 (54 of 1966).
- Diffusion of scientific knowledge regarding standardization of seeds according to the National/International Standards.

- To recognize varieties and kinds, (where, improved varieties are not available) eligible for seed certification and publish annually lists indicating the name of such varieties and kinds.
- To maintain a list of source of breeder and foundation seeds approved by the Central Seed Certification Board in the case of varieties grown in more than one State and by the State Certification Board in the case of varieties of local importance.
- To verify upon receipt of an application for certification that the application has been submitted in accordance with the procedure prescribed by the Central Seed Certification Board and that the source of seed used for planting is from approved source.
- To do the inspections of seed processing plant seed lots in accordance with the procedure outlined by the central Seed Certification Board.
- To ensure that the seeds certified in the state conform the the standards prescribed by the Central Seed Certification Board.
- To carry out educational Programme designed to promote the use of certified seed.
- To undertake promotional activities for seed certification in the state.
- To establish coordination with different departments of the State Government, Central Government and other Agencies and regard to the certified seed production.

Data on Production and Distribution of Certified Seed:

Area and Production for last Five years											
Sr. No.	Crops	2014-15		2015-16		2016-17		2017-18		2018-19	
Kharif		Area in Ha	Production in qtls	Area in Ha	Production in qtls	Area in Ha	Production in qtlsin	Area in Ha	Production in qtls	Area in Ha	Production in qtls
1	Paddy	355.05	2858.80	298.37	3417.0	331.94	1525.50	195.37	1054.20	117.61	129.30
2	Maize	0.00	0	0	0	0	0	100	2800	121.44	2400
3	Mash	99.04	136.13	118.93	186.06	144.20	657.97	141.80	32.84	52.20	0
4	Arhar	0.08	0	0.08	0	0.08	0	0.16	0	0.13	0
5	Moong	6.40	3.20	0.99	0	0.39	0	0.019	0	0.76	0
6	Kulthi	3.74	5.190	0.40	0	0	0	0	0	0	0
7	Rajmash	28.13	67.68	18.39	58.15	14.68	73.32	15.52	81.64	12.13	51.46
8	Till	14.33	8.44	5.65	1.17	7.30	4.03	0	0	6.64	0
9	Soyabean	29.31	170.72	31.0	244.18	21.41	396.80	22.72	78.27	24.36	0
10	Turnip	0.05	0.44	0	0	0.10	0.52	0.100	0.12	0.05	0.15
11	Capsicum	0.16	0.03	0	0	0.16	0	0	0	0	0
12	Turmeric	0.40	0	0.43	0	0.16	0	0.500	0	1.00	0
13	Bhindi	3.90	3.44	2.96	8.44	2.28	0	2.98	6.30	1.660	0
14	Beans	0.24	0.78	0.48	0.85	0.40	1.18	0.16	0.39	0	0
15	Potato	485.49	61079.0	538.25	61306.04	538.60	80328.60	443.62	52054.80	360.51	28251.50
16	Ginger	1.60	0	0.40	0	0.40	0	0.20	0	0.50	0
17	Cowpea	10.87	21.22	6.30	24.40	7.81	0	11.79	30.140	2.71	0
Total		**1038.75**	**64335.07**	**1022.64**	**65246.29**	**1069.79**	**82987.94**	**934.94**	**56138.70**	**701.70**	**30832.41**

Sr. No.	Crops	2014-15		2015-16		2016-17		2017-18		2018-19	
Rabi		Area in Ha	Production in qtls	Area in Ha	Production in qtls	Area in Ha	Production in qtls	Area in Ha	Production in qtls	Area in Ha	Production in qtls
1	Wheat	3487.74	26740	3082.33	31288.9	3415.47	38922.0	2480.08	53380.05	2669.84	0
2	Barley	2.00	0	2.40	21.70	2.08	0	2.400	4.65	6.01	0
3	Gram	15.87	4.10	7.10	18.55	11.91	0	6.72	14.15	11.89	0
4	Lentil	6.68	3.40	3.69	5.75	2.60	4.31	2.96	3.40	2.24	0
5	Toria	16.30	44.75	14.50	0	26.16	45.50	12.40	1.25	9.40	0
6	Methi	0.16	0.40	0.04	0	0.24	0.85	0.04	0.68	0.24	0
7	Garlic	0	0	4.80	0	0.52	0	1.86	0	7.25	0
8	G.Sarson	4.77	3.74	1.50	2.55	6.04	0	2.60	11.15	1.74	0
9	Peas	0.66	3.00	0.40	0	0.20	0.700	0.22	0.60	0.09	0
10	Cauliflower	0.24	0.01	0	0	0.16	0.540	0	0	0	0
11	Ch. Sarson	1.57	0	1.75	17.89	0.97	12.77	1.58	5.94	0.37	0
12	Spinach	0.08	0.07	0	0	0.22	0.26	0.68	0	0.100	0
13	Radish	1.11	0.08	1.38	1.91	0.66	0.45	0.08	0.08	0.06	0
14	Oat	15.35	103.300	14.66	126.90	0.72	34.45	7.75	68.00	8.22	0
Total		3552.53	26903.15	3134.56	31484.49	3474.49	39021.83	2519.37	53489.95	2717.45	0
Grand Total		4591.28	91258.22	4157.19	4544.28	4544.28	122009.75	3454.31	109628.65	3419.15	30832.41

Note: Sealing/tagghing work for the year 2018-19 is in progress

The Department of Agriculture is implementing the Seed Village Programme under Central Sector Scheme "National Mission on Agriculture Extension and Technology (NMAET). Wheat seed distributed under this scheme and the same is implemented on 90:10 (Central: State basis).

As per the preliminary assessment made by the Department in respect of approved hybrids, about 13940 qt of Maize, 3743 qt of Bajra, 14429 qt of Sorghum, 249.50 qt of Paddy, 162.50 qt of Tomato, 52.70 Kg of Cabbage, 31.68 kg of Capsicum, 17.50 kg of Cauliflower and 237.50 kg cucumber and 5500 seeds of cucumber for polyhouses, 31 kg Chilies, 54 kg of Brinjal, 363 kg Radish, 3859 kg Lady Finger, 43.45 kg Bottle Gourd, 155.45 kg of Bitter Gourd and 14 kg Broccoli hybrid seeds are required for 2019-20.

The seed Division, Ministry of Agriculture, Government of India through their Seed Net Portal allotted Breeder Seed of Paddy (11.40 qt), Soybean (3 qt), Black Gram (3.50 qt), Green Gram (0.75 qt), Sesame (0.05 qt) to Himachal Pradesh, accordingly, the same has been lifted by the Department from the source.

The Department of Agriculture purchased Breeder/Foundation Seed of Soyabean, Cowpea, Black Gram, Green Gram, Rajmash, Til, Paddy from State Agriculture University. Regarding Certified Seed, Department purchase these seed from Government agencies/undertaking for distribution of farming community, department also produce certified seed in their Seed Farms under the supervision of H.P. State Seed and Organic Seed Certification Agency. For Kharif 2019, the department has sufficient quantity of seeds to meet out the demand and supply.

2.9 Extent of Soil Conservation & Practices for Soil Conservation

I) Soil Conservation

Soil erosion is the main soil degradation type; therefore, the extent of water-induced soil erosion in the state has been computed on the basis of soil resource map of the state. The data indicated that about 22□% of TGA of the state has annual soil loss less than 5 t ha−1, and this can be termed as very well within the tolerance limit. This area does not require any specific soil conservation measures. Improved land and crop production technologies need to be adopted for improving the productivity on sustainable basis. These areas are distributed in small patches in the entire state. About 7 and 5□% areas are experiencing annual soil loss in the range of 5.0–10.0 and 10.0–15.0 t ha−1, respectively. While slight erosion (5–10 t ha−1) class has been termed as within safe limit, yet this along with moderate erosion (10.0–15.0 t ha−1) class needs appropriate conservation measures to sustain the agricultural production from these areas of the state. These areas can be rehabilitated by adoption of low-input soil conservation measures, viz. land shaping, contour farming, field bunding, conservation tillage and introduction of erosion-resistant crops or cropping sequences. About 27□% area of the state has soil loss >15 t ha−1, and it includes moderately severe (15–20 t ha−1), severe (20–40 t ha−1), very severe (40–80 t ha−1) and extremely severe class (>80 t ha−1) having 3.75□%, 7.40□%, 5.74□% and 10.08□% area, respectively. These areas are concentrated in patches in the entire state, but no area of extremely severe erosion class is present in Hamirpur and Bilaspur districts. It has been deduced that the state experiences a total soil displacement to the tune of 258 M tonnes, out of which 83□% is contributed by 10□% area subjected to extremely severe erosion class. This area has been delineated in the map, and effective conservation measures here can not only cause marked reduction in soil loss but can pave way for regeneration of areas under other erosion classes.

Water erosion, a physical process of land degradation, causes physical, chemical and biological deterioration of soil properties. The resultant effect is the non-reversible loss in soil productivity. The loss in productivity depends upon severity of erosion, soil type and crops to be grown. Velayutham and Bhattacharyya (2000) reported loss in crop productivity in the range of 5-50% due to moderate erosion (10-20 t ha-1 yr-1). Besides loss in productivity, its off-site effects may result in siltation of multi-purpose dams, floods and sediment deposition in fluvial plains and damage to the infra-structures. Many dams and reservoirs have been constructed across the rivers flowing through the state of Himachal Pradesh (HP) and their life span is dependent on the sediment load of the water channels.

Therefore, an inter-institutional project between Central Soil and Water Conservation Research and Training Institute, Dehradun and National Bureau of Soil Survey and Land Use Planning, Nagpur was undertaken to quantify the average annual soil loss from HP using universal soil loss equation (USLE). Quantitative assessment of soil erosion in Himachal Pradesh through USLE showed that 21.59, 6.82, 5.43 3.75, 7.40, 5.74 and 10.08% area in the state was experiencing soil loss in the range of <5, 5- 10, 10-15, 15-20, 20-40, 40-80 and >80 t ha-1 yr-1, respectively.

About 39.2% area under rock outcrops and glaciers, having no soil on surface, has been delineated separately. Out of the total soil loss of 258.06 Mt annually, 82.6% (213.23 Mt) is contributed by 10.08% area experiencing extremely severe erosion of >80 t ha-1 yr-1 while 28.41% of geographical area having annual soil loss <10 t ha-1 yr -1 contributed only 2.27% of total soil loss in the state. In spite of the inherent limitations of USLE and scale of map, the scientific database on soil loss in Himachal Pradesh would be very useful for planners, administrators and scientists in prioritisation of the problem areas, planning of conservation works in prioritised areas and make ecology of the hill state stable.

II) Practices for Soil Conservation:-

1) Agricultural conservation measures : These are practices such as mixed cropping, contour cultivation, mulching, and manuring

1.1) Crop management: Good crop management reduces soil erosion by water and wind and improves soil fertility.

1.2) Crop selection:- Perennial crops are more effective in soil conservation than annual crops. Tea, fodder grasses, sugar cane and sweet potatoes are among the most effective.

1.3) Early planting: This ensures that the crop shoots from the ground within one or two weeks after the onset of the rains and protects the ground against raindrop impact.

1.4) Crop rotation:- Crop rotation ensures the addition of humus, soil fertility, control of erosion and reduction of pests and diseases.

1.5) Inter-cropping:- Fast growing legumes such as beans and cowpeas provide soil cover early in the season before maize or cotton develop a canopy to shield the soil from impact of raindrops.

1.6) Cover cropping:- This is the growing of crops to cover cultivated ground, reducing erosion by raindrop splash and overland flow. It protects the soil from excessive heat and creates a good environment for microorganisms. The fallen leaves of the cover crop decompose and add organic matter to the soil.

1.7) Strip cropping:- This is growing alternate strips of different crops in the same field. It controls water and wind erosion. Contour strip cropping combined with crop rotation and minimum tillage is an effective method of soil and water conservation.

2) Soil management:- Inappropriate land use activities often cause changes in soil conditions, which in turn contribute to soil erosion. Soil management is to create optimum conditions for plant growth through improved soil fertility and structure. It increases infiltration rates, improve water-holding capacity, and reduce runoff and erosion.

2.1 Use appropriate tillage practices: Tillage aims to optimize soil physical and biological conditions for crop production and to ensure timely seedbed preparation, planting and weed control. Use an appropriate tillage practice that; Does not make the surface soil too fine and powdery; and Breaks up the hardpan if necessary. The main tillage methods are slash and burn, hand hoeing, ploughing and harrowing, conservation or minimum tillage, deep tillage.

2.2) Applying organic manures and mineral fertilizers :

- Adding manure and fertilizers to the soil provides the required plant nutrients for vigorous crop growth.
- Fast growth gives quicker cover to the ground and higher yields.

- Inorganic fertilizers provide major plant nutrients - nitrogen, phosphorus, potassium, and occasionally sulphur-that are needed by plants.
-

Inorganic fertilizers are no substitute for organic matter, and therefore should be used in combination. Sources of organic fertilizers include farmyard manure, compost, and green manuring.

2.3) Mulching and the use of crop residues: Dead plant materials such as dry grass, straw, dry leaves, banana leaves, sugar cane trash, and other crop residues are spread on the bare soil surface or placed around the stem of the plants to control soil erosion and conserve moisture.

3) Agro-forestry:

- Agro-forestry involves planting trees or shrubs, or keeping those that are already there.
- Trees cushion the impact of raindrops on the soil, so reducing the amount of rain-splash erosion.
- They shade the soil, reducing the soil temperature and cutting the amount of water that would evaporate into the air.
- They break the wind, reducing the amount of wind erosion.
- They recycle nutrients from deep in the soil; leguminous trees fix nitrogen that benefits food crops.

4) Contour farming practices :- Contour farming involves ploughing, planting and weeding along the contour that is across the slope rather than up and down. 50% on gentle slopes.

- **Contour ridges** are used in semi-arid areas to harvest water, and in higher rainfall areas for growing potatoes.

- **Trash-lines** are constructed by laying plant residues in lines along the contour. Trash-line help in slowing down the runoff and trapping eroded soil.

- **Grass barrier strips** of Napier or other fodder grasses are planted along the contour.

5)Physical soil conservation measures:- Physical soil conservation structures are permanent features made of earth, stones or masonry, designed to protect the soil from uncontrolled runoff and erosion and retain water where needed

Selection and design of structures depend on:

- Climate and the need to retain or discharge the runoff
- Farm sizes
- Soil characteristics (texture, drainage, and depth)
- Availability of an outlet or waterway
- Labour availability and cost
- Adequacy of existing agronomic or vegetative conservation measures.
- Below are some of the physical conservation measures:

5.1) Cut – off drains:-Cut-off drains are dug across a slope to intercept surface runoff and carry it safely to an outlet such as a canal or stream. They are used to protect cultivated land, compounds, and roads from uncontrolled runoff, and to divert water from gully heads.

5.2) Retention ditches:- These are dug along the contours to catch and retain incoming runoff and hold it until it seeps into the ground. They are an alternative to cut-off drains when there is no nearby waterway to discharge the runoff. They are often used to harvest water in semiarid areas.

5.3) Infiltration ditches:- This is a structure designed to harvest water from roads or other sources of runoff. They consist of a ditch 0.7-1.5m deep, dug along the contour, upslope from a crop field. Water is diverted from the roadside into the ditch, which is blocked at the other end. Water trapped in the ditch seeps into the soil.

5.4) Water-retaining pits:- Water-retaining pits trap runoff and allow it to seep into the soil. A series of pits are dug into the ground where runoff normally occurs. The soil from the pit is used to make banks around the pits. Furrows carry excess water from one pit to the next. The size of the pit depends on the amount of runoff: a typical size is 2m square and 1m deep.

5.4) Broad beds and furrows :- In a broad bed and-furrow system, runoff water is diverted into field furrows (30cm wide and 30 cm deep). The field furrows are blocked at the lower end. When one furrow is full, the water backs up into the head furrow and flows into the next field furrow. Between the field furrows are broad beds about 170cm wide, where crops are grown.

5.5) Bench terraces :- These are level or nearly level steps constructed or formed on the contour and separated by embankments known as risers. They are formed by excavation or developed from grass strips or fanya juu terraces. Suitable on slopes up to 55%.

5.6) Stone terraces:- Stone terraces are useful in areas with steep slopes but high population density and scarce land. The terrace risers are made of stones collected from the land.

III) Challenges in Soil and Water Conservation:-

- Fragmented land ownership makes it difficult for farmers to invest optimally in soil and water conservation.
- Conservation structures need a lot of labour to build and maintain.
- Crop production in semi-arid areas involves many risks, including flooding. This makes it difficult for farmers to realize the full benefits of conservation.
- Many farmers lack the skills to design and build conservation structures, sub-standard and poorly constructed structures often results.
- Land tenure systems determine the ownership of the structures and influence farmers' interest in conservation and in maintaining the structures.
- Irregular rainfall reduces the effectiveness of vegetative erosion-control practices.

2.10 Narrow based Agriculture and Impacts

Poor nutrition due to narrow based agriculture and consequent increase in health care needs. In rural areas earlier people used to grow a wide varieties of crops & vegetable cultivated and wild fruits and consume them seasonally to maintain a good health but in recent years when crops base has been much narrowed down and use of wild edibles has been outdated whereas, they are good suppliers of important minerals & vitamins and they have medicinal values.

Pollution Threat and Environmental Degradation: - Due to growing use of chemical fertilizers, pesticides/weedicides etc. there is higher & higher pollution of water, food articles, milk & meat etc. Which is causal to serious disease outbreak in village people that was never observed earlier that impact overall community.

Decline in Population of Domestic Animals & FYM Supply:-

Decline in Agriculture Labour Work Force: - earlier joint family constitute a good agriculture work force but nowadays single families can't afford a fairly good labour & wages rates.

Tendency Use of Non-Renewable Energy Resources in Agriculture:-
We are emphasizes on more & more non-renewable energy resources e.g. direct, electricity so we may be shift to solar based energy system in agriculture. So that carbon footprints of agriculture sector can be reduced. If we currently using non-renewable energy system in agriculture whereas, in order to have less energy inputs

and more environment friendly technologies. We must start investing in application of renewable energy inputs in agriculture sector will increase farmer income as well help in reducing carbon footprints in allied sector.

Faulty Marketing Practices: - fetch low and faulty returns to farming communities. Agricultural extension agency teach high agriculture adaptation the emphasizes of agriculture extension officers and agency they are emphasizing on use of high input agriculture rather than advising ways and measures for lower cost in agriculture production.

2.11 Response in Agriculture System:-

1. Emphasizes On Organic Farming Practices & Discard The Use Of Chemicals in Agriculture:- The department of agriculture now laying more & more emphasis on organic farming & gradually discouraging the indiscriminate use of chemicals in agriculture because till now the consumption of chemicals in agriculture has increases to more than double.

2. Crop Damage by Stray and Wild Animals:- Main damage to crops is from wild pigs, monkey, birds & stray animals like Cows & Nilgai .these wild & straw animals. Presently govt. taking steps such as gaushala & monkey sterilization but these initiative are not sufficient. These initiative will be successful with involvement of community.

3). Promoting Technological Application in Agriculture: - Government is taking initiative to modernize hill agriculture & now the application of various new technologies however, some practices have become alarming to the environment such as chemical fertilizers, fungicides/pesticides, we have to replace these chemical with the environment friendly bio pesticides, bio fertilizers, bio fungicides. Government has also introduced power tillers, small tractors, harvesters. Thresher etc. however, there is need to think on technological application in term of local environmental concerns & must explore technologies that lead to environment & economic sustainability. Another hand the practices such as use of bullock & draught animals for ploughing is useful as they will consume agriculture waste & provide manure useful for agricultural crops.

4). Promotion of Organic Farming & Zero Tillage: - Government of H.P has taken many initiative for promotion of organic farming & minimal tillage (zero tillage). In this system analysis from the cosmos, earth, cattle and plants are systematically & synergistically harvest this is also known as biodynamic agriculture. In fact, the state of H.P traditionally practiced organic farming and recent efforts to receive the same for reducing cost inputs and maximizing the output gain. The concept of minimum tillage (zero tillage) is to disturb the soil minimum.

5). Increasing Green Cover & Forest Plantation in the State: - Due to decline in green cover area the rainfall pattern gets disturbed and same thing happened such as gully formation & snowfall precipitation etc. The good grass cover on hill slope prevent soil erosion. The thick forest and snow glaciers are responsible for slow release of water into rivers/perennial streams.

6). Significance of Agroforestry in Hill Agriculture: - Agroforestry practices in hills has many direct & indirect benefits. Direct benefits include such as supply of fodder, f uelwood, timber &fruits and indirect benefits are wind break, this indirectly provide environmental services & economic gain agroforestry services not provide benefit to hills but also the adjoin areas.

7). Rain Water Harvesting: - Sloppy agriculture lands in hills make it problematic to provide irrigation

(kuhals) in agriculture. The best possible way to store rain water by constructing rain water harvesting structures such tanks & ponds in which excessive surface rainwater can be conserved for use during winters & rainy seasons and farmer can take advantages of growing cash crops.

HORTICULTURE AND ENVIRONMENT

CHAPTER-3

Horticulture is a boon of nature which is refined by human skill as a science to obtain more and more benefits. It involves rigorous cropping expertise including the improvement, production and use of vegetables, fruits, flowers, medicinal plants, woody landscape and green house plants. Horticulture is now one of the fastest growing industry with great change which has succeeded in Himachal Pradesh. The un-sustainability of agriculture and the pressure of population, horticulture development has become a sustainable farming system which is supposed to be a basic need for the preservation of fragile mountains.

Due to diverse agro-climatic conditions, State is suitable for the cultivation of a variety of horticultural crops such as fruits, vegetables, potatoes, mushrooms, flowers spices and medicinal plants. So far, only fruits, vegetables and flowers have been grown for commercial market though in a limited area. Some horticultural crops have very specific agro-climatic and soil requirements, the cultivation of such crops, is, therefore limited to certain areas. The State has features that are favourable for the development of certain horticultural crops. There are other horticultural crops which have greater adaptability and can be grown in various locations provided the basic requirements are met either naturally or artificially.

In the State, both temperature and sub-tropical fruits can be grown successfully. In certain areas, even tropical fruits like mangoes and bananas are cultivated, but such cultivation is localized. In temperate regions, fruits and nuts such as apples, pear, cherries, hops, almonds, walnuts, peaches, apricot, plums, pecans, hazelnuts, kiwi as well as berries e.g. strawberries, raspberries are grown in different elevations. At lower elevations, sub-tropical fruits such as citrus, pomegranates, guava and stone fruits are being grown successfully (Table I). Temperate fruits like apple, cherries have a monopoly in the region as they can be grown under temperate conditions. In the region because they can be grown under cool climate and therefore, do not compete with the kinds of fruits grown in plains.

Sub-tropical and tropical fruits have the additional advantage of maturing later because of the lower temperatures, and therefore, give a better economic return to the farmers in the market and also due to better colour and taste. Besides fruits, vegetable cultivation creates employment & generate income as their cultivation is labor cum capital intensive in nature and there are appreciable financial returns. In the State, diverse climatic and soil conditions are congenial for growing a wide range of temperature and sub-tropical vegetables. Among the temperate vegetables: cabbages, cauliflowers, capsicums, tomatoes and beans are important crops which have scope for providing "off season" supplies to the other parts of the country. By taking the advantage of altitudinal gradients, two or three crops can be grown in a year in the State. The mountain regions of the State provide ideal climate for raising seeds of cabbage, cauliflower and carrot crops.

Because of suitable agro-climatic conditions, opportunities for growing ancillary horticultural crops have been found in abundance. Growing of floriculture crops like, carnation, chrysanthemum, gerbera, gladiolus, marigold and rose etc. and mushroom cultivation has also become very popular. On the other hand, cultivation of spices and medicinal plants and the practices of apiculture are carried-out all over the State with varying degree of success.

Agro-climatic zone-wise fruit crop distribution in the State

S.No.	Description of Zone	Elevation range (m, MSL)	Rainfall (cm)	Suitable fruit crops
1.	Low hill and valley areas near the plains	365-914	60-100	Mango, litchi, guava, loquat, citrus, fig, papaya, grapes, jackfruit, banana, low chilling varieties of plum, peach and pear, strawberry
2.	Mid hills (Sub-temperate)	915-1523	90-100	Stone fruits (peach, plum, apricot, almond), persimmon, pear, pomegranate, pecan nut, walnut, kiwi fruit, strawberry.
3.	High hills and valleys in the interiors (temperate)	1524-2742	90-100	Apple, pear, cherry, almond, walnut, chestnut, hazelnut, strawberry.
4.	Cold and dry zone (dry temperate)	2743-3656	24-40	Apple, grapes, prunes, drying type of apricot, almond, chilgoza, pistachio, walnut, hazelnut.

3.1 STATUS OF HORTICULTURE

The Government of Himachal Pradesh has placed great emphasis on the development of horticulture in the State and this sector takes priority in policy decisions. Various facilities such as supplies of inputs like plant material, seeds, fertilizers pesticides at subsidized rates, long-term loans for plantations on easy terms and provisions of technical services in the production areas are provided to the farmers to encourage horticulture for livelihood security and overall economic development. Moreover, to address the researchable issues and for capacity building of the farmers and to generate human resource for quality development a separate university namely Dr. YS Parmar University of Horticulture & Forestry was established during the year 1985 by the State Government. Consequently, the State has achieved a transformation in the horticulture sector over the last fifty years. The total area under fruits which was only 752 ha. In1952 has increased to 229202 ha in 2016-17. Similarly, the fruit production has also increased from 1200 MT. In 1950 to 5.65 lakh tonnes during 2017-18. The horticulture industry is now contributing about □777 crores per annum to the Gross Domestic Product of the State. The development of Horticulture in the State has generated many employment opportunities not only at the farm level but also in other related activities such as post-harvest management operations of packing, grading, transportation, processing, marketing etc. It has been estimated that about 900 lakh man-days of employment are generated in the fruit production activities alone. Every year about 35000 trucks are required for the transportation of fruits from the State to various markets in the country. Besides fruits, ancillary horticultural activities like mushroom farming, floriculture and beekeeping is also being promoted. Therefore, horticulture industry has a great role in the amelioration of the rural economy of the state through the earning from total farm exports, in providing sustainable farm income, nutritional security and diversification. Moreover, fruit growing may play an important role in ecologically sensitive hilly, rain fed and dry land areas because of its perennial nature.

Production and supply of planting material in fruit crops is arranged through 65 progeny-cum-demonstration orchards and nurseries and 479 private nurseries. The state is self-sufficient in the production and supply of most temperate fruit plants but is deficient in planting material for mango, citrus and other sub-tropical fruits, some nuts particularly grafted walnuts, pecan nuts, kiwi fruits, cherry and spur type of apples. Various programmes have been initiated for increasing the production of the plant material for these fruits in Himachal Pradesh. Two plant tissue laboratories, one each in the public and private sectors, have been

established for the rapid propagation of the fruit plants, wherever the protocol are available. To supply improved planting material and root stocks, the State Department of Horticulture has imported root stocks of Apple, Pear, Plum and Cherry, which are being multiplied in the Progeny cum demonstration orchards of the State for advisory services in fruit plant nutrition, three plant tissue analysis laboratories have been established at Shimla, Kullu and Dharamshala, in which around 14500 plant tissue samples are analyzed annually for the diagnosis of the nutritional disorders and suggesting fertilizer application practices. This has helped the orchardists to make judicious use of chemical fertilizers. The supply of pesticides is arranged through 354 sales outlets established in the fruit growing areas by the department. Every year around 2.25 lakh hectare area is covered under plant protection activities and the pesticides (technical grade material) are distributed to the farmers every year. A Biological Control Laboratory to reduce chemical use in pest control has also been established at Shimla.

For the development of mushroom cultivation, the Department of Horticulture has established four mushroom compost manufacturing units at Solan, Palampur, Baijnath (Kangra) and Bajaura (Kullu). Annually, about 579.71 MT of pasteurized compost for mushroom growing is distributed to the mushroom growers. In addition, about twenty mushroom compost manufacturing units are also operating in the private sector with total mushroom production of 3899 MT in the state.

Himachal Pradesh occupies prestigious position in floriculture. The area under flowers during the year 2018-19 was 705.77 ha.,which has produced flowers having gross value of 9117.05 lakhs. For the promotion of floriculture, seven nurseries have been established at various places for the multiplication and supply of planting material. One Model Floriculture Centre has been established at Mahog Bag in Chail (Solan) to serve as a training center in commercial floriculture. In the state presently an area of 796 hectares has been brought under flower cultivation. For the development of bee keeping, 32 bee keeping stations have been established all over the state for providing technical know how to the farmers at a commercial level. About 1722 bee colonies are maintained in these stations for multiplication and supply to the farmers. Two bee breeding multiplication centers have also been promoted in the private sector. AG-marking laboratories for honey have been established in the state.

The State Department of Horticulture is also taking steps to introduce essential new technologies for the development of this sector through improvement of productivity of existing orchards, quality of crop produce and diversification of the horticulture industry. Modernization of the nursery production programme for the production of virus free certified planting material on suitable rootstocks is being taken on priority. Introduction of improved fruit varieties and rootstocks from advanced countries and their multiplication for supply to the farmers has been initiated. With the objective of obtaining higher productivity of quality fruits per unit area, the present low-density plantation is being converted to medium and high-density orchards. Minimum use of pesticides with emphasis on Integrated Pest Management (IPM) and Biological Control of pests and diseases is being promoted.

Weather forecast based agro advisory as well as dissemination of technical knowhow and marketing information through the utilization of the information technology has become common in the state. The capacity building of the farmers on water management practices on their farms through adoption of scientific water harvesting, storage and application practices has been done. Creation of scientific post-harvest management infrastructure, value addition and diversification in processing industry, market promotion through branding, advertisement and exports is being promoted by the department. The horticulture extension services have been strengthened to grass root level, consequently, the programmes relating to the farmer's trainings, demonstrations, fruit shows, exhibitions. seminars and workshops for the dissemination of

the technical know-how to the ultimate users are being conducted regularly.

The State Department of Horticulture also provides incentives in the form of assistance to the various categories of farmers for helping them in adopting horticulture as a way of life, through the centrally sponsored schemes such as: integrated development of horticulture through the Horticulture Technology Mission, RKVY, Schedule Caste Component Plan, Tribal Sub-Plan Special Central Assistance, Drought and Natural Calamities Relief and through the State sponsored schemes such as Hi-Tech horticulture by launching Pt. Deen Dayal Upadhyay Kisan Bagwan Samridh Yojna and HP High Density Plantation Project. In order to promote sub-tropical horticulture a new scheme namely Sub Tropical Horticulture, Irrigation and Valuation Addition (HPSHIVA) is being envisaged by the State government.

3.2 ENVIRONMENTAL STATUS

Horticulture encompasses a huge range of sectors and crops and some form of production occurs in almost every part of the State i.e. from subtropical to cold desert (dry temperate) region. This geographical variation has allowed a large range of crops to evolve and humans have been quick to exploit the full potential. Almost every crop within every location has evolved its own production system and all of them interact with the environment at some point. Mostly those interactions are negative since humans are still driven by the need to produce more. Furthermore, the social costs of horticultural development are also being realized due to higher impetus on commercial production systems as a result of knowledge of number of wild trees, shrubs and herbs which supplement the nourishment of people in the state is declining. Reasons for this decline are many including absence of market, lack of tested technology for cultivation and value addition as well as weak public policies promoting use of wild edibles. However, there are examples of positive interactions e.g. carbon sequestration especially through the adoption of perennial horticulture. Moreover, increase in tree cover by newly established fruit orchards is helping in soil and water conservation through the reduction of impacts of falling rain drops.

In the state, the interaction between horticultural production and the environment can be of three major categories: -

- Exploitation and degradation of natural resources (land and water).
- The generation of pollution from synthetic resources like energy, fertilizer and pesticides.
- The third category is environmental degradation through infrastructure development including climate change.

In the State environmental costs of horticultural development is now being increasingly realized. Horticulture land use expansion often involves encroachment on forest land. In our efforts to increase horticultural development, we have also encroached marginal lands and steep slopes and to enhance infrastructural facilities for better transportation/marketing, mismanagement of vegetation covers through unscientific removal, biomass burning, unstable geology, seismic disturbances by blasting for road construction activity and excessive water discharge from upper catchments resulted in large scale landslides which have created serious problems in the environment.

Water is most under-utilized and at the same time most abundant resource in the State. Despite the surplus of water resource, scarcity in the form of short supply of drinking water, predominance of rainfed farming is common. Status of other essential loses (drinking water and sanitation) and productive uses (irrigated farming) is grim. About 80% of the net sown area in the State is rainfed. Though water stress limiting productivity may not be true for high altitude areas, however, low level and erratic crop yields on slopes in mid and low hills are partly

due to non-availability of water at critical stages of crops. Incidences of reduced discharges and drying up of springs have been found increased in the recent past. Though there are no controversies on such trends, effectiveness of natural and human factors contributing to hydrological imbalances has emerged as contentious issue. Hydrological imbalances currently observed in the State are considered to be linked with large scale development which under the influence of geo-morphological forces in geologically active belts exacerbate the process of landslides and erosion. These factors apart from directly deteriorating the local environment have significant implications for the plains.

To keep pace with alarming increase in human population and their food demand farmers in the State are being forced to produce higher yields by adopting multiple and intensive cropping systems which necessitated more and more use of chemicals. Although, the consumption of fertilizers (0.8% of the country) and chemical pesticide (0.5% of the country) is meager in the State. However, indiscriminate use of these chemicals because of lack of knowledge has led to environmental degradation especially due to commercial horticulture based farming which has started impacting soil and water quality and hence necessary measures need to be taken in time.

In the State like other parts of country and world as a whole climate variability/ change has come upon us in relatively short space of time and is accelerating with alarming speed. Climate change is a portending issue not only for our time, but indeed for generations to come. The change in climate is causing adverse impacts on plants distribution, agriculture/ horticulture and various other aspects of environment. Rise in temperature increases evapo-transpiration and in drier regions leads to water stress causing yield reduction. In Himachal Pradesh the monsoon is expanding but the precipitation is decreasing. The quantum of snowfall and rainfall has gone down (winter rains in general have gone down sharply, summers have prolonged and winter have shortened). Rise in temperature has already impacted the yield and quality of apples in the state. In apple growing regions, effective chill units have decreased to the tune of 215.48 to 312.48 chill units over last thirty-one years. In stone fruit crops a meager decrease of 28.39 chill units has been noticed. However, there was an increase in accumulated Growing Degree Days (37.05-167.59) for mango crop. In subtropical low hill region production of major fruit mango is being greatly affected by frequent occurrence of frost.

In addition to this hail storms are causing extensive damage to crop and affecting the productivity. It has been noticed as one of the most feared weather phenomena as it has the potential to destroy plants, trees, crops, animals and human life upon impact if strong enough. Even small pieces of hail combined with strong winds can be damaging to vegetation especially crops. This can leave farmers who rely on this type of produce as one of their main sources of income to become financially devastated. In the last decade, Himachal Pradesh has been repeatedly battered by frequent hailstorms. In Northern region during last 35 years, hailstorms occurred during 20 years in Himachal Pradesh with maximum occurrence of 13 days during May 1994, followed by 8 days in March 1986. Also one day events of hailstorm occurrence were more common in Himachal Pradesh with maximum occurrence during the month of May. The probability of occurrence of hailstorms in Himachal Pradesh is 66-70 %. The inclement weather, heavy rainfall and hailstorm left many villages of high reaches of Shimla district in the State with ruined apple crop forcing the farmers to bear extensive loss. One of the glaring examples of such loss was recorded in some pockets of Kullu and Shimla with 30-40 percent damage to apple crop during the year 2016. The field surveys across the state estimated that the loss to apple crop till date due to hailstorms is over rupees 200 crores.

The average maximum and minimum temperature showed an increase since last thirty years at all major fruit growing areas, whereas, annual rainfall revealed an erratic trend. The drought in the kharif season of the year 2009 in the state is a glaring example that how climate variability can influence the crop production. The

studies which focused on agronomic impacts of climate change indicated that the irrigation potential is likely to decrease in the near future, particularly in the Indo-Gangetic plains with the fast melting of Himalayan glaciers. Besides, there would be competition for water use by other sectors and the situation will be more alarming in HP where 80% of the land is rainfed. In subtropical parts of the state it has been observed that small rivulets (Khad/nallha) which used to start flowing from mid-June to October are not flowing now even during peak rainy season. Evergreen (Barahamasi) khads and nallah have become barsatee khad/nallah and that too with half of the water what used to flow 25 years back. The water collecting points have either shifted up or dried. The changing climate has also affected the species composition in barren, scrub and grasslands. These lands used to serve as source of grazing for domestic animals are now covered with new invasive species like Lantana, Parthenium, Polygonum etc. The studies on land use change and its effect on water resources in Mid hills of Himachal Pradesh indicated that the area under vegetable, orchard and urban settlements has increased, whereas traditional agriculture and forest has decreased in the region during last 30 years.

3.3 PRESSURE STATE IMPACT RESPONSE MODEL FOR HORTICULTURAL ENVIRONMENT IN THE STATE

3.3.1 Strengths:

The major strengths of the horticulture sector in Himachal Pradesh are as follows:

- Presence of wide agro and microclimatic conditions in the state that provides an opportunity for the cultivation of large variety of temperate to sub-tropical horticultural crops (fruits, vegetables, flowers, etc.).
- Off season production of horticultural crops as compared to plains.
- Vast domestic market for mountain horticultural produce due to paucity of areas for the production of such fruits in the country.
- Well-developed institutional framework for the development of horticulture through research, extension, credit, marketing, processing and communication infrastructure with state of art facilities.
- Excellent transport facilities to supply crop products to the big wholesale markets like Delhi.
- Limited and judicious use of pesticides in the state. Thus, pesticide residues found in the fruits and vegetables grown in the state is far below the permissible limits for human consumption.
- Most of the horticulture crop production is organic by default.
- Adoption of ecofriendly packaging.
- Better quality of crop products as compared to plains because of mild growing seasons.

3.3.2 Pressures:

- Low irrigation potential of the state due to geographical constraints, consequently, most of the horticultural farming is rain fed contributing to low productivity.
- Increasing population as well as small and scattered landholdings.
- Shallow and sloppy land with more soil erosion.
- Unavailability of skilled labour
- Horticulture production is done mainly on marginal land having low soil fertility and water retentivity.
- Lack of microclimate level production technology.
- Practice of mono-cropping has reduced yield due to enhanced proneness to disease and pest attack
- Widespread and frequent occurrence of natural calamities such as drought, hail storms and frost events has exerted lot of pressure on better growing conditions for the crops
- Non-availability of quality planting material.
- Climate variability/change and its impact on horticulture crop production.

- A large number of old and senile plantations in many fruits (more than 40% orchards have passed their economic productive life)
- Inadequate production technology at the farm level
- A large number of old and senile plantations in many fruits (more than 40% orchards have passed their economic productive life)
- Poor quality of planting material (both the rootstock and scion)
- Long gestation period of existing varieties. Seedling rootstock comes to bearing only by 7 to 10 years after planting, reaching mature yield in 15 years. Clonally multiplied dwarfing rootstock will come to bearing in 2-3 years, reaching mature yield in 5 years
- The State has negligible pre-cooling facilities; similarly, integrated packaging and sorting facilities are non-existent. Also, the cold storage capacity is limited and concentrated in a few districts (Shimla and Mandi), and many districts do not have such facility (Lahaul, Chamba, etc.). This not only inhibits the development of a commercially viable cold supply-chain but also limits the growth of processing industry within the State.
- Inadequate availability of quality planting material is an important deterrent in the development of a sound horticulture industry in the State. It is of special significance, especially in fruit tree crops which have a long gestation period and effects are known only in later stages.
- Threat to survival of indigenous rare species and varieties of number of crops due to urbanization, overexploitation and other anthropogenic reasons.

3.3.3 Impacts:

- Likely increase in competition from foreign producers in the fruit trade, even in the domestic market after the World Trade Order becomes fully effective.
- Adverse impact on horticultural crops due to climate variability and change.
- Likely increase in the inter-state competition for marketing of horticulture produce as other hilly states have started commercial horticulture crop production.
- Likely change in the policy of the Central/State Governments for reduction in import duties and subsidies/support price for horticultural produce as a sequel to the global trading regime.
- Climate variability/ change has started impacting crop phenology and chilling requirements in temperate fruits and enhanced water stress especially on the horticulture industry.
- Unscientific use of scarce and costly resources i.e. water and fertilizers lead to either over or deficit fertigation. Excessive irrigation leach N below the root zone and reduces nutrient use efficiency. Secondly, excessive N nutrition increases vegetative growth and reduce fruit quality and storage potential. Despite these, the existing packages and practices in the state, (irrigation schedules, fertilizer doses, management practices, etc.) are for the traditional varieties.
- Injudicious use of chemicals has influenced bee keeping activities in the state.

3.3.4 Responses:

- Ample opportunities for the diversification of horticulture industry through introduction of high value fruit crops which have so far remained un-exploited due to different constraints, e.g., nut crops (walnut, pecan nut, hazelnut), cherry, red strains of pear, Kiwi fruit, small fruits (berries), oil yielding fruit crops like olive, amla (Indian Gooseberry), pomegranate, fig, etc.
- Opportunities for the accelerated production of fruit crops in dry land, rainfed areas by employing newly adapted technologies such as "in-situ" plantation of mango in the low hill regions.
- Enhancing availability and adoption of improved true-to-type, disease free, elite planting materials of horticulture crops by establishing a locally robust nursery industry.
- Adoption of drip irrigation system can provide multiple advantages in terms of improving the productivity and quality of produce, reducing labour cost, minimizing disease incidence and economizing on the use of fertilizers through fertigation.
- Promotion of high density plantations in valley areas having sufficient water resources.
- Adoption of natural/organic farming as a mitigation strategy to climate change may help in reducing the input cost and production of quality crop products and in enhancing environmental quality.
- Opportunities for the improvement of productivity and quality of fruit crops already under cultivation by introducing improved/standardized technologies.

Although in the foreseeable future, the domestic market will continue to be the main focus of the horticulture industry of H.P. yet opportunities do exist for exploring the market in the adjoining countries of SAARC, West Asian region and Middle East countries for the future export of Himachal fruits.

- Developing and commercialization of improved fruit tree cultivars.
- Standardize and certify planting materials by implementation of a system of inspection and certification.
- Training and capacity building of private sector (small scale) nurseries, organizing them into a nursery grower association
- Importing of true-to-type, disease free planting material (both root stocks and cultivars).
- Strengthening of post entry quarantine facilities and disease and pest surveillance.
- Establishing nursery using modern techniques in propagation.
- Training and capacity building of farmers, including study tours, workshops, vocational and academic training, preparation of technical advice module etc.
- Promoting Climate Resilient Technologies.
- Wide scope for value addition of horticultural commodities produced in Himachal Pradesh, through adopting efficient post-harvest management, packing and storage technologies for improving shelf life, reducing losses and increasing the marketing season/period in the year.
- Diversification of existing processing industry because of the wide range of fruits and vegetables

available for processing.

- There are opportunities for industry-linked horticulture production through suitable forward and backward link such as production for processing both for domestic and export markets.
- Irrigation and rainwater harvesting are seen as important requirements to meet the rainfall irregularities due to climate change.
- Planning and management of water resources based on hydrological units may help in reducing water stress in crops for enhancing crop production.
- Characterization of wild indigenous species and varieties with the help of advanced technology as DNA fingerprinting for the survival and conservation of indigenous rare species and varieties of crops.

In the state there is a need to focus on rain fed farming which constitute nearly 80% of the net cultivated area and is projected to be impacted more because of rising temperature and reducing rainfall. Furthermore, these are areas where the green revolution technologies made limited or no impact and wherein vast majority of the poor live and whose livelihoods are intimately linked to our ability to impact farming in these areas. There is considerable potential to enhance productivity of rain fed areas. Realizing this potential essentially hinges on our ability to reverse the process of degradation – processes that will contribute to institutionalize water conservation, reduced run-off and erosion. Thus, resource conservation issues represent an essential prerequisite to achieve enhanced productivity. Given the wide variations in soil, climate and socio-economic situations, it is obvious that these technologies have to evolve and spread considering local situations and in a participatory manner.

There is an urgent need to focus attention to sustainably increase productivity, enhance resilience and reduce/remove greenhouse gases (GHGs) and to have synergies between three pillars: productivity, adaptation and mitigation. Therefore, focused research on issues like: breeding varieties to heat and drought stress, information on impacts of climate change on pest dynamics, identification of sensitive stages of crops to weather aberrations, biotechnological approaches for multiple stress tolerance, development of crop simulation models for enabling regional impact, adaptation and vulnerability analysis and development of post-harvest produce storage systems which can meet the challenges of climate related risks. Various mitigation adaptation options like: resource conservation, ecofriendly disease-pest management strategies. natural farming and emphasis on recycling/usage of crop biomass as well as crop diversification, water harvesting and in-situ soil moisture conservation, introduction of efficient irrigation systems, weather based agro- advisory, crop insurance, improved agronomic practices for enhanced nutrient use efficiency, respectively can help us in combating climate change.

To achieve sustainable horticultural productivity and livelihood security in the state under changing environmental situations we have to increase income of the farmers per unit land and water by shifting from a crop, commodity and enterprise based agriculture to integrated multi-enterprise system. Integration of dairy, forestry, fisheries, mushroom cultivation, horticulture with dominant cropping system and agro-tourism based on conservation principals can help convert climate variability/change into opportunity and ensure livelihood security and environmental conservation on sustainable basis.

BIODIVERSITY AND ENVIRONMENT

CHAPTER-4

4.1 Concepts and Scope

Biological diversity or biodiversity refers to the diversity of life. It has been generally defined as the 'full variety of life on Earth'. More specifically, biodiversity is the study of the processes that create and maintain variations. It is the variability within and between all micro-organisms; plants and animals both wild and domesticated, and the ecological system in which they co-exist. It is concerned with the variety of individuals within populations, the diversity of species within communities, and the range of ecological roles within ecosystems. Biodiversity is the result of evolutionary plasticity of living organisms, and increased geometrically through perhaps 3.5 billion years, proliferating by trial and error, controlled by natural selection, filling almost every one of the habitable ecological niches created in a likewise evolving world environment.

The word biodiversity which is the abbreviated word for biological diversity appears to have come into prominence around 1980, when Norse and McManus (1980) first defined it. Its abbreviation into 'biodiversity' was apparently made by Walter G. Rosen in 1985 during the first planning meeting of the 'National Forum on Biodiversity' held at Washington DC in September 1986. The book entitled Biodiversity by Wilson and Peters (1988) introduced the notion of biodiversity and popularised this word among the scientific community as well as the public.

United Nations General Assembly has declared 2011-2020 as “United Nations Decade of Biodiversity”. The strategic goals incorporated under the declaration include, preventing the extinction of endangered species, halving the loss of forests and natural habitats, sustainable fishing, halting ocean fertilisation, saving coral reefs, reducing pollution, increasing protected terrestrial and inland water areas from 12% to 17% and increasing protection for marine and coastal areas from 1% to 10%. Also included is a provision requiring governments to reclaim 15% of degraded lands, in an attempt to get nations to expand from conservation into restoration. A land mark step in conservation of bio-resources was initiated on December 29, 1993 when 'Convention on Biological Diversity' came into force with objectives of conservation of biological diversity, sustainable use of the components of biological diversity and equitable sharing of the benefits arising out of the utilization of its genetic resources.

Human society relies on biological resources and their diversity, and the ecosystems that sustain them, to provide essential goods and services. Biodiversity, besides its ecological and intrinsic values, represents a considerable socioeconomic and monetary asset as well. Values attached to biodiversity can be classified into three categories: Productive use value, Consumptive use value and Indirect values. Productive use value is a value assigned to products that are commercially harvested for exchange in formal markets and is therefore the only value of biological resources that is reflected in national income accounts. Products such as fuel wood, timber, fish, animal skins, musk, fodder, fruits, cereals and medicinal plants come under this category. In 1994-95, the share of agriculture, forestry, and fisheries in India's gross domestic product was nearly 30% or 736.88 billion rupees.

On the other hand consumptive use value is the value placed on natural products that are consumed directly, i.e. goods do not enter the normal channels of trade. The value of such goods can be considerable. A significant number of such non-timber forest products as soft broom grass and cane fall under this category. Indirect values are related primarily with the functions of ecosystems, do not normally appear in national accounting systems, but they may far outweigh consumptive and non-consumptive values. Maintenance of ecological balance and prevention of soil erosion are examples of such indirect values.

Biodiversity is our natural wealth. Its conservation is important in both economic and ethical reasons. It provides us goods and services fundamental to our survival, including clean air, fresh water, medicines and shelter. It enables us to adapt to changing needs and circumstances. For example, forested ecosystems provide us fuel, medicine, construction material and wildlife habitat; wetlands and riparian areas protect water quality and aquatic life; oceans provide food and regulate climate; and agro-ecosystems produce food. Biodiversity also provides people with recreational, psychological, emotional and spiritual enjoyment. Some people believe that we should protect and restore biodiversity because of its benefits to mankind, while others believe that it is our moral obligation to care about biodiversity simply because all species have right to live and have value in the nature, whether or not we understand their benefits to human.

India is one of the recognized megadiverse countries of the world. Comparative account of India's position on species diversity shows that it is well placed in several groups. In terms of species richness, India ranks seventh in mammals, ninth in birds and fifth in reptiles. In terms of endemism of vertebrate groups, India's position is tenth in birds with 69 species, fifth in reptiles with 156 species and seventh in amphibians with 110 species. India's share of crops is 44% as compared to the world average of 11%. India also has 23.39% of its geographical area under forest and tree cover.

