Arth Ganga Project: District Tehri(Garhwal)

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EXECUTIVE SUMMARY

Tehri Garhwal is the sacred place of the state of Uttarakhand is known for washing away all sins and thus is of religious importance. An agrarian economy with an adequate amount of precipitation, the district is traversed by Bhilangna, Alaknanda, Ganga, and Yamuna rivers.

The total geographical area of the district is 3642 Km^2, out of this the permanent pastures are 500 ha, the Cultivable wasteland is 5000 ha. The district has been divided into one or two agro-ecological zones. The barren and uncultivable land constitutes 5000 ha. Soil types are based on rock physiography also, humus content and embedded parental matters impact fertility. With the net sown area of 56206 ha and gross cropped area of 88461 ha, the Cropping intensity of the district is 157.39%. The irrigating intensity is 190.29%. Cropland area decreased from 900.2 km^2 in 2005 to 853.5 km^2 in 2015. The area under barren land has significantly increased from 1.22 % to 1.47% whereas its share increased from 1.15% to 1.19% during the period. The net sown area has decreased by 0.8% percent during 2009-10 to 2018-19 whereas the area under non-agriculture uses in 2018-19 which has significantly reduced to 10.43%. The major crops types are Wheat, Rice, maize, barnyard millet, finger millet, black gram, masoor, rapeseed mustard, etc. Among the horticulture crops are apple, peach, plum, citrus fruits, dry fruits, etc. along with vegetables, spices. The use of chemical fertilizers is low in the district. The livestock consists of cattle, buffalos, goats, sheep; along with poultry. The share of the primary sector went down from 20.87% in 2011-12 to 14.76% in 2016-17, with an annual average growth rate of 0.18%. The share of the agriculture sector in GDP went down from 43.79% in 2011-12 to 37.84% in 2016 whereas livestock share rose from 30.15% to 33.49% and that of Fishery increased from 0.04% to 0.49% during the same period.

The total forest cover in the district is 2065.98 Km^2 (56.73%). From this total area 272.71 Km^2 comes under the Very Dense Forest category, 1084.08 Km^2 is Moderately Dense Forest, and 709.19 Km^2 area is Open Forest. Forest area increased from 63.54% in 2005 to 64.73% in 2020. The share of forestry and logging in GDP went up from 26.02% to 28.19% during 2011-16. The number of flora and fauna is 1654 with a total of 649 species. The district comprises 29 wetlands mostly rivers/streams. Many temples and scenic aesthetics along with biodiversity pose attractions for tourists every year. Many adventures like trekking, water sports, etc. are present for tourists and should be maintained and promoted as eco-tourism.

The main source of lightning is electricity (87.62%) and the main fuel source is firewood (59%) followed by LPG/PNG (38%). Under the Solar thermal scheme different programs such as Solar water heating systems, solar cooking systems, etc. The source of electricity from solar is only 2.24%. Biomass production potential is high. Five family-sized biogas plants have been installed in the district. Biogas potential from animal waste is calculated approximately as 55 lakh m^3/year and 2 crores m^3/year from agricultural waste. Two hydropower plants are in operation, and 23

hydropower stations are undergoing. Sal, Deodar, Chir, Oak, Grewia optiva, endangered Musk Deer, Snow Leopard, Tiger, etc., are a few of the large varied biodiversity residing in the district.

The district needs to buckle up to enhance and promote agricultural practices like organic farming, animal husbandry, and poultry, high-yielding variety seeds, drip irrigation, medicinal plant, spice cultivation, etc. along with promoting small-scale and large-scale industries and commercializing. With adequate measures and precautions along with proper monitoring and promoting eco-supporting actions, the overall development of the district could be enhanced.

1 DISTRICT OVERVIEW

1.1 INTRODUCTION

Tehri Garhwal is a district in the hill state of Uttarakhand, India. Its administrative headquarters is at New Tehri. The district Tehri Garhwal is located between 30º-31' north latitude and 78º-79' east longitude. In the east lies district Rudraprayag west side is bounded by district Dehradun and in the north district Uttarkashi forms its boundary whereas southern boundary is demarcated by district Pauri Garhwal. Geographical area of the district is 3642 sq km. It is fifth largest district in terms of area in Uttarakhand. The district of Tehri Garhwal is divided into two subdivisions: Kirti Nagar and Tehri-Pratap Nagar. The district comprises 7 sub-districts, 7 towns and 1862 villages.

Most of the district is covered under forests which form prominent economic activity of the district. The area covered under forests consists of vast range of species found in the Himalayas. Some of the forests of Chir, Oak, Conifers, Sal and Deodar found in the district are very valuable. Besides this, various types of fruit trees like comel, fig, kaiphal, mulberry, raspberry, kingora, blackberry, apple, pear and plum are found in the district.

Although agriculture is not a remunerative occupation but the economy of the district is based on agriculture. Being in the Himalayan region, the district of Tehri Garhwal contains little level ground. The slope of the hills is usually too steep to cultivate without terracing. In the greater part of the district there are two harvests Kharif and Rabi, as in plains but in cooler climate of the hills the crops require a longer period to ripen and are therefore sown somewhat earlier and reaped later in the plains. Wheat, barley, gram, pea and masoor are chief crops of Rabi whereas paddy, maize, sanwa, mandua and soybean are grown during Kharif. Potatoes and tobacco are extensively produced in the district. There is no large scale industry in the district. Up to March 2009, 24 medium level industries were registered under Factory Act, 1948, out of which 22 medium and 4678 small scale industries are functioning. Dhalwala area is an industrial area where 2 factories of steel/rods are in function.

The total population of the district is 618,931 divided into the 548,792 in rural and 70,134 in urban areas. In four tehsils of Ghansali, Pratapnagar, Jakhnidhar and Dhanaulti there are no urban population. The sex ratio in the district is 1,077. In the rural areas of the district the sex ratio is high at 1.116 while it is only 417 in urban areas. In the district about 76.4 per cent of the population is literate as against about 78.8 per cent in the state of Uttarakhand. In the district about 45.3 per cent in the (280442 persons) pertains to the catetory of working population. Of the total worker population in the district 68% are cultivators, 2.9 per cent engaged as agricultural labourers, 1.4% in household industry and 28.9 % as other workers. Non-workers contribute about 55 per cent of total population.
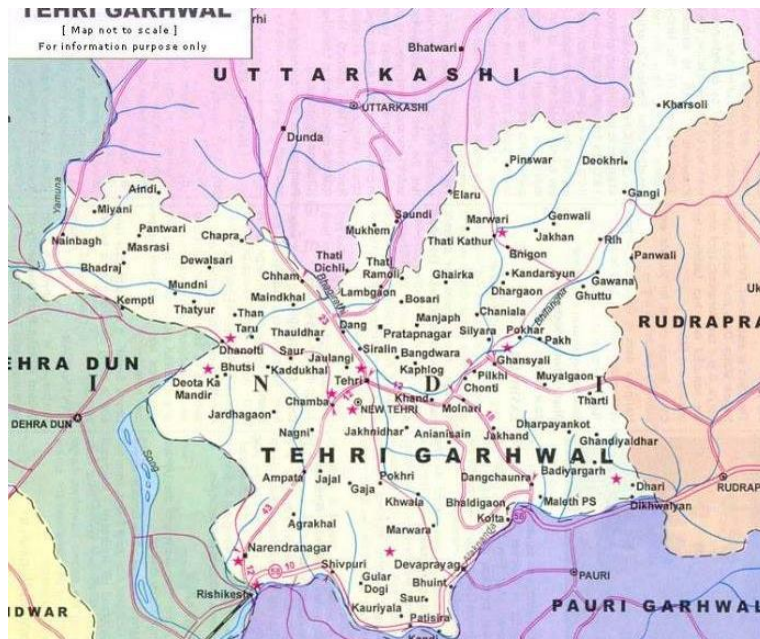
Figure 1 Map of the district

1.2 DEMOGRAPHIC PROFILE OF TEHRI(GARHWAL)

Geographic area: 3642 Km^2
Altitude: 1550 m
Rainfall: 1060.3 mm
Forest area: 2065.98 Km^2
Rivers: Bhilangna, Alaknanda, Ganga and Yamuna

Administrative Divisions:

District Headquarter	New Tehri town

No. of Tehsil	7
No. of Blocks	9
No. of Villages	1862

Demographic and Socio-economic Parameters:

Population	6,18,931
Population Density	170 / Km^2
Sex Ratio	1077
Literacy	76.36% 4
Occupation/Livelihood	Agriculture

Table 1 demographic overview

Agriculture is the backbone of the economy of the district. 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, rice, tea, maize, barley, tobacco, apples, pear, lime, plum, mango, papaya, potato, onion, peas, etc. In the year 2016-17 the gross domestic product in the district was Rs. 6,47,262 lakh at current price and Rs. 5,32,788 lakh at constant prices in the year 2011-2012. The net domestic product in the district during the period 2016-17 was Rs. 5,65,842 lakh at current price and Rs. 4,62,686 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. 83,662 at current price and Rs. 68,410 at constant prices in the year 2011-2012 (Indian District Stat.).

