Arth Ganga Project: District Pauri(Garhwal)

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EXECUTIVE SUMMARY

Pauri(Garhwal) is a district in the state of Uttarakhand, an agrarian economy with adequate precipitation with a high literacy rate and sex ratio is a significant contributor to the state GDP. The rivers Alaknanda, Nayyar embrace the district.

The total geographical area of the district is 5,329 Km^2, out of this the permanent pastures are 35200 ha, the Cultivable wasteland is 38500 ha, and the Land under non-agricultural use constitutes 15500 ha. The district is divided into three agro-climatic zones depending upon soil characteristics and topography. The major soil types are Alluvial mixed with boulders and shingles, Alluvial sandy soil, residual sandy loam, sandy loam, Red to Dark. With the net sown area of 78486 ha and gross cropped area of 110875 ha, the Cropping intensity of the district is 141.26%. The net irrigated land area is 7800 ha. The major crops types are Barnyard millet, Wheat, Finger millet, Barley, etc. Among the horticulture crops are apple, peach, plum, citrus fruits, dry fruits, pea, potato, tomato, etc. The livestock consists of cattle, buffalos, goats, sheep; along with poultry. Different farming systems exist in the district divided into 5 categories by their position. The tertiary sector of the district economy is the largest contributor, with an increased share from 51.89% in 2011-12 to 56.62% in 2016-17 with an average annual growth rate of 8.54%. The primary sector's share went down from 18.86% in 2011-12 to 13.41% in 2016-17, with an annual average growth rate of - 0.40 percent. Fishery and livestock had an average annual growth of 5.46 percent and 5.1 percent respectively. The share of cultivable wasteland and current fallow increased to 6.36% and 2.24% respectively in 2015-16.

Sonanadi Wildlife Sanctuary and Rajaji National Park are two main centers of eco-tourism. Chilla Wildlife Sanctuary is also another place with rich biodiversity and tourist attraction along with a few temples and sites that are aesthetically sound. The total forest area constitutes 63.71% of the total geographical area, out of which, 547.26 Km^2 are very dense forests, 1902.03 Km^2 are moderately dense forests, and 918.7 Km^2 are open forests. Forestry & logging grew at the rate of less than one percent during 2011-17. Forest plantation has decreased from 13.26% to 11.91% whereas open forest has increased from 43.13% to 45.71%. The scrubland has slightly decreased. The water bodies have increased from 1.23% to 1.48%. The total number of flora and fauna observed in the district is 1845 whereas the total number of species present is 724. The district has a rich biodiversity. The district comprises 76 wetlands (rivers/streams). The wetland size is large in general, the number of natural wetlands is high.

The main source of lightning is electricity (89.04%) whereas the main source of fuel is firewood (47%) followed by LPG/PNG (38%). Installation of 761 solar cookers and different solar power plants, two solar power plant projects, have been set up in Uregi village, Mukhyamantri Saur Swarojgar Yojana, etc. shows the government's effort to enhance the use of solar energy. The district has a high biomass potential as well as biogas production which

is calculated approximately as 83 m^3/year and 19 crores m^3/year from animal and agricultural waste, respectively. The district has 4 biomass energy plants. There are many ongoing and developing hydropower projects on different streams/rivers such as Alaknanda, Ganga, Ramganga, etc.

The implementation of various schemes, promoting local participation, taking measures for utilization of timber products and cultivating medicinal plants, increasing irrigation, improving storage and transportation, creating awareness, horticulture, agroforestry, organic farming, etc. can aid the overall development of the district.

1 DISTRICT OVERVIEW

1.1 INTRODUCTION

District Pauri is situated in the south-western part of the state of Uttarakhand. It lies between latitude 29º26' and 30º19' north and longitude 78º12' and 79º14' east. The maximum length from east to west is 103 km. and the maximum breadth from north to south about 100 km. Total geographical area of the district is 5,329 sq km. Administration wise the district is divided into 15 development blocks namely, Kot, Kaljikhal, Pauri, Pabau, Bironkhal, Dwarikhal, Dugadda, Jaihrikhal, Ekeshwar, Rikhnikhal, YamkeshwarNainidanda, Pokhra and khirsu. Moreover, it comprises 9 sub-districts, 8 towns, and 3473 villages. The total population of the district is 697,078 in which 607,203 live in rural areas and the rest 89,875 in urban areas.

The economy of the district depends on Agriculture, Horticulture, Livestock, Forest, Mining, Manufacturing, Hospitality and other miscellaneous sectors. Agriculture sector and daily wages labor contributes to the major employment of the district with 38.81% and 38.67% respectively. The district‟s GDP contributes nearly 4.23% to the state's GDP. District Pauri stands at number five, after Haridwar, Dehradun, U. S Nagar, and Nainital contribute to the state's GDP. Even though the district accounts for 10.17% of the total geographical area of the state and is the fifth most populated district, it accounts for only 4.23% of the state's GDP. Further, the MPCE (Monthly Per Capita Consumer Expenditure) for Pauri (rural) is Rs.1294.87 and for Pauri (urban) is Rs.2145.62, which is lower than the state and national average. . In the total population of the district of 697,078 as much as 38.7 per cent are workers and the rest of 61.3 % are non-worker. Among w-orkers 24.6 percent are main workers and the rest 14.1% are marginal workers of the total population.

Primary sector comprises Agriculture, Horticulture, Livestock, Fisheries and other allied activities, Forest Produce, Quarrying and Mining. Although nearly 40% of the population is engaged in Agriculture and allied activities, the contribution of this sector has reduced significantly over the years. The farmers now appear to see farming as a non-profitable venture. The chief agricultural products in the district are wheat, tea, maize, oilseeds, barley, etc.

.Secondary sector includes Manufacturing, Construction, and Processing etc. It contributes around 30% to the District‟s GDP and has increased from the 2004-05 figures. This is mainly due to the establishment of the Industrial Growth Centre SIDCUL at Sigaddi, Kotdwar. As per the Industrial Profile of District PauriGarhwal, Ministry of MSME there are a total of 6,272 numbers of registered units in Pauri as of 2016, giving permanent and semi-permanent employment to around 20,000 people.

Tertiary sector includes Hotels, Restaurants, Tourism, Tour & Travels and other Services. This sector contributes the largest share to the District‟s GDP, around 54%. This suggests that the majority of the population is either engaged in a salaried job or in Service sector business. The per capita income for the District Pauri is Rs.1,09,973, which is considerably lower than the state‟s average of Rs.1,61,102 (2016-17). In Pauri, around 29.36% of population is below the poverty line, which is highest in the state whereas, TehriGarhwal has the lowest percentage of 10.15%

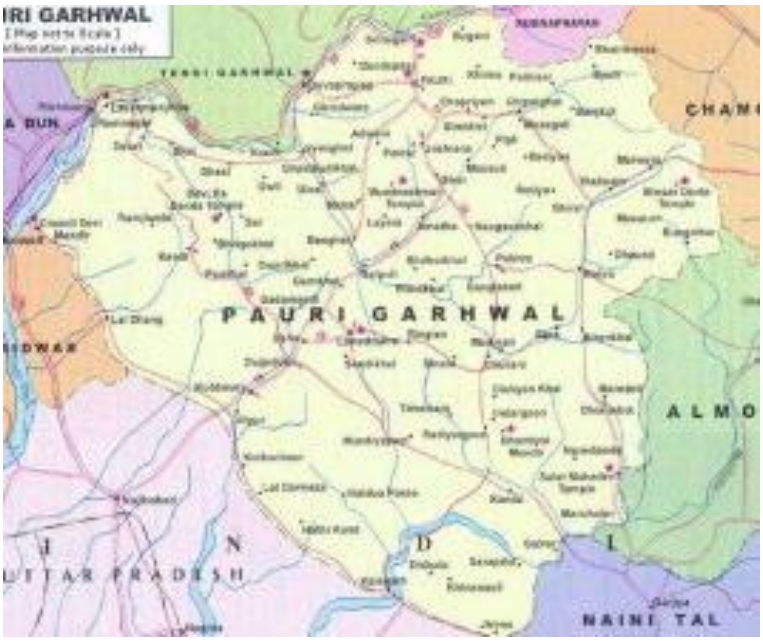


Figure 1 Map of the district

1.2 DEMOGRAPHIC PROFILE OF PAURI (GARHWAL)

Geographic area: 5,329 Km^2
Altitude: 1814 m
Rainfall: 1026.9 mm
Forest area: 3394.99 Km^2
Rivers: Alaknanda, Nayyar.

Administrative Divisions:

District Headquarter	Pauri
No. of Subdivisions	9
No. of Blocks	15
No. of Villages	3473

Demographic and Socio-economic Parameters:

Population	6,87,271
Population Density	225 / Km^2
Sex Ratio	1103
Literacy	82.02% 4
Occupation/Livelihood	Agriculture

Table 1 demographic overview

The economy of the district is mainly dependent on agriculture. Most of the lands in the district are used for agricultural purposes. More than half of its population are engaged in agriculture in order to earn their livelihood. The chief agricultural products in the district are wheat, tea, maize, oilseeds, barley, potato, onion, lemon, apple, mango, peas, etc. The district is rich in mineral resources as well. Limestone, iron, copper, gold, gypsum, etc are some of the commonly found mineral resources in the district. The district is scantily industrialized, but the State Industrial Development Corporation of Uttarakhand (SIDCUL) has promoted some large and small industrial units. Some of the foremost industries in the district are Shree Sidhbali Industries, Wipro Ltd, Simpex Pharma, Sri Sri Ayurveda, etc. In the year 2016-17 the gross domestic product in the district was Rs. 8,28,356 lakh at current price and Rs. 6,72,885 lakh at constant prices in the year 2011-2012. The net domestic product in the district during the period 2016-17 was Rs. 7,37,696 lakh at current price and Rs. 5,94,147 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. 1,09,973 at current price and Rs. 88,574 at constant prices in the year 2011-2012.

The district is well-known as an abode of several reputed educational institutions. It provides a platform for higher education. Some of the recognised educational institutions in the district are Govind Ballabh Pant Engineering College, Hemwati Nandan Bahuguna Garhwal University, Veer

Chandra Singh Garhwali Government Medical College, National Institute of Technology Uttarakhand, etc.

1.3 AGRO CLIMATIC PROFILE OF THE DISTRICT

1.4 ECONOMIC PROFILE OF PAURI (GARHWAL)

The tertiary sector of the district economy is the largest contributor, whose share in GDDP has increased from 51.89% in 2011-12 to 56.62% in 2016-17. The average annual growth rate of the sector was highest at about 8.54%. The share of the secondary sector in the DGDP has a marginal rise from 29.25% in 2011-12 to 29.97% in 2016-17. It grew at an average rate of 7.10% per annum. The primary sector has constantly been declining in terms of its share in DGDP. The share went down from 18.86% in 2011-12 to 13.41% in 2016-17, with an annual average growth rate of - 0.40 percent. It indicates that the entire increase in the share of the tertiary sector is due to a decline in the primary sector as the share of the secondary sector has remained almost constant. Overall, the district economy recorded an average growth rate of 6.59 percent per year, though it varies across years. The per capita income of the district went up from Rs.70456 in 2011-12 to Rs.100312 in 2016-17, with an average annual growth rate of 7.34%. From the statistics, it is clear that the economic condition of the people depending on the primary sector has weakened with vis-a-vis the other two sectors.