The faunal and floral diversity in Himachal Pradesh is very rich and diversified, primarily due to varied climatic conditions ranging from tropical in the foothills to arctic environment in the trans-Himalayan region. Moreover, historical influx of fauna from adjacent biogeographical regions and subsequent speciation in relation to local environment has greatly enriched the animal resources of the area. There is a pronounced dominance of Palaearctic and endemic animals above timber line (3000 m), and largely Oriental and some Palaearctic and some Ethiopian elements at lower and middle altitudes.

Himachal Pradesh is mainly a hilly state of the Indian Himalayas lying between 30º22' to 33º 12' North latitude and 75º 47' to 79º 04' East longitude. The physiography of this state is almost mountainous with elevations ranging from 350 to 6500 metres above mean sea level and total area of the state is 55,673 sq km. The State lies in the lap of the Indian Himalayas which are one of the most magnificent complex folded and youngest mountain systems in the world and form a physical barrier between the high plateaus of Tibet and Central Asia, and the Indian plains.

This hilly state is divided by a general increase in elevation from West to East and from South to North into four biogeographical zones viz., Shiwalik or Outer Himalayas, Lower or Lesser Himalayas, Higher or Greater Himalayas and Trans Himalayas. The Shiwalik ranges are the southern most zone of about 40 to 60 km width, comprising several highly eroded low ridges.

A zone of medium to high ranges (about 80 km wide), the Lesser Himalaya runs North of the Shiwalik and parallel to the main range. The Great Himalayan ranges lie just towards the North of the Chandrabhaga river in Lahaul-Spiti and Pangi region of Himachal Pradesh. This range is nearly 24 km wide and comprises the Great peaks rising up to an elevation of over 6000 metres amsl. Spiti area of the state constitutes a separate and distinct unit, i.e. Trans Himalaya. Moreover, there are five major mountain ranges in the state viz., Shiwalik, Dhauladhar, Pir Panjal, Greater Himalaya and Zanskar range. Varied physiographic and climatic factors have given rise to the diverse natural ecosystems/habitats, namely, forests, grasslands and pastures, river, lake and wetlands, glaciers etc. in this region.

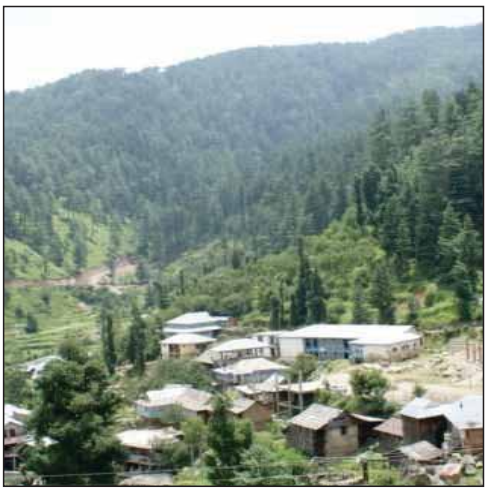
Himachal Pradesh is also bestowed with several natural freshwater and brackish water lakes, and a few large man made reservoirs. Natural lakes are distributed among different climatic zones of Himachal Pradesh. Some of prominent among these are: Bhrigu, Dashair, Nako, Renuka, Rewalsar, Prashar, Khajjiar, Manimahesh, Chandertal, Surajtal, Kareri, Mani Mahesh, Lam Dal, Mahakali etc. Some large reservoirs have also been formed due to damming of rivers viz., Pong and Govind Sagar. Besides five major rivers which flow through the state viz., Yamuna, Sutlej, Beas, Ravi and Chenab, there is an intricate network of seasonal and perennial torrential streams. Himalayan rivers do not depend on the

monsoon rain since they are fed by the melting snow in Himalaya. Though the volume of water may vary, they never dry up completely. Of the five major rivers flowing through Himachal Pradesh, Sutlej, Beas, Ravi and Chenab belong to Indus system, whereas, Yamuna belongs to Ganges system.

Rich diversity of animals in Himachal Pradesh is reflected by the presence of around 3,000 described faunal species belonging to different groups as compared to around 89,500 animal species of the country. Himachal Pradesh has a small geographical area of 55,673 square kilometres which is only 1.7% of India but it harbours more than 7 % of the total fauna of the country. Invertebrates constitute 88.4 % and vertebrates 11.6 % of the fauna in Himachal Pradesh. Insects and other arthropods form a predominant group among invertebrates, whereas vertebrates are dominated by birds comprising more than 600 species.

The forest wealth of the state consists of diversified flora comprising higher plants, ferns, mosses, fungi and lichens. Coniferous forest dominates the mid and high hills with oaks in depressions. In the foothills forests are dry deciduous with Sal as the predominant species. In dry localities Chir pine occur as the dominant species. The state is also rich in medicinal herbal plants and people in some villages are dependent on the medicinal herbs for their livelihood. Domesticated animal biodiversity in Himachal Pradesh is also very rich. There are a number of breeds of sheep, goats and ponies, which are also able to withstand hazards of mountainous areas. Some of these are Bhadarwah (Gaddi), Rampur Bushairi, Biangi, Mewati and Khand, among sheep; Chamba, Gaddi, Pashmina and Chegu, among goats; Spiti and Chummarti among ponies.

Recently, the state of Himachal Pradesh has made a rapid progress on many fronts due to which several animal and plant species have come under tremendous stress as a result of industrial expansion, deforestation, increasing human population, pesticides, pollution, construction of various river valley projects etc. Many natural habitats have been over-exploited, degraded and even destroyed as a result of which many animal and plant species in the area are highly endangered and conservation of already depleted biological resources is perhaps the only option left to overcome this situation.



4.2 IMPORTANCE OF BIODIVERSITY

4.2.1 Cultural Heritage

Throughout history, societies have put great value on physical features of their environment. In developed and developing countries, a diversity of ecosystems is a source of aesthetic, historic, religious, and ritualistic values. Species diversity assures people of national and state symbols, and many such symbols are protected. Genetic diversity continues in part because of the cultural value of plants and animals. Gardeners around the world share seed material ensuring genetic survival.

4.2.2 Benefits to Agriculture and Harvested Resources

In agriculture, a diversity of ecosystems, species, and genetic material provides increased amounts and quality of yields. In a world where population is rapidly increasing, assuring a continued increase in harvested resources is essential. Diversity in an agroecosystem provides habitat for predators of crop pests and breeding sites for pollinators. Diversity of species can be a buffer against economic failure and can also play an important role in pest management. Further, the use of genetic materials by breeders has attributed to at least 50 percent of the increase in agriculture yields and quality.

4.2.3 Benefits to Ecological Processes

Knowledge of the relationship between diversity and ecological processes is fragmentary, but it is clear that diversity is crucial to the functioning of all major life processes, for diversity helps maintain productivity and buffers ecosystems against environmental change. Diversity within ecosystems is essential for protective, productive, and economic benefits. Species diversity is necessary for a stable food web and diversity of genetic material allows species to adapt to changing environmental conditions.

4.2.4 Benefits to Recreation and Tourism

Millions of people worldwide derive benefits from recreation and tourism provided by biological diversity. Without diverse ecosystems, countries would lose tremendous amounts of foreign exchange. Without wilderness areas, national parks, or national forests, city dwellers would have no place to "escape" the daily pressures. Species diversity is essential to the millions of wildlife photographers, bird lovers, and plant and animal watchers and without genetic diversity, horticulturists, gardeners, animal breeders, and anglers would find little enjoyment in their avocations.

4.2.5 Benefits to Research

Research may hold answers to many of the questions facing this complex world. The results of research on the patterns and processes of temperate forests have provided methods for sustainable management of those ecosystems. Knowledge of tropical rain forests will result in similar strategies. Without diversity of species, researchers would not have the needed plant/animal material to develop many vaccines, intravenous fluid, or other medicines. The potential for further advancement has not been fully realized, yet a loss of species diversity will adversely affect future research. Protection of genetic diversity is equally essential, because materials from plants and animals have provided valuable knowledge on viruses, immunology, and disease resistance.

4.3 THREATS TO BIODIVERSITY AND ITS CONSERVATION

Knowledge of the relationship between diversity and ecological processes is fragmentary, but it is clear that diversity is crucial to the functioning of all major life processes, for diversity helps maintain productivity and buffers ecosystems against environmental change. Diversity within ecosystems is essential for protective, productive, and economic benefits. Species diversity is necessary for a stable food web and diversity of genetic material allows species to adapt to changing environmental conditions.

Biodiversity loss is one of the world's most pressing crises and there is growing global concern about the status of the biological resources on which so much of human life depends. The estimated current species extinction rate is between 1,000 and 10,000 times higher than it would naturally be. Many species are declining to critical population levels, important habitats are being destroyed, fragmented and degraded, and ecosystems are being destabilized through climate changes, pollution, invasive species, and direct human impacts. At the same time, there is also growing awareness of how biodiversity supports livelihoods, allows sustainable development and fosters co-operation between nations. This awareness is generated through products such as the IUCN Red List of Threatened Species.

Traditional and substantial dependence on biodiversity for fodder, fuel wood, timber and minor forest produce has been an accepted way of life for the rural population that accounts for nearly 74 percent of India's population. With radical demographic changes, the land to man ratio and forest to man ratio has rapidly declined. The lifestyles and the biomass resource needs having remained unchanged, the remnant biodiversity has come under relentless pressure of encroachment for cultivation, and unsustainable resource extraction rendering the very resource base unproductive and depleted of its biodiversity. Today this diversity of life is threatened by human activities, although the exact rate of species loss is difficult to ascertain. These activities are unabated human population growth, overexploitation of resources, pollution, and global climatic change. Disappearance of species is not an aberrant process in the course of time.

IUCN Red List Categories:

Extinct (EX): A taxon is Extinct when there is no reasonable doubt that the last individual has died.

Extinct In The Wild (EW): A taxon is Extinct in the wild when it is known only to survive in cultivation, in captivity or as a naturalized population (or populations) well outside the past range.

Critically Endangered (CR): A taxon is Critically Endangered when it is facing an extremely high risk of extinction in the wild in the immediate future, as defined by any of the criteria.

Endangered (EN): A taxon is endangered when it is not Critically Endangered but is facing a very high risk of extinction in the wild in the near future, as defined by any of the criteria.

Vulnerable (VU): A taxon is Vulnerable when it is not Critically Endangered or Endangered but is facing a high risk of extinction in the wild in the medium-term future, as defined by any of the criteria.

Lower Risk (LR): A taxon is Lower Risk when it has been evaluated, does not qualify for any of the threatened categories Critically Endangered, Endangered or Vulnerable or Data Deficient (LR/nt- near threatened, Lr/lc- least concerned, LR/cd- conservation dependent).

Near Threatened (NT): A taxon is Near Threatened when it has been evaluated against the criteria but does not qualify for Critically Endangered, Endangered or Vulnerable now, but is close to qualifying for, or is likely to qualify for, a threatened category in the near future.

Least Concern (LC): A taxon is Least Concern when it has been evaluated against the criteria and does not qualify for Critically Endangered, Endangered, Vulnerable or Near Threatened. Widespread and abundant taxa are included in this category.

Data Deficient (DD): A taxon is Data Deficient when there is inadequate information to make a direct, or indirect, assessment of its risk of extinction based on its distribution and/or population status.

Not Evaluated (NE): A taxon is Not Evaluated when it is has not yet been assessed against the criteria.

Endemics (E): Species restricted to India.

Extinction rates far higher than the normal background rates are resulting in rapid loss of biodiversity. By losing species we are losing potential contributors to future food medicine and valuable links in natural and biological cycles. Although extinction is a natural phenomenon, fossil records show that on an average one species dies out every 100 years. During the last 200 years the rate of extinction has been at least 40 times greater than this. The main causes of extinction are habitat loss and habitat degradation. Changes in land use patterns had a detrimental impact on habitats, which have been fragmented and reduced in extent and diversity.

As per the IUCN Red List (2008), India has 413 globally threatened faunal species, which is approximately 4.9% of the world's total number of threatened faunal species. These include 53 species of mammal, 69 birds, 23 reptiles and 3 amphibians. India contains globally important populations of some of Asia's rarest animals, such as Asiatic Lion, the Bengal Tiger, and the Indian White-Rumped Vulture. The Indian White-Rumped Vulture suffered almost extinction situation due to feeding on the carrion of diclofenac-treated cattle. At least 10 percent of the country's recorded wild flora and possibly the same percentage of its wild fauna are estimated to be in threatened list while many of them are on the verge of extinction.

4.3.1 Major Threats to Biodiversity

Many species are declining to critical population levels, important habitats are being destroyed, fragmented and degraded, and ecosystems are being destabilized through climate change, pollution, invasive species and direct human impacts.

4.3.1.1 Habitat Loss and Degradation

The most pervasive threat to birds, mammals and plants, is habitat loss and degradation, affecting 89% of all threatened birds, 83% of the threatened mammals assessed. Agricultural activities (including crop and livestock farming, and timber plantations), extraction activities (mining, fisheries, logging and harvesting), and development (human settlements, industry and associated infrastructure) are the three main causes of habitat loss. Agricultural activities affect bird species (70% of all), but surprisingly, only 92 (13%) of the threatened mammals.

4.3.1.2 Exploitation:

Exploitation, including hunting, collecting, fisheries and fisheries bycatch, and the impacts of trade in species and species' parts, constitutes a major threat for birds (37% of all), mammals (34% of all), and trade affects 13% of both threatened birds and mammals.

4.3.1.3 Alien Invasive Species:

Alien invasive species are a significant threat, affecting (30%) of all threatened birds. The commonest cause of extinction of bird species since the start of 19th century, especially those on islands, is the introduction of alien invasive species such as the black rat.

4.3.1.4 Disturbance, persecution and uprooting, including deliberate eradication of species considered to be pests.

4.3.1.5 Incidental take, particularly the drowning of aquatic reptiles and mammals in fishing nets.

4.3.1.6 Disease, both exotic and endemic, exacerbated by the presence of large number of domestic livestock or introduced plant species.

4.3.1.7 Limited distribution, which may compound the effects of other factors. In the majority of cases individual species are faced by several of these threats operating simultaneously, and it is often difficult or impossible to identify with confidence the primary cause of decline. However, the major category of threat, which affects 76% of species, is habitat loss and modification frequently due to cultivation and settlements.

4.3.2 Conservation Measures

Following conservation measures can be useful for continuous survival of threatened species in Himachal Pradesh:

1. Development of national plans, strategies or programmes for conservation and sustainable use of biodiversity and integrating these into relevant sectoral or cross-sectoral plans, programmes and policies.
2. Multiplication and breeding of threatened species through modern techniques of tissue culture and biotechnology.
3. Protection of domesticated plant and animal species in order to conserve indigenous genetic diversity.
4. Development of ex-situ measures for biodiversity conservation, as a complement to in-situ approaches.
5. Conservation of microorganisms, which help in reclamation of wastelands and revival of biological potential of land.
6. Restriction on introduction of exotic species without adequate investigations.
7. By establishing database at various levels to document support for protecting traditional skills and knowledge for conservation.
8. To establish conservation parks for the rare, endemic document local resources and support for threatened species.
9. Inventorisation and monitoring of components of biodiversity and of processes adversely impacting it; developing and strengthening of in-situ mechanisms for biodiversity conservation both within and outside protected areas.
10. Restoration of degraded ecosystem and recovery of endangered species.
11. Adopting measures to avoid and minimize adverse impacts on biodiversity.
12. Encourage capacity building in the field of taxonomy, wildlife management and conservation.
13. Strengthen ongoing conservation measures on biodiversity.
14. Encourage propagation and conservation of lower animals like insects and other invertebrates.
15. Maintenance of corridors between different nature reserves for the possible migration of species in response to climate, or any other disturbing factor.

16. Rehabilitation of rural poor/tribals displaced due to creation of protected areas.

17. Protection and sustainable use of genetic resources/germplasm through appropriate laws and practices.

18. Control of over-exploitation through local stakeholders and other agencies.

19. Adopting economically and socially sound measures that act as incentives for conservation and sustainable use of components of biodiversity.

20. Facilitating access to genetic resources on mutually agreed terms and prior informed consent, and taking measures for fair and equitable sharing of benefits arising from utilisation of the resources thus transferred, under

Convention on Biological Diversity and Indian Biological Diversity Act.

21. Facilitating access to and transfer of technology, including biotechnology to other parts under fair and most favourable terms.

22. Facilitating exchange of information relevant to biodiversity.

23. Promoting scientific and technical co-operation among Himalayan researchers.

24. Consideration of a protocol for safe transfer, handling and use of living modified organisms resulting from biotechnology.

25. Providing liberal funds for animal biodiversity related programmes and projects.

26. There is a need to undertake these programmes extensively among rural people particularly women, farmers, tribal, graziers and shepherds.

27. Developing educational and public awareness programmes with respect to conservation and sustainable use of biodiversity.

4.3.3 Biological Diversity Act and Conservation of Biodiversity

The Biological Diversity Act-2002 covers conservation, use of biological resources and associated knowledge occurring in India for commercial or research purposes or for the purposes of bio-survey and bio-utilisation. It provides a framework for access to biological resources and sharing the benefits arising out of such access and use. The Act also includes in its ambit the transfer of research results and application for intellectual property rights (IPRs) relating to Indian biological resources.

The Act stresses on conservation of bio-resources for sustainable use and the funds for these two activities will be generated by access and benefit sharing provisions. Involvement of common stakeholders in the form of Biodiversity Management Committees (BMCs) formed at the local bodies like Gram Panchayats, Block level, Zila Parishad level, Nagar Panchayats, Municipal Councils and Municipal Corporations is the basic idea for association of common masses in conservation of vast bio-resources of the country.

In exercise of powers conferred by Section 38 of the Biological Diversity Act, 2002 (18 of 2003), The Ministry of Environment and Forests, Govt. of India in consultation with the Govt. of Himachal Pradesh, has notified the species of plants and animals as listed below, which are on the verge of extinction, and prohibit or regulate the collection, thereof, subject to the conditions specified in the Annexure to the notification, for the State of Himachal Pradesh.

Notified threatened species of Himachal Pradesh

Plant Species	*Animal Species*
I. Aconitum deinorrhizum Stapf (Indian Aconite, Mohra)	*I. Murina grisea Peters (Peter's Tube-nosed Bat)*
ii. Aconitum heterophyllum Wall (Atish, Patish)	*ii. Cervus duvaucelii (Cuvier) (Swamp Deer)*
iii. Aconitum violaceum Jacq (Meetha Morha)	*iii.Capra falconeri (Wagner) (Markhor)*
iv. Nardostachys grandiflora DC (Jatamansi)	*iv. Moschus chrysogaster (Hodgson) (Musk Deer)*
v. Dactylorhiza hatagirea D. Don (Hath-Panja)	*v. Capricornis sumatraensis Hodgson (Mainland Serow)*
vi. Taxus wallichiana Zucc (Himalayan Yew, Rakhal)	*vi. Cervus elaphus hanglu Linnaeus (Kashmir Stag)*
vii. Eremostachys superba Royle ex Benth (Gajar Mula)	*vii. Gyps bengalensis (Gmelin) (White-rumped Vulture)*

The details of faunal and floral biodiversity of the State are as follows:

4.4 FAUNAL DIVERSITY

India is situated at the tri-junction of the Afro-tropical, the Indo-Malayan and the Paleo-Arctic realms, which display significant biodiversity. Being one of the 17 identified megadiverse countries, it is home to 8.58 per cent of mammalians, 13.66 per cent of avians, 7.91 per cent of reptilians, 4.66 per cent of amphibians, 11.72 per cent of fish, and 11.80 per cent of plant species documented so far. From the biodiversity standpoint, India has some 59,353 insect species, 2,546 fish species, 209 amphibian species, 456 reptile species, 1,232 bird species and 390 mammal species, of which 18.4 per cent are endemic and 10.8 per cent are threatened.

Out of total 89,500 animal species of the country, Himachal Pradesh possesses a little more than 7 % of the total fauna. This shows richness of the faunal resources of the State considering its small geographical area which is only about 1.7 % of the country. Insects and other arthropods form a predominant group among invertebrates, whereas vertebrates are dominated by birds comprising more than 600 species.

Number of described faunal species

Taxonomic Group	No. of Species		
	World	**India (% in India)**	**Himachal**
PROTISTA Protozoa	31250	2577 (8.24)	89
Total (Protista)	**31250**	**2577 (8.24)**	**89**
ANIMALIA			
Mesozoa	71	10 (14.08)	-
Porifera	4562	486 (10.65)	01
Cnidaria	9916	842 (8.49)	01
Ctenophora	100	12 (12)	01
Platyhelminthes	17500	1622 (9.27)	-
Nemertinea	600	-	-
Rotifera	2500	330 (13.20)	-
Gastrotricha	3000	100 (3.33)	-
Kinorhyncha	100	10 (10)	-
Nematoda	30000	2850 (9.5)	127
Nematomorpha	250	-	-
Acanthocephala	800	229 (28.62)	-
Sipuncula	145	35 (24.14)	-
Mollusca	66535	5070 (7.62)	-
Echiura	127	43 (33.86)	-
Annelida	12700	840 (6.61)	50
Onychophora	100	1 (1)	-
Arthropoda	**987949**	**68389 (6.90)**	
Crustacea	35534	2934 (8.26)	04
Insecta	867391	59353 (6.83)	1544
Odonata Lepidoptera (Butterflies) Lepidoptera (Moths) Hemiptera Hymenoptera Dermaptera Coleoptera Plecoptera Mantodea Orthoptera Diptera Ephemeroptera	6000 142500 80000 120000 2000 350000 2100 2310 17250 100000 2200	499 15000 6500 10000 320 15500 113 162 1750 6093 106	77 268 184 382 319 30 187 20 07 50 14 06
Arachnida	73440	(7.9)	107
Pycnogonida	600	(2.67)	-
Pauropoda	360	-	-
Chilopoda	3000	100 (3.33)	-
Diplopoda	7500	162 (2.16)	-
Symphyla	120	4 (3.33)	-
Merostomata	4	2 (50)	-
Phoronida	11	3 (27.27)	-
Bryozoa (Ectoprocta)	4000	200 (5)	01
Endoprocta	60	10 (16.66)	-
Brachiopoda	300	3 (1)	-
Pogonophora	80	-	-
Praipulida	8	-	-
Pentastomida	70	-	-
Chaetognatha	111	30 (27.02)	-
Tardigrada	514	30 (5.83)	-
Echinodermata	6223	765 (12.29)	-
Hemichordata	120	12 (10)	-
Chordata	**48451**	**4952 (10.22)**	921
Protochordata (Cephalochordata+Urochordata)	2106	119 (5.65)	-
Pisces	21723	2546 (11.72)	104
Amphibia	5150	209 (4.06)	17
Reptilia	5817	456 (7.84)	14
Aves	9026	1232 (13.66)	657
Mammalia	4629	390 (8.42)	129
Total (Animalia)	**1196903**	**868741 (7.25)**	**2757**
Total (Protista+Animalia)	**1228153**	**89451 (7.28)**	**2846**

Himachal Pradesh exhibits zone specific affinities and therefore is an admixture of fauna from Palaearctic and the Oriental realms. Zone wise presence of some important faunal groups is as under:

I. Subtropical Biome:

Animals: Rhesus Monkey, Nilgai, Sambhar, Chital, Barking Deer, Ghoral, Wild Boar, Himalayan Black Bear, Indian Crested Porcupine, Jackal, Red Fox, Jungle Cat, Leopard Cat.

Birds: Red Jungle Fowl, Indian Peafowl, Pheasants, Golden backed Woodpecker, Laughing and Whistling Thrushes, White cheeked Bulbul, Black Partridge.

Reptiles: Common Rat Snake, Cobra, Russell's Viper, Krait, Python, Monitor Lizards.

II. Temperate Biome:

Animals: Ghoral, Barking Deer, Musk Deer, Himalayan Tahr, Leopard, Himalayan Black Bear and Brown Bear, Stone Marten, Yellow throated Marten, Himalayan Weasel, Asiatic Jackal, Langur, Rhesus Monkey.

Birds: Thrushes, Himalayan Bulbul, Nuthatch, Jays, Monal, Kaleej Pheasant, Bearded Vulture, Himalayan pied Woodpecker.

III. Alpine Biome:

Animals: Snow Leopard, Bharal, Ibex, Musk Deer, Marmots.

Birds: Monal, Snow Cock, Snow Pigeon, Red billed Chough, Horned Lark, Tibetan Snow Grouse.

IV. Cold Desert Biome:

Animals: Snow Leopard (Uncia uncia), Tibetan Argali (Ovis ammon), Tibetan Gazelle (Procapra piticaudata), Hangul or Kashmir Stag (Cervus elaphus hanglu)

Birds: Chukor, Snow Cock, Tibetan Snow Finch, Horned Lark.

4.4.1 Mammals

One of the most fascinating features of the Indian biodiversity is its mammalian fauna, which includes the species as large as whales, elephants, rhinoceroses and tigers, and as small as shrews, mice and bats. The term 'mammals' refers to animals possessing mammary or milk glands producing milk for nourishing their young ones, and another feature include the presence of hairs on the body at least during some period of their life cycle.

The mammalian fauna of the world includes 4629 species belonging to 1135 genera, 136 families and 26 orders (Wilson and Reeder, 1993). Of these, 390 species belonging to 180 genera, 42 families and 13 orders are found in India. Another 13 orders are found in our country. Out of 180 genera, 61 are monotypic and 105 are represented in our country by a single species. Of the 390 species, 175 are threatened with extinction to various levels, and on that basis 75 have been listed in Schedule I, 73 in Schedule II, 8 in Schedule III and 19 in Schedule IV of the Wild Life (Protection) Act 1972 (Agrawal, 1998). Out of 107 species of mammals found in the state, 21 have been included in Schedule I of the Indian Wildlife (Protection) Act, 1972.

Mammalian fauna of Himachal Pradesh

S. No.	Systematic List	Common Name	Conservation Status
	Order: Insectivora		
	Family: Soricidae		
1.	*Soriculus nigrescens*	Himalayan Shrew	
2.	*Crocidura attenuata*	Grey Shrew	
3.	*Suncus murinus* (Linnaeus, 1776)	Grey Mask Shrew	CAMP: DD (Globally)
4.	*Chimarrogale himalayica* (Gray, 1842)	Himalayan Water Shrew	CAMP: DD (Globally)
	Family: Erinaceidae		
5.	*Hemiechinus collaris* (Gray, 1830)	Indian Long eared Hedgehog	IWPA: Schedule V
6.	*Hemiechinus micropus*	Pale Hedgehog	
	Order: Chiroptera		
	Family: Pteropodidae		
7.	*Cynopterus sphinx*	Short-nosed Fruit Bat	IWPA: Schedule V
8.	*Pteropus giganteus* (Brunnich, 1782)	Indian Flying Fox	CITES Appendix ii
9.	*Rousettus leschenaulti* (Desmerest 1820)	Fulvous Fruit Bat	CAMP: DD (Globally)
	Family: Vespertilionidae		
10.	*Hesperopterus tickelli*	Tickell's Bat	IWPA: Schedule V
11.	*Kerivoula picta*	Painted Bat	
12.	*Miniopterus schreibersii* (Kuhl)		
13.	*Myotis siligorensis* (Horsefield)		
14.	*Barbastella leucomelas* (Cretzschmar, 1862)	Eastern Barbestella	CAMP: DD (Globally)
15.	*Eptesicus serotinus* (Schreber, 1774)	Serotine	CAMP: DD (Globally)
16.	*Myotis blythi* (Tomes, 1757)	Lesser Mouse Eared Bat	CAMP:DD (Globally)
17.	*Myotis formosus* (Hodgson 1835)	Hodgsons Bat	CAMP: DD (Globally)
18.	*Myotis muricola* (Gray, 1846)		CAMP : DD (Globally)
19.	*Myotis mystacinus* (Kuhl, 1870)	Whiskered Bat	CAMP: DD (Globally)
20.	*Nyctalus montanus*	Lesser Noctule	
21.	*Nyctalus noctula* (Schreber, 1774)	Common Noctule	CAMP: DD (Globally)
22.	*Pipistrellus babu* Thomas, 1950	Babu Pipistrelle	NE
23.	*Pipistrellus coromandra* (Gray, 1838)	Indian Pipistrelle	CAMP: DD (Globally)
24.	*Pipistrellus mimus* Wroughton 1889	Indian Pygmy Pipistrelle	NE
25.	*Pipistrellus ceylonicus*	Kelaart's Pipistrelle	
26.	*Pipistrellus darmeri*	Darmer's Bat	
27.	*Plecotus auritus*	Brown big-eared Bat	CAMP: DD (Globally)
28.	*Scotophilus heathi*? (Horsfield, 1831)	Asiatic Greater yellow Bat	CAMP : DD (globally)
29.	*Scotophilus kuhlii* Leach, 1821	Asiatic Lesser yellow Bat	CAMP: DD(Globally)
30.	*Murina tubinaris* (Scully, 1881)	Scullys tube nosed Bat	CAMP; Vurnerable (Nationally)
	Family: Hipposideridae		
31.	*Hipposideros armiger* Hodgson		
32.	*Hipposideros fulvus*	-	
	Family: Megadermatidae		
33.	*Megaderma lyra*	Indian False Vampire	
	Family: Rhinolophidae		
34.	*Rhinolophus ferrumequinum*	Greater Horse-Shoe Bat	
35.	*Rhinolophus lepidus*	Blyth's Horse-Shoe Bat	
36.	*Rhinolophus rouxii* Temminck, 1853	Rufuous Horses-hoe Bat	CAMP: DD (Globally)
37.	*Rhinolophus luctus* Temminck	Great Eastern Horse-Shoe Bat	
38.	*Rhinolophus affinis* Horsefield		
	Family: Rhinopomatidae		
39.	*Rhinopoma hardwickei*	Hardwicke's Bat	
	Order: Primates		
	Family: Cercopithecidae		
40.	*Macaca mulatta* (Zimmermann, 1780)	Rhesus Macaque	CITES: Appendix II, IWPA: Schedule II
41.	*Semnopithecus entellus* (Dufresne, 1797)	Common Langur	CITES: Appendix I, IWPA: Schedule II
	Order: Carnivora		
	Family: Canidae		
42.	*Canis aureus* Linnaeus, 1758	Jackal	CITES: Appendix III, IWPA: Sch II
43.	*Canis lupus* Linnaeus, 1758	Wolf, Hin Bheria	CITES: Appendix I, IWPA: Sch I
44.	*Vulpes bengalensis* (Shaw 1800)	Indian Fox, Hin Lumri, lom	CITES: Appendix III, IWPA: Sch I
45.	*Vulpes vulpes* (Linnaeus, 1758)	Common Red Fox	CITES: Appendix III, IWPA: Sch II
46.	*Cuon alpinus*	Indian Wild Dog	IWPA: Schedule II
	Family: Herpestidae		
47.	*Herpestes edwardsii* (Geoffrey Saint Hilaire, 1882)	Common Indian Mongoose	CITES: Appendix III, IWPA: Sch IV
48.	*Herpestes javanicus*	Small Indian Mongoose	CITES: Appendix III, IWPA: Sch IV

	Family: Viverridae		
49.	*Peguma larvata* (Hamilton-Smith 1827)	Himalayan Palm Civet	CITES: Appendix III, IWPA: Sch II
50.	*Paradoxuras harmphroditus* (Pallas, 1717)	Common Palm Civet	IWPA: Sch II
51.	*Vivvricula indica* (Dasmerest 1804)	Small Indian Civet	CITES: Appendix III, IWPA: Sch II
	Family: Mustellidae		
52.	*Amblonyx cinereus* (Illiger 1815)	Small Clawed Otter, Hin Ud	CITES: Appendix II, CAMP: NE (nationally)
53.	*Lutra lutra* (Linnaeus 1758)	Common Otter	CITES: Appendix I, IWPA: Sch II
54.	*Lutrogale perspiciliata* (Geoffroy Saint- Hilaire, 1826)	Smooth coated Otter, Hin Ud bilao	CITES: Appendix II, IWPA: Sch II
55.	*Mellivora capensis* (Schreber, 1776)	Honey badger	IWPA: Sch I
56.	*Martes flavigula* (Boddaert, 1785)	Yellow throated Marten Hin Tuturala	CITES: Appendix III, IWPA: Sch II
57.	*Martes foina* (Erxieben, 1777)	Beach Marten	IWPA: Sch II
58.	*Mustella altica* Pallas 1811	Mountain Weasal	CITES: Appendix III, IWPA: Sch II
59.	*Mustella kathia* Hodgson , 1835	Yellow-bellied Weasel	CITES: Appendix III, IWPA: Sch II
60.	*Mustella sibirica* Pallas 1773	Siberian Weasel	CITES: Appendix III, IWPA: Sch II
	Family: Ursidae		
61.	*Ursus arctos*	Brwon Bear	CITES: Appendix I, IWPA: Sch I
62.	*Ursus thibetarus*	Asiatic Black Bear	CITES: Appendix I, IWPA: Sch II
	Family: Hyaenidae		
63.	*Hyaena hyaena*	Striped Hyaena	IWPA: Schedule III
	Family: Felidae		
64.	*Prionailurus bengalensis* (Kerr, 1792)	Leopard Cat, Hin Chita billi	CITES: Appendix I, IWPA: Sch I
65.	*Panthera pardus* (Linnaeus, 1758)	Leopard	CITES: Appendix I, IWPA Sch I
66.	*Panthera tigris* (Linnaeus, 1758)	Tiger	CITES: Appendix I, IWPA Sch I
67.	*Felis chaus* Guldenstadt	Jungle Cat	CITES: Appendix II, IWPA: Sch II
68.	*Uncia uncia*	Snow Leopard	CITES: Appendix I, IWPA: Sch I
69.	*Lynx lynx*	Lynx	CITES: Appendix II, IWPA: Sch I
	Order: Pholidata		
	Family: Manidae		
70.	*Manis crassicaudata*	Indian Pangolin	CITES: Appendix I
	Order: Perissodactyla		
	Family: Equidae		
71.	*Equus kiang*	Kiang or Tibetan Wild Ass	CITES: Appendix II
	Order : Artiodactyla		
	Family: Cervidae		
72.	*Cervus elaphus hanglu*	Kashmir Stag	CITES: Appendix I, IWPA: Sch I
73.	*Ceruvs unicolor*	Sambar	IWPA: Sch III
74.	*Axis axis* (Erxbelen, 1777)	Cheetal or Spotted Deer	IWPA: Sch III
75.	*Axis porcinus* (Zimmermann 1780)		IWPA: Sch III
76.	*Muntiacus muntjank* (Zimmermann,1780)	Barking Deer	IWPA: Sch III
	Family: Moschidae		
77.	*Moschus chrysogaster*	Musk Deer	CITES: Appendix I, IWPA: Sch I
	Family: Bovidae		
78.	*Bos grunniens* Linnaeus 1766	Yak	CITES: Appendix I, IWPA: Sch I
79.	*Boselaphus tragocamelus*	Nilgai	IWPA: Sch III
80.	*Capra falconeri* (Wagnar 1839)		IWPA: Sch I
81.	*Capra sibirica* (Pallas, 1776)	Himalayan Ibex	IWPA: Sch I
82.	*Hemitragus jemlahicus* (Smith 1826)	Himalayan thar	IWPA: Sch I
83.	*Procapra picticauda*	Tibetan Gazelle	IWPA: Sch I
84.	*Gazella benetti*	Indian Gazelle or Chinkara	IWPA: Sch I
85.	*Naemorhedus goral* (Hardwicke, 1825)	Goral	CITES: Appendix I, IWPA: Sch III
86.	*Naemorhedus sumatrensis* (Bechstein,1799)	Serow	CITES: Appendix I, IWPA: Sch I
87.	*Ovis omon* (Linnaeus 1758)	Argali or Nayan	CITES: Appendix I, IWPA: Sch I
88.	*Pseudois nayaur* (Hodgson, 1833)	Bharal	IWPA: Sch I
	Order: Rodentia		
	Family: Sciuridae		
89.	*Marmota himalayana* (Hodgson, 1841)	Himalayan Marmot	CITES : Appendix III
90.	*Marmota caudata*	Long-tailed Marmot	CITES: Appendix III, IWPA: Sch II
91.	*Eupataurus cinereus*	Kashmir Flying Squirrel	IWPA: Sch II
92.	*Hylopetes fimbriatus* (Gray, 1837)	Smaller Kashmir Flying Squirrel	IWPA: Sch II, CAMP : LRnt (Nationally)
93.	*Funambulus pennanti* Wroughton, 1905	Northern Palm Squirrel	IWPA: Sch IV
94.	*Petaurista petaurista* (Pallas 1766)		NK
	Family: Hystricidae		
95.	*Hystrix indica*	Indian Porcupine	IWPA: Sch IV
96.	*Hystrix brachyura*	. . . . .	IWPA: Sch II
	Family: Muridae		
97.	*Alticola roylei* (Gray 1842)	Royles Vole	CAMP: DD (Nationally)
98.	*Alticola blanfordi* (Scully 1880)	Altic Vole	
99.	*Microtus lucurus*	Blyth's Vole	

100.	*Apodemus sylvaticus*	Wood Mouse	IWPA: Sch V
101.	*Apodemus rusiges* Miller, 1913		IWPA: Sch V
102.	*Apodemus wardi* (Wroughton, 1908)	Yellow nacked Field Mouse	NK
103.	*Nosekia indica*	Short-tailed Bandicoot Rat	
104.	*Hyperacrius fertilis*(True, 1849)	Trues Vole	IWPA: Sch IV
105.	*Hyperacrius wynnei* (Blanford, 1881)	Murees Vole	IWPA: Sch V
106.	*Pitymys leucurus*(Blyth, 1863)	Blyths Vole	IWPA: Sch V
107.	*Tatera indica* (Hardwicke, 1807)	Indian Gerbil	IWPA: SchV
108.	*Bandicota bengalensis* (Gray and Hardwicke, 1833)	Leser Bandicoot Rat	IWPA: Sch V
109.	*Bandicota indica*(Beehstein, 1800)	Greater Bandicoot Rat	IWPA: Sch V
110.	*Gollunda ellioti* Gray 1837	Indian Bush Rat	IWPA: SchV
111.	*Millardia meltada* Gray, 1837	Soft furred Field Rat	IWPA: Sch V
112.	*Mus booduga* (Gray 1837)	Little Indian Field Mouse	IWPA: Sch V
113.	*Mus musculus* Linnaeus, 1758	House Mouse	IWPA: Sch V
114.	*Mus saxicola* Elliot 1839	Elliots Spiny Mouse	IWPA: Sch V
115.	*Mus cervicolor*	Fawn-colored Mouse	IWPA: Sch V
116.	*Mus platythrix*	Spiny Field Mouse	IWPA: Sch V
117.	*Niviventer fluviscens* (Gray 1847)	Chestnut Rat	IWPA: Sch V
118.	*Niviventer niviventer* (Hodgson, 1836)	White bellied Rat	IWPA: Sch V
119.	*Cremnomys cutchicus*	Kutch Rat	IWAP: Sch V
120.	*Rattus norvegicus* (Berkenhout, 1769)	Norway Rat	IWPA: Sch V
121.	*Rattus rattus* (Linnaeus , 1758)	House Rat	IWPA: Sch V
122.	*Rattus turkestanicus* (Satunin)	Turkestan Rat	IWPA: Sch V
123.	*Rattus vicerex* (Bonhote 1903)	Short tailed Turkestan Rat	IWPA: Sch V
124.	*Vandeleuria oleracea* (Bennett, 1832)	Indian Long tailed Tree Mouse	IWPA: Sch V
	Order : Lagomorpha		
	Family: Leporidae		
125.	*Lepus nigricollis* Cuvier, 1832	Black-naped Hare	IWPA: Sch IV
126.	*Lepus oiostolus*	Wooly Hare	
	Family: Ochotonidae		
127.	*Ochotona roylei* (Ogilby, 1839)	Royle's Pika	IWPA: Sch IV
128.	*Ochotona ladacensis*	Ladak Pika	IWPA: Sch IV
129.	*Ochotona macrotis*	Large-eared Pika	IWPA: SchIV

(Sources: Alfred et al., 2002; Chakraborty et al., 2005; Mattu et al., 2005)

4.4.2 Birds

Himachal Pradesh lies in the 'Western Himalayas' Endemic Bird Area (EBA 128). Of the, 55 bird species which are endemic to India, 10 are known to occur in Himachal Pradesh. These include Western Tragopan (Tragopan melanocephalus), Cheer Pheasant (Catreus wallichii), Brook's Leaf Warbler (Phylloscopus subviridis), Tytler's Leaf Warbler (Pylloscopus tytleri), Kashmir Flycatcher (Ficedula subrubra), White cheeked Tit (Aegithalos leucogenys), White-throated Tit (Aegithalos niveogularis), Kashmir Nuthatch (Sitta cashmirensis), Spectacled Finch (Callacanthis burtoni) and Orange Bullfinch (Pyrrhula aurantiaca). These are confined to elevations between 1,500 to 3,600 m in the Temperate Coniferous/Broadleaf Forests, Sub-alpine Forests and Montane Grasslands.

Birds evolved about 150 million years ago and their diversification of forms was noticeable sometimes during 60 million years ago. World list of living birds computes about 9026 species under 1800 genera, 182 families and 30 orders. India ranks amongst one of the most biodiverse countries in the world. Currently around 1300 species of breeding, staging and wintering birds, spread over 88 families and 22 orders, occupying a wide array of natural, semi-natural and urban habitats are known from India.

A. Critically threatened birds in India

Migratory Wetland Species	Baer's Pochard (*Aythya baeri*), Siberian Crane (*Leucogeranus leucogeranus*), Spoon-billed Sandpiper (*Eurynorhynchus pygmeus*)
Non-migratory Wetland Species	White-bellied Heron (*Ardea insignis*)
Grassland Species	Bengal Florican (*Houbaropsis bengalensis*), Great Indian Bustard (*Ardeotis nigriceps*), Jerdon's Courser (*Rhinoptilus bitorquatus*), Sociable Lapwing (*Vanellus gregarius*)
Forest Species	Forest Owlet (*Heteroglaux blewitti*)
Scavengers	Indian Vulture (*Gyps indicus*), Red-headed Vulture (*Sarcogyps calvus*), Slender-billed Vulture (*Gyps tenuirostris*), White-backed Vulture (*Gyps bengalensis*)

Practically extinct	Himalayan Quail (*Ophrysia superciliosa*), Pink-headed Duck (*Rhodonessa caryophyllacea*)

B. Threatened birds found in Himachal Pradesh

Taxon	IUCN Status (2013.2)	Population size, population trends and habitat (Birdlife Int. 2015; IUCN, 2013; Kazmierczak, 2000)	Distribution size	Major threats (Birdlife Int.)
Oriental Darter (*Anhinga melanogaster*)	Near Threatened	· 22000 mature individuals · Population trends: Decreasing Shallow inland wetlands including lakes, rivers, swamps and reservoirs	7,230,000 km^2 (Breeding/resident)	Habitat loss, pollution, disturbance, hunting, egg collection
Painted Stork (*Mycteria leucocephala*)	Near Threatened	· 10000-17000 mature individuals · Population trends: Decreasing Freshwater marshes, lakes and reservoirs, flooded fields, rice fields, freshwater swamp forest, river banks, intertidal mudflats and saltpans	1,930,000 km^2 (Breeding/resident)	Habitat loss, disturbance, pollution, wetland drainage and the hunting of adults and collection of eggs and nestlings from colonies
Asian Woollyneck (*Ciconia episcopus*)	Vulnerable	· 35,000 individuals · Population trends: Decreasing Wetland habitats, also artificial habitats such as rice paddy-fields, flooded pastures, and cultivated fields	3,860,000 km^2	Habitat loss and fragmentation
Ferruginous Duck (*Aythya nyroca*)	Near Threatened	· 163,000-257,000 individuals · Population trends: Decreasing Fresh standing water and is very rarely found on flowing streams or rivers; requires shallow water 30-100 cm deep close to littoral vegetation for feeding; generally avoids large open areas	1,200,000 km^2	Degradation and destruction of well-vegetated shallow pools and other wetland habitats: Habitat loss
Bearded Vulture (*Gypaetus barbatus*)	Near Threatened	· 1300-6700 mature individuals · Population trends: Decreasing Remote, mountainous areas, with precipitous terrain	8,580,000 km^2	Non-target poisoning, direct persecution, habitat degradation, food shortage, changes in livestock-rearing practices and collisions with powerlines and wind turbines. Potential threat: Diclofenac poisoning
Egyptian Vulture (*Neophron percnopterus*)	Endangered A2bcde+3bcde+4bcde	· 13000-41000 mature individuals · Population trends: Decreasing Typically nests on ledges or in caves on cliffs, crags and rocky outcrops, but occasionally also in large trees and buildings. Forages in lowland and montane regions over open arid country and also human settlements.	19,700,000 km^2	Habitat degradation, reduced food availability, poisoning, collisions with electric wires and wind turbines. Potential threat: Diclofenac poisoning

White-rumped Vulture (*Gyps bengalensis*)	Critically Endangered	· 2500-9999 mature individuals · Population trends: Decreasing Light woodland, villages, cities, and open areas in plains and foothills	4,170,000 km^2	Diclofenac poisoning, habitat destruction, changes in disposal pattern of dead livestock, non-target poisoning, avian malaria and pollution (pesticide use)
Slender-billed Vulture (*Gyps tenuirostris*)	Critically Endangered	· 1000-2499 mature individuals · Population trends: Decreasing Dry open country and forested areas usually away from human habitation	847,000 km^2	Diclofenac poisoning, habitat destruction, changes in disposal pattern of dead livestock, and pollution (pesticide use)
Himalayan Griffon (*Gyps himalayensis*)	Near Threatened	· 66000-334000 mature individuals · Population trends: Stable Mountainous areas, juveniles wander into the plains during winter months	2,680,000 km^2	Diclofenac poisoning, habitat degradation and shortage of suitable nesting sites and pollution (pesticide use)
Cinereous Vulture (*Aegypius monachus*)	Near Threatened	· 14000-20000 mature individuals · Population trends: Decreasing Inhabits forested areas, scrub and arid and semi-arid alpine steppe and grasslands	13,700,000 km^2	Direct mortality caused by humans, decreasing availability of food, poisoning, destruction of nests. Potential threat: Diclofenac poisoning
Red-headed Vulture (*Sarcogyps calvus*)	Critically Endangered	· 2500-9999 mature individuals · Population trends: Decreasing Open country usually away from human habitation, well-wooded hills and dry deciduous forest with rivers	3,690,000 km^2	Habitat degradation, demise of wild ungulates, diclofenac poisoning, direct persecution and disease
Greater Spotted Eagle (*Clanga clanga*)	Vulnerable C2a(ii)	· 3300-8800 mature individuals · Population trends: Decreasing Lowland forests near wetlands	12,800,000 km^2	Hybridisation with Lesser Spotted Eagle (*Clanga pomarina),* habitat destruction and disturbance, poaching, electrocution and poisoning.
Eastern Imperial Eagle (*Aquila heliaca*)	Vulnerable C2a(ii)	· 2500-9999 mature individuals · Population trends: Decreasing Forests, steppe and agricultural areas with large trees and semi-deserts. Wetlands are the preferred habitats on the wintering grounds.	9,440,000 km^2	Habitat alteration, shortage of food, human disturbance of breeding sites, nest robbing and illegal trade, shooting, poisoning and electrocution by powerlines.
Pallid Harrier (*Circus macrourus*)	Near Threatened	•9,000-15,000 pairs •Population trends: Decreasing Breeds in semi-desert, steppe and forest-steppe, agricultural areas, boreal forest and forest-tundra zones. Semi-desert, scrub, savanna and wetlands used in winter.	5,840,000 km^2	Destruction and degradation of steppe grasslands, use of harmful pesticides, rodenticides and other toxic chemicals

Western tragopan (*Tragopan melanocephalus*)	Vulnerable C2a(i)	· 3300 mature individuals · Population trends: Decreasing Thick undergrowth in mixed coniferous forest and alpine shrubbery on steep slopes	21,600 km^2	Habitat degradation and fragmentation, disturbance by grazers, collectors of edible fungi and medicinal plants, hunting and trapping for its meat and decorative plumage
Cheer pheasant (*Catreus wallichii*)	Vulnerable C2a(i)	· 2000-2700 mature individuals · Population trends: Decreasing Steep, rugged, south facing grassy hillsides, also scrub with scattered trees, wooded ravines.	149,000 km^2	Hunting and habitat destruction
Sarus Crane (*Antigone antigone*)	Vulnerable	· 13000-15000 mature individuals · Population trends: Decreasing In India inhabits open wet and dry grasslands, agricultural fields, marshes and pools, while in South-East Asia and Australia the species shows a preference for dry savannah woodlands with ephemeral pools, and wetlands	1,830,000 km^2	Combination of loss and degradation of wetlands, pesticide use, hunting of adults and collection of eggs and chicks
River Lapwing (*Vanellus duvaucelii*)	Near Threatened	· 670-17000 mature individuals · Population trends: Unknown Larger rivers and lakes	1,550,000 km^2	Habitat degradation, hunting, disturbance at breeding sites
Wood Snipe (*Gallinago nemoricola*)	Vulnerable C2a(ii)	· 2500-9999 mature individuals · Population trends: Unknown Breeds in alpine meadows and marshes with scattered low bushes. Winters in swampy ground in and at the edge of evergreen forest and marshy grassland and scrub.	102,000 km^2	Habitat loss mainly due to degradation of evergreen forest, wooded wetlands, marshes and swamps
Eurasian Curlew (*Numenius arquata*)	Near Threatened	· 765,000-1,065,000 individuals · Population trends: Decreasing *Breeds around wetland ecosystem*, also open grassy or boggy areas in forests, damp grasslands, meadows, non-intensive farmland in river valleys. During winter frequents muddy coasts, estuaries, rocky and sandy beaches with many pools, mangroves, inland lakes and rivers.	6,800,000 km^2	Loss and fragmentation of habitats, hunting, diseases.
Great Thick-knee (*Esacus recurvirostris*)	Near threatened	•670-17000 mature individuals •Population trends: Decreasing Riverbed shingle and rocks, stony banks and mud around large lakes, nearby grassy flats, and coastal beaches and estuaries.	2,970,000 km^2	Disturbance, degradation and loss of habitat nest predation by dogs, disturbance by human and domestic animals.