1.3 AGRO CLIMATIC PROFILE OF THE DISTRICT

1.4 ECONOMIC PROFILE OF TEHRI(GARHWAL)

The primary sector of the district economy has constantly been declining in terms of its share in the GDDP. The share went down from 20.87% in 2011-12 to 14.76% in 2016-17, with an annual average growth rate of 0.18 percent (Table 1). The secondary sector rose from 35.04% to 35.64% during the same period, thus recording an average annual growth rate of 6.74%. Similarly, the tertiary sector's share went up from 44.09% to 49.6% during the same period, with an annual growth rate of 8.95%. Overall, the district economy grew at 6.43 percent per year during the period under study. The real per capita income in the district went up from Rs. 62593 in 2011-12 to Rs.78775 in 2016-17, with an annual growth rate of 4.76% per annum. It can be inferred that the economic condition of the people depending on the primary sector has worsened vis-à-vis the other sectors. However, the agriculture situation of Tehri Garhwal has been much better than of other hill districts along River Ganga as it recorded positive growth on average. In contrast, other districts of the region experienced negative growth.

Table 1: Trends in Gross District Domestic Product and Per Capita DGDP in Tehri 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	81204	136306	171512	389023	-	-	-	-	62593	-
	(20.87)	(35.04)	(44.09)	(100)						
2012-13	85285	145749	183195	414229	5.03	6.93	6.81	6.48	65428	4.53
	(20.59)	(35.19)	(44.23)	(100)						
2013-14	99886	155427	207454	462767	17.12	6.64	13.24	11.72	72132	10.25
	(21.58)	(33.59)	(44.83)	(100)						
2014-15	76946	163707	228954	469606	-22.97	5.33	10.36	1.48	72060	-0.10
	(16.39)	(34.86)	(48.75)	(100)						
2015-16 RE	76298	176495	242524	495316	-0.84	7.81	5.93	5.47	74798	3.80
	(15.40)	(35.63)	(48.96)	(100)						
2016-17 PE	78241	188873	262901	530015	2.55	7.01	8.40	7.01	78775	5.32
	(14.76)	(35.64)	(49.60)	(100)						
Average growth rate					0.18	6.74	8.95	6.43	-	4.76

Source: UKDES

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

Since our focus is on agriculture and allied activities, we further disintegrate the primary sector GDP to know which sub-sector is laggard and which is driving the sector's growth. Table 2 shows the sub-sectoral trends in the primary sector. The sector is divided into agriculture, allied activities, and mining & Quarrying (M & M&Q). As far as sub-sectoral growth of agricultural and allied sectors is concerned, agriculture, including horticulture, increased by 0.48 percent per year from 2011-12 to 2016-17. Livestock, forestry & logging, and Fishery recorded 1.90%, 1.38%, and

225% average annual growth rates. The share of the agriculture sector went down from 43.79% in 2011-12 to 37.84% in 2016-17, while the corresponding share of livestock rose from 30.15% to 33.49%; the share of forestry and logging went up from 26.02% to 28.19%, and that of Fishery increased from 0.04% to 0.49% during the same period. Mining & quarrying output shows a negative growth of 3.26% per annum. Thus, agriculture allied activities (livestock, forestry & logging, and Fishery) are the growth drivers of the primary sector of the agriculture sector.

Table 2: Trends in GDDP from Agriculture and Allied Sectors in Tehri Garhwal at Constant Prices in Rs. Lakhs (Base 2011-12)

Year	Agriculture	livestock	Forestry & logging	Fishery	Total Agri & allied	Mining & Quarrying	**Primary Sector**
2011-12	32547	22408	19340	27	74323	6882	**81204**
	(43.79)	(30.15)	(26.02)	(0.04)	(100)		
	-	-	-	-	-	-	**-**
2012-13	38523	23888	18890	28	81329	3955	**85285**
	(47.37)	(29.37)	(23.23)	(0.03)	(100)		
	[18.36]	[6.60]	[-2.33]	[3.70]	[9.43]	[-42.53]	**[5.03]**
2013-14	50835	24934	20207	20	95996	3890	**99886**
	(52.96)	(25.97)	(21.05)	(0.02)	(100)		
	[31.96]	[4.38]	[6.97]	[-28.57]	[18.03]	[-1.64]	**[17.12]**
2014-15	29422	23524	19434	29	72410	4536	**76946**
	(40.63)	(32.49)	(26.84)	(0.04)	(100)		
	[-42.12]	[-5.65]	[-3.83]	[45.00]	[-24.57]	[16.61]	**[-22.97]**
2015-16 RE	27340	23954	20099	349	71742	4556	**76298**
	(38.11)	(33.39)	(28.02)	(0.49)	(100)		
	[-7.08]	[1.83]	[3.42]	[1103.45]	[-0.92]	[0.44]	**[-0.84]**
2016-17 PE	27696	24510	20630	355	73192	5049	**78241**
	(37.84)	(33.49)	(28.19)	(0.49)	(100)		
	[1.30]	[2.32]	[2.64]	[1.72]	[2.02]	[10.82]	**[2.55]**
Average growth	0.48	1.90	1.38	225.06	0.80	-3.26	**0.18**

Source: Compile from UKDES

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

2. Figures in [ ] are annual growth rates.

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

Table 3 demonstrates the percentage share of sub-sectors within the secondary and tertiary sectors. Manufacturing contributed 36.8 to 41.3% share within the secondary sector, while construction's share ranged from 17.7 to 21.1%. The average annual growth rate is observed highest in manufacturing (36.06 %), followed by electricity, gas and water supply (6.59%) and construction (5.44%). Thus, secondary sector growth in the district is led by manufacturing activities.

Within the tertiary sector, trade, hotels and restaurants constituted the highest share (27.46%) in 2016-17, followed by other services (25.03%), transport, storage and communication (16.74%), and public services (12.13%). The average annual growth rate is observed highest in other services (12.89%), followed by transport, storage and communication (9.75%), financial services (8.51%), and public services (8.26%). Overall, the district economy is driven by the growth of non-agriculture sectors as agriculture and allied activities achieved very low growth as compared to non-agricultural sectors.

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

Year	Manufacturing	Electricity, gas, water supply	Construction	**Secondary**	Transport, storage, communication	Trade, repair, hotels and restaurant	Financial services	Real estate & professional services	Public administration	Other services	**Tertiary**
2011-12	39.32	41.03	19.65	**100**	16.12	28.61	10.42	9.46	14.22	21.18	**100**
2012-13	36.77	41.25	17.72	**100**	16.46	29.33	10.51	9.63	9.47	24.61	**100**
2013-14	39.90	39.03	21.07	**100**	15.85	28.13	10.17	8.31	12.01	25.53	**100**
2014-15	39.66	40.07	20.27	**100**	16.10	27.28	10.23	8.63	12.98	24.77	**100**
2015-16	40.96	40.06	18.97	**100**	16.83	27.50	10.48	8.54	12.80	23.86	**100**
2016-17	41.30	40.66	18.03	**100**	16.74	27.46	10.22	8.42	12.13	25.03	**100**
Average annual growth (%)	36.02	6.59	5.44	**6.74**	9.75	8.03	8.51	6.56	8.26	12.89	**8.95**

Source: Estimated from statistical handbooks

1.5 The Livelihood Status

Table 4 shows the livelihood status of the workforce in Tehri Garhwal district and Uttarakhand. In 2017, approximately 45% of workers were self-employed, while the corresponding figure for the state is 56.9%. Regular employment is higher (39.2%) in the district than the state average (24.2%). Casual employment of the workforce is lower in Tehri Garhwal (15.5%) than the state average (18.9%). Thus, the quality of livelihood is relatively good in Tehri Garhwal compared to the state as a whole.

Sectoral distribution of employment again reveals that the primary sector dominates the district economy in terms of workforce. Against 39.3% of workers engaged in the primary sector in the state, the corresponding percentage in the district was 50.9. Contrary to this, the secondary sector contributed only 19.2% to the total workers in the district, while its share in the state was 25.4%. An almost similar pattern is observed in the case tertiary sector. Thus, taking employment and GDP together, we can infer that the economic condition of workers in the primary sector is poorer in the district vis-à-vis other sectors than the state as a whole.

Table 4: Livelihood Status in Tehri Garhwal (2017)

Employment Status			Sectoral distribution of employment			Distribution of workers by Skills		
	Tehri	Uttara-khand	Sector	Tehri	Uttara-khand	Skill	Tehri	Uttara-khand
Self-employed	44.4	56.9	Primary	50.9	39.3	Low	15.7	24.9
Regular	39.2	24.2	Secondary	19.2	25.4	Medium	73.2	65.5
Casual	15.5	18.9	Tertiary	29.9	35.3	high	11.1	9.6
Total	100	100	Total	100	100	Total	100	100
Poverty (%)	13.0	15.6	Gini Coeff	0.301	0.308			

Source: Uttarakhand Human Development Report

The distribution of workers by their skills-set indicates that only 11.1% of workers in the district and 9.6% in the state come under the high skills category and the majority of them fall under medium and low categories of skills. Poverty and inequality are slightly lower in the district than in the state, as depicted in the table.

Highlights-1

The primary sector plays a major role in the district economy, with almost 51% workforce engaged in it, although its contribution to the GDDP is less than 15%.

The agricultural economy of the district is largely driven by livestock, forestry & logging, and Fishery.

