Arth Ganga Project: District Haridwar

February 2022

Submitted to

National Mission for Clean Ganga (NMCG)

Submitted by:

IIM Lucknow

IIT Roorkee

TABLE OF CONTENTS

EXECUTIVE SUMMARY

Haridwar, a religious district of Uttarakhand is located at the foothills of the Himalayas. An ancient pilgrimage this culturally rich district hosts many Hindus' sacred festivals. With an above-average literacy rate, still is partially an agrarian economy owing to surplus water, adequate climate, etc.

Agriculture and animal husbandry are important economic drivers of the district which is highly impacted by regional topography. But in 2017, the primary sectors' contribution to the economy had decreased from the year 2011 whereas secondary sectors' share has increased. The agricultural sector share went down to 56% in 2017. Varied farming systems are prevalent here like mixed farming which includes animal husbandry as well. The cropping intensity is 136.3%. The barren and uncultivable land has increased from 1.16% in 2009-10 to 1.18% in 2017-18. Areas under trees and gardens increased in 2018-19. The net sown area has decreased by two percent during 2009-10 to 2018-19. The net cultivated area under irrigation ranges between 93.67 to 95.51 percent whereas gross irrigated areas as a percentage are about 93.63-95.51%. There are three agro-climatic regions depending on the soil and topography which are Upper, Gangetic, and Plain regions out which plains are most suitable for irrigation. The soil type is sandy loam to loam with high porosity. Major crop varieties are Sugarcane, wheat paddy, groundnut, mustard, potato, etc. Although chemical fertilizer is variable at different places in the district, in 2019, nitrogen usage increased to about 79%, while shares of phosphorous and potassium have declined to 18% and 3%. Along with indigenous and crossbred cattle, buffalo, sheep, goats, poultry, etc. are also part of the economy. The share of livestock rose from 19.24% to 30% in 2017 whereas growth of fishery increased 268.58% per year. Ragged topography, waterlogged soils, non-scientific methods, lack of awareness, droughts, etc. have adverse impacts on the agriculture sector.

Industrial estates State Industrial Development Corporation of Uttarakhand (SIDCUL) and Bharat Heavy Electricals Limited (BHEL) have been actively involved in industrializing the district. Mining and Quarrying recorded a growth of 196.96 % per year. The district has 24.8% of the geographical area under forest with the highest moderately dense forests closely followed by open forests and a few very dense forests. Forest area decreased from 34.77% in 2009-10 to 34.48 in 2018-19. An overall increase in the share of forestry and logging during 2011-17 from 11.04% to 12.67%, with an annual average growth rate of 0.25%. There is varied biodiversity in the district. There are different plant varieties in rural and urban districts. There are 374 wetlands generally small which mostly are tanks/ponds and rivers/streams and the number of natural wetlands is less than man-made. Under School Nursery Yojana, decided to develop a city forest in Haridwar at an estimated cost of Rs 2.5 crore.

There are many tourist attractions Rajaji National Park, Chilla Wildlife Sanctuary, Har ki Pauri, Mansa Devi temple, etc. are various high tourist attractions. Kanwar yatra, Kumbh Mela, etc attract thousands of tourists every year. Owing to the high biomass due to higher agricultural, horticulture, animal husbandry practices the amount of biogas produced should be adequate and plants are being

set up for the purpose. About 40% of households use firewood followed by 39% who use LPG/PNG and 17% use cow dung cake for cooking purposes whereas 86% use electricity for lighting purposes followed by 13.07% who use kerosene. Many schemes and activities are carried out to enhance solar energy usage. Only one hydroelectricity project has been established to date.

Thus, with proper measures and advertisement, creating awareness, cultivation of aromatic and medicinal plants, crop rotation, introducing high revenue crops, practicing eco-tourism, agro-forestry and drip and sprinkler irrigation, use of renewable sources of energy, and different methods of irrigation, Miyawaki plantation, etc. the development and economy of the district can be boosted.

1 DISTRICT OVERVIEW

1.1 INTRODUCTION

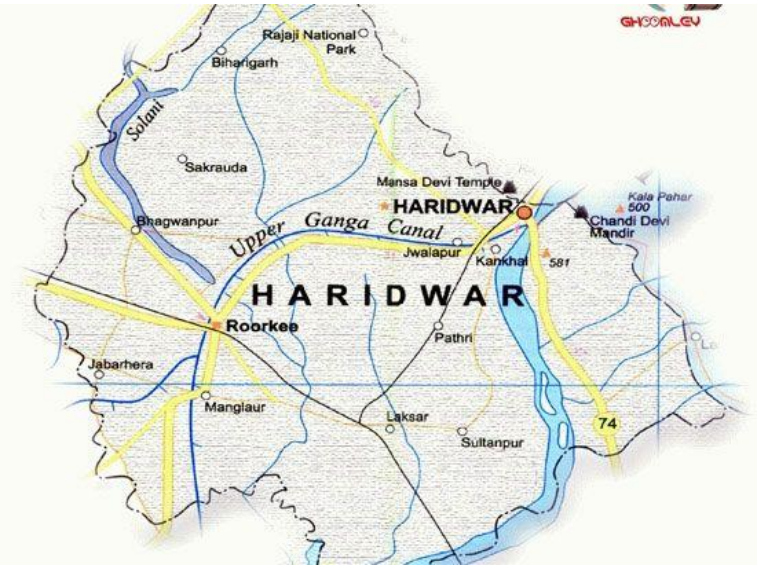


Figure 1 Map of the district

1.2 DEMOGRAPHIC PROFILE OF HARIDWAR

Haridwar district is in the state of Uttarakhand, India. It is headquartered at Haridwar which is also its largest city. The district is ringed by the districts Dehradun in the north and east, Pauri Garhwal in the east and Uttar Pradesh districts of Muzaffarnagar and Bijnor in the south and Saharanpur in the west.

1. District Overview:
   Geographic area: 2360 Km^2
   Altitude: 314 m
   Rainfall: 884.3 mm
   Forest area: 525.25 Km^2
   Major Rivers: Ganga

Administrative Divisions:

District Headquarter	Haridwar City
No. of Subdivisions	3
No. of Villages	612

Demographic and Socio-economic Parameters:

Population	18,90,422
Population Density	801 / Km^2
Sex Ratio	880
Literacy	73.43 % 4
Occupation/Livelihood	Agriculture

Agriculture is the mainstay of this well irrigated district. Industrial estates State Industrial Development Corporation of Uttarakhand (SIDCUL) and Bharat Heavy Electricals Limited (BHEL) have turned Haridwar into industrial district which contributes highly to the district's economy. The SIDCUL has now established 'industrial development zone' in the district, to encourage industrialization, with industrial giants like Hindustan Lever, Dabur, Mahendra & Mahendra and Havells having moved in. In the year 2016-17 the gross domestic product in the district was Rs. 58,16,824 lakh at current price and Rs. 49,66,149 lakh at constant prices in the year 2011-2012. The net domestic product in the district during the period 2016-17 was Rs. 33,75,110 lakh at current price and Rs. 28,69,545 lakh at constant prices in the year 2011-2012. The Per Capita Income or NDDP, At Factor Cost in the district during the period 2016-17 was Rs. 2,54,050 at current price and Rs. 2,16,143 at constant prices in the year 2011-2012

1.3 AGRO CLIMATIC PROFILE OF THE DISTRICT

1.4 ECONOMIC PROFILE OF HARIDWAR

The primary sector of the district economy has constantly been declining in terms of its share in the GDDP. The share went down from 7.17% in 2011-12 to 4.70% in 2016-17, with an annual average growth rate of - 0.98 percent. Contrary to this, the share of the secondary sector rose about one percentage point from 72.08% to 73.21% during the same period, thus recording an average annual growth rate of 7.37%. Similarly, the tertiary sector's share went up from 20.75% to 22.09% during the same period, with an annual growth rate of 8.36%. Overall, the district economy grew at the rate of 7.03 percent per year during the period under study. The real per capita income in the district went up from Rs.185880 in 2011-12 to Rs.240401 in 2016-17, with an annual growth rate of 5.29% per annum. It can be inferred that the economic condition of the

people depending on the primary sector has worsened vis-à-vis the other sectors. Overall, the district economy is driven by the secondary sector.

Table 1: Trends in Gross District Domestic Product and Per Capita GDDP in Haridwar at Constant Prices (base 2011-12) in Rs Lakhs

Year	Sector-wise GDDP (Rs, lakhs)				Annual growth rates				Per capita DGDP (Rs.)	Growth rate
	Primary	Secondary	Tertiary	Total GDDP	Primary	Secondary	Tertiary	total		
2011-12	237929	2393558	689102	3320590	-	-	-	-	185880	-
	(7.17)	(72.08)	(20.75)	(100)						
2012-13	253152	2612405	750829	3616386	6.40	9.14	8.96	8.91	199070	7.10
	(7.00)	(72.24)	(20.76)	(100)						
2013-14	271790	2790479	814012	3876281	7.36	6.82	8.42	7.19	210102	5.54
	(7.01)	(71.99)	(21.00)	(100)						
2014-15	212089	2908166	897082	4017337	-21.97	4.22	10.21	3.64	214353	2.02
	(5.28)	(72.39)	(22.33)	(100)						
2015-16 RE	209539	3188396	950813	4348748	-1.20	9.64	5.99	8.25	227717	6.23
	(4.82)	(73.32)	(21.86)	(100)						
2016-17 PE	219030	3411978	1029297	4660305	4.53	7.01	8.25	7.16	240401	5.57
	(4.70)	(73.21)	(22.09)	(100)						
Average Growth Rate					-0.98	7.37	8.36	7.03	-	5.29

Source: UKDES

Note: Figures in Parentheses are percentage share in the total GDDP

Since our focus is on agriculture and allied activities, we further disintegrate the primary sector GDP to know which sub-sector is laggard and which one is driving the growth of the primary sector. Table 2 shows the sub-sectoral trends in the primary sector. The sector is divided into agriculture and allied activities and mining & Quarrying (M&Q). As stated above, the primary sector recorded negative growth of about one percent per year, but M&Q recorded an impressive growth of 196.96 % per year, though the growth shows ups and downs across years. A high growth rate in M&Q is a serious concern for the ecology and environment.

As far as sub-sectoral growth of agricultural and allied sectors is concerned, we observe that agriculture, including horticulture, declined by 5.93 percent per year during 2011-12 and 2016-17. Consequently, the share of the agriculture sector went down approximately from 69% to 56% during the period. Contrary to this, the share of livestock rose from 19.24% to 30% during the same period. Livestock evinces a positive growth of 6.70% per year. Share of forestry and logging increased from 11.04% to 12.67% during the same period, with an annual average growth rate of 0.25%. Though Fishery has a negligible share in the total GDP of agriculture and allied sectors, it seems to be the highest growing sub-sector in the district economy as it grew at the rate of 268.58% per year. Thus, livestock, forestry & logging, and Fishery (allied activities) are the

primary sector's growth drivers, and agriculture is pushing down the growth of the agriculture & allied sectors. Can crop and horticulture sectors be the growth drivers of the district rural economy? Or should the sustainable development model for the growth of the district economy rely more on livestock, agroforestry, and Fishery? Can organic farming initiatives taken by the government through PKVY and Namami Gange programmes be able to revitalize agriculture and provide a decent livelihood to the rural workforce engaging the agriculture? Or should we think of an integrated model of sustainable development focusing on horticulture, livestock, agroforestry, bio-energy and tourism? How can these activities be integrated into the system and re-enforced one another? To get the answer to these questions, we need to get feedback from the district administration.