River Tern (*Sterna aurantia*)	Near threatened	· 50,000 and 100,000 individuals · Population trends: Decreasing rivers and freshwater lakes, also occurring rarely on estuaries, and breeds on sandy islands	5,100,000 km^2	Flooding, damming, predation and disturbance at nesting sites,
Black-bellied Tern (*Sterna acuticauda*)	Endangered	· 6700-17000 mature individuals · Population trends: Decreasing Large rivers and marshes, occasionally on smaller pools and ditches	2,470,000 km^2	Destruction of breeding habitat, collection of eggs, overfishing, flooding of nests.
Alexandrine Parakeet (*Psittacula eupatria*)	Near Threatened	· Unknown mature individuals · Population trends: Decreasing Moist and dry forests and woodlands, as well as cultivated areas, mangroves and plantations	------	Habitat loss, persecution and trapping pressure
Tytler's leaf-warbler (*Phylloscop us tytleri*)	Near threatened	· Unknown mature individuals · Population trends: Decreasing · Summer: Forest edges, conifers, hedges, dwarf willows, birches (above treeline post breeding) Winter: dwarf broadleaved forests	213,000 km^2	Habitat loss and degradation

4.4.2.1 Vultures

Six, out of nine species of vultures found in India have been facing problem of existence and therefore declared as threatened. Of these, three species endemic to South Asia, the Indian White-backed Vulture *Gyps bengalensis,* Long-billed Vulture *Gyps indicus* and Slender-billed Vulture *Gyps tenuirostris* are at high risk of global extinction and are listed as critically endangered because of rapid population declines within the last decade in the Indian Subcontinent.

A recent study on vultures of Himachal Pradesh has shown the presence of 24 breeding colonies of Oriental White-backed Vulture (Gyps bengalensis), supporting 102 nests. A slight increase was reported in breeding/fledgling success from 56.10% in 2009-2010 to 79.41% in 2011-2012. Most of the nesting areas were mainly confined to Shahpur, Nurpur and Kangra belts of Kangra District. All the nests of Oriental White-backed Vulture were recorded on pine trees (Pinus roxburghii), indicating a nesting tree preference of 100%, towards pine. Human activity and motor interference were the major causes of the concern to most of the breeding sites of Oriental White-backed Vultures in Himachal Pradesh. Nesting sites of Oriental White-backed Vulture can be divided into two types on the basis of ratio of immatures/adults which ranged from 0.34% to 2.25%. There were no significant fluctuations in the ratio of immatures/adults during different seasons of the year, but the overall data of three years of study pointed towards a small increase in this ratio from 0.44 to 0.98%. Frequency of sighting of carcasses in the Kangra valley supporting most of population of Oriental White-backed Vulture was normally high, however, counts of vultures around two cowsheds in Kangra valley, pointed towards the attraction of vultures towards easily available sources of food. Information on socio-cultural practices of

disposal of carcasses and accessibility of Diclofenac to the vultures revealed that only 5% of the chemists in surroundings of nesting sites indicated the use of human diclofenac to the cattle.

Further, Red-headed Vulture Sarcogyps calvus has been recently upgraded to critical category. Moreover, Egyptian Vulture Neophron percnopterus has been categorised as endangered and Cinereous Vulture Aegypius monachus has been placed under near threatened category.

Indian White-backed Vulture Gyps bengalensis was once one of the most common raptors in the Indian subcontinent. A population decline of >95%, starting in the 1990s was noted at Keoladeo National Park, India. The major cause of the population decline has been attributed to the use of the non-steroidal anti-inflammatory drug (NSAID) diclofenac. Likewise, due to this chemical these vultures suffer from a disease called gout and the vultures which die due to this disease have diclofenac in their liver and kidneys. In India, as estimated, 5 million diclofenac injections were given to cattle annually.. Besides this, environmental changes have also produced adverse effects on the population of vultures as well. Food shortage, caused by the burial or burning of carcasses to reduce the nuisance and health risks have also contributed to their decline. Other reasons for the decline are anthropogenic (related with human population) like loss of nesting habitat, decreased breeding efficiency, infectious diseases, general environmental pollution etc.

Similarly, study on Himalayan Griffon (Gyps himalayensis), showed a total of 14 nesting colonies from Bilaspur, Mandi, Solan, Shimla and Sirmour districts of Himachal Pradesh. Numbers of occupied nests in these sites increased from 49 in 2009-2010 to 64 in 2010-2011 and 69 in 2011-2012. High, steep and inaccessible cliffs with suitable ledges, on the elevated part of small valleys around human settlements have been used as nesting sites. Counts of individuals conducted at Taradevi nesting site revealed that in addition to the adults and immatures, this site has been used by the individuals of nearby nesting colonies as a staging/roosting site. Therefore, the population of Himalayan Griffon in Bilaspur, Mandi, Solan, Shimla and Sirmour districts of Himachal Pradesh at least remained relatively stable between the three years despite potential threats to this and related species particularly in South Asia.

The minimum decline in White-backed vulture numbers in India during the period 1992-2003 was 99.7% and 97.4% for Long-billed/Slender-billed. This corresponds with a minimum estimated rate of decline of 34% per year for White-backed Vultures and 27% per year for the Long-billed/Slender-billed group. In the most recent census, there is evidence that the rate of declines may be increasing with a measured 81% decline between 2002 and 2003 in White-backed vultures, a 59% decline in Long-billed vultures, and a 47% decline for Slender-billed vultures.

Government of India on May 11, 2006, through Drugs Controller General (F.No. 18-03/2006-DC) with approval of Health Ministry has withdrawn all the licenses granted to manufacture diclofenac formulations for veterinary use and marketing of such formulations.

Status of vultures found in Himachal Pradesh

S.No	Species	Conservation Status (IUCN, 2007)	Distribution (altitudinal range)
1.	Bearded Vulture *Gypaetus barbatus* (Linnaeus, 1758)	NT	1200 to 4000 m
2.	Egyptian Vulture *Neophron percnopterus* (Linnaeus, 1758)	EN A2 abcd+3bcd+4abcd	up to 2500 m
3.	White-rumped Vulture *Gyps bengalensis* (Gmelin, 1788)	CR A2 ce+3ce	UP TO 2500 M
4.	Slender-billed Vulture *Gyps tenuirostris* (G.R. Gray, 1844)	CR A2 ce+3ce	
5.	Himalayan Griffon *Gyps himalayensis* Hume, 1869	NT	600 to 3000 m
6.	Eurasian Griffon *Gyps fulvus* (hablizl, 1783)	LC	
7.	Cinereous Vulture *Aegypius monachus* (Linnaeus, 1766)	NT	up to 3600 m
8.	Red-headed Vulture *Sarcogyps calvus* (Scopoli, 1786)	CR A2 abcd+3bcd+4abcd	up to 2000 m

1.4.3 Reptiles

Reptiles are cold-blooded vertebrates which breathe by lungs throughout their life and have the body covered by scales. Their skull articulates with the vertebral column by a single median occipital condyle. They were the dominant group of vertebrates during the Mesozoic period and they reached their maximum and most diversified development at that time. Most of the orders of reptiles were established by the end of Triassic and some became extinct at that time. Of the 19 orders of reptiles only 4 survive today. These are Crocodylia, Testudines, Squamata and Rhynchocephala.

India harbours 456 species of reptiles belonging to 25 families and 4 orders including 3 species of Crocodilia, 31 of Testudines, 178 of lizards and 244 species of Serpents. Information on reptilian fauna of Himachal Pradesh is limited and only 14 species of reptiles are known from the State.

Reptiles found in Himachal Pradesh

Order: Testudines **Family: Emydidae** 1. *Kachuga kachuga* (Gray) **Family: Gekkonidae** 2. *Hemidactylus brooki* Gary 3. *Hemidactylus flaviviridus* Ruppell **Family: Agamidae** 4. *Agama tuberculata* Hardwicke & Gray 5. *Calotes versicolor* (Daudin) **Family: Varanidae** 6. *Varanus bengalensis* (Daudin) 7. *Varanus flavescens* (Hardwicke & Gray)	**Family: Scincidae** 8. *Mabuya carinata* (Schneider) 9. *Riopa punctata* (Gmelin) **Order: Serpentes** **Family: Typhlopidae** 10. *Typhlops porrectus* Stoliczka **Family: Viperidae** 11. *Vipera russelli* (Shaw) 12. *Echis carinatus* (Schneider) 13. *Agkistrodon himalayanus* Guenther **Family: Colubridae** 14. *Ptyas mucosus* (Linnaeus)

(Sources: Waltner, 1974; Mehta, 2000)

4.4.4 Amphibians

Amphibians are poikilothermic (cold blooded) vertebrates with smooth skins leading a bimodal life i.e. life in water as well as land. They may or may not possess limbs and tails. Much of gas exchange in them occurs through their skin whose secretion protects it from desiccation. They are the least amongst the vertebrates and comprise nearly 6.6% of the total life on the earth. Total number of species in the world has been estimated around 3140 and in India 214 species are known, while in Himachal Pradesh only 17 species belonging to 4 families has been recorded.

Amphibians found in Himachal Pradesh

Family : Ranidae 1. *Rana cyanophlyctis* Schneider 2. *Rana limnocharis* (Boie) 3. *Rana tigerina* Daudin 4. *Rana (Tomopterna) breviceps* Schne. 5. *Rana (Paa) minica* Dubois 6. *Rana (Paa) liebigii* Annandale 7. *Rana (Paa) vicinia* Stoliczka 8. *Amolops afgahanus* Gunther 9. *Amolops himalayanus* Boulenger	**Family : Rhacophoridae** 1. *Polypedates maculates* Gunther **Family : Bufonidae** 2. *Bufo melanistictus* Schneider 3. *Bufo stomaticus* Lutken 4. *Bufo andersonii* Boulenger 5. *Bufo himalayanus* Gunther 6. *Bufo viridis* Laurenti **Family : Microphylidae** 7. *Microhyla ornata* Dumm. & Bobron *Uperodon systoma* Schneider

(Sources: Dubois, 1975; Tilak and Mehta, 1983; Mehta, 2000 & 2005)

1.4.5 Fish

Fishes are aquatic cold-blooded vertebrates that have gills for respiration throughout life and limbs, if any, are in the shape of fins and are primarily dependent on water as a medium in which to live. The living fishes are divided into 4 classes, out of which 2 classes, viz., Chondrichthyes (those with cartilaginous skeleton) and Osteichthyes (those with bony skeleton) are represented in India. This group comprise about half the total number of vertebrates. Nelson (1984) estimated 21,723 species of fishes under 4,044 genera, 445 families and 50 orders in the world. Talwar (1991) estimated 2546 species of fishes belonging to 969 genera, 254 families and 40 orders in the Indian region. Chondrichthyes are represented by 131 species belonging to 67 genera, 28 families and 10 orders, and Osteichthyes by 2415 species in 902 genera, 226 families and 30 orders.

A total of 104 species of fishes belonging to 48 genera, 14 families and 8 orders are known from all 12 districts of Himachal Pradesh. A maximum number of species i.e. 57 are reported from Sirmour district, followed by 55 from Kangra and 50 from Bilaspur. Minimum number of species (2 species) are from Lahaul and Spiti district.

Fish found in Himachal Pradesh

Class : Actinopterygii
Order : Osteoglosiiformes
Family : Notopteridae
1. *Notopterus notopterus* (Pallas)
2. *Chitala chaitala* (Hamilton-Buchanan)

Order : Cypriniformes
Family : Cyprinidae
3. *Barilius barila* (Hamilton-Buchanan)
4. *Barilius barna* (Hamilton-Buchanan)
5. *Barilius bendelisis* (Hamilton-Buchanan)
6. *Barilius modestus* (Hamilton-Buchanan)
7. *Barilius shacra* (Hamilton-Buchanan)
8. *Barilius vagra* (Hamilton-Buchanan)
9. *Raiamas bola* (Hamilton-Buchanan)
10. *Brachydanio rerio* (Hamilton-Buchanan)
11. *Rasbora daniconius* (Hamilton-Buchanan)
12. *Danio devario* (Hamilton-Buchanan)
13. *Tor putitora* (Hamilton-Buchanan)
14. *Tor tor* (Hamilton-Buchanan)
15. *Tor chelynoides* (McClelland)
16. *Tor mosal* (Hamilton-Buchanan)
17. *Carassius auratus* (Linnaeus)
18. *Crassius crassius* (Linnaeus)
19. *Catla catla* (Hamilton-Buchanan)
20. *Cirrhinus reba* (Hamilton-Buchanan)
21. *Cirrhinus mrigala* (Hamilton-Buchanan)
22. *Crossocheilus latus latus* (Hamilton-Buch.)
23. *Crossocheilis latius diplocheilus* (Ham.-Buc.)
24. *Cyprinus carpio communis* Linnaeus
25. *Cyprinus carpio specularis* Lacepedes
26. *Cyprinus carpio nudus* Bloch
27. *Gara gotyla gotyla* (Gray)
28. *Garra lamta* (Hamilton-Buchanan)
29. *Ctenopharyngodon idellus* (Valenciennes)
30. *Labeo bata* (Hamilton-Buchanan)
31. *Labeo boga* (Hamilton-Buchanan)
32. *Labeo calbasu* (Hamilton-Buchanan)
33. *Labeo dero* (Hamilton-Buchanan)
34. *Labeo dycocheilus dycocheilus* (McClelland)
35. *Labeo pangusia* (Hamilton-Buchanan)
36. *Labeo rohita* (Hamilton-Buchanan)
37. *Labeo gonius* (Hamilton-Buchanan)
38. *Neolissochilus hexagonolopsis* (McClelland)
39. *Osteobrama cotio cotio* (Hamilt.-Buchanan)
40. *Esomus danricus* (Hamilton-Buchanan)
41. *Puntius phutunio* (Hamilton-Buchanan)
42. *Puntius chola* (Hamilton-Buchanan)
43. *Puntius conchonius* (Hamilton-Buchanan)
44. *Puntius ticto* (Hamilton-Buchanan)
45. *Puntius sarana sarana* (Hamilt.-Buchanan)
46. *Puntiuis sophore* (Hamilton-Buchanan)
47. *Puntius waagenii* (Day)
48. *Puntius tetrarpagus* (McClelland)
49. *Puntius stigma* (Hamilton-Buchanan)
50. *Puntius punjabensis* (Day)
51. *Slamostoma bacaila* (Hamilton-Buchanan)
52. *Chagunius chagunio* (Hamilton-Buchanan)
53. *Schizothorax richardsonii* (Gray)
54. *Diptus maculatus* Steindachner
55. *Hypophthalmichthyes molitrix* (Valenc.)

Family : Cobiitidae
56. *Botia birdi* Chaudhari
57. *Botia dayi* Hora
58. *Botia dario* (Hamilton-Buchanan)
59. *Botia lochachata* Chaudhari
60. *Botia geto* (Hamilton-Buchanan)
61. *Lepidocephalus guntea* (Hamilt.-Buchanan)
62. *Noemacheilus botia* (Hamilton-Buchanan)
63. *Noemacheilus carletoni* Fowler
64. *Noemacheilus corica* (Hamilton-Buchanan)
65. *Noemacheilus horai* Menon
66. *Noemacheilus himachalensis* Menon
67. *Noemacheilus montanus* (McClelland)
68. *Noemacheilus punjabensis* (Hora)
69. *Noemacheilus rupecola* (McClelland)
70. *Noemacheilus nilgiriensis* (Menon)
71. *Triplophysa stoliczkae* (Steindachner)

Order : Siluriformes
Family : Amblycipitidae
72. *Amblyceps mongois* (Hamilton-Buchanan)

Family : Bagridae
73. *Mystus bleekri* (Day)
74. *Mystus vittatus* (Bloch)
75. *Aorichthys aor* (Hamilton-Buchanan)
76. *Aorichthys seenghala* (Sykes)

Family : Siluridae
77. *Wallago attu* (Bloch & Schneider)

Family : Clariidae
78. *Clarias batrachus* (Linnaeus)

Family : Schibeidae
79. *Clupisoma garua* (Hamilton-Buchanan)

Family : Sisoridae
80. *Bagarius bagarius* (Hamilton-Buchanan)
81. *Glyptothorax brevipinnus* Hora
82. *Glyptothorax c. conirostrae* (Steindachner)
83. *Glyptothorax garhwali* Tilak
84. *Glyptothorax gracile* (Gunter)
85. *Glyptothoraxkashmirensis* Hora
86. *Glyptothorax pectinopterus* (McClelland)
87. *Glyptothorax stoliczke* (Steindachner)
88. *Glyptothorax dakpathri* Tilak & Hussain
89. *Gyptosternon reticulatum* McClelland
90. *Pseudecheneis sulcatus* (McClelland)

Order : Order
Family : Salmonidae
91. *Salmo gardnerii gardnerii* Richardson
92. *Salmo trutto fabrio* Linnaeus

Order : Beloniformes
Family : Belonidae
93. *Xenentodon cancila* (Hamilton-Buchanan)
Order : Channiformes
Family : Channidae
94. *Channa gachua* (Hamilton-Buchanan)
95. *Channa marulius* (Hamilton-Buchanan)
96. *Channa orientalis* Block and Schneider
97. *Channa punctatus* (Bloch)
98. *Channa striatus* (Bloch)

Family : Centropomidae
99. *Pseudambasis baculis* (Hamilt.-Buchanan)

Family : Gobidae
100. *Glossogobius giuris* (Hamilton-Buchanan)

Family : Heteropneustidae
101. *Heteropneustes fossilis* (Bloch)

Order : Perciformes
Family : Nandidae
102. *Badius badis* (Hamilton-Buchanan)

Order : Synbranchiformes
Family : Mastacembelidae
103. *Mastacembelus armatus* Lacepede
104. *Macrognathus pancalus* Hamilt.-Buchanan

(Sources: Sharma and Tandon, 1990; Mehta, 2000; Johal et al., 2002; Dhanze and Dhanze, 2004; Mehta & Uniyal, 2005)

4.5 FLORAL DIVERSITY

India is home to at least 18,664 species of vascular plants, of which 26.8 per cent are endemic. Out of a total 45,000 plant species found in the country, as many as 3295 species (7.32%) are reported in Himachal Pradesh. There is great altitudinal and latitudinal variations in different areas of the State resulting in the presence of different types of vegetation in different bio-geographic zones of the State.

The vegetation types in this region range from tropical to alpine, due to large differences in altitude and precipitation. In the lower regions, the vegetation type is tropical. The temperature in this part is high and receives a large amount of rainfall, especially during the monsoon. The prevailing forest types in this part are mainly sal and mixed deciduous. On the southern slopes of the Himalayas, the temperature is low, reaching even zero degrees in winter. Temperate forests consist of temperate mixed deciduous coniferous forests, blue pine forests, deodar forests and oak forests. These areas receive a very large amount of rainfall during the monsoon, because of convection of the monsoon clouds that come from the south.

At higher altitudes climate changes into alpine, being very dry and often temperature below zero in winter. Because of these low temperatures and very small amount of precipitation, most of this region is barren.

Natural vegetation of the state is classified into six broad types of forests viz., Tropical forests (confined to foothills), represented by two subtypes, namely thorn-scrub of Acacia and Zizyphus, and dry deciduous forests of Shorea robusta; Subtropical forests (500-1800 m), which are further composed of two subtypes i.e. subtropical dry evergreen forests of Terminalia, Albizzia, Olea etc (below 1200 m), and subtropical pine forests of chir pine (Pinus roxburghii) found upto 1800 m; Temperate forests (1500-3000 m) which are also divided into two subtypes i.e. Himalayan moist temperate covers areas between 1500 and 3000 m, where the flora is dominated by oaks (Quercus spp.), deodar (Cedrus deodara), fir (Abies pindrow), blue pine (Pinus wallichiana) and horse chestnut (Aesculus indica), and another is the Himalayan dry temperate subtype of Holm oak (Quercus ilex) and edible pine (Pinus gerardiana) which is best developed at 2000 to 3000 m in the greater Himalayan regions of upper Sutlej valley in Kinnaur district; and Sub-Alpine and Alpine vegetation (above 4000 m) which is dominated by birch and rhododendron and interspersed with high-altitude meadows, found in most parts of Lahaul, Spiti and Kinnaur districts of the State.

4.5.1 Sub-Tropical Zone

Floral diversity in sub-tropical zone	
1. *Apluda mutica* (Apluda) 2. *Arthraxon* spp 3. *Arundinella nepalensis* (Arundinella) 4. *Arundinella setosa* (Arundinella) 5. *Atylosia scarabaeoides* (Ban kulthi) 6. *Bothriochloa pertusa* 7. *Bothriochloa intermedia* 8. *Cymbopogon jwarancusa* 9. *Cymbopogon martinii* (Citronella) 10. *Cynodon dactylon* (Bermuda) 11. *Chrysopogon gryllus* (Chota Dholu) 12. *Chrysopogon fulvus* (Bara Dholu) 13. *Dichanthium annulatum* (Marval) 14. *Desmodium* sp 15. *Digitaria marginata* 16. *Digitaria longiflora* 17. *Eulaliopsis binata*	18. *Eragrostis curvula* (Lane grass) 19. *Heteropogon contortus* (Spear grass) 20. *Imperata cylindrica* (Chhiz) 21. *Medicago polymorpha* (Khukhani) 22. *Medicago denticulata* 23. *Penniselum orientale* (Barijhan) 24. *Paspalum scrobiculatum* 25. *Paspalum orbicular* (Kodri) 26. *Phaseolus* sp 27. *Poa annacra* 28. *Sorghum halepense* (Johnson grass) 29. *Sorghum nitidum* (Chota Bru) 30. *Saccharum spontaneum* (Kash) 31. *Saccharum bengalensis* (Munya) 32. *Setaria glauca* (Cheti jhan) 33. *Themeda anathera* (Lungi)

4.5.2 Humid Sub-Temperate Zone

Floral diversity in humid sub-temperate zone	
1. *Arundinella setosa* (Arundinella) 2. *Agrostis canina* 3. *Agropyron longearistatum* (Wheat grass) 4. *Agropyron semicstatum* (Wheat grass) 5. *Arthraxon* sp. 6. *Bothriochloa intermedia* 7. *Bromus catharticus* (Brome grass) 8. *Cymbopogon gryllus* (Chota dholu) 9. *Cymbopogon echinulatus* 10. *Cymbopogon jwvarancusa* 11. *Chrysopogon martinii* (Makore) 12. *Cynodon dactylon* (Bermuda grass) 13. *Chlris montana* 14. *Digitaria* sp. 15. *Danthonia jacquemontii* 16. *Dactylis glomerata* (Cock spoot) 17. *Festuca kashmiriana* (Feswe grass) 18. *Festuca arundinacea* (Feswa grass)	19. *Heteropogon contortus* (Spern grass) 20. *Koeleria cristata* 21. *Lolium perenne* (Rye grass) 22. *Lotus corniculatus* (Bridsfoot trefoil) 23. *Microstegium ciliatum* 24. *Muhlenbergia duthieana* 25. *Medicago falcata* (Lucerne) 26. *Medicago denticulata* 27. *Onobrychis vicifolia* (Sain join) 28. *Phleum pratense* (Timothy grass) 29. *Pennisetum orientale* (Barijhan) 30. *Poa bulbosa* (Blue grass) 31. *Poa pratensis* (Kentucky blue grass) 32. *Poa annua* 33. *Phaseolus* sp. 34. *Stipa concinna* 35. *Themeda anathera* 36. *Trifolium repens* (Winter clover) 37. *Trifolium pratense* (Red clover)

4.5.3 Dry Temperate and Alpine Zone

Floral diversity in dry temperate and alpine zone	
1. *Agrostis stolonifera* 2. *Agrostis canina* 3. *Agrostis alba* Bant Grass 4. *Agrostis myriantha* 5. *Agropyron cognatum* Wheat Grass 6. *Agropyron repens* Wheat Grass 7. *Bromus oxydlon* Broom Grass 8. *Bromus inermis* Smooth Broom Grass 9. *Chrysopogon gryllus* 10. *Dactylis glomerata* Cooksfoot 11. *Deyeuxia scabriscens* 12. *Deschempsia caespitosa* 13. *Festuca valesiaca*	14. *Helictotrichon virescens* 15. *Trisetum micans* 16. *Lolium perenne* Perennial Rye Grass 17. *Phleum alpinum* Timothy grass 18. *Poa bulbosa* Blue grass 19. *Poa sterilis* Blue grass 20. *Poa alpina* Kentucky Blue Grass 21. *Phalaris minor* 22. *Themeda anathera* 23. *Trifolium repens* White clover 24. *Trifolium fragiferum* Strawberry clover 25. *Trifolium pratense* Red clover

4.5.4 Wild Fruit Plants Diversity

Wild fruits of Himachal Pradesh

Sr. No.	Scientific Name	Common/local Name	Climate Zone (Area of occurence)
1.	Aesculus indica	Khanor (Horse chestnut)	High Hills
2.	Corylus	Wild Hazelnut	High Hills
3.	Malus spp.	Crab apple	High Hills
4.	Prunus armeniaca	Chuli	High Hills
5.	Prunus mira	Behmi	High Hills
6.	Prunus persica	Wild peach	High Hills
7.	Hippophae rhamnoides	Sea buckthorn	High Hills
8.	Artocarpus lacucha	Dehu	Low hills
9.	Mangifera indica	Wild mango	Low hills

11.	Zizyiphus chebula	Harar	Low hills
12.	Zizyiphus spp.	Ber	Low hills
13.	Morus laecigata	Wild mulberry	Low/ mid hills
14.	Aegle marmelos	Bel	Low/ mid hills
15.	Carissa spinarum	Wild Karonda	Low/ mid hills
16.	Citrus spinarum	Hill lemon	Low/ mid hills
17.	Ficus palmata	Wild Fig (Anjir)	Low/ mid hills
18.	Ficus roxburghii	Timal	Low/ mid hills
19.	Musa spp.	Hill banana	Low/ mid hills
20.	Diospyros lotus	Amlook	Mid hills
21.	Punica granatum	Wild pomegranate	Mid hills
22.	Berberis aristata	Kashmal	Mid hills
23.	Cordia abliqua	Lassura	Mid hills
24.	Debregeasia hypoleuca	Siarru	Mid hills
25.	Emblica officinalis	Wild amla	Mid hills
26.	Flacourtia sapida	Kangu	Mid hills
27.	Fragaria indica	Wild strawberry	Mid hills
28.	Murraya koenigii	Gandhellu	Mid hills

29.	Phoenix sylvestris	Wild date palm	Mid hills
30.	Pyrus serotina	Zarenth	Mid hills
31.	Rubus ellipticus	Akhae	Mid hills
32.	Rubus niveus	Akhae	Mid hills
33.	Syzygium spp.	Wild jamun	Mid hills
34.	Vitis himalayana	Wild grapes	Mid hills
35.	Vitis lanata	Wild grapes	Mid hills
36.	Elaeagnus unbellata	Ghain	Mid/high hills
37.	Myrica nagi	Kaphal	Mid/high hills
38.	Pyrus pashia	Kainth	Mid/high hills
39.	Olea cuspidata	Wild olive	Mid/high hills

4.5.5 Important Temperate and Sub-tropical Fruits and Vegetables in Himachal

Fruit plants	
1. *Malus malus* (Apple)	16. *Olea europaea* (Olive, Zaitoon)
2. *Malus auccata* (Crab apple)	17. *Citrus reticulata* (Orange)
3. *Prunus domestica* (Plum)	18. *C. sinensis* (Malta)
4. *P. persica (Peach*, Aaru)	19. *C. limon* (Kagzi Nimbu)
5. *P. armeniaca* (Apricot, Khumani)	20. *C. aurantifolia* (Galgal)
6. *P. avium* (Cherry)	21. *Citrus sp.* (Kinnow)
7. *P. cerasus* (Cherry)	22. *Litchi chinensis* (Litchi)
8. *P. amygdalus* (Almond)	23. *Artocarpus heterophyllus* (Jackfruit)
9. *Juglans regia* (Walnut)	24. *Punica granatum* (Pomegranate)
10. *Corylus colurna* (Hazelnut)	25. *Mangifera indica* (Mango)
11. *Carya pecan* (Pecan nut)	26. *Psidium guajava* (Guava)
12. *Castanea vulgaris* (Chestnut)	27. *Vitis vinifera* (Grapes)
13. *Pinus gerardiana* (Chilgoza, Neoza)	28. *Carica papaya* (Papaya)
14. *Pyrus communis* (Pear, Nashpati)	29. *Actinidia deliciosa* (Kiwi)
15. *Cydonia vulgaris* (Quince, Beehdana)	

Vegetables	
1. *Brassica oleracea var. capitata* (Cabbage)	20. *Amaranthus dubius* (Chaulai)
2. *B. oleracea var. botrytis* (Phulgobhi, Cauliflower)	A. *hypochondriacus* (Chaulai)
3. *B. campestris var. rapa* (Shaljam, Turnip)	21. *Phytolacca acinosa* (Jalga)
4. *Raphanus sativus* (Muli, Radish)	22. *Perilla frutescens* (Banjeera)
5. *Cucurbita moschata* (Pumpkin)	23. *Pisum sativum* (Pea, Matar)
6. *C. maxima* (Kadu)	24. *Phaseolus vulgaris* (French bean)
7. *Cucumis sativus* (Cucumber)	25. *Vicia faba* (Bakla)
8. *Lagenaria siceraria* (Bottle gourd, Ghiya)	26. *Vigna sinensis var. sesquipedalis* (Rongi)
9. *Luffa acutangula* (Ridge gourd, Tori)	27. *Sechium edule* (Cho-cho)
10. *Luffa cylindrica* (Sponge gourd, Ghiya Tori)	28. *Solanum tuberosum* (Alu)
11. *Trichosanthes anguina* (Snake gourd)	29. *Amorphophallus campanulatus* (Zamikand)
12. *Momordica charantia* (Bitter gourd, Karela)	30. *Colocasia esculenta* (Arvi)
13. *Benincasa hispida* (Petha, Ash gourd)	31. *Lycopersicon esculentum* (Tamatar, Tomato)
14. *Beta vulgaris var. bengalensis* (Palak)	32. *Solanum melongena var. esculentum* (Baingan)
15. *Spinacia oleracea* (Vilayati Palak)	33. *Capsicum annuum* (Shimla mirch)
16. *Trigonella foenum-graecum* (Methi)	34. *C. frutescens* (Chilli, Lal mirch)
17. *Brassica campestris var.* cuneifolia (Lai Patta)	35. *Abelmoschus esculentus* (Bhindi, ladies finger)
18. *B. campestris var. rugosa* (Lohi patta)	36. *Daucus carota* (Gajar, Carrot)
19. *Chenopodium album* (Bathua)	

4.5.6 Medicinal Plants

Our knowledge of the intimate relationship between early man and plants has come to us mainly through surviving traditions. The history of plant exploration is concomitant with the evolution of human beings. The co-evolution of cultures, life forms and habitats has conserved the biological diversity on this planet. Primitive man must have learned early in his career to appease his hunger and eke out his existence by eating the numerous wild plants, which everywhere attracted his attention. He soon became aware of the inedible nature of some of these plants. At first the nomadic tribes were content to gather in a region where the edible wild plants were most abundant and to linger long enough to harvest them before moving on. Later, man began to cultivate these plants. Finally, as civilization progressed and as the nutritive qualities and physiological action of these foods were studied, our present day plants were gradually developed. Most of the changes and improvements have been brought about by selection and hybridization. In many cases wild plants are still used, thousands of them used daily by the native people and most of these still unknown to man.

Unplanned and excessive exploitation of wild plants leading to habitat destruction and placing threat on biodiversity is largely due to illiteracy, poverty and the shortage of off-farm employment opportunities for the rural population. The illiteracy and poverty have forced the rural people to continue activities which help them survive in the present, but will cause more severe problems in the future. Himachal Pradesh which is a part of the Himalayas is the reservoir of genetic wealth ranging from tropical, sub-tropical, sub-temperate to temperate including dry temperate and cold deserts, culminating into alpine flora (both dry and moist). The conservation of diversity in plant based ecosystems has special significance in mountains, as people are traditionally dependent on the natural resources for multifaceted uses such as food, fodder, medicinal plants and host of other uses.

Diversity of tradable commodities in Himachal Pradesh

Agro-climatic Zones	Characteristic features	Plant Life Form	Representative commodity species
1. Shivalik / Lower Motane Zone (< 800 m asl, covering about 35% of the total area and about 1/3rd of cultivated area)	· Tropical to subtropical climate with annual precipitation of about 1500 mm.	A. Trees	*Acacia catechu*, *Aegle marmelos*, *Bauhinia racemosa*, *Bombax ceiba*, *Mangifera indica*, *Grewia optiva*, *Morus alba, Terminalia chebula,*
	· Soils sandy loam with poor moisture retention capacity	B. Shrubs	*Vitex negundu*, *Woodfordia fruticosa*, *Zizyphus mauritiana*
	. Highly erosion prone	C. Herbs / Grasses	*Centella asiatica, Rauvolfia serpentina*, *Sanchrus* sp.
2. Mid-Hills / Middle Motane Zone (800-1600 m asl, covering about 32% of the total area and about 53% of cultivated area)	· Mild temperate climate with annual precipitation of about 1800 mm.	A. Trees	*Pinus roxburhii*, *Prunus armeniaca*, *Juglans regia*, *Celtis australis*
	· Soils sandy loam to loamy	B. Shrubs	*Vitex negundo*, *Berberis* sp., *Carissa karandas*
	. Northern slopes bear good forests while southern and western slopes have grasslands.	C. Herbs/ Grasses	*Swertia chiraiya, Lilium polyphyllum, Habenaria* sp., *Lolium* sp., *Dactylis*, *Phleum* sp., *Phylaris minor*.

3. High Hills /Temperate Zone (1600-3000 m asl, covering about 25% of the total area and about 11% of cultivated area)	· Moist temperate climate with annual precipitation of upto 1500 mm. . Soils loamy . Lower areas have good forests and higher reaches bear extensive alpine pastures	A. Trees B. Shrubs C. Herbs / Grasses	*Cedrus deodara*, *Pinus wallichiana*, *Picea smithiana*, *Abies pindrow*, *Acer* sp., *Fraxinus* sp., *Betula utilis*, *Aesculus indica*, *Alnus nitida*, *Juglans regia*, *Robinia* *Berberis aristata*, *Dioscorea deltoidea* *Podophyllum hexandrum, Meconopsis aculeata, Aconitum* sp., *Dactylorhiza hatageria*, *Festuca*, *Dactylis*, *Bromus*, Lucerne, White Clover, Red Clover
4. Cold Dry Zone (>3000 m asl covering about 8% of the total area and about 3% of cultivated area)	· Dry temperate climate with annual precipitation of upto 200 mm, with heavy winter snow. · Soils dry and fragile. . Scanty natural vegetation.	A. Trees B. Shrubs C. Herbs/ Grasses	*Betula utilis, Juniper* sp., *Ephedra gerardiana, Artemsia* sp., *Juniper* sp., *Festuca arundinacea*, *Dectylis glomerata, Saussurea costus, Hissopus officinalis*

4.5.6.1 Conservation status of tradable medicinal commodities in Himachal

Many of the plant species found in the state are near endemics, making this floristic richness all the more important. About 60 medicinal plant species of Himachal Pradesh are facing various categories of threat as per IUCN guidelines, whereas 12 of these species have been assessed as 'Critically Endangered', 21 species have been assessed as 'Endangered' and 27 species have been assessed as 'Vulnerable'. Category-wise list of these Red Listed medicinal plants is given below:

Critically Endangered medicinal plants

Sr. No.	Botanical Name	Common/ Local Name
1	*Aconitum heterophyllum*	Atis
2	*Arnebia benthami*	Ratanjot
3	*Arnebia euchroma*	Ratanjot
4	*Atropa acuminata (= Atropa belladona)*	Jharka
5	*Dactylorhiza hatagirea (= Orchis latifolia)*	Salam panja
6	*Dienia mucifera (= Malaxis mucifera)*	Jeevak/ Rishabhik
7	*Gentiana kurroo*	Kutki
8	*Lilium polyphyllum*	Ksheer kakoli
9	*Rauvolfia serpentina*	Sarpagandha
10	*Saussurea gossypiphora*	Ghooghi
11	*Saussurea obvallata*	Brahma kamal
12	*Swertia chirayita (= S. chirata)*	Chirayata

Endangered medicinal plants

Sr. No.	Botanical Name	Common/ Local Name
1	*Aconitum deinorrhizum*	Mohra
2	*Angelica glauca*	Chora
3	*Betula utilis*	Bhojpatra/ Bhoj
4	*Datisca cannabina*	Bajar bhang
5	*Dioscorea deltoidea*	Shingli mingli
6	*Ephedra gerardiana*	Somlata
7	*Fritillaria roylei*	Ksheer kakoli
8	*Habenaria intermedia*	Riddhi
9	*Hyoscyamus niger*	Khurasani ajwaiin
10	*Juniperus polycarpos (= J. macropoda)*	Jau, Hauber
11	*Jurinea dolomiaea (= J. macrocephala)*	Dhoop
12	*Meconopsis aculeata*	Patishan rooli
13	*Nardostachys grandiflora (= N. jatamansi)*	Balchharh
14	*Paris polyphylla*	Meethi bach, Dudh bach
15	*Picrorhiza kurroa*	Karu, Kutki
16	*Podophyllum hexandrum (= P. emodi)*	Bankakri
17	*Polygonatum cirrhifolium*	Salam mishri, Maha meda
18	*Rheum emodi (= R. australe)*	Revandchini
19	*Rheum moorcroftianum*	Revandchini
20	*Taxus wallichiana (= T. baccata)*	Talishpatra
21	*Zanthoxylum armatum (= Z. alatum)*	Tirmur

Table 17: Vulnerable medicinal plants

Sr. No.	Botanical Name	Common/ Local Name
1	*Aconitum violaceum*	Mithi patish, Mitha telia
2	*Allium stracheyi*	Jambu, Faran
3	*Bergenia stracheyi*	Pashanbhed
4	*Bunium persicum (= Carum bulbocastanum)*	Kala zira, Shia zira
5	*Cinnamomum tamala*	Tejpatta
6	*Colchicum luteum*	Suranjan kadvi
7	*Didymocarpus pedicillata*	Pathar laung, Patharphori
8	*Embelia tsjeriam-cottam*	Vibidang
9	*Eremostachys superba*	Gaju mulla
10	*Ferula jaeskeana*	Kindal
11	*Gloriosa superba*	Kalihari
12	*Heracleum lanatum*	Patrali
13	*Hippophae rhamnoides*	Chharma, Seabuckthorn
14	*Hypericum peforatum*	Basant, Khoontir
15	*Hyssopus officinalis*	Juffa
16	*Litsea glutinosa (= L. chinensis)*	Meda sak
17	*Physochlaena praealta*	Bajar bhang
18	*Polygonatum multiflorum*	Salam mishri
19	*Polygonatum verticillatum*	Salam mishri
20	*Rheum speciforme*	Revandchini, Chukri
21	*Rheum webbianum*	Revandchini
22	*Rhodiola heterodonta*	
23	*Rhododendron anthopogon*	Talispatra
24	*Rhododendron campanulatum*	Kashmiri patta
25	*Rhododendron lepidotum*	Kashmiri patta
26	*Roylea cinerea (= R. calycina)*	Karvi
27	*Valeriana jatamansi (= V. wallichi)*	Mushkbala, Tagar, Tagarganth

4.5.6.2 Export potential of tradable commodities of Himachal Pradesh

In addition to the self-use based dependence of local communities on tradable commodities to meet their day-to-day requirements, many people are also engaged in collection and trade of the products and derive a substantial part of their annual income from this activity. The major component of the tradable commodities that is traded from the state is medicinal plants. At a gross level, an estimated 2500 MT of non timber forest products, mainly medicinal plants, worth about Rs. 10 crores are officially traded from the state annually. Official statistics of the State Forest Department in respect of export of listed non timber forest products is presented below:

Table 18: Medicinal plants in high trade with in Himachal Pradesh

No.	Name of Species	Trade Name	Major Supply Source	Estimated Annual Trade (MT)	Price Range (Rs. Per Kg)
1	*Abies spectabilis* (D.Don) Spach	Talispatra	Tm	500-1000	30-50
2	*Acacia catechu* (L.f.) Willd.	Katha	Tm	200-500	10-15
3	*Aconitum heterophyllum* Wall. *ex* Royle	Atis	Tm	200-500	2000-4000
4	*Acorus calamus* L.	Vach	Tr	500-1000	30-35
5	*Adhatoda zeylanica* Medic. [=*A. vasica* Nees; *Justicia adhatoda* L.]	Adusa	Tr	2000-5000	10-15
6	*Aegle marmelos* (L.) Corr. *ex* Schultz	Bael	Tr	2000-5000	10-25
7	*Asparagus racemosus* Willd.	Shatavari	Tr	2000-5000	40-70
8	*Bacopa monnieri* (L.) Pennell	Brahmi	W	2000-5000	30-35
9	*Berberis aristata* DC.	Daruhaldi	Tm	500-1000	15-35
10	*Bergenia ciliata* (How.) Stern.	Pashanabheda	Tm	200 - 500	15 - 20
11	*Bombax ceiba* L. [=*B. malabaricum* DC.]	Mochrus	Tr	100 - 200	50 - 60
12	*Butea monosperma* (Lam.) Taub. [=*B. frondosa* Koen.]	Tesu phool	Tr	200 - 500	15 - 20
13	*Cassia fistula* L.	Amaltas	Tr	200 - 500	30 - 40
14	*Cassia tora* L. [=*Senna tora* (L.) Roxb.]	Chakoda beeja	W	5000 - 10000	5 - 10
15	*Cedrus deodara* (Roxb.) Loud.	Devdar	Tm	500 - 1000	25 - 35
16	*Celastrus paniculatus* Willd.	Malkangani	Tr	200 - 500	48 -55
17	*Centella asiatica* (L.) Urban	Brahmi booti	W	500 - 1000	30 - 35
18	*Centratherum anthelminticum* (L.) O.Kuntze [=*Vernonia anthelmintica* (L.) Willd.]	Kali zeeri	W	500 - 1000	70 - 75
19	*Cinnamomum tamala* Nees & Eberm.	Tejpatta	Tm	500 - 1000	15 - 35
20	*Emblica officinalis* Gaertn. [=*Phyllanthus emblica* L.]	Amla	Tr	16000	30 - 35
21	*Ephedra gerardiana* Wall.	Somlata	Tm	200 - 500	25 - 35
22	*Gloriosa superba* L.	Kalihari	Tr	100 - 200	600 - 750
23	*Holarrhena pubescens* (Buch.-Ham.) Wall. *ex* G.Don [=*H. antidysenterica* (Roxb. ex Fleming) Wall.]	Kutja	Tr	1000 - 2000	75 - 100
24	*Juniperus communis* L.	Hauber	Tm	500 - 1000	35 - 45
25	*Jurinea macrocephala* (Royle) C.B.Clarke [=*J. dolomiaea* Boiss.]	Dhoop	Tm	1000 - 2000	60 - 150
26	*Litsea glutinosa* (Lour.) Robinson	Maida chhal	Tr	, , , - , , ,	20-35
27	*Nardostachys grandiflora DC.*	Jatamansi	Tm	200-500	110-150
28	*Onosma hispidum* Wall. *ex* G.Don	Ratanjot	Tm	500 - 1000	50-60
29	*Oroxylum indicum* (L.) Vent.	Tetu chhal	Tr	1000 - 2000	20 - 30
30	*Parmelia perlata* (Huds.) Ach.	Chadila	Tm	1000 - 2000	80-90
31	*Picrorhiza kurroa* Royle *ex* Benth.	Kutaki	Tm	200-500	220-230
32	*Pistacia integerrima*	Kakar singi	Tm	150-200	90-110
33	*Rheum australe* D.Don [=*R. emodi* Wall. ex Meissn.]	Revan chini	Tm	500-1000	25-30
34	*Rhododendron anthopogon* D.Don	Talispatra	Tm	100-200	15-30
35	*Sapindus mukorossi* Gaertn.	Reetha	Tr	200-500	30-40
36	*Swertia chirayita* (Roxb. *ex* Fleming) Karst.	Chiraiyata	Tm	500-1000	200-225
37	*Taxus wallichiana* Zucc.	Talispatra	Tm	100-200	75-90
38	*Terminalia arjuna* (Roxb.) Wight & Arn.	Arjun	Tr	2000-5000	10-15
39	*Terminalia bellirica* Roxb.	Behra	Tr	2000-5000	10-15
40	*Terminalia chebula* Retz. & Willd.	Harda	Tr	5000-10000	10-15
41	*Tinospora cordifolia* (Willd.) Hook.f. & Thoms.	Giloy	W	2000-5000	10-15
42	*Valeriana jatamansi* .	Musakbala	Tm	100-200	95-100
43	*Viola pilosa* Bi.	Banafsha	Tm	200-500	300-350
44	*Withania somnifera* Dunal	Ashwagandha	Tr	2000-5000	60-70
45	*Woodfordia fruticosa* (L.) Kurz	Dhai phool	Tr	2000-5000	10-15

(**Tr = Tropical Zone; Tm = Temperate Zone; C = Largely Cultivated**; Source: Ved and Goraya, 2008)

Some important medicinalplants of Himachal Pradesh

Aconitum heterophyllum (Atish)

Angelica glauca (Chora)

Arnebia benthamii (Rattanjot)

Bunium persicum (Kala Zera)

Dactylorhiza hatagirea (Hathpanja)

Dioscorea deltoidea (Shingli mingli)

4.6 Biodiversity Related Activities carried out in the State of Himachal Pradesh:

It is beyond any doubt that the biodiversity provides enormous direct socio-economic benefits, an array of indirect essential services through natural ecosystems to the human kind and accordingly, plays a prominent role in modulating ecosystem functions and stability. One must realize that the biodiversity being the very essence of human survival and economic well being, encompasses all the life-forms, ecosystems and ecological processes thereby, acknowledging the hierarchy at genetic, taxon and ecosystem levels.

However, our knowledge on biodiversity is remarkably incomplete and on the top of it, methodologies for its assessment and conservation also remain inadequate. Apart from it, ethical values and aesthetics of biodiversity are also of the incalculable value to human health. In view of all this, biodiversity has emerged at the centre of one of the most contentious global debate of this century. Virtually all the governments, organizations and communities have responded to this situation in several ways and accordingly, efforts for biodiversity conservation and related research have dominated all recent activities of international organizations.

Stemming from rapidly increasing human and livestock population and diverse demands for growth, pressure on the biodiversity of Himachal Pradesh and Jammu & Kashmir like in other parts of the country, is intense. Industrial society reaching and extending into the most remote regions of this Himalayan State, human induced habitat conservations and species losses are arguably at a record level.

In view of the above, different biodiversity related studies were conducted by the Institute from time to time in different ecologically sensitive and fragile zones in the state of Himachal Pradesh and Jammu & Kashmir. Outcome of the studies clearly revealed that these areas have the presence of unique biodiversity including medicinal plants those are/ were being used by the various stakeholders for their common use.

4.6.1. Cold Desert Biosphere Reserve (CDBR) - Ecologically Fragile Areas:

The study was conducted in different altitudes varying from 2700m-5000m in different areas of cold deserts of Pooh sub-division of district Kinnaur, Himachal Pradesh which revealed that total number of plant species in cold desert of Pooh sub-division was 351 belonging to 75 families and 192 genera. Total number of plant species was 191 belongingto 47 families and 127 genera in Labrang area, 191 species belonging to 49 families and 134 genera in Lippa —Asrang area, 192 species belonging to 55 families and 136 genera in Pooh area, 160 species belonging to 51 families and 119 genera in Ropa-Giavung area, 142 species belonging to 49 families

and 105 genera in Namgia area and 130 species belonging to 41 families and 101 genera in Hango area. The study also revealed the presence of 114 medicinal plant species from the area. Out of these medicinal plants, 24 species i.e. *Aconitum heterophyllum, Aconitum violaceum, Arnebia euchroma, Bergenia stracheyi, Betula utilis, Dactylorhiza hatagirea, Datisca cannabina, Ephedra gerardiana, Ferula jaeskeana, Hippophae rhamnoides, Hyssopus officinalis, Hyoscyamus niger, Juniperus polycarpos, Jurinea dolomiaea, Meconopsis aculeata, Picrorhiza kurrooa, Polygonatum verticillatum, Rheum webbianum, Rheum moorcroffianum, Rhodiola heterodonta, Rhododendron anthopogon, Rhododendron campanulatum, Saussurea gossypiphora, Saussurea obvallata* fall in the category of threatened plants.