Mining & Quarrying recorded negative growth of -3.26 during the period.

Within the secondary sector, manufacturing grew faster than other sub-sectors. Consequently, its share in the secondary sector went up from 39.32% in 2011-12 to 41.30% in 2016-17.

Construction contributes slightly over 18% of the secondary sector's GDP and electricity, gas, water supply contributes less than 41%. The electricity, gas and water supply sector in the district contributes almost equal to that of manufacturing to the secondary sector's GDDP. The influence of power generation in Tehri Dam is visible in the secondary sector's GDDP.

In the case of the tertiary sector, the other services recorded 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 analysed two types of data--GIS-based and statistical data compiled from the district statistical handbooks of Tehri Garhwal. As per the GIS-based data (Figure 1 and Table 5), between 2005 and 2015, the area under snow and glacier as a percentage of the total geographical area has decreased from 226.3 km^2 in 2005 to 218.27 km^2 in 2015. Cropland area also decreased from 900.2 km^2 in 2005 to 853.5 km^2 in 2015. Forest area marginally increased from 63.54% in 2005 to 64.73% in 2020. The area under barren land has significantly increased from 1.22 % to 1.47% during the period.

Table 5: Land use/ Land cover statistics classes of Tehri Garhwal district

LULC classes	2005		2015	
	Area (Km^2)	Area(%)	Area (Km^2)	Area(%)
Water	39.08	1.07	53.69	1.47
Forest	2314.08	63.54	2357.64	64.73
Shrubs	112.46	3.09	82.57	2.27
Crops	900.2	24.72	853.5	23.43
Built-Up	5.49	0.15	16.87	0.46
Barren	44.39	1.22	59.45	1.63
Snow and Ice	226.3	6.21	218.27	5.99
Total	**3642**	**100**	**3642**	**100**
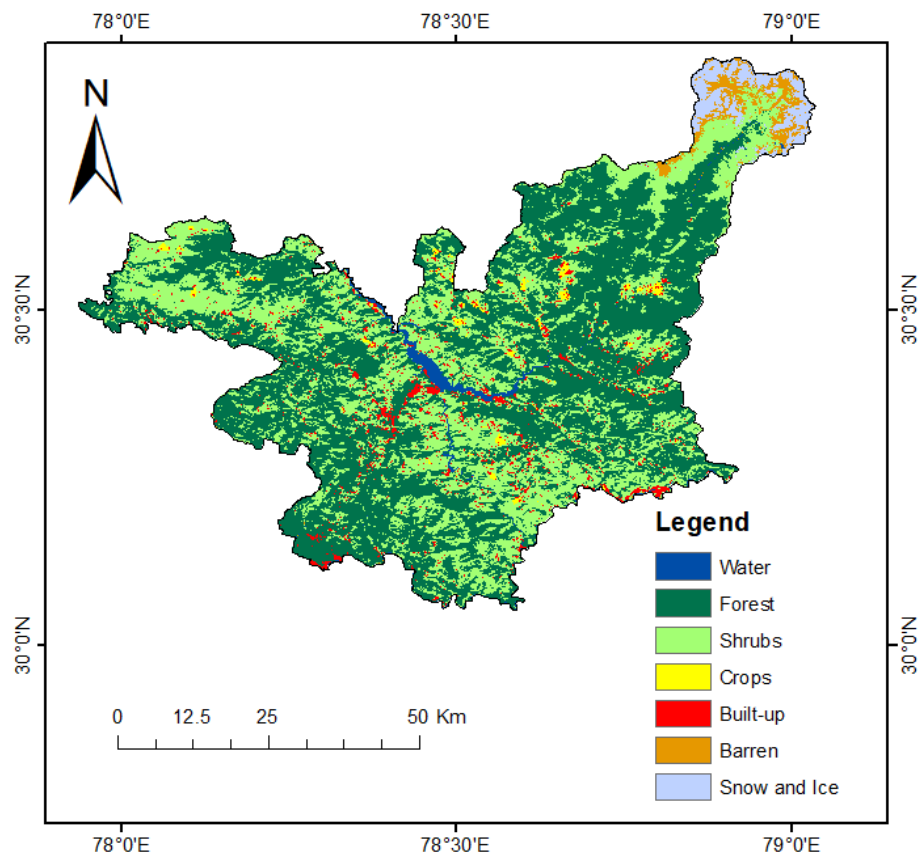
Figure 1: Land Use/Land Cover map of Tehri Garhwal district

Table 6 shows that forest area constituted 66.23% of the total reported area, and it remained constant during the period. The share of barren and uncultivable land has marginally increased from 1.15% in 2011-12 to 1.19% in 2017-18. Areas under permanent pastures have decreased and under trees and gardens have increased in 2018-19. The net sown area has decreased by 0.8% percent during 2009-10 to 2018-19 (Table 6). Overall, land-use pattern does not evince any visible change during the last 8 years, except the area under non-agriculture uses in 2018-19 which has significantly reduced from 11.23% in 2011-12 to 10.43% in 2018-19.

Table 6: Trends in Land-use Pattern in Tehri 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
2011-12	485517	66.23	16.24	1.46	1.56	1.15	1.57	0.10	0.45	11.23

2012-13	485517	66.23	15.24	1.92	1.76	1.21	1.46	0.05	0.93	11.21
2013-14	485517	66.23	15.24	1.94	1.77	1.21	1.46	0.05	0.93	11.18
2014-15	485517	66.23	15.24	1.87	1.77	1.21	1.46	0.05	0.93	11.25
2015-16	485517	66.23	15.24	2.01	1.79	1.21	1.46	0.05	0.93	11.08
2016-17	485517	66.23	15.26	2.12	1.82	1.21	1.46	0.05	0.93	11.08
2017-18	485517	66.23	15.28	2.35	1.84	1.19	1.47	0.01	0.93	10.63
2018-19	485517	66.23	15.42	2.40	1.85	1.19	1.47	0.01	0.99	10.43

Source: Prepared from District Statistical Handbooks of Tehri Garhwal

2.1.2 Trends in Operational Land Holdings

In Tehri Garhwal district, the total number of operational holdings has decreased from 86433 in 2010-11 to 85204 in 2015-16, a net decrease of 1.42 percent. Similar to this, in the state, the number has declined from 912650 in 2010-11 to 881305 in 2015-16, a net decline of 3.43%. The majority of land holdings in the district are marginal and small. These categories of holding together constituted 95.09% 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 (0-1 ha)	Small (1-2 ha)	Semi-Medium (2-4 ha)	Medium (4-10 ha)	Large (10 & above, ha)	Total (Nos.)
Tehri Garhwal	2010-11	75.11	19.03	5.18	0.65	0.02	86433
	2015-16	75.32	19.77	4.51	0.39	0.01	85204 [-1.42]
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.

2.3.3 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 eight years. Wheat, ragi, and Saava together comprise the largest share in the gross cropped area (GCA). The area under these crops marginally declined from 65.13 percent in 2012-13 to 57 percent in 2018-19. Ragi is high nutritious cereal and is in high demand by the consumers. All cereals (rice, wheat, barley, maize, ragi and saava) have a little over 83 percent of the GCA of the district. Pulses consisted of about 14.80 percent share in the total cropped area. Overall, food grains shared over 92.7 percent of GCA in 2018-19. The share of oilseeds is only about two percent. In addition to food grains and oilseeds, Potato is another important crop.

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

Crop/Year	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19
Rice	13.40	14.62	13.73	14.14	14.64	13.53	15.23
Wheat	29.92	28.81	28.88	28.99	28.00	26.87	24.75
Barley	2.09	2.43	2.49	1.97	1.92	2.69	2.46
Maize	2.54	2.30	2.49	2.18	2.18	2.74	2.23
Ragi	15.07	15.62	14.30	13.43	14.35	14.39	13.79
Saava	20.14	18.33	18.67	18.85	18.36	18.95	18.46
Total Cereal	83.16	82.10	80.56	79.57	80.13	79.91	77.92
Urad	2.50	2.34	0.25	3.07	3.10	3.62	3.90
Masoor	2.24	1.45	1.19	1.06	1.18	0.77	1.08
Arhar	1.44	1.33	1.97	1.89	1.54	2.01	2.25
Kulthi Bean (Gehat)	-	1.23	-	3.77	3.68	4.71	5.30
Bhatt	-	0.24	-	0.18	0.18	0.10	0.20
Kidney Bean	-	-	-	1.31	1.29	1.45	1.46
Total Pulses	6.41	5.36	6.36	6.15	11.23	13.06	14.80
Total Food Grains	89.57	87.46	86.92	85.72	91.37	92.97	92.72
Mustard	1.24	1.09	1.28	1.00	1.14	1.02	1.03
Net Til	0.54	0.56	0.45	0.51	0.52	0.61	0.66
Soybean	0.73	0.74	0.69	1.07	0.88	0.77	0.83
Total Oilseeds	2.52	2.39	2.42	2.58	2.60	2.46	2.53
Potato	0.45	1.61	1.45	1.33	1.03	1.26	1.67
Net Sown Area (% of GSA)	65.62	69.88	66.41	66.41	66.35	67.05	69.12
Gross Sown Area (ha)	82914	77673	82222	82222	81095	76993	73287
Cropping Intensity	152.39	143.09	150.58	150.58	150.71	149.14	144.68

Source: Estimated from District Statistical Handbooks

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 14.4 qtls/ha in 2012-13 and as high as 19.67 qtls/ha in 2017-18. Similarly yield of wheat ranges between 14.89 to 21.11 qtls/ha during 2012-13 to 2018-19. A more or less similar pattern is also observed in barley. Maize yield shows significant variation across years (Table 9). It is significant to note that the average productivity of ragi and saava has been at par with rice and wheat. Relatively being high-value crops, these crops have the potential to raise the farmers' income if proper marketing support is provided to the farmers. Marketing support and R&D intensification can make these crops more remunerative for farmers.