Table 2: Trends in Gross District Domestic Product from Agriculture and allied activities in Haridwar at Constant Prices (base 2011-12) in Rs. Lakhs

Year	Agriculture	livestock	Forestry & logging	Fishery	Total Agri, & allied	Mining & Quarrying	Primary Sector
	163854	45502	26112	988	236456	1473	237929
	(69.30)	(19.24)	(11.04)	(0.42)	(100)		
2011-12	-	-	-	-	-	-	-
	169374	45365	26591	998	242328	10825	253152
	(69.89)	(18.72)	(10.97)	(0.41)	(100)		
2012-13	[3.37]	[-0.30]	[1.83]	[0]	[2.48]	[634.89]	[6.40]
	147456	50567	26318	709	225050	46740	271790
	(65.52)	(22.47)	(11.69)	(0.32)	(100)		
2013-14	[-12.94]	[11.47]	[-1.03]	[-28.24]	[-7.13]	[331.78]	[7.36]
	122506	54697	25725	65	202993	9096	212089
	(60.35)	(26.95)	(12.67)	(0.03)	(100)		
2014-15	[-16.92]	[8.17]	[-2.25]	[-90.83]	[-9.80]	[-80.54]	[-21.97]
	117031	61169	26207	1014	205421	4118	209539
	(56.97)	(29.78)	(12.76)	(0.49)	(100)		
2015-16 RE	[-4.47]	[11.83]	[1.87]	[1460]	[1.20]	[-54.73]	[-1.20]
	118554	62589	26419	1034	208596	10434	219030
	(56.83)	(30)	(12.67)	(0.50)	(100)		
2016-17 PE	[1.30]	[2.32]	[0.81]	[1.97]	[1.55]	[153.38]	[4.53]
Average growth	-5.93	6.70	0.25	268.58	-2.34	196.96	-0.98

Source: Compile from UKDES

Note: 1. Figures in () are percentage share in the total agriculture & allied GDDP

Figures in [ ] are annual growth rates.

Table 3 demonstrates the percentage share of sub-sectors within the secondary and tertiary sectors. Manufacturing contributed 82.35 to 84.41% share within the secondary sector, while construction's share ranged from 13.68 to 16.24%. The average annual growth rate is observed highest in manufacturing (7.85%), followed by electricity, gas, and water supply (6.59%) and construction (5.44%).

Within the tertiary sector, trade, hotels and restaurants constituted the highest share (34.77%) in 2016-17, followed by real estate and professional services (22.43%), transport, storage and communication (16.60%) and other services (15.42%). The average annual growth rate is

observed highest (12.89%) in other services, distantly followed by transport, storage and communication (9.15%), financial services (8.51), public services (8.26%). Overall, the district economy is driven by the growth of non-agriculture sectors as agriculture achieved negative growth.

Table 3: Trends in percentage share of non-agriculture sub-sectors in GDDP at Constant Prices (base 2011-12)

Year	manufacturing	Electricity, gas, water supply	Construction	secondary	Transport, storage, communication	Trade, repair, hotels and restaurant	Financial services	Real estate & professional services	Public administration	Other services	Tertiary
2011-12	82.58	1.94	15.48	100	16.01	35.30	5.94	24.55	5.47	12.72	100
2012-13	84.41	1.91	13.68	100	16.10	35.48	5.87	24.49	3.57	14.48	100
2013-14	81.96	1.80	16.24	100	16.01	35.55	5.93	22.08	4.73	15.70	100
2014-15	82.35	1.87	15.78	100	16.14	34.52	5.98	22.98	5.13	15.25	100
2015-16	83.63	1.84	14.53	100	16.67	34.78	6.12	22.70	5.05	14.68	100
2016-17	84.32	1.87	13.81	100	16.60	34.77	5.97	22.43	4.80	15.42	100
Average annual growth (%)	7.85	6.59	5.44	7.37	9.15	8.03	8.51	6.56	8.26	12.89	8.36

Source: Estimated from Statistical Handbooks

1.5 The Livelihood Status

Table 4 shows the livelihood status of the workforce in Haridwar district and Uttarakhand. In 2017, approximately 40.9% of workers were self-employed, while the corresponding figure for the state is 56.9%. Casualization of the workforce is much higher in Haridwar (26.3%) than the state average (18.9%). Similarly, the share of regular workers in the total workforce is higher in the district than in the state. Sectoral distribution of employment again reveals that in terms of workforce, the district economy is dominated by the tertiary sector as against 35.3 workers engaged in the tertiary sector in the state, the corresponding percent is 38.6% in the district. Contrary to this, the primary sector contributes only 28.7% to the total workers, while its share in the state is 39.3%. An almost similar pattern is observed in the case secondary sector. Thus, taking employment and GDP together, we can infer that the economic condition of workers in the primary sector is poorer in the district vis-à-vis other sectors of the district economy.

Table 4: Livelihood Status in Haridwar (2017)

Employment Status			Sectoral distribution of employment			Distribution of workers by Skills		
	Haridwar	Uttara-khand		Haridwar	Uttara-khand	Skill	Haridwar	Uttara-khand
Self-employed	40.9	56.9	Primary	28.7	39.3	Low	34.6	24.9
Regular	29.2	24.2	Secondary	32.7	25.4	Medium	57.1	65.5
Casual	26.3	18.9	Tertiary	38.6	35.3	high	8.3	9.6
Total	100	100		100	100	Total	100	100
Poverty status	15.3	15.6	Inequality (Gini Coeff.)	0.293	0.308			

Source: Uttarakhand Human Development Report

The distribution of workers by their skills-set indicates that only 8.3% of workers in the district and 9.6% in the state come under the high skills category and the majority of them fall under medium and low categories of skills. Poverty and inequality are slightly lower in the district than the state average, as depicted in Table 4.

Highlights-1

In terms of employment, the tertiary sector plays a major role in the district economy, with almost 38.6% workforce engaged in it, although its contribution to the district GDP is about 22%. However, the growth driver of the district economy is the secondary sector (particularly manufacturing), which contributes over 73% to the GDDP and about 33% to employment.

The crop sector recorded negative growth during 2011-2017, while livestock, forestry and Fishery achieved positive GDP growth during the same period.

Mining & Quarrying recorded massive growth during the period, thus having implications for the environmental sustainability of the district.

Within the secondary sector, manufacturing recorded the highest average annual growth (7.85%), followed by electricity, gas and water supply (6.59%).

In the case of the tertiary sector, other services recorded the highest growth (12.89%), followed by transport, storage and communication (9.15%) and financial services (8.51%).

Manufacturing contributes over 84% of the secondary sector's GDP and its share has increased over the period.

Construction contributes about 14% of the secondary sector's GDP and electricity, gas, water supply contributes less than 2%

2 QUANTITATIVE DATA ANALYSIS

2.1 Agriculture and Allied Activities

2.1.1 Trend in Land Use and Land Cover

To understand the trends in land-use and land-cover, we analyze two types of data-GIS-based data and statistical data compiled from the district statistical handbooks of Haridwar. As per the GIS-

based data (see Figure I and Table 5), between 2010 and 2020, the area under cropland as a percentage of the total geographical area has decreased from 70.56 in 2010 to 69.81 in 2020. Forest area remains more or less constant. Built-up area and water bodies also increased between 2010 and 2020.

Table 5: Land use/ Land cover statistics classes of Haridwar district

LULC classes	Area(km^2) Year-2010	Area(km^2) Year-2020
Cropland	1710.98 (70.56 %)	1692.91 (69.81 %)
Forest plantation	236.44 (9.75 %)	234.00 (9.65 %)
Open forest	355.83 (14.67 %)	355.00 (14.64 %)
Dense forest	19.84 (0.82 %)	19.92 (0.82 %)
Scrub-land	34.36 (1.42 %)	31.55 (1.305 %)
Built-up land	40.64 (1.68 %)	64.30 (2.65%)
Water bodies	26.89 (1.11 %)	27.30 (1.13 %)
Total Geographical area	2424.98	2424.98

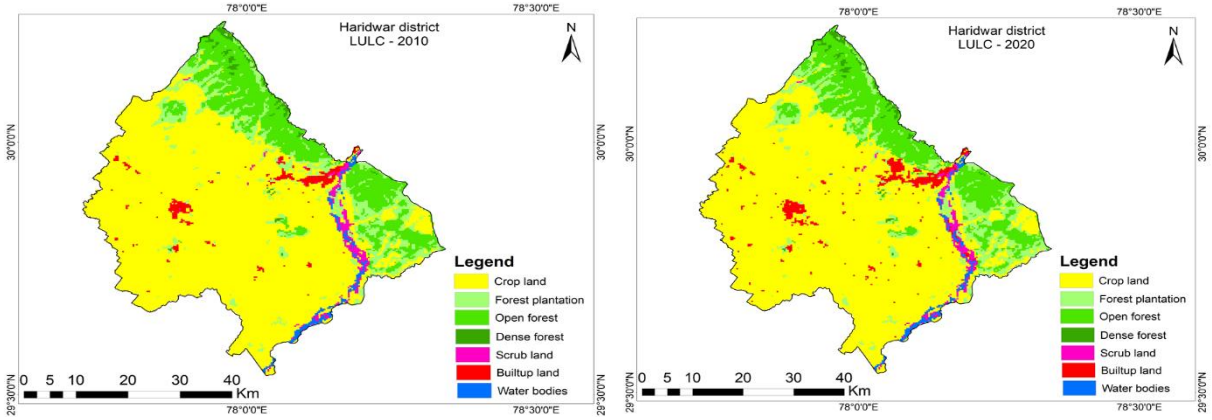


Fig 1: LULC map of Haridwar

GIS-based map shows 2424 square kilometers geographical area of the district, while the handbook shows 2431 sq.km reported area of the district in the year 2009-10 and it is increased marginally in the year 2018-19. Forest area decreased from 34.77% in 2009-10 to 34.48 in 2018-19. The share of barren and uncultivable land has increased from 1.16% in 2009-10 to 1.18% in 2017-18. Areas under trees and gardens increased in 2018-19. The net sown area has decreased by two percent during 2009-10 to 2018-19 (Table 6). Overall, the land-use pattern does not reveal any visible change during the last nine years.

Table 6: Trends in Land-use Pattern in Haridwar (as % of the total reported area)

Year	Total Reported Area (ha)	Area under forest	Cultivable waste land	Current Fallow	Other Fallow	Barren and uncultivable land	Land other than agriculture use (%)	Pasture land	The area under trees and gardens	Net Sown Area
1	2	3	4	5	6	7	8	9	10	11
2009-10	243162	34.77	0.59	1.19	1.62	1.16	11.40	0.03	0.32	48.92
2010-11	243151	34.77	0.78	1.13	1.54	1.12	11.45	0.03	0.66	48.52
2011-12	243151	34.77	0.77	0.77	1.86	1.13	11.50	0.03	0.68	48.49
2012-13	243151	34.77	0.73	1.05	1.59	1.13	11.78	0.02	0.71	48.22
2013-14	232641	31.13	0.73	1.72	1.43	1.40	12.48	0.02	0.87	50.21
2014-15	232798	31.11	0.75	2.01	1.44	1.46	12.68	0.03	0.66	49.86
2015-16	232798	31.11	0.77	2.47	1.66	1.46	12.85	0.03	0.66	48.99
2016-17	232798	31.11	0.52	2.41	1.67	1.46	13.09	0.03	0.67	49.04
2017-18	244507	34.41	0.66	1.78	1.60	1.35	12.56	0.03	0.93	46.68
2018-19	244002	34.48	0.69	1.79	1.65	1.18	12.80	0.03	0.63	46.75

Source: Prepared from District Statistical Handbooks of Haridwar

2.1.2 Trends in Operational Land Holdings

In Haridwar district, the total number of operational holdings has increased from 130545 in 2010-11 to 146890 in 2015-16, a net increase of 12.52 percent. Contrary to this, in the state, the number has declined from 912650 in 2010-11 to 881305 in 2015-16, a net decline of 3.43%. The majority of land holdings in the district are marginal and small. These categories of holding together constituted 89.28% in 2015-16, while the corresponding percentage in the state was 91.67% (Table 7).