Rheum moorcroftianum

Arnebia guttata

Ephedra gerardiana

Similar exercise for documentation of Medicinal plants which was carried out in Miyar Valley, of the district Lahaul & Spill falling in the state of Himachal Pradesh showed the presence of 50 most promising medicinal plants and some of them are *Podophyllum emodi, Meconopsis aculeata, Viola biflora, Geranium wallichianum, Rosa webbiana, Bergenia stracheyi, Potentilla atrisanguinea, Angelica glauca, Bunium persicum, Ferula jaeskeana, Pleurospermum brunonis, Inula racemosa, Arnebia euchroma, Picrorhiza kurrooa, Rheum australe, Polygonatum verticillatum, Trillium govanianum* etc.

4.6.2 Wild-life Sanctuaries:

This ecosystem is another important area of interest and provides uniqueness to the thought process of the stakeholders in general and the specialist in particular. Findings of some of the prioritized sanctuaries revealed as below. The survey and phyto-sociological study were carried out in Rakchham Chitkul wildlife Sanctuary, district Kinnaur, Himachal Pradesh and which showed the presence of 322 plant species belonging to 70 families and 162 genera. The study also included the presence of 98 plant species of medicinal importance. Twenty two plant species of threatened categories were recorded from the sanctuary, out of which 3 were critically endangered, 11 endangered and 13 vulnerable. Critically Endangered Species included *Aconitum heterophyllum, Dactylorhiza hatagirea and Saussurea obvallata whereas, Acer caesium, Angelica glauca, Betula utilis, Dioscorea deltoidea, Jurinea dolomiaea, Meconopsis aculeata, Picrorhiza kurrooa, Podohyllum hexandrum, Polygonatum cirrihifolium, Rheum australe and Taxus wallichiana belonging to Endangered category were recorded. Vulnerable Species of the area included Aconitum violaceum, Bergenia stracheyi, Heracleum lanatum, Hippophae rhamnoides, Ferula jaeschkeana, Polygonatum verticillatum, Polygonatum multiflorum, Rheum webbianum, Rhodiola heterodonata, Rhododendron anthopogon, Rhododendron campanulatum and Rhododendron lepidotum.*

Meconopsis aculeata

Saussurea obvallata

Dactylorhiza hatagirea

The studies conducted in Renuka Wildlife Sanctuary showed that the sanctuary comprises of 61 species of trees, 64 species of shrubs and 157 species of herbs. In Simbalwara Wildlife Sanctuary, the presence of 53 species of trees, 32 species of shrubs and 1/b species of herbs was registered. further analysis of the data collected showed that Kenuka and Simbalwara Wildlife Sanctuaries are having the presence of 95 plants species having medicinal value. Some of the Threatened Medicinal Plants included *Acorus calamus, Aegle marmelos, Asparagus racemosus, Celastrus paniculata, Chonemorpha fragrans, Gloriosa superba, Hedychium spicatum, Nelumbo nucifera, Nervilia prainiana, Oroxylum indicum, Pistacia chinensi, Smilax aspera, Zanthoxylum armatum* etc.

Hedychium spicatum

Gloriosa superba

In Kalatop- Khajjiar Wildlife Sanctuary, total number of plant species recorded were 232 and were found belonging to 76 families and 218 genera. The dominant families were Asteraceae, Rosaceae, Fabaceae, Lamiaceae, Poaceae, Ranunculaceae and Polygonaceae. Out of 100 medicinal plant species recorded from the Kalatop-Khajjiar wild life sanctuary, 7 species viz *Cinnamonum tamala, Dioscorea deltoidea, Paris polyphylla, Podophyllum hexandrum, Polygonatum verticillatum, Taxus wallichiana, Zanthoxylum armatum* fall in the category of threatened plants. *diola heterodonoto, Rhododendron anthopogon, Rhododendron corn ponulatum and Rhododendron lepidotum.*

Podophyllum hexandrum ***Roscoea alpine***

4.6.3 Shimla Water Catchment Sanctuary

The above sanctuary showed the presence 476 species of vascular plants i.e., Angiosperms (101 families, 307 genera and 431 species), Gymnosperms (3 families, 7 genera and 9 species) and Pteridophytes (11 families, 17 genera and 36 species) were recorded in all. Of the total species, 39 species were the trees, 81 shrubs, 320 herbs and the remaining 36 species were Pteridophytes. Total 119 species (15 Trees; 20 Shrubs and 84 Herbs including 4 Ferns) belonging to 111 genera and 62 families were identified under different threat categories. Ten (10) species were identified as Critically Endangered, 31 species as Endangered; 48 species as Vulnerable and 30 species as Near Threatened. Species namely Acer caesium and Dioscorea deltoidea as recorded in the sanctuary have also been recorded in the Red Data Book of Indian Plants.

Pyrus pashia ***Zanthoxylum armatum***

4.6.4 Hemis National Park, Ladakh, Jammu & Kashmir:

The study resulted in enumeration of 458 taxa belonging to 215 genera spread over 59 families of Gymnosperms and Angiosperms. Family Asteraceae with 74 taxa belonging to 29 genera was found to be the most dominant family of flowering plants contributing to 16.2 per cent of the flora.

Hippophae rhamnoides

Peganum harmala

4.6.5 Shikari Devi Wildlife Sanctuary, Mandi, Himachal Pradesh:

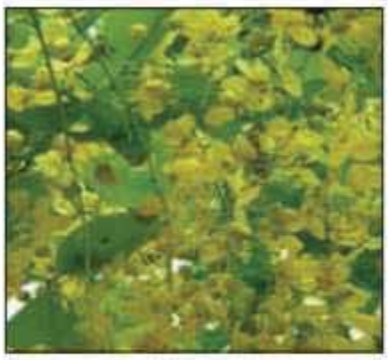
While studying the floristic details of Shikari Devi wild life sanctuary, a total of 201 plant species belonging to 70 families and 149 genera were recorded. Out of 112 medicinal plants, 7 species viz *Angelica glauca, Bergenia stracheyi, Betula utilis, Polygonatum verticillatum, Rhodiola heterodonta, Rhododendron companulatum and Taxus wallichiana* fall in the category of threatened plants.

General View of Shikari Devi WLS

Rhododendron campanulatum

Hydro-electric Project Sites:

The state of Himachal Pradesh is going for the production of hydro power in a big way. In view of this, the institute was involved by various implementing agencies during preparation EIAs and EMPs for these areas. Results of the survey conducted in many of the Hydro-electric Project Sites revealed that in the catchments of Kol Dam Hydroelectric Project Site -which rather falls in Sub-tropical to sub-temperate climate revealed the presence of 227 plant species belonging to 77 families and 194 genera. When considered micro-climatically within the state- recorded the presence of 129 plants of medicinal value. The plant species viz *Zanthoxylum armatum, Gloriosa superba, Roylea cinerea, Valeriana jatamansi, Taxus wallichiana* were fall in the category of threatened medicinal plants.



Cassia fistula

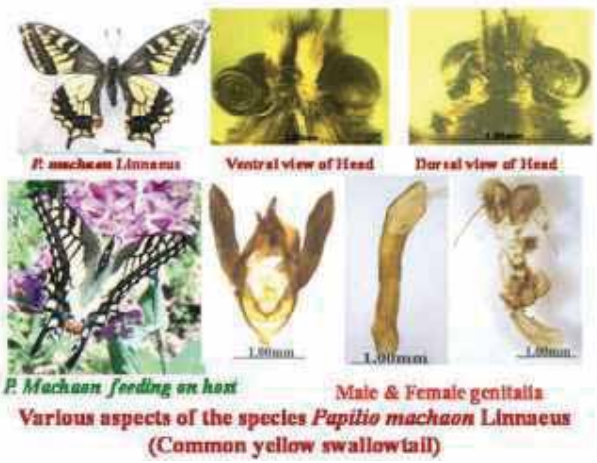
Punica granatum

Calotropis procera

4.7 Diversity of Butterflies in sub-alpine forests of Himachal Pradesh

Study was conducted in subalpine forests of Himachal Pradesh to know the status of Butterflies in these forests. During the study 70 butterfly species belonging to 48 genera and 5 families were identified. 53 species of butterflies were recorded for the first time from Western Himalayan Sub Alpine Forests ot H.P. Similarly, a study was conducted to know the diversity ot Noctuid Moths in Conifer torests ot Himachal Pradesh. Total 107 species of Noctuid moth were identified from the Conifer Forests (Chirpine, Ka il, Deodar, Chilgoza, Juniper, Fir &Spruce. In-fact, it can be concluded that the Western Himalayas which also includes the state of Himachal Pradesh and Jammu & Kashmir is a home to a number of plant species those are quite important from medicinal point of view. Beside, its altitudinal zonations along with variations in terms of its size, climate have created environments those are unique and characteristic to this region only.

Dark Clouded Yellow / *Colias Fieldii* (Menetries)



Various aspects of the species *Papilio machaon* Linnaeus (Common yellow swallowtail)

4.8 MAIN ISSUES OF BIODIVERSITY IN HIMACHAL PRADESH

- Effective valuation of biodiversity especially agro-biodiversity needs proper understanding of traditional farming practices.
- No information base of traditional ecosystem in marginalized / remote areas is available.
- People are totally ignorant of the values of genetic resources available to them in the state.
- Forest fires create havoc, but no fire fighting system/ fireproof system is available for the prevention and control of fire.
- Lack of initiatives for eradication, rehabilitation and alternative use of exotic weeds namely; Lantana camara, Ageratum, Eupatorium and Parthenium in the State.
- Over grazing, soil erosion, exploitation and unlawful activities by intruders are leading to degradation of the biological resources of the state.
- Advancement of development, cement projects, hydroelectric power projects, pose a sevre threat to biodiversity.
- Increase in pollution, population, use of toxic pesticides, chemical fertilizer and changing weather conditions are affecting biodiversity.
- Lack of awareness programmes for the conservation of biological resources in the State.
- Illegal hunting and poaching is one of the main causes for the loss and decline of wildlife biodiversity.
- Habitat destruction, wrong and erratic use of natural habitats, change in climatic conditions and imbalance in natural ecosystems are also causing problems to biodiversity in the state.
- Change in food habits leading to the cultivation of only a few selected cereals, pulses, oil seeds and other economic plants, is also posing a threat to the agriculture.
- Propagation of monoculture practices.
- Introduction of exotic species of flora and fauna adversely affecting the indigenous species in the state.
- Due importance has not been given to biodiversity in the extra-curricular activities of schools, colleges and training institutes.
- People are unaware of the importance and dangerous consequences of losing the biodiversity.
- Efforts for the conservation of biodiversity in the state are not optimum.
- Lack of R&D and transfer of R&D activities related to biodiversity.
- Increased sedimentation from deforestation and mining and unauthorized and indiscriminate fishing using destructive fishing methods: poisoning, electrocuting, dynamiting is threatening aquatic biodiversity.
- Biodiversity education is not an integral part of both formal and non-formal education in the state.
- Poor co-ordination amongst developmental plans, executing bodies, local communities, research and academic institutions.
- Poor control on contractors of medicinal herbs/plants; contracting and collection by outsiders is often done without the knowledge of local people.

ENERGY AND ENVIRONMENT

CHAPTER-5

5.0. Introduction

Energy is one of the major inputs for the development of any economy. India's economic growth is dependent on its ability to provide affordable, reliable, clean and sustainable energy to the vast population. As such the priority for the government is to ensure access to sustainable and clean energy sources for environment protection and address climate change concerns. India accounts for about 18% of world's population and its primary energy consumption is around 6% of the world's energy consumption. India's per capita energy consumption equals 0.6 tons of oil equivalent (toe) as compared to the global per capita average of 1.8 toe. The country is endowed with huge potential of 1,45,000 MW for hydro power and 93,000 MW of pumped storage but only a fraction of this capacity (about 30%) has been harnessed so far [1]. However, the electricity generation could not grow with rapid industrialization and population growth as a result, there is a shortage of 2.1% and peak shortage of 2.6% energy in the country. Even today, India has 75 million households without access to electricity and demand for electricity is expected to rise further. Considering the present energy requirement, India's power sector will depend on imported coal till 2030 [2]. Despite high coal reserves, the share of imported coal in the country may rise to over 30% in the next few years due to challenges in domestic production and the quality of coal [3]. There is an increased environmental concern due to air pollution caused by coal-based power generation. The import of natural gas is also likely to increase from about 25% to over 60% by 2035 to meet the four times increase in the demand for the fuel [4].

India has a good solar energy potential with average solar irradiation around 4-7 kWh/m^2/day which can be used for solar power generation and to meet the demand of low to medium process heat required in domestic, industrial and commercial sectors.

5.1 Fossil fuels and greenhouse gas emission concerns

The rapid industrialization and economic development in India, are expected to increase the dependence on fossil fuel based energy sources [5]. The increased fossil fuel use in the past has raised concerns about the fast depletion of fossil fuels . Anthropogenic activities are responsible for dumping about 8 billion metric tons of carbon into atmosphere every year out of which 6.5 billion tons are from fossil fuels and1.5 billion tons from deforestation. A thermal power plant contributes about 0.9–0.95 kg/kWh of CO_2 [6]. This has also resulted in serious environmental concerns causing climate change which is affecting agriculture thus endangering food security, increasing natural disasters, species extinction, spread of vector-borne diseases, expected rise in sea-level and accelerating erosion of coastal zones.

The dependence on fossil fuel based power production needs to be reduced in view of resulting carbon emissions and from energy security point of view [7]. The greenhouse gas emissions can further be reduced by power generation technologies based on renewable energy sources [8]. China is leading emitters of carbon dioxide (CO_2) followed by United States, the European Union, India, Russian federation, Japan, and Canada based on the data which include CO_2 emissions from fossil fuel combustion, cement manufacturing and gas flaring. India is the fourth largest CO_2 emitter in the world where power sector contributing nearly half of the country's carbon emissions. At present, India has 5th largest power generation in the world based on fossil fuels like coal, gas and oil. The hydro and renewable power generation has a little share in comparison to the fossil fuels. The RE share has increased from 3.2% in 2002 to 22% in 2019 whereas total electricity generation has increased from 3.5% in 2008 to 9.5% in 2019 [9].

5.2 National Initiatives on climate change and improving power generation

It is important to review the initiatives taken on climate change at national level to improve power sector by including renewable energy sources. The total installed capacity for electricity generation in India from different sources as on 31st December 2019 is given in Table 1.

Installed capacity for electricity generation in India* (as on 31.12.2019) [10]

Sector	Electricity generation (MW)	% of total generation
Central Sector	92,797	25.0%
State Sector	103,815	28.5%
Private Sector	170,668	46.6%
Total	**3,67,281**	

Fuel	MW	% of total
Total Thermal	2,30,701	62.8%
Coal	1,98,495	54.2%
Lignite	6,760	1.7%
Gas	24,937	6.9%
Diesel	510	0.1%
Hydro (Renewable)	45,399	12.4%
Nuclear	6,780	1.9%
Renewable Energy sources RES** (MNRE)	84,400	23.1%
Total	**367,281**	-

It is clear from Table that contribution from renewable energy sources (RES) which include solar, wind, small hydro, biomass, urban and industrial waste is only 23.1%. This points to the need that India must increase its share of renewables in the overall energy mix for electricity generation to meet its commitment to reduce carbon emissions. The large-scale deployment of renewable energy can help India in addressing the three main issues: energy access, energy security and GHG emissions. To mitigate the impact of climate change in India, the Govt of India has taken several initiatives.

5.2.1 National Action Plan on Climate Change

India is committed to reduce the green house gas emissions by 20–25% till 2020 from 2005 levels. A National Action Plan on Climate Change (NAPCC) was launched on June 30, 2008 with eight "National Missions" to promote renewable power generation development while addressing climate change effectively. The missions are "National Solar Mission; National Mission for Enhanced Energy Efficiency; National Mission on Sustainable Habitat; National Water Mission; National Mission for Sustaining the Himalayan Ecosystem; Green India Mission; National Mission for Sustainable Agriculture; National Mission on Strategic Knowledge for Climate Change".

The National Action Plan on Climate Change (NAPCC) addresses the climate change mitigation from fossil fuel to non-fossil fuel based economy by utilizing renewable energy sources. The plan envisages that India's per capita greenhouse gas emissions should not exceed those of developed countries.

• Program to phase out inefficient coal-fired power plants and support research and development of supercritical technologies

• Promotion of renewable energy under the Electricity Act 2003 and the National Tariff Policy 2006 vide which central and the state electricity regulatory commissions must purchase a certain percentage of grid-based power from renewable sources.

• Energy audit and energy labeling of appliances for large energy consuming industries has been introduced under the Energy Conservation Act 2001.

• The Renewable Purchase Obligation (RPO) is the major driving force in India to promote the renewable energy sector. The national renewable energy purchase standard is set at 5% of the total grid purchase initially and increased by 1% each year for 10 years. The state electricity regulatory commissions were given flexibility to set higher targets at any time.

5.2.2 National Solar Mission

In order to promote solar technology in the country Jawaharlal Nehru National Solar Mission (JNNSM) was launched in 2010 to address energy security issues and environmental concerns. The mission is being implemented by Ministry of New and Renewable Energy (MNRE) government of India (GOI) and is a major initiative to meet the global challenges of climate change. The main objective of the mission is to create favorable policy conditions for solar energy promotion in the country. The mission sets a power generation target of 175GW upto 31 Dec 2022 which will play a major role to meet the energy needs of the country. The mission aims at reduced cost of solar power generation through long term policy initiatives, research and development, production of critical raw materials, components and products, to achieve grid tariff parity.
The sector wise renewable energy power generation & cumulative upto December 31, 2019 is presented in Table 2

Installed renewable energy power capacity in India as on 31.12.2019 [11]

Sector	(Capacity in MWp)
I. Grid-interactive power	
Wind Power	37505.18
Solar Power - Ground mounted	31397.30
Solar Power - Roof top	2333.23
Small Hydro Power	4671.55
Biomass (Bagasse) Cogeneration)	9186.50
Biomass (non-bagasse) Cogeneration)/Captive Power	674.81
Waste to Power	139.80
Total	**85908.37**
ii. Off-grid/ captive power	
Waste to Energy	191.13
SPV Systems	945.22
Total	**1136.35**
III. Other renewable energy systems	
Biogas plants (No.)	50.39 lakhs

5.3. Impact of climate change on Himalayan ecosystem - National Mission for Sustaining the Himalayan Ecosystem.

The use of fossil fuels, greenhouse emissions have started to impact the Himalayan ecosystem, forest cover and the glaciers. The recession of Himalayan glaciers due to global warming is a cause of concern and may pose a major danger to the country although no systematic trends of recession of Himalayan glaciers have been established as yet. Himalayan glaciers are the main sources of water for Indian rivers emanating from the region.

The National Mission for Sustaining the Himalayan Ecosystem (NMSHE) was launched in 2010 with the main objective to conserve bio-diversity, forest cover and ecology in the Himalayan region to protect Himalayan ecosystem and receding glaciers. The mission is being implemented by Ministry of Science and Technology, GOI and covers all 12 Indian Himalayan States namely Jammu & Kashmir, Himachal Pradesh, Uttarakhand, Sikkim, Arunachal Pradesh, Nagaland, Manipur, Mizoram, Tripura, Meghalaya, and hill regions of Assam and West Bengal.

5.4 Integration of renewable energy sources in conventional electricity production

Wide-ranging reforms in electricity sector including restructuring of State Electricity Boards (SEBs) and various regulations by state electricity regulatory commissions (SERCs) have been introduced under Indian Electricity Act (IEA), 2003. However, IEA, 2003 changed the legal and regulatory framework for the renewable energy sector as it provided a provision of policy formulation by the Government of India and makes it mandatory for SERCs to take steps to promote renewable sources of energy within their area of jurisdiction. The formulation of National Electricity Policy (NEP), tariff policy, and the plan for development of power systems based on optimal utilization of all energy resources including renewables are mandatory under the act. For the first time, promotion of cogeneration and generation of electricity from renewable energy sources were made the responsibility of SERCs, which were bound to consider these while formulating terms and conditions of tariff regulations. All SERCs have issued their tariff regulations incorporating suitable clauses to provide preferential treatment to renewable energy during the tariff determination process. Thus, the feed-in tariff (FiT) was formally introduced.

5.5 Status of energy programmes in Himachal Pradesh

Major source of electricity in Himachal Pradesh is hydro power with share from thermal (coal & gas) and nuclear power plants in central sector followed by renewable sources (RES).

5.5.1 Hydro Power Development in Himachal Pradesh

Hydro power is a clean, green, sustainable source of power with estimated Green house gas(GHG) emissions of 4 gm CO_2/kWh whereas coal based thermal plants emit about 1001 gm CO_2/kWh (Intergovernmental Panel on Climate Change in 2011). In India, hydropower projects up to 25 MW are considered as small hydropower projects generating clean energy at a competitive cost. The technology used in these projects is mature, largely indigenous and can meet the power requirements of remote and isolated areas. The large hydropower projects are no longer considered as 'renewable' due to associated adverse problems like rehabilitation, resettlement deforestation and environmental damage.

Small hydropower (SHP) is regarded renewable worldwide due to least adverse environmental impact and minimum energy payback period. One GWh of electricity produced by small hydropower can result in reduction of 480 tons of CO_2 emissions. The maximum power production by SHP located in hilly regions of

India is in the summers due to melting of glaciers and monsoon seasons. The generation season of SHPs coincides also with peak seasonal demand .

Hydro power development in Himachal Pradesh has contributed to the economic development through revenue generation, increased employment opportunities and improvement in the quality of life. The hydro power development in HP now mainly focuses on run of the river hydro projects. Himachal Pradesh State Electricity Board Limited (HPSEBL) is responsible for hydro power generation through a network of transmission, and distribution lines and has achieved 100 % electrification in all census villages in 1988 and ensures uninterrupted power supply with lowest tariff in the country.The small hydro power projects up to 5 MW capacity are undertaken by HIMURJA.

The state has snow and rainfall fed perennial rivers namely Sutlej, seas, Ravi, Chenab/ Chandra-Bhaga, Jhelum, Yamuna and their tributaries which accounts for 23% of harnessed hydropower potential of India (above 25 MW capacity). The development of hydro power has several environmental problems associated with it such as land use changes, impact on local habitats, ecological imbalance and decrease in production due to siltation etc. Keeping in view these aspects, HP Govt. has focused on environmentally sound and socially sustainable hydro power development in the state through the active involvement of public and private sectors.

The estimated hydro potential of State of Himachal Pradesh is 27,436 MW out of which 24,245 MW has been assessed to be ha rvestable, the Govt. has decided to forgo certain potential to protect the environment, ecology and address the social concerns. The state has commissioned 157 power projects of 10596.27MW capacity (in Central, joint and private sectors) and of 58 under-construction projects of 2351.29MW only 25 projects of 2010.5 MW are in the private sector, according to the status report of the Directorate of Energy as on December 2019 (Table 1.

Hydro power projects installed in Himachal Pradesh upto December 2019 [12]

S. No.	Sector		Commissioned		Under construction	
			No. of projects	Capacity (MW)	No of projects	Capacity (MW)
1	HIMURJA	State Private	10 83	2.37 313.95	1 34	5.0
2	HPSEBL		23	487.55	1	111.99
3	HPPCL		2	165.0	3	100.0
4	Central & Joint		12	7457.73	1	691.0
5	Yamuna Projects (HP Share)		0	131.57	0	800.0
	Ranjeet Sagar Dam (HP share)		0	27.60	0	0
	Kishau Dam (660 MW, HP share)		0	0	0	0
6	Private		25	2010.5	18	0
Total			**157**	**10596.27**	**58**	**2351.29**

5.6 Solar power generation in Himachal Pradesh

Solar energy has not been adequately exploited in India although about 5109 GWh of solar energy is incident annually over India ranging from 4–7 kWh per m^2/day. According to National Institute of Solar Energy (NISE) the HP state has estimated potential of 34 GW considering 3% of total wasteland and roof top surface area of the consumers. IREDA has estimated a potential of about 53 GW taking into account 5% of the waste land. Recently an extensive solar potential assessment of Solan Sirmaur, Bilaspur, Una and parts of Mandi and Kangra districts has been done under a HPERC project by identifying for solar power plants in the state [13]. Thus, the state has huge unexploitable solar power potential.

In consonance with the National Policy of Renewable Energy for achieving a target of 40 GW under the grid connected rooftop solar programme, the Govt of H.P. has adopted the programme and a notified in the state Solar Power Policy, 2016 [14]. The H.P. State Regulatory Commission (HPERC) has notified the regulations for the grid connected rooftop solar programme under the Net Metering Scheme which are being implemented by HPSEBL & HIMURJA, the state nodal agency for renewable energy [Himachal Pradesh Electricity Regulatory Commission (Rooftop Solar PV Grid Interactive System based on Net Metering) (First Amendment) Regulations, 2018]. One kWp rooftop solar plant produces about 4.5-5.5 kWh (units) of energy per day during clear sunny conditions. On an average considering 280 sunny days, a 1 kWp grid connected rooftop solar plant is expected to generate 1300 units in a year. As per HPERC regulations, the energy generated from a solar power plant will first be consumed by the beneficiary and surplus energy is fed to the grid and if the beneficiary avails less than 50% subsidy then HPSEBL will buy surplus power @ Rs 5.00 per unit. In case, the subsidy availed is more than 50% the applicable tariff is Rs 2.50 per unit [14].

MNRE has revised the subsidy pattern for the state vide which subsidy for grid connected rooftop solar plant will be 40% of total cost upto 3 kW, and 20% above 3 kW upto 7 kW [15].

Some of the major installations under the grid connected rooftop solar programme include 600 kWp plant at MMU University, 350 kWp at Sirmaur, 120 kWp at Chitkara University, 400kWp at Shoolini University, Solan. Himurja has set up target to install roof top solar power plants in 60 govt buildings, out of which roof top solar power plants have been installed in 48 govt building generating 1350 kW of electricity. In domestic sector or GCRTS generating 6794.68 kW electricity with 70% subsidy from GOI and Rs. 4,000 from state govt have been installed. The off grid solar power plants of 2159 kW capacity have also been installed in the state. The state govt is also providing 30% subsidy on solar water heating systems.

Further a road map has been prepared by HIMURJA for the future and accordingly MNRE, GOI has been requested to allocate a target of 2.5 MW for grid connected Rooftop Solar Plants (GCRTS) to be installed in govt. buildings/ institutions in Shimla City for which the beneficiary share will be borne by the state govt. The ground mounted solar power plants of 21 MW capacity have been installed in the state along with 312 off grid solar power plants installed in government schools.

5.6.1 Roof Top Solar power plants- Net Metering policy

The electricity consumers of HPSEBL are eligible to install minimum 1 kW to maximum 5 MW capacity solar PV plants on the building roof tops or premises which will be connected to grid with bidirectional meters, where in consumer will use solar generation for own consumption and only draw from grid to meet the deficit which will be billed and surplus generation will be injected in to the grid which will be paid to the consumer by HPSEBL.

HPERC has already framed regulations for tariff in the region, to encourage investment. The necessary guidelines and updated information are available at HPSEBL HPERC & Himurja websites. HPERC has prescribed a long term Renewable Power Purchase Obligation (RPPO), in line with National Action Plan on Climate Change (NAPCC), under which by 2022 the HPSEBL has to purchase at least 19% of electricity including 3% from solar source of total energy consumption, from renewable sources, as against 17% under NAPCC. The energy available from non solar (SHP) sources is already more than RPPO but against solar RPPO, the state requires about 250 MW capacity whereas presently long-term source of supply available from CPSUs is about 35 MW. In order to match the State's target with National target of 100 GW, HP should require about 700 MW capacity to be created by 2022.

5.6.1.1 Policy Issues:

Himachal being a hilly state, the logistics, operation &maintenance and installation costs for roof top PV systems is higher as compared to those of states with flat terrain thus the benchmark for PV systems should be more realistic, Besides reducing central subsidy and incentives at this stage of implementation will affect this new initiative in the state and require to be restored for hilly states of India.

5.6.1.2 Energy storage

With ambitious plans to use solar PV – to meet the rapidly growing electricity demand, there is a need for additional power system flexibility in the coming decade. Energy storage especially batteries are essential for solar electricity flexibility by storing it during sunny periods and feeding it back to the grid during non-sunny period. Battery storage coupled with solar PV is one of the most cost-effective ways to provide affordable electricity to rural and remote locations. Falling costs are a necessary condition for the widespread market-driven deployment of battery storage. Electricity market reforms, accuracy and precision of battery storage systems are crucial to incentivise investment.

5.6.2 Empowering electricity consumers to lower carbon footprint

Reducing electricity demand during CO_2 intensive hours and creating awareness among users about hours of the day which are the most CO_2 intensive and which are best hours to use electricity. Consumer actions to change when electricity is used will be influenced by electricity pricing and incentives. Presently most consumers pay the same price for a kWh consumed at midnight, or a kWh consumed at midday, different tariff structures are needed to provide consumers a financial incentive to shift or reduce their electricity use. The variable renewable generation corresponds with relatively low prices in electricity wholesale markets so shifting electricity demand to times of low CO_2 intensity can potentially save consumers money on their electricity bills. The increased availability of data and new tools can help provide real-time information on the CO_2 intensity of electricity By setting different prices for different times of the day, time of use electricity tariffs can incentivize consumers to shift their consumption to benefit from lower price of solar PV in the middle of the day. Innovative business models and new tariff structures can encourage consumers to shift demand, without compromising affordability and security of supply.

5.7 Initiative on Solar passive building technology in Himachal Pradesh

World's building sector, is one of the significant consumer of energy and accounts for about 55% of the global electricity demand for lighting, space heating, and cooling which is expected to become more than triple by 2050. Thus, applying energy conservation and CO_2 emission reduction measures in building sector is important. In India the building sector consumes about 35% of total energy consumption which is increasing by 8% annually However, the buildings must provide a healthy and comfortable indoor environment also to the occupants. The poor comfort conditions lead to high energy consumption and can be avoided by using site specific and climate responsive building designs incorporating natural heating and cooling features and using renewable energy resources. In most climates, proper building orientation can reduce building energy demand for heating and cooling at no cost increase.

5.7.1 Adoption of Passive Solar Building design and technologies

A passive solar design takes advantage of a building's site, climate, and materials to minimize energy use and to meet heating demand in winters and cooling demand in summers. The climate specific passive solar technologies have been found to improve thermal comfort besides reducing energy consumption by 40 % - 60 %.

5.7.2 Solar House Action Plan for Himachal Pradesh

A. Solar House Action Plan (SHAP) for Himachal Pradesh was formulated and co-ordinated by one of the authors (S.S.Chandel) while working in State Council for Science, Technology & Environment, H.P (HPSCCTE), the co-ordinating agency for the implementation of SHAP. HP govt approved the plan to be implemented by HPPWD, HP Housing board and other agencies in the state.The state has snow and rainfall fed perennial rivers namely Sutlej, Beas, Ravi, Chenab/ Chandra-Bhaga, Jhelum, Yamuna and their tributaries which accounts for 23% of harnessed hydropower potential of India (above 25 MW capacity). The development of hydro power has several environmental problems associated with it such as land use changes, impact on local habitats, ecological imbalance and decrease in production due to siltation etc. Keeping in view these aspects, HP Govt. has focused on environmentally sound and socially sustainable hydro power development in the state through the active involvement of public and private sectors.

The estimated hydro potential of State of Himachal Pradesh is 27,436 MW out of which 24,245 MW has been assessed to be harvestable, the Govt. has decided to forgo certain potential to protect the environment, ecology and address the social concerns. The state has commissioned 157 power projects of 10596.27MW capacity (in Central, joint and private sectors) and of 58 under-construction projects of 2351.29MW only 25 projects of 2010.5 MW are in the private sector, according to the status report of the Directorate of Energy as on December 2019 (Table 3).

Policy Decisions

- Himachal Pradesh is the first state Govt. in the country to make Solar passive building technology mandatory in the design and construction of all govt /Semi Govt govt / semi-govt. and commercial sectors buildings housing boards w e f May 1994.
- Another policy decision was taken in 2000 that; All the departments including Corporations, Boards, Universities, HP Housing Board [Now HIMUDA] & HPPWD should incorporate solar passive features in the building designs at places above 2000 meters (msl), vide notification no. STV(S&T)A(5)V93 dated August 18, 2000.
- Based on the successful implementation of the program ,another policy decision was taken on the initiative of HPSCTE by the Town & Country Planning department (TCP) that all govt/Semi govt buildings and commercial buildings are to be designed incorporating solar passive features .This has been included in the building byelaws by TCP Department w.e.f 2009 vide which no map can now be passed without inclusion of solar passive features.

25 passive solar buildings were designed and constructed initially:namely HP co-operative Bank, State Bank of India, HIMURJA Office building, MLA Hostel, Judges & Ministers Houses, IGMC Hospital, Nirman Bhavan, HP; Schools, Teacher Hostels and residential buildings in cold desert region of Spiti during 1998-2000.The buildings constructed under the Solar House Action Plan, have several solar passive heating design features and systems installed resulting in considerable saving of energy and improving thermal comfort living conditions. In these buildings wall mounted solar air heaters, Trombe wall systems and roof top solar air heater with electric backup were provided along with sunspaces , thermal air heating panels, and double glazed windows. In number of houses in high altitude regions of Kinnaur, Chamba, Lahaul & Spiti, Shimla locally fabricated solar air heating systems were installed under the plan.

The monitoring of these buildings showed that locally fabricated passive air heating systems could meet partially the energy needs and there is further need to develop high performance systems with thermal storage for night time heating and which could be installed easily and readily available in the market.

The performance of solar passive designed HP Cooperative Bank building with limited solar access carried by [16] showed that the air heating system design of solar wall and roof top air heating system can further be improved to include integration of PV panels and thermal storage. Several passive / active solar air heaters have been developed with or without thermal storage. However, with the advent of new advanced materials and design strategies, it is imperative to develop advanced collector designs.

5.7.3 Policy concerns & follow-up

Himachal Pradesh is the first state in the country to take such a policy decision and its successful implementation to save energy on such a massive scale. This programme along with focus on various other energy conservation measures is being undertaken by state housing agencies, HPPWD, HP Housing board, HPSCTE and the Department of Energy in the state. However, the policy require to be reviewed and revised to extend to all new and old houses, commercial residential buildings including hotels and govt /semi govt/ Institution buildings which are large consumers of electricity. Besides with the introduction of Energy conservation, Green building concepts, Energy star rating, Roof top solar power plants, net metering policy modification in building bye laws is also essential, Thus a new Solar passive building technology policy is required to be formulated to save energy and environment as well as improving living conditions for the people of the state.

5.7.4 Energy Star Rating for buildings -Green Rating for Integrated Habitat Assessment

The Green Rating of buildings for Integrated Habitat Assessment known as (GRIHA) is a rating tool to assess the performance of the building as per nationally acceptable benchmarks. The Star Rating of buildings is based on actual performance of the building in terms of specific energy usage (kWh/ m^2/year) i.e. Energy Performance Index (EPI). Rating of buildings on a 1-5 Star scale with 5-Star labeled buildings being the most efficient. It evaluates the environmental performance of a building over its entire life cycle, thereby providing a definitive standard for a ' green building. The rating in accordance with national standards and guidelines namely the National Building Code 2016 and the Energy Conservation Building Code 2017, and other regulations pertaining to waste management, have been structured to new concepts in the design and construction sector like life cycle assessment and life cycle cost analysis of materials, a water performance index to reduce the stress on municipal supply lines, emphasis on the treatment of grey and black water, elf-sufficiency through urban agriculture, the integration of renewable energy generation with optimized energy use and enhanced management of waste with a focus on the generator's responsibility. All new construction projects with built up area more than 2500 m^2 (excluding parking, basement area, and typical buildings) are eligible for certification under GRIHA v.2019. GRIHA Council has developed detailed guidelines as GRIHA v.2019 [18].

5.7.5 Energy audit of buildings

According to National action Plan on climate change and Directorate of energy has mandate to promote energy audit of all the institutions in the state. The energy audit of all the Govt and Pvt buildings, institutions, Industry need to be made mandatory for energy conservation and to mitigate climate change.

5.8 Other Solar thermal applications

Solar energy can be directly converted into heat efficiently as such has wide range of applications.Solar thermal applications are economically viable and used for water heating, drying and cooking. Solar water heating is a mature technology, used in house, industry, hotel, hospital etc. The flat plate collectors and evacuated plate collectors are used for solar water heating and solar drying and industrial heat processing. Concentrated solar technologies are used for cooking and industrial process heat. Some of relevant solar thermal applications to the state and which have already been promoted in the state, are presented in this section.

5.8.1 Concentrated solar steam community cooking systems

Concentration solar thermal (CST) technology produces temperature ranging from 100 to 450˚C or more which has a vast potential in industries and commercial establishments. There are six main CST technologies commercially available in India:

- Fixed focus automatically tracked elliptical dish (Scheffler)
- Dual axis tracked paraboloid dish
- Fresnel reflector-based dish (ARUN dish)
- Single axis tracked parabolic trough concentrator
- Non-imaging concentrators
- Linear Fresnel reflector

A concentrated Scheffler type dish uses steam for cooking food. As a thumb rule 3 to 4 dishes of 16 sq. m. each are enough for cooking food for around 250-300 persons depending on location and solar radiation availability. Mainly two types of solar steam generating systems are used: fixed receiver East-West automatic tracking (Scheffler) and the other fully tracked receiver on dish technology (Arun). A 10 dish system (160 sq. m.) is sufficient to cook food for 1000 persons A number of fixed receiver solar steam cooking systems with

tracking have been installed in the state: for 5000 persons at Eternal University, Baru Sahib, for 500 girl students in a Girl's hostel at Shoolini University and for 500 students at National Institute of Technology, Hamirpur. Several such systems have been installed recently in the state. The technology is suitable for community cooking in hostels residential schools, institutional kitchens, industrial, canteens, religious ashrams, hotels, hospitals, police and armed forces kitchens to save considerable LPG, fuel wood and other fuels.

5.8.2 Follow up:

Proper training and operation maintenance issues along with technical support by the concerned installing companies are some of the issues required to be addressed. The performance evaluation of these systems along with R&D as per local requirements need to be carried out through Energy Research Centres established in the state Institutions.

5.9 Promoting solar cooking in domestic sector

In recent years there is lack of interest in promoting solar cooking in the state. The use of a standard box type solar cooker leads to saving of at least one LPG cylinder per month for a small family. There is a need to promote solar cooking in domestic sector in urban and rural areas as efficient designs of solar cookers are now available. A dish solar cooker of smaller size can cook food for about 10-12 people and saves around 8-10 LPG cylinders in a year, Also bigger size solar cookers are also available for mid-day meal cooking in schools.

5.9.1 Follow up:

The development of low cost and improved designs along with a massive solar cooker promotion awareness programme is required in the state to conserve LPG and electricity being used for cooking in domestic sector.

5.10 Energy needs for year long hot water requirement in the state

The water heating is a major yearlong requirement apart from cooking in this hilly state. This is being met using fuelwood, LPG, solar heating and electricity. In rural areas people use fuel wood based simple system known as Hamam and cook stove integrated water heaters which are useful technologies but require further improvements. Keeping in view the environmental pollution due to fuel wood /fossil fuel-based systems, the solar water heating systems are propagated in the state. Upto now 19,52,370 litre per day capacity solar water heaters are installed in the state. However, a promotion campaign is required in the state to conserve daily energy used for water heating.

5.10.1 Follow up:

Further focus is required on low cost solar water heating as well as developing hybrid solar -biomass- based improved water heating domestic systems for rural areas and promotion of alternate options in domestic, industrial, and commercial sectors.

6.4. Potential for solar drying of agriculture/ horticulture produce

Himachal Pradesh is a mountainous state known as fruit bowl of India. Large quantities of fruits and vegetables are damaged due to their perishable nature / bad weather or lack of transportation facilities resulting in loss to the farmers. About 20% tomatoes, 10% ginger, 10% mushroom, 30% amla (Emblica officinalis) and 5% apples are generally damaged during a year [18]. People in the state dry fruits apple, peach,

palm nut, and vegetables chilly, turmeric, ginger and wild pomegranate (Anardana) in open Sun, resulting in poor quality of the dried product due to dust, fungus, infection, insects, sudden rains, wild animals particularly monkeys. The main crops dried in the state are summarized in Table.

Yearlong schedule of potential crops to be solar dried commercially

Month	Potential crops to be solar dried
January	Turmeric, Methi, Sarson
February	Amla, Rhododendron (Brass) flower, Guchhi
March	Banaksha, Herbal plants
April	Peas, Garlic
May	-
June	Mango
July	Beans, Potato, Pumpkin
August	Anardana (wild pomegranate seeds), Kala Jeera
September	Red chilly, Maize
October	Apples, Walnut, Apricot, Almond, Ginger, Brahmi, Kesar
November	-
December	Mulhathi, Tulsi, Sarpgndha, Ashwagandha, Jatamasi

The tomatoes and Anardana (wild pomegranate seeds) are produced during rainy seasons and open sun drying of these products has more chances of damage due to bad weather resulting in low returns to the farmers. Solar drying of fruits and vegetables can reduce the losses, better food preservation technology and improve the quality of product with better price in the market. Various solar driers have been developed using different materials but could not be adopted by the farmers due to high costs. Various types of low-cost natural convection solar driers were developed at Energy Research Centre of the Dr Y.S. Parmar University of Horticulture & Forestry, Nauni (Solan) during 1988. Solar drying techniques for different crops were developed and popularized among farmers throughout the state. An indirect solar drier has been developed recently for the drying of fruits, vegetables, seeds and medicinal plants. The drier has a temperature controller to regulate the temperature for drying different crops and blower at inlet to provide dry air at inlet for enhancing collector efficiency and a thermal storage using gravel and iron scrap to radiate heat after sunset. The comparison of market rates of open and solar dried products is given in Table .

Higher returns of solar dried products in local market ($/kg)

Product	Open sun dried ($/kg)	Solar drier dried ($/kg)	Increase in return (%)
Garlic powder	4.0	6.0	50.0
Apricot	1.5	2.7	68.8
Almond	-	6.0	0.0
Turmeric	2.0	4.0	100.0
Ginger (Sonth)	6.0	10.0	66.7
Peas	2.0	6.0	200.0
Turmeric	4.0	6.0	50.0
Red Chili	2.8	3.6	28.6
Apple Chips	2.0	6.0	200.0
Turmeric	1.6	4.0	150.0
Red Chili	2.0	3.0	50.0

The solar drier maintains natural quality, quality standards of dried products contain higher quantities of Phyto-nutrients as compared to electric oven and open sun dried products. The higher shelf life, less drying time, higher market rates, protection from dust, insects, pests are the value addition of solar dried products (Table).

Value addition of solar dried products [19]

Parameters	Open sun	Oven	Solar drier
Tomatoes			
Reducing sugar (%)	20.25	21.20	21.70
Total Sugar (%)	22.60	23.49	24.18
Titratable acidity (%)	12.40	13.71	13.09
Ascorbic acid (mg/100gm)	7.85	10.39	12.09
Moisture content (%)	11.32	7.58	9.02
Colour	Light brownish	Brownish pink	Pink
Ginger			
Colour	Greenish yellow	Dull	Original yellow
Oleoresin (%) on dry w basis	4.79	4.98	5.25
Moisture content (%)	9.54	5.88	9.3
Red Chilly			
Colour	Light red	Blackish dark re	Redish pink
Moisture content (%)	11.94	6.38	7.34
Turmeric			
Colour	Light redish yellow	Blackish yellow	Dark redish yello
Moisture content (%)	11.37	7.59	9.23

About 17 solar driers of 40 kg capacity were installed at different locations in HP and Uttarakhand to demonstrate the usefulness of the technology to the farmers.

5.12 Promoting LPG - Saving bio-mass resource

In past decades the use of LPG has increased considerably both in domestic and commercial sectors in the state. According to petroleum planning and analysis Cell of the Ministry of Petroleum & Natural Gas, GOI, there are 17.27 lakhs LPG connections in HP till 1st April 2019. The state govt has distributed 1,13,925 gas connections under PM Ujjawala Yojana till 19/6/2019. However, the increased promotion of LPG in rural areas is not desirable as people still use fuelwood in rural areas for cooking and space heating requirements. The improved cookstoves and biogas are the better alternatives in rural and remote regions of the state.

5.13. Reducing Pollution and dependence on petroleum products in Transport & other Sectors

The consumption of petrol and diesel in the cities due to ever increasing vehicles is a cause of concern resulting in increased pollution ,GHG emissions and climate change concerns. According to the National Ambient Air Quality Standards (NAAQS), the recommended concentration of air quality parameters are given in Table.

National Ambient Air Quality Standards (NAAQS)

SO_2 in industrial, residential, rural and other areas	80 $\mu g/m^3$
NO_2	80 $\mu g/m^3$
Particulate Matter (PM_{10})	100 $\mu g/m^3$
Particulate Matter ($PM_{2.5}$)	60 $\mu g/m^3$
Ozone (O_3) 8 hrs	100 $\mu g/m^3$

As per directions of National Green Tribunal (NGT) to maintain the ambient air quality, the HP State Pollution Control Board has formulated guidelines for fuels in following sectors :

Transportation: Bharat Stage VI compliant petrol and diesel with 10 ppm Sulphur, LPG,Natural Gas/Compressed Natural Gas (CNG), Biofuels etc.,

Industries : Liquefied Petroleum Gas (LPG) .Liquefied Natural Gas (LNG),Piped Natural Gas (PNG).High Speed Diesel (HSD) ,Bio Gas, Bio-fuels (Bio-Ethanol etc.),Refuse Derived Fuel (RDF): for Cement kiln & Waste to Energy plant ,Biomass as fuel (like Pine Needles, Briquettes/Pellets of Pine Needles and other Lantana etc. Cement Industries which are using Pet-Coke and Coal as a fuel will meet at least 0.1 % of their annual fuel consumption from forest based biomass.

Commercial Sector: LPG, Biogas, Biofuels Any other fuel notified/ notified by the Central /State Government from time to time.

5.13.1 Follow up in Transport sector

In order to reduce carbon emissions, the use of petrol and diesel with 10 ppm Sulphur, LPG ,Natural gas/Compressed Natural Gas (CNG),biofuels based vehicles and mandatory use of electric /solar based vehicles are the new options for local transport . The local transport (buses, taxis and two wheelers) can be replaced with solar /electric vehicles in a phased manner along with introducing solar power run metro railway services at least in major towns namely Shimla, Mandi, Solan, Dharmshala, Chamba etc. The extension of railway lines to major town sin the state, is one of the major issues for clean transport in the state which requires priority attention especially using solar/hydro power which is likely to be available in abundance soon in the state.

5.14. Wind power resource assessment and power generation

Wind energy is the fastest growing renewable energy technology for generating grid connected power worldwide. India is the 5th largest wind power producer in the world after China, USA, Germany and Spain. Wind resource assessment in the country is being carried by National Institute of Wind Energy (NIWE), Chennai under MNRE. As per the Indian wind atlas, the onshore estimated wind potential is 49,130 MW on 50m height and 1,02,000 MW on 80 m height.

For the sake of potential estimation 2% land availability is assumed for all the states except for Himalayan states, North eastern states and Andaman & Nicobar Islands. In Himachal Pradesh the wind mills were installed at few locations but could not be successful due to low density of wind.

Some preliminary wind resource assessment and solar wind hybrid systems have been done at the Centre for Energy and Environmental Engineering, NIT Hamirpur with the installation of a 6 kWp Solar -Wind hybrid system.

5.14.1 Follow up

There is a need to carry out a detailed wind resource assessment in the state to identify locations in valleys and mountain passes in the state. However, there is a scope of micro wind turbines and solar based wind hybrid systems in the state to meet the house hold energy needs There is need to focus n R&D by the Energy Research Institutions in the state .However, further initiatives need to be followed in collaboration with NIWE to focus on micro level Wind resource assessment in the state.

5.15 Potential of Bio-Energy promotion in the state

Bio-energy is one of the vast sources of energy which requires priority attention especially in hilly regions with enough biomass availability. The potential areas are domestic sector, power production and biogas cogeneration by utilizing Chir pine needles. rice husk, stalk, stems, straw, agro-industrial residues, and fuel wood from energy plantations. The estimated potential of power generation from bio mass in India is 17,000 MW and 5000 MW biogas cogeneration. A cumulative capacity of 4013.55 MW has been installed in the country. The off grid small biogas power plants of capacity 3 kW to 250 kW are also being promoted which utilizes animal, agriculture, kitchen and municipal solid wastes.

5.15.1 Follow up

Biomass gasification is one of the potential areas of research as well as applications in domestic and commercial sectors with availability of mature technologies. Utilization of vast Chir pine needle biomass to prevent forest fires is one of priority areas for the state.