Among pulses, per hectare yield is higher in arhar and urad than other crops. Among oilseeds, soybean is an important crop. Its yield ranges between 6.8 to 9.83 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 75.47 to 191.87 qtsl/ha. Thus, ragi, saava, urad, arhar, masoor, soybean and Potato are promising crops for farmers of the district.

Table 9: Per hectare yield of Principal Crops in Tehri Garhwal District (in Quintal)							
Crop/ Year	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19
Rice	14.4	15.8	16.814	17.1	15.71	19.67	17.8
Wheat	14.89	14.51	10.95	12.23	14.19	15.83	21.11
Barley	13.57	13.4	12.24	10.81	14.96	12.71	17.04
Maize	11.56	11.56	25.24	16.77	16.88	22.53	16.78
Ragi	14.93	14.57	15.06	15.88	17.27	15.83	13.93
Saava	14.57	15.42	15.507	14.62	15.31	13.32	15.74
Amaranth	-	-	-	9.63	10.46	10.49	10.49
Total Cereals	14.53	14.71	14.144	14.33	15.34	15.96	17.52
Urad	6.43	8.66	8.83	7.07	7.24	5.76	7.7
Masoor	7.45	8.85	8.04	7.46	6.04	6.08	5.39
Arhar	7.63	7.63	10.7	10.5	10.78	11.33	8.78
Kulthi bean (Gehat)	-	8.79	-	8.33	9.38	6.48	8.7
Bhatt	-	7.26	-	7.15	6.62	6.89	6.88
Kidney Beans	-	9.36	-	8.83	8.48	6.5	9.5
Total Pulses	7.76	8.2	8.657	8.25	8.42	7.01	8.22
Total Food Grains	13.68	13.71	13.429	13.56	14.49	14.7	16.04
Mustard	5.52	5.5	3	6.73	9.73	5.4	7.17
Till	2.43	2.43	2.47	2.58	3	3.14	3.18
Soybean	8.96	8.95	9.93	9.5	5.21	6.8	8.98
Total Oil Seeds	5.73	6.09	4.88	7.07	6.7	5.24	6.73
Potato	90.67	92.24	91.3	75.47	100.43	191.87	113.57
Source: Estimated from District Statistical Handbooks							

iii. Trends in Production of Principal Crops

Table 10 depicts that among the individual cereal crops, wheat consisted of the highest production (38298 tons), followed by saava (21291 tons), rice (19864 tons) and ragi (14071 tons). Saava and ragi together had a 33.34 percent share in the total cereal production in 2018-19. **These high-value and high-nutrition crops can be promoted under organic farming to enhance farmers' income.** Among pulses, Kulthi bean (Gehat) had the highest share (37.8%) in the total pulses

production. It is followed by urad (24.7%). In the case of oilseed production, soybean and mustard are the main crops, which comprised about 87% of the total oilseeds production of the district. Production of Potato was highest (18669 metric tons) in 2017-18 and lowest (3273 metric tons) in 2012-13.

Table 10: Trends in Production of Principal Crops (in Metric Tons)

Crop/ Year	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19
Rice	17448	18563	18985	19881	18655	20486	19864
Wheat	17448	18563	18985	29139	32230	32749	38298
Barley	2614	2762	2509	1755	2332	2634	3071
Maize	2447	2374	5172	3007	2986	4747	2745
Ragi	19073	17105	17704	17541	20102	17545	14071
Saava	26187	22950	23798	22659	22797	19432	21291
Total Cereal	110485	100857	94482	94465	99679	98175	100061
Urad	1962	2566	2125	1784	1822	1607	2202
Masoor	864	1018	789	648	579	358	425
Chana	5	95	3	4	9	3	9
Matar	151	47	113	56	66	96	45
Arhar	1151	1326	1733	1636	1350	1749	1446
Kulthi bean (Gehat)	-	-	-	2585	2803	2351	3378
Bhatt	-	-	-	105	96	51	100
Kidney Beans	-	-	-	954	884	724	1017
Total Pulses	8417	10164	8655	7772	7668	7053	8916
Total Food Grains	118902	111021	103137	102237	107347	105228	108977
Mustard	622	756	315	553	896	426	542
Till	140	122	92	108	141	160	154
Soybean	592	826	565	838	374	405	548
Total Oil Seeds	1354	1704	974	1499	1412	991	1247
Potato	3273	11613	10874	8272	8406	18669	13924

Source: Compiled from District Statistical Handbooks

We have calculated crop-wise average, standard deviation (SD) and coefficient of variation (COV) in the area, production and yield of principal crops to understand variability across years. In the case of area under different crops, the lowest variability is observed in rice (4.08%), closely followed by total cereal (5.92%) saava (6.79%), and ragi (6.94). It is observed highest Kulthi bean (58.57%) Bhatt (54.09%) and kidney bean (53.89%). Overall, area under pulses has more variability than the area under cereals and oilseeds (Table 11).

Table 11: Variability in Area, Production and Yield of Principal Crops (2012-13 to 2018-19)

Crop/Year	Area	Production	Yield

	Average	SD	COV	Average	SD	COV	Average	SD	COV
Rice	11261	460	4.08	19003	1068	5.62	16.76	1.57	9.37
Wheat	22328	2266	10.15	24852	7266	29.24	14.82	2.99	20.22
Barley	1818	198	10.89	2434	363	14.89	13.53	1.86	13.72
Maize	1893	191	10.08	3250	1312	40.37	17.33	4.74	27.33
Ragi	11464	796	6.94	18178	1156	6.36	15.35	1.01	6.55
Saava	14969	1017	6.79	22971	2176	9.47	14.93	0.77	5.18
Total Cereal	64000	3792	5.92	99691	5910	5.93	15.22	1.10	7.26
Urad	2112	919	43.51	1978	337	17.03	7.38	1.03	14.00
Masoor	1023	403	39.38	709	232	32.74	7.04	1.15	16.33
Arhar	1407	242	17.22	1491	249	16.67	9.62	1.46	15.13
Kulthi Bean (Gehat)	2911	1705	58.57	2580	1420	55.05	8.34	3.95	47.36
Bhatt	139	75	54.09	84	50	58.94	6.96	3.23	46.37
Kidney Bean	1077	576	53.49	854	474	55.46	8.53	4.05	47.51
Total Pulses	7111	2776	39.04	8288	1081	13.05	8.07	0.50	6.21
Total Food Grains	71111	2572	3.62	107979	6212	5.75	14.23	0.86	6.07
Mustard	888	117	13.16	595	213	35.75	6.15	1.91	31.03
Net Til	435	37	8.48	127	25	19.47	2.75	0.32	11.61
Soybean	650	114	17.45	600	199	33.18	8.33	1.57	18.82
Total Oilseeds	1987	121	6.07	1322	289	21.84	6.06	0.76	12.55
Potato	992	312	31.41	10185	5081	49.89	107.94	35.87	33.24

Source: District Statistical Handbooks

Overall, variability in the production of different crops is higher than in the area under these crops. Bhatt has the highest COV in production (58.94 %), followed by kidney beans (55.5%) and Kulthi bean (55.05%). Variability in production depends on the variability in the area under the crop and variability in the yield. In some crops, variability in yield is higher than that in the area (for example, Potato, mustard, wheat and maize), while in some crops, it is lower than that in the area (for example, saava, urad). Several factors, such as market prices and rainfall patterns, affect the variability in agricultural production. **High variability in the production of various crops implies that returns to farmers from agriculture is volatile and cause farmers' income vulnerability.**

2.1.4 Consumption of Chemical Fertilizers

It is significant to note that per hectare, the use of chemical fertilizers is almost negligible. Table 12 shows that the use of nitrogen ranges between 0.79 kgs/ha to 1.44 kgs/ha of GCA. Phosphorous use ranges between 0.30 kgs/ha to 0.58 kg/ha of GCA. The use of potassium is almost zero. Total fertilizers use ranges from 0.81 kg/ha to 1.75 kg/ha of GCA (Table 12). **It can be inferred from the fertilizers consumption data that the district's agriculture is almost chemical-free, and farmers have a natural advantage to do organic farming.**

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

Fertilizer/Year	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19
Nitrogen	1.25	1.15	1.44	1.12	0.91	0.79
Phosphorous	0.38	0.56	0.58	0.50	0.30	0.41
Potassium	0.02	0.05	0.02	0.01	0.03	0.00
Total	1.52	1.75	0.81	1.63	1.24	1.20

Source: Compiled from 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 that there is not much progress in adding the length of canals during the last five years. The length ranges between 717 to 823.3 kilometers. The number of water tanks has increased from 9190 in 2013-14 to 9672 in 2019-20, a net increase of 482 tanks. Length of *Gool* has increased from 4360 Kms in 2013-14 to 5085.4 Kms in 2019-20, a net gain of 455 kms during the period. The number of high drums declined from 96 in 2013-14 to 25 in 2019-20.