Table 1: Trends in Gross District Domestic Product and Per Capita DGDP in Pauri Garhwal 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	90209	139907	248236	478352	-	-	-	-	70456	-
	(18.86)	(29.25)	(51.89)	(100)						
2012-13	91992	151090	253491	496573	1.98	7.99	2.12	3.81	73366	4.13
	(18.53)	(30.43)	(51.05)	(100)						
2013-14	93159	162698	293075	548932	1.27	7.68	15.62	10.54	81473	11.05
	(16.97)	(29.64)	(53.39)	(100)						
2014-15	87271	169711	326738	583720	-6.32	4.31	11.49	6.34	87010	6.80

	(14.95)	(29.07)	(55.98)	(100)						
2015-16	86728	184598	345790	617117	-0.62	8.77	5.83	5.72	93176	7.09
	(14.05)	(29.91)	(56.03)	(100)						
2016-17	88217	197071	372316	657604	1.72	6.76	7.67	6.56	100312	7.66
	(13.41)	(29.97)	(56.62)	(100)						
Average growth rate					-0.40	7.10	8.54	6.59		7.34
Source: UKDES Note: Figures in Parentheses are percentage share in the total GDDP										

The primary concern of the study is agriculture and activities related to it. Hence, we get detailed information on the primary sector GDP to determine which sub-sector is going down and which is rising within the primary sector. As far as sub-sectoral growth of agricultural and allied sectors is concerned, we observe that agriculture, including horticulture, declined by 3.97 percent per year during 2011-12 and 2016-17. Consequently, the share of the agricultural sector went down from 38% to 29%, with a straight decline of nine percent during 2011-12 and 2016-17. Fishery and livestock had a remarkable average annual growth of 5.46 percent and 5.1 percent, respectively. Forestry & logging grew at the rate of less than one percent during the period.

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

Year	Agriculture	livestock	Forestry & logging	Fishery	Total Agri & allied	Mining & Quarrying	Primary Sector
2011-12	30938	22098	28275	49	81360	8849	90209
	(38.03)	(27.16)	(34.75)	(0.06)	(100)		
	-	-	-	-	-	-	-
2012-13	35761	23745	27504	50	87059	4933	91992
	(41.08)	(27.27)	(31.59)	(0.06)	(100)		
	[15.59]	[7.45]	[-2.73]	[2.04]	[7]	[-44.25]	[1.98]
2013-14	33225	25196	28951	36	87408	5752	93159
	(38.01)	(28.83)	(33.12)	(0.04)	(100)		
	[-7.09]	[6.11]	[5.26]	[-28]	[0.4]	[16.6]	[1.27]
2014-15	25654	24943	27527	51	78175	9096	87271
	(32.82)	(31.91)	(35.21)	(0.07)	(100)		
	[-22.79]	[-1]	[-4.92]	[41.67]	[-10.56]	[58.14]	[-6.32]
2015-16	23892	27590	28422	56	79960	6768	86728
	(29.88)	(34.50)	(35.55)	(0.07)	(100)		
	[-6.87]	[10.61]	[3.25]	[9.8]	[2.28]	[-25.59]	[-0.62]
2016-17	24203	28230	29101	57	81591	6626	88217
	(29.66)	(34.60)	(35.67)	(0.07)	(100)		
	[1.3]	[2.32]	[2.39]	[1.79]	[2.04]	[-2.1]	[1.72]
Average growth	-3.97	5.1	0.65	5.46	0.23	0.56	-0.4

Source: Compile from UKDES
Note: 1. Figures in () are percentage share in the total agriculture & allied GDDP
2. Figures in [ ] are annual growth rates.

Livestock, forestry & logging, and Fishery (allied activities) are the growth drivers of the primary sector, while agriculture is pushing down the growth of the agriculture & allied sectors. Can crop and horticulture sectors be the district's rural economy's growth drivers? Or should a sustainable development model for growth rely more on livestock, forestry, and Fishery? Can organic farming initiatives by the government through PKVY and Namami Gange programmes 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 each other? To get the answer to these questions, we need to get feedback from the district administration.

It needed to be studied the factors that affect agriculture growth. It should be concerned which programmes of the government will be able to support the agriculture sector growth and uplift the level of livelihood of the people in the district. The district administration feedback is necessary to find the impact of the various programmes and sustainable development of the district's primary sector.

Table 3 demonstrates the percentage share of sub-sectors within the secondary and tertiary sectors. Within the secondary sector, the share of manufacturing has increased from 68.52% in 2011-12 to 70.80% in 2016-17, while construction's share decelerated from 20.73% to18.71% during the same period. 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, repair, hotels and restaurants constituted the highest share (23.98%), followed by public services (21.86%), other services (20.86%) and transport, storage and communication (16.10) in 2016-17. The average annual growth rate is observed highest (12.89%) in other services, distantly followed by transport, storage and communication (9.76%), financial services (8.51%), public services (8.26%), and trade, hotels and restaurants (8.03%). Overall, the district economy is driven by the growth of non-agriculture sectors as agriculture recorded negative growth.

Table 3: Trends in percentage share of non-agriculture sub-sectors in DGDP 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	Public administration	Other services	Tertiary
2011-12	68.52	10.76	20.73	100	15.16	24.45	8.33	9.73	25.06	17.27	100
2012-13	70.78	10.71	18.51	100	16.20	26.21	8.80	10.35	17.46	20.98	100
2013-14	68.17	10.03	21.79	100	15.27	24.63	8.33	8.75	21.68	21.33	100
2014-15	68.43	10.40	21.17	100	15.36	23.64	8.30	9.01	23.21	20.48	100
2015-16	70.05	10.31	19.64	100	16.08	23.85	8.51	8.91	22.91	19.75	100
2016-17	70.80	10.49	18.71	100	16.10	23.98	8.35	8.85	21.86	20.86	100
Av. Annual Growth Rate (%)	7.85	6.59	5.44	7.1	9.76	8.03	8.51	6.56	8.26	12.89	8.54
Source: Estimated from statistical handbooks											

1.5 The Livelihood Status

Table 4 shows the livelihood status of the workforce in Pauri Garhwal district and Uttarakhand. In 2017, approximately 47% of workers were self-employed, while the corresponding figure for the state is 56.9% which indicates the lower rate of self-employed persons in the district than the state. The major difference is observed in regular employment, which was higher in the district (35.8%) than in Uttarakhand (24.2%). Casualization of the workforce is slightly higher in the state (18.9%) than in the district (17.3%). The poverty status of the district (approx. 15%) is almost similar to that of the state.

Sectoral distribution of employment reveals that the primary sector dominates the district economy. Against 39.3 workers engaged in the primary sector in the state, the corresponding percentage in the district is 53.2%. Contrary to this, the secondary sector contributes only 14.6% to the total workers. In comparison, its share in the state is 25.4%, but tertiary sector contribution in the total employment is 32.2%, almost near the state's average (35.3%). Thus, taking employment and GDP together, we can infer that the economic condition of workers in the primary sector is poorer vis-à-vis other sectors.

Table 4: Livelihood Status in Pauri Garhwal (2017)

Employment Status			Sectoral distribution of employment			Distribution of workers by Skills		
	Pauri Garhwal	State		Pauri Garhwal	State	Skill	Pauri Garhwal	State
Self-employed	46.9	56.9	Primary	53.2	39.3	Low	14.4	24.9
Regular	35.8	24.2	Secondary	14.6	25.4	Medium	73.6	65.5
Casual	17.3	18.9	Tertiary	32.2	35.3	high	12	9.6
Total	100	100	Total	100	100	Total	100	100
Poverty status	14.8	15.6	Inequality (Gini Coeff.)	0.319	0.308			
Source: Uttarakhand Human Development Report								

The distribution of workers by their skills-set indicates that only 12% of workers in the district and 9.6% in the state come under the high skills category. The majority of them fall under the medium and low categories. Poverty and inequality are lower in the district than in the state.

Highlights-1

The primary sector plays a significant role in the district economy, with almost 53% workforce engaged in it, although its contribution to the district GDP is less than 13.41% in 2016-17.

The crop sector recorded negative growth during 2011-2017, while livestock, forestry, and fisheries achieved positive growth.

Within the secondary sector, manufacturing recorded the highest average annual growth (7.85%), followed by electricity, gas, water supply (6.59%), and construction (5.44%).

In the tertiary sector, other services recorded the highest growth (12.89%), followed by transport, storage, communication (9.76%).

Manufacturing contributed about 70% of the secondary sector's GDP in 2016-17, and its share has increased marginally over the period.

Construction contributes about 19% of the secondary sector's GDP and electricity, gas, water supply contributes about 10%.

Within the tertiary sector, trade, hotels and restaurants have the

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 and statistical data compiled from the District Statistical Handbooks of Pauri Garhwal. As per the GIS-based data (see Figure 1 and Table 5), between 2010 and 2020, the area under agriculture as a percentage of the total geographical area had decreased from 7.65% in 2010 to 5.98% in 2020. Forest plantation has decreased from 13.26% to 11.91%, whereas open forest has increased from 43.13% to 45.71%. There is no significant change in the dense forest during the period and the share of dense forest is approximately 34%. The scrubland has slightly decreased. The water bodies have increased from 1.23% to 1.48%, which may be attributed to the water management activities. There is a significant change in the built-up area, and it had increased from 0.11% in 2010 to 0.17% in 2020. This change indicates that the construction activities have increased in the district.

Table 5: Land use/land cover Statistics classes of Pauri Garhwal district

LULC classes	Area(km^2) Year-2010	Area(km^2) Year-2020
Crop-land	420.47 (7.65)	328.44 (5.98)
Forest plantation	728.76 (13.26)	654.84 (11.91)
Open forest	2370.86 (43.13)	2512.7 (45.71)
Dense forest	1876.82 (34.15)	1889.71 (34.38)
Scrubland	25.74 (0.47)	20.59 (0.37)
Builtup land	6.20 (0.11)	9.09 (0.17)
Water bodies	67.73 (1.23)	81.21 (1.48)
Total Geographical area	5496.58	5496.58

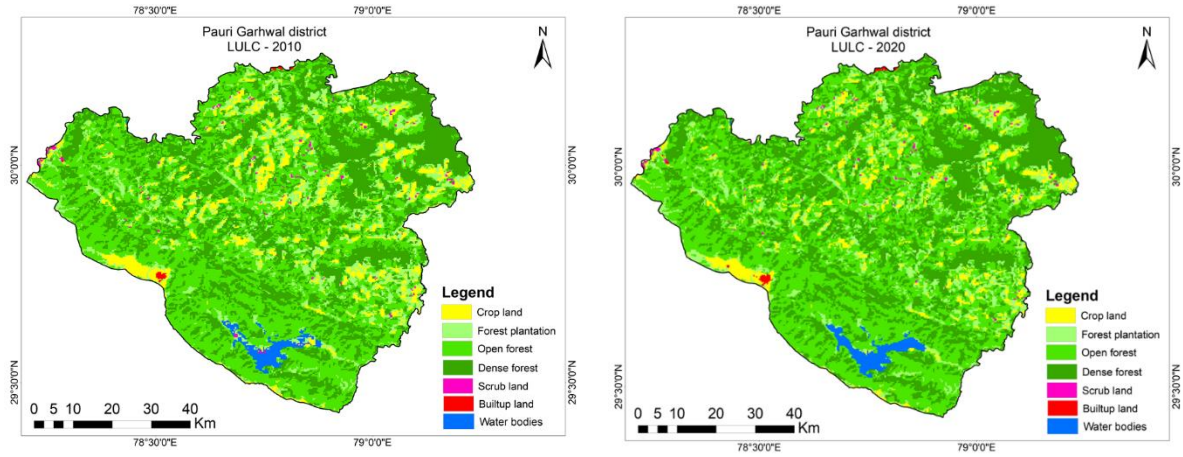


Figure 1: Land use/land cover map of the Pauri Garhwal district for the years 2010 and 2020

We notice some discrepancies when the GIS-based data are compared with the data compiled from the district statistical handbooks. The GIS-based map shows 5496.58square kilometers of the geographical area of the district, while the handbook shows 6690.55 sq.km reported area of the district.