5.15.2 Domestic Bio-gas potential

Biogas is one of the best options to meet energy needs in rural areas with potential for rural employment. A family type biogas plant generates biogas from cattle dung, kitchen waste ,night soil etc. The National Biogas and Manure Management Programme (NBMMP) is a Central sector scheme, which provides for setting up of family type biogas plants in rural and semi-urban areas. MNRE is implementing the programme in all the states and UTs of the country and provides subsidy for family type biogas plants. This is 100% centrally sponsored scheme under which subsidy @ Rs.7000 per biogas plant of one cubic meter and Rs.11,000 per biogas plant of two and above cubic meter capacity, is being provided. The state has a potential of 1,25,000 biogas plants out of which 47,650 biogas plants have been installed as per MNRE report 2017-18. However, the biogas programme implemented by Department of Agriculture, in Himachal Pradesh could not be much successful due to technical, climatic factors , design issues as well as implementation failure

5.15.3 Follow up

There needs to be refocus on quality installation rather than target-oriented approach

5.15.4 Research, development and potential for Improved cooking & space heating stoves

India is world's biggest consumer of fuelwood with 40% of the population dependent on fuel wood for basic energy needs. It is estimated that 65% of the rural population and 22% of the urban population depends on fuel wood for cooking [20]. Fuel wood collection and sale is a source of livelihood for 11% of the population, making it the single largest employer in the energy sector. It has been reported that 93% of the population of Himachal Pradesh use fuelwood as a source of energy. 94% of the households collect fuelwood from nearby forests [21].

The mud cookstoves are used in low altitude regions and metal cookstoves in high altitude areas of the state. The National Programme on Improved Cookstoves (NPIC) was launched in 1984 by Department of Non-Conventional Energy Source (DNES) now the Ministry of New and Renewable energy (MNRE) Government of India. A Technical Back up Support Units (TBSU) was established in 1988 in Himachal Pradesh at Dr. Y.S. Parmar University of Horticulture & Forestry, Nauni to provide technical inputs to the nodal agencies namely Rural Development department, Agriculture Department, HIMURJA were the implementinag encies. A cookstove having thermal efficiency of 20% and more are called Improved Cookstove (IC).

5.15.5 Development of improved space heating metal stoves

TBSU, Solan has developed improved metal cookstove in 1996 for high altitude areas to meet out the demand of cooking and heating. The cooking efficiency of this stove was 18.7% with power output rate of 1.08 [22]. The stove fitted with water tank of 30 litres capacity and has heating efficiency of 40%. It increased the room temperature by 8^{0}C giving space heating efficiency of 30%. The total thermal efficiency of stove was 88.7%. The metal stove was approved by MNRE for dissemination in the field.

The TBSU has developed improved metal cookstoves for Ladakh region of India having cooking efficiency of 25.23% and space heating efficiency of 36.11% thus, total efficiency of 61.34 as compared to traditional efficiency of 45.3- 46.4% [23]. This resulted in saving of 25% cooking time by 25-30 min and total fuel saving of about 28,700 tons.

5.15.6 Indoor air pollution due to wood burning cook stoves

Indoor air pollution due to wood burning stoves were carried out in the state by TBSU during 2014-15 revealed that these cookstoves affect human health and the concentration of particulate matter (PM_{10}) and Volatile Organic Compounds (VOCs) increase with the increase in altitude [24]. The results showed that improved cookstove still require to be promoted in the state .

5.15.7 National Biomass Cookstoves Initiative

After the closure of NPIC a new programme National Biomass Cookstoves Initiative (NBCI) was launched by MNRE in 2009 to enhance the use of improved biomass cookstoves. The initiative stressed the need to set up of state-of-the-art testing, certification and monitoring facilities and strengthening R&D programmes to develop efficient, cost effective devices. However the existing infrastructure in the country was neglected and currently most of the TBSUs are not functional including in the state which was are very important considering the rural population still depends on the biomass.

5.16 Potential for Biomass Briquetting

The protection of forest resources, controlling deforestation, and consumption of fuelwood is essential by using alternatives to fuelwood. Biomass briquettes made from agricultural/forest waste offer better alternative to be used in industrial and in domestic sectors. Biomass briquettes produce less carbon

emissions than traditional coal briquettes. Briquettes have higher thermal value, low ash content and uniform rate of combustion, being cheaper than coal. Low moisture and high density of briquettes gives better boiler efficiency, The bio-mass briquettes can be recycled as compost. The absence of Sulphur, fly ash in briquettes makes them eco-friendly. with low smoke emissions and a steady flame. The raw materials for making briquettes is huge and include saw dust, wood pieces, tree bark , twigs, pine needles, wild grass, sunflower waste, rice husk, groundnut shell, almonds shell, cotton stalks, sugarcane bagasse, leaves, trash, bamboo dust, mustard husk/stalk, pine needles and other wastes. The pine needles causing forest fires, can be used for making briquettes which will also generate employment for rural youth.

5.17 Waste to energy conversion potential

The increasing industrialization, urbanization and changes in the pattern of life, economic growth, give rise to generation of large quantities of waste leading to increased threat to the environment. In recent years, technologies have been developed that not only help in generating substantial quantity of decentralized energy but also in reducing the quantity of waste for its safe disposal.

The MNRE is promoting technology options available for setting up projects for recovery of energy from urban wastes. In developed countries, environmental concerns rather than energy recovery is the prime motivator for waste-to-energy facilities, which help proper disposal and treatment of wastes. Energy in the form of biogas, heat or power improves the viability of such projects. The incineration, bio methanation, pyrolysis and gasification are the options for waste to energy conversion.

5.17.1 Follow up

Indoor air pollution due to wood burning stoves were carried out in the state by TBSU during 2014-15 revealed that these cookstoves affect human health and the concentration of particulate matter (PM_{10}) and Volatile Organic Compounds (VOCs) increase with the increase in altitude [24]. The results showed that improved cookstove still require to be promoted in the state. More innovative waste recycling ,waste management and waste to energy projects are required for all towns and villages also to protect the environment of the state.

5.18 Geothermal energy

Several geothermal power plants, which generate more than 10,000 MW power are operational in 24 countries worldwide. Geothermal energy is being used directly for heating in at least 78 countries [25]. The USA is the largest producer of geothermal energy generating about 3086 MW of electricity. India has huge potential but, the power generation through geothermal resources is still in initial stages. 340 geothermal hot springs have been identified in India. Most of them are in the low surface temperature range from 37^0C to 90^0C which is suitable for direct heat applications. These springs are grouped into seven geothermal provinces Himalayan (Puga, Chhumathang), Sahara Valley, and Cambay Basin, Son-Narmada-Tapi lineament belt, West Coast, Godavari basin and Mahanadi basin. Some of the prominent geothermal resources include Puga Valley and Chhumathang in Jammu and Kashmir, Manikaran in Himachal Pradesh, Jalgaon in Maharashtra and Tapovan in Uttarakhand,Tattapani in Chhattisgarh. MNRE has been supporting geothermal energy exploration, R&D and resource assessment for the deployment of geo-thermal capacity of 1000 MW by 2022. However. geothermal power projects could not be exploited at mass scale, due to availability of coal , need for deep drilling is another issue. However, with technological development, understanding of reservoir characteristics, increasing environmental problems and widening gap between energy demand and supply India is looking for utilizing energy from geothermal.

5.18.1 Follow up

The geothermal resource assessment has to be carried out of Manikaran & Vashisht (District Kullu) , Tatapani (District Mandi) along with smaller sources in the state which can be utilized for heat recovery, space heating , power generation and tourism development .

5.19 Energy Research Centres in the State

The main Energy Research Centres in different Institutions in the state are as follows :

5.19.1 Energy Research Centre, Dr YS Parmar University of Horticulture & Forestry, Nauni

A Technical Back Up Support Unit (TBSU) was established by MNRE, Govt of India in 1988 at the Energy Research Centre of the University to develop improved wood burning Cook stoves to reduce burden on forests and to improve indoor air pollution. The Centre also developed solar driers for the drying of fruits and vegetables. A state level energy park has been established by MNRE in 2013 for demonstrating renewable energy technologies m to combat climate change. The University is planning to install roof top power plant, Community solar steam cooking system and urban solid waste to compost plant.

5.19.2 Biogas research Centre, HP Krishi Vishwavidalaya, Palampur

The Biogas Research Centre at HP Krishi Vishwavidalaya, Palampur has carried out excellent R&D activities during late 1980s in developing of biogas plants and provided technical assistance to state agriculture department .The Centre needs to be activated.

5.19.3 Appropriate Technology Development Centre at Govt Polytechnic, Sundernagar

The HPSCTE established Appropriate Technology Development Centre in1995 at Govt Polytechnic, Sundernagar under a MOU signed with the two organizations, The Centre has excellent training and technology development facilities and has developed and promoted technologies like Water mills (Gharat),, improved cookstove, solar drier, Green houses, rainwater harvesting etc.

5.19.4 Centre for Energy & Environmental Engineering, National Institute of Technology, Hamirpur

A Centre for Energy & Environmental Engineering was established in 2009 at National Institute of Technology, Hamirpur, The Centre ha sexcellent research facilities and offers M.Tech (Energy Technology) and Ph.D programmes. A state level Energy Park is also established demonstrating renewable energy technologies.

5.19.5 Centre of Excellence in Energy Science & Technology, Shoolini University, Solan

A Centre of Excellence in Energy Science and Technology, has been established in 2012 at Shoolini University, Solan which is working in the field of solar thermal, concentrated solar, solar passive housing , hydropower, nano materials, phase changing materials, Green buildings. The Centre is also starting energy M.Tech (Energy Technology) and Ph.D programmes wef June2020 . A concentrated solar steam cooking system for 500 students is installed in Girls hostel and a 400 kWp roof top solar power plant is installed for supplementing the energy needs of the University.

5.20 Energy & Environment agencies in the state

5.20.1 State Council for Science, Technology & Environment, Himachal Pradesh

HPSCTE supports "HP Specific Research & Development Projects" in various fields of Science, Technology & Environment in the State of Himachal Pradesh especially renewable energy. The state policy on solar passive housing technology was formulated by Council in 1994 and modified in 2000, 2009 vide which incorporation of solar passive features have been made mandatory in govt. / semi govt. and commercial buildings .

5.21 HIMURJA -the state Renewable Energy Agency

Himurja is the state nodal agency for renewable energy in the state and is promoting solar systems in the state to meet the energy requirements in the state including solar power, solar power plants , small hydro and related technologies. The Himurja is mainly responsible for implementing renewable energy policies of MNRE in the state.

5.22 HP State Pollution Control Board

The HP state pollution control board is the state agency for the pollution reduction, GHGs emission, environmental protection and promoting clean technologies in the state.

5.23 Conclusions

In this report the status of energy development, policy issues and environment concerns in the State of Himachal Pradesh are presented along with identifying follow up action which needs to be taken as identified in each sections, The main conclusions are summarized as follows: .

1. Himachal Pradesh is one of the most progressive Indian hill states which has taken major policy decisions in the area of energy conservation and environment protection. Making solar passive building technology mandatory in the State, is one of such initiatives which is being implemented in the State. However, in recent years further technology upgradation is required to be included in the policy in view of development of modular solar space heating systems with energy storage .

2. Solar passive feature should be now be made compulsory in all types of buildings including houses , private and commercial sectors after the successful implementation of the technology in Govt. sector to utilize solar energy for space heating and lighting as most of electricity is consumed in these sectors.

3. The promotion of grid connected roof top solar photovoltaic system programme requires net metering policy changes with better incentives for the Himalayan State so that the benefit of this policy reaches to every person in the state ,

4. There is a need to modify building bye laws regarding south facing roof slopes to capture maximum solar radiation to improve the efficiency of roof top solar plants along with integration of solar passive features in houses and buildings.

5. There is need to reduce dependence on conventional energy sources including fossil fuel use for reducing in GHG emissions and to follow an integrated approach for energy usage in domestic, building, commercial, industrial and transport sectors .The renewable and alternate energy technologies as identified are to be

implemented effectively .

6. Waste to energy technologies are to be utilized to manage solid and municipal wastes both in urban and rural areas.

7. Energy policy must be framed separately for rural areas where the use of energy efficient stoves, solar systems and biogas needs to be encouraged for cooking, water and space heating requirements solar drying of fruits and vegetables. The briquetting of biomass wastes, pine needles, biomass gasification require to be explored to reduce adverse environmental impacts. The LPG access to rural areas needs to be promoted only to meet additional energy requirements.

8. Concentrated solar steam cooking system needs to be promoted in community cooking like, hostels, hotels , army headquarter, institutions to reduce fuelwood ,electricity and LPG consumptions

9. The intervention to promote electrical vehicles and alternate transport modes in cities is urgently required to reduce pollution and greenhouse emissions.

10. Solar, wind, geothermal and bio energy resource assessment of the state required to be carried out for further utilizing the vast resources available.

The state agencies need to encourage state specific research and development by involving state Institutions and Energy Research Centres along with strengthening existing infra structure for developing innovative and cost effective energy technologies.

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ENVIRONMENT POLLUTION AND MANAGEMENT

CHAPTER-6

"Environment" includes water, air & land and the inter- relationship which exists among and between water, air and land, and human beings, other living creatures, plants, micro-organism and property; "Pollutant" means any solid, liquid or gaseous substance present in such concentration as may be, or tend to be, injurious to environment; "Environmental Pollution" means the presence of any pollutant in the environment.

6.1 AIR POLLUTION

The earth is enveloped in a layer of gaseous mixture that is called the atmosphere or more commonly air. The atmosphere performs several important functions. The water cycle in the atmosphere is responsible for earth's climate, weather and for the processes of weathering and erosion. The carbon cycle incorporates the process of photosynthesis and cell respiration that are the source of carbon dioxide and oxygen. The nitrogen cycle results in nitrogen fixation i.e. nitrogen is made available in the form that living beings can use. The atmospheric ozone layer absorbs the damaging ultraviolet radiation from the sun. The atmosphere also protects the earth's surface from lethal cosmic rays from the space. The presence of ionosphere results in reflection of the outgoing radio waves back towards the earth making communications possible. The atmosphere maintains the heat balance of the earth. The living organisms thus depend upon the atmosphere for survival but they also modify its composition. The smoke and fumes from forest fires, volcanoes and crude domestic heating and cooking arrangements have caused air pollution since long, but it is the present human activities in aggregate that have caused great changes in the air composition.

The H.P. State Pollution Control Board (HPSPCB) was constituted in 1975 to perform regulatory functions as prescribed under various environmental legislations. The State Board has twenty-five monitoring locations, which are situated at Shimla (2), Parwanoo (2), BBN (4), Damtal (2), Paonta Sahib (2), Kala Amb (2), Una (2), Sunder Nagar (2), Manali (2), Dharamshala (2) and Rohtang area (3). There is a Central Laboratory at Parwanoo and four Regional Laboratories at Paonta Sahib, Jassur, Shimla and Sunder Nagar for providing scientific support to the regulatory functions.

6.1.1 Ambient Air Quality

Monitoring of Ambient Air Quality was started in H.P as far as back in 1987. Over these 30 years, there have been significant change in pattern of industrialization and other activities that have an impact on air pollution. The road network in the State today is reaching far more interior; the dams are being constructed in remote areas. The air quality is thus bound to deteriorate. Air pollution in the State is thus governed from many sources such as industrial, vehicular, commercial, mineral mining, stone crushers, brick-kilns etc. However, pollution control regulatory authority such as State Pollution Control Board takes necessary measures to control/minimize pollution from time to time.

1. Pollution is the release of environmental contaminants. Carbon monoxide, Sulfur dioxide, Chlorofluorocarbons (CFCs), and Nitrogen Oxides produced by industry and motor vehicles are common air pollutants. Sunlight converts nitrogen oxides and hydrocarbons to ozone or smog. Water pollutants may

consist of a wide range of organic and inorganic chemicals such as heavy metals, petrochemicals, chloroform, and bacteria. Water pollution may also occur in the form of thermal pollution and dissolved oxygen depletion. Land pollution is an important aspect of environmental pollution; this phenomenon occurs when chemicals are released by spill or underground storage tank leakage. Among the most significant soil contaminants are hydrocarbons, heavy metals, herbicides, pesticides and chlorinated hydrocarbons.

2. Air pollution is a broad term applied to any chemical, physical (e.g. particulate matter), or biological agent that modifies the natural characteristics of the atmosphere. The atmosphere is a complex, dynamic natural system that is essential to support life on planet earth. Stratospheric ozone depletion due to air pollution has long been recognized as a threat to human health as well as to the earth's ecosystems. Air pollution is caused by gases like SO_2, CO, CO_2, NO_2, hydrocarbons Photo oxidants etc.

6.1.2 Air Pollution from Vehicles

Tourism in Himachal Pradesh is one of the most important sectors for the State's economy. The major attractions in the State are tribal areas, its pilgrim centers, mountaineering and winter sports. Religious tourism is big as the State has more than two thousand temples attracting thousands of devotees from all over the country.

Year	Indian	Foreigners	Total
2005	69.28	2.08	71.36
2006	76.72	2.81	79.53
2007	84.82	3.39	88.21
2008	93.73	3.77	97.50
2009	110.37	4.01	114.38
2010	128.12	4.54	132.66
2011	146.05	4.84	150.89
2012	156.46	5.00	161.46
2013	147.16	4.14	151.30
2014	159.25	3.90	163.15
2015	171.25	4.06	175.31
2016	179.98	4.53	184.51

(Source: Directorate of Tourism and Civil Aviation Government of Himachal Pradesh)

The number of visitors in Himachal Pradesh are increasing every year (table). Tourism industry in Himachal Pradesh is emerging as a major contributor to the gross State domestic product. It is clear from the table that 175.31 lacs tourists visited in the State during 2015 as compared to 163.14 lacs recorded in 2014 with the growth rate of 7.8%. In 2005, there was total inflow of 71.36 lacs tourists, which has increased to 175.31 lacs in the year 2015 with the annual increase of 14.0%. The large number of tourist's inflow leads to very high vehicular influx as the State being hilly the rail and air connections are limited. As per one estimate it was found that 72% of the tourists preferred road transport followed by 24% of them by railways and the air transport. The unprecedented growth in vehicular based tourist inflow has increased the pollution load on

The vehicle population in the State has shown a phenomenal growth over the past few decades. From an average growth rate of 2.7 % during 1980-85, growth rate of vehicle population in HP increased to 7.8% in 1995-2000 (Himachal SoER, 2005). The total registered motor vehicles in the State have been reported to be 12,96,937 as on 31st March 2017 that is a 108.6 % increase over a total of 621,714 vehicles registered in 2011, making an annual increase of over 18%.

This clearly indicates an exponential growth in traffic volumes particularly personal vehicles in HP. This in combination with slow growth in road infrastructure and services has led to the rising problems of congestion, pollution, depleting air quality etc. over the years. Easy availability of finance, rising affordability of the locals along with lack of adequate public transport system have led to the increasing preference of personalized modes. This therefore, calls in for a need to promote measures that wean people away from personalized modes and help promote more sustainable modes especially public transport.

6.1.3 Air Pollution from Industries

Mineral constitutes a fundamental component of state's economic base. The state has considerable mineral resources including rock salt, limestone, gypsum, silica-sand and baryte. Due to the high availability of quality limestone, a key raw material, the cement industry has flourished within the state. Many domestic companies and MNCs have established their manufacturing facilities here. Their units are located at following places.

Air Pollution from Industries

Sr. No.	Cement factories	Type	Location
1	Ambuja Cemet Limited Dharlaghat- Kashlog Lime Stone Mines	CEMENT	Darlaghat Solan
2	Jaypee Himachal Cement Grinding and Blendig	CEMENT	Bagheri Solan
3	Ambuja Cements Limited	CEMENT	Nalagarh Solan
4	ACC Ltd unit 1	CEMENT	Barmana Bilaspur
5	Ambuja Cements Ltd. (Suli Plant)	CEMENT	Darlaghat Solan
6	Ambuja Cement Ltd. Darlaghat (Rauri)	CEMENT	Arki, Solan
7	Rajban Cement FactoryCement Corporation of India Ltd	CEMENT	Rajban Paonta Sirmour
8	Asian cement Solan	CEMENT	Nalagarh Solan
9	UltraTech Cement Limited, Unit: Baga Cement works	CEMENT	Baga Solan

Air quality

National Ambient Air Quality Standards (NAAQS):

An air quality standard is a description of a level of air quality that is adopted by a regulatory authority as enforceable and it provides a legal framework for air pollution control. The National Ambient Air Quality Standards (NAAQS) are the levels of air quality with an adequate margin of safety, to protect the public health, vegetation and property. The NAAQS standards were notified by the Central Government & Central Pollution Control Board under Section 6 & 25 of the Environment (Protection) Act, 1986 and Section 16 2(h) of the Air (Prevention & Control of Pollution) Act, 1981 respectively in November, 2009, which is given below in Table.

National Ambient Air Quality Standards (NAAQS)

Sr. No.	Pollutant	Time Weighted Average	Concentration in Ambient air		
			Industrial, Residential, Rural and Other Area	Ecologically Sensitive Area (Notified by Central Govt.)	Method of Measurement
1	Sulphur Dioxide	Annual*	50 µg/m^3	20 µg/m^3	-Improved West and Gaeke -Ultraviolet fluorescence
		24hours**	80 µg/m^3	80 µg/m^3	
2	Nitrogen Dioxide	Annual*	40 µg/m^3	30 µg/m^3	-Modified Jacob and Hochheiser (Na-Arsenite) - Chemiluminescence
		24hours**	80 µg/m^3	80 µg/m^3	
3	Particulate Matter (PM_{10}) (size less than 10 micron)	Annual*	60 µg/m^3	60 µg/m^3	-Gravimetric - TOEM - Beta attenuation
		24hours**	100 µg/m^3	100 µg/m^3	
4	Particulate Matter ($PM_{2.5}$) (size less than 2.5 micron)	Annual*	40 µg/m^3	40 µg/m^3	-Gravimetric -TOEM -Beta attenuation
		24hours**	60 µg/m^3	60 µg/m^3	
5	Ozone (O_3)	8 hours**	100 µg/m^3	100 µg/m^3	-UV photometric - Chemiluminescence - Chemical method
		1 hour**	180 µg/m^3	180 µg/m^3	
6	Lead (Pb)	Annual*	0.50 µg/m^3	0.50 µg/m^3	-AAS/ICP method after sampling on EPM 2000 or equivalent filter paper -ED-XRF using Teflon filter
		24hours**	1.0 µg/m^3	1.0 µg/m^3	
7	Carbon Monoxide (CO)	8 hours	2.0 mg/m^3	2.0 mg/m^3	-Non Dispersive Infra Red (NDIR) Spectroscopy
		1 hour	4.0 mg/m^3	4.0 mg/m^3	
8	Ammonia (NH_3)	Annual*	100 µg/m^3	100 µg/m^3	-Chemiluminescence -Indophenol blue method
		24hours**	400 µg/m^3	400 µg/m^3	
9	Benzene (C_6H_6)	Annual*	5.0 µg/m^3	5.0 µg/m^3	-Gas Chromatography based continuous analyzer - Adsorption and desorption followed by GC analysis
10	Benzo(a) Pyrene (BaP)-Particulate phase only	Annual*	1.0 ng/m^3	1.0 ng/m^3	-Solvent extraction followed by HPLC/GC analysis
11	Arsenic (As)	Annual*	6.0 ng/m^3	6.0 ng/m^3	-AAS/ICP method after sampling on EPM 2000 or equivalent filter paper
12	Nickel (Ni)	Annual*	20.0 ng/m^3	20.0 ng/m^3	-AAS/ICP method after sampling on EPM 2000 or equivalent filter paper

[CPCB: Notified on 18th November 2009]

* Annual Arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.

** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.

NOTE: Whenever and wherever monitoring results on two consecutive days of monitoring exceed the limits specified above for the respective category, it shall be considered adequate reason to institute regular or continuous monitoring and further investigations.

The monitoring of Ambient Air Quality under the National Ambient Air Quality Monitoring Programme (NAMP) with the objective to find the current status of pollution and to study the trends as a result of increasing industrialization. The general objectives of the programme are:

1. To evaluate the general air quality conditions in the cities and to provide the basis for analyzing long term trends of pollution concentrations.

2. To provide the data for subsequent development of air quality standards and pollution prevention and control programme for the cities.

The Respirable Suspended Particulate Matter (RSPM) is monitored with the help of Respirable Dust Sampler on the basis of three days per station per week for 24 hours at 11 Towns/Cities covering 25 nos. of locations in the State.

6.1.4 AIR QUALITY TRENDS IN HP

The recent trend of air quality revealed that higher concentration of RSPM in Residential areas such as Station No-1 in Paonta Sahib, Station No-1 in Jassur and Sector – IV in Parwanoo is mainly due to more traffic movement in these areas. Whereas, higher concentration of RSPM in Paonta Sahib industrial area is contributed by industrial, construction activities & vehicle movement in the area. Station-wise details of concentration of SPM/RSPM, SO_2 and NOx are illustrated as below.

NAMP Annual Average Himachal Pradesh w.e.f. 2012 to 2018

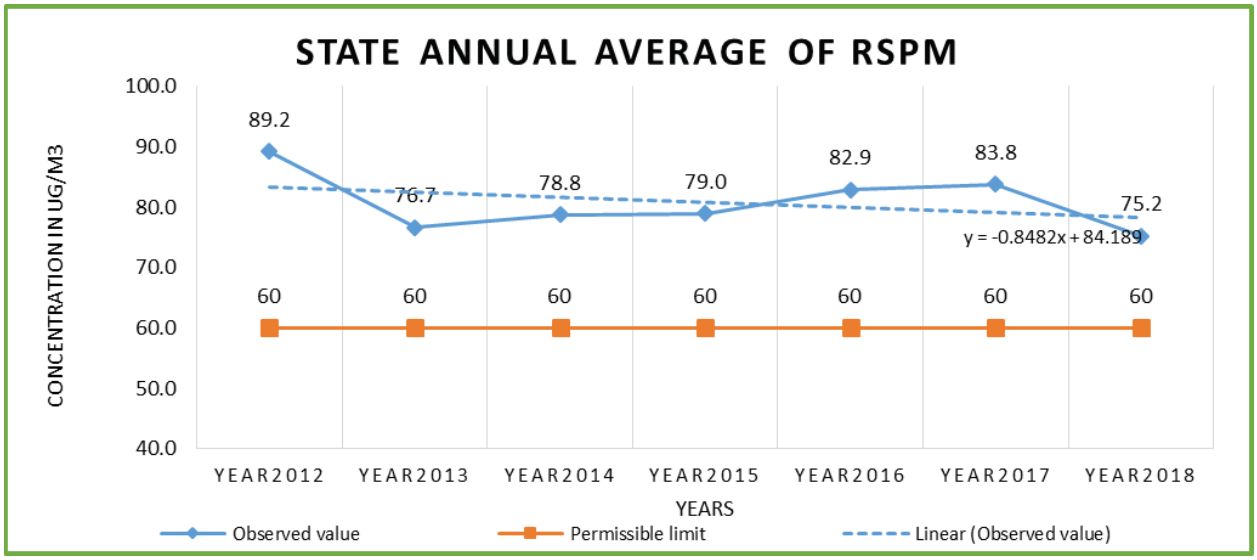
S. No	Station	2012			2013			2014			2015			2016			201 7			201 8		
		SO_2	NOx	RSPM	SO_2	NOx	RSPM	SO_2	NOx	RSPM	SO_2	NOx	RSPM	SO_2	NOx	RSPM	SO_2	NOx	RSPM	SO_2	NOx	RSPM
1	Shimla (2)	2.0	11.2	57.4	2.0	10.3	46.5	2.0	11.1	47.1	2.0	13.2	55.5	2.0	17.0	52.9	2	19.42	48.87	1.35	13.4	37.95
2	Parwanoo (2)	2.1	7.7	78.9	2.7	12.0	67.9	2.0	12.6	66. 1	2.0	11.9	60.0	2.0	10.2	70.5	2	4.8	64.9	2	4.65	60.55
3	BBN (4)	2.0	22.0	102.1	2.0	26.4	112.6	2.0	25.5	109.7	2.0	21.9	102.0	2.0	22.7	114.4	2	24.1	162.45	2	29.85	156.67
4	Damtal (2)	2.0	12.0	97.4	2.0	12.0	85.8	2.0	11.8	97.0	2.0	14.5	106.3	2.0	11.3	83.1	2.2	9.55	55.45	2	10.6	66.85
5	Paonta Sahib (2)	2.9	15.4	153.3	2.7	14.6	116.1	2.9	14.3	126.7	3.1	13.8	118.6	2.9	14.1	120.4	2.7	13.35	85	3.05	14	83.95
6	Kala Amb (2)	2.9	14.9	146.5	2.8	14.2	113.1	2.9	14.0	113.2	3.3	13.2	102.3	3.0	13.8	128.5	3.05	13.85	117.85	3.05	14	99.15
7	Una (2)	0.0	0.0	67.8	2.2	6.0	93.4	2.1	5.5	76.8	2.0	5.7	77.5	2.1	5.2	69.7	2.05	5.25	64.4	Nil	Nil	65.95
8	Sunder Nagar (2)	2.0	14.3	99.0	2.0	9.5	84.4	2.1	13.7	96.5	2.1	13.6	88.8	2.0	14.1	97.5	2	10.85	78.85	2	9.1	77.3
9	Manali (2)	4.1	11.7	90.0	2.5	10.5	47.1	2.2	11.1	39.6	2.1	10.1	44.7	2.0	12.9	51.0	2.25	8.7	47.05	2.2	9.3	63.15
10	Dharamshala (2)	0.0	0.0	0.0	0.0	0.0	0.0	1.0	5.6	15.5	2.0	8.7	34.7	2.0	7.8	41.4	2	6.3	34.05	2	6.7	40.05
State Annual Average		**2.0**	**11.6**	**89.7**	**2.1**	**12.8**	**79.2**	**2.1**	**13.5**	**80.8**	**2.2**	**13.3**	**80.5**	**2.2**	**13.6**	**85.0**	**2.2**	**11.6**	**75.9**	**2.0**	**11.2**	**75.2**

[Source: HPSPCB Shimla]

Respirable Suspended Particulate Matter (RSPM)

The state level annual average of RSPM is observed little higher than the permissible limit. However the trendline recorded a decline during last five years. Amongst all RSPM concentration Paonta Sahiba and Kala Amb areas ranked the top while Manali and Dharamshala recorded lowest readings. Paona Sahib and Kala Amb areas are the relatively flat and border areas of Himachal Pradesh towards the south western portion of the State. Cross border vehicular movement between Uttarakhand and Haryana through these area contribute to the higher concentration of RSPM.

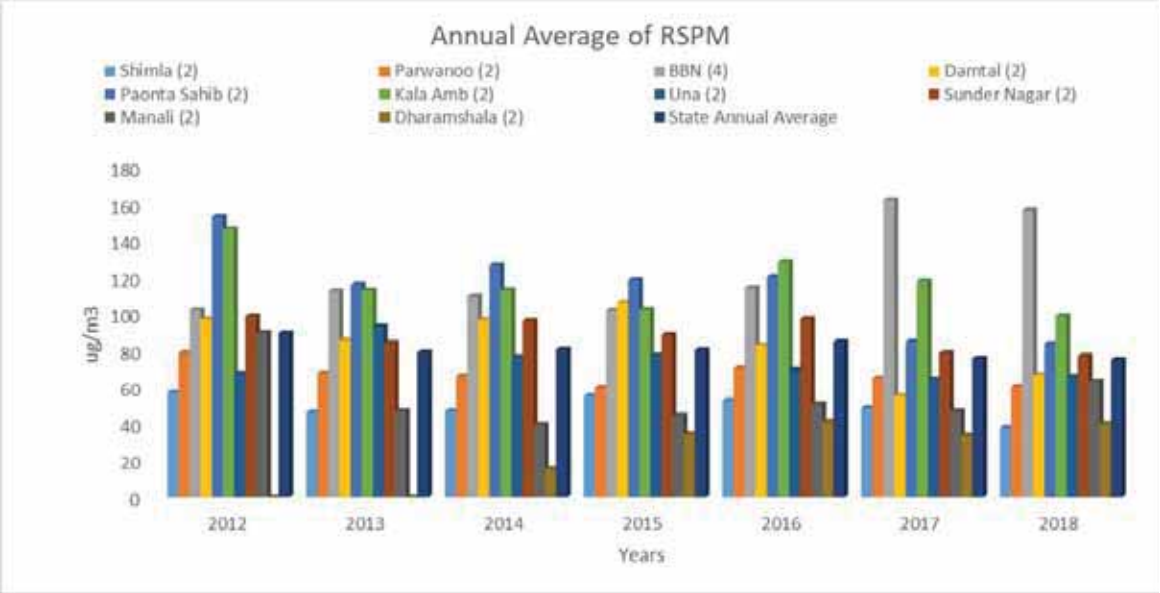
The annual average of RSPM level in Shimla is observed within the prescribed standards at Tekka Bench near the ridge maidan Shimla. However the concentration at Bus stand seems to be fluctuating around the permissible limit i.e. 60 microgram/m^3. High observance at Bus Stand is mainly due to traffic movement near the old Bus stand. However overall annual average trend of both these locations tend to decrease marginally during 2012-2018.



At Parwanoo, RSPM is observed higher than permissible limit at Sector 1, while this level is fluctuating near the permissible limit at Sector-4, which is mainly of residential type. While high observance at Sector-1 is mainly due to vehicular movement. Observance of RSPM at Paonta is high at both locations i.e. Paonta town and Gondpur industrial area. The relatively high value is mainly on account of trafficular type at Paona town while higher value of RSPM at Gondpur is attributed to industrial activities.

All the annual average values at Baddi, Barotiwala and Nalagarh areas are monitored to be on the higher side. Amongst all, location at DIC Baddi, which is the hub of Baddi industrial and commercial activities has the highest concentration of RSPM, followed by AHC Baorotiwala, MC Nalagarh areas and HB Baddi areas, which were observed running neck to neck. Only DIC Baddi location has shown a positive trendline though during 2012-18. Higher observance at these locations are mainly attributed to the higher traffic movement of mixed type and partly due to industrial activity. The RSPM concentration at Damtal (located in the western tip of Kangra District of Himachal Pradesh) is also observed to be high on account of vehicular movement. The first station located near to the earstwhile regional office of RO office is observed to be little higher than the permissible limit, while second location near the Ram Gopal Mandir is mainly due to vehicular movement, which was observed to be very high. Though both stations have recorded a substantial decline in the concentration of RSPM during the period 2015-2016.

Kala Amb industrial area is located in the western tip of Sirmour district of Himachal Pradesh, which has shown higher concentration of RSPM than the permissible limit during the period 2012-18. However, overall five yearly trend reflected a marginal decline in RSPM concentration. Another location is of that of Trilokpur industrial area, north of Paona Sahib town, which is marginally higher than permissible limit, though observance is little lower than Paona Sahib. Two monitoring stations in Una District are placed one at headquarter of the district and second is located at Mehatpur industrial area. The observance of RSPM are running neck to neck with little fluctuation over the permissible limit. Mehatpur area has shown little more concentration of RSPM compared to Una Town. Though annual average has shown marginal increase during 2012-18. RSPM concentration in Sundernagar has also indicated higher concentration of RSPM during the period. However both of these stations are near to busy roads and vehicular traffic contribute to the higher level of RSPM. Among the two, location at MC Sundernagar has recorded higher than the location of Regional Laboratory office of HP State Pollution Control Board of Sundernagar. Overall linear trend of Sundernagar has shown a marginal increase during 2012-18.



The RSPM concentration at Manali is well within the permissible limit. However during 2012, it was observed to be on the higher side, which have declined in the next year. The first station is located at Nehru Park, which has shown higher concentration than the second location at Hidimba Temple, which is well below the permissible limit. The yearly trend has also recoded a decline during 2012-16.

So_2

The SO_2 concentration at all 25 monitoring stations covered under NAMP programme recorded substantially low concentration than the permissible limit of 50 microgram. Most of the value were well within 4 microgram. This insignificant concentration has however recorded changes. However such occurances of flucatuation are aberations and don't pose any threat whatsoever. The overall state observance is near to 2 microgram, which is much lower than permissible limit.

Nox

The observance of NOx has however recorded observance of about 15 microgram and below, which is well within the permissible limit of 40 microgram. Most of the locations followed more or less similar pattern of

lower concentration except in Baddi area. Since Baddi is one of the fastest industrially developed area, traffic movement is observed to very high. They partially contribute to the higher level of NOx, however they are well within the permissible limit.

WATER POLLUTION

Water is one of the most important and basic natural resources. Water is not only one of the most essential commodities of our day-to-day life, but the development of this natural resource also plays a crucial role in economic and social development processes. While the total amount of water available in the world is constant and is generally said to be adequate to meet all the demands of mankind, its quality and distribution over different regions of the world is uneven and causes problems of scarcity and suitability. It is therefore imperative that man develops, uses and manages this scarce commodity as rationally and efficiently as possible.

Water Quality

Water quality is a complex subject, which involves physical, chemical, hydrological and biological characteristics of water and their complex and delicate relations. From the user's point of view, the term "water quality" is defined as "those physical, chemical or biological characteristics of water by which the user evaluates the acceptability of water". For example for drinking water should be pure, wholesome, and potable. Similarly, for irrigation dissolved solids and toxicants are important, for outdoor bathing pathogens are important and water quality is controlled accordingly.

6.2.1 Surface Water Quality

The assessment of the status of water quality of the natural water bodies and rivers is one of the most important activities of the State Pollution Control Board. Analysis of water quality data not only helps in ascertaining the nature and extent of the pollution control measures but also impact on the water quality. The Central Pollution Control Board (CPCB) under the National Program of Monitoring of Natural Aquatic Resources (MINARS) is sponsoring the water quality monitoring of major rivers of the State. The samples are collected quarterly i.e. in the month of January, April, July and October each year. In all 34 points have been selected on major rivers i.e. Satluj, Beas, Ravi, Parvati and samples are being analyzed for 36 parameters which includes the Physio-chemical and bacteriological contents. Recently the Central Pollution Control Board/Ministry of Environment & Forests, Govt. of India has issued Water Quality Protocol which is being followed by the State Board.

There are four major rivers systems in the State, whose catchments cover 75% of the State's physical area, and is the home to 80% of its population. These rivers are Satluj, Beas, Ravi and Yamuna.

Surface Water quality monitoring results under MINARS for the month December 2018 is as below:

Table –MONITORING RESULTS OF MINAR FOR THE MONTH OF DECEMBER 2018							
Sr. No.	**Name of location**	**Sample Code**	**pH**	**D.O. mg/l**	**BOD mg/l**	**F.C. MPN /100ml**	**T.C. MPN /100ml**
1	River Beas U/s Manali	1001	8.01	10.1	0.1	22	170
2	River Beas D/s Kullu	1002	8.07	9.8	0.2	63	540
3	River Beas D/s Aut	1003	8.12	9.5	0.1	21	170
4	Exit of Dehar Power House Beas River	1005	7.91	8.9	0.2	31	280
5	River Beas D/s Mandi	1006	8.13	11.2	0.1	43	350
6	River Beas D/S Alampur	1007	8.05	7.6	0.3	2	79
7	River Beas D/s Dehra	1008	7.88	7.1	0.3	2	79
8	River Beas D/S Pong Dam	1009	7.92	7.1	0.1	4	94
9	River Beas U/s Pandoh Dam	1010	8.11	11.3	0.1	31	220
10	River Satluj U/s Tattapani	1013	7.94	8	1.6	32	120
11	River Satluj U/s Slapper	1014	7.5	9.6	0.1	23	210
12	River Satluj D/s Slapper after conf. of Beas River	1015	7.86	9.8	0.2	34	240
13	River Satluj D/S Bhakhra	1016	7.78	7.1	0.3	4	79
14	River Satluj U/s Rampur	1086	7.69	8	1.7	27	130
15	River Satluj D/s Rampur	1087	7.78	8	1.8	40	220
16	River Ravi U/S Madhopur Head Works	1088	6.92	7.3	0.2	2	49
17	River Ravi U/S Chamba	1089	7.86	8.7	0.2	2	94
18	River Sainj D/s Largi	1090	8.1	9.2	0.1	34	240
19	River Parvati before Confluence to River Beas at Bhunter	1290	8.03	10.5	0.1	31	220
20	Govindsagar Lake D/s Bilaspur	1291	8.05	9.8	0.4	43	540
21	Pong Dam lake at Pong Vill	1292	12.5	7.2	0.2	2	63
22	Wangtu Bridge	1389	7.71	8.9	1.7	26	39
23	Renuka Lake	1429	8.14	6.8	1.8	22	49
24	River Tons at H.P. Boundary	1510	7.27	8.5	0.9	22	70
25	River Beas U/s Mandi	1550	8.15	10.8	0.1	27	180
26	River Sirsa U/s Sitomajri Nalla	1551	7.55	6.9	0.2	2	22
27	River Sirsa D/s Nalagarh Bridge	1552	8.34	5.2	2.2	23	110
28	River Yamuna U/s Paonta Sahib	1553	8.08	8.2	1.6	17	38
29	River Yamuna D/s Paonta Sahib	1554	8.19	8.1	1.9	21	43

Table –MONITORING RESULTS OF MINAR FOR THE MONTH OF DECEMBER 2018							
Sr. No.	**Name of location**	**Sample Code**	**pH**	**D.O. mg/l**	**BOD mg/l**	**F.C. MPN /100ml**	**T.C. MPN /100ml**
30	River Satluj before conf. with River Spiti at Khab	1867	7.94	10	0.9	11	17
31	River Sirsa D/s Nalagarh Town	1868	8.56	6.4	1.8	94	220
32	River Swan D/S Santokhgarh	1869	7.79	7	0.4	6	110
33	River Sukhna at Parwanoo	1870	8.23	3.8	28.0	47	920
34	River Markanda at Paonta Sahib	1871	7.68	9.2	0.2	11	26
35	Lift Nala D/s MSW Processing Site Shimla	1872	7.45	6.7	4.5	170	540
36	Stream/Nallah at D/s MSW dump site Salogra	1874	7.97	7.8	0.4	<1.8	4
37	River Beas D/s Manali	2601	7.93	7.5	0.2	43	350
38	River Beas U/s Kullu	2602	8.08	9.9	0.2	34	430
39	River Beas D/s Pandoh Dam	2603	8.17	11.4	0.1	43	280
40	River Beas D/S Jaisinghpur	2604	7.82	7.5	0.5	4	94
41	River Parvati U/s Manikaran	2605	7.81	10.8	0.1	14	130
42	River Parvati D/s Manikaran	2606	7.86	10.7	0.1	21	150
43	Suketi Khad U/s Mandi	2607	8.13	10.7	0.2	94	540
44	River Binwa D/S Paprola/Baijnath	2608	7.02	7.7	0.4	2	70
45	River Neugal D/S Thural	2609	7.72	7.8	0.4	2	63
46	River Spiti before conf. with River Satluj at Khab	2610	7.81	9.8	1.7	17	24
47	River Satluj after conf. with River Spiti at Khab	2611	8.01	9.9	0.8	17	24
48	River Baspa U/s reservoir at kuppa	2612	7.81	10	1.5	21	70
49	River Ravi D/S Chamba	2613	7.32	8.6	0.3	2	70
50	Chamera Reservoir stage -I	2614	7.57	8.6	0.5	4	110
51	River Ravi D/S Chamera-III reserviour	2615	7.98	8.8	0.3	2	70
52	River Siul D/S Surgani	2616	7.85	8.7	0.4	2	79
53	River Pabbar U/s Dhambari	2617	6.79	8.6	1	21	50
54	River Pabbar U/s Rohru	2618	7.08	8.7	1.5	26	84
55	River Pabbar at Snail D/s of TRT of Swara Kuddu	2619	7.32	8.2	0.6	26	63
56	Ashwani Khad U/s Yashwant Nagar	2620	7.48	7.0	1.0	3.7	26

Table –MONITORING RESULTS OF MINAR FOR THE MONTH OF DECEMBER 2018							
Sr. No.	**Name of location**	**Sample Code**	**pH**	**D.O. mg/l**	**BOD mg/l**	**F.C. MPN /100ml**	**T.C. MPN /100ml**
57	Giri River D/s Yashwant Nagar	2621	7.52	7.3	1.2	3.6	21
58	River Giri U/s CCI mines	2622	8.08	8.4	0.7	11	32
59	River Giri D/s Sataun	2623	8.06	8.4	0.8	14	34
60	River Markanda U/s Kala Amb	2624	7.86	7.9	1	17	41
61	River Markanda D/s Kala Amb	2625	7.88	7.9	1.6	21	43
62	River Batta U/s Paonta Sahib	2626	8.28	8.3	0.5	11	31
63	D/s of River Batta at Paonta Sahib	2627	8.31	8.2	0.9	17	40
64	Rewalsar Lake	2649	8.08	8.3	4	210	1600
65	Khajiar Lake	2650	7.36	5.9	0.7	4	180
66	River Beas D/S Nadaun Bridge	3855	7.18	7.2	0.6	2	70
67	Swan River U/s Gagret	3856	7.56	7.2	0.2	2	63
68	Swan River D/s Gagret	3857	7.83	7.2	0.3	4	79
69	Swan River U/S Santokhgarh Bridge	3858	7.98	7	0.3	4	70
70	Swan River U/S Una Town Ghaluwal Bridge	3859	7.72	7.2	0.2	2	63
71	R. Giri D/s CCI on India, Rajban	3860	8.11	8.2	1.6	14	39
72	Salani Khad Near Bridge NH-7 Moginand Kala Amb	3861	7.92	8.2	1	17	39
73	Markanda R. D/s of Salani Khad	3862	7.98	8.2	0.7	15	34
74	Rampur Jattan Moginand Nallah Before conf. to R. Markanda Near Radha Swai Satsang Bhawan	3863	7.23	Nil	610	>1600	>1600
75	Markanda R. D/s of Moginand Nallah	3864	8.32	8.1	2.4	21	47
76	Roon Nallah Near Meerpur Kotla, Gurudwara	3865	7.97	7.7	1.6	22	40
77	Manalsu Nalla before conf. to R. Beas	3866	8	7.2	0.1	17	150
78	Sarvari Nalla before conf. to R. Beas	3867	8.23	9	0.1	31	280
79	Baragram Nalla before conf. to R. Beas	3868	8.27	8.1	0.1	21	170

Table –MONITORING RESULTS OF MINAR FOR THE MONTH OF DECEMBER 2018							
Sr. No.	**Name of location**	**Sample Code**	**pH**	**D.O. mg/l**	**BOD mg/l**	**F.C. MPN /100ml**	**T.C. MPN /100ml**
80	River satluj D/s TRT of Rampur HEP	3869	7.86	8.3	1.3	26	94
81	Karcham Dam	3870	7.89	8.5	1.3	26	39
82	River Satluj D/s Power house Kashang HEP	3871	7.8	9	1.5	27	40
83	River Satluj D/s Tidong HEP	3872	7.35	9	1.1	17	33
84	River Ravi U/S STP Barga (Chamba)	3873	7.7	8.6	0.3	4	94
85	River Ravi D/S STP Bhagot (Chamba)	3874	7.58	8.5	0.4	2	79
86	Surajmukhi Nallah U/s WSSS Galyana	3875	8.17	7.6	1.2	8.1	39
87	Giri River at Village Maryaog after confluence of R, giri and Ashwani	3876	8.13	7.4	1.4	9.1	58
88	River Giri U/s LWSS Sainj	3877	7.61	8.6	1.5	33	140
89	River Giri D/s LWSS Sainj	3878	8.04	8.7	1.5	34	130
90	Bhatian Nallah U/S Bhatian Village Nallagarh	3879	7.7	6.2	0.1	9.1	58
91	Bhatian Nallah U/S Sara Textile Nallagarh	3880					
92	Bhatian Nallah D/S Sara Textile Nallagarh	3881	8.67	5.7	0.8	21	94
93	Manjhi Khad U/S Dharamshala at Khaniara	4023					
94	Manjhi Khad D/S Dharamshala at Chetru	4024					
95	Mol Khad U/s Palampur	4025	7.42	7.3	0.3	2	63
96	Mol Khad D/S Palampur	4026	7.28	7.6	0.2	2	79
97	River Giri D/s Rajgarh Town	4027	8.34	8	0.2	11	26
98	River Giri D/s Kalgidhar Trust, Baru Sahib	4028	8.29	8	0.2	14	31
99	Tallo Nallah (From Nahan Town) at Khaddar Ka Bagh B/c to River Markanda	4029	7.83	9	0.3	14	32
100	Swan River before Conf. Of Garni Khad	4030	7.53	7.2	0.3	4	94
101	Swan River after Conf. Of Garni Khad	4031	7.87	7.2	0.2	2	70
102	U/s Khairian Solid Waste Dumping Site Bilaspur	4032	8.44	9.9	0.1	21	220

Table –MONITORING RESULTS OF MINAR FOR THE MONTH OF DECEMBER 2018							
Sr. No.	**Name of location**	**Sample Code**	**pH**	**D.O. mg/l**	**BOD mg/l**	**F.C. MPN /100ml**	**T.C. MPN /100ml**
103	D/s Khairian Solid Waste Dumping Site Bilaspur	4033	8.4	9.7	0.2	43	350
104	Sahu Nallah U/S of Bhuri Singh SHEP	4034	7.76	8.5	0.2	2	70
105	Sahu Nallah D/S of Bhuri Singh SHEP	4035	7.81	8.7	0.3	2	63
106	Kunni Pul,Vill Samahu, PO Kunihar ,Tehsil Arki	4036	8.10	6.0	1.8	11	63
107	River Beas D/S Manalsu Nallah	4037	8.31	8	0.2	27	180
108	River Tirthan before confluence to River Sainj	4038	8.23	9.5	0.1	11	140
109	River Pabbar U/s Hatkoti	4039	7.24	9.1	1.1	26	110

Table - Designated Best Use Classification of Surface water by CPCB

Designated-Best-Use	Class of water		Criteria
Drinking WaterSource without conventional treatment but after disinfection	A		Total Coliforms Organism MPN/100ml shall be 50 or less
			pH between 6.5 and 8.5
			Dissolved Oxygen 6mg/l or more
			Biochemical Oxygen Demand 5 days 20C 2mg/ or less
Outdoor bathing (Organised)	B		Total Coliforms Organism MPN/100ml shall be 500 or less pH between 6.5 and 8.5 Dissolved Oxygen 5mg/l or more
			Biochemical Oxygen Demand 5days 20C 3mg/l or less
Drinking water source after conventional treatment and disinfection	C		Total Coliforms Organism MPN/100ml shall be 5000 or less pH between 6 to 9 Dissolved Oxygen 4mg/l or more
			Biochemical Oxygen Demand 5 days 20C 3mg/ or less
Propagation of Wild life and Fisheries	D		pH between 6.5 to 8.5 Dissolved Oxygen 4mg/l or more
			Free Ammonia (as N) 1.2 mg/l or less
Irrigation, Industrial Cooling, Controlled Waste disposal	E		pH betwwn 6.0 to 8.5
			Electrical Conductivity at 25C micromhos/cm Max.2250
			Sodium absorption Ratio Max. 26
			Boron Max. 2mg/l

6.2.2 Sanitation

In the State of Himachal Pradesh, sewage management is the fundamental responsibility of I&PH Department, Urban Development Department.