Agriculture in the district is mostly under rain-fed conditions. The net cultivated area under irrigation ranges between 13.11 to 14.70 percent. There is not much progress in bringing more area under irrigation. Gross irrigated areas as a percentage of GCA is also quite low (16.59-18.95%).

Table 13: Types of Irrigation Systems year-wise data in Tehri Garhwal District

Name/Year	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
Length of Canal (KM)	717	760.959	781.859	781.383	784.413	784.683	823.273
No. Of Ground level pump set	5	5	5	5	5	5	5
No. Of borewell pump set	2	2	2	2	2	2	2
No. Of tanks	9190	9370	9437	9479	9523	9588	9672
Gool in KM	4630	4842	4913	4962	4993.788	5029.402	5085.397
No. Of high drums	96	96	32	32	32	25	25
% Of NIA	13.52	13.11	14.17	14.70	13.49	14.70	-
% Of GIA	17.80	16.59	17.32	18.29	17.04	18.95	-

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 in the district has been gradually changing from 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. As agriculture is not remunerative and able to generate gainful employment, the youths out-migrate in search of better livelihood options, which 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 the promotion of high-value crops (HVCs) such as vegetables, fruits, mushrooms, flowers, and medicinal crops. If HVCs are promoted, hotels and dhabas, largely driven by tourists, may get fresh vegetables, fruits, and other food items from the local farmers. The floating population in the district is quite high. This population needs different kinds of agro-products and handicrafts which 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. However, there are three deterrents—out-migration, the menace of wild animals, and interspersing of cultivated land with inactive and abandoned landholding. The possibility of evolving an economically viable model of convergence of MGNREGA activities with the concerned line departments needs to be explored to promote HVCs and improve livelihood. Uttarakhand Human Development Report (2018) shows that about three-fourths of the total first-time migrant in Tehri Garhwal migrated alone and about 25.4 percent with family members (Table 14).

Table 14: Process of Migration (First Migration) in Tehri 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
Tehri Garhwal	62.1	25.4	7.6	4.9	0.0	0.0	100
UK	72.1	18.0	6.6	2.6	0.1	0.6	100

Source: Uttarakhand Human Development Report

2.1.7 Status of Organic Farming

To promote sustainable agricultural practices and improve the farmers' livelihood, the Government of India launched PKVY and Namami Gange schemes. Under these schemes, farmers are incentivized to form groups to do organic farming and sell their products with PGS certification. The state set up the Uttarakhand Organic Commodity Board (UOCB) in 2003 as a nodal agency to facilitate organic clusters and provide technical support to promote organic farming. The area under organic farming in the state was about 18% of the NSA in 2019 (https://www.downtoearth.org.in/blog/agriculture/how-indian-states-are-promoting-organic-natural-farming-73306). Uttarakhand is the first state of India which enacted Organic Farming Act in 2020 and declared 10 of its blocks (Dunda, Pratapnagar, Jaihari Khal, Jakholi, Augustmuni,

Ukhimath, Dewal, Salt, Betalghat and Munsyari) fully organic. The hill districts of the state, including Tehri Garhwal, have a natural advantage in organic farming as per hectare use of chemical fertilizers is quite low. Pratapnagar block of the district also belongs to the category of a fully organic block. The use of chemical fertilizers and pesticides is banned in this block.

Table 15 shows the status of organic farming PGS groups constituted under PKVY and Namami Gange schemes. As on June 30, 2021, there are a total of 860 organic farming groups with 44845 registered farmers in the district. Out of these groups, about 79% constituted under the PKVY and 21% under the Namami Gange. The median number of farmers per group is 50 under PKVY and 51.5 under the Namami Gange. The high value of SD in the case of organic farmers of Namami Gange groups indicates that the number of farmers per group has higher variability in the Namami Gange scheme than PKVY. Block-wise data show that under PKVY, the highest number of groups and number of farmers are in Narendranagar (130 and 6235), followed by Deoprayag (93 and 4710) and Jaunpur (86 and 4229) and lowest in Jakhnidhar (44 and 2397).

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

S.No.	Block	Scheme	No. of groups	No. of farmers in groups			
				Total	Average	Median	SD
1	Bhilangna	PKVY	66	3328	50.42	50	3.73
		Namami Gange	18	1505	83.61	74.5	49.46
2	Chamba	PKVY	85	4224	49.69	50	4.98
		Namami Gange	27	1665	61.66	56	31.96
3	Deoprayag	PKVY	93	4710	50.64	50	5.09
		Namami Gange	24	1273	53.04	51	20.68
4	Jakhnidhar	PKVY	44	2397	54.47	50	17.93
		Namami Gange	11	1089	99	87	43.99
5	Jaunpur	PKVY	86	4229	49.17	50	4.25
		Namami Gange	0	0	0	0	0
6	Kirtinagar	PKVY	67	3292	49.13	50	4.09
		Namami Gange	51	2872	56.31	49	26.61
7	Narender Nagar	PKVY	130	6325	48.65	50	6.01
		Namami Gange	37	1935	52.29	50	21.2
8	Pratapnagar	PKVY	59	2889	48.96	50	6.63
		Namami Gange	0	0	0	0	0
9	Thauldhar	PKVY	50	2468	49.36	50	2.01
		Namami Gange	12	644	53.66	49.5	22.34
10	Total district (Tehri Garhwal)	PKVY	680	33862	49.79	50	6.71
		Namami Gange	180	10983	61.01	51.5	32.2
		Total	860	44845	52.14	50	16.51

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

Pratapnagar and Jaunpur do not have any group under the Namami Gange scheme. The highest number of groups under the scheme is in Kirtinagar (51), followed by Narendranagar (37). Since economies of scale in both production and marketing matter in organic farming, possibilities of some institutional framework in the forms of SHGs/ farm cooperative/PFOs/contract farming, etc., may be designed. Organic farming could be an economically viable option in the district if the government builds strong marketing networks linking farmers, processors, and distributors with the easy certification process and minimizing farmers' risk by protecting their farm income through payments of ecosystem 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 in the district.

2.2 Trends in Livestock

Livestock has an important place in the rural economy. Table16 shows that the total number of cattle (cows and bulls) has decreased from 122738 in 2003 to 86362 in 2019. During this period, there has been a decline in the number of male and female cattle, but the number of male cattle has drastically declined, probably due to a lack of demand for animal power. A similar trend is observed in the case of Buffalo. Comparing 2003 and 2019 data, we observe that number of buffaloes has also declined substantially, particularly the male ones. The number of sheep shows ups and downs during the entire period. It was highest in 2012 (43323) and then declined to 21145 in 2019. However, the number of goats has increased during the period from 101637 to 126944. Between 2003 and 2012, the number of poultry has approximately doubled.

Table 16: Trends in Livestock population (in numbers) during 2003-2019

Livestock	Category	2003	2007	2012	2019
Indigenous Cattle	Total Male	72445	79092	52394	40818
	Total Female	48025	41804	32530	40015
	Total	120470	120896	84924	80833
Exotic Cattle	Total Male	1298	520	6013	1267
	Total Female	970	1310	9249	4262
	Total	2268	1830	15262	5529
Total Cattle		122738	122726	100186	86362
Buffalo	Total Male	16741	17021	15140	2599
	Total Female	97298	89555	76341	76795
	Total	114039	106576	91481	79394
Sheep	Total Indigenous Sheep	14749	21456	20064	12969
	Total Exotic Sheep	7177	2699	23259	8176

	Total Sheep	14878	24155	43323	21145
Goat	Total Male	-	-	-	34910
	Total Female	-	-	-	92034
	Total	101637	134245	125899	126944
Pig	Total Indigenous Pig	1232	934	412	420
	Total Exotic Pig	923	12	197	203
	Total Pig	2155	946	609	623
Total Livestock		372875	407904	377878	-
Total Poultry		28611	46130	58941	-

Source: Compiled from District Statistical Handbook

Table 17 shows that the number of cattle hospitals and cattle development centres increased over the period. The number of man-made reproduction centres also increased from 29 to 33. There is no change in the number of sheep development centres and poultry units.

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

Category	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
Cattle Hospital	32	33	37	38	38	38	38
Cattle Development Centre	80	82	91	92	92	92	92
Man-Made Reproduction Centre	29	30	36	44	33	33	33
Man-Made sub-Centre	-	-	0	0	18	18	18
Cattle Reproduction Farm	0	0	1	1	1	1	1
Sheep Development Centre	4	4	4	4	4	4	4
Poultry Units	1	1	1	1	1	1	1

Source: Compiled from District Statistical Handbook

2.3 Trends in Horticulture Crops

The district has a high potential for horticulture development. With policy support and a well-designed action plan, this sector can be the growth driver for the agriculture sector. Table 18 shows that in 2019-20, walnut constituted the highest share (23.12%), followed by apple (18.48%), and mango (17.30%). The total area under fruits shows variation across years.