Forest area constituted 57.56% of the total reported area, and it remained constant during the period. The share of cultivable wasteland has increased from 4.79% in 2008-09 to 6.36% in 2015-16. Share of current fallow has also increased from 1.3% to 2.24%. Similarly, other fallow-land, land other than agriculture, and pasture land have a slight increase in their percent areas. The net sown area has declined from 11.69% in 2008-09 to 9.28% in 215-16. Barren and uncultivable land and area under trees and gardens have slightly decreased during the period. Overall, the land-use pattern does not manifest any visible change during the last seven years.

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

Year	Total Reported Area (ha)	Area under forest	Cultivable wasteland	Current Fallow	Other Fallow	Barren and uncultivable land	Land other than agriculture use (%)	Pasture land	Area under trees and gardens	Net Sown Area
1	2	3	4	5	6	7	8	9	10	11
2008-09	669055	57.56	4.79	1.30	3.28	5.13	2.38	4.98	8.89	11.69
2009-10	669055	57.56	5.37	0.30	4.05	4.99	2.39	5.13	8.82	11.40
2010-11	669055	57.56	5.38	1.58	3.54	5.00	2.40	5.13	8.96	10.45
2011-12	669055	57.56	5.00	2.00	3.45	5.13	2.41	5.13	8.97	10.10
2012-13	669055	57.56	6.35	1.80	3.78	5.10	2.54	5.08	8.03	9.76
2013-14	669055	57.56	6.35	1.88	3.78	5.10	2.54	5.08	8.03	9.69

2014-15	669055	57.56	6.35	2.18	3.80	5.10	2.54	5.08	8.03	9.36
2015-16	669055	57.56	6.36	2.24	3.81	5.10	2.55	5.07	8.03	9.28
Source: Prepared from District Statistical Handbooks of Pauri Garhwal										

2.1.2 Trends in Operational Land Holdings

In Pauri Garhwal district, the total number of operational holdings has decreased from 84429 in 2010-11 to 79410 in 2015-16, a net decline of 5.94 percent, while 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 holdings together constituted 95.26% 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 (No.)
Pauri Garhwal	2010-11	62.77	25.76	9.50	1.90	0.07	84429
	2015-16	77.17	18.09	4.4	0.32	0.01	79410
							[-5.94]
Uttarakhand	2010-11	73.65	17.24	7.1	1.9	0.12	912650
	2015-16	74.78	16.89	6.59	1.64	0.1	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 the Cropping pattern

The agriculture of the district economy is dominated by food grains. Table 8 shows the trend in the area under principal crops during the last 7 years. Rice, wheat, and ragi comprise the largest share (66.78%) in the gross cropped area (GCA) in 2009-10, which declined to 59.15 percent in 2015.16. All cereals (rice, wheat, barley, maize, ragi and saava, etc.) have 83-89 percent of the GCA of the district, except for the years 2013-14 and 2014-15, when it is around 55 % of the GCA.

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

Crop/Year	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16
Rice	17.83	16.61	16.29	16.22	15.24	15.61	15.20

Wheat	26.75	27.30	25.78	23.75	24.56	22.35	20.37
Barley	5.55	8.31	6.16	6.21	6.62	6.64	6.01
Maize	1.98	1.89	2.48	2.22	2.29	2.52	2.82
Ragi	22.20	22.03	22.06	23.05	21.68	22.12	23.58
Saava	15.30	15.95	15.61	15.49	16.23	14.74	14.82
Total Cereal	89.62	89.48	88.39	86.94	55.77	55.28	83.29
Urad	2.95	3.18	3.62	2.67	4.22	4.53	4.91
Masoor	0.80	0.93	0.86	1.56	0.86	1.10	0.93
Arhar	0.16	0.42	0.16	0.32	0.24	0.39	0.74
Total Pulses	4.07	4.67	4.76	4.58	8.04	9.09	9.84
Total Foodgrain	93.69	94.15	93.15	91.52	95.03	93.56	93.13
Mustard	0.69	1.16	1.23	1.26	1.19	1.83	1.44
Soyabean	0.25	0.37	0.39	0.33	0.35	0.38	0.57
Total Oil Seeds	1.03	1.61	1.68	1.65	2.28	2.26	2.05
Potato	0.62	0.43	0.43	0.48	0.44	0.63	0.97
NSA (% of GCA)	72.25	67.61	68.88	68.25	70.98	67.12	75.38
GCA(ha)	105576	103452	98105	95715	91331	93294	82364
Cropping Intensity	138.41	147.90	145.18	146.52	140.88	148.98	132.66
Source: Estimated from District Statistical Handbooks							

Pulses consisted of about 4 to 10 percent share in the total cropped area. Overall, food grains shared over 93.13 percent of GCA in 2015-16. The share of oilseeds is only about two percent. In addition to food gains and oilseed, potato is another important crop and contributed less than 1 percent to the GCA in 2015-16.

ii. Trends in Per Hectare Yield of Principal Crops

Crop yields in the district are quite low. The per hectare yield of rice was as low as 10.78 qtls/ha in 2009-10 and as high as 13.38 qtls/ha in 2015-16. Similarly yield of wheat ranges between 9.04 to 11.01 qtls/ha during 2009-10 to 2015-16. A more or less similar pattern is also observed in the case of barley. Table 9 depicts that maize yield has improved in recent years. It is significant to note that the average productivity of ragi has been higher than that of rice and wheat. Relatively being a high-value crop, it has the potential to raise the farmers' income if proper marketing support is provided to the farmers. Another high nutrition and value crop is saava, which has a higher yield than rice and wheat, as demonstrated by Table 9. Marketing support and R&D intensification can make these crops more remunerative for farmers.

Among pulses, per hectare yield is higher in arhar than other crops, followed by urad. Arhar constituted one percent of GCA. Among oilseeds, soybean is an important crop. Its yield ranges between 7 to 8 qtls/ha. Since per quintal soybean prices are higher than that of rice and wheat, its cultivation can provide a better return to the farmers. Potato is another high-value crop in the district. Its yield ranges between 90.55 to 93.9 qtsl/ha. Thus, ragi, saava, urad, soybean and potato are promising crops for farmers of the district.

Table 9: Trends in Per hectare productivity of Main Crops (in Quintals)

Crop/Year	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16
Rice	10.78	10.85	11.54	11.91	12.86	11.91	13.38
Wheat	9.04	11.65	12.79	16.25	13.67	12.06	11.01
Barley	9.43	10.82	10.63	14.2	12.33	11.31	9.92
Maize	8.51	8.75	9.01	11.58	10.19	17.54	18
Ragi	11.13	11.79	13.11	16.66	12.66	13.6	13.92
Saava	11.27	11.03	12.64	14.4	12.21	12.27	12.29
Total Cereal	10.3	11.31	12.36	14.95	12.64	12.55	12.65
Urad	6.13	8.18	8.88	15.88	7.23	6.16	3.0
Masoor	6.61	5.29	5.96	6.91	6.31	5.04	3.7
Arhar	7.5	6.13	7.14	10.72	8.71	8.73	5.0
Total Pulses	6.18	7.38	8.26	12.44	7.32	6.49	4.87
Total Foodgrain	10.12	11.12	12.15	14.83	11.97	11.96	11.82
Mustard	3.75	5.6	5.25	8.85	5.24	5.25	5.24
Soybean	7.0	7.17	2.45	11.69	6.17	2.8	8.0
Total Oil Seeds	4.38	5.79	4.49	9.44	5.27	4.84	5.96
Potato	90.55	89.53	104.43	69.52	90.83	91.4	93.9
Source: District Statistical Handbook							

iii. Trends in Production of Principal Crops

Table 10 depicts that among the individual cereal crops, ragi consisted of the highest production (27051 tons), followed by wheat (18483 tons) and rice (16757 tons). These three crops had a 71.77 percent share in the total cereal production in 2015-16. Among pulses, urad had the highest share (30.72%) in the total pulses production. In oilseed production, mustard is the main crop which comprised about 62 percent share in the total oilseed production in 2015-16. Potato production was highest (7503 tons) in 2015-16 and lowest (3212 tons) in 2012-13 and 2013-14.

Table 10: Trends in Production of Principal Crops (in metric tons)							
Crop/Year	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16
Rice	20304	18646	18438	18496	17909	17359	16757
Wheat	25523	32893	32345	36938	30675	25147	18483
Barley	5524	6382	6426	8437	7450	7004	4907
Maize	1781	1708	2195	2460	2136	4118	4183
Ragi	26100	26877	28377	36762	25075	28065	27051
Saava	18202	18202	19361	21352	18243	16881	15000
Total Cereal	97434	104708	107142	124445	102822	98961	86790
Urad	1909	2691	3156	4050	2789	2604	1213
Masoor	557	508	505	1031	499	518	287
Arhar	130	268	110	329	216	315	305
Total Pulses	2654	3564	3855	5453	8483	5511	3948
Total Foodgrain	100088	108272	110997	129898	111305	104472	90738
Mustard	275	674	632	1070	569	896	623
Soyabean	186	274	93	373	199	99	375

Total Oilseeds	477	964	739	1491	1180	1024	1008
Potato	5913	3966	4428	3212	3212	5384	7503
Source: District Statistical Handbooks							

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 ragi (7.06%), closely followed by maize (7.93%), saava (9.89%), rice (13.53 %) and wheat (17.55%). It is observed highest in Arhar (50.56%), followed by masoor (26.19%) and total cereal (24.59%). Overall, the area under pulses has more variability than the area under cereals and oilseeds (Table11).

Table 11: Variability in Area, Production and Yield of Principal Crops (2009-10 to 2015-16)

Crop/Year	Area			Production			Yield		
	Av	SD	COV	Av	SD	COV	Av	SD	COV
Rice	15503	2097	13.53	18273	1126	6.16	11.89	0.97	8.12
Wheat	23511	41263	17.55	28858	6185	21.43	12.35	2.25	18.24
Barley	6231	1121	17.99	6590	1180	17.91	11.23	1.61	14.32
Maize	2196	174	7.93	2654	1053	39.68	11.94	4.12	34.5
Ragi	21399	1510	7.06	28330	3883	13.71	13.27	1.79	13.48
Saava	14797	1463	9.89	18177	1969	10.83	12.3	1.1	8.91
Total Cereal	75461	18555	24.59	103186	11473	11.12	12.39	1.43	11.53
Urad	3519	584	16.58	2630	899	34.18	7.92	3.99	50.31
Masoor	961	252	26.19	558	226	40.59	5.69	1.11	19.44
Arhar	323	163	50.56	239	90	37.47	7.7	1.88	24.46
Total Pulses	6014	1874	31.16	4781	1926	40.27	7.56	2.4	31.79
Total Foodgrain	89439	7460	8.34	107967	12059	11.17	12	1.44	11.97
Mustard	1190	285	23.95	677	252	37.2	5.6	1.55	27.76
Soybean	356	64	18.03	228	117	51.25	6.47	3.16	48.92
Total Oil Seeds	1696	344	20.26	983	320	32.56	5.74	1.74	30.34
Potato	539	147	27.2	4803	1569	32.66	90.02	10.38	11.53
Source: District Statistical Handbooks									

2.1.4 Consumption of Chemical Fertilizers

Table 12 shows that the consumption of nitrogen ranges between 0.19 kgs/ha to 5.04 kgs/ha of GCA. Phosphorous use ranges between 0.06 khs/ha to 1.78 kg/ha of GCA. The use of potassium is almost zero. Total fertilizers use ranges from 0.25 to 6.75 kh/ha of GCA. It can be inferred from the fertilizers consumption data that though the quantity of chemical fertilizers used in agriculture varies across years, the per hectare use of fertilizer is almost negligible in district agriculture. It implies that farmers of the district have the natural advantage of practicing chemical-free agriculture.