Table 7: Distribution of Operational Holdings by Size-categories of farms (in %)

	Agri, Census	Marginal Holdings (0-1 ha)	Small Holdings (1-2 ha)	Semi-Medium Holdings (2-4 ha)	Medium Holdings (4-10 ha)	Large Holdings (10 & above, ha)	Total Holdings (Nos.)
Haridwar	2010-11	73.96	15.36	8.14	2.40	0.14	130545
	2015-16	73.74	15.54	8.36	2.27	0.08	146890 [12.52]
Uttarakhand	2010-11	73.65	17.24	7.10	1.90	0.12	912650
	2015-16	74.78	16.89	6.59	1.64	0.10	881305 [-3.43]

Source: Compiled from Statistical Handbook 2018-19, UKUES. Figures in [ ] are percentage increase/decrease in 2015-16 over 2010-11.

2.1.3 Trends in Area, Production and Yield of Principal Crops

i- The trend in Cropping Patterns

The agriculture of the district economy is dominated by sugarcane, followed by wheat and rice. Table 8 shows the trend in the area under principal crops during the last six years. Sugarcane, wheat, and rice together comprise the largest share in the gross cropped area (GCA). The area under these crops marginally declined from 80.52 percent in 2013-14 to 79.93 percent in 2018.19. Sugarcane has a little over 43.73 percent of the GCA of the district. Cereal consisted of about 36.59 percent share in the total cropped area. Overall, food grains shared over 36.86 percent of GCA in 2018-19. The share of oilseeds is a little over one percent.

Table 8: Trends in Cropping Pattern (as % GSA) and Cropping Intensity

Crop/Year	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19
Wheat	26.93	27.40	28.56	28.60	27.89	27.40
Rice	7.22	8.06	8.78	9.19	8.41	8.80
Maize	0.35	0.30	0.32	0.32	0.37	0.39
Total Cereal	34.50	35.77	37.66	38.11	36.67	36.59
Masoor	0.22	0.21	0.20	0.21	0.15	0.15
Total Pulses	0.32	0.30	0.31	0.32	0.30	0.27
Total Food Grains	34.82	36.06	37.97	38.44	36.98	36.86
Mustard	0.56	0.64	0.73	0.79	0.86	0.79
Groundnut	0.58	0.63	0.48	0.50	0.40	0.34
Total Oilseeds	1.27	1.40	1.38	1.48	1.43	1.33
Sugarcane	46.37	44.97	43.39	41.97	43.70	43.73
Potato	0.11	0.10	0.08	0.11	0.08	0.04
Net Sown Area	116081	116082	114059	114163	114124	114077
Cropping Intensity	140.69	139.28	142.57	142.00	140.27	140.69
Source: Estimated from District Statistical Handbooks						

ii- Trends in Per Hectare Yield of Principal Crops

The per hectare yield of sugarcane was as low as 566 qtls/ha in 2013-14 and as high as 700 qtls/ha in 2018-19. Similarly yield of wheat ranges between 27.03 to 36.11 qtls/ha during 2013-14 to 2018-19. A more or less similar pattern is also observed in the case of rice. From Table 9 it is observed that maize yield has improved in recent years. Relatively being a high-value crop, sugarcane has the potential to raise the farmers' income if proper marketing support is provided to farmers. Another value crop is potato, which also has a higher yield than rice and wheat, as shown in Table 9. Marketing support and R&D intensification can make these crops more remunerative for farmers.

Pulses are not the main crops in the district. Except for Masoor, which has about 0.15 percent share in the GCA, all other pulses have a negligible share in the GCA. The main reason for not growing pulses in the district is the intrusion of wild animals who eat these crops. The issue is not the low productivity or low return; the problem is crop damage. Overall, the per hectare yield of pulses ranges between 3.95 to 9.56 q/hs, indicating high variability across years. Among oilseeds, mustard is an important crop. Its yield ranges between 7.88 to 9.73 qtls/ha. Potato is another high-value crop. Its yield ranges between 131.77 to 215.53 qtsl/ha. Thus, sugarcane, wheat, rice, mustard, and potato are promising crops for farmers of the district.

Table 9: Yield under Principal Crops year-wise data for Haridwar District (in Quintal per Hectare)

Crop/Year	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19
Wheat	27.03	20.66	29.29	32.25	34.26	36.11
Rice	19.72	22.25	21.42	20.46	24.35	22.38
Barley	18.33	10.71	11.67	15	17.14	12.86
Maize	18.89	14.1	14.13	22.07	22.78	20.49
Total Cereal	25.42	20.96	27.32	29.32	31.87	32.64
Masoor	6.31	3.09	10.52	7.13	5.33	6.32
Total Pulses	6.18	3.95	9.56	7.02	7.27	7.59
Total Food Grains	25.24	20.82	27.18	29.13	31.66	32.46
Mustard	7.9	7.9	7.87	7.88	9.73	9.12
Groundnut	11.68	11.03	14.39	12.99	13.76	10.83
Total Oilseeds	9.06	8.77	9.42	8.87	9.97	8.48
Sugarcane	566	592	571	571	700	681
Potato	215.53	207.43	195.36	217.98	131.77	183.33
Source: Estimated from District Statistical Handbooks						

iii- Trends in Production of Principal Crops

Table 10 depicts that among the individual crops, sugarcane consisted of the highest production (4779462 metric tons), followed by wheat (158784 metric tons) and rice (31622 metric tons). These three crops had about 80 percent share in the total GCA. These crops are the highest consumer of water and chemical fertilizers and have some implications for soil and water resources degradation. Pulses have insignificant production in relation to the total foodgrains production of the district. Their share was only 0.16% in the total foodgrains in 2018-19.

Among oilseeds, mustard had the highest production (1154 metric tonnes) in the total oilseed production. Production of groundnut shows deceleration in the recent year. Potato is another important crop. However, its production shows fluctuation mainly because of changing market conditions.

Table 10: Trends in Production of Principal Crops in Haridwar District (in Metric Tonnes)

Crop/ Year	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19
Wheat	118889	91526	136003	149535	152931	158784
Rice	23249	29007	30574	30475	32778	31622
Maize	1073	681	729	1145	1353	1277
Total Cereal	143236	121229	167317	181167	187074	191692

Masoor	230	106	343	240	131	154
Total Pulses	321	190	481	369	355	324
Total Food Grains	143557	121419	167798	181536	187429	192016
Mustard	723	812	933	1009	1347	1154
Groundnut	1108	1127	1117	1048	877	567
Total Oilseeds	1884	1992	2119	2133	2297	1803
Sugarcane	4286318	4304432	4028633	3884856	4896990	4779462
Potato	3815	3402	2442	3989	1634	1265

We have calculated crop-wise average, standard deviation (SD) and coefficient of variation (COV) in the area, production and yield to understand variability across years. In the case of area under different crops, the lowest variability is observed in wheat (2.56%), closely followed by sugarcane (3.76%), total food grains (3.47%) and it is highest in potato (30.76%).

Table 11: Variability in Area, Production and Yield of Principal Crops (2009-10 to 2017-18)

Crop/Year	Area			Production			Yield		
	Average	SD	COV	Average	SD	COV	Average	SD	COV
Wheat	44949.00	1152.19	2.56	134611.33	25487.72	18.93	29.11	4.68	16.07
Rice	13595.33	1098.81	8.08	29617.50	3364.15	11.36	21.01	2.37	11.29
Total Cereal	59104.83	2062.59	3.49	165285.83	27768.86	16.80	27.92	4.36	15.60
Masoor	310.17	51.96	16.75	200.67	87.93	43.82	6.44	2.09	32.40
Total Pulses	491.17	35.72	7.27	340.00	93.88	27.61	6.93	1.84	26.55
Total Food Grains	59596.00	2070.19	3.47	165625.83	27824.26	16.80	27.75	4.34	15.63
Mustard	1176.17	174.42	14.83	996.33	228.34	22.92	8.21	0.70	8.57
Groundnut	789.50	180.30	22.84	974.00	220.16	22.60	12.23	1.33	10.83
Total Oilseeds	2235.00	119.32	5.34	2038.00	180.96	8.88	9.10	0.53	5.83
Sugarcane	71195	2676	3.76	4363448	402074	9.21	610.89	48.10	7.87
Potato	140.33	43.16	30.76	2757.83	1152.36	41.78	190.35	30.61	16.08

Source: Own Estimation based on data compiled from District Statistical Handbooks

Overall, variability in the production of different crops is higher than in the area under these crops. Variability in production depends on the variability in the area under the crop and variability in the yield. Among all crops, variability in production is observed highest in masoor (43.82%), followed by potato (41.78%). In the case of yield, the highest variability is estimated in masoor (32.40%) and the lowest in oilseed. Several factors, like market prices and rainfall patterns, affect the variability in agricultural production.

2.1.4 Consumption of Chemical Fertilizers

Table 12 shows trends in the consumption of chemical fertilizers in agriculture. The recommended ratio of nitrogen to phosphorous to potassium is 4:2:1, which is not being maintained in the district. For example, in 2010-11, nitrogen constituted 75% of total fertilizers used while the shares of phosphorous and potassium were 21% and 4%, respectively. In 2019-20, the share of nitrogen had further increased to about 79%, while shares of phosphorous and potassium have declined to 18% and 3%, respectively. The table also indicates that the consumption of chemical fertilizers varies substantially across years, which may be due to various factors, including rainfall patterns, cropping patterns, etc.

Table 12: Quantity of fertilizers used in Haridwar District year-wise data (in Metric Tonnes)

Fertilizer/Year	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
Nitrogen	20579	26143	22424	26321	12674	8220	10114	25325	26419	15951
Phosphorous	5745	7284	5465	4517	3666	2787	2790	6859	7632	3748
Potassium	1113	1660	754	580	526	328	326	981	2301	575
Total	27437	35087	28643	31418	16866	11335	13230	33165	36352	20274
Gross Sown Area (ha)	166930	162083	159986	163311	161681	162615	162114	160084	160494	160494

Source: Compiled from District Statistical Handbook

2.1.5 Irrigation Structure and Status

Haridwar being under the upper Ganga canal command region, canal and groundwater irrigation is mostly used. Table 13 shows a decline in the length of canals from 420.63 km to 173.19 km during the last five years. The number of government tube well has increased from 369 in 2010-11 to 513 in 2018-19. The private bore well increased significantly from 311 in 2010-11 to 1604 in 2018-19. Agriculture in the district is under irrigated conditions. The net cultivated area under irrigation ranges between 93.67 to 95.51 percent. There is significant progress in bringing more area under irrigation. Gross irrigated areas as a percentage of GCA is high (93.63-95.51%).

Table 13: Types of Irrigation Systems and percentage of the net and gross Irrigated Area

Name/Year	2014-15	2015-16	2016-17	2017-18	2018-19
Length of Canal (KM)	420.63	449.63	449.63	173.19	173.19
No. Of Govt. Tube wells	369	390	449	479	513
No. of Ground level Pump set	242	242	242	242	242
No. of bore-well pump set	26724	26810	26899	27023	27126
No. of Private tube wells	311	311	311	1664	1604
Gool in KM	360.58	391.31	406.56	406.56	427.38
% Of NIA	93.67	94.23	94.60	95.81	96.41
% Of GIA	93.63	94.44	94.64	95.07	95.51

Source: Compiled from District Statistical Handbook

2.1.6 Out-Migration and Agriculture

Agriculture is a key growth driver of the district economy. It can be integrated with the promotion of high-value crops (HVCs) such as vegetables, fruits, mushrooms, flowers and medicinal crops. If HVCs are promoted, hotels and dhabas, largely driven by tourists, may get fresh vegetables and fruits and other food items from the local farmers. It may be relevant to mention that the floating population in the district may be even more than the actual population. This population needs different kinds of agro-products that the local market can supply. Diversifying agriculture and allied activities toward low volume and high-value agro-products would work as a multiplier in the local economy, generating additional employment avenues in the non-farm activities. The possibility of evolving an economically viable model of convergence of MGNREGA activities with the concerned line departments would be explored to promote HVCs and improve people's livelihood. Uttarakhand Human Development Report (2018) shows that about 77.6 of the total first-time migrant in Haridwar migrated alone and about 12.8 percent with family members (Table 14).