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

Crop/Year	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
Apple	18.32	18.35	27.66	20.03	19.91	19.87	18.48
Pear	8.57	8.79	13.14	4.86	4.78	4.80	8.75
Peach	1.16	1.02	1.66	6.01	5.87	5.87	1.09
Plum	5.74	5.74	8.65	5.83	5.71	5.87	12.88

Apricot	7.41	7.25	10.85	3.79	3.80	3.81	7.23
Walnut	23.48	23.44	34.99	9.67	9.85	9.89	23.12
Lemon	7.87	7.62	11.57	23.85	23.75	23.63	7.73
Mango	17.34	17.14	25.98	14.35	14.46	14.42	17.30
Litchi	0.20	0.18	0.29	0.43	0.44	0.51	0.21
Other Fruits	9.91	10.46	15.01	11.19	10.98	11.04	10.33
Total (ha)	21001 (100)	20318 (100)	13812 (100)	4143 (100)	4287 (100)	4338 (100)	20867 (100)

Source: Estimated from District Statistical Handbook

Production of apples ranges from 736 tons in 2016-17 to 1984.3 tons in 2019-20. Its production has steeply declined in recent years but improved drastically in 2019-20. The same pattern has been observed in all other horticulture crops. The total output of fruits ranges from approximately 6914 tons in 2017-18 to 28268 tons in 2019-20 (Table 19).

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

Crop/Year	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
Apple	1923.5	1815.78	1910.18	736.02	756.557	772.23	1984.3
Pear	4860	4672.9	4901.13	142.23	225	233.81	4936.63
Peach	951.6	810.04	894.17	198.7	269.813	275.2	926.65
Plum	2653.2	2565.52	2627.26	130.54	240.498	254.54	2687.9
Apricot	1244.8	1208.74	1198.97	164.3	197.096	203.55	1214.35
Walnut	1183.6	1151	1156	611.07	695.745	710.98	1179.91
Lemon	2973.6	2585.81	2876.8	1618.26	1778.787	1795.64	2910.5
Mango	10376.85	9464.88	10227.92	1590.71	1816.534	1838.1	10265.04
Litchi	10.27	7.38	10.02	14.52	19.337	21.86	12.37
Other Fruits	2127	2527.42	2091	729.73	864.536	889.13	2150.77
Total	28304.42	26809	17733.52	5936.08	6914.27	7015.1	28268.42

Source: Compiled from District Statistical Handbook

Table 20 shows that the per hectare yield of almost all crops has declined during 2013-14 to 2019-20. The productivity of Plum decreased from 2.2 tons/ha in 2013-14 to 1 ton/ha in 2019-20. The yield of peach evinces ups and downs during the period. Per hectare yields of all fruits range from 1.0-1.86 tons/ha. Overall, the productivity of total fruits has remained less than 1.75 tons/ha. The above analysis indicates that there is not much change in the district's overall yield of fruits. The reasons for this stagnant condition of horticulture in the district need to be explored, and measures should be taken to improve it.

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

Crop/Year	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
Apple	0.50	0.49	0.50	0.89	0.89	0.90	0.51

Pear	2.70	2.62	2.70	0.71	1.10	1.12	2.71
Peach	3.90	3.90	3.90	0.80	1.07	1.08	4.07
Plum	2.20	2.20	2.20	0.54	0.98	1.00	1.00
Apricot	0.80	0.82	0.80	1.05	1.21	1.23	0.81
Walnut	0.24	0.24	0.24	1.53	1.65	1.66	0.24
Lemon	1.80	1.67	1.80	1.64	1.75	1.75	1.80
Mango	2.85	2.72	2.85	2.67	2.93	2.94	2.84
Litchi	0.25	0.21	0.25	0.81	1.01	0.98	0.28
Other Fruits	1.02	1.19	1.01	1.57	1.84	1.86	1.00
Total Fruits	1.35	1.32	1.28	1.43	1.61	1.62	1.35

Source: Compiled from District Statistical Handbook

Area, production, and yield of almost all fruits evince a high magnitude of variability as indicated by COV values. In the area, the highest COV is in Plum, closely followed by walnut, apricot, and pear. In production, COV is highest in pear, followed by Plum, apricot, and mango. In yield, the highest variability is observed in walnut, followed by litchi and peach. The high variability in production is due to both variabilities in area and yields.

Table 21: Variability in Area, Production and Yield of Principal of Fruit Crops (2013-14 to 2019-20)

Crop/Year	Area (ha)			Production (tones)			Yield (tons/ha)		
2019-20	Average	SD	COV	Average	SD	COV	Average	SD	COV
Apple	2542.65	1585.30	62.35	1414.08	618.63	43.75	0.67	0.21	31.22
Pear	1120.24	856.37	76.44	2853.10	2482.98	87.03	1.95	0.92	47.26
Peach	237.77	16.95	7.13	618.02	349.82	56.60	2.67	1.59	59.28
Plum	999.27	881.14	88.18	1594.21	1297.29	81.38	1.45	0.72	50.00
Apricot	931.67	720.61	77.35	775.97	550.01	70.88	0.96	0.20	20.78
Walnut	2943.44	2363.58	80.30	955.47	266.68	27.91	0.83	0.73	88.52
Lemon	1349.24	318.49	23.60	2362.77	606.09	25.65	1.74	0.07	3.83
Mango	2308.78	1586.73	68.73	6511.43	4465.83	68.58	2.83	0.10	3.52
Litchi	31.56	11.41	36.15	13.68	5.26	38.46	0.54	0.37	69.17
Other Fruits	1406.90	875.84	62.25	1625.66	761.72	46.86	1.36	0.39	28.86
Total of Fruits	12680.95	8254.14	65.09	17282.97	10604.97	61.36	1.42	0.14	9.69

Source: Estimated from District Statistical Handbook

2.4 Trends in Area, Production and Yield of Vegetable Crops

Table 22 shows the trends in area, production and per hectare yield of total vegetable crops. The area under vegetables shows ups and downs. It was lowest (2717 ha) in 2016-17 and highest in 2019-20 (8265 ha). However, the per hectare yield of vegetables shows less variation across years. It ranges from 7.76 tons/ha to 8.98 tons/ha. The area under Potato has decreased for three-year period from 2015-16 to 2018-19, but in 2019-20 it again reached the same level as in 2013-14. The yield of Potato ranges between 16.38 tons/ha to 19.49 tons/ha.

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

Crop/Year		2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
Total Vegetables	A	8176	7992	8229	2717	2788	2853	8265
	P	73434	70643	73896	21226	21745	22611	64135
	Y	8.98	8.84	8.98	7.81	7.80	7.93	7.76
Potato	A	2561	2511.5	2528.1	792.35	830.153	834.07	2534.57
	P	49934	48833	49118	12976	13682	13763	49210
	Y	19.49	19.45	19.42	16.38	16.48	16.50	19.42

Source: Compiled from District Statistical Handbook

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.

Highlights-3

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

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 2019-20, the area under walnut crop constituted the highest share (23.12%), followed by Apple (18.48 %) and Mango (17.30%).

On average, the production and yield of most of the fruit crops have declined over the period.

Area, production, and yield of fruits show high variability across years. The variability in production is driven by both variability in the area as well as the variability in yield.

2.3 Forestry

Total geographic area of the district is 3642 Km^2. As per 2019 Forest survey of India assessment, the district has 56.73% of forest area of total geographic area. The total forest cover in the district is 2065.98 Km^2. From this total area 272.71 Km^2 comes under very dense forest (VDF) category, 1084.08 Km^2 is moderately dense forest (MDF), and 709.19 Km^2 area is open forest (OF) (FSI, 2019).
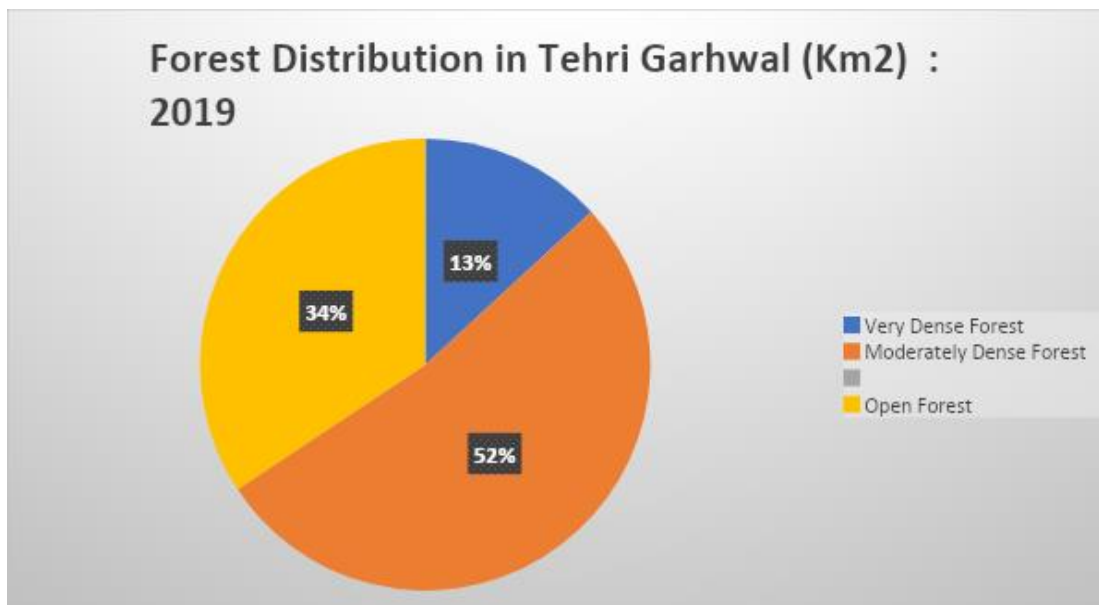
Forest Survey of India 2019 Uttarakhand vs Tehri Garhwal Comparative Assessment						
Area	Geographical Area	Very Dense Forest	Moderately Dense Forest	Open Forest	Total	%of Geographical Area
Tehri Garhwal	3642	272.71	1084.08	709.19	2065.98	56.73%
Uttarakhand	53483	5046.76	12805.24	6451.04	24303.04	45.44%

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 Tehri Garhwal district. As per the data, 1654 flora and fauna have been observed till now. A total of 649 species are present in the district, in which 52.85% are insects, 21.73% plant species, 0.46% amphibian, 1.69% mammal species, 17.1% birds, and 1.39% reptiles.