Table 12: Trends in Use of Chemical Fertilizers in Agriculture (Kgs/per ha GSA)

Fertilizer/Year	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16
Nitrogen	2.21	3.77	2.91	3.67	3.70	4.17	0.19	5.04
Phosphorous	1.04	1.78	1.41	1.37	1.27	1.41	0.06	1.56
Potassium	0.14	0.37	0.27	0.32	0.19	0.13	0.01	0.16
Total	3.39	5.92	4.59	5.36	5.15	5.71	0.25	6.75
Source: District Statistical Handbooks								

2.1.5 Irrigation Structure and Status

Being the hilly region, the possibility of groundwater extraction for irrigation is almost nil. Only surface irrigation structure exists in the district. Table 13 shows no progress in adding the length of canals during the last nine years. The length ranges between 829 to 836 kilometers. The number of water tanks has increased from 5883 in 2008-09 to 6754 in 2015-16, a net increase of 871 tanks. Length of *Gool* has increased from 3252 Kms in 2008-09 to 4447 Kms, a net increase of 1195 kms during the period. The number of high drums stood 217 from 2008-08 to 2014-15 and decreased to 184 in 2015-16 (Table 13).

Agriculture in the district is mostly under rain-fed conditions. The net cultivated area under irrigation ranges from 9.26 to 10.34 percent and gross irrigated areas from 12.21 to 13.83%.

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

Name/Year	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17
Length of Canals (km)	836	836	836	829	829	831	831	831	831
No. of Government Tube-wells	35	37	40	45	47	48	49	51	55
No. of Ground-level Pump sets	0	2	2	2	2	4	5	5	7
No. of Tanks	5883	6099	6241	6429	6539	6593	6593	6754	-
Gool in km	3252	3308	3586	4064	4256	4293	4293	4447	-
No. of High drums	217	217	217	217	217	217	217	184	-
% of NIA	9.41	10.32	9.96	10.06	9.81	9.26	10.34	9.94	-
% of GIA	12.77	13.66	12.58	12.75	12.85	13.21	13.83	12.21	-
Source: Compiled from District Statistical Handbooks									

2.1.6 Out-Migration and Agriculture

Due to lop-sided development in the state during the post-statehood period, the intensity of out-migration has increased (Mamgain & Reddy, 2015). Moreover, out-migration has been gradually changing from seasonal or temporary to permanent, having far-reaching consequences for the rural economy. The exodus makes it difficult for the remaining people to do farming as cultivated land intersperses with inactive uncultivated land. There is a vicious cycle between out-migration and agriculture. Since agriculture is not remunerative and can generate gainful employment, the youths

out-migrate in search of better livelihood options. It leads to the abandonment of agriculture to a greater extent.

Tourism is a key growth driver of the district economy. It can be integrated with promoting 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 hill region is quite high. 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 check the out-migration and work as a multiplier in the local economy, generating additional employment avenues in the non-farm activities. There are three deterrents—out-migration, the menace of wild animals and interspersing of cultivated landholding with inactive and abandoned landholding. 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 82 percent of the total first-time migrant in Pauri Garhwal migrated alone and about 12 percent with family members (Table 14).

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

	Migrated alone	Migrated with family members	Migrated with members of community/ Village	With quittances/Friends (other than col 4)	Middle men/ contractors	Any other	Total
1	2	3	4	5	6	7	8
Pauri Garhwal	82.3	12.3	3.2	1.1	1.1	0.0	100
UK	72.1	18.0	6.6	2.6	0.1	0.6	100

Source: Uttarkhand 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 is 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. The hill districts of the state, including Pauri Garhwal, have the natural advantage of organic farming as per hectare use of chemical fertilizers is quite low.

Table 15 shows the status of organic farming PGS groups constituted under PKVY and Namami Gange schemes. As of June 30, 2021, there were 513 organic farming groups with 23638 registered farmers in the district. All these groups were constituted under the PKVY scheme. The

median number of farmers per group is 50. Block-wise data show that Bironkhal block had the highest number of groups (65), followed by Thalisain (58) and Zahrikhal (47). Out of the total of 23638 registered organic farmers in the district, Bironkhal block consisted of the highest number of farmers (2986), followed by Thalisain (2748) and Pabau (2072).

Since economies of scale in both production and marketing of organic products are the key concern in promoting organic farm practices, possibilities of some institutional framework in the forms of SHGs/ farm cooperative/PFOs/contract farming etc., may be explored. Organic farming could be an economically viable option in the district if the govt. builds strong marketing networks linking farmers, processors and distributors with the easy certification process and minimizing 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 district has a natural advantage for organic farming. The state government can ban the distribution of chemical fertilizers and pesticides in the district and promote the production, distribution and use of bio-fertilizers and vermicompost to develop clusters of HVCs under the organic farming system.**

The major problem for the growth of organic farming are:

1. Lack of awareness and knowledge about bio-fertilizers and bio-pesticides and other supplementary nutrients required to enrich the soil productivity.
2. Shortage of biomass and its incapability in fulfilling all soil nutrients.
3. Although efforts are being made to integrate the farmers with the market network, farmers still have inadequate marketing and distribution network access.

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

S no.	Block	Scheme	No of groups	No. of Farmers in Groups			
				Total	Average	Median	SD
1	Bironkhal	PKVY	65	2986	45.94	47	8.76
		Namami Gange	-	-	-	-	-
2	Dugadda	PKVY	29	1300	44.83	48	11.20
		Namami Gange	-	-	-	-	-
3	Dwarikhal	PKVY	27	1112	42.77	43	9.48
		Namami Gange	-	-	-	-	-
4	Ekeshwar	PKVY	37	1664	44.97	49	7.56
		Namami Gange	-	-	-	-	-
5	Kaljikhal	PKVY	25	1182	47.28	50	1.35
		Namami Gange	-	-	-	-	-
6	Khirsu	PKVY	26	1136	43.69	50	10.07
		Namami Gange	-	-	-	-	-
7	Kot	PKVY	30	1361	45.37	50	10.01

		Namami Gange	-	-	-	-	-
8	Nainidanda	PKVY	14	699	49.93	50	3.65
		Namami Gange	-	-	-	-	-
9	Pabau	PKVY	45	2072	46.04	50	9.52
		Namami Gange	-	-	-	-	-
10	Pauri	PKVY	25	1237	49.48	50	5.12
		Namami Gange	-	-	-	-	-
11	Pokhra	PKVY	23	1088	47.30	50	13.68
		Namami Gange	-	-	-	-	-
12	Rikhnikhal	PKVY	26	1197	46.04	46	12.83
		Namami Gange	-	-	-	-	-
13	Thalisain	PKVY	58	2748	47.38	50	10.67
		Namami Gange	-	-	-	-	-
14	Yamkeshwar	PKVY	36	1850	51.39	50	5.80
		Namami Gange	-	-	-	-	-
15	Zahrikhal	PKVY	47	1956	41.62	44	10.44
		Namami Gange	-	-	-	-	-
16	District (Pauri Garhwal)	PKVY	513	23638	46.08	50	9.70
		Namami Gange	-	-	-	-	-
		Total	513	23638	46.08	50	9.70
Source: Compiled from https://pgsindia-ncof.gov.in/							

Highlights-2

The agricultural sector contributed 29.66 % of the total GDP of Pauri Garwhal district, with a decline of around 4% growth in 2016-17.

NSA in the district is around 9.28% of the total reported area, a decline of around 2% from 2008-09 (11.69%).

The area under forest is about 60% of the total reported area. Forest-based livelihood activities have the potential for income generation in the district.

Marginal and small farmers constituted about 95% of the total farmers of the district.

Rice, wheat and ragi together comprise the largest share in the gross cropped area (GCA).

Ragi, saava, urad, mustard and potato are promising crops. Marketing support and R&D intensification can make these crops more remunerative for farmers.

High variability in the production of different crops indicates the farmers' vulnerability, which needs to be addressed through insurance and income protection measures.

The use of chemical fertilizers in agriculture is negligible and farmers have a natural advantage for organic farming.

Both NSA and GCA are quite low, 9.94 % and 12.21% respectively in

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 335262 in 1998 to 361563 in 2003 and then declined to 344631 in 2007 and further to 304251 and 256311in 2012 and 2019, respectively. During 1998 and 2019, there has not been much decline in the number of female cattle, but the number of male cattle has drastically declined, probably due lack of demand for animal power. In the case of Buffalo, a continuous declining trend has been observed. Comparing data, we observe that numbers of buffaloes have

decreased from 81233 in 1998 to 30076 in 2019 and the decline was substantial for both male and female Buffaloes. A similar trend has been observed for the sheep counts and their numbers had declined from 66401 in 1998 to 13276 in 2019. However, the number of goats shows ups and downs (data shows a declining trend from 1998 to 2003, increasing trend from 2003 to 2012 and again decreasing trend from 2012 to 2019). The number of pigs in the district is quite low. Between 1998 and 2007 number of poultry has decreased from 84855 to 59582 and again increased to 86161 in 2012.

Table 16: Trends in Livestock population (in numbers)

	Category	1998	2003	2007	2012	2019
Indigenous Cattle	Total Male	142184	150410	132808	89784	47353
	Total Female	189322	201001	191966	180609	188059
	Total	331507	351412	324774	270394	235412
Exotic Cattle	Total Male	1481	3059	5401	6856	1554
	Total Female	2274	7092	14456	27000	19345
	Total	3755	10151	19857	33857	20899
Total Cattle		335262	361563	344631	304251	256311
Buffalo	Total Male	19463	16275	12219	5519	1523
	Total Female	61769	53841	45186	35141	28553
	Total	81233	70115	57405	40661	30076
Sheep	Total Indigenous Sheep	65901	31322	23376	24634	13159
	Total Exotic Sheep	500	2682	1953	889	117
	Total Sheep	66401	34004	25329	25523	13276
Goat	Total Male	-	-	-	-	40289
	Total Female	-	-	-	-	102527
	Total	191797	151547	172976	179705	142816
Pig	Total Indigenous Pig	388	1366	591	686	1085
	Total Exotic Pig	166	333	187	125	7
	Total Pig	554	1699	778	811	1092
Total Livestock		678718	623115	613621	612626	-
Total Poultry		84855	70125	59582	86161	-

Source: Compiled from District Statistical Handbook and Livestock Census

Table 17 shows animal hospitals and development centres in the district. The number of cattle hospitals remained almost the same over the period. However, cattle development centers had increased from 67 in 2008-09 to 108 in 2016-17. The number of man-made production centres increased from 34 in 2008-09 to 60 in 2016-17. There has not been any change in the number of Sheep Development centres. There is only one Poultry unit present in the district since 2013-14.