In Himachal Pradesh, current sewage management practices include Sewage Treatment Plants and Septic Tanks/ Soak Pits. The total no. of STP in the State is 70. Out of 70 STPs, 45 Sewage Treatment Plants, based on Activated Sludge Process/ Extended Aeration / USAB are operational. The work on establishment of 25 numbers of Sewage Treatment Plants is in progress.

Existing Status of Sewage Management as supplied by I & PH Department

Total No. of STPs /		**70**	
Operational		**45**	
Under Construction		**25**	
Names of STPs inoperation		**(Proposed or under construction)**	
With Consent	**Without Consent**	**Without Consent/ NO COP**	**With Consent**
Badah (Kullu) 2018	Arki	Zone-I, Kangra	Rewalsar
BhootNath, Kullu 2018	Palampur	Zone II, Kangra	Zone-D,Una
Zone-I , Sujanpur 2020	Reckong-Peo	Zone III, Kangra	Kunihar
Dharamsala 2018	Shitla Bridge, Chamba	Zone-III, Paonta	Shah talai
Nadaun 2020	Barga, Chamba	Nurpur	Sarkaghat Zone-B-17
Joginder Nagar-2020	Jard Kullu	Zone-II, Santokhgarh	(STP Zone-I, II & III) Chintpurni
Lanka Bekar, Kullu-2018	Bhagot Chamba	Zone-I, Kotkhai	(STP Zone- II) Chintpurni
Jawalamukhi 2018	Zone-B, Solan	Zone-II, Kotkhai	(STP Zone-III) Chintpurni
Manali-2021	. . . . .	Bhagsunag	STP Dalhouji
Sundernagar 2019	Jubbal -	Mehatpur ABC	STP Jhakri
Rampur (Khopri) 2019	Mela ground, Bhunter	STP THEOG	STP Gagret 31.03.2018
Rampur (Chhuabha) 2019	Sharabhai, Bhunter-	Suni	Dehra
Ragunat ka Padhar-2021	Sanjauli-		Sarkaghat
Khaliar-2021	Lalpani-		
Ghumarwin 31.03.2020	North Disposal-		
Zone- III, Hamirpur 2020	Dhalli-		
Zone-I , Hamirpur-2020	Snowden-		
Zone- II, Hamirpur-2020	Summer Hill-		
Narkanda 31.03.2018	Zone-I, Paonta 2017		
Naina Devi 31.03.2020	Zone-II, Paonta 2017		
Tanda Medical College 31.03.2020	Zone- A&B, Una		
NIT Hamirpur			
Zone-II Sujanpur 31.03.2018			

6.3 Solid Waste Management Status

ULB - wise waste processing facilities are as below:

ULB	Collection Summary	Waste processing done (Yes/No)
Bilaspur (M Cl)	D2DGC & source seg. Started in all 11 wards. Bye-laws have been adopted and user fee collected. Waste is collected & transported through 6 vehicle deployed for the purpose (3own vehicle & 3 hired)	Yes
Ghumarwin (M Cl)	D2DGC & source seg. Started in all 7 wards. Bye-laws adopted but user fee not collected. 3vehicles engaged for waste collection & transportation.	Yes
Naina Devi	D2DGC & source seg. has started in all 7 wards. bye-laws are adopted and user fee collected. 1 vehicle engaged for collection & transportation of waste	Yes
Talai (NP)	D2DGC & source seg. Started in all 7 wards. Bye-laws adopted and user charges are collected. 1vehicle engaged for waste collection & transporation	Yes
Chamba	D2DGC being done in 5 out of 11 wards and source seg. is nil. Bye-laws adopted and user charges are collected. 3 garbage collection transportation vehicles deployed	No
Chowari	D2DGC started in 6 wards. source seg. not being done. 100% D2DGC & source seg. to be implemented by 31.03.2019. Bye-laws adopted and user charges collected	No
Dalhousie	D2DGC done in all 9 wards. source seg. to be started by 31.03.2019. Bye-laws adopted and user charges collected	No
Bhota	D2DGC being done in all 7 wards. source seg. to be started by 31.03.2019. Bye-laws adopted and user charges collected	Yes
Hamirpur	D2DGC started in all 11 wards. source seg. Started in 9 wards. Source seg. in all wards to be started by 28.02.2019. 6 vehicles deployed for waste transportation. Bye-laws adopted and user charges collected	Yes
Nadaun	D2DGC started in all 7 wards. sourde seg. to be started by 31.03.2019. Bye-laws have been adopted.	No
Tira Sujanpur	D2DGC and source seg. Has started in all 9 wards of MC Sujanpur. Bye-laws have been adopted and user charges collected	No
Baijnath	Bye-laws adopted. D2DGC & source seg. to be started by 31.03.2019	No
Dehra	Bye-laws adopted. D2DGC started in all 7 wards. source seg. to be started by 31.03.2019	No
Dharmsala	D2DGC & source seg. to be started by 28.02.2019.	No

Jawalamukhi	D2DGC & source seg. has started. Bye-laws adopted and user charges collected	No
Jawali	D2DGC & source seg. to be started by 31.03.2019	No
Kangra	D2DGC & source seg. Started. bye-laws adopted and user charges collected	Yes
Nagrota Bagwan	D2DGC & source seg. Started. bye-laws adopted and user charges collected	Yes
Nurpur	D2DGC started in all 9 wards. source seg. to be started by 31.03.2019. Bye-laws have been adopted and user charges collected	No
Palampur	D2DGC & source seg. being done in all 7 wards of Palampur. Bye-laws have been adopted and user charges collected	Yes
Banjar	D2DGC started in all 7 wards. source seg. to be started by 15.02.2019. Bye-laws adopted and user charges collected	No
Bhuntar	D2DGC started in all 7 wards. source seg. to be started by 31.03.2019. Bye-laws adopted and user charges are collected	No
Kullu	D2DGC started in all 13 wards. source seg. shall be started by 31.03.2019. Bye-laws adopted and user charges are collected	No
Manali	D2DGC and source seg. is started. Bye-laws has been adopted and user charges being collected	No (plant under construction)
Jogindarnagar	D2DGC & source seg shall be started by 31.03.2019. Bye-laws have been adopted	No
Karsog	D2DGC, source seg. Implementation and bye-laws adoption to be done by 31.03.2019.	No
Mandi	D2DGC started in all 13 wards. source seg. started in 2 wards, shall be replicated in all 13 wards by 31.03.2019	Partial waste is being processed.
Nerchowk	D2DGC started in all 11 wards. source seg. to be started by 31.03.2019. Bye-laws adopted and user fee collected	Partial waste is being processed.
Rewalsar	D2DGC has started in all 7 wards. source seg. to be started by 15.02.2019. Bye-laws adopted and user charges collected	Partial waste is being processed.
Sarkaghat	D2DGC has started in all 7 wards. source seg.yet to be started. Bye-laws adopted and user fee collected	No
Sundernagar	D2DGC and source seg. has started in all 13 wards. Bye-laws have been adopted and user charges collected	Partial waste is being processed.
Chaupal	The D2DGC & source seg. has been started in all the 7 wards of Chaupal. Bye-laws have been adopted and user charges collected	No
Jubbal	D2DGC & source seg. is yet to be started. Bye-laws have been	No

Kotkhai	D2DGC started in all 7 wards. source seg. to be started by 31.03.2019. Bye-laws have been adopted	No
Narkanda	D2DGC & source seg. started in all 7 wards of Narkanda. Bye-laws have been adopted and user fee collected	No
Rampur	D2DGC & source seg. Started in all 9 wards. Bye-laws adopted and user fee collected	No
Rohru	D2DGC started in all 7 wards. source seg. also has been initiated and shall be implemented 100% within next 6 months. Bye-laws adopted and user charges to be collected from March, 2019	No
Sunni	D2DGC & source seg. has started in all 7 wards. Bye-laws have been adopted	No
Shimla	D2DGC & source seg. has been started in all 34 wards of Shimla. Bye-laws have been adopted and user fee collected	Yes
Theog	D2DGC has been started in all 7 wards, source seg. is yet to be started. Bye-laws have been adopted and user charges collected	No
Arki	D2DGC & source seg. Started in all 7 wards. Bye-laws adopted and user fee is collected	No
Baddi	D2DGC has started. Source seg. yet to be started.	Yes
Nalagarh	D2DGC & source seg. has started in all 9 wards. Bye-laws adopted and implemented	No
Parwanoo	D2DGC & source seg. has started in all 9 wards. Bye-laws adopted and implemented	No
Solan	D2DGC has started in all wards. source seg. is to be started by 28.02.2019. Bye-laws have been adopted	Partial processing being done
Daulatpur	D2DGC being done in all 7 wards. source seg. to be implemented from 31.03.2019. Bye-laws have been adopted and user fee collected	No
Gagret	D2DGC & source seg. to be implemented by 31.03.2019	No
Mehatpur Basdehra	D2DGC & source seg.has been started in all 9 wards of Mehatpur. Bye-laws have been adopted and user fee collected	Partial waste processing being done
Santokhgarh	D2DGC & source seg. has been implemented. Bye-laws adopted and user fee collected	Partial waste processing being done
Tahliwal	D2DGC has started in all 7 wards. source seg.yet to be implemented. Bye-laws have been adopted and user fee to be collected	No
Una	D2DGC has started. Source seg. yet to be implemented. Bye-laws have been adopted	No
Nahan	D2DGC & source seg. has started in all 13 wards. Bye-laws adopted and user fee collected	Partial waste processing done
Paonta Sahib	D2DGC & source seg.to be started by 28.02.2019. Bye-laws have been adopted	No
Rajgarh	D2DGC & source seg.has started in all 7 wards of Rajgarh. Bye-laws have been adopted and user fees collected	Partial waste processing done

6.4 Status of Biomedical Waste in Himachal Pradesh

Waste generated during the diagnosis, treatment or immunization of human beings or animals or research activities pertaining thereto or in the production or testing of biological or in health camps, including the categories mentioned in Schedule I appended to these rules.

Till 31 March 2018, the State Board has inventoried 9743 Health Care Facilities/Institutions under Biomedical Waste Management Rules, 2016. For Sensitization on the provisions of newly notified Rules, the State Board has organized 32 numbers of workshops for the stakeholders at State & District level. For the collection, transportation and disposal of Bio-medical Waste, the State Board has authorized three Common Bio-Medical Waste Treatment Facilities at Kullu, Solan and Kangra catering to the Health Care Facilities of ten numbers of Districts in the State. So far the Health Care Institutions of Districts Kinnaur, Lahaul-Spiti and few far-flung areas of other Districts of the State are not yet covered by these Common Bio-medical Waste Treatment Facilities. The management of Bio-medical Waste in the State is quite satisfactory wherein approximately 1427Kg/day Bio-medical Waste is being disposed of by three CBWTF facilities and 292 Kg/day by the Health Care Facilities at their own level. To keep a strict vision on air emission in CBWTF, the State Board has got installed online emission monitoring systems in these facilities and also linked authorized transporter of the Bio-medical Waste through GPS for better coordination and movement tracking. During 2017-18, 05 nos. of Consent and 60 nos. authorization/renewal of authorization have been granted to the health care facilities.

Characteristics of Hospital waste

- 80% of the waste generated in HCF is non-hazardous and Non-toxic.
- BMW generated from medical activities are hazardous, toxic and even lethal.
- Possess high potential for diseases transmission.
- Ragpickers and waste workers are worst affected.
- 15% is infectious waste and 5% is hazardous waste.
- Segregation at Source reduces the problem proportionately.
- Organizational setup, training and motivation and compliance to the rules improve the situation considerably.

Introduction about BMWM Rules 2016

Disposal Status

- Through Common Biomedical Waste Treatment Facilities
- Through Captive Incinerators (3Nos)
- Through Deep Burial

CBWTFs in Himachal Pradesh

1. **CBWTF at Sandli Arki District Solan:**
   Covering Area:
   Solan, Parwanoo, Baddi, Barotiwala, Dharampur and Nalagarh area of Solan district,
   Shimla town, Rampur of Shimla district, Nahan, Paonta and Kala Amb area of Sirmour district

2. **CBWTF at Pirdi, District Kullu:**
   Covering:
   Bilaspur and Ghumarwin area of Bilaspur district, Mandi, Sundernagar, Ner Chowk and Sarkaghat area of Mandi distric, Kullu and Manali area of Kullu district.

3. **CBWTF, Dhugiari, Kangra:**
   Covering:
   Kangra, Palampur, Jawalji, Baijnath, Nurpur, Jassur and Nagrota area of Kangra district, Chamba, Kakira and Surgani area of Chamba district, Hamirpur, Nadaun, Badsar and Bhota area of Hamirpur district, Una, Mehatpur, Santokhgarh, Amb and Daulatpur Chowk area of Una district.

4. **Deep Burial Practices in Himachal**
   Deep Burial:
   In rest of the areas where Common Biomedical Waste Treatment Facilities not available,deep burial practices is being adopted as per the provisions of BMW rules.

6.5 HAZARDOUS AND OTHER WASTES (MANGEMENT AND TRANSBOUNDARY MOVEMENT) RULES, 2016:

Till the year 31st March, 2018, the Board has identified about 3078 units generating hazardous waste. Out of which 2761 are operational as on 31st March, 2018 and responsible for generating of hazardous waste under Hazardous and Other Waste (Management and Transboundary Movement) Rules, 2016 and all such units are required to obtain authorization under the said rules. The Board has granted authorization to 2761 units. The Common Treatment, Storage, Disposal Facility (TSDF) at Village Majra, Tehsil Nalagarh, District Solan is operational since June, 2008 and is being used for scientific disposal of landfillable hazardous waste generated by the industries. A total of 139268 MT of landfillable hazardous waste has been disposed off in TSDF by various landfillable hazardous waste generating industries in the State till date and 16790.9 MT of landfillable hazardous waste has been disposed off in TSDF during the year 2017-18.

6.6 NOISE MONITORING DONE BY THE STATE BOARD:

The State Board is regularly conducting ambient noise monitoring for different areas/zones at selected locations (48 locations) in the State including Shimla town on weekly basis. It is evident from the Ambient noise level monitoring carried out by the State Board the observed values are exceeding the prescribed standard especially for silence zone (IGMC, Shimla) in Shimla city. The State Board is regularly spreading awareness about adverse affect of noise pollution among public through advertisement in newspaper and jingle through FM radio.

As per notification dated 1-5-2001 issued by the State Government, respondent State Board has mandate to submit report to the State Government regarding complaint received and disposed off under the provisions

of Noise Rules 2000. As per returns filed by the concerned Environment Engineers/ Assistant Environment Engineers w.r.t. number of complaints entertained on noise pollution in the year 2015-16, 2016-17 & 2017-18 it would be evident that the complaints received by Sr. Environmental Engineers/ Environmental Engineers/ Assistant Environmental Engineers are being attended and disposed off by them. The return under Noise Pollution (Regulation & Control) Rules 2000 is being further submitted to State Government. Copies of returns submitted for the year 2015-16, 2016-17 & 2017-18.

The State Board regularly issues directions to all Deputy Commissioner & Superintendent of Police and Regional Officers of the State Board to take necessary measures to comply with the Noise Pollution (Regulation and Control) Rules, 2000 regarding monitoring and control of noise pollution and ensure that noise and ambient air quality standards are maintained within area of their jurisdiction during Diwali festival. The State Education Department is also being advised to educate students about the harmful effect of noise & air pollution. The State Board also monitors ambient noise monitoring during Diwali festival to assess the air and noise pollution due to bursting of firecrackers, besides, conducting awareness campaign/ mass awareness program for reduction of bursting of fire crackers.

FOREST AND ENVIRONMENT

CHAPTER-7

7. Introduction

Forests contribute substantially to the national economy. With increasing population increased demand of fuel wood, expansion of area under urban development and industries has lead to over exploitation of forest Forests are habitat to all wild animals, plants and support millions of species. Forests also play an important role in combating pollution. Forest vary in composition and diversity and can contribute substantially to the economic development of any country. Plants along with trees cover large areas, produce variety of products and provide food for living organisms, and also important to save the environment.

7.1 State

7.1.1 Land Use Pattern & Forest Cover

As per India State of Forest Report 2017, the recorded forest area of the state is 37,033 Km2 which is 66.52% of its geographical area. Reserved Forests constitute 5.13%, Protected Forests 89.46% and Unclassed Forests 5.41% of the recorded forest area. About two third of the state's geographical area is under recorded forests but a substantial part is not conducive for tree growth, being under permanent snow, glaciers and cold deserts.

Forest Cover Change Matrix						(Area in sq Km)
Class	2017 Assessment					Total IFSR 2015 Updated
	VDF	MDF	OF	Scurb	NF	
Very Dense Forest	2956	233	25	0	11	3225
Moderately Dense Forest	55	6184	37	1	110	6387
Open Forest	95	193	4723	0	84	5095
Scrub	0	0	3	291	6	300
Non-Forest	4	95	497	16	40054	40666
Total ISFR	3110	6705	5285	308	40265	55673
Net Change	-115	318	190	8	-401	

The main objective of Himachal Pradesh Forest Policy is the proper utilization of forests, conservation and extension. The aim of the Forest department is to enhance the forest cover in the state to 30% of its geographical area by 2030 to meet the Sustainable Development Goals (SDGs). The state has three distinct regions, viz. the Shiwalik with altitudes up to 1,500 m, Middle Himalayan region between 1,500m to 3,000 m and the Himadris higher than 3,000m. The average annual rainfall is about 1,800 mm. The temperature varies from sub-zero to 35°C. The Himachal Pradesh has a geographical area of 55,673 Km^2. The altitude of state varies from 350m to 6,975 m above mean sea level. (Source: India State of Forest Report 2017)

7.1.2 Physiographically, the state can be divided in to following five zones:

- Wet Sub-temperate zone: Palampur and Dharamshala of district Kangra, Jogindernagar area of district Mandi and Dalhousie area of district Chamba.

- Humid Sub-temperate zone: Districts Kullu, Shimla, parts of district Mandi, Solan, Chamba, Kangra and Sirmour.
- Dry Temperate-alpine Highlands: Major parts of district Lahaul-Spiti, Pangi of Chamba and district Kinnaur.
- Humid Sub-tropical zone: District Sirmaur, Bhattiyat valley of district Chamba, Nalagarh area of district Solan, Dehragopipur and Nurpur areas of district Kangra.
- Sub-Humid Sub-tropical zone: Sirmaur and Indora area of district Kangra.

Forests are the important source of subsistence, employment, revenue earning and raw materials to a number of industries and also play a vital role in ecological balance, environmental stability, biodiversity conservation, food security and sustainable development of a country or region (Gupta H.K., 2007). Many important earth system ecological processes are governed by the extent of forest cover on the land surface. The extent of forest resources is the foremost requirement characterizing sustainable forest management.

7.2 Forest Resources

In Himachal Pradesh the forests and other natural ecosystems constitute two-thirds of the geographical area of the state which are crucial for its environmental, ecological and economic well being. This also influence the state's forests transcends well beyond its boundaries, significantly impacting on the ecology and economy of the Indo-Gangetic plains. The forests play an important role in preserving the fragile Himalayan ecosystem of the state because of its rich biodiversity. Biodiversity or biological diversity pertains to the diversity of biological organisms, both animals and plants in a region (Negi S.S. and Stimm B.).

Forest's act as a primary livelihood source for the rural population, the prime source of fresh water for both urban and rural populations. Forests provide essential services, such as food, fuel wood, fodder, timber, raw material for forest based industries and non-timber forest products in addition to performing important ecological functions. As per records nearly 66% of the geographical area of the state is forest lands; however, the extent of actual forest cover on all categories of land is only 27.12%. Himachal Pradesh has 2 National Parks, 33 Wildlife Sanctuaries and 3 Conservation Reserves covering 0.768 million ha which constitutes 13.80% of the state's geographical area, which are home to some rare and endangered faunal and floral species such as the Snow leopard, Musk deer, Himalayan Yew, Himalayan Pheasants, Western Tragopan and Monals.

The cold desert region of the state comprising Spiti sub-division of Lahul and Spiti District and Pooh sub-division of Kinnaur district are having distinct biome and manifests remarkable ecological and biological diversity unique characteristics of isolation and marginality. The forests of Himachal Pradesh, known for their grandeur and majesty, are like a green pearl in the Himalayan crown. The Driving forces, Pressures, State of affairs, Impact and the consequent Responses (DPSIR) affecting the forests of the state are discussed in a nutshell as follows.

7.3 Driving Forces:

Due to the impact of modern civilization, economic development and growth in human and cattle population the life supporting systems in the mountainous state of Himachal Pradesh are now under great threat. According to the National Forest Policy, 1988, at least two-thirds of the geographical area should be under forests in mountainous states like Himachal Pradesh. The recorded forest area is 66.52 % of the state's geographic area, but only 27.12 % of the area is under forests. Tree cover of the State has been estimated using TOF inventory data collected and high resolution (LISS-IV) remotely sensed data having spatial resolution of 5.8 meter was used for classification of TOF resources into blocks, linear and scattered strata. The estimated tree cover in the state is 822 Km^2 which is 1.48% of its geographical area. The growing stock in the recorded forest area has been estimated on the basis of the current forest cover map, forest type map and forest inventory data. For Tree Outside Forests (TOF), the same has been estimated using TOF inventory data (in million).

Forest	TOF	Total
315.580	23.199	338.779

7.4 Pressures:

Forest resources play an important role in the development of the economy and preserving the environment of Himachal Pradesh. Population growth has caused increasing pressure on the limited land available for agriculture, and the forests remain the principal source of grazing, fuel wood and fodder, especially among the poorest, as well as for rights and concessions such as Timber Distribution Rights. For the poor and especially the landless people the non-wood forest products constitute an important source of livelihood. Due to the increasing demand placed on the forest sector diminished its capacity to meet the forest needs of the people and sustainability has become the major challenge which has been observed at national, state and local levels.

7.5 State of Affairs:

The forests are still contributing about two per cent to the National Domestic Product, while in Himachal Pradesh their share in the state GDP is about eight per cent. Forests were previously considered the main source of income of the state. Now the focus has shifted from exploitation to conservation. The State Forest Corporation has been carrying out the extraction of trees and sale of timber since 1974, mostly the markings confined to salvage markings. The Forest Department concerns itself mostly with planting and the conservation of forests. The forest sector has to meet many diverse demands for forest products and services as the country has experienced three policy phases since independence, that is, industrial forestry, social forestry and conservation forestry. Degradation of forests, apart from deforestation, is currently the major problem in the forest sector, though deforestation was recorded in the past. Despite all the above factors, as per the recently released 15th India State of Forest Report (ISFR)-2017 by Forest Survey of India (FSI), the forest cover in the state has expanded by 393 square kilometers (sq kms), in comparison with the previous assessment year report 2015. The total forests cover in ISFR-2015 was 14,696 which has increased to 15,100 in ISFR-2017.

7.6 Impacts:

Cumulatively, deforestation and forest degradation result in the adverse ecological and livelihood consequences listed below, leading to the reduced well-being of present and future generations.

- Due to destruction of habitats of fauna and flora causes reduction in biodiversity.
- Irregular water flow, drying up of natural springs and increased vulnerability to flash Floods during rains.
- Reduction of agricultural productivity due to loss of soil fertility associated with soil erosion.
- Rapidly increasing prices and increasing imports of timber and other wood products due to widening gap between demand and supply for wood products.
- Scarcity of fodder and fuel-wood.
- Increase in carbon levels contributing to global warming.

7.7 Responses:

The Government of Himachal Pradesh has started important schemes and programmes including Social forestry, Joint Forest Management to slow losses to its forests and increase tree cover through assistance from external donor agencies and recently linking forest development with its rural development and poverty reduction strategies. The classification by vegetation and ecological types has been done for the scientific management of forests, mainly for silvicultural purposes and legal categorization into Reserved Forests, Demarcated Protected Forests and Unclassed Forests which is based on the degree of control. However, in the changed context for meeting environmental needs, forests are to be managed as an ecosystem for which functional classification of forests is important in the context of this Policy to promote appropriate land use for increased productivity, providing enhanced livelihood opportunities and improved conservation.

7.8 Legal and Administrative Status of Forests:

The forests have been classified into Reserved, Protected and Unclassed forests. The status of recorded forest as per legal classification the forest area and the growing stock of important tree species.

- **Reserved Forests (RFs):**

Reserve forests are the category most important to conservation or scientific management, and have been efficiently demarcated and notified under provisions of the Indian Forest Act (1927). These forests benefit from the highest degree of state control and the exercise of its proprietary rights. Generally, local villagers do not have any rights in reserve forests.

- **Protected Forests (PFs):**

Protected forests are similar to reserve forests but the state exercises a lower degree of control and proprietary rights. Local villagers can exercise some rights, unless specifically prohibited by notifications.

- **Un-classed Forests (UFs):**

All publicly-owned forests other than reserved forests and protected forests are categorized as un-classed forests. The state government exercises lesser degree of control over such forests compared to RFs and DPFs as their boundaries are not fully defined, demarcated and the local rights in these forests are not properly settled and recorded, hence, these type of forests are currently in a state of degradation. There is a gradual process of bringing un-classed forests into the category of reserved and protected forests. Within the administrative/ legal classification of recorded forests framework, some areas which are rich in rare and endangered flora and fauna are specifically earmarked for preservation of wildlife, flora, and natural ecosystems. This has been achieved by creating 2 national parks (under the Wildlife Preservation Act, 1972),

33 wildlife sanctuaries and 3 conservation reserves in HP.

Status of Recorded Forest Area in Himachal Pradesh

Legal Classification		
	Area(Km2)	**Percentage**
1. Reserved Forests	1896	5.12
2. Demarcated protected Forests	11387	30.75
3. Un-demarcated protected Forests	21656	58.48
4. Unclassed Forests	976	2.63
5. Others(managed) by Forest Department	370	1.00
6. Not managed by Forest Department	748	2.02
Total	37033	100.00

Forests Area/ Growing Stock of Important Tree Species

Name of Species	Forests Area (km^2)	Growing Stock (000 m^3)	Prescribed Annual Yield (00 m^3)
Deodar	890	16517	1736
Kail	698	13365	1320
Chil	1346	12481	981
Fir/spruce	1029	39364	2430
Sal	190	4852	280
Ban Oak	596	5949	156
Mohru Oak	32	201	n.p.
Kharsu	118	1717	21
Maple	n.a.	298	12
Walnut	n.a.	126	2
Bird Cherry	n.a.	15	n.p.
B.L. Species	533	5217	30
Total	5432	100102	6968

Source: Himachal Forest Statistics 2010

7.9 Forest Types of Himachal Pradesh:

Himachal has a diverse and rich flora as a result of varied physio-climate in its four agro-ecological zones. Differences in elevation lead to eco-zones with different vegetative cover, land use, and land capabilities. The vegetation of the state varies from tropical forests in the lower hills to alpine pastures in the high mountains. It has a rich and diversified flora because of the wide variety of soils, altitudes and climatic conditions. The altitudinal pattern of vegetation in Himachal Pradesh parallels latitudinal patterns of vegetation found globally. Hence the forest types seen in the higher altitudes of the state are more akin to those found in temperate latitudes. The forests of Himachal Pradesh are rich in vascular flora, which form the conspicuous vegetation cover. Out of a total of 45,000 species of plants found in the country as many as 3,295 species (7.32%) are reported in the state. More than 95% of the species are endemic to Himachal and characteristic of the Western Himalayan flora, while about 5% (150 species) are exotics introduced over the last 150 years. Among the rare plants is, the living fossil tree Ginkgo biloba, a native of China, of which two plant species have been found in Manali and Kalpa.

The forests can be classified on an ecological basis broadly into coniferous forests and broad-leaved forests as laid down by Champion and Seth. The distribution of species follows altitudinal stratification, apart from area with microclimatic changes resulting from aspect, exposure, and local changes in rock and soil.

Forest Types with Dominant Tree Species occurring in Himachal Pradesh

Forest Types	Area (km^2)	Important Tree Species
Tropical Dry Deciduous	2,140	*Shorea robusta, Acacia catechu, Anogeissus latifolia, Boswellia serrata, Lanea coromandelica, Aegle marmelos, Mallotus philipinensis.*
Tropical Thorn	43	*Prosopis spicigera, Salvadora spp., Acacia spp., Azadirachta indica etc.*
Sub-Tropical Pine	3,853	*Pinus roxburghii, Cedrus deodara, Pinus wallichiana, Quercus incana, Lyonia ovalifolia, Pyrus pashia, Crataegus crenulata, Rhododendron arboreum.*
Sub-Tropical Dry Evergreen	470	*Olea cuspidata, Pinus roxburghii.*
Himalayan Moist Temperate	4,064	*Quercus incana, Cedrus deodara, Pinus wallichiana, Pinus roxburghii, Rhododendron arboreum, Lyonia ovalifolia, Litsia umbrosa,, Quercus dilatata, Q. semicarpifolia, Picea smithiana, Abies pindrow.*
Sub-Alpine and Alpine	2,512	*Abies spectabilis, Pinus wallichiana, Picea smithiana, Rhododendron companulatum, Taxus bacccata.*

Source: India State of Forest Report 2011

7.10 Agro-ecological Zones and Vegetation Types:

The state of Himachal Pradesh has been divided into four agro-ecological zones based on altitudes associated with different forest types with trees, shrubs and herb species.

- Sub-tropical zone, comprising low hills up to 1000 m.
- Sub-tropical zone, covering mid- hills between 1000 m and1500 m.
- Temperate wet zone representing high hills between 1500 m and 3000 m.
- Temperate dry zone representing high hills above 3000 m (Alpine pasture zone).

(I) Sub-tropical, Low hills zone; up to 1000 m: This zone is mainly dominated by tropical mixed deciduous forest and thorn scrub in the foothills and fallow lands. The main native tree species found are: Acacia catechu, Embelica officinalis, Dalbergia sissoo, Terminalia chebula, Cassia fistula, Anogeissus latifolia, Zizyphus jujuba. The most common shrubs found are Euphorbia royaleana, Adhatoda vasica, Vitex negundo and Woodfordia fruticosa.

(ii) Sub-tropical, Mid hills zone 1000-1500 m: The sub tropical zone is characterized by the presence of Group 9 Sub-tropical pine forests also known as Upper Himalayan Pine forests. It bears an almost pure crop of Pinus roxburghii. The other species found in the mixture are Quercus incana, Lannea sp., Lyonia ovalifolia, Rhododendron arboreum, Indigofera sp., Myrsine sp., Rubus sp.
Several sub-types of Pinus roxburghii dominated forests can also be recognized in this zone:

a) Pinus-Carissa, Terminalia chebula and Lannea.
b) Pinus -Carissa -Indigofera with abundant pine regeneration.
c) Pinus-Quercus with Myrsine and Berberis.
d) Pinus-Acacia catechu with Mallolotus and Lannea.
e) Pinus -Wendilandia with Dodonea and Carissa.
f) Pinus -Carissa with Flacourtia.

Himalayan scrub: These areas are characterized by dry and shallow soil with intensive influence of biotic factors. The species met with are Diospyros melanoxylon, Embelica officinalis, Carrissa sp., Dodonea viscosa, Acacia catechu, Anogeissus sp., Lannea sp., Cassia fistula.

Euphorbia scrub: The vegetation is dominated by Euphorbia royleana with a mixture of palms controlled by edaphic factors and rocky ridges, steep slopes and very shallow soils.

Dry evergreen bush: The vegetation consists of Olea cuspidata with Punica granatum. Such vegetation is met with in plain alluvial beds in the valley.

iii) Temperate wet high hills zone between 1500-3000 m: Group 12, Himalayan moist temperate forests constitute the major forest types in Himachal Pradesh and are dominant in the temperate wet zone.

The sub-types of group 12 forests are:

12/C1 Lower Western Himalayan temperate forests
12/c 1a Ban oak forest (Quercus incana)
12/c 1b Moru oak forest (Q. dilata) DS1 Oak scrub
12/c 1c Moist Deodar forest (Cedrus deodara)
12/c 1d Western mixed coniferous forest (Picea smithiana, Pinus wallichiana and Abies pindrow).
12/c 1e moist temperate deciduous forest
12/c 1f Low level blue pine forests (Pinus wallichiana)
DS1 Oak scrub
DS2 Himalayan temperate secondary scrub.
12/C2 Upper West Himalayan temperate forest
12/c 2a Kharsu oak forest (Quercus semicarpifolia)

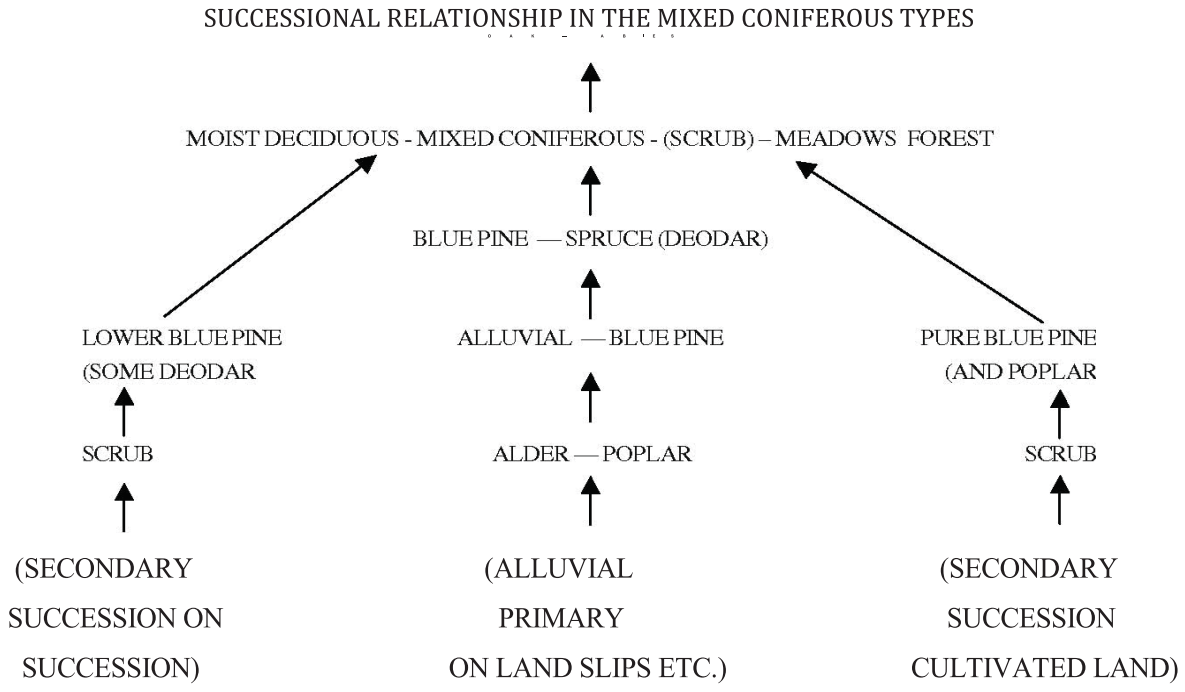
12/c 2b West Himalayan upper oak/fir forest
12/c 2c moist temperate secondary scrub.

The main conifer tree species met with are *Pinus wallichiana, Cedrus deodara, Picea smithiana, Abies pindrow* and main broad-leaved trees found are three Oaks species namely: *Quercus incana, Q. semecarpifolia, Q. dilata along with Aesculus indica, Acer caesium, Prunus padus, Populus cilata, Corylus colurna, Ulmus wallichiana, Juglans regia, Pyrus lanata, Betula alnoides, Fraxinus sp., Carpinus sp.* In this zone, typical of Western Himalayan forests, the three common oaks provide a simple and convenient basis for sub-division into altitude zones each with its typical coniferous counterpart as shown below.

Western Himalayan Oaks

Altitude	**Broad-leaved**	**Coniferous**
3,000 m	Sub-alpine Birch-*Rhododendron*	*Abies spectabilis*
2,500 m	*Quercus semecarpifolia*	*Abies pindrow*
2,250 m	*Quercus dilatata*	*Abies pindrow, Picea smithiana*
2,000 m	*Quercus leucotricophora*	*Cedrus deodara, Pinus wallichiana*
1,500 m	(Sub-tropical tree species)	*Pinus roxburghii*

The succession phases of dominant species found in typical West Himalayan Temperate Forests is illustrated in the following diagram.



iv) Temperate dry high hills zone; above 3000 m: The main grass species found in subalpine pastures are *Agropyron longeristatum, A. semicostatum, Bracypodium sylvaticum, Bromus asper, B. japonicus, Dactylus sp., Danthonia sp., Festuca sp., Milium effusum, Oryzopsis, Phleum, Poa sp.).* Alpine pastures (meadows) are composed mostly of mesophytic herbs with very little grass such as

Primula, Anemone, Fritillaria, Iris, Gentiana spp. and at higher altitudes to stony desert with herbs such as *Sedum crassipes, Primula minutissima, Saxifraga imbricata, Potentilla fruticosa, Draba gracillima, Kobresia duhtei. Dwarf shrub species of Juniperus wallichiana, J. communis and Caragana sp.* predominate in the zone. Alpine scrub, which adjoins the dry temperate forests, may take its place under heavy pressure of grazing and has been described as *Alpine steppe.*

7.11 The Extent of Forest and Pasture Areas:

The perception of what constitutes a forest, and thus the size of the area classified as forest, has changed in recent years in the state. Until the mid eighties, forests were conceived in terms of tree production, and only the cultivatable area was measured. Since the introduction of the new forest policy, forests have been considered more as an ecosystem, and the definition of forest area extended to include areas of rocky precipices, alpine snow, and meadows which, although devoid of actual tree cover, are nonetheless an integral part of the larger forest eco-system. The legal forest area is now calculated to be 37,947 km^2, or 68.16% of the total geographical area of the state of which 14,679 km^2 (26.37 % of state geographical area) is under forest cover. About 65 percent of the forest area is found at altitudes above 1,800 m. Himachal Pradesh has been divided in to three bio-geographic zones, Trans Himalayas, The Himalayas and Semi Arid.

Table : Protected Areas in Himachal Pradesh

Sr. No.	Name of NPs/Santuaries	Area (km^2)	Name of District
1.	Great Himalayan NP	754	Kullu
2.	Pin Valley National Park	675	Lahaul Spiti
3.	Chail	109	Solan
4.	Simbalbara	19	Sirmour
5.	Renuka Ji	4	Sirmour
6.	Churdhar	66	Sirmour
7.	Majathal	40	Solan
8.	Darlaghat	6	Solan
9.	Talra	40	Shimla
10.	Shilli	2	Solan
11.	Lipa Asrang	31	Kinnaur
12.	Raksham Chhitkul	304	Kinnaur
13.	Rupi Bhaba	503	Kinnaur
14.	Daran Ghati	167	Shimla
15.	Shimla Water Catchment	10	Shimla
16.	Kais	14	Kullu
17.	Bandali	41	Mandi
18.	Shikari Devi	214	Mandi
19.	Khokhan	13	Mandi
20.	Kanawar	54	Kullu
21.	Nargu	278	Mandi
22.	Manali	29	Kullu
23.	Naina Devi	123	Bilaspur
24.	Pong Dam	307	Kangra
25.	Govind Sagar	100	Bilaspur
26.	Dhauladhar	944	Kangra
27.	Gamgul Siyabehi	109	Chamba
28.	Kalatop Khajjiar	69	Chamba
29.	Kugti	379	Chamba
30.	Tunda	64	Chamba
31.	Sechu Twan Nala	103	Chamba
32.	Sainj	90	Kullu
33.	Tirthan	61	Kullu
34.	Kibbar	1400	Lahaul Spiti
35.	Chandra Tal	39	Lahaul Spiti
Total		7161	

Source: Himachal Forest Statistics 2010

Bio-Geographic Zones and provinces in Himachal Pradesh:

Sr. No.	Bio-Geographic Zones	Provinces	Protected Area
1.	2.	3.	4.
1	**Trans Himalayas**	Ladakh Himalayas	Pin Valley National Park, Kaza
		Tibetan Plateau	Kibber Wildlife Sanctuary
2.	**The Himalayas**	North West Himalayas	Bandli, Gamgul-Siyabehi, Kais, Kalatop-Khajiar, Kanawar, Khokhan, Kunhti, Manali, Sechu-Tuan Nala, Shikari Devi, Tirthan, Tundah, Sainj, Lipa-Asrang, Nargu, Rupi-Bhaba, Dhauladhar WL Sanctuaries & Great Himalayan National Park, Kullu.
		West Himalayas	Churdhar, Chail, Daranghati, Majathal, Rakchham-Chitkul, Shilli, ShimlaWater Catchment, Tarla wild life Sanctuaries.
3.	**Semi-Arid**	Punjab Plains	Govindsagar, Pong Dam, Naina-Devi, Renuka & Simbalbara WL Sanctuaries.

Source: Himachal Forest Statistics 2010

7.12 Forest Cover and Related Statistics of Himachal Pradesh:

"Forest cover refers to all lands with a tree canopy of more than ten per cent and may not be recorded as forest and should be distinguished from forest area which refers to all land recorded as forest and may not necessarily bear forest/ tree cover."

The forest cover in the state, based on interpretation of satellite data of October-December 2015, is 15100 Km2 which is 27.12% of the state's geographical area. In terms of forest canopy density classes, the state has 3,110 Km2 areas under very dense forest, 6,705 Km2 areas under moderately dense forest and 5,285 Km2 areas under open forest**.** (Source: India State of Forest Report 2017)

Forest Cover Change Matrix						(Area in sq Km)
Class	2017 Assessment					Total IFSR 2015 Updated
	VDF	MDF	OF	Scurb	NF	
Very Dense Forest	2956	233	25	0	11	3225
Moderately Dense Forest	55	6184	37	1	110	6387
Open Forest	95	193	4723	0	84	5095
Scrub	0	0	3	291	6	300
Non-Forest	4	95	497	16	40054	40666
Total ISFR	3110	6705	5285	308	40265	55673
Net Change	-115	318	190	8	-401	

7.13 Land Use Pattern & Forest Cover

The population of the state is 6.86 million (census 2011) which constitutes 0.57% of the country's population. Of this rural population is 89.96% and urban 10.04%. The population density is 123 persons per Km^2. The scheduled tribes constituting 4.02% of the population are mainly distributed in three districts. The livestock population is 5.23 million (Livestock Census 2007).

Land Use Pattern		
Land Use Types	Area(in 000' ha	Percentage
Total Geographic Area	5567	
Reporting Area for land Utilization	4576	100.00
Forests	1126	24.61
Not available for land cultivation	1127	24.63
Permanent pastures and other grazing lands	1510	33.00
Land under misc.tree crops and groves	64	1.40
Culturable wasteland	122	2.67
Fallow land other than current fallows	22	0.48
Current fallows	54	1.18
Net area sown	550	12.02

Source: Land Use Statistics, Ministry of Agriculture, GOI, 2013-14.

Table : District-wise Forest Cover (Area in km2)

District- wise Forest Cover							(Area in sq Km)	
District	Geographical Area	2017 Assessment				Percent of GA	Change	Scurb
		Very Dense Forest	Mod-Dense Forest	Open Forest	Total			
Bilaspur	1167	23	161	191	375	32.13	14	0
Chamba	6522	775	986	682	2443	37.46	1	21
Hamirpur	1118	39	86	188	313	28.00	71	2
Kangra	5739	297	1274	626	2197	38.28	130	8
Kinnaur	6401	79	266	278	623	9.73	14	71
Kullu	5503	582	843	562	1987	36.11	22	23
Lahul & Spiti	13841	15	31	147	193	1.39	3	24
Mandi	3950	368	722	671	1761	44.58	84	28
Shimla	5131	736	1039	624	2399	46.76	9	31
Sirmaur	2825	131	568	688	1387	49.10	2	56
Solan	1936	46	426	394	866	44.73	16	44
Una	1540	19	303	234	556	36.10	27	0
Grand Total	55673	3110	6705	5285	15100	27.12	393	308

Source: India State of Forest Report 2017

7.14 Impacts:

Forests in Himachal Pradesh have a most productive ecological niche. As per latitude, the state falls in the tropical zone, but its geographical location and good forest cover have enriched it, both biologically and economically. During the immediate post-independence period, the forests of the state were identified mainly as a source of timber. This led to large scale felling and clearing of forest areas to meet the timber needs of industries set up in the plains and of the flourishing horticulture industry in the state.

Application of remote sensing technology in the assessment of forest cover of the country was made by the Forest Survey of India and National Remote Sensing Agency (NRSA) of the Department of Space in the early 1980s. The forest cover of the country is assessed biennially by FSI using satellite data. Beginning in 1987, nine such assessments have been made up to 2003 and brought out in the State Forest Reports (SFRs). The forest cover is classified into open forest (canopy density between 10 and 40 %), open forest (canopy density between 1040 %, scrub (canopy density less than 10 %) and non-forest. Based on SFRs, Based on changes in forest cover there occurred a change in growing stock of commercially important species; this is represented in Table 5.61 based on statistics derived from Forest Working Plans of Forest Department.

7.15 Forest Produce Extracted from HP Forests:

I) Timber:

Most of the villages in the state are situated on steep slopes and connected by tracks, village paths or by village roads. Moreover, the villages are either adjacent to or are enclosed by forests, which are thus deeply integrated with the livelihood of the local people. They depend on the forests for timber, for the construction of houses, firewood, agricultural implements, fodder and a variety of other products and services, including certain medicinal herbs and other NTFP (Non Timber Forest Produce). Some of the users of forest products feel equally responsible for their conservation and ensure certain protection and regular regeneration of forests. Forest Corporation was constituted by the government of Himachal Pradesh in 1974 and it is the only agency responsible for harvesting and exploitation of forests, including resin tapping. Previously, private contractors carried out all activities relating to forests. This resulted in unscientific harvesting and over-exploitation of forest resources.

ii) Non-timber Forest Products:

Besides timber, the forests of Himachal Pradesh are rich in fodder, grass and other grazing plants, organic manure and fibre, gum, resins, medicinal plants/herbs and other products including fruits. The Himachal Pradesh State Forest Corporation is the only agency responsible for extracting resins from the state forests. The state Forest Department issues permits for the collection of other non-timber products. Medicinal and aromatic plants are of special value. Some of these herbs are found only in Himachal Pradesh and there might be many still undiscovered. The main concern at present is the unscientific harvesting and excessive and ruthless exploitation of these resources by private pharmaceutical companies, whose sole motive is to maximize their profits. These companies have no or very little interest in the regeneration and management of the forest. This has resulted in several species of medicinal and aromatic plants either becoming extinct or being listed as endangered species Pinus gerardiana, which yields Chilgoza nuts, is facing extinction and has already been listed as an endangered species.

Medicinal and aromatic plants have the potential of earning foreign currency and these need to be exploited scientifically using modern management methods. The main products were muskbala/nihani, pathin, rakhal, dorighas and neoza. Recently, the state has introduced Lavender, which yields high value aromatic oil at Salooni in Chamba district along with setting up of an oil extraction unit. A Lavender bush remains productive for 15 years and starts yielding flowers for oil extraction in the second year of its cultivation. The processing of Lavender oil and its consequent use in production of agarbati, dhoop and cosmetic creams could earn additional income. Sea buckthorn is another wild plant, of immense medicinal and environmental value that can be grown in abundance in Lahaul & Spiti, Pangi and Kinnaur. China has successfully used its Sea buckthorn treasure. As such, some medicinal plants which are not regularly cultivated are being collected from the wild and becoming scarce and threatened with extinction. NTFPs that is resin, bamboos, bhabbhar grass, fodder and medicinal plants extracted from the forests.

7.16 Responses - Plantations raised by HP Forest Department:

Regeneration of forests becomes essential as more and more forest areas become degraded because of social and economic causes, forest fires and other natural phenomena. Large-scale afforestation programmes undertaken by the HP Forest Department in selected areas in the recent past, also involving such institutions as Joint Forest management have yielded good results. The equation between forest degradation and forest

regeneration should be maintained, to ensure that forest cover does not get depleted. Local factors are important for natural regeneration of forest species. Natural regeneration of Khair, Chir, Shisham, eucalyptus and bamboo has been going on in the state. Natural regeneration is not the only way of afforestation and should be supplemented with artificial regeneration.

Artificial Regeneration is the main method adopted to increase the forest cover of the state. Plants of economically as well as ecologically important species, such as Chil, Khair, Deodar, Robinia, Poplar, Fir/Spruce and Kail are being planted. Seeds of some of these species are also being developed by the state.