Table 1 Bird species recorded in the district.

Number of species	608
Number of rare/accidental species	5
https://avibase.bsceoc.org/checklist.jsp?lang=EN&p2=1&list=clements&synlang=&region=INwhuktg&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
3642	272.71	1084.08	709.19	2065.98	56.73	0.98	97.44

Forest cover

- Very dense forest
- Mid dense forest
- Open forest
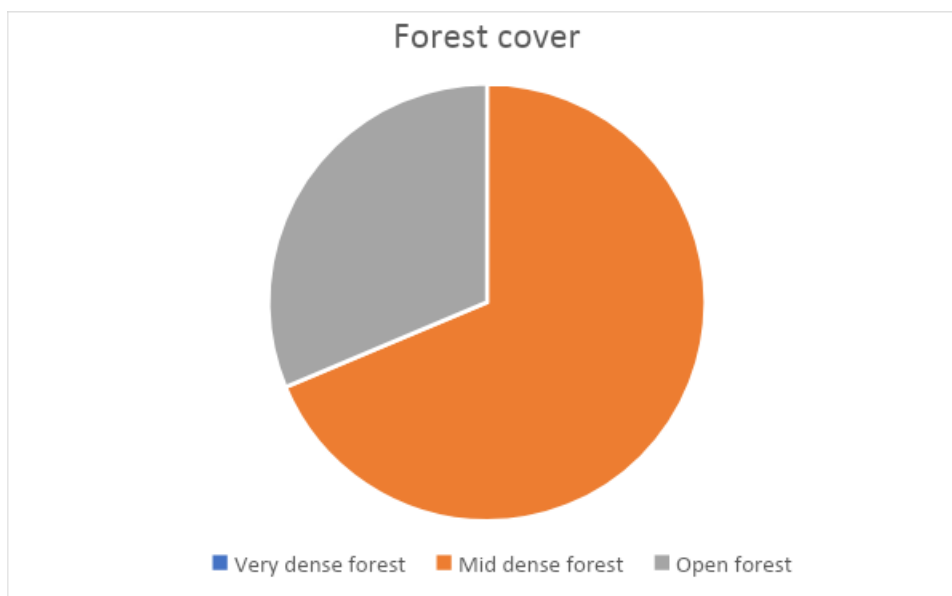
2.4 Tourism

2.5 Wetlands

The district does not consist of many wetlands. The district consists of areas like the Tehri dam reservoir, one of the large size water bodies present in the district. Table 1 represents the number of wetlands and their area representation in the district.

Table 1: Wetland Data of Tehri Garhwal District

Wetland Types	Total Number of												Aquatic Vegetation
	Wetlands:			Area (ha)									
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	11	11	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 (39)	1	12	11	17	0	0	0	0	0	0	0	1	1

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

- The district comprises 29 wetlands; most of them are rivers/streams.
- One artificial wetland is available in the district.
- One wetland has 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 graph represented by Fig. 1 represents the percentage of households using different sources for lightning. This data is according to the 2011 census. 87.62% households depend on electricity for lightning, 9.40% on kerosene and only 2.24% on solar.
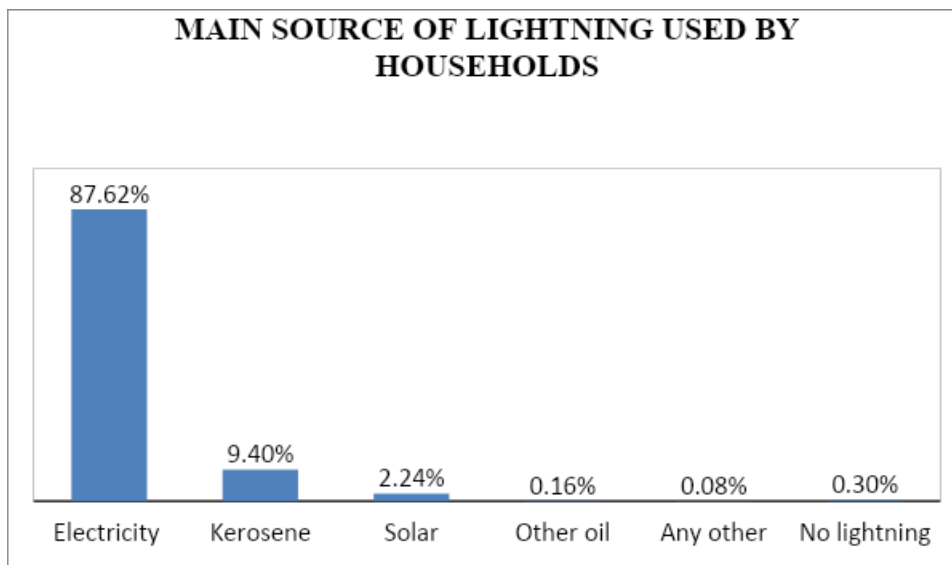
Fig.1

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

Solar water heating systems were proposed to be installed in 2019-2020 at Girls hostel, Aampata, Narendrenagar; Girls hostel Routu Ki Veli, Jonpur; Girls hostel, Koshal, Tholdhar; Girls Hostel, Akhodi, Bhilangana and Girls Hostel, Sujadgaon, Pratapnagar of 2300 LPD capacity in the district Tehri Garhwal.

442 Solar cookers were installed under the Mid day meal and market mode programme up to the year 2015-2016.

Concentrating solar technology (CST) is a device which can concentrate solar radiation using mirrors to produce temperatures in the range of 100 to 450˚C or more. These are very useful in medium and high temperatures required for various applications. A CST system was installed in 2011-2012 in the district of 16 sqm. at Gau Tirth Ashram, Koteshwapuram, Tehri for distillation of cow urine for medicinal use.

A 4MWp solar panel has been installed at Thal, Nainbag. Solar Panels have also been installed at Kastal (Patti Nagun) and Lingwana (Devprayag) villages of 200 kW and 400kW capacity each. Another project costing 200 Lakh and employing 3 people of 500kW capacity at the village Silkoti has been installed.

2.6.2.Biomass Energy

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

The economy and the livelihood of the district is dependent on agriculture and hence a good amount of biomass is produced in the form of agricultural residue. The cropping intensity of the district is 157.40% with 56200 ha of net sown area and 88460 ha as the gross sown area. The major crops and their productivity is given in table 1.

CROP	PRODUCTIVITY (q/ha)
Rice	25-30
Finger millet	20-23
Barnyard millet	20-23
Urd	12-23
Soyabean	30-35
Arhar	16-20
Wheat	30-35
Gram	20-26

Table 1

The district Tehri Garhwal has 56.73% of its area under forests out of the total geographical area which accounts to 2065.98 sq. km. 272.71 sq. km. area is under very dense forests, 1084.08 is under moderately dense forests and 709.19 sq. km. is under open forests. The biomass production of chir pine *(Pinus roxburghi)* from the forests of the district accounts between 105.8-132.7 Mg/ha (Sharma et. al. 2020).
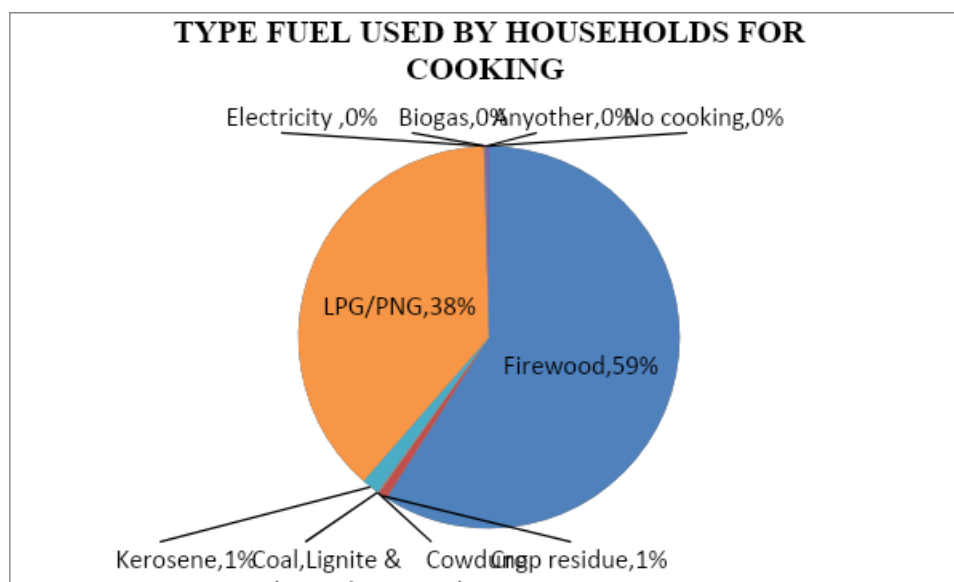
Fig. 1

According to the data from the 2011 census (as depicted in figure), 59% people use firewood, 38% use LPG/PNG, 2% kerosene and 1% crop residue as cooking fuel.