Table 14: Process of Migration (First Migration) in Haridwar (in %), 2017

	Migrated alone	Migrated with family members	Migrated with members of community / Village	With quittances/Friends (other than col 4)	Middlemen / contractors	Any other	Total
1	2	3	4	5	6	7	8
Haridwar	77.6	12.8	3.2	6.4	0	0	100
UK	72.1	18	6.6	2.6	0.1	0.6	100

Source: Uttarakhand Human Development Report

2.1.7 Status of Organic Farming

To promote sustainable agricultural practices and improve the farmers' livelihood, the Government of India launched PKVY and Namami Gange schemes. Under these schemes, farmers are incentivized to form groups to do organic farming and sell their products with PGS certification. The state set up the Uttarakhand Organic Commodity Board (UOCB) in 2003 as a nodal agency to facilitate organic clusters and provide technical support to promote organic farming. The area under organic farming in the state was about 18% of the NSA in 2019 (https://www.downtoearth.org.in/blog/agriculture/how-indian-states-are-promoting-organic-

natural-farming-73306). Uttarakhand is the first state of India which enacted Organic Farming Act in 2020 and declared 10 of its blocks fully organic.

Table 14 shows the status of organic farming PGS groups constituted under PKVY and Namami Gange schemes. On June 30, 2021, there were 116 organic farming groups with 3459 registered farmers in the district. Out of these groups, about 99% constituted under the PKVY and only 1% under the Namami Gange. The median number of farmers per group is 22 under PKVY and 20 under the Namami Gange. The high value of SD in the case of organic farmers of PKVY groups indicates that the number of farmers per group has higher variability in the PKVY scheme than Namami Gange. Block-wise data show that under PKVY, the highest number of groups and number of farmers are in Bhagwanpur (35 and 895), followed by Bahadrabad (32 and 1098) and Roorkee (17 and 551) and lowest in Khanpur (05 and 177).

Table 15: Status of Organic Farming PGS Groups under PKVY and Namami Gange Schemes in Haridwar (as on June 30, 2021)

Sl. No	Block	Scheme	No of Groups	No of Farmers in Groups			
				Total	Average	Median	SD
1	Bahadrabad	PKVY	32	1098	34.31	30	12.33
		Namami Gange	1	20	20	20	0
2	Bhagwanpur	PKVY	35	895	25.57	20	10.29
		Namami Gange	-	-	-	-	-
3	Khanpur	PKVY	5	177	35.4	28	12.93
		Namami Gange	-	-	-	-	-
4	Laksar	PKVY	14	449	32.07	20	15.64
		Namami Gange	-	-	-	-	-
5	Narsan	PKVY	12	269	22.41	20	8.37
		Namami Gange	-	-	-	-	-
6	Roorkee	PKVY	17	551	32.41	30	12.57
		Namami Gange	-	-	-	-	-
7	Total (Haridwar)	PKVY	115	3439	29.9	22	12.47
		Namami	1	20	20	20	0
		Total	116	3459	29.81	22	12.45

Source: Compiled from https://pgsindia-ncof.gov.in/

Since economies of scale in both production and marketing matter in organic farming, possibilities of some institutional framework may be in the forms of SHGs/ farm cooperative/PFOs/contract farming, etc.. Organic farming could be an economically viable option in the district if the government builds strong marketing networks linking farmers, processors, and distributors with the easy certification process and minimizes farmers' risk by protecting their farm income through payments of ecosystem services. Organic farming Act is a good initiative and its provisions should be effectively enforced. A long-term system of incentive as well as regulation

may be evolved to retain the existing farmers and motivate others to move towards the sustainable farming system in the district.

The major problem for the growth of organic farming observed through discussion with farmers are:

- The major problem of the farmers in this area was poor marketing of the organic products and not being able to fetch a premium in the market for their organic produce. Although efforts are being made to integrate the farmers with the market network, farmers still have inadequate marketing and distribution network access.

- Farmers growing organic sugarcane hardly get premium prices because there is no market infrastructure. Being inadequate quantity of production in relation to the total production of the district, sugar processors do not distinguish between organic and non-organic sugarcane and offer the same prices to the farmers. A few sugar crashers claim to be producing organic sugar, but local people do not have faith in their claim as they also get sugarcane from non-organic farmers. Farmers producing organic wheat or rice somehow manage to get premium prices for their meager quantity of produce due to their contract with the consumers. But they are not motivated to scale up their production due to a lack of marketing institutions and infrastructure. The problem of marketing is even more serious in the case of perishable vegetable crops. If marketing facilities are created, Haridwar district has huge potential for organic vegetable production, particularly bitter-guard and cucumber. Contract farming companies can be encouraged.

- Inspection of organic farms was rarely conducted. Farmers were reported to practice organic farming only on a small part of their land (about one ha) to get the scheme's benefit; there was hardly any farmer reported to grow organic crops on the whole land.

- Although organic farming is encouraged to be practiced in clusters, organic farmers allocate a part of their lands to organic farming and practice conventional farming in the rest of the area, which leads to contamination of the organic produce and also fails the purpose of the cluster approach in organic farming.

- Some of the conventional farmers showed interest in switching to organic farming but stated that the low availability of organic inputs and problems in being able to earn a premium at the local market constrained them not to do so.

- The financial support offered in the conversion period under the Namami Gange works as an incentive for some farmers to adopt organic farming, but according to the farmers after the first transfer payment of the subsidy under Namami Gange, they were not provided with the remaining of the amount.

- According to the farmers, implementing policies initiated to promote organic farming in the area is not very efficient as the inspection is not conducted regularly, and the farmers did not receive subsidies in time under the scheme.

- The knowledge level regarding practices under organic farming was not high among farmers, and the awareness regarding its benefits was also low.

2.2 Trends in Livestock

Livestock has an essential place in the rural economy. Data on livestock come from the livestock census, which is conducted periodically. Table16 shows that the total number of cattle (cows and bulls) has increased from 128068 in 2003 to 179395 in 2019. Comparing 2003 and 2019 data, we observe that numbers buffaloes have decreased from 2003 to 2019. The number of sheep shows ups and downs during the entire period. It was highest in 2012 (5571) and then declined to 4697 in 2019. However, the number of goats has increased during the period. The number of pigs and poultry in the district has declined from 2003 to 2019.

It is significant to note that the number of female cattle (cows) has substantially increased over the period, indicating the growth of livestock products, including milk. The substantial decline in the number of male cattle and male buffaloes also shows the rising farm mechanization and declining relevance of animal power, mainly because of the high maintenance cost of livestock. At the same time, it may also hint that male livestock is catering to the rising demand for meat consumption and fuelling the growth of the livestock economy, which has been growing much faster than the crop sector in the district.

Table 16: Trends in Livestock population (in numbers) Haridwar

	Category	2003	2007	2012	2019
Indigenous Cattle	Total Male	45338	25809	21896	12747
	Total Female	57016	41682	38248	50981
	Total	102354	67491	60144	63728
Exotic Cattle	Total Male	7717	23840	15501	11654
	Total Female	17997	48070	76875	104013
	Total	25714	71910	92376	115667
Total Cattle		128068	139401	152520	179395
Buffalo	Total Male	77641	84491	49743	32568
	Total Female	190894	187973	187462	181912
	Total	268535	272464	237205	214480
Sheep	Total Indigenous Sheep	2145	4026	5186	4209
	Total Exotic Sheep	125	261	385	488
	Total Sheep	2270	4287	5571	4697
Goat	Total Male	-	-	8153	5529
	Total Female	-	-	16245	21065
	Total	21265	26115	24398	26594
Pig	Total Indigenous Pig	12863	5819	5454	3856
	Total Exotic Pig	3126	4031	3751	2273
	Total Pig	15989	9850	9205	6129
Total Livestock		470384	467048	444329	-

Total Poultry		63201	40780	46390	-
Source: Compiled from District Statistical Handbook and http://dahd.nic.in/animal-husbandry-statistics					

Table 17 shows animal hospitals and development centers in the district. The number of cattle hospitals remains the same over the period. The number of cattle development centers increased from 36 to 40. The number of man-made reproduction centers remains the same over the period.

Table 17: Year-wise number of Cattle Hospitals and Development Centers

Category	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
Cattle Hospital	16	16	16	16	16	16
Cattle Development Centre	36	36	39	39	40	40
Man-Made Reproduction Centre	16	16	16	16	16	16
Man-Made sub-Centre	36	36	39	39	39	41
Poultry Units	1	1	1	1	1	1
Source: Compiled from District Statistical Handbook						

2.3 Trends in Horticulture Crops

The district has a high potential for horticulture development. With policy support and a well-designed action plan, this sector can be the growth driver for the agriculture sector. Table 18 shows the percentage share of major fruit crops in the total cropped under fruits. In 2019-20, mango constituted the highest share (35.14%), followed by litchi (10.58%) and lemon (9.11%). The total area under fruits shows variation across years.

Table 18: Trends in percentage share of principal fruit crops in total area under fruits

Crop/Year	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
Pear	0.00	0.82	0.81	0.89	0.89	0.89
Peach	0.00	1.00	1.03	1.06	1.03	1.08
Lemon	9.40	9.42	9.28	9.63	9.09	9.11
Mango	37.86	34.52	34.58	36.51	35.19	35.14
Litchi	10.85	10.87	10.75	11.10	10.52	10.58
Other Fruits	39.98	43.36	43.51	40.81	38.49	38.42
Total of above Fruits (ha)	14618.3	15316.2	15541.75	15058.8	15991.1	16023.6
Source: Compiled from District Statistical Handbook						

Production of mango ranges from 25096 metric tons in 2014-15 to 26278 metric tons in 2019-20. Total production of fruits has increased from 14618 metric tons in 2014-15 to 16023 metric tons in 2019-20 (Table 19).

Table 19: Production under Horticulture Crops year-wise data for Haridwar District (in Metric Tons)						
Crop/Year	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
Pear	-	1600.8	1600.8	1691.1	2330.2	1354
Peach	-	718.2	729	752	675	705
Lemon	5546	5823.15	5374.4	5843.5	5611.5	5632.5
Mango	25096	22143.8	22916.3	23020.2	23763.3	26278
Litchi	4171	4385.85	4409.6	4397	4372.4	4698.4
Other Fruits	66466	64010.1	6443.6	59913.8	59738.8	60565
Total of above Fruits	103598	97963.65	99576.1	15058.8	15991.1	16023.6
Source: Compiled from District Statistical Handbook						

Table 20 shows that the per hectare yield of almost all crops has declined during 2014-15 to 2019-20. The productivity of mango decelerated from 4.53 tons in 2014-15 to 4.67 tons in 2019-20. The yield of pear evinces ups and downs during the period. Per hectare yield of all fruits (pear, peach, plum, lemon, mango and litchi) have declined during the period. Overall, productivity went down from the peak of 7.09 tons/ha in 2014-15 to 1.0 tons/ha in 2019-20. The above analysis indicates the dismal scenario of fruits production in the district.

Table 20: Yield under Horticulture Crops year-wise data for Haridwar District (in Metric Tons per hectare)						
Crop/Year	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
Pear	-	12.70	12.70	12.62	16.41	9.50
Peach	-	4.68	4.56	4.70	4.08	4.08
Lemon	4.04	4.04	3.73	4.03	3.86	3.86
Mango	4.53	4.19	4.26	4.19	4.22	4.67
Litchi	2.63	2.63	2.64	2.63	2.60	2.77
Other Fruits	11.37	9.64	0.95	9.75	9.71	9.84
Total of above Fruits	7.09	6.40	6.41	1.00	1.00	1.00
Source: Compiled from District Statistical Handbook						

Area, production, and yield of almost all fruits evince a magnitude of variability indicated by COV values. In the case of area, the highest COV is in pear, closely followed by peach. In the case of production, COV is highest in pear, followed by peach. In yield, the highest variability is observed in pear, followed by peach and mango. A perusal of Table 21 reveals that the variability in production is higher than yield and area. The high output variability is more due to variability in area than the variability in yield.