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

Category	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17

Cattle Hospital	40	40	40	40	40	40	40	40	40
Cattle Development Centre	67	67	67	67	110	110	110	110	108
Man-Made Reproduction Centre	34	34	34	34	53	53	58	58	60
Sheep Development Centre	8	8	8	8	8	8	8	8	8
Poultry Units	-	-	-	-	-	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 area under fruits. In 2016-17, Mango constituted the highest share (29.65%), followed by Lemon (20.53%) and walnut (14.21%). The total area under fruits does not show high variation across years; however, there is a drastic decline in the area in 2016-17.

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

Crop/Year	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17
Apple	6.12	4.88	5.22	5.08	5.08	5.02	5.43	5.40	5.24
Pear	5.47	5.79	6.09	5.92	5.92	5.85	6.08	6.04	3.39
Peach	4.08	4.23	4.47	4.35	4.35	4.30	4.61	4.59	6.72
Plum	4.69	4.58	4.80	4.66	4.66	4.61	4.75	4.69	1.51
Apricot	6.78	5.56	5.95	5.75	5.75	5.69	5.69	5.60	1.06
Walnut	11.59	12.19	12.22	11.95	11.95	11.81	10.70	9.59	14.21
Mango	15.55	14.86	15.34	14.95	14.95	14.78	15.03	14.84	29.65
Litchi	0.76	0.83	0.86	0.85	0.85	0.84	0.92	0.98	3.73
Lemon	11.32	11.83	12.00	11.70	11.70	11.57	11.66	12.98	20.53
Other Fruits	33.64	35.25	35.25	35.95	35.95	35.53	35.12	35.29	13.79
Total fruits (ha)	19840 (100)	19340 (100)	19340 (100)	20047 (100)	20047 (100)	20280 (100)	20301 (100)	20781 (100)	4047 (100)

Source: Compiled from District Statistical Handbooks

Production of Mango increased from 3988 tons in 2008-09 to 6329 tons in 2016-17. Similarly, the output of Lemon has increased from 4716 tons in 2008-09 to 5337 tons in 2015-16. However, it steeply declined to 4710 tons in 2016-17. Production of Apple, Pear, Plum, Apricot and other fruits has declined during the period. However, the production of Peach, Walnut, Mango and Litchi has increased. Total production of fruits has declined from 30698 tons in 2008-09 to 22103 tons in 2016-17 (Table 19).

Table 19: Year-wise production of fruit crops in Pauri Garhwal District (in tons)

Crop/Year	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17
Apple	3870	2467	2683	2738	2738	2636	3020	3057	856
Pear	4420	2868	3095	3312	3312	2835	3356	3415	1095
Peach	665	701	738	929	929	739	1144	1176	1199

Plum	2101	1275	1374	1743	1743	1366	1748	1770	340
Apricot	1995	1271	1383	1643	1643	1209	1676	1683	283
Walnut	1307	1243	1245	1365	1365	1170	1985	2028	2236
Mango	3988	5341	5455	6271	6271	6060	6328	6222	6329
Litchi	290	235	241	365	365	363	417	457	669
Lemon	4716	5063	5132	5384	5384	5227	5452	5537	4710
Other Fruits	7346	6894	6894	7438	7438	6789	7245	7985	4382
Total fruits (ha)	30698	27358	27358	30532	30532	28394	32371	33330	22103
Source: Compiled from District Statistical Handbooks									

Table 20 shows that the per hectare yield of almost all crops has increased during 2008-09 and 2016-17. The productivity of Mango accelerated from 1.29 tons/ha in 2008-09 to 5.27 tons/ha in 2016-17. Similarly, the yield of Lemon has increased from 2.10 tons/ha in 2008-09 to 5.67 tons/ha in 2016-17. The yield of peach has significantly increased from 0.82 tons/ha in 2008-09 to 4.41 tons/ha in 2016-17. Per hectare yields of apple, pear, plum and apricot have declined during 2008-09 to 2015-16 and then substantially increased in 2016-17. Overall, the productivity of fruit crops has increased from 1.55 tons/ha in 2008-09 to 5.46 tons/ha in 2016-17. The above analysis indicates an improved scenario of fruits productivity in the district.

Table 20: Per hectare yield of principal fruits in Pauri Garhwal District (tons/ha)

Crop/Year	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17
Apple	3.19	2.61	2.66	2.69	2.69	2.59	2.74	2.72	4.04
Pear	4.07	2.56	2.63	2.79	2.79	2.39	2.72	2.72	7.99
Peach	0.82	0.86	0.85	1.07	1.07	0.85	1.22	1.23	4.41
Plum	2.26	1.44	1.48	1.86	1.86	1.46	1.81	1.82	5.57
Apricot	1.48	1.18	1.20	1.42	1.42	1.05	1.45	1.45	6.58
Walnut	0.57	0.53	0.53	0.57	0.57	0.49	0.91	1.02	3.89
Mango	1.29	1.86	1.84	2.09	2.09	2.02	2.07	2.02	5.27
Litchi	1.93	1.47	1.44	2.15	2.15	2.14	2.23	2.24	4.43
Lemon	2.10	2.21	2.21	2.29	2.29	2.23	2.30	2.05	5.67
Other Fruits	1.10	1.01	1.01	1.03	1.03	0.94	1.02	1.09	7.85
Total fruits (ha)	1.55	1.41	1.41	1.52	1.52	1.40	1.59	1.60	5.46
Source: Compiled from District Statistical Handbooks									

As indicated by COV values, the area, production, and yield of almost all fruits evince a high magnitude of variability. In the case of area, the highest COV is in apricot (36.6%), closely followed by plum (34.9%), other fruit crops (34.4%), and pear (33%). In the case of production, it is highest in Litchi (35%), followed by apricot (34.5%), plum (33.8% and apple (29.7%.

Table 21: Variability in Area, Production, and Yield of Principal Crops (2008-09 to 2016-17)

Crop/ Year	Area (ha)			Production (tons)			Yield (tons/ha)		
	Av	SD	COV	Av	SD	COV	Av	SD	COV
Apple	962	292	30.39	2674	795	29.73	2.88	0.47	16.28

Pear	1063	351	33.03	3079	876	28.45	3.41	1.79	52.41
Peach	808	206	25.53	913	216	23.62	1.38	1.15	83.55
Plum	839	293	34.9	1496	505	33.79	2.17	1.3	59.86
Apricot	1044	382	36.6	1421	491	34.53	1.92	1.76	91.67
Walnut	2105	590	28.0	1549	410	26.49	1.01	1.1	108.79
Mango	2806	606	21.59	5807	779	13.42	2.28	1.15	50.29
Litchi	170	17	10.01	378	132	34.99	2.24	0.88	39.11
Lemon	2199	529	24.06	5178	304	5.87	2.6	1.16	44.49
Other Fruits	6328	2175	34.38	6935	1026	14.79	1.79	2.28	127.28
Total fruits (ha)	18225	5336	29.28	29186	3367	11.54	1.94	1.32	68.05
Source: Estimated from District Statistical Handbooks									

In the case of yield, the highest variability is observed in other fruit crops (127.3%), followed by walnut (108.8%) and apricot (91.7%). A perusal of Table 21 reveals that the variability in yield is higher than production and area. **The high variability in the yield of fruits affects the farmers' income and therefore needs to be addressed through easy and affordable access to insurance services and income protection measures. The government should ban the distribution of chemical fertilizers and pesticides in the district and take the initiative to make a common brand, "Namami Gange," organic fruits so that the farmers may get premium prices for their produce.**

2.4 Trends in Area, Production, and Yield of Vegetable Crops

Table 22 shows the area, production, and per hectare yield of total vegetable crops. It is evident from the data that the area, production, and yield of potato crops in the district have declined during 2008-09 and 2016-17. The total area under potato cultivation has declined from 1192 ha in 2008-9 to 497 ha in 2016-17. Potato production has declined from 20020 tons in 2008-09 to 5717 tons in 2016-17, which is due to the decline in the area and yield of the potato cultivation. Similarly, the area under vegetable cultivation has decreased from 4665 ha in 2008-09 to 1261 ha in 2016-17. The production of vegetables also declined from 39839 tons in 2008-09 to 20063 tons in 2016-17. The decline in vegetable production is mainly due to a decline in the area under vegetable cultivation as the per hectare yield of vegetables has increased from 9.10 tons/ha in 2008-09 to 15.9 tons/ha in 2016-17.

Table 22: Area, Production, and Yield of Vegetables (area in ha, and production and yield in tons)

Crop/Year		2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17
Potato	A	1192	1262	1262	1040	1040	1040	985	1008	497
	P	20020	20500	20500	14584	14584	13502	12832	13973	5717
	Y	16.8	16.24	16.24	14.02	14.02	12.98	13.03	13.86	11.49
Total Vegetables	A	4665	4720	4720	4578	4578	4578	5735	4773	1261
	P	39839	39962	39962	28560	28560	27040	29504	34508	20063
	Y	9.10	8.47	8.47	6.24	6.24	7.15	5.14	7.23	15.9
Source: Compiled from District Statistical Handbooks										

Overall, agriculture and allied sectors can improve rural livelihood through diversification into areas such as 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. It is significant to note that the state government has initiated the consolidation of land holdings in the hilly region. It would make it possible for farmers to bring their scattered land to one place. Then, they can make more farm investment to diversify their cropping pattern from low-value wheat and rice crops to high-value horticulture crops (fruits and vegetables).

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 cattle and buffaloes, particularly males, has declined in 2019 over 1998.

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.

In 2016-17, the area under the Mango crop constituted the highest share (29.65%), followed by Lemon (20.53%) and walnut (14.21%). Per hectare yields of various fruit crops show high variability, thus indicating income fluctuations and farmers' vulnerability.

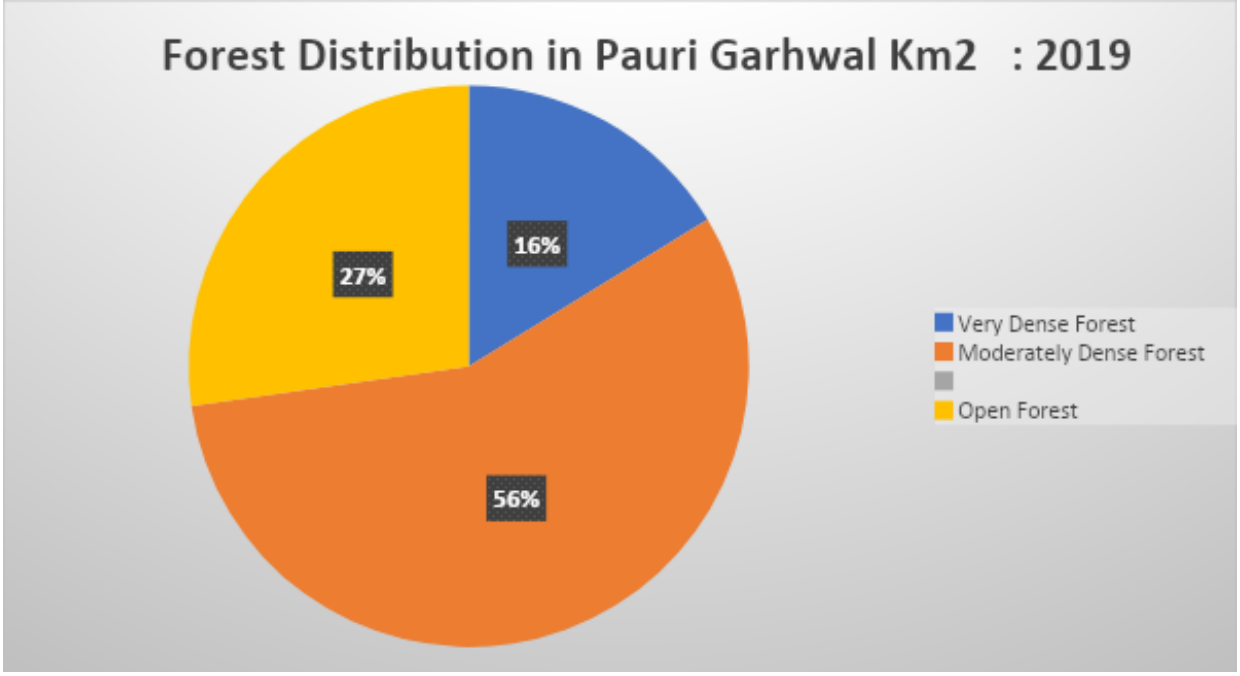
The variability in production is driven mainly by variability in yields.