7.17 Historical Perspective of Forest Management in Himachal Pradesh:

The development of a historical timeline of forest management in HP has been shown through eight generations:

- **1st Generation - Prior to 1850s. (Period of usage and customary rights) -** Era of princely states: the kings and local rulers are the decision-makers. No role of communities' rights enjoyed at the pleasure of the king, though traditional institutions of PFM existed.
- **2nd Generation - 1850-1950 (Period of codification of rights) -** Era of British Rule: British replace the kings as outsider decision-makers. Customary rights are recognized and codified in forest settlements and given official sanctity. Still all decisions made by the British, though communities consulted during the settlement of rights. Involvement of people in PFM is sought through the setting up of Forest Cooperative Societies in Kangra district from 1940 onwards.
- **3rd Generation - 1950-1975 (Period of metamorphism) -** Indiscriminate use of rights after Independence: The local forest officers replace the British as the implementing agency. Period of no-decision. People continued exercising the rights on increasing levels. Forest resources start showing signs of depletion and degradation.
-
- **4th Generation - 1975-1980 (Period of awakening) -** Beginning of social forestry. The FDs prefer forestry schemes with the involvement of people and communities. Still no participation of communities. The HP State forest policy of 1980 comes into effect.
- **5th Generation - 1980-1990 (Period of donor-driven social forestry) -** Donor-led social forestry projects are launched. FDs and donors seek involvement of local people and communities: however, much of decision-making transferred to donors, though alienation of communities continues.
- **6th Generation - 1990-1993 (Period of seeking participation of communities)** National Forestry Policy 1988 and GoI circular of June 1990 on participatory forest management issued. The FD attempts participation of people in formulation of forestry schemes. People (Forest Users) given limited decision-making powers within existing classical framework of the FD.
- **7th Generation - 1993-2001 (Period of institutionalization of PFM) -** Role reversal of foresters and communities in decision- making sought. Foresters to act as catalysts and enablers. Registration of VFDC under the state government. JFM Order of 1993 initiated.
- **8th Generation - 2001 onwards (Linking Rural Livelihoods and Panchayati Raj Institutions with Forest Management) -**Participatory Forest Management Regulations, 2001 and empowerment through village forest development societies begins. Livelihood-focused JFM initiated and Link with Panchayati Raj institutions.

7.18 Evolution of Participatory Forest Management in Himachal Pradesh:

Traditional initiatives in PFM and regulated use of forests through the deota (village deity) institutions exist in several villages of HP. There are numerous cases of people's active participation in forest resource management, especially in the regulation, collection and distribution of forest products. Such traditional systems existed long before the advent of the present day Joint Forest Management. The initial efforts to develop joint arrangements for forest management were initiated prior to independence through Cooperative Forest Societies (CFS) in the Kangra district of Himachal Pradesh. After Independence in 1947 and until about the early 1970s, the sole emphasis was on the consolidation of the FD, establishment of forest-based industries, and afforestation on all types of land. The report of the National Agriculture Commission (1976) emphasized the need to start forestry programmes for meeting the daily needs for fuel wood, fodder and timber of the rural people. Subsequently, in the 1980s, many donor agencies supported the implementation of people-oriented forestry programmes through social forestry projects. The 1988 Forest Policy gave a boost to the social forestry programme by recognizing the fact that rural people's economy and livelihood was dependent on forests and, therefore, the people had first charge on the use of forest resources for their sustenance. The GoI's memorandum of 1990 laid the foundation for (re) introduction of PFM in the states. The Government of Himachal Pradesh (GoHP) issued its order on PFM on May 12, 1993. Since then JFM has been the main thrust of all forestry programmes in the state. The following gives a brief description of the main initiatives involving PFM in the past few decades.

7.19 Cooperative Forest Societies (CFSs):

Experiments with CFSs began after the state took over control of the forests following forest demarcation and settlement procedures. The concept behind forest cooperatives was based on the realization that the FD would be unable to control the resultant rapid deforestation of the forests. In order to find alternative management strategies for degraded areas of Kangra district, intense discussions took place between the FD, the district administration and the Revenue department during the year 1932. The objective was to hand over UPFs, unclassed forests and shamlat (village common) lands to the village Panchayats for management and income generation. The Panchayats were to appoint their own staff for protection. David in a forester, in 1932, argued that forest guards should not be allowed to interfere. Revenue from sale of trees should be used for conservancy and regeneration of forests on the presumption that the Panchayat would close part of the forest handed over to it for the purpose of regeneration. Chaudhry in 1945 stated "The forest-society's scheme is one of the first of its kind to be introduced in India in which government forests are being handed over to the villagers for management and for enjoying their income."
The other argument was that forests were to be managed as Village Forests (VFs). The FD should work for the Panchayats and carry out all measures in cooperation with them. The FD should not impose its decisions on the Panchayat, especially with regard to closure, but in silvicultural measures, for example, the marking of trees. The Panchayat should abide by the decision of the FD (Kangra district records, 1932).

- In 1935, in a National Forest Conference held in Madras (now Chennai), a resolution on finding alternative management strategies for degraded areas of Kangra district was passed. The resolution described: "That the conference is firmly of the opinion that the state of the undemarcated forests is so deplorable that the recent policy for their management must be changed. The practicability of forming VFs should be examined, and the government may be asked to appoint a committee to decide what particular steps should be taken in each district of the outer Himalayas."
- In 1937, the Garbett Commission was set up by the Punjab government to enquire into the difficulties

- **6th Generation - 1990-1993 (Period of seeking participation of communities)** National Forestry

Policy 1988 and GoI circular of June 1990 on participatory forest management issued. The FD attempts participation of people in formulation of forestry schemes. People (Forest Users) given limited decision-making powers within existing classical framework of the FD.

- **7th Generation - 1993-2001 (Period of institutionalization of PFM) -** Role reversal of foresters and communities in decision- making sought. Foresters to act as catalysts and enablers. Registration of VFDC under the state government. JFM Order of 1993 initiated.

- **8th Generation - 2001 onwards (Linking Rural Livelihoods and Panchayati Raj Institutions with Forest Management) -**Participatory Forest Management Regulations, 2001 and empowerment through village forest development societies begins. Livelihood-focused JFM initiated and Link with Panchayati Raj institutions.

- In 1937, the Garbett Commission was set up by the Punjab government to enquire into the difficulties experienced by 'those who live in and near the forests, and to suggest strategies for enlisting their cooperation with the FD. The Commission found that 20.4% of the forests of Kangra were under scientific management, and the remaining 79.6% was burdened with heavy rights.
- The other argument was that forests were to be managed as village forests. The FD should work for the Panchayats and carry out all measures in co-operation with them. The FD should not impose its decisions on the Panchayat especially with regard to closure, but in silvicultural measures e.g. marking of trees, the Panchayat should abide by the decision of FD (Kangra DC records, 1932). The commission recommended that :

- ✓ The villagers should agree to management according to simple working plans approved by the government, which would involve closing, where closures were demonstrably necessary.
- ✓ In order that this demonstration may be convincing, government should associate themselves with the management of the forests and the representatives of the people.
- ✓ An effort is made to teach the villagers that whatever profits may accrue from the management of the shamlat and the reserves will be to their benefit.
- ✓ In order that the people may have qualified representatives, Panchayats must be formed to whom the details of the forest management of the area in which the village is situated could be explained.
- ✓ For this purpose a working scheme of management for each village must be prepared. The scheme would envisage management of not only the shamlat, but also of the protected and reserved forests to which the village had rights, in such a way as to secure the maximum crop of forest produce for the benefit of the villagers.
- ✓ If possible, the cost of management was to be met from the proceeds of sales, but the value of these provisions of securing the catchment area was felt to be far greater than some small expenditure on the staff, which was to be paid for, in part or wholly by the government. This was a major shift as it accepted the maximum priority to be given to soil and forest conservation and that this was not possible without the involvement of the communities.

7.20 Formation and Working of CFSs:

The Punjab Government ordered FD to draw up a scheme on the recommendations of the Garbett Commission in 1938, and the FD launched the Co-operative Forest Society scheme in the same year. The scheme was sanctioned in 1940 and conditions and terms of grants-in-aid along with CFS rules were notified in 1941. The CFS schemes were sanctioned initially for a period of five years with an annual grant-in-aid of Rs. 50,000. The scheme was extended for another five years in 1945 with total of 63 CFS formed by then. By 1956, seventy Co-operative Forest Societies were operational managing 23,556.29 ha of forestlands forming about 10% of the total forestland of District Kangra. In 1961, the scheme extended by 10 years but grant-in-aid limit

to Rs, 50,000 was cancelled and the income from CFS was to be given back to them as grant after making the necessary service deductions. In 1969, Rawal's integrated working plan (WP) covering 70 the CFSs came into effect with the merger of Kangra district in HP in 1966. In 1971, scheme was not extended and FD withdrew its technical support. The FD took over working of the CFS forest area based on Rawal's WP as the income from CFS reduced to insignificant sums. HP Government passed orders for extending the scheme for two years, but the above situation continued. In 1972, 29 CFS were found to be in poor condition. In 1972 with the promulgation of 'HP Common Lands Vesting and Utilization Act', the control of shamlat lands was taken from the Panchayat and the Deputy Commissioner. In 1983, Rawal's WP period expired and the FD included the CFS forest areas in a revised territorial Working Plan for respective Divisions. Although the grant-in-aid to CFSs were discontinued in 1971, there is evidence to suggest that people in many villages are still using the forest resources within the framework of a CFS.The EC of the societies worked with the FD to implement Working Plans, which mainly comprised closing forestlands for regeneration, detecting offences, and settling disputes. Membership in CFSs was limited to all heads of households paying land revenue and did not include women, the landless, village artisans, and other non-agriculturists. The management of the society centered on landholders (not user groups), thereby alienating a large section from participating in the protection and management of forests.

7.21 Historical Overview of Participatory Development Process in Himachal Pradesh:

The significant experimentation with participatory planning has been done by Forest Department in the following schemes, projects/events:

1976-80	Three Dimensional Forest Farming
1980-89	Indo-German Dhauladhar Farm Forestry Project
1984-93	National Social Forestry (Umbrella) Project
1991-93	Van Lagao-Rozi Kamao Scheme
1993	HP Government JFM Resolution
1993-2004	Indo-German Eco-Development Changer Project
1991-2005	Integrated Watershed Development Kandi (Hills) Project
1994-2001	Indo-UK Himachal Pradesh Forestry Project
1998 onwards	Sanjhi Van Yojna (Community Action in Forestry)
1999-2000	Himachal Pradesh Forest Sector Review
2001	Himachal Pradesh Parictipatory Forest Management Regulations
2002-2006	Himachal Pradesh Forest Sector Reforms Projects
2002 onwards	Forest Development Agencies through GOI schemes

7.22 Three Dimensional Forest Farming:

Experiments involving the local people in forest conservation and development began in right earnest with the introduction of the concept of Three-dimensional Forest Farming (TDFF) in 1976. The TDFF had three objectives, soil conservation, and production of timber and fodder for domestic cattle. With the enunciation of the State Forest Policy in 1980, people's participation in afforestation programmes was highlighted. For synergy, TDFF was later merged with social forestry/farm forestry schemes.

7.23 National Social Forestry (Umbrella) Project (1985-1993):

National Social Forestry (Umbrella) Project was launched in 1985 with USAID and IDA participation in HP. This project had the objective of increasing the production of fuel, fodder and timber to provide enhanced income opportunities to the landless and other villagers and to strengthen forestry institutions. In this Umbrella Project, the plantations were to be carried out after consultation with VDCs and preparing 'Integrated Resource Management Plans (IRMPs).

7.24 The VDCs were charged with the responsibility for:

- Assisting in preparation of the Integrated Resource Management Plans (IRMPs).
- Identifying areas for raising fuel, fodder plantation and grassland development.
- Selecting the species to be raised and encouraging the villagers to raise Kisan nurseries.

During the project period, the local people were involved in the various programmes, under different components of the project. The response of the local people was quite encouraging, and the various VDCs formed under the project worked well towards the protection and development of forests. With the termination of the project in 1993, these committees also stopped working. The main reason for these committees becoming defunct in the absence of project aid appears that the main thrust was given on achievement of targets. Sustenance of the programme, which started during the project period, was not given attention. The thrust was on implementation of the scheme, so the training aspect was not given importance to the level required for the changed working. So, during the project period the scheme produced very good results, but these could not be sustained after the project ended.

During Phase II of the social forestry project, beginning in 1991, the HP government launched the Van Lagao Rozi Kamao Yojna (Plantation and Employment Scheme). It had the twin objectives of providing employment to the poorest of the poor and greening the barren hills with tree cover. The aim was to provide employment to 75,000 families and raise plantations of species required by the farmers on 140,000 ha of degraded land during the eighth and ninth Five-year Plans. The programme envisaged providing on lease 2 ha of contiguous village lands to each household below the poverty line. The beneficiary households were expected to plant trees and protect them. A good beginning was made in this direction. The poorest of poor beneficiaries were selected and employed as van sewaks. Linking the payments with survival percentage of the plantations ensured their involvement in forest protection. The people, on the basis that it was de-facto privatization of their common grazing lands, however, opposed the scheme. The scheme had to be abandoned because of objection from the GoI on legal grounds, that keeping in view the Forest Conservation Act, 1980, plantation by individuals on government land is a violation of the Act and, therefore, cannot be allowed. The scheme closed with the culmination of the project in 1993.

This project covered all of HP's 12 districts and attempted to implement its activities through villagers or in consultation with villagers. The FD started the dialogue with the villagers'gram panchayat's (GP) or other existing VLIs such as MMs. Village forest development committees (VFDCs) were set up in many villages for the first time to implement the scheme. However, attempts to seek the active participation of an entire village community by including one woman (from the MM), one representative from the scheduled castes, and one from the GP, were not very successful.

The VDCs evolved neither participatory mechanisms nor bottom-up systems for planning and management. The lack of representation of local forest users and domination by the elite reduced the experiment to pro forma 'involvement' of the people. As ex-offico member secretary of the VDC, the FD forest beat guard formulated the integrated resource management plan (IRMP) for the village, leading to FD rather than community ownership. While on paper the social forestry programme succeeded in planting over 100,000 ha of plantations, community participation was limited and the FD continued choosing the species to be planted (like eucalyptus), without reference to the needs of the community – leading many communities to call it 'un-social' forestry.

Committees constituted in HPFD under various projects/schemes:

Name of Project	Project Period	Name of Institution	No. of Committee	Registered under
HP Forestry Project (HPFP)	1994 -2001	Village Forest Development Committee (VFDC)	154	JFM Notification dated 12.05.1993
Indo-German Eco Development Project	1994-2005	Village Development Committee (VDCs)	294	JFM Notification dated 12.05.1993
IWDP Kandi Project	1993-2005	Village Development Committee (VDCs)	137	Societies Registration Act, 1860
Sanjhi Van Yojana	1998 ongoing	Village Forest Development Societies (VEDCs)	360	Societies Registration Act, 1860
Great Himalayan National Park	1993 ongoing	Village Eco-Development Committee (VEDCs)	18	Director, GHNP
Mid Himalayan Watershed Dev. Project	2005 ongoing	Gram Panchyats	602	-
National Afforestation Project (NAP)	2010 ongoing	Joint Forest Management Committees (JFMC)	1567 JFMCs	Registered by CFs/DFOs as per the provision laid down in Revised Operational Guidelines,2009 of NAEB.
Integrated Watershed Management Swan River Project	2006 ongoing	Project Development Committees	NA	Societies of Registration act 1860

Source: H.P. Forest Department

7.25 Salient Features of HP Participatory Forest Management Regulation 2001.

HP Participatory Forest Management Regulations were issued on 23.8.2001, is a major improvement on 1993 administrative order for JFM as these are issued under Sections 80 and 81 of Indian Forest Act 1927. In accordance with the wider objectives and plans of government for sustainable forest management, the Village Forest Development Society and the Forest Department will manage the selected area jointly.

The salient features of H.P. Participatory Forest Management Regulation 2001 are:

- It is applicable to all forest areas, and any government forest and government land including common land may be brought under participatory forest management, based on an application made to the Divisional Forest Officer signed by at least 50% of the voters of a Gram Panchayat ward.
- It considers and recognized the majority of stakeholders, such as migrant graziers, self help groups, user groups
- It brings in total community control, as the Secretary will be from the community and Forest Guard's role of facilitator or any other government functionaries.
- It balances gender with a 50% reservation to women and Joint Secretaries will be women.
- The legal back-up is provided to VFDS which are to be registered under the Society Registration Act 1860.

Year - wise Fund Allocation and Plantations under the SFDA.

Year	Work Programme approved (in lakhs)	Funds released	Expenditure incurred	Physical Targets (ha)	Physical targets achieved (ha)
2007-08 (**only 11 FDAs**)	-	743.31	644.31	2143	1719
2008-09 (**only 9 FDAs**)	962.27	672.00	448.17	3633	2263
2009-10 (**only 7 FDAs**)	-	359.04	675.37	1249	2263
2010-11 (**36 FDAs**)	603.63	345.00	575.40	2245	2467.10
2011-12 (**36 FDAs**)	753.14	348.82	325.41	1601	1337.78
2012-13 (**36 FDAs**)	1028.05 (work programme approved for Rs. 364.68 lakhs)	172.00 (1st installment)	94.88	2561	743 (up to 11/2012)
		189.92 (2nd installment)	2nd installment received during March, 2013 funds are being utilized.	1159	Yet to be achieved
2013-14 (**33 FDAs**)	798.94 (proposed)	To be released and transferred to SFDA account	-	-	-

Source: H.P. Forest Department

The structure for linking PFM with Panchayati Raj Institutions was provided in the HPPFM Regulations 2001 issued under Sections 80 and 81 of the Indian Forest Act 1927. The Panchayat ward will be the basic unit for setting up of the VDC. The state Panchayati Raj Act, 1994, includes forests in its list of 29 activities. The GoHP order in 1997 entrusted supervision and monitoring responsibilities related to 15 departments, including the FD to PRIs. It includes social and farm forestry, minor forest produce, watershed development, land improvement and soil conservation, and fuel and fodder. Members of Panchayats (Pradhans / Panch) are nominated/ex-officio members of the VFDC/ VFDS / VDC executive Committee. There is normally one Society

for a Gram Panchayat ward, but where the ward is not compact and the hamlets within it do not have common land or common rights and concessions, more than one Society may be formed for each cluster of hamlets. The regulation entitles the society to some benefits of NTFP collection and a share in the sale proceeds of all intermediate harvests, subject to protection of forests and plantations for at least three years from the date of agreement. The Society will also be allowed to expand the area after a period of five years. After twenty years from the date of agreement, 75% of the net sale proceeds from the selected area will be put into the accounts of the Society) and the remaining 25% will go to the concerned Gram Panchayat. The notification also mentions that at least 40% of the net sale proceeds should be used on forest management activities, including soil and water conservation.

7.26 Research wing of H.P. Forest department:

Research wing is currently implementing the following activities:

Following projects are undertaken under NMPB,

- High Altitude Transition Zone Project Himachal Pradesh:

A Project named High Altitude Transition Zone is being taken up to assess the effects of Global warming and trials to rehabilitate degraded sites. The project budget is for 200 Lakhs with project period for five years (1.4.2011 to 31.3.2016.)

- National Bamboo Mission:

Conservator of Forests Research has been declared as State Mission Director. An annual Action Plan for the year 2013-14 for Rs. 204.00 Lakh has already been submitted to National Bamboo Mission (GoI).

- Research Nurseries:

Two Nurseries one at Ropari near Sundernagar and One at Kothi in Kullu Forest Division have been established to undertake trials for development and up gradation of nursery techniques.

- Wildlife and its Conservation

Wildlife and its conservation in India draws strength from Article 48-A of 'Directive Principles of State Policy under the Constitution of India, which states that "the state shall endeavor to protect and improve the environment and to safeguard the forests and wildlife of the country". The Constitution vide Article 51-A (g), specifying fundamental duties of the citizens of India, states that it shall be the duty of every citizen of India to protect and improve the natural environment including forests, lakes, rivers, and wildlife and to have compassion for living creatures.

The primary law governing matters related to wildlife in the country is the Wildlife (Protection) Act, 1972. The state of Himachal Pradesh has adopted this Act and its subsequent amendments as the prime legislation to manage and guide wildlife related matters in the state. Himachal Pradesh is home to a very impressive, diverse and unique fauna–many of which are rare. The state's scheme aim at protection, improvement of environment and wildlife.

Protected Area Network

With a view to conserve the total range of wildlife available in the state, the Government of Himachal Pradesh

has declared several areas, covering all the agro-climatic zones in the state and having significant ecological, geomorphological and biodiversity value, as Conservation Reserves, Wildlife Sanctuaries and National Parks. At present, there are 5 National Parks, 26 Wildlife Santuaries and 3 Conservation Reserves. The details are as under:

Sr.No.	Category of Protected Area	Area in Sq.Km
1	National Parks	**2407.28**
2	Wildlife Sanctuaries	**5964.9731**
3.	Conservation Reserves	**19.17**
	Total	**8391.4231**

Snow Leopard: The large cat of Felides family Snow Leopard, native to the snow mountain ranges of the Great Himalayas. The endangered snow leopard habitat is extremely difficult to access, they prefer steep, rugged terrains with rocky outcrops and ravines. Because of the in accessibility of much of the snow leopards habitat, the exact numbers left in the wild is unknown.

Another felid of Himalaya is "The clouded leopard" found from the Himalayan foothills through mainland northeast India to neighbor countries. The powerful predator of hills has been classified as vulnerable with suspected to be fewer than 10,000.

Himalayan Wild Yak: The Yak, a long-haired bovine found throughout the Himalayan region of India. The massively-built animal with a drooping head are among the largest bovids with males standing about 6 feet tall at shoulder. The shaggy beast is among the most useful animals of Himalayan, Besides of meat,fiber, milk, and hide, yaks are used as beasts of burden. Yak is one of the local inhabitants of the cold desert and Yak Safari is thus unique to enjoy.

Himalayan Blue Sheep: The bharal or Himalayan blue sheep is a goat-antelope or caprid found in the high hill of Himalaya Mountains. The wild Himalayan sheep is a member of Bovidae family, with a bluish-grey coat and round backward-curving horns. The bharal is one of the major food of the powerful felid predators snow leopard and clouded leopard. The Himalayan Blue Sheep hunt is one of the most challenging sheep hunting in neighbor countries.

Himalayan Black Bear: There are two species of bear found in Himalaya, Himalayan Brown Bear and Himalayan black bear. The Himalayan black bear is also known as Indian black bear is a vulnerable species due to deforestation and active hunting forits body parts. Himalayan Black Bears is a rare subspecies of the Asiatic black bear, with necklace of white fur across its chest. The natural habitat of the Himalayan black bear is forested area with rocky outcrops having caves. The Indian black bear are very aggressive toward humans and also known as most deadly animal of India.

Himalayan Wolf: The critically endangered Himalayan wolf is species of wolf found in the cold environment of Himalayan region. The habitat of the Himalayan Wolf is very wild and remote wilderness of the Himalayan Mountains, also spotted in the Spiti Valley of Himachal Pradesh. The Himalayan Wolf of India are the world's oldest species of wolves found anywhere else in the world. The Himalayan wolf may also represent an ancient isolated line of wolves in India.

The strategy of Himachal Pradesh Government in forestry management is conservation along with rational utilization and side by side expanding its base. The plan programmes taken up by the Forest Department aim at fulfilling these policy measures. Some of the important plan programmes are as under (Source: Economic Survey of Himachal Pradesh 19-20):-

Forest Plantation: Forest plantation is being carried out under various state plan schemes such as Improvement of tree cover, and soil conservation, Compensatory Afforestation Fund Management and Planning Authority (CAMPA) as well as centrally sponsored scheme "National Afforestation Programme", pasture and grazing lands of the state are being managed under state scheme development of Pasture and grazing lands

Van mahotsava : Van mahotsava at state, circle and division levels is also celebrated for educating the masses and creating awareness amongst all stakeholders regarding forestry and environmental concerns under New Forestry Scheme (Sanjhi Van Yojana). Apart from this, the department is organizing plantation drive involving local communities like Mahila Mandals, Yuvak Mandals, Local people and public representatives since 2018-19.

During the monsoon season, the department organized 5 days plantation campaign throughout the state w.e.f. 20th to 24th July, 2019 and target to plant 25 lakh was fixed. This drive gained a huge success and 1,18,932 people enthusiastically participated in the campaign and 26,47,146 plants were planted at 727 selected places.

For the year 2019-20, plantation target of 9,000 hectares Including CAMPA and centrally sponsored schemes has been fixed out of which 8,475.23 hectares target stands achieved and remaining target would be achieved upto 31.03.2020.

Forest Management (Forest Fire Prevention & Management Scheme): 7.80 Forests in the state are subject to increasing biotic pressure due to increase in human populations, changing animal husbandry practices and developmental activities. Forests are exposed to perils of fire, illicit felling, encroachments and other forest offences. Forest protection is being strengthened by equipping check posts at sensitive places with CCTVs to ensure electronic surveillance to curb forest offences. Fire fighting equipment and improved techniques are also being introduced and made available to all the forest divisions where fire is a major destructive element. Communication network for effective management and protection of forest wealth is very important. Keeping these factors in view, centrally sponsored scheme-

Forest Fire Prevention & Mananagement Scheme (earlier known as Intensification of Forest Management Scheme) Forest Fire Prevention & Mananagement Scheme (earlier known as Intensification of Forest Management Scheme) is being implemented in the state. During the year 2019-20 an outlay of `222.07 lakh has been approved as Central share (90%) and state share `24.67 lakh under Forest Fire Prevention and Management Scheme. Another scheme under state plan namely "Forest Fire Management Scheme" has been introduced with a budget provision of `100 lakh during 2019-20.

Experimental Silvicultural Felling: Forest wealth of Himachal Pradesh is estimated at more than `1.50 lakh crore. By the permission of Hon'ble Supreme Court of India the state has been allowed for silvicultural green felling of three species viz. Khair, Chil and Sal on experimental basis in three ranges-Nurpur range of Nurpur Forest Division, Bharari range of Bilaspur Forest Division and Poanta range of Poanta Forest Division under the supervision of Hon'ble Supreme Court Monitoring Committee constituted for the purpose. The felling of trees was carried out during 2018-19 and during 2019-20 Fencing, plantation, recuperation of areas under Experimental Silvicultural Felling is being carried out strictly as per recommendations of the Hon'ble Supreme Court Monitoring Committee . New Schemes: 7.82 In order to sensitize the local communities, students and general public about the importance of forests and their role in environmental conservation for sustainable harvest handling, value addition to wild harvested non-timber minor forest produce and enhancing economic returns, the following new schemes have been launched:-

I) Samudayik Van Samvardhan Yojna The main objective of this scheme is to ensure participation of local communities in conservation & development of forests through plantation, improving quality of forest and increasing the forest cover. Rejuvinate and strengthen the bound of rural communities with nature and to ensure sustainable flow of ecosystem services from the forest. The scheme will be implemented through existing 90 JFMCs/VFDSs. During 2018-19, 20 sites have been selected and 11 new sites (JFMCs /VFDSs) have been kept for 2019-20. During current year plantation and soil conservation activities will be carried out in all the 31 selected sites by the selected JFMCs/VFDSs as per approved micro plan of each selected JFMCs/ VFDSs.

ii) Vidyarthi Van Mittar Yojna The main objective of the scheme is to sensitize the students about the importance of forests and their role in environmental conservation, to inculcate in students a sense of attachment towards nature conservation; to motivate students in sensitizing communities towards conservation and protection of forests and to create forest grooves & increase forest cover. A budget provision of `125.00 lakh has been kept under this scheme during 2019-20 and 150 new schools have to be selected. Till December, 2019, 131.5 hectare area has been selected for raising plantation through 146 schools.

iii) Van Samridhi Jan Samridhi Yojna This scheme has been started to strengthen the NTFP resource base in the state through active community participation. Empowerment of local communities in collection, conservation and marketing of NTFPs to augment the incomes of rural population. The scheme will be implemented initially in 7 most biodiversity rich districts namely, Chamba, Kullu, Mandi, Shimla, Sirmour, Kinnaur and Lahaul & Spiti and subsequently in the remaining districts of the State.

iv) Ek Buta Beti k Naam (Started during 2019-20) To sensitize people about the importance of daughters and forest conservation, a new scheme “Ek Buta Beti k Naam” has been launched during 2019- 20. It is believed that by planting a sapling in the name of a girl child and with the effort of nurturing each sapling into a tree communities would be sensitized to be more committed towards the rights of the girl-child leading to realization of her full potential. Upon the birth of a girl-child anywhere in the state, the Forest Department would gift robust and healthy tall plants (Saplings) alongwith “kit” & instructions phamplet to the family. The plants will be planted by the parents of the girl during monsoon or winter season as per suitability of the locality either on their homested land or Govt. land.

7.27 Externally Aided Projects Himachal Pradesh Forest Ecosystems Climate Proofing Project (K.F.W assisted):

Himachal Pradesh Forest Ecosystems Climate Proofing Project with the assistance of KfW Bank Germany is being implemented in Chamba and Kangra districts of the state for the period of 7 years w.e.f. 2015-16. The cost of the project is `308.45 crore. The funding pattern of the project is 85.10 percent loan and 14.90 percent state share.

The main objective of this project is the rehabilitation, protection and sustainable use of the selected forest ecosystems in Himachal Pradesh to increase and secure the resilience of forest ecosystems against climate change and ensure flow of forest based products and other services, which benefit the forest dependent communities. In the long run this will contribute in strengthening the adaptation capacity of forest eco systems to climate change, protection of biodiversity, stabilization of catchment areas, conservation of natural resource base and at the same time result in better livelihoods for the people of Himachal Pradesh. An outlay of `43.46 crore has been approved for the current financial year 2019-20.

Himachal Pradesh Forest Eco systems Management and Livelihood Improvement Project

A new Project namely "Himachal Pradesh Forest Eco systems Management and Livelihood Improvement Project" for 8 years (2018-19 to 2025-26) amounting to `800.00 crore has been started with the assistance of Japan International Cooperation Agency (JICA).The Funding pattern of the project is 80 percent loan and 20 percent state share. The project will be implemented in Bilaspur, Kullu, Mandi, Shimla, Kinnaur, Lahaul-Spiti districts and tribal areas of Pangi and Bharmour sub-divisions of chamba districts with project headquarter at Kullu Shamshi, district Kullu and Regional office at Rampur, district Shimla. The objectives of the project are to conserve the forest and mountain eco system and improve livelihood of the forest and pasture dependent communities by increasing forest cover, density and productive potential using scientific and modern forest management practices; enhancing biodiversity and forest ecosystem conservation and to reduce pressure/ stress on forest resources by providing the village communities with alternative livelihood opportunity. During the financial year 2019-20, the government has provided `29.71 crore under this project and expenditure of `19.94 crore has been incurred upto 31.12.2019. World Bank Aided Integrated Development Project for Source Sustainability and Climate Resilient Rain-fed Agriculture.

The World Bank has agreed to support this project at a cost of `650.00 crore titled 'Integrated Project for Source Sustainability and Climate Resilient Rain-fed Agriculture'. The funding pattern of the project is 80 percent loan and 20 percent is state share. The project period is 7 years. The project would be implemented in 900 gram panchayats in Shiwalik and Mid Hills agro-climatic zones spread across various watershed in the state.

The key objectives of this project include comprehensive treatment of around 2 lakh hectares non-arable and 20,000 hectares arable lands; and enhancement of water productivity/ efficiency, milk production and livelihood improvement in the project area. An outlay of `35.74 crore has been 92 approved under this project during the current financial year 2019-20 out of which expenditure of Rs 7.49 crore has been incurred up to 31.12.2019.

7.28 Environment Forestry and Wildlife:

Himachal Pradesh is home to a very impressive, diverse and unique fauna–many of which are rare. The state's scheme aim at protection, improvement of environment and wildlife, development of wildlife sanctuaries/national parks and improvement of wildlife habitat so as to provide protection to various species of birds and animals facing extinction. To protect, develop and scientifically mange the wildlife and to improve its habitat an outlay of Rs. 21.25 crore was approved for the financial year 2019-20.

HEALTH AND ENVIRONMENT

CHAPTER-8

8. State

Environmental Contamination and Emerging Infectious Diseases are causing Public Health problems which are a matter of concern worldwide. These Public health threats are affected by the relationship between people and the Physical, Chemical & Biological nature of our Natural Environments. Population growth and the associated pressures of development are increasing the difficulties associated with sustaining effective public health practices and policy. Vector-borne and zoonotic diseases, water contamination, air borne contaminants, bio accumulative contaminants in the food chain and environmental threats to public health the world over require marshalling of all our scientific knowledge and know-how to develop new solutions. Understanding environmental and ecological health is a prerequisite to protecting public health. To provide better health services to the people, the government is strengthening the existing infrastructure by providing modern equipments, specialized services, increasing the strength of the medical and paramedical staff in the medical institutions. Improvement in health status of the people has been the cornerstones of the State Government's Development Policy.

8.1 Issues related to the Health Sector:

- Inaccessible remote areas.
- Lack of awareness in health care.
- Malnutrition, poverty and unhygienic living conditions.
- Little access to clean drinking water.
- Improper sanitation in rural and urban areas.
- Pollution in urban areas due to improper sewerage treatment, municipal effluents treatment and industrialization and use of chemicals in agriculture.
- Growth in number of vehicles causing increased air pollution h) Inadequate infrastructure facilities i) High energy living styles.

Pressures:

1. Growing number of patients in the hospitals.
2. Decreasing per capita quantity of water.
3. Increase in demand for a safe drinking water due to growth in population and improvement in living standards.
4. Accelerated population growth in addition to transition of disease patterns.
5. Increased stress on resources and service demands.

Impact:

1. Emergence of new diseases.
2. Growing incidence of epidemics.
3. Increase of health Expenditure.
4. Demand for more infrastructural facilities.
5. Disturbance in doctor patient's ratio.
6. Shortage of paramedical personnel.

Responses:

1. Programme of mass immunization.
2. Strengthening of health services.
3. Medical/ Ayurvedic colleges.
4. Pharmacist Training Centres.
5. Health Policy.
6. Health Insurance.

8.2 Health Care Scene in Himachal Pradesh:

The population of Himachal Pradesh generally enjoys better health than the populations of many other states, as reflected in a number of health indicators. The government is aware that primary health care has to be the hub of the health system. The attempt of the Himachal Pradesh Government in providing health care to the people of the State has been to follow the determining principle of the World Health Organisation meet held at Geneva in 1979. It was "with the objective of continually improving the state of health of the total population, every individual should have access to primary health care and through it, to all levels of a comprehensive health system." It has to comprehensively address the main health problems in the community by providing services which include:

Health education and its promotion.

- Promotion of nutrition.
- Adequate supply of safe water.
- Basic sanitation.
- Maternal and child care and family welfare services.
- Immunization against the major infectious diseases.
- Prevention and control of the locally endemic diseases.
- Appropriate treatment for common diseases and injuries.

Achieving the above may not be a distant dream for the State as the Health and Family Welfare Department is providing services which include curative, preventive, promotive and rehabilitative services through a network of 75 Civil Hospitals, 87 Community Health Centres, 533 Primary Health Centres, 13 ESI Dispensaries and 2,078 Sub Centres. The coverage of rural population by the Primary Health Care Institutions speaks for itself.

(Source: Economic Survey Himachal Pradesh, 2016-17)

8.3 Modern System of Medicine:

A survey has shown that though the Indian System of Medicine draws a larger percentage of people here than in the neighbouring States of Punjab and Haryana, a considerable chunk of the population prefer the modern system of medicine. The state has a fairly extensive network of public health institutions on the allopathic side.

Hospitals	75
Primary Health Centres	538
Community Health Centres	89
ESI Dispensaries	17
Sub Centres	2083
Beds Available	10, 756
Ayurvedic Hospitals	32
Ayurvedic Health Centres	1151
Beds Available	941
Unani Dispensaries	3
Homeopathy Dispensaries	14
Patients Treated (000)	
Indoor	2047
Outdoor	18919
Total:	20966

Sorce:- Statistical year book of Himachal Pradesh, 2017-18

The second factor that helps in assessing the impact of Primary Health Care is the median distance covered by the Health Institutions in Rural areas. According to Rural Health Statistics of India, average rural area covered by a Sub-centre, PHC and CHC is 26.84 km^2, 117.44 km^2 and 739.36 km^2 respectively in the State. Similarly in terms of number of villages covered by a Sub-centre, PHC and CHC is 10, 44 and 272 respectively.

8.4 Medical Education and Research:

At present the State has Six Government Medical Colleges Indira Gandhi Medical College Shimla,Dr.Rajendra Prasad Medical College, Tanda, Dr. Yashwant Singh Parmar Government Medical College Nahan,Pt. Jawahar Lal Nehru Government Medical College, Chamba, Dr. Radha Krishnan Government Medical College Hamirpur,Sh. Lal Bahadur Shastri Government Medical College Mandi and one Government Dental College in Shimla are functioning. Besides this, one Medical College and four Dental colleges in private sector are also functional in the State. During the academic session 2017-18, 139 seats for ANM training course 1,186 seats up for GNM courses, 914 seats for B.Sc. Nursing course, 185 seats for Post Basic B.Sc. Nursing courses, and 85seats for M.Sc. Nursing degree coursewere filled both in Government and private sectors. Total 650 MBBS seats were filled in Government and Private Sector besides 205 PG seats in various specialties were filled in IGMC Shimla and RPGMC Tanda and also 340 BDS seats and 94 MDS seats were filled in both in Government and Private sector during academic session 2017-18. The Institutionwise major achievements under thisDirectorate are as follows:-

IGMC, Shimla:-

This College is the premier institute of the State established in the year, 1966,which was the residence of Lord Kitchener (1902-1909) the erstwhile Commander-in Chief of British-Indian Army. Over the years, the Medical College has grown to a stature of a modern & prestigious medical institution in the Country. The college is equipped with latest machinery and equipments. Several of its alumini are the faculty members in well known Medical Colleges in India and abroad.

Indira Gandhi Medical College and Hospital now upgraded as Super specialty Institute, is the premier health institute of the State. The State Government has approved the proposal for the construction of Super Specialty Block at Chamyana under phase–III of PMSSY scheme for which an area of6,600 square meters has been finalised and transferred in the name of IGMC, Shimla. During this financial year Rs. 304.00 lakh has been utilised for the procurement of machinery and equipments at IGMC, Shimla The Govt.of India has sanctioned a project Prevention and Control of Diseases-Development of tools to prevent outbreaks of Epidemics/ Hepatitis in Shimla City with a cost of Rs. 138.34 lakh under which a study of water and sewerage sources in the city shall be carried out. During this year the IGMC has started the Online registration of Prescription Slip from anywhere and Online Lab test reports down loading facility with SMS message for the benefits of the patients. M.Sc. Nursing Degree Courses in Sister Nivedita Govt.Nursing College, IGMC Shimla has been started from the academic session2016-17 with intake capacity of 25seats.

Future Proposals: Construction and shifting of Sister Nivedita Govt. Nursing College from IGMC Shimla to Ghanahati Shimla, establishment of Trauma Centre at New OPD lift Block to install DSA machine costing approximately Rs.7.00 crore in the department of Radiology and digital radiography machine with latest technology for KNSHM&C Shimla costing around Rs. 3.00 crore are the proposals.

Dr. Rajendra Prasad Govt. Medical College, Kangra at Tanda: - Dr. Rajendra Prasad Medical College, Kangra at Tanda is the 2ndMedical College of the state established in October, 1996. with an intake capacity of

50 MBBS students. The first batch was started in 1999 and recognized by MCI on 24.02.2005. At present 18thBatchwith an intake capacity to 100 MBBS students is undergoing training in this institution. The Govt. of India has accorded/released funds amounting to Rs.4.86 crore for equipments and Rs.121.50 lakh for upgradation and strengthening of emergency facilities at Dr. RPGMC, Tanda. During the year 2016-17 a sum of Rs. 289.56 lakh has been utilized in procurement of Machinery and Equipments. The construction work for the building of Lecture Theatres, Examination Hall and Anatomy Block has been completed with the estimated cost of Rs.8.56 crore.

Future Proposals: There is a proposal for the construction of a Sarai building and a shopping complex to provide better facilities to the patients and their attendants for which the Govt. has accorded the approval to construct the sarai building. Also aproposal for acquisition of land situated adjacent to the campus of Medical College from main gate to water tank for future expansion of college campus.

Dr. Y.S.P. Government Medical College, Nahan: Dr. Y.S.P. Government Medical College, Nahan Distt. Sirmaur is the third Medical College of the State established with an intake capacity of100 MBBS students. The first batch has been started from the academic session2016-17.The Govt. has provided a sum of Rs.4.68 crore for the procurement of machinery and equipments to Dr. Y.S.P. Nahan. The construction work of two Lecture Theaters, four Operation Theatres, Central Library and Laboratories have been completed for which Rs.10.03 crore have been utilized so far.

Future Proposals: Construction of new OPD/IPD hospitalblock with 300 beds capacity, NewNursing School building with the cost of`1.30 crore and also Establishment ofTrauma Centre Level-II and MCH asper Govt. guidelines at Dr. Y.S.P. Govt.Medical College, Nahan.

Dental College and Hospital Shimla: H.P. Govt. Dental College and Hospital, Shimla Hospital is the only Dental College in the State which was established in the year 1994 with an intake capacity of 20 students per year. Himachal Pradesh Government Dental College and Hospital, Shimla was established in 1994 with an in take capacity of 20 students per year. From the year 2007-08 the admission of 60students to BDS course has been started. Besides this the MDS courses in six specialities Oral Surgery, Periodontics, Orthodontics, Prosthodontics, Operative Dentistry and Paedodontics are also being made with in take capacity of 15 PGs students per year.

The main objective of the opening of the Dental College and Hospital was to meet the ever increasing demand of Dental Doctors and Para Medical staff with the view to provide better dental health services to the people of the State. The Department of Prosthodontics, Oral, Maxillofacial Surgery & OMR PG and Consultant Treatment Chambers have been constructed on NAAC parameter shaving ultra modern Dental Units. Freedental treatment to the IRDP and BPL families of the State is being provided by the institution. 63,780 out patients were treated during the period w.e.f.01.01.2016 to 31.12.2016. Muskaan Yojna & Chief Minister Student Dental Health Scheme and other schemes are also being running by the institution.
(Source: Economic Survey Himachal Pradesh, 2016-17)

8.5 Health and Family Welfare training courses:

The training institutions at Shimla and Kangra are meant to impart in-service training to Medical Officers and Paramedical staff of the health department regularly according to the needs of the department. A Principal, who is assisted by an Epidemiologist, Medical Lecturer and other faculty heads, each training centre. Guest faculty is also invited from H&FW Directorate, other institutions and departments. Both these Institutes need

to be developed to be the nodal centres for all training programmes in health in the State. This need to be upgraded to become Institutions of Excellence and the Centre at Shimla should be the apex Centre with an officer of the rank of Joint Director heading the Institution to be designated as Director (Training). Health Vision –2008 prepared by the Health and Family Welfare Department has following to say about the training:

I) In-service training will also focus on management issues in the health sector.
ii) Induction training for Medical Officers, with a focus on management, will be started on priority basis.
iii) It will be ensured that high quality training is provided.
iv) Private training institutions will be encouraged.
v) A basic pre requisite for the development of a training system will be the creation of a separate cadre of trainers.

A brief description of various health and family welfare activities carried out in the State during 2016-17 is as under:-

(I) National Vector Borne Disease Control Programme: During the year 2016-17, (up to December, 2016) 33,344 blood slides were examined, out of which 98 slides were found positive and no death due to malaria was reported.

(ii) National Leprosy Eradication Programme: Under this Programme the prevalence rate, which was 5.14 per ten thousand in 1995, has been reduced to 0.24 per ten thousand as on December, 2016. During 2016-17 (up to December, 2016), 114 new cases of Leprosy have been detected, 120 cases were deleted after completion of treatment and 168 cases of leprosy are under treatment. They are getting MDT from different health institutions free of cost.

(iii) Revised National T.B. Control Programme: Under this programme, 1 T.B. sanatorium, 12 district T.B. centres/clinics, 72 T.B. units and 208 microscopic centres having a provision of 315 beds were functioning in the state. During the year 2016-17 up to 31.12.2016, 14,333 cases were detected having symptoms of this disease and sputum tests of 80,936 persons were carried out. Himachal Pradesh is one of the States where all the districts have been covered under this project. The achievement of total cases notification rate was 210 per lakh per year (82 %) against the target of 257 per lakh per year.

(iv) National Programme for Control of Blindness: Under this programme during the year 2016-17 (upto November, 2016) 21,948 cataract operations were performed against the target of 27,500 cataract operations. Out of this 21,733 cataract operations were performed with I.O. lenses.

(v) National Family Welfare Programme: This programme is being carried out in the State as a part of Reproductive and Child Health Programme, on the basis of community needs assessment approach. Under this approach, grass-root level workers like multipurpose health workers (both male & female) give an estimate of the various family welfare activities required in the area/ population covered by them. Under this programme8,059 sterilisations, 16,117 I.U.D. insertions, 30,842 OP Users and 83,731 CC Users were done during 2016-17 (upto December, 2016).

(vi) Universal Immunization Programme: This programme is also being implemented in the state as a part of RCH programme with an aim to reduce the morbidity and mortality among mothers, children and infants. The vaccine preventable diseases viz. Tuberculosis, Diphtheria, Pertusis, Neo-natal Tetanus, Poliomyelitis and Measles have shown remarkable reduction.

Immunization Programme target and achievement 2016-17

Sr. No.	Item	2016-17	
		Targets	Achievement upto December,16
1	2	3	4
1	**D.P.T.**	108183	100
2	**Polio**	108183	77381
3	**Pentavalent**	108183	77433
4	**B.C.G.**	108183	75031
5	**Hepatitus-B**	108183	165
6	**Measles**	108183	80972
7	**Vit.A 1st dose**	108183	68865
8	**D.P.T. Booster**	104390	77167
9	**Polio Booster**	104390	77183
10	**Vit. A 2nd Dose**	108183	85229
11	**D.P.T. (5-6 years)**	87720	87391
12	**T.T. (10 years)**	102460	84162
13	**T.T. (16 years)**	123055	94693
14	**T.T. (PW)**	128560	77707
15	**IFA (Mother)**	128560	77715

Like previous years, the Pulse Polio campaigns were also launched in the State during the year 2016-17.The first round of this campaign is on 29.01.2017 and second round will be held on 02.04.2017.

(vii) Mukhya Mantri State Health Care Scheme: The State Government has started Mukhya Mantri State Health Care Scheme to Ekal Narri, Senior Citizens above 80 years of age, Daily Wages Workers, Part Time Workers, Anganwari Workers/ Helpers, Mid Day Meal Workers, Contractual Employees and Persons with more than 70 percent special ability with effect from 01-03-2016. More than one lakh Smart cards have been issued to the selected families and cash less treatment more than Rs.1.00 crore has been availed by the smart card holders under the scheme.

(viii) National Rural Health Mission: Under this scheme 95 Health Institutions were identified to provide 24 hours emergency services. Apart from this 682 Rogi Kalyan Samities are also functioning at District Hospital, Civil Hospital and Community Health Centers. A sum of Rs.12.40 crore has been distributed to all the RKS till 31st December, 2016.

(ix) National AIDS Control Programme: During the year 2016-17 up to December, 2016, Total 1,31,201 persons screened out of which 384 HIV positive cases were detected.

Integrated Counselling and Testing Centre: Total 45 ICTC centres in Himachal Pradesh are providing Counselling and testing services. In the year 2016-17, up to December 2016, out of total tested persons, 40,178 were ANC clients, out of which 15 were diagnosed as HIV positive. Two Mobile ICTC Vans units are also functional.

STI/RTI: Clinics Total 20 clinics are providing STI/RTI services in various districts of Himachal Pradesh. In the year 2016-17 up to December 2016, total 30,203 people have availed the services of these RTI/ STI clinics.

Blood Safety: Total 15 Blood Banks and 3 Blood Component Separation Units IGMC, Shimla, ZH Mandi and RPGMC Tanda are functioning in the state. During the year 2016-17, up to December 2016, 350 VBD Camps have been organized in the State. One Mobile Blood Bus with four donor couches is also functional in State.

Anti Retroviral Treatment Programme: State has 3 ART centre at IGMC, Shimla, RH Hamirpur and Dr. RPGMC Tanda and 10 Link ART Centres through these free ART Drugs are being provides to people living with HIV/AIDS.

Targeted Interventions: 18 Targeted Interventions Project are being implemented in the state for High Risk Groups. During the year 2016-17 up to December 2016, 17,396 HRG population get STI/RTI services. 7,164 were tested in integrated counselling and tested centre, out of these 7 were detected positive.