Table 21: Variability in Area, Production and Yield of Principal of Fruit Crops (2009-10 to 2017-18)			
Crop/Year	Area (ha)	Production (tones)	Yield (tons/ha)

	Average	SD	COV	Average	SD	COV	Average	SD	COV
Pear	111.75	55.23	49.42	1715.38	772.99	45.06	12.79	5.66	44.27
Peach	135.30	66.61	49.23	715.84	293.36	40.98	4.42	1.83	41.33
Lemon	1437.23	31.69	2.20	5638.51	176.18	3.12	3.92	0.13	3.31
Mango	5492.36	138.02	2.51	23869.60	1544.31	6.47	4.34	1.65	38.04
Litchi	1661.83	38.61	2.32	4405.71	168.73	3.83	2.65	0.06	2.30
Other Fruits	6283.94	347.12	5.52	52856.22	22892.67	43.31	8.54	3.78	44.20
Total Of above Fruits (ha)	15424.96	545.73	3.54	58035.20	46423.15	79.99	3.81	3.09	81.10
Source: Compiled from District Statistical Handbook									

2.4 Trends in Area, Production and Yield of Vegetable Crops

Table 22 shows the trends in the area, production, and per hectare yield of total vegetable crops. The table shows that area, production, and yield of vegetables in the distruct increased from 2014-15 to 2019-20. The per hectare yield has increased

from 14.84 tons/ha in 2014-15 to 20.73 tons/ha in 2019-20. Similarly, total production also increased from 58761 tons in 2014-15 to 91327 tons in 2019-20. The area under potato increased from 1570 ha to 1688 ha. As a result, the production increased from 32103 tons to 35355 tons. The yield of potatoes also increased from 20.45 tons/ha in 2014-15 to 20.97 tons/ha in 2019-20.

Agriculture and allied sectors can improve rural livelihood by diversifying towards horticulture, aromatic and medicinal plants, animal husbandry, including dairy, fisheries, sericulture, bee-keeping, mushroom production, etc. Fruits, vegetables, potatoes, mushrooms, spices, medicinal plants, and flowers can provide remunerative returns to farmers as their demand is income-elastic.

Highlights-3

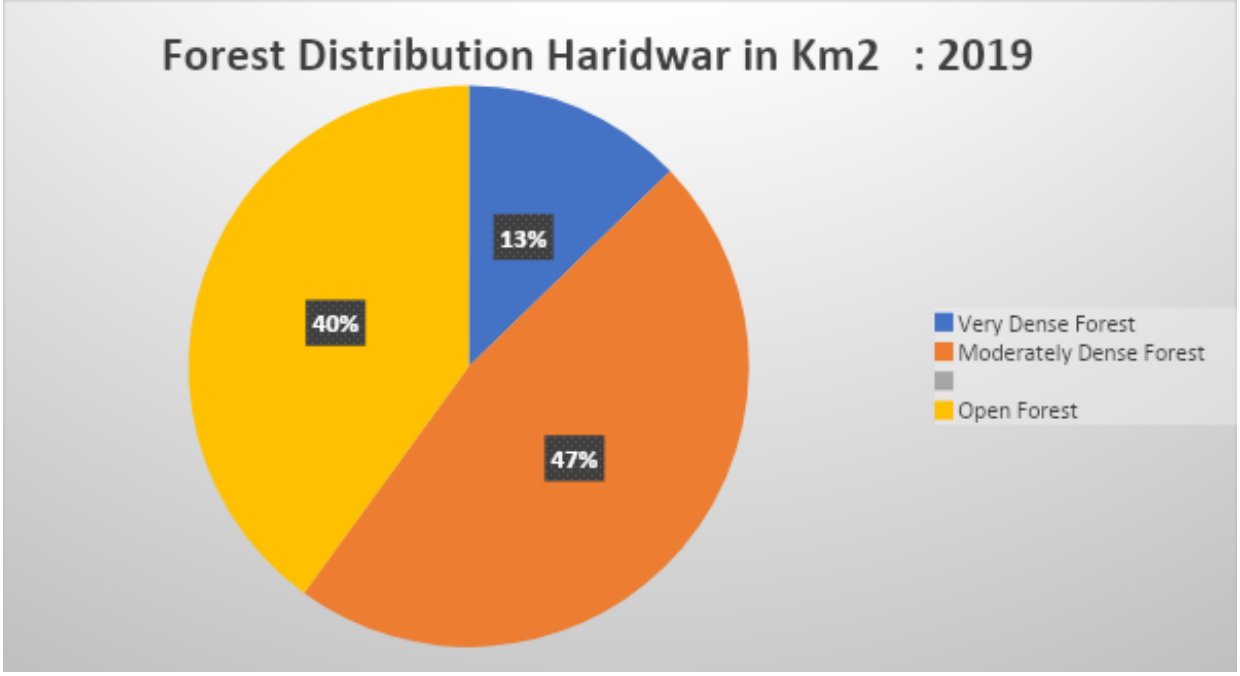
Livestock has an important place in the rural economy. Its contribution to agriculture has been gradually rising. However, livestock census data indicate that the total number of cows increased in 2019 over 2003.

The district has a high potential for horticulture development. With policy support and a well-designed action plan, this sector can be the growth driver for the agriculture sector. Roorkee, Bhagwanpur, Narsan, and Bhahadarabad have a high potential for vegetable production as farmers of these blocks are already producing vegetables. Organic vegetable growing clusters can be developed with effective market linkages.

In 2018-19, the area under the mango crop constituted the highest

2.3 Forestry

Total geographic area of the district is 2360 Km^2. As per 2019 Forest survey of India assessment, district has total 24.80% of forest area of total geographic area. The total forest cover in the district is 585.25 Km^2. From this total area 74.74 Km^2 comes under very dense forest (VDF) category, 276.42 Km^2 is moderately dense forest (MDF), and 234.09 Km^2 area is open forest (OF).



Forest Survey of India 2019 Uttarakhand vs Haridwar Comparative Assessment						
Area	Geographical Area	Very Dense Forest	Moderately Dense Forest	Open Forest	Total	%of Geographical Area
Haridwar	2360	74.74	276.42	234.09	585.25	24.80%
Uttarakhand	53483	5046.76	12805.24	4160.26	6451.04	45.44%

About 20 sawmills are present in the district, The saw mills are present in Jawalapur, Roorkee & Manglore. Two ply wood factories are present in Bhagwanpur, the total annual production capacity of the plywood factory is about 21,265 m^3 per annum. Two paper and Board mills are also established in Bahadrabad and Jagjitpur (Singh, 2017).

2.3.1. Biodiversity:

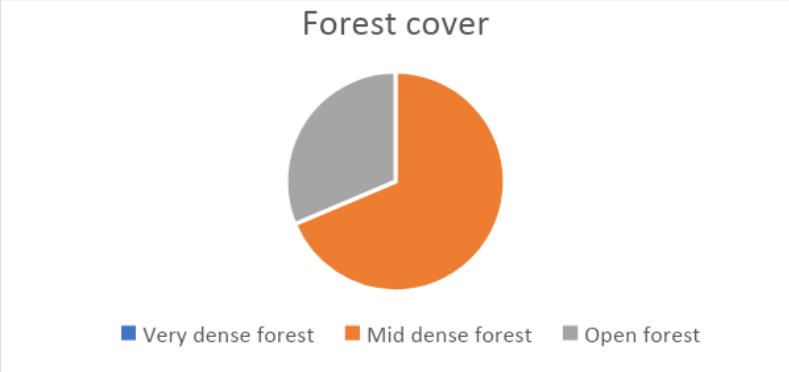
The district's biodiversity data includes crop production, livestock population, bird species, and forest cover. Umbrella project biodiversity of Uttarakhand reports the biodiversity data of the Dehradun district. As per the data, 865 flora and fauna have been observed till now. A total of 361 species are present in the district, of which 26.59% are insects, 31.3% plant species, 0.83% amphibian, 3.6% mammal species, 32.13% birds, and 1.94% reptiles.

Table 1 Bird species recorded in the district.

Number of species	554
Number of rare/accidental species	7
https://avibase.bsceoc.org/checklist.jsp?lang=EN&p2=1&list=clements&synlang=&region=INwhukha&version=text&lifelist=&highlight=0	

Forest cover (in sq. km.)

Geographical area	Very dense forest	Mid dense forest	Open forest	Total	% of Geographical area `	Change with respect to 2017 assessment	Scrub
2360	74.74	276.42	234.09	585.25	24.80	-2.75	6.00



2.4 Tourism

2.5 Wetlands

The district does not consist of a large number of wetlands. The district consists of areas like the Jhilmil jheel, baanganga wetland which are some of the large water bodies present in the district. Table 1 represents the number of wetlands and their area representation in the district. Around 32 wetlands were sized greater than 2.25 Ha and 342 less than 2.25 Ha areas. The region consists of small wetlands, generally less than 20 Ha in area.

Table 1: Wetland Data of Haridwar District

Wetland Types	Total Number of Wetlands:			Area (ha)									Aquatic Vegetation
Natural Wetlands	**NRCD**	**NWIA**	**Diff.**	**<2.25**	**<5**	**<10**	**<20**	**<50**	**<200**	**<500**	**<1000**	**>1000**	
Lake/ponds	0	0	0	0	0	0	0	0	0	0	0	0	0
Ox-bow lakes/cut off meanders	4	4	0	0	3	1	0	0	0	0	0	0	2
High altitude Wetlands	0	0	0	0	0	0	0	0	0	0	0	0	0
Riverine Wetlands	0	0	0	0	0	0	0	0	0	0	0	0	0
Waterlogged	0	0	0	0	0	0	0	0	0	0	0	0	0
River/Stream	0	9	9	0	0	0	0	0	0	0	0	0	0
Man-made Wetlands	**NRCD**	**NWIA**	**Diff.**	**<2.25**	**<5**	**<10**	**<20**	**<50**	**<200**	**<500**	**<1000**	**>1000**	**AV**
Reservoirs/Barrages	0	0	0	0	0	0	0	0	0	0	0	0	0
Tanks/ponds	14	18	4	0	9	3	2	0	0	0	0	0	3
Waterlogged	1	1	0	0	0	0	0	0	1	0	0	0	1
Salt pans	0	0	0	0	0	0	0	0	0	0	0	0	0
Total (374)	19	32	13	342	12	4	2	0	1	0	0	0	6

Source: (National River Conservation Directorate, 2008), (Space Application Centre-ISRO, 2007)

- The district comprises 374 wetlands; most are tanks/ponds and rivers/streams.
- The wetland size is small in general, the number of natural wetlands is less than man-made.
- Fewer wetlands have aquatic vegetation.

2.6 Energy

2.6.1 Biomass Energy

In Uttarakhand, operation and execution of various schemes based on non-conventional energy resources is handled by Uttarakhand Renewable Energy Development Agency (UREDA) through local panchayats, volunteer organizations and district administrations.
In the district Haridwar main source of income is from the agriculture sector . The net sown area of Haridwar is 11840 ha. The district has 1700 ha of total cultivable wasteland, 2700 ha of current fallow and 2700 ha as other fallows. Major crops grown in the district are rice, wheat, lentils, mustard etc. Major horticultural crops are citrus fruits, mango, sugarcane etc.The cropping intensity in the district is 136.3% which is considered to be good.

Table.1 gives an account of productivity of major crops in the district.

CROPS	PRODUCTIVITY(kg/ha)
Rice	2150
Wheat	2590
Lentil	450
Mustard	910
Citrus fruits	40646

Sugarcane	623

Table :1

Fig. 1 depicts the type of fuel used by households for cooking purposes, and this data is taken from the 2011 census. It is clear that approximately 40% households use fire wood , 39% use LPG/PNG and 17% use cow dung cake for cooking purposes. It is important to divert people away from using firewood and encourage them to use clean and green energy.