The consolidation of land holdings would allow farmers to bring their scattered land to one place. Then, they can make more farm investment to diversify their cropping pattern from low-value crops such as wheat and rice to high-value horticulture crops (fruits and vegetables).

Fruits, vegetables, potatoes, mushrooms, spices, medicinal plants

2.3 Forestry

Total geographic area of the district is 5329 Km^2. As per 2019 Forest survey of India assessment, the district has 63.71% of forest area of total geographic area, which is the highest in the state. The total forest cover in the district is 3394.99 Km^2. From this total area 547.26 Km^2 comes under very dense forest (VDF) category, 1902.03 Km^2 is moderately dense forest (MDF), and 918.7 Km^2 area is open forest (OF) (FSI, 2019).



Forest Survey of India 2019 Uttarakhand vs Pauri Garhwal Comparative Assessment						
Area	Geographical Area	Very Dense Forest	Moderately Dense Forest	Open Forest	Total	%of Geographical Area
Pauri Garhwal	5329	547.26	1902.03	918.7	3394.99	63.71%
Uttarakhand	53483	5046.76	12805.24	6451.04	24303.04	45.44%

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 Pauri district. As per the data, 1845 flora and fauna have been observed till now. A total of 724 species are present in the district, in which 33.47% are insects, 29.18% plant species, 0.55% fungi, 3.46% mammal species, 28.35% birds, and 1.8% reptiles.

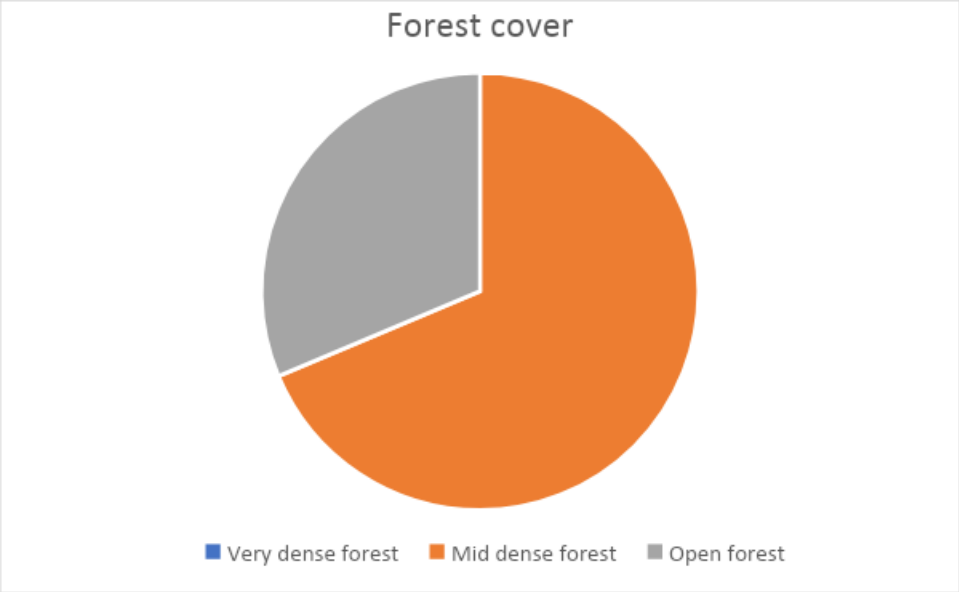
Table 1 Bird species recorded in the district.

Number of species	667
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
5329	574.26	1902.03	918.70	3394.99	63.71	0.99	95.97



2.4 Tourism

2.5 Wetlands

The district does not consist of a large number of wetlands. The district consists of areas like the ramganga reservoir, which is of the large size water body present in the district. Table 1 represents the number of wetlands and their area representation in the district.

Table 1: Wetland Data of Pauri (Garhwal) 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	0	0	0	0	0	0	0	0	0	0	0	0	0
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	60	60	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	1	1	0	0	0	0	0	0	0	0	0	1	1
Tanks/ponds	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
Salt pans	0	0	0	0	0	0	0	0	0	0	0	0	0
Total (76)	1	61	60	15	0	0	0	0	0	0	0	1	1

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

- The district comprises 76 wetlands; most of them are rivers/streams.
- The wetland size is large in general, the number of natural wetlands is high.
- Fewer wetlands have aquatic vegetation.

2.6 Energy

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 information present on the website of UREDA mentions installation of 761 solar cookers upto 2015-2016. Also a solar water heating system of 6000 LPD was proposed to be installed in KGBV school in 2019-2020. There has also been installation of solar power plants in different villages in the district which is providing employment to various people. Such as a 1 MW solar power plant at Palli village employs 5 persons and a 1700 kW solar power plant at Dhari village employs 6 persons. The project costs have been 503 lakh and 793 lakh rupees respectively for the two villages. Two solar power plant projects have been set up in Uregi village of the district of capacity 200 kW and 600 kW costing 101.15 lakh and 304.5 lakh respectively. The two projects in total have employed 6 people.

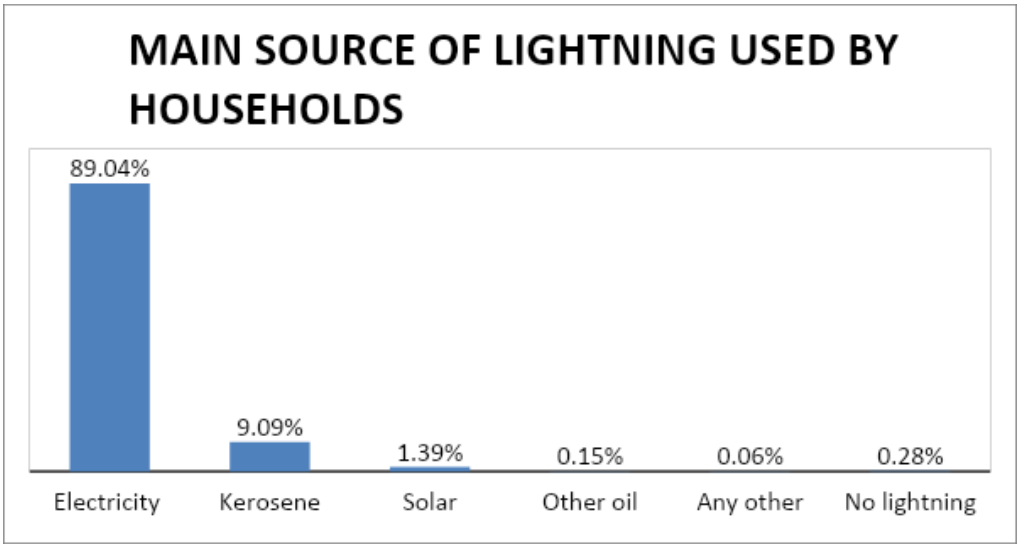


Fig. 1

The data (Fig. 1) of 2011 census indicates that approximately 90% households use electricity for lightning and only 1.39% use solar energy for lightning. Although, the district presently is giving a fairly good performance in the solar energy sector but has potential of doing better.

2.6.2.Biomass Energy

In district Paurigarhwal agriculture is one of the main sources of biomass. The cropping intensity of the district is 141.26%, which is quite good. The productivity of the major crops in the districts is - Wheat: 1340 kg/ha, Barley: 1248 kg/ha, Rice: 1142 kg/ha, Maize: 1020 kg/ha. The major horticulture crops are apple, pear, plum, apricot etc. The net sown area is 78486 ha in the district. PauriGarhwal has 38500 ha as total cultivable waste land, 7800 ha as current fallow and 18200 ha as other fallows. 385100 ha is the total forest cover of the district. Pine trees are one of the major trees found which can be used in biomass energy production.

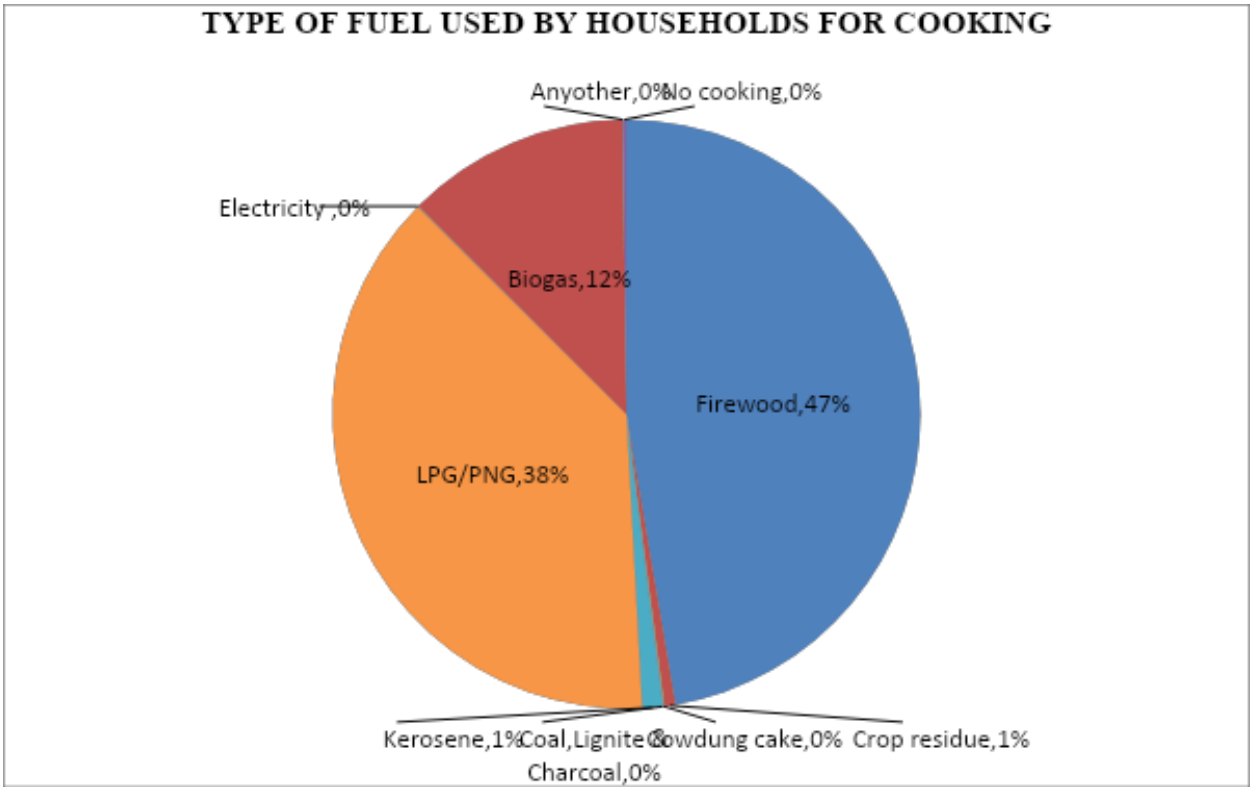


Fig. 1

The pie diagram (Fig. 1) depicts the data from 2011 census about the type of fuel used by Ohouseholds for cooking. It is clear that more than half the population of the district depends on firewood while the other chunk of population uses LPG/CNG.