(Source: Economic Survey Himachal Pradesh, 2016-17)

8.6 PARA-MEDICAL TRAINING SCHOOLS:

The details of the training schools in nursing for GNM course and BSc. Nursing provided by govt. As well as private sectors in the State are shown below:

GNM Schools in Government Sector:

Sr. No.	Name of Institution	Starting year	No of seats
1.	GNM Training School at Zonal Hospital Mandi	1982	30
2.	GNM Training School at Zonal, Hospital Dharamshala (likely to be Shifted to Dr. RPGMC, Kangra at Tanda)	1999	30

GNM Schools in Private Sectors:

Sr. No.	Name of Institution	Starting Year	No. of Seats
1.	Lord Mahavira Institute of General Nursing & Midwifery, Nalagarh (Solan)	2002	40
2.	Chamunda Institute of Medical Sciences (Nursing) Adhyatam Welfare Society, Dhalpur, Kullu	2002	50
3.	Shivalik Institute of Nursing, Chibber Complex, Kamla Nagar (Bhattakuffer),Sanjauli,Shimla-6	2009	40

Sr. No.	Name of Institution	Starting Year	No. of Seats
4.	Himalayan School of Nursing (Maa Saraswati Educational Trust), VPO, Kala Amb Teh. Nahan Distt. Sirmour	2009	30
5.	Kamakshi School of Nursing , Nurpur (Shayama Multipurpose Educational Society,) Nurpur	2009	40
6.	Himcapes School of Nursing, VPO Badhera, Tehsil Haroli, Distt, Una	2009	40
7.	Nanda Institution of Nursing Nanda Hospital, Una	2009	40
8.	Madren Shiksha Samiti, Annandale, Shimla-3	2009	40
9.	Sai Sanjivini Hospital, Solan	2009	40
10.	Kol Valley Institute of Nursing Village Nehar, PO Harnora, (Kaldam), Distt. Bilaspur-174013(HP)	2009	40
11.	Netaji Subhash Nursing Institution, Behind Cinema Hall Building, Palampur-176061, Distt. Kangra(HP)	2009	40
12.	Himalayan Group of Professional Institution, Biling Complex Cinema Road, Main Market, Jogindernagar, Distt. Mandi (HP)	2009	40
13.	Kusum Gupta Association, Solan (HP)	2009	30
14.	Gayatri Educational Society, Maa Janki School of Nursing, Hira Nagar, Hamirpur (HP)	2010	40
15.	Himalayan Institute of Health Sciences (Madhuri Educational Ethics Trust), Ner Chowk Mandi (HP)	2010	30
16.	Grace School of Nursing, Mission Hospital Complex, Kangra Distt. Kangra-176001 (HP)	2010	40
17.	Swami Shri Rajeshwaranand Bharti Nursing Training Institution, Kangra Kamlari, Distt Chamba (HP)	2010	40
18.	Sri Sai Charitable Hospital & Institution of Medical Sciences, Vill. Trot, PO Kanaid, Tehsil Sundernagar, Distt. Mandi (HP)	2010	40
19.	Him Navodaya Sikshan Sansthan, Mah-Surara, Distt. Chamba, Near Narsingh Mandir (HP)	2010	40
20.	Jakh Institute of Nursing ,Near MGMSC, Khaneri Rampur, Distt Shimla (HP)		
21.	Shimla College of Nursing, (RCS Associates),Shimla (HP)	2010	40
22.	Jeevan Rekha School of Nursing (Jeevan Rekha Associates), Sundernagar, Distt. Solan (HP)	2010	40
23.	Awasthi Institute of Nursing Ward No.9, Nalagarh, Distt. Solan (HP)	2010	50

B.Sc. (Nursing) Colleges in Govt. Sector:		Starting year	No. of Seats
1.	Sister Nivedita College of Nursing, IGMC, Shimla, H.P.	2010	60
B.Sc. (Nursing) Colleges in Govt. Sector:			
1.	Akal College of Nursing, Baru Sahib, Distt. Sirmour, H.P.	2008	60
2.	Lord Mahavira Institute of General Nursing & Midwifery, (Solan)Nalagarh, H.P.	2009	40
3.	Shivalik Institute of Nursing, Chhiber Complex, Kamla Nagar (Bhattakuffer),Sanjauli,Shimla-6	2009	50
4.	Neta ji Subhash Institute of Nursing, Palampur, H.P.	2009	40
5.	Kusum Gupta Associates, Solan, H.P.	2009	40
6.	Kamakshi School of Nursing, Nurpur (Shayama Multipurpose Educational Society) Nurpur Kangra, H.P.	2010	40
7.	M/s RCS & Association, 74/1,Lower Bazar, Shimla, H.P.	2010	40

B.Sc. (Para-Medical) Courses:

Sr. No.	Name of Course	Institution Wise No. of Seats		Total
		IGMC, Shimla	Dr. RPGMC, Tanda	
1.	B.Sc. Radiology	10	10	20
2.	B.Sc. Medical Laboratory	10	10	20
3.	B.Sc. Anaesthesiology	10	6	16
Total		**30**	**26**	**56**

Dental Courses:

Sr. No.	Institution	Sanction Intake Capacity 2009-10		Proposed Increase in Intake Capacity	
		Dental Hygienist	Dental Mechanic	Dental Hygienist	Dental Mechanic
1.	H.P. Govt.	10	10	20	20

7.1.7 INDIAN SYSTEM OF MEDICINE:

Indian System of Medicines and Homoeopathy plays a vital role in the Health Care System of the State of H.P. The separate Department of Ayurveda was established in 1984 and Health Care Services are being provided to the general public. As per survey on the utilization of health care services across the systems of medicine in Himachal Pradesh vis-à-vis the neighbouring states and India reveals that the percentage of treatments in the allopathic system in rural Himachal Pradesh is slightly lower than that in the neighbouring States of Punjab and Haryana and even under the Indian average. It means that more people than those in the neighbouring States have faith in the Indian System of Medicine and Homeopathy. It is because the state government had been playing a pro-active role in promoting the Indian System of Medicine. The department of Ayurveda is also associated with National Health Programmes like Malaria, Family welfare, Anaemia free, AIDS and immunisation and pulse polio etc

District wise number of Ayurvedic/Unani/Homoeopathy/Amchi Health Centres is as under:

Sr. No.	Name of District	SYSTEMS	Total Number of Centres			
		Ayurveda	Homo.	Unani	Amchi	
1	Bilaspur	65	2	-	-	67
2	Chamba	102	2	1	-	105
3	Hamirpur	70	1	-	-	71
4	Kangra	227	1	1	-	229
5	Kinnaur	27	1	-	2	30
6	Kullu	65	1	-	-	65
7	Lahaul & Spiti	21	1	-	2	24
8	Mandi	163	1	-	-	164
9	Shimla	145	1	1	-	147
10	Sirmour	78	1	-	-	79
11	Solan	77	1	1	-	79
12	Una	69	1	-	-	70
	Total	**1109**	**14**	**4**	**4**	**1130**

(Source: Department of Ayurveda)

Rajeev Gandhi Government P.G. Ayurvedic College, Paprola:

The college withintake capacity of 50 students for B.A.M.S. degree is functioning at Paprola in Kangra district. Besides this the PG Classes in Kayachikitsa, Shalakya Tantra, ShalyaTantra, Prasuti Tantra, Samhita and Sidhant, Dravya Guna, Rog Nidan, Swasth Vritta, Panchkarma and Balrogare also there. There is a Panchkarma Units at Paprola besides there are two units at Dharamshala and Bilaspur respectively. Panchkarma is one of the unique therapeutic procedures in Ayurveda advocated for the radical elimination of the causing factors, vitiated doshas, leading to normal health. The five fold therapeutic measures of this therapy for internal

purification of the body are; Vamana (controlled therapeutic emesis), Virechana (controlled therapeutic purgation); Anuvasana (Medicated oil enema), Asthapana (medicated decotion enema) and Nasya (Drug administration through nostrils). The chances of recurrence of the disease are rare in patients having undergone Panchkarma therapy as it also promotes positive health by rejuvenating the body. It prevents aging process and improves memory and functions of all sense organs. Panchkarma therapy is very e□ective in the management of autoimmune disorders, chronic ailments like RheumaticArthritis, Bronchial Asthma, G.I.T. disorders and mental diseases. Panchkarma requires some preparatory measures i.e. Snehana and Swedana and some Post-Panchkarma measures i.e. Samsarjana Krama.The list of Ayurvedic Hospitals where Panchkarma Therapy is available in the State are:

Panchkarma Units in the State

Sr. No.	Name of Hospital
1.	Rajiv Gandhi Govt. Ayurvedic Hospital, Paprola
2.	District Ayurvedic Hospital Bilaspur
3.	District Ayurvedic Hospital, Dharamshala District Kangra

Ayurveda Department has proposed the target of opening 10 New Ayurvedic Health Centres, 02 Homoeopathic Health Centres, 01 Ayurvedic Hospital, upgradation of one AHCs to 10-bedded Hospital, upgradation of one 10/20 bedded Hospital to 30/50-bedded Hospital and providing of Panchkarma/Sharsutra at 11 centres during the year 2012-13.

Development of Herbal Resources:

Four herbal gardens at Jogindernagar (Mandi), Neri (Hamirpur), Dumreda (Shimla) and Jungle Jhalera (Bilaspur) are functioning in the state. An Annual Action Plan for 2016-17 under the Centrally Sponsored Scheme of National Mission on Medicinal Plants at a project cost of Rs. 61.98 lakh has been approved by the National Medicinal Plants Board, Department of AYUSH, Govt. of India. Under this, 1 model nurseries of four hectare area each and 10 small nurseries of one hectare area each will be established in the public sector. Besides this, cultivation of medicinal plants will be undertaken by the farmers in 72 hectare area in the State.

Drug Testing Laboratory:

During the year 2016-17 (upto December, 2016), DTL Jogindernagar has analyzed 590 samples (from Government and Private Pharmacies) and generated a revenue of Rs. 2.36 lakh.

Development Activities:

- Free Camp: To popularise and make people aware of AYUSH treatment, 48 free medical camps have been organized at different places of the State during the year 2016-17 under which thousand of patients were checked-up and treated.

-Government Ayurvedic Pharmacies: Presently there are three Departmental Ayurvedic Pharmacies manufacturing Ayurvedic Drugs for free distribution through Ayurvedic Insitututions in the State. The Pharmacies have been located at Majra in Sirmour, Jogindernagar in Mandi and Paprola, in Kangra. Pharmacy at Paprola is also attached with Ayurvedic College Paprola for practical purpose for the students of P.G. Ayurveda College, Paprola.These Pharmacies supply drugs toall health institutions of Ayurvedic Department.

Presently department has been procuring raw herbs through H.P. State Civil Supplies Corporation Ltd. for manufacturing medicines due to non availability of the same locally.

(Source: Economic Survey Himachal Pradesh, 2016-17)

8.8 Training facilities in ISM & H Department:

There are two institutions which impart training:
- Ayurvedic College at Paprola (Kangra) has an yearly intake of 50, for five and half years course of BAMS.
- Pharmacy Training School at Jogindernagar has the capacity to train Ayurvedic Pharmacists ina two year course and training is conducted as per the needs of the department. The department has inbuilt system of production of medicines through 3 Ayurvedic Pharmacies, at Jogindernagar (District Mandi), Majra (District Sirmaur) and Paprola (District Kangra).

8.9 Vanaspati Van (HERBAL GARDENS):

The Western Himalayas have about 1350 herbal and aromatic plants. Half the number is available in the hills of Himachal Pradesh. The varied Agro-climatic conditions from Sub tropical to temperate and extreme cold make Himachal Pradesh a natural habitat for the cultivation of a large number of medicinal and aromatic plants, which are used as raw material for manufacturing a large number of Ayurvedic Medicines. The State is considered ideal for growing the following seven plants: Shatavari, Daru Haldi, Vatsnabh, Atees, Chirayata, Kuth and Kutki. A herbal- medicine board is also functioning in the State. Due to the high demand for quality raw material in the pharmaceutical industries many valuable species are under threat of extinction due to large-scale indiscriminate extraction and exploitation from the wild. Keeping this in view the Department of Ayurveda has launched a programme in 1995 for the promotion and conservation of the herbal wealth by setting up herbal gardens in the di□erent Agro-climatic zones. The Herbal Garden at Jogindernagar has made its mark. A number of medicinal herbs are being grown there for demonstration purposes. A Herbarium, visited by foreigners and natives, has also been established. Presently the following Herbal Gardens have been established in the different Agro Climatic Zones: -

- Herbal Garden, Jogindernagar (Mid-Hills/Sub temperate Zone).
- Herbal Garden, Neri (Hamirpur)-(Sub Tropical zone).
- Herbal Garden, Dhumrera (Rohru), Shimla. (High Hill Temperate wet zone)
- Herbal Garden, Jungal Thalera, (Bilaspur at 4.54 hidan land)-(Sub Tropical zone)

OBJECTIVES OF HERBAL GARDENS:

- To raise the Germ plasm of the indentified genuine species of the medicinal plants of the respective agro climatic zones.
- To develop Agro-Techniques of Medicinal Plants for making cultivation of medicinal plants to supplement the income of the people of the State.
- To develop pre & post harvesting methodology for maintaining the herbal drug efficacy for quality control.
- To generate awareness on the various aspects of the medicinal plants among the people of the state.
- To provide practical demonstration to the students of Ayurvedic College, Paprola for identification of the medicinal plants.

8.10 Health & Disease Control Programmes:

The National Rural Health Mission (NRHM) and its Accredited Social Health Activists (ASHA) are gaining ground in delivering critical, community-based health services for women, children, and families. Under

National Rural Health Mission (NRHM) scheme 125 Health Institutions were identified to provide 24 hours emergency services. Apart from this 572 Rogi Kalyan Samitis are also functioning at District Hospitals, Civil Hospitals and CHCs.National T.B. Control Programme: Under this programme, 1 T.B. sanatorium, 12 district T.B. centres/clinics, 44 T.B. units and 175 microscopic centres having a provision of 310 beds were functioning in the state. Integrated Child Development Services (ICDS) programme, which focuses upon maternal and child health and Nutrition is proving a success in benefitting the targeted groups in Himachal Pradesh. ICDS is being implemented in all the Child Development Blocks of the State. The programme envisages supplementary nutrition, non formal and pre-school education, immunization, health check- ups, referral services, and nutrition & health education. As many as 18386 Anganwari Centres and 359 Mini Anganwari Centres have been sanctioned to meet the objectives of ICDS programme. Out of which 18352 Anganwari Centres and 177 Mini Anganwari Centres are function by May, 2012.

Integrated Disease Surveillance Project (IDSP): IDSP is a Surveillance programme which is state based and decentralized one in the country as a whole. The rapid Globilisation, Industrialisation, Urbanisation has made a tremendous effect on the health of the people. It is expected beyond doubt that outbreaks are likely to occur in near future. IDSP addresses this issue in Scientific and systemic way. IDSP intends to detect early warning signals of impending outbreaks and help initiate an effective response in a timely manner. It is also expected to provide essential data to monitor progress of on-going disease control programmes and help allocate health resources more efficiently. IDSP was launched in March, 2005 which includes 18 diseases (5 State specific diseases). The Objective of IDSP is to improve disease surveillance system for use in timely health planning, management and disease control strategies.

- Establishing a decentralized district- based system of surveillance for communicable, non-communicable diseases and risk factors so that timely and effective public health actions can be initiated in response to health challenges in rural and urban areas.
- To integrate existing surveillance activities (to the extent possible without having a negative impact on their activities) so as to avoid duplication and facilitate sharing of information across all disease control programmes and other stakeholders, so that valid data are available for decision making at district and state level.
- Setting up Public Health Laboratories (ALL Distt HQs. / CHCs/ PHCs).
- Involving private and NGO institutions in the surveillance network.
- To share relevant information with the Health Administration, Community and other stakeholders to detect disease risk factors, monitoring and evaluation.
- Using IT and networking in disease surveillance.
- Daily registration of diseases under IDSP schedule at PHC/ CHC level in the OPD register and then sending weekly reports to DSO and further transmission to SSO. This can help us in monitoring of progress of project.

Initiatives Taken:

- 80 Medical officers have been trained at NIHFW.
- Water testing labs have started in three places at Kandaghat, CRI, Kasauli and IGMC, Shimla.
- Construction of Public Health Labs has started in all the districts.
- V-Sat has been installed at state head quarter.
- District surveillance units have been established in all the districts including one SSU at state level.
- 26 data entry operators have been appointed on contract.

Computers have been installed in all the districts and have started reporting as per the software provided by. Govt. of India.

Health & Family Welfare Department Himachal Pradesh is also taking various initiatives under following programmes:

1. National Programme for Control of Blindness
2. National Leprosy Eradication Programme
3. National School Health Programme
4. National Vector Borne Disease Programme
5. Revised TB Control Programme
6. National School Health Programme
7. MCH Programme
8. Universal Immunization Programme
9. National AIDS Control Programme

8.11 Private Sector:

This is a developing sector in the State. A large number of private clinics, nursing homes and hospitals have sprung up mainly at Shimla and other district capitals & towns. A few private hospitals have also been set-up in the State. Total bed capacity of the private sector in the state is about 2400. The supply of private health services in the state is smaller than in other Indian states but is still substantial. HP residents have easier access to private clinics than to PHCs and CHCs. In a survey of 106 villages in HP, 82 had a private clinic within 10 km, 75 had a PHC and 56 had a CHC within that distance. These data indicate that private clinics are widespread throughout the state and at least as accessible as government clinics above the Sub-Centre level. In contrast, private hospitals are less accessible than government hospitals. One current undertaking that allows for competition between the public and the private sectors for hospital care is the new insurance plan. This competition could both induce better service in public facilities and reduce prices in the private sector. Highly performing health systems in India (e.g., in Kerala) and developed countries utilize mixed delivery systems, with private providers playing the most significant role, enabled by a strong government role in financing.

In order to establish a better co-ordination between the public and private sectors, Health Vision 2008 prescribes the following steps:

I) Enact legislation to regulate the private sector (private clinics, nursing homes) and put check on quackery.
ii) Establish norms and standards for space, equipment and human resource for private medical care institutions.
iii) Involvement of genuine private sector in the preventive and promotive health care activities like immunization, special campaigns, IEC activities, control of epidemics.
iv) Establish a foolproof mechanism for coordinating the activities of the two sectors at the state, District and Block levels.

8.12 NGO and Voluntary Sector:

It is unknown as far as the curative care services are concerned. A large number of NGOs are, however, coming forward to mitigate the suferings of humanity in collaboration or under the guidance of the Department of Health and Family Welfare. A charitable hospital at Bhota in Hamirpur District being run by a religious organization is exemplary for the state. The contribution of Chinmaya Tapovan Trust, Kangra, in running training programmesforvillage health guides through traditional birth attendants, Bal Sevikas, Mahila Mandal Workers, Multipurpose Health Workers and adolescent field workers is laudable. There are a few NGOs extending support in the Health Care. A few of them may be named as Himachal Pradesh Voluntary Health Association (HPVHA) at Shimla, Society for Social Uplift through Rural Action (SUTRA) at Jagjitnagar, Solan, People's Action for People in Need (PAPN) at Sirmour, Society for Environmental and Rural Awakening (ERA) at Kangra.

8.13 Overall Development concerns for future:

The biggest challenge to the health-care education is not just technical, managerial or financial development but overall development in the areas concerned with health that includes:

- formation of young health professionals and supportive state who are responsible to social, technical, scientific and management abilities to work electively in a comprehensive health system;
- development of a faculty consisting of not only good teachers but good role models with social vision, commitment to ethical norms and values that inspires the community; and
- Development of a team of supportive staff that complements with skill and dedication the faculty in the educational institutions.
- Besides, significant impact of women/ mothers education on child's health and mortality through recent trends should be explored.
- There are quite a few basic and in-service training institutions in the state.

8.14 Health Vision 2020:

The primary goal of the Vision is health for all. It is thriving for clearing the path, removing the hurdles for better state of the health of the people leading towards improvement in quality of their lives. The primary goal, however, needs to be broken into compartments related to morbidity, mortality, fertility etc. The at-a-glance above shows the indicators and likely level of achievements during 2020. In between is the year 2015 that shows how much has been achieved by that year and how to gear up the Department to achieve the given targets by 2020.

World Health Organization also worked on Global Burden of Disease Profiles and has given the following findings regarding Himachal Pradesh.

Health Indicators and Likely Achievements

No.	Indicator	At 2000	2015	2020
1	Infant Mortality Rate	64 -1998	20	15
2	Crude Death Rate	7.7-1997	6.5	6
3	Child Mortality Rate	14.1	6	5
4	Maternal Mortality Rate	408-1992	75	50
5	Life Expectancy at Birth	64.6-1995	75	78
6	Babies with low Birth Weight	30%	15%	10%
7	Crude Birth Rate	22.6-1997	17	15
8	Effective Couple Protection Rate	54%	75%	80%
No.	**Indicator**	**At 2000**	**2015**	**2020**
9	Total Fertility Rate	2.14-1998	1.8	1.5
10	Essential Ante-natal Care	79%	100%	100%
11	Deliveries by Trained Attendants	78%-1997	100%	100%
12	Institutional Deliveries	29%-1998	70%	80%
13	Growth Rate	1.48%	1.1%	<1%

Source: Health Vision 2020

8.15 Structural Reforms:

- The Civil Dispensaries functioning in the rural areas of the State that were doing the job of dispensing medicines. These were brought to the mainstream of providing preventive, promotive and curative health care.
- To increase the number of institutional deliveries, 24 hour service in selected Institutions has been started. These Institutions have been working since 2002 and the results have been encouraging.
- Appointment of ad-hoc and on contract Doctors to fill the vacant posts of Medical Officers in PHCs.

8.16 Functional Reforms:

a) Efficiency Related:

- Functional integration of department of Indian system of medicines and the department of health and family welfare to follow standard protocol in national health programmes. The ISMH earmarked 661 Institutions in the state for the purpose. The training of ISMH Medical Officers started in the year 2005.
- Decentralisation of administrative and financial powers right up to the PHC level.
- Capacity building of Medical Officers in correct of the powers is being done along with the RCH refresher courses held in the two training centres of the state at Shimla and Kangra.
- A new training policy approved for Health & Family Welfare Department wherein pre-service trainings to Female Health Workers, Male Health Workers, Staff Nurses, Radiographers, Lab Technicians, Operation Theatre Assistants, Pharmacists, Paramedical Ophthalmic Assistants & other Para-medical categories shall be given on continuous basis.
- Merging of all health and family welfare societies into one at the State and the District levels.
- Inter connectivity for MIS for collecting data for NHP/disease surveillance and manpower planning. To begin with, the field data is being collected in the revised and consolidated Forms 6, 7, and 8. This has considerably reduced the paperwork in the field. More attention is being given to health related problems.
- Privatization of support services in health institutions: Three support services; viz., scavenging, laundry, and diet are being transferred to the private sector, wherever possible.
- Rationalization of drug use: essential drug list, drug formulary and standard treatment guidelines have been prepared after forming the Essential Drug Policy. Capacity building of Medical Officers in the use of generic drugs is a continuing process and is on before generalizing their use.
- Confidential report writing is an annual feature. It was a centralised process and for want of latest ACRs, promotion of deserving candidates used to be held up. Channel of writing such reports has now been squeezed and the nearest possible authority has been given the powers to express his opinion.

b) Resource Related:

- Establishment of society under the Registration of Societies Act called ROGI KALYAN SAMITI at all Hospitals up to the CHC Level. These Samitis would improve: System efficiency; Service quality; Patient satisfaction; Local decisions and so initiative of the officers; Accountability at hospital level; Resource utilization; The hospital itself; Resource generation through community financing and user's charges.
- Provision of seed money is there to improve such facilities that add to resource generation in the hospitals.

c) Governance Related:

- Roles and responsibilities have been given to Panchayati Raj Institutions: Health and Family Advisory Committees have been formed at the three levels of the Panchayati Raj Institutions. These have been named PARIKAS (Parivar Kalyan Salahkar Samiti). Their composition and works have been defined.
- Policy formulation: A Health Vision for 2020 has been developed for the State.
- Burden of disease survey was conducted for the first time in Himachal Pradesh through PGI Chandigarh.

The findings of the report present a detailed picture of the diseases in this State. A brief of the findings is given hereunder

8.17 Risk Factors driving the most Deaths and Disability combined Risk Factors in 2016

1. Malnutrition (9.2%)
2. High Blood Pressure (8.7%)
3. Air Pollution (8.2%)
4. Dietary Risks (8.0%)
5. Tobacco Use (6.5%)
6. High Fasting Plasma Glucose (4.7%)
7. High Total Cholesterol (4.4%)
8. Alcohol and Drug Use (4.1%)
9. Occupational Risks (3.4%)
10. WaSH (2.4%)

- Malnutrition is child and maternal malnutrition.
- WaSH is unsafe water, sanitation and handwashing.
  It is worth noting that Himachal Pradesh which is considered to be pollution free has the risk of deaths or disability due to air pollution falling in first three of the risks.
- Source: WHO Global Burden of Disease Profiles, Himachal Pradesh 1990-2016

Himachal Pradesh is a Smoke Free State Entire Himachal Pradesh was declared smoke-free on July 2, 2013 by the then Health Minister of the State. A survey was conducted by the Population Science Unit of Himachal Pradesh in six districts and Community Health Medicine Department in the remaining six districts of the State to assess the implementation of COTPA-2003, i.e. Cigarette and other Tobacco Products (Prohibition of Advertisement and regulation of Trade and Commerce-Production, Supply and Distribution) Act, 2003. The international standard is that if 85% of the ground is covered then it is considered as cent percent covered. So, though Himachal Pradesh had achieved 85.42% on the indicators of COTPA-2003, yet the State was declared as smoke-free. The following table shows the indicators and the compliance report on the basis of which Himachal Pradesh was declared smoke-free.

Indicators	**2011 Baseline**	**2013 Compliance**
%age of signage	23	71
%age of active smoking	30	6
%age of stimulus (ash tray or cigarette lighter)	23	5.5
%age of recent smoking	36	8
%age of butts found	49	24
Combined percentage of all indicators for Himachal Pradesh is 85.42 higher than 85%, so HP was declared as the Smoke-free State.		

8.18 Top Ten Causes of Disease Burden:

The top ten causes of diseases burden in di□erent age group in males and for females are shown in tables (a) and (b). Among children of 0-4 years still Diarrhoeal diseases, low birth weight and lower respiratory infection are leading causes of diseases burden. Among the reproductive age group, road accidents and other unintentional injuries, iron deficiency anaemia, tuberculosis,chronic obstructive pulmonary diseases and upper respiratory infections are the leading causes of diseases burden. Abbreviations commonly used in the tables concerned with the Burden of Diseases are DALY, YLL and YLD. DALY has two components namely years life lost due to premature mortality (YLL) and year life lost due to disability (YLD). The local data essential for the mortality (YLL) component of disability-adjusted life years (DALY) are the number of deaths by age, sex and average age at death within respective age groups.

(a): Top Ten Causes of Burden of Diseases (DALYs) among Males in H.P.

Rank	0-4 yrs	5-14 yrs	15-44 yrs	45-59 yrs	60 +yrs
1.	Diarrhoeal diseases	Iron-deficiency anaemia (IDA)	Other unintentional injuries (OUI)	Chronic Obstructive Diseases	Chronic Obstructive Pulmonary Disease
2.	Low birth weight	OUI	Road accident	OUI	OUI
3.	Lower Respiratory	Asthma	Iron –deficiency	Ischaemic heart	OUI
	Infectious		anaemia	disease	
4.	Other infectious	Other infectious	Chronic Obstructive	Tuberculosis	Ischaemic
	diseases	diseases	Pulmonary Diseases		heart disease
5.	IDA	Diarrhoeal diseases	Self-inflicted injury	Road accident	Tuberculosis
6.	Dental caries	Otitis Media	Tuberculosis	Other infectious diseases	Road accident
7	Upper Respiratory Infections	Dental caries	Asthma	Peptic ulcer	IDA
8.	Asthma	Upper Respiratory Infections	Other infectious diseases	IDA	Cataracts
9.	Otitis Media	Lower Respiratory Infections	Upper Respiratory Infections	Asthma	Asthma
10	OUI	Vitamin A Deficiency	Dental caries	Dental caries	Dental caries

(b): Top ten causes of burden of diseases (DALYs) among females of H.P.

Rank	0-4 yrs	5-14 yrs	15-44 yrs	45-59 yrs	60 +yrs
1	Diarrhoeal diseases	Iron-deficiency anaemia	Iron-deficiency anaemia	Chronic Obstructive Pulmonary Disease	Chronic Obstructive Pulmonary Disease
2.	Low birth weight	Diarrhoeal diseases	Other unintentional injuries	Iron-deficiency anaemia	Other infectious diseases
3.	Other infectious diseases	Other infectious diseases	Chronic Obstructive Pulmonary Disease	Other unintentional injuries	Other unintentional injuries
4.	Lower Respiratory Infectious	Other unintentional injuries	Self-inflicted injury	Other infectious diseases	Rheumatic heart disease
5.	Iron deficiency anaemia	Otitis Media	Tuberculosis	Tuberculosis	Ischaemic heart disease
6.	Dental caries	Asthma	Road accidents	Ischaemic heart disease	Iron-deficiency anaemia
7	Upper Respiratory Infections	Dental caries	Peptic Ulcer	Dental caries	Dental caries
8.	Otitis Media	Road accident	Dental caries	Asthma	Diarrhoeal diseases
9.	Other unintentional injuries	Upper Respiratory Infections	Lower Respiratory Infections	Road accident	Tuberculoses
10	Other digestive injuries	Lower Respiratory Infections	Other infectious diseases	Cataracts	Asthma

(Source: Department of Health and Family Welfare)

The overall top ten causes of burden of diseases among males and females are shown in Table7.12. Respiratory infections, diarrhoeal diseases, iron deficiency anaemia, tuberculosis, chronic obstructive pulmonary diseases and road accidents are six major causes of disease burden in both sexes. The disease burden on account of iron deficiency anaemia and tuberculosis in both the sex is mostly in the age group 15-44 years. This calls for early diagnosis and treatment for both the conditions.

Leading Causes of Disease burden (DALY) in Male and Female of H.P.

Male	%	Female	%
Chronic Obstructive Pulmonary Disease	15.22	Iron deficiency anaemia	12.95
Iron deficiency anaemia	8.28	Chronic Obstructive Pulmonary Disease	11.03
Other unintentional injuries	7.14	Diarrhoeal diseases	8.39
Dental caries	4.13	Other unintentional injuries	8.16
Diarrhoeal diseases	3.59	Other infectious diseases	7.48
Asthma	3.46	Dental caries	4.70
Other infectious diseases	3.05	Asthma	3.77

Male	%	Female	%
Upper Respiratory Infections	2.80	Tuberculosis	3.61
Lower Respiratory Infections	1.89	Road accident	3.46
Otitis media	1.33	Upper Respiratory Infections	3.07

The leading causes of DALYs lost in different age group are:

1. Lower respiratory infection, diarrhoeal diseases and low birth weight predominantly a□ects infants and children.
2. Tuberculosis continues to be the leading cause of death in group I diseases.
3. Among the non communicable diseases ischemic heart diseases, COPD and digestive disorders were the leading causes both among the males and females. Other causes include cerebrovascular diseases and asthma as well as the cancers.
4. Falls, roads accidents and other unintentional injuries were the leading causes of death among injuries and accidents.

Leading DALYs lost in Different Ages

Rank	0-4 yrs	05-14 yrs	15-44 yrs	45-59 yrs	60+yrs	All age group
1.	Diarrhoeal diseases	Iron deficiency anaemia	Iron deficiency anaemia	Chronic Obstructive Pulmonary Diseases	Chronic Obstructive Pulmonary Diseases	Chronic Obstructive Pulmonary Diseases
2.	Lower birth weight	Other unintentional injuries	Other unintentional injuries	Other unintentional injuries	Other infectious diseases	Iron deficiency anaemia
3.	Other infectious diseases	Diarrhoeal diseases	Road accidents	Ischaemic heart diseases	Other unintentional injuries	Other unintentional injuries
4.	Lower Respiratory Infection	Other infectious diseases	Chronic Obstructive Pulmonary Diseases	Iron deficiency anaemia	Ischaemic heart diseases	Diarrhoeal diseases
5.	Iron deficiency anaemia	Asthma	Self inflicted injury	Tuberculosis	Cataracts	Other infectious diseases
6.	Dental caries	Otitis Media	Tuberculosis	Other infectious diseases	Iron deficiency anaemia	Road accidents
7.	Upper Respiratory Infection	Dental caries	Asthma	Road accidents	Tuberculosis	Dental caries
8.	Otitis Media	Upper Respiratory Infection	Other infectious diseases	Dental caries	Dental caries	Asthma

Rank	0-4 yrs	05-14 yrs	15-44 yrs	45-59 yrs	60+yrs	All age group
9.	Asthma	Road accidents	Upper Respiratory Infection	Asthma	Road accidents	Tuberculosis
10.	Other unintentional injuries	Upper Respiratory Infection	Dental caries	Peptic ulcer	Diarrhoeal diseases	Ischaemic heart diseases

Leading Causes of Premature Mortality (YLL) in Males and Females in H.P.

Male	%	Female	%
Road accident	12.75	Diarrhoeal diseases	13.25
Diarrhoeal diseases	10.77	Other unintentional injuries	11.32
Other unintentional injuries	9.34	Road accident	9.67
Ischaemic heart diseases	9.09	Lower birth weight	9.23
Tuberculosis	6.54	Tuberculosis	8.32
Lower birth weight	5.85	Ischaemic heart diseases	7.87
Self inflicted injury	5.78	Self inflicted injury	7.44
Other unintentional injuries	5.48	Other unintentional injuries	6.23
Chronic Obstructive Pulmonary Diseases (COPD)	4.12	Other digestive diseases	4.82
Other digestive diseases	3.32	COPD	3.55

The common leading causes of disability (YLD) in both sexes of Himachal Pradesh are obstructive pulmonary disease, iron deficiency anaemia diarrhoeal disease, and other unintentional injuries .

Leading Causes of Disability (YLD) in Males and Females in Himachal Pradesh

Male	%	Female	%
Chronic Obstructive Pulmonary Diseases	26.09	Iron deficiency anaemia	20.13
Iron deficiency anaemia	14.19	Chronic Obstructive Pulmonary Diseases Other unintentional injuries	17.15
Other unintentional injuries	12.24	Diarrhoeal diseases	13.04
Dental caries	7.08	Other unintentional injuries	12.68
Diarrhoeal diseases	6.15	Other infectious diseases	11.64
Asthma	5.92	Dental caries	7.31
Other unintentional injuries	5.23	Asthma	5.87
Upper Respiratory Infection	4.80	Tuberculosis	5.61
Lower Respiratory Infection	3.24	Road accident	5.38
Otitis media	2.28	Upper Respiratory Infection	4.78

An acquaintance with the burden of diseases in the state takes one to the patient population of the state and it is surprising to note that in the year 2004, there were 1,61,63,768 patients under treatment of either ISMH or HFW. This does not include the lakhs of people who go to the private practitioners. It appears rather strange that one crore people more than that of the total population of Himachal Pradesh attended one or the other Health Institutions which means that a person - child or old-man or woman-visits a Health Care Centre 2.65 times in a year.

The gap in their Information Collection System is that they do not collect the disease-wise information. They have identified 42 diff erent types of illness under seven main heads – 1.Nervous System; 2. Digestive System; 3. Blood Flow System; 4. Respiratory System; 5. Skin System: 6. Fevers; and 7. Eye Diseases.

Following table shows the utilization of Health Services in the State in details including number of patients - outdoor as well as indoor - that went to the Institutions.

Utilization of Health Services in the State

Services	Year			
	2007	2008	2009	Up to 15.11.2010
OPD	98,78,309	99,45,301	1,03,99,673	83,44,365
IPD	14,53,710	14,84,816	15,55,385	7,91,174
Total (OPD + IPD)	1,13,32,019	1,14,30,117	1,19,55,058	91,35,539
Surgeries	93,949	98,102	89,763	1,29,805
Normal Deliveries	81,563	84,860	83,407	77,266
Caesarian Section	4973	5207	5508	8043
Lab Test	14,67,942	15,47,518	13,51,475	25,07,513
X Rays	5,50,284	4,91,698	5,36,091	4,99,646
USG	1,12,986	1,12,161	1,14,567	1,33,328
MRI	2584	3316	3420	4236
CT Scan	15,468	14,239	12,710	16,828
ECG	53,879	55,866	64,066	70,456

(htp://hphealth.nic.in/pdf/Vision_Document.pdf)

8.19 Challenges for the Health and Family Welfare Department:

1. Environment related:

- Unclean houses and unhealthy style of living.
- So far unknown infectious diseases.
- Microbiological and chemical contaminants.
- Infectious Waste Management2. Society related.

3. Society Related:
- Increasing accidents.
- Violence and molestation.
- Increasing geriatric population.
- Decreasing female population especially in the 0-6 age group.

3. Public Health:
- Unsafe drinking water.
- Poor sanitation.
- Unhygienic food.
- Unhealthy life style.

8.20 Health and Environment:

Himachal Pradesh has entered an era in which, as a result of the spread of education and enhanced awareness, the public is expressing increasing concern about protecting human health and preserving the quality of our environment. With the improvement in Health Care Systems, overall development in the standards of living and ever increasing population, the problem of huge amount of medical waste generation and its systematic and scientific disposal in a prescribed manner has become an issue of growing concern today.Hospital waste generated during patient care is its latest concern. It is a potential health hazard to the health care workers, the public and the flora and fauna of the area. Emission of gases by incinerator such as Furan, Dioxin, Hydrochloric acid have compelled the Department of Health and Family Welfare to think seriously about the matter and the diseases transmitted through improper disposal of hospital waste. The Central Government has already passed an Act in 1996 and Bio-medical Waste (Handling and Management) Rules were introduced in 1998. The State Government in the Department of Health and Family Welfare has brought out a Hospital Manual and its Chapter XIII is on Prevention of Hospital Acquired Infection and Hospital Waste Management. The confessional point is that during hospitalization or after the discharge of the patient from the hospital, he or she may develop an infection called Nosocomial Infection. This occurs as a result of:

1. Improper asepsis of the environment due to accumulation of untreated hospital waste and the unscientific way in which this waste is disposed of.
2. Improper asepsis of equipment, instruments.
3. Poor sterilization/ disinfection techniques.
4. Invasive monitoring and therapeutic procedures.
5. Transmission of infection by staff carriers.
6. Consumption of infected food, milk and water.
7. An epidemic arising in the community and spreading to the hospital.

The Manual prescribes an adequate surveillance programme for constant reporting and investigation of infections, the first being the formation of HIFCOM (Hospital Infection Control Committee),the other steps that are to be taken to check the menace are:

a. adequate sanitation and disinfection of the environment.
b. adhere strictly to aseptic techniques while performing surgical and instrumentation procedures.
c. segregate contaminated instruments.
d. provision of source isolation.
e. discourage indiscriminate use of antibiotics.

7.1.17 Hospital Waste Management:

Bio-Medical Waste management poses aesthetic, environmental as well as health related problems (directly or indirectly) due to its hazardous nature. It has been more than thirteen years since the Bio-Medical Waste

(Management and Handling) Rules have been framed yet a lot is required to be done in this sector for its implementation.On an average, a Hospital in India generates average of 0.250 kgof Bio-Medical Waste per bed per day while the quantity for Himachal Pradesh is 0.145 kg per bed /day.

Bio-Medical Waste Management

Area	Total No. of HCF's	Total No. of Beds	Bio-Medical Waste Generated /Day
India	137746	1420563	354994
Himachal Pradesh	555	9782	1417

Waste Generation in Major Hospitals of Shimla Town

Sr. No.	Name of the Hospital	Quantity of Bio-medical Waste/bed in kg/day	Total quantity in kg/day
1	Indira Gandhi Medical College & Hospital	0.107	79.5
2	Kamala Nehru Hospital	0.277	48.2
3	Deen Dayal Hospital	0.184	27.7
4	Dental College & Hospital	0.362	5.8
5	Shimla Sanatorium & Hospital	.0358	1.4
5	Indus Hospital	.0371	1.3
	Total	**1.002**	**163.9**

Source: HPSPCB, 2009-10

The Health and Family Welfare Department has issued detailed instructions in the Manual for managing the Hospital Waste. The brief of the same is placed below:

1. Constitute Waste Management Committees with MS as Chairperson. Matron / Nursing Superintendent or senior most sisters will be the Waste Disposal Officer (WDO) and be the Secretary of the Committee. It will meet once in four weeks. The WDO will develop a Waste Disposal Plan.
2. The Plan will include:

- Detailed specification of container's bags for waste collection.
- Paths for waste collection trolleys through the hospital.
- Timetable of frequency of collection of waste from the various areas.
- Defining the duties and responsibilities of various health personnel.
- Procedure for segregation, pre-treatment, storage and handling of waste requiring special treatment before disposal.

3. The waste will be segregated at the point of generation and stored in coloured containers as per the colour code prescribed in the Bio-medical Waste (Management and Handling) Rules 1998.
4. The Manual also mentions the disinfectants to be used for disinfecting sharp waste, disposable infectious plastics, infectious glassware, blood and body fluids. It says that the most economical and effective disinfectant is Sodium hypochlorite.

5. The duties of MS have been defined in the Manual as the officer who would apply to the H.P. Pollution Control Board for authorization for the handling of bio-medical waste and see that the new waste bags and containers are ordered on a regular basis to maintain continuous supply.
6. Till 31st March 2012, the State Board has inventorised and covered 567 Health Care facilities under Biomedical Waste (Management & Handling) 1998 Rules. During 2012-13, 89 health care facilities have been granted authorization/renewal of authorization for the block year 2011-14.(Source: HPSPCB, annual report, 2012-13)

8.22 Tobacco free initiatives in Himachal Pradesh:

Smoking prevalence in the state of Himachal Pradesh is on higher side as compared to the country (India). However no study has been conducted for the high prevalence of smoking in the state but it is presumed that being a hilly cold region people prefer to smoke and it is deeply added in the local culture. Beedi and cigarette are often o□ered / served in marriages and functions to the guests.

Status of Tobacco Use in India and H.P.

Use of any kind of Tobacco (%age)		Use of cigarete / Beedi (%age)					
Women	Men	Women	Men				
India	H.P.	India	H.P.	India	H.P.	India	H.P.
10.8	1.2	57	40	1.4	1.1	32.7	33.6

Initiatives:

The following actions have been taken by the State Government ;
1. State/District Level Coordination & Monitoring Committees notified.
2. Sensitization Workshop under the Chairmanship of Chief Secretary to the Govt. of HP organized in which all Secretaries/ HODs were sensitized regarding implementation of the COTPA & Rules made there under on 5.5.2009.
3. Police Head Constable and above have been authorized to act against the violation of section 4 &6.
4. State level sensitization workshop organized on 11.12.09 at Hotel Peterhoffs Shimla for the state level Officers, all HODs and district /block level officers followed by sensitization workshops (Shimla, Solan, Mandi, Kangra, Hamirpur, Karsog, Kinnaur, Una and Kullu) in the districts/ blocks.
5. The guidelines regarding the printing of receipt /Challan books and opening of bank account for depositing the fees and fine has been issued to the departments.
6. 66000 flex boards/signages have been printed in the HP Govt press for further distribution to the various departments through NRHM
7. 100% health institution have displayed the boards and signages in HP.
8. Department of education has issued order to sign an oath /pledge by the parents/students, before admission in school for not indulging in smoking, tobacco use and drug abuse. The students involved in tobacco use will be resticated from the schools.
9. De addiction centres with tobacco cessation facilities will be operational from themonth of Oct. 2010 in every district hospital in HP. Presently two tobacco cessation centers are operational at IGMC and RPGMC Tanda in the State.

Shimla Declared Smoke Free City: A survey was conducted in the month of May 2010 to assess and measure whether public places conform to smoke free laws. 97% of public places observed did not have active smoking. More than 80% of all public places observed had prominent signages. 84% of public places were

observed to be free from tobacco smoke. 94% of public places did not have any cigarette butts and Beedi ends.94% of public places had no smoking aids such as ashtrays, matchboxes.

Of the fuels, wood is still the most used fuel in the rural areas. Smoke coming out of wood fire has an adverse effect on the health of the person who cooks the meals and also the environment. Keeping in view depleting sources of conventional fuel i.e. firewood, biogas plants have assumed great importance in the low and mid hills in the State. Till March, 2011 since inception, 43,373 biogas plants have been installed in the State.

8.3 Water source and sanitation facility:

These are two important factors that have an influence on the health of the people. Provision of safe drinking water & water management is important issue. All the villages in the State have been provided with drinking water facilities by March,1994. As per the latest updated/validated survey of drinking water supply schemes on 31.03.2008 in Himachal Pradesh, all 45,367 habitations have been covered with safe drinking facility by March, 2008. With the coming in force of National Drinking Water Supply guidelines w.e.f. 1.4.2009 and subsequent realignment. Mapping of habitations, there are 53,205 habitations in the state, out of which 19,473 habitations (7,632 habitation with population coverage >0<100 and 11,841 habitations with 0 population coverage) are identified having inadequate drinking water. The criteria of coverage of habitations have been changed to population based coverage to ensure Water Security at household level. As per request of various States, During 2010-11 Govt. of India had directed the states for data correction of survey status of 1-4-2009 and as per data updation during 2013 status of habitations as on 1-4-2013 was finalized as given below:after realignment/ mapping of habitations, there were 53,604 habitations in the state. The criteria of coverage of habitations have been changed to population based coverage to ensure Water Security at household level. Accordingly the status as on 1.4.2011 was finalized.

Water Source and Sanitation Facility

Total No. of Habitations	Habitations with 100% population coverage	Habitations with population Coverage >0and< 100
53,604	29,911 (55.80%)	23,693 (44.20%)

(Source: Economic Survey, 2013-14)

The National Urban Sanitation Policy urges states to come up with their own detailed State-level urban sanitation strategies and city sanitation plans. It moots the idea of totally sanitised cities and the setting up of a multi-stakeholder city sanitation task force to achieve.Himachal Pradesh doesn't have detailed State-level urban sanitation strategies and city sanitation plans except for the City Development Plan (which inter alia covers sewage sector) for Shimla under the JNNURM initiative administered by Municipal Corporation of Shimla. Source: EMP

Total Sanitation Campaign (TSC): TSC is being implemented in Himachal Pradesh with an aim of bringing about an improvement in the quality of life in the rural areas by ensuring sanitation coverage to all through a comprehensive strategy of making it a community led campaign. In order to ensure peoples participation and also bring into focus that the maintenance of environmental sanitation is a local body responsibility TSC is being implemented through PRIs. In the State the TSC addresses the constraints viz.
- Lack of awareness amongst people about the need for sanitation.
- Improvement in sanitation facilities in the Schools, Anganwaris and Community places.

- Provisions of Waste Disposal mechanism.
- The lack of awareness of the role of the local bodies or the community and the problems of erstwhile supply driven approach. In order to address the aforesaid constraints Sanitation Campaign in the State has focused more at Information Education & Communication (IEC) interventions for developing appropriate mechanism for sustainable delivery through a consensual community approach, so that the people may themselves demand for sanitation facilities and thereafter take appropriate actions in this regard. At present the Sanitation Campaign is being implemented in all the 12 Districts of the State and presently Himachal Pradesh is considered a leading State in the field of Sanitation.

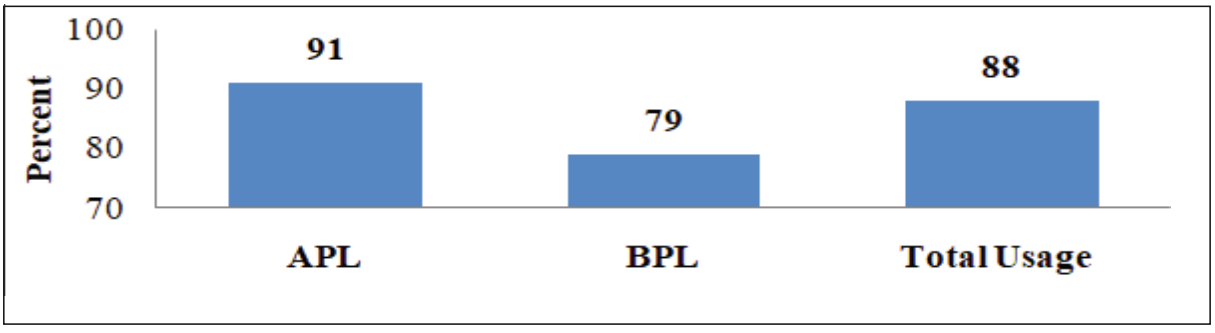
Physical Target

Component	Objective	Performance
IHHL	850737	1024808
BPL toilets	218154	248323
APL toilets	632583	776485
SchoolToilets	17863	16530
Anganwaritoilets	10408	8377
SanitaryComplexes	1229	602

Source: Economic Survey of Himachal Pradesh 2011-12

Latrine Use and Sanitation Facility: As per IHDS data 2005, Latrine use and Sanitation facility were below 50%. Considering that many studies have found estimated reductions in a child's risk of death associated with toilet and latrine ownership, public investments in improved sanitation. On the issue of usages of toilets in Himachal WSP-SA had recently conducted an independent study on "Processes and Sustainability of Outcomes in Himachal Pradesh" and major findings regarding usage of toilets in Himachal are as under:

Latrine Usage by APL/BPL



Source: H.P. Rural development Department

CONCLUSIONS:

Data on health status offer strong evidence that mother's education is the key to reducing infant and child mortality. The Department should consider possible partnerships with the Department of Education to further strengthen resources and opportunities for women's education in the state. Mother's education and

access to adequate sanitation facilities emerged as important determinants of child health, indicating areas of future public health interventions. Himachal Pradesh can still aim for vast improvements in both education levels among women as well as improvements in sanitation and health infrastructure. In the end, it is recognized that health needs are dynamic and keep changing over time, hence health department needs continuous adaptation and prioritization. An improved standard of governance, with more empathetic and committed attitude to serve the peopleof the State who are the real assets to take the state to the greater heights, socially and economically, will definitely help in improving the health status of people of Himachal Pradesh.