From the official website of UREDA two power projects have been recorded from the district .One at Ram Bahadur Narayan Sugar Mill Laxar of 15 MW capacity which is bagasse based cogeneration type. The other at Birla Tyre kesoram Industries Luxar of 7.5 MW capacity which is a rice husk based cogeneration plant.

It can be inferred from the data available from various sources that the district is capable of producing biomass energy, if development is done in the appropriate direction.

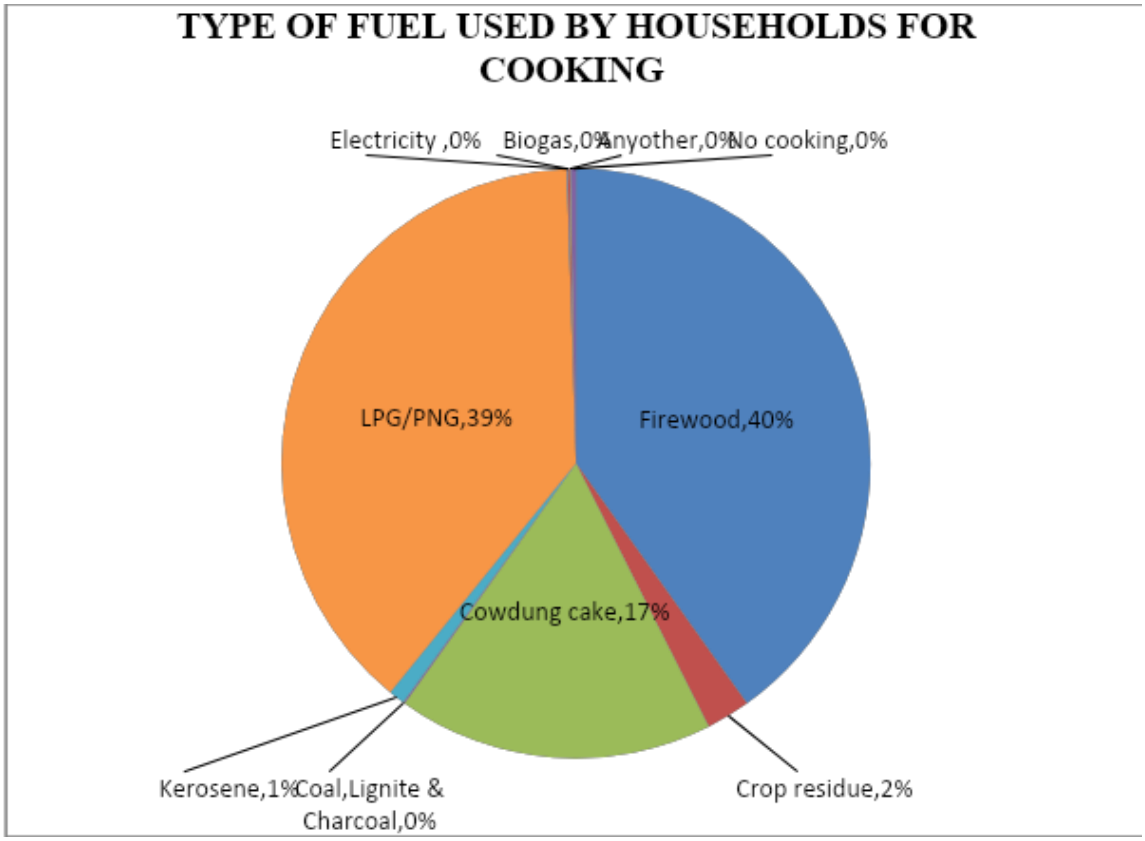


FIG. 1

2.6.1 Solar Energy

In Uttarakhand, operation and execution of various schemes based on non-conventional energy resources is handled by Uttarakhand Renewable Energy Development Agency (UREDA) through-local panchayats, volunteer organizations and district administrations.

The graph represented by Fig. 1 represents the percentage of households using different sources for lightning. This data is according to the 2011 census. It is very clear that more than half the households, nearly 86%, use electricity for lighting purposes, 13.07% use kerosene and only 0.13% use solar for lighting purposes.

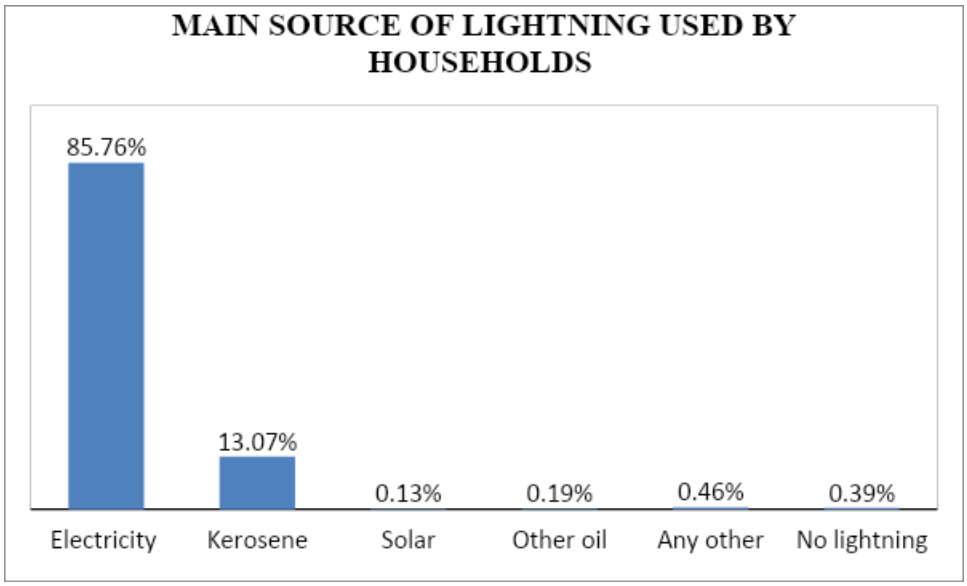


Fig. 1

The data on the district website gives an account on the installed units utilizing solar energy in the form of solar photovoltaic and solar thermal. Under the Solar thermal scheme the state of Uttarakhand provides different programs such as Solar water heating systems, Solar cooking systems, Solar Steam cooking system and Parabolic concentrator solar water heating systems. Under Solar energy schemes there are mainly two of them one is the Mukhyamantri Saur Swarozgar Yojana and the other National Solar Policy, phase-II.

In the district Haridwar 176 Dish solar cookers under Mid Day Meal and Market Mode Programme upto 2015-2016 have been installed. Solar water heating systems were also installed in the year 2019-2020 at K.G.B.V. Harjoli, Girls Hostel in Bandiwala and Gobardhanpur and boys Hostel Alipur and Laldhang. CST (Concentrating Solar Technology) systems have also been installed in Shantikunj, Haridwar for cooking of food to 1000 persons and Rajiv Gandhi Navodaya Vidyalaya, Shikarpur, Haridwar for cooking of food for 300 children.

2.6.1 Biogas Energy

Five hundred nine family-sized biogas plants have been installed in the district between the years 2009 to 2019. Two biogas power generation plants of capacity 35 and 85 m^3 have been installed

in the district. Biogas potential has been evaluated by average livestock and agricultural waste production. Biogas potential from animal waste is calculated approximately as one crore m^3/year and twenty-two crore m^3/year from agricultural waste. This amount of biogas generation can efficiently complete the energy demand of the district.

2.6.1 Hydropower Energy

The city is located on the Ganges river's right bank, near the foothills of the Shivalik peaks. Only one hydroelectric power plant exists in the district, and no future site has been investigated.

3 QUALITATIVE DATA ANALYSIS

3.1 AGRICULTURE, ALLIED ACTIVITIES,

3.2 FORESTRY

The 2019 Forest Survey has enlisted most abundant tree species in the urban as well as rural region. Pinus roxburghi, Grewia oppositifolia, Mangifera indica, Quercus leucotrichophora, Ficus species are some of the most occurring species in the rural region. Urban region includes trees like Quercus leucotrichophora, Mangifera indica, Cedrus deodara. Some commercially important medicinal and aromatic plants (MAPs) of the state are Aconitumsp, Acorus calamus, Adhatoda vasica, Swerita chirauita, Nardostachys grandiflora, Berberis aristata, Hedychium spicatum, Juniperus communis, Picrorhiza kurrooa, Podophyllum emodi, Rauvolfia serpentina, Emblica officinalis, Aegle marmelos, Terminalia chebula, Terminalia bellir-ica, Cedrus deodara, Sapindus emarginatus, Rheum emodi, Saussurea lappa,Swertia chirayitaand, Valeriana jatamansietc.

During 2015 research about medicinal and aromatic plants in the district, total 30 species were identified in active trade (Kala, 2015).

Plant	Rates per Kg.
Shikakai Fruit	100
Buch Leaf	300
Faran/jambu Leaf, stem	3000
Balchhadi Root	600
Bhoj patra Bark	1200

Brahmi buti Leaf	250
Brahmi buti Leaf with stem	200
Safed musli – yellowish Root	1200
Safed musli – white Root	800-1000
Shankhpushpi Whole	100
Nagarmotha Root	100
Bhringraj Leaf	100

School Nursery Yojana by the government of India is another great initiative to involve educational institutions as stakeholder. This scheme aims to provide an environment for the students to understand and appreciate the significance of plant in maintaining and sustaining the natural eco-systems. Each school will receive **Rs. 50,000/-** as grant under this scheme. Out of this, Rs. 40,000/- will be used by the school for creation of nursery. Balance Rs. 10,000/- will be utilized for miscellaneous activities. Under the School Nursery Scheme, thirty Nurseries (Single Nursery per School) are to be developed in the State. The implementation of this scheme has not yet started in the state. Under this scheme **76** proposals related to 10 districts have been sent to the Govt. of India in the 1st phase. **Haridwar** district has **10** proposed school nurseries.

Recently, the Uttarakhand State Forest department has decided to develop a city forest in Haridwar at an estimated cost of Rs 2.5 crore. The department has already identified eight hectares of land along the Ganga in Kankhal area. According to the plan, the forest will have a seven-kilometre-long track for joggers, a park for kids, and a herbal medicinal garden (Times of India, 2021).

3.2.1. Biodiversity :

The Shivaliks, amid the Himalayan foothills, is home to Rajaji National Park, an Indian national park and tiger reserve. It spans 820 square kilometers in three Uttarakhand districts: Haridwar, Dehradun, and Pauri Garhwal. Over 500 elephants, 12 tigers, 250 panthers, and a diverse prey base that includes Spotted Deer, Sambhar, Wild Boar, Barking Deer, and Goral. Rajaji National Park is a fantastic wildlife and bird-watching site, with two types of bears, Himalayan Black and Sloth, and over 400 bird species.

On the east bank of the Ganga, the Chilla Wildlife Sanctuary has an area of 249 square kilometers. The sanctuary was formed in 1977, and in 1983, it was joined with the Motichur and Rajaji sanctuaries to form Rajaji National Park. Elephants, tigers, bears, tiny cats, and fun birds can all be found in the sanctuary.

3.3 ENERGY

3.3.1 Biomass Energy

The district Haridwar is potentially capable of energy from the available biomass but there has been limited development in this sector. The district also has a good amount of fallow land available which can be used for setting up biomass plants. The energy produced from the biomass of the district can add to renewable energy resources and reduce the use of conventional sources of energy which add to pollution. Small startups should be encouraged to set up biomass based energy plants by providing them with required financial assistance . This will increase entrepreneurship in the district and will increase employment opportunities.

According to the article in the Economic Times Uttarakhand has launched an initiative to generate biofuel from used cooking oil during kumbh. This was initiated to reduce the health related hazards. For this purpose, companies authorized by the government collected reused cooking oil from hotels, restaurants and traders in Haridwar at 25 Rupees per kilogram. It is reported that on an average 8 to 10 liters of biofuel can be prepared from 10 liters of used cooking oil. Along with protecting the environment, the initiative will also prove beneficial for people's health.