It is important to divert the people away from using firewood. The district has good forest cover and for utilizing the pine needles the state has Pirul Based Energy Scheme which is comes under the BioMass Energy scheme of the MNRE, Government of India. Although there are rice husk based co-generation plants in other districts, PauriGarhwal does not have one.

2.6.3.Biogas Energy

Five family-sized biogas plants have been installed in the district between the year 2009 to 2019. Biogas potential has been evaluated by average livestock and agricultural waste production. Biogas potential from animal waste is calculated approximately as eighty-three m^3/year and nineteen crores m^3/year from agricultural waste. This amount of biogas generation can efficiently complete the energy demand of the district.

2.6.4.Hydropower Energy

The Alaknanda River, one of the significant tributaries of Ganga, is flowing along the western border of the district and separating it from the border districts of Tehri Garhwal, Dehradun, Haridwar. This river has a large potential for exploitation at many places like Srinagar, Baisghat,

Swargashram, etc. Nayyar River is the major river system within the district's territory and is one of the major tributaries of Alaknanda.

Name of project	Installed capacity (MW)	Stream/river	Developer	Status
Bilkot	0.05	Ramganga	UREDA	In operation
Chilla	144	Ganga	UJVNL	In operation
Dior II phase	-	Alaknanda/Ganga	UREDA	In operation
Dior I phase	0.1	Ramganga	UREDA	In operation
Dunao	2	Eastern Nayar	UJVNL	Under construction
Gauni Chhira	0.5	Nayar East	UREDA	Under construction
Kanwashram	0.1	Ganga	UREDA	In operation
Ramganga	198	Ramganga	UJVNL	In operation
Shrinagar	330	Alaknanda	GVK	Under construction
https://www.iitr.ac.in/wfw/pdf/Hydropower_stations_in_operation_and_under_construction_in_uttarakhand.pdf				

3 QUALITATIVE DATA ANALYSIS

3.1 AGRICULTURE, ALLIED ACTIVITIES,

3.2 FORESTRY

There are extensive forests in the district Pauri Garhwal. These forests are serving, as a base for many industries, local needs of fuel wood, fodder resources and ecological stability. Reverie forests, occur in areas of lower elevations. Its main constituents species are: Acacia Catechu (Khair), Shorea robusta (Sal), Dalbersia sisso (Sheesham), Bombex ceiba (Bamboo) etc. The hills of the district abound wild cherry, wild Apple, Spindle Wood, Oak, Fig, Poplar, Holly, Rhododendron, Masuri Berry, Dogwood, Horse Chestnut and hill tuna. At higher altitudes, forests are crowded with Himalayan cypress, Deodar, Blue pine, Fir and Long leafed pine (District Webdata). Many of these fruit varieties are eaten raw and used locally, but not been considered as a source of alternative food products and, therefore, still large quantities of fruits or edible of almost1 all species are wasted (R.K. Maikhuri, 2014). Chir pine and Deodar are being used for supply of timber, paper and match industries. These industries are located in the Ganga plain

adjoining the Garhwal hills. The khair forest occurring in the lower hills are feeding the Kattha industries located at Kotdwar and other foothill towns of U.P. The pine forests are being extensively tapped for the production of resin. This resin is transported to the resin and turpentine factories. These forests are also yield pulpwood (for paper industry), wood for match industry, Gums, Tannins, Paint fibre, Canes and minor forests products. The local people depend on these forests to a great extent. They derive their fuel wood for cooking & heating purpose, fodder for cattle, grasses for thatching of roofs, small wood for agricultural implements, timber for house building & furniture from these forests. In this area over 90% of the cattle owned by local people graze in these forests (District Webdata).

Some of the medicinal plants in the district with their uses (District Webdata).

Species	Uses
Acacia Arabica (Babul)	– This tree and other of same genus yield a gum, which is used as substitute for gum Arabic.
Egle Marmelos (Bel)	– The fruit is a specific in atonic diarrhea and dysentery.
Artemisia Vulgris (Pati)	– It has stomachic and tonic properties and is given in fevers.
Boenning Hausenia albiflora (Pisu-ghas)	– Exported and used as a medicine for poultry.
Bauhinia Veriegata (Kachnar)	– The root in decoction is useful in dyspepsia and flatulency, the flowers with sugar as gentle laxative, and the bark, flowers or root triturated in rice-water as a cataplasm to promote suppuration.
Berberis Lycium (Kingora-ki-jar)	– An extract from the roots is known as rasaut. The medicinal extract is highly esteemed as a febrifuge and as a local application in eye diseases.
Bombax Malabaricum (Semal)	– The gum is given in asthenic cases, the root furnishes one of the musali and is used as a stimulant and tonic and in large doses as an emetic, and the leaves are employed as an aphrodisiac and in special diseases.
Cinnamomum Tamala Tej (Bark), Tejpat (Leaves)–	-The bark and leaves are used as a carminative, aromatic and stimulant in coughs and dyspepsia and generally as substitute for tree cinnamon.
Aconitum Hetrophyllum Atis (Root)	- It is used as a tonic, febrifuge and aphrodisiac.

The district also has 2 major wildlife parks for eco-tourism.

1.Sonanadi Wildlife Sanctuary 2. Rajaji National Park

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. There are over 500 elephants, 12 tigers, 250 panthers, and a diverse prey base that includes Spotted Deer, Sambhar, Wild Boar, Barking Deer, and Goral. Chilla Wildlife Sanctuary is home to 23 mammalian species and 315 bird species, with the possibility of 500 with some migrating species.

3.3 ENERGY

5.5.1. Solar

The main economic activity of the district is agriculture only, hence for the development of the people and to raise their living standards it is important to provide them with facilities which would add to their income. In the past few years, under various programmes, rooftop panels, solar cookers, solar water heating systems have been installed, which is appreciable. Most recent development in programme planning by the state has been done in form of 'Mukhyamantri Saur SwarojgarYojana'. This programme is for the farmers who are unable to make proper use of their land which is eventually turning barren. So these farmers will be provided with solar panels at subsidized rates and can sell electricity to Uttarakhand Power Corporation Limited.

According to an article in The Times of India, the government of the state has proposed that UREDA will be setting up solar power plants to meet the growing energy need. These will be set up in Dehradun, Chamoli, Tehri, Pauri, Uttarkashi, Nainital, Bageshwar and Pithoragarg districts.

5.5.2. Biomass

In PauriGarhwal there is a large forest cover consisting of pines, which should be made use of in producing biomass energy. This will also be helpful in avoiding fires in forests which destroy tress, medicinal plants and herbs. A large number of wild animals are also affected. According to the news article in Jagran, 4 pirul based biomass energy plants have been allocated to the district.

A report available on vikaspedia, gives an estimate that a 100 kW gasifier running for 24 hours requires 4,500 kg of pine needles. Thus, about 1350 tonnes of pine needles are required per year. Uttarakhand, biomass collection is mostly done by women and thus forgasifier also, mostly women can be employed for the collection of pine needles. Since the pine forests shed their needles in summer season, the pine collection activities are done during the month of April to June and stored for the complete year. This will provide an extra source of income to the women and hence would help in improving the economy of the district.

5.5.3. Biogas

A total of twenty-two biogas plant of three cubic meters has been installed for the year 2020-21.

5.5.4. Hydropower

GVK has developed a 330 MW hydro project on the river Alaknanda in Tehri/ Pauri Garhwal district of Uttarakhand. A Power Purchase Agreement (PPA) has been signed with Uttar Pradesh, and 12% output will be given free to the state of Uttarakhand.

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-cultural significance. However, the region's wetlands also have many traditional medicinal plants. The data gathered and analysed demonstrates the region's production and potential products derived from the raw product. The list of sources and the possible products are mentioned below:

- The district is affluent in biodiversity and is a shelter of animals and birds abound in the thick forests.
- Production of ayurvedic medicinal plants is reasonably high like babul, bel, Pati, kachnar.
- Forest products play an essential role in the economy of the district. Besides supplying fuel, fodder, bamboos and medicinal herbs, they also yield a variety of products like honey, lac, gum, resin, catechu, wax, horns and hides
- The shore a forest host birds like the Jewel Thrush, Black-headed Oriole, Black-headed yellow Bulbul, Rosy Minivet, Laughing Thrush, Golden Backed Woodpecker and the Blue fly Catcher, Wintering waterfowl.

4 ACTION PLAN DEVELOPMENT

4.1 AGRICULTURE

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4.2 FORESTRY

Currently, no particular schemes are present for the district even though the region is full of timber yielding and NTFP trees. The district does not have any schools listed under School Nursery Yojana. The highest net sown area has been found in the Pauri district (18.88 %). This can be used as a platform for agro-forestry. To implement agro-forestry in the urban area as well, ready sampling of native plants are required. It is important for the government to take initiative for establishing nurseries at all major towns in the district and same nurseries can be acted as collection centres for the NTFPs. This creates circular economy effect. District has dense forests of deodar trees which is one of the most used trees for furniture making and building material.

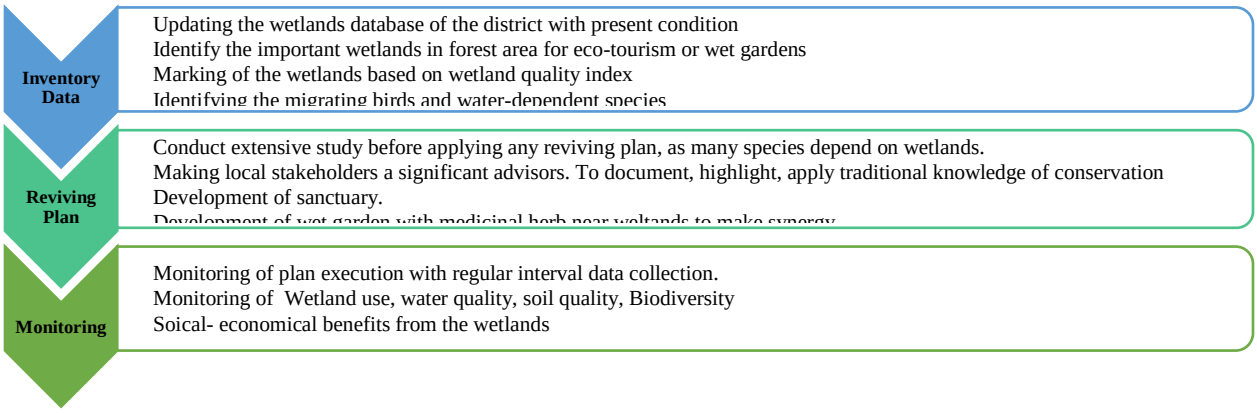
4.2.1 Biodiversity:

The district comes to the news every year because of the forest fire. Therefore, there is an urgent need to initiate research in fire detection, behavior, and fire ecology to better manage forest fire and establish fire towers in specific areas where the fire is not easily detected in time.

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 various 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 revitalise extant and extinct wetlands.