A pre-feasibility report for establishment of proposed 50.0 KLD molasses based distillery alongwith 3.0 MW cogeneration power at Khundi village in Haridwar by Uttam Sugar Mills Limited states that the company has cogeneration facility in its plant and the surplus power is exported to the state's grid. The entire power being generated in all the plants is through Bagasse / Biomass, which is a clean "Zero Carbon Footprint" fuel.

It is evident that the government has plans for biomass energy production. The need is for people to get aware about it and also the concerned authorities should survey about the feasibility of the policies for biomass energy production.

3.3.2 Solar Energy

The state government has two types of schemes one is solar energy schemes and the other are solar thermal energy schemes. The quantitative data collected gives a glimpse of solar energy development in Haridwar. It seems that the district has more installations for thermal energy as compared to photovoltaic types. An article in Energy World with the title 'Haridwar ashrams look forward to cooperating with Center on boosting use of solar power' is about how Ashrams in Haridwar are quite enthusiastic about the Union government's proposal to create 40,000 MW solar power capacity and to enlist the cooperation of religious institutions for this objective. Upendra Tripathi, secretary, ministry of new and renewable energy, had said a few days ago that ashrams and spiritual organizations, many of which have a substantial following, can act as partners of the International Solar Alliance, a global grouping of over 100 'sunshine countries' between the tropics of Cancer and Capricorn that was launched by PM Modi at the Paris climate summit last December.

An article in Saur Energy titling 'Rituals For BHEL Haridwar's 5 MW Interactive Solar PV Plant Done' is about A 5MW grid interactive solar PV plant to be set up at BHEL Haridwar, had its land rituals (Bhoomi Pujan) performed by General manager (in-charge) HEEP (Heavy Electricals Equipment Plant) Sanjay Gulati and general manager (in-charge) CFFP (Central Foundry Forge Plant) Rajiv Mehra. The plant will be built near BHEL's 132 KV sub-station. Post the event, Gulati

said that sustainable energy produced from non-conventional resources is the future of power in India. The plant will help achieve almost 20 percent of the electricity requirement of HEEP unit of BHEL Haridwar corresponding to about 92 lakh electricity units per year eventually resulting in saving approximately Rs 4.75 crore from its annual electricity bill after the commissioning of the plant, commented Gulati. BHEL and its several units will manufacture all the prominent equipment such as Solar Panels, Power Conditioning Units, Sun trackers and Vacuum Circuit Breakers, he added. The trackers will be mounted with solar panels of 1.25MW capacity chasing the sun throughout the day and while another 1.25MW capacity for simple East-West trackers and the rest 2.5 MW would have fixed Module Mounting Structures in order to maximize the power generation, he mentioned further.

3.3.3. Biogas Energy

Two cogeneration/waste to energy type captive biomass-based power generation plants with 15.0 and 7.5 MW capacities are present in the district. The compressed biogas (CBG) facility in Nauranagbad village, Gandikhata, Haridwar District, Uttarakhand, is a successful business model that other gaushalas (cow shelters) in the area may emulate. Shri Krishnayan Desi Gauraksha and Golok Dham Seva Samiti handle it. Within a 4-6 km radius of the CBG facility, Shri Krishnanayan Desi Gorakhsashala and Golok Dham Seva Samiti have four Gaushalas with 3500-4000 cows.

3.3.4. Hydropower Energy

Pathri powerhouse, Bahadrabad, Haridwar is a HydroElectric Power plant under UJVNL, Uttrakhand, on the Upper Ganga Canal at Bahadrabad, Haridwar. It was constructed in 1955. It has three electricity generating units; each unit produces 6.8 MW of electricity. The UP Irrigation Department regulates the canal discharge based on the irrigation requirements in the command area of the irrigation canal.

3.4 TOURISM

3.5 WETLAND

Wetlands provide many ecosystems and habitats for a variety of species. Wetlands create a one-of-a-kind ecosystem that supports many species simultaneously, including aquatic, terrestrial, and human beings. The district has numerous potential sources and opportunities to harness valuable products through the scheme and launch the pilot project. Local stakeholders rely on the wetland for income and small-scale business. These businesses can be transformed into large-scale production hubs with the right approach. In India, the region is known for its religious significance. However, the region's wetlands have a large variety of turtles also. The data gathered and analyzed demonstrates the region's production and potential products derived from the raw product. The list of sources and the possible products are mentioned below:

- Sugarcane production is high as commercial crops in the region, leading to products that are product-related like sugar, jaggery and other by-products.
- Production of ayurvedic medicinal plants is reasonably high
- Forest products play an essential role in the economy of the district. Besides supplying fuel, fodder, bamboo and medicinal herbs, they also yield various products like honey, lac, gum, resin, catechu, wax, horns and hides.

Lush green forests and small ponds add to the scenic beauty of this holy land.

4 ACTION PLAN DEVELOPMENT

4.1 AGRICULTURE

4.2 FORESTRY

To implement agro-forestry in the urban area as well, ready sampling of native plants is required. It is important for the government to take initiative for establishing nurseries at all major towns in the district and the same nurseries can act as collection centres for the NTFPs. This creates a circular economy effect.

Pradhan Mantri Jan Van Yojana launched in 2018, is a scheme under which tribal people and local people can sell their collected forest products at certain MSPs.

Haridwar is a holy place for pilgrimage as thousands of people around the world visit the city. The local people and forest dwellers can directly open and sell forest products and wood-based products if the government directly provides the outlet and ready to ship product chain. This will directly infuse money into the local economy.

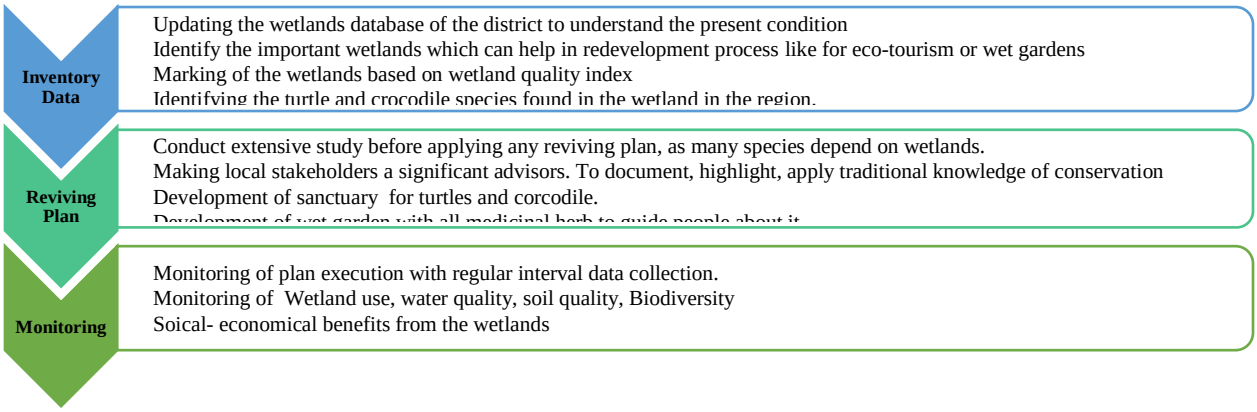
4.2.1 Biodiversity

Forest area has decreased by approximately 2.75% from the year 2017 to the year 2019. Government should take action to know the reason for deforestation and how to reforest those affected forest areas.

4.3 TOURISM

4.4 WETLANDS

Some of the most productive wetland ecosystems are found in this district. They sustain and offer goods and services to millions of people. They support aquatic vegetation and wildlife and a diverse range of bird species, especially migratory birds. Floods are reduced, and groundwater is replenished. They must be looked after, and action must be made on various fronts. The action plan below shows how to protect, conserve, and revitalize extant and extinct wetlands.



4.5 ENERGY

4.5.1 Solar

The concerned authorities have been installing solar energy units in different forms in the district in schools, institutions etc., which is a good indication that people in the district understand about solar energy. The need is to make people aware about the policies of the government so that they could benefit from them according to their requirement. Since the district's economy is dependent on agriculture, farmers should be made aware of Kusum Yojana. Energy requirements for farming should be fulfilled by solar energy, so that there is less burden on the discoms to supply power in the required seasons. Along with Kusum Yojana, The **Mukhayamantri Saur Swarojgar Yojna (MSSY) Scheme should also be brought to the picture. This scgeme should be promoted more and more among the people as it provides an additional source of income. People should be made acquainted with the various types of schemes and educated about the one most appropriate for them.**

The urban and the rural households should also be made aware of the benefits of solar energy. The households should be encouraged to install solar rooftop panels under **Grid connected solar rooftop program, phase –II.** Since the winters are severe in the district, solar thermal energy should also be promoted. Use of solar cookers and solar water heaters should be encouraged. Use of solar room heaters should be encouraged in hotels, restaurants and guest houses. Solar water heaters should be used in industries wherever required. Using solar energy in the maximum possible ways would definitely help the district progress and improve its economy.

PROJECTION AND MONITORING MATRIX

Firstly people in the district should be made aware about the different government policies such as the National Solar Mission, Kusum Yojana and **Mukhayamantri Saur Swarojgar Yojna and the benefits they can get from these policies.**

Secondly, a policy for the remote areas where electrification has yet not been done should be formulated providing financial assistance for the off grid connections.

Thirdly, a survey based study should be conducted to analyze the requirement of different policies in the district and accordingly the promotion and execution should be started as per the requirement.

Fourthly, grid connected solar panels should be encouraged in urban areas, which would add to the grid supply supporting the power production. Also industries should be provided with some amount of financial assistance, especially the MSMEs so that they can easily afford clean and green energy. Along with this the infrastructure development is also important so that people can easily go for the on-grid solar panels.

Lastly, norms should be made for the hotels, restaurants etc., for using solar thermal energy for heating purposes.

4.5.2 Biomass Energy

The state government offers quite a good number of policies for utilizing biomass .The district Haridwar practices agriculture on a large scale and hence produces a good amount of biomass .The district also has rice and sugar mills . In Spite of having the basic requirements for producing biomass energy, i.e the policies and the biomass, the district is not doing well in this sector.The need is to develop an environment which is friendly for setting up biomass plants.

Educating people and making them aware about biomass energy and how they can help the government to use the biomass for producing green and clean energy is also important. Once the people get diverted away from firewood, cow dung cakes and crop residue and start using LPG for their cooking purpose then these can be supplied to biomass plants for the production of biomass energy. The concerned authorities should develop a well connected transportation system so that there is uninterrupted supply of biomass.

The norms should be made such that the price of agricultural residue is feasible for both the farmers and the biomass power plant owners.Since the district has the sugar and the rice mills, the mill owners should be encouraged to produce bioenergy.

Agricultural waste is available only at the time of crop cultivation hence other sources of biomass such as industrial waste, municipal solid waste, food waste etc should be managed so that the availability of biomass is maintained throughout the year.

These biomass plants could be set up somewhere in between the rural and the urban areas, so that the requirement of raw materials is fulfilled and transportation could also be done easily

PROJECTION AND MONITORING MATRIX

First and the foremost thing required is to make people aware of biomass energy by campaigning etc.

Second step should be collecting information about the area specific availability of biomass and the prime location for setting up the biomass plant so that transportation of biomass will be easy and will not hinder the continuous supply of biomass. Further, steps should be taken in developing ease for developing biomass based plant.Since the district cultivates sugarcane, rice,wheat etc., Bagasse based biomass plants and biomass based gasifiers are suggested for the district.

Third step can be developing a proper transport system for collecting and supplying the biomass. Also attention should also be made on storage of biomass during and after the harvest season.

Fourth thing the government can do is provide financial assistance to the people willing to set up biomass energy plants.

These steps together will lead to an all around development of the district in a sustainable manner.

4.5.3 Biogas Energy

A survey should be conducted on areas where biogas plants have been installed to know their existing condition (Are they working efficiently or not?).

4.5.4. Hydropower Energy

The Upper Ganga Segment from Gangotri to Rishikesh might be the ideal potential location in Uttarakhand for capturing hydrokinetic energy using hydrokinetic turbines. This area is surrounded by towering mountains, heights varying from 3000 to 350 meters above sea level. The region features a steep gradient of 15 m per 1 km and high velocities, making it a good location for building hydrokinetic turbines. Government should implement a small hydropower project of 10 MW in this area.

5 RECOMMENDATIONS

5.1 AGRICULTURE AND ALLIED SECTORS

- There is a huge scope for improving the livelihood of local people and regeneration of natural capital through the promotion of organic agriculture, horticulture and agroforestry, and tourism.
- The possibility of evolving an economically viable model of convergence of MGNREGA activities with the concerned line departments would be explored to promote HVCs, including vegetables, to improve the people's livelihood.
- Agriculture R&D and extension services need to be reinvigorated and oriented toward sustainable agricultural practices in the case of HVCs, horticulture, livestock and agroforestry. There is a huge scope for the cultivation of aromatic and medicinal plants and other high revenue generation crops like capsicum, strawberry, the mushroom.
- Agriculture production is vulnerable to natural and market risks. A compulsory and subsidized crop insurance system must be adopted to protect farmers' livelihood and income.
- A new institutional framework needs to be set up at the district level where the concerned line departments' technical, human and financial resources may be pooled or converged together to provide customized solutions to the farmers related to technology, training, marketing needs and other needs advisory services.
- A three-tier framework of agro-processing (primary, secondary and tertiary processing) can be set up to reduce post-harvest losses and generate value addition and local employment. Primary processing can be done at the cluster level, secondary at a local town, and tertiary at SIIDCUL and be well-integrated with the supply chain network.
- The Organic Farming Act is a good initiative, and its provisions should be effectively enforced. A long-term system of incentive as well as regulation may be evolved to retain the existing farmers and motivate others to move towards the sustainable farming system.
- The Bhagwanpur and Bahadrabad blocks observed a deep-water table. Hence, there is high scope for the implementation of micro-irrigation for the horticulture crops.
- In the district, Laksar and Khanpur blocks require a proper subsurface drainage system and crop rotation for the high income of the farmers. The barren lands could be efficiently utilized for the expansion of animal husbandry.
- Mustard and potato are promising crops in the district. Marketing support and R&D intensification can make these crops more remunerative for farmers.

- Drip and Sprinkler irrigation should be introduced for higher water and crop yields.
- Roorkee and Narsan blocks' climate and soil conditions are highly favorable for the cultivation of dragon fruit with the proper irrigation facility, which also generates higher income for the farmers.
- Since it is a religious and holy place, there is scope for expanding flower cultivation.

- Some landowners who migrated and settled elsewhere do not want to give their land to the local farmers. Hence, they keep their small landholdings uncultivated, and such lands become the shelter of wild animals, which quite often damage the crops of nearby farmers.
- The Bhagwanpur and Bahadrabad blocks have no major source of irrigation and observed a deep-water table and difficult to install pumping wells, so most of the crops in these regions are rainfed. Hence, there is high scope for developing a proper irrigation strategy to cultivate the other crops, and also there is a scope for implementation of micro-irrigation for the horticulture crops.
- There is a huge scope for the cultivation of aromatic and medicinal plants for the production of drugs.
- In the districts, Laksar and Khanpur blocks require a proper subsurface drainage system and crop rotation for the high income of the farmers. The barren lands could be efficiently utilized for the expansion of animal husbandry.
- Mustard and potato are promising crops in the district. Marketing support and R&D intensification can make these crops more remunerative for farmers.
- The irrigation is done by only flood irrigation. Drip and Sprinkler irrigation should be introduced for higher water yield and crop yield.
- The high revenue generation crops like capsicum, strawberry, the mushroom could be cultivated widely.
- The districts Roorkee and Narsan's climate and soil conditions are highly favorable for the cultivation of dragon fruit with the proper irrigation facility, which also generates higher income for the farmers.
- Since it is a religious and holy place, there is scope for expanding flower cultivation.
- Agriculture R&D and extension services need to be reinvigorated and oriented toward sustainable agricultural practices suited to the hill areas in the case of HVCs, horticulture, livestock and agro-forestry.
- A three-tier framework of agro-processing (primary, secondary and tertiary processing) can be set up to reduce post-harvest losses and generate value addition and local employment. Primary processing can be done at the cluster level, secondary at a local town, and tertiary at SIIDCUL and be well-integrated with the supply chain network.
- Mass awareness is required for fertilizer application and vermicompost application

- Agriculture production in the district has a high level of variability and is vulnerable to natural factors. To protect farmers' livelihood and income, compulsory and free crop insurance should be provided.
- A new institutional framework needs to be set up at the district level. The concerned line departments' technical, human and financial resources may be pooled or converged together to provide customized solutions to the farmers related to technology, training, marketing needs, and other advisory services.
- The Organic Farming Act is a good initiative, and its provisions should be effectively enforced. A long-term system of incentive as well as regulation may be evolved to retain the existing farmers and motivate others to move towards the sustainable farming system.

5.2 FORESTRY

The current forest percentage 24.8% is lower than National Forest Policy's goal of 33%. The district lacks organizational productivity through the forestry sector. Data unavailability about Timber and NTFP products is a major issue while considering the policy and scheme framework. District is an important tourist attraction in the country. District needs a single window institution for buying and selling these forest products. District currently produces essential oils, bamboo-based products and Sonapatha, Talispatra, Giloe, Chirata which are some of the important medicinal plants. The District's Industrial Development Zone has many industry giants like Hindustan Unilever, Dabur which are involved in FMCG. Government and forest regulators can act as mediators in between corporate and local people to ensure right pricing and trust.

5.2.1. Biodiversity

It is recommended to construct more household biogas plants in rural areas and a centralized municipal solid waste treatment plant in Haridwar city.

5.3 WETLAND

The wetlands must be preserved, but they must also be wisely planned in order to benefit the district economically, socially, and environmentally, resulting in a significant reduction in stress from the Ganga River. It will also reduce the local population's reliance on the Ganga River for small-scale industry or basic daily needs. The following recommendations and interventions are required to obtain valuable products and resolve issues/challenges faced by the people of that region.

- Sugarcane producing farmers need to switch to organic and water-efficient irrigation systems.
- It is recommended to promote animal husbandry in the area. This provides a boost to the economic growth of the local people.

- It is recommended to promote forest areas in the region to support the forest-related industry and wetlands can support the water supply for the cultivation.
- It is recommended to promote eco-tourism in the region as the region can be developed with a wet garden with medicinal herbs around the wetlands area and biodiversity. It will attract visitors and help in the economic growth of the region.
- Development of sanctuary and parks for turtle/crocodile conservation and tourism.

5.4 TOURISM

5.5 ENERGY

5.5.1. Biomass Energy

- ❖ Many people in the district use firewood for cooking, which should be discouraged. People should be made aware about the proper use of biomass generated, instead of burning it directly.
- ❖ Proper arrangements should be made by the concerned authorities so that cooking fuel shifts away from using firewood.
- ❖ A proper channel of biomass collection should be developed. Both the urban and rural areas should be included.
- ❖ Since the district mainly cultivated rice, wheat, and sugarcane, bagasse based power plants and biomass based gasifier plants should be encouraged.

5.5.2 Solar Energy

- ❖ The agriculture sector needs to adapt using solar energy to fulfill its energy requirements. Hence when improvements will be made and the barriers in expansion of solar energy will be removed, the district will automatically flourish sustainably.
- ❖ Kusum Yojana, National Solar Mission and **Mukhayamantri Saur Swarojgar Yojna should be promoted in the district and people should be made aware about it.**
- ❖ Subsidies to the industries, especially cottage and MSMEs,for any one type of connection that is on grid or off grid should be provided..

5.5.3 Biogas Energy

According to the cleanliness index, Haridwar had come down to 285 this year from 246 last year. Waste collection service should be improved in the district by improving infrastructures like

washrooms and garbage bins. A centralized biogas plant needs to be constructed to treat household waste collected by the municipal corporation.

5.5.4. Hydropower Energy

It is recommended to construct a small hydropower plant with a capacity of 5 MW in the upper Ganga segment.

6 Discussion during the Report Presentation

- The district has a large no. of footfalls because its religious importance.
- Ganga Aartis are being conducted regularly.
- NYKS volunteers are very active.
- The fairs/ melas will be utilized to promote Jalaj Model.
- The IIML Report for Arth Ganga should be a regular Agenda item for next 6-8 DGC meetings.
- Hon'ble PM during the post-Budget webinar on Tourism had spoken about market potential of destination weddings. It was suggested that suitable Ashrams in Ganga Basin may be identified for such purpose to promote blissful experience, cost reduction, livelihood opportunities and better upkeep.
- Allocate separate space for Namami Gange Awareness and Jalaj Marketing kiosk in Melas/Congregatios/Fairs for providing better marketing opportunities to the Jalaj products.
- As Dilli Haat Centre – Namami Gange Awareness and Marketing Centre – is being launched soon, it was requested that every district to identify niche products with a creative story and link it with Jalaj in their area.
- To identify Arth Ganga Tourist Trails and organize Ganga Guide training
- Promotion of Natural Farming in Ganga Basin and training workshops should be organized on a regular basis. NMCG is supporting this initiative in coordination with MoA& FW and NCOF.
- Make plans for reuse of treated waste water for agriculture, industrial etc. purpose and also the sludge.
- Training of volunteers for Ganga awareness & Aarti workshops to promote regular aartis on Ghats.

7 REFERENCES

Kala, C. (2015). Medicinal Plants in Active Trade at Haridwar City of Uttarakhand State in India.

Singh, S. (2017). Timber yielding plants of district Haridwar and adjacent siwalik hills .

Times of India. (2021). *Haridwar to get its first city forest along Ganga.*

https://censusindia.gov.in/2011census/dchb/0513_PART_B_DCHB_H

https://agricoop.nic.in/sites/default/files/haridwar.pdf

https://www.orfonline.org/research/energy-news-monitor1/

http://environmentclearance.nic.in/writereaddata/Online/TOR/06_Oct_2018_1314062707KMSE9B4PreFeasibilty_Molasses_uttam.pdf

https://censusindia.gov.in/2011census/dchb/0513_PART_B_DCHB_H

https://ureda.uk.gov.in/dpages/solar-tharmal-schemes

https://energy.economictimes.indiatimes.com/news/renewable/haridwar-ashrams-look-forward-to-co-operating-with-centre-on-boosting-use-of-solar-power/54350593

6 APPENDICES

Table 2 Biogas potential from animal waste.

Livestock	Residue type	Total population as of 2012	Manure yield* (kg/day)	Total manure generation annually (kg)	Average collection (75%)	Dry manure after removing Moisture content	Manure required for biogas* (kg/m^3)	Biogas potential (m^3/yr)
Cattle	Manure	152520	10	55,66,98,000	417523500	83504700	25	3340188
Buffalo	Manure	237205	15	1,29,86,97,375	974023031.3	194804606.3	25	7792184.25
Sheep	Manure	5571	1	20,33,415	1525061.25	305012.25	25	12200.49
Goat	Manure	24398	1	89,05,270	6678952.5	1335790.5	25	53431.62

Pig	Manure	9205	2.5	83,99,563	6299671.875	1259934.375	25	50397.375
Poultry	manure	46,390	0.1	16,93,235	1269926.25	253985.25	25	10159.41
Total		**4,75,289**						**11258561.15**

Table 3 Biogas potential from agricultural waste.

Crop	**residue type**	**Total crop production (tons) (2017-18)**	**Residue production ratio**	**Residue amount (tons)**	**Average collection (70%)**	**Moisture content**	**Residue amount after removing moisture (tons)**	**Biogas potential [m3/(tons of dry matter)]**	**Overall biogas potential (m3)**
Maize	**straw**	1205	1.5	1807.5	1265.25	15	1075.4625	800	860370
Wheat	**straw**	151428	1.5	227142	158999.4	30	111299.58	800	89039664
Sugarcane	**Bagasse**	3910722	0.33	1290538.26	903376.782	80	180675.3564	750	135506517.3
Total		**4063355**							**2254065513**