4.5 ENERGY

4.5.1 Solar

In PauriGharwal, agriculture is the main economic activity. In order to bring development in the district agriculture should be solarized. KusumYojana of the central government should be adopted in the district on large scale, along with Mukhyamantri Saur SwarojgarYojana. Both the schemes can together lead to the development of the district. Component C of KusumYojana should be implemented, i.e. solarization of segregated feeders should be done. This will remove the burden on the discoms and they could supply uninterrupted electricity to the farmers. Those farmers who can afford standalone solar water pumps should be encouraged to irrigate their fields using solar energy. They can be provided with subsidy under the Component B of KusumYojana. While the Mukhyamantri Saur SwarojgarYojanacan help those whose land does not yields much. Thus this agriculture dependent district can prosper using its own resources.

Also the grid connected solar rooftop panels should be encouraged in the urban areas in the district to support the discoms in providing full-fledged electricity supply. 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. People's choice for power supply can be inclined towards solar energy by providing subsidy in utility supply to those who use solar power.

PROJECTIONS AND MONITORING MATRIX

Firstly, solarisation of agricultural feeders is important. For this, proper infrastructure should be developed which supports feeder segregation followed by which its solarisation should be done. This can be done under KusumYojana.

Secondly, the schemes should aim at building the remote, areas of the district, self-sufficient for their energy requirements by providing the households with solar powerat low costs, so that they have access to off grid power.

Thirdly,use of solar thermal energy can be encouraged by making people aware of solar thermal scheme providing solar water heating systems, solar cooking systems and solar steam cooking systems at subsidized rates to the people. This would definitely raise the living standards of the people.

Fourthly, the Mukhyamantri Saur SwarojgarYojna should be implemented by making the necessary improvements overcoming the technical obstacles.

Lastly, grid connected solar panels should be encouraged in urban areas, which would add to the grid supply supporting the power production.

4.5.2 Biomass

The district PauriGarhwal has good forest cover and also a good agricultural productivity. It is required to wisely utilize the biomass produced from the two sources for energy production. For the collection of agricultural residue a centralized and well-connected system should be developed. Government can encourage community based co-generation plants or the gasifier. This way the cost burden could be shared by the whole village or a goup of people.

Other than the agricultural residue, the district also has a good supply of pine needles. The need is to make people aware about benefits of using pine needles for energy production.Friendly environment for private investors should be constructed forsetting up pine based gasifiers. This would encourage the small start-ups and hence the economy of the district would accelerate towards development. This way employment opportunities would be created for the people in the district

It is also required to make people aware regarding the use of biomass for energy production and discourage them from directly burning firewood. This can be done by organizing campaigns, demo programs at various places in the district.

PROJECTIONS AND MONITORING MATRIX

First and the foremost thing required is making people aware about biomass energy and encouraging them to set up Pine based gasifiers andco-genneration plants. Second step should bein developing ease for establishment of biomass based plants. Thirdly, attention should be paid on the working condition of those who are collecting pine needles, especially the women. If they will be provided with good working condition, then more and more people will be attracted towards it, hence making pine needles available in large quantities round the year. Fourthly, for agriculture residue collection a proper transport system should be developed. These steps together will lead to an all-round development of biomass energy production.

4.5.3 Biogas

A lot of biogas potential exists in the state from agricultural and livestock waste. Government should promote participation with private industries that can convert this waste to biogas.

4.5.4 Hydropower

The high-capacity hydroelectric project should not be built in the district because the area is prone to natural disasters like earthquakes, cloud bursts, glacier bursts, and land sliding. Small hydropower projects should be constructed for irrigation purposes and electricity generation near the village areas of 1.0-2.0 MW capacity.

5 RECOMMENDATIONS

5.1. Agriculture and allied sectors

- There is a huge scope for improving local people's livelihood, regenerating natural capital, and abating youths' migration through the promotion of organic agriculture, horticulture, and agroforestry.

- Some landowners who migrated and settled elsewhere do not want to give their land to the local farmers as they fear they may grab their land. Hence, they keep their tiny landholdings uncultivated and such lands become the shelter of wild animals, which quite often damage the crops of nearby farmers. It discourages the remaining farmers not to doing farming. The state government has recently notified the consolidation of land holdings in the hilly districts. It is an important initiative towards bringing tiny land plots together. The government horticulture and forest departments should take uncultivated and barren lands on lease from those individual farmers who do not want to do farming due to various reasons. The departments can do large-scale horticulture and agroforestry activities under MGNREGA convergence. These departments can set up horticulture and agroforestry zones and prepare the DPRs under the convergence framework, with detailed techno-economic feasibility and socio-economic and environmental impact analysis. Wire fencing of these zones can be done by the departments to protect the crops and plantations from the wild animal. Such fencing would be more cost-effective as compared to the fencing of individual farmers' land.

- Ragi, Saava urad, urad, gahat, bhatt and potato, spices and condiments (chilies, ginger and garlic), soybeans, and floriculture are promising crops in the district. Marketing support and R&D intensification can make these crops more remunerative for farmers. One of the major challenges is the transportation of agricultural products from the remote villages to the market; therefore, it is highly recommended to diversify the hill agriculture from traditional crops to high-value and low-volume products.

- Most of the crops are rainfed because of the restricted availability of irrigation water; hence there is a need to develop some rainwater harvesting structures and soil moisture conservation practices (bunding, terracing, mulching, check dams etc.)

- Farmers in the district have a natural advantage in practicing organic farming as the use of chemical fertilizers per hectare is negligible. However, there are three deterrents—out-migration, the menace of wild animals and interspersing of cultivated landholding with inactive and abandoned landholding. Horticulture and agro-forestay have the potential to generate additional livelihood opportunities for rural households. There is a need to converge the scheme of NHM with the activities of MGNREGS.

- A small percentage of total farmers in the district are covered under PKVY and there is a huge scope for encouraging other farmers to be a part of the organic farming scheme.

- The area under forest is about 60% of the total reported area. Forest-based livelihood activities have the potential for income generation in the district.

- 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 agroforestry.

- 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 the local town, and tertiary at SIIDCUL and be well-integrated with the supply chain network.

- Agriculture production in the district has a high level of variability and is vulnerable to natural factors. Compulsory and free crop insurance should be provided to protect farmers' livelihood and income.

- 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.

- To improve the local economy and livelihood, there is a need to encourage agro and forest-based micro and small enterprises (e.g. herbs, fruits, frozen tulsi, jam, fruit juices, etc.) to improve the local economy and livelihood. Since markets are a major problem, links between retailers and firms should be developed.

Since the agricultural practices in the hilly region are different from the plains. Therefore, there is a need for proper strategy and management in agricultural and allied activities. Based on the present agricultural activities and available resources the following recommendation will help to improve the agricultural outcomes of the farmers.

- The district has only 9% cultivated land of the total area and productivity of the crops are less, therefore, there is need to introduce new varieties of crops instead of old varieties and also need a proper management strategy.
- Diversification toward the horticulture crops, tea cultivation, spices and condiments (chilies, ginger and garlic), oilseeds, floriculture and traditional hill grains like, mandua, urad, gahat, bhatt could increase the income of the farmers.
- Most of the crops are rainfed because of the restricted availability of irrigation water, hence there is a need to develop some rainwater harvesting structure and soil moisture conservation practices (bunding, terracing, mulching, check dams etc.)
- The district has a favorable climate for fruits and vegetables, there is a higher scope for increased the productivity of fruits and needs of food processing and storage units for a proper supply of the products.
- Horticulture and agro-forestay have the potential to generate additional livelihood opportunities to rural households. There is a need to converge the scheme of NHM with the activities of MGNREGS.
- There is a need to construct a network of ponds, even on private land, especially in the agriculturally developed plain districts of the state. These ponds, if planned properly, would help not only in development of fisheries but also serve the purpose of storing rainwater and recharging groundwater.
- One of the major challenges is the transportation of agricultural products from the remote villages to the market, therefore it is highly recommended to diversify the hill agriculture from traditional crops to high to low volume products, like mushrooms. Spices, soybean, medicinal and herbal plants etc. And there is a need for training pertaining to primary processing of the products.
- There is a need to encourage the agro-based MSMEs, industrial activities to promote agricultural and allied activities. This could increase the income of the local agro-based industries (e.g. herbs, fruits, frozen tulsi, jam, fruit juices, etc.) and also be beneficial for the farmers.
- There is a huge opportunity for organic farming and creating a brand for organic products under the PKVY scheme.
- There is a high scope to promote agriculture based on medicinal, herbal and aromatic plantations. Since markets are a major problem, links between the retailers and firms should be propagated by signing an MOU backed by the legislation to prevent the exploitation of farmers.

5.2. Forestry

- Pauri currently holds enough forest area to fulfill the national policy requirement of 33%. But what the district lacks is organizational productivity through the forestry sector.
- It is important for local government and policy makers to establish trust between forest product collectors and organizations. Local governments can invite foreign investors and Indian pharmaceutical companies for collaboration between tribal people and new business opportunities.
- Major timber species are found in the district, and also various medicinal plants are present in the region. There is huge potential for clusters and emporiums to sell these products to the tourists in the region.
- District is has highest cultivated area by percentage in the state, that enables agroforestry a most viable option for local to increase the side income.

5.2.1 Biodiversity

Establishing a forest management committee at the village level and applying modern technologies to prevent and control a forest fire is recommended.

5.3. Tourism

5.4. Wetlands

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.

- It is recommended to promote organic farming of medicinal plants and herbs in the region
- 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's
- Developing wetland habitat for the migrated birds and further as a bird sanctuary.

5.5. Energy

5.5.1. Solar

- People should be made aware about the benefits of solar energy to them and their environment.
- KusumYojana should be implemented and whatever infrastructure development is required under it should be done.
- Since the district experiences severe winters, use of solar thermal energy should be encouraged.
- People should be made aware of the state's Mukhyamantri Saur SwarojgarYojna, to help them in overcoming the damages caused to them by Covid.
- Solar energy has good potential in the district and can lead to an overall development of the district.

5.5.2. Biomass

- 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 shifts away from using firewood.
- Pirul Based Energy Scheme should be implemented in a full-fledged manner, so that maximum is extracted from the forest biomass. Attention should be paid to the working conditions of those collecting pine needles.
- A proper channel of biomass collection should be developed.

5.5.3. Biogas

- It is recommended to build more household biogas plants in the district by educating people (spreading awareness) and providing incentives. The existing biogas plant should be checked for its current condition and to do maintenance.

5.5.4. Hydropower

- Building a large number of small hydropower projects of 1.0-2.0 MW capacity is recommended rather than large hydropower projects.

6. Discussion during the Report Presentation

- The presentation was appreciated, and the officials ensured to take up the report as the base for future DGC Meetings.
- Natural Farming is being promoted by the State Government.
- MoA&FW has initiated number of outlets for organic produce.
- 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.

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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	303712	10	1,10,85,48,800	831411600	166282320	25	6651292.8
Buffalo	Manure	38720	15	21,19,92,000	158994000	31798800	25	1271952
Sheep	Manure	25523	1	93,15,895	6986921.25	1397384.25	25	55895.37
Goat	Manure	179705	1	6,55,92,325	49194243.75	9838848.75	25	393553.95
Pig	Manure	686	2.5	6,25,975	469481.25	93896.25	25	3755.85
Poultry	manure	85,957	0.1	31,37,431	2353072.875	470614.575	25	18824.583

Total		**6,34,303**						**8395274.553**

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
Rice	**husk**	3910722	0.25	977680.5	684376.35	80	136875.27	750	102656452.5
Total		**4063355**							**192556486.5**