The district website and the other resources available do not have any data about the biomass energy plants. Hence it is clear that in spite of having a good source of biomass in the form of agriculture residue and forest residue the district lacks awareness about biomass energy.

2.6.3.Biogas Energy

Five family-sized biogas plants have been installed in the district between the years 2009 to 2019. One biogas power generation plant, "Uttarakhand Gau Sambardhan, Gau-Tirthashram, Koteshwarpuram," of capacity 85 m^3, was installed in the district. Biogas potential has been evaluated by average livestock and agricultural waste production. Biogas potential from animal waste is calculated approximately as fifty-five lakh m^3/year and two 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 rushing Bhagirathi River, which runs through the district, appears to divide it in half, while the Bhilangna, Alaknanda, Ganga, and Yamuna rivers border it on the east and west, respectively. Two hydropower plants are in operation, and twenty-three hydropower stations are under construction in the district.

3 QUALITATIVE DATA ANALYSIS

3.1 AGRICULTURE, ALLIED ACTIVITIES,

SWOT Analysis for Organic Farming

Based on the data analysis related to the cropping pattern, production, yields, and use of chemical fertilizers, we find that the district has ideal conditions for sustainable agricultural practices, including natural and organic farming. Organic farming in high-value ragi, saava, urad, kulthi, mustard, and soybean can be promoted on a cluster basis under the PKVY and Namami Gange schemes within the crop sector. Within horticulture, off-season vegetables, including Potato, cabbage, and the production of fruits, can be developed. Technology transfer through KVK and horticulture and agricultural universities of the region can help the organic farmers reduce the cost of cultivation and enhance productivity per unit of land, labor, and other resources. To understand the potential of up-scaling of organic farming in the district, we conduct the SWOT analysis as given below:

SWOT Analysis of Organic Farming in the District

Strengths	Weaknesses
● Suitability of agro-ecology for horticulture and livestock ● Agro-biodiversity and multiple cropping System ● A natural advantage for organic farming (OF) as agriculture is almost chemical-free ● The abundance of organic manure (forest leaves and cattle urine & Dung) ● Community-based certification system (PGS) ● Less dependence on external inputs ● Agriculture and Horticulture Universities in the region ● Market Proximity (Dehradun, Delhi NCR)	● Ecological Fragility ● Small and scattered land holdings ● Lower productivity during the transition period ● Inadequate marketing infrastructure and market linkages ● Knowledge and skills-deficit in OF ● Lack of effective monitoring ● Inadequate irrigation facilities ● Inadequate testing and certification system ● Lack of effective farmers' Organisation ● Poor road connectivity to remote villages
Opportunities	Threats
● Consolidation of agricultural holdings ● Income-elastic demand for organic products ● Crop-livestock integrated farming system ● High tourists flow and scope for agro-tourism ● Common "Namami Gange" brand ● Possibility of Convergence with MGNREGA ● Local employment generation ● Agro-processing at primary and secondary levels ● Government Institutional and policy support	● The intrusion of wild animals ● Abandonment of agriculture due to out-migration ● Vulnerability to natural factors (landslides and disasters) ● The declining number of cattle and buffaloes ● High transaction cost ● Market risks ● Women drudgery

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Highlights-2

NSA in the district is less than 12% of the total reported area, indicating less potential for development of the crop sector.

The area under forest is about 66% of the total reported area. Forest-based livelihood activities have the potential for income generation.

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

Agriculture is dominated by food grains which comprise 93% of the GCA. Three cereal crops-wheat, ragi and saava together constituted 57% of the GCA.

Variability in the production of different crops is higher than in the area under these crops. Variability in production depends on the variability in area and variability yield.

Pratapnagar block of the district has been made fully organic.

Per hectare, the use of chemical fertilizers is almost negligible. Agriculture in the district is almost chemical-free, and farmers have a natural advantage to do organic farming.

Agriculture is mostly under rain-fed conditions. The net cultivated area under irrigation is low.

There are three deterrents in promoting HVCs—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 can be explored to promote HVCs and improve people's

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3.2   FORESTRY

The chir, the oaks, the conifers, the sal, the deodar, the haldlu. the yew, the cypress, the rhododendron, the birch, the horse chestnut, the cycamore the willow, the alder and various types of fruit trees like the cornel, the figs, the kaiPhal, the mulberry, the kingora, the raspberry, the blackberry, currants, medlars, gooseberries, hazelnuts, apples, pears, cherries, apricots, plums, peaches, oranges, limes, bananas, pomegranates and walnuts are found in the district besides a variety of herbal plants bushes, scrubs and grass(District Website).

District has dense forests of Sal, Deodar, Chir, Oak trees. These trees are important for furniture and as a structural material in the local areas.

The Devalsari region is the district is likely to be declared as the first biodiversity heritage site of Uttarakhand. Different kinds of flora and fauna including smaller species like butterflies and moths are found abundantly in Devalsari region. A group of five van (forest) panchayats including Bangsil, Teva, Moldhar, Butkottheek and locals working to protect the area sent a detailed proposal to the biodiversity board last month (Hindustan Times, 2021).

In Tehri Garhwal the tree species like Grewia optiva, Celtis australis, Melia azedarach, Morus alba, Emblica officinalis etc were common in the lower Himalayan region. The Grewia optiva is one of the species that thrives the diverse altitudinal range and used for the fodder purpose in the lean period during winter season. In Tehri Garhwal the tree species like Grewia optiva, Celtis australis, Melia azedarach, Morus alba, Emblica officinalis et are common in the lower Himalayan Region. The Grewia optiva is one of the species that thrives the diverse altitudinal range and used for the fodder purpose in the lean period during winter season (Bijalwan, 2013).

3.2.1. Biodiversity

Many trees can be found here, including chir, Oaks, Conifers, Sal, Deodar, Haldu, Yew, Cypress, Rhododendron, Birch, Horse-Chestnut, Cycamore, Willow, and Alder. Brahmi and Ashwagandha are only two of the many therapeutic herbs, shrubs, and bushes found here. Cornel, Figs, Kaiphal, Mulberry, Kingora, Raspberry, Blackberry, Currants, Medlars, Gooseberries, Hazelnuts, Apples, Pears, Cherries, Apricots, Plums, Peaches, Oranges, Limes, Bananas, Pomegranates, and Walnuts are among the fruits available.

Tehri Garhwal is home to various animals, including mammals, reptiles, fish, and birds. Monkeys, Langurs, Wild Cats, Goats, Pigs, Foxes, Wild Dogs, Black Bears, and Flying Squirrels abound in the forests (locally called Rinoola). When coming from Dehradun, elephants can only be found in the Terai woods. The highly endangered Musk Deer, also known as the Kastura, is the star (and elusive) attraction in Tehri Garhwal's woodlands. The Tehri Garhwal region is home to various carnivore species, including the Snow Leopard, Leopard, and Tiger. The Snow Leopard is a rare and endangered species. Pheasants, Kalij, Koklas, Cheers, Monal, Wild Fowls, Harial, Parrots, Chatak, Papiha, Haldu, Neelkanth, Pigeons, Partridges, Kala Titar, Chakor, and Neora, are among the avian species. Cobra, Russell's Viper, Ancistrodon Himalayans, Rat Snake, Leech, and Blood-Sucking Lizard are among the reptiles found in the area.

3.3   ENERGY

As per the data of the year 2013, Tehri Garhwal district energy consumption is around 132 TJ/year and 5.5 GJ/capita/year. GHG emission of 8,950 Ton CO_2 equivalent and 0.373 Ton CO_2 equivalent/capita has been evaluated for the district.

5.5.1. Solar Energy

The district has been progressing in the solar energy sector from quite a good time and has achieved well in this sector. It has been in the news quite often.

According to a recent news article in Amar Ujala- The Chauras, Srinagar and Tehri campuses of HNB Garhwal (Central) University will soon be solar powered. The plant will save the university about two rupees per unit. Under the scheme of the central government, solar power plants are to be set up in government institutions to eliminate dependence on conventional sources of energy. Under this, the central government signed an agreement with a company. As per the agreement, the cost and maintenance of the project will be borne by the company for 25 years. In return, the university will buy electricity at the rate of Rs 1.90 per unit. Solar rooftop plants of 480 KW capacity have been installed in the University's Chauras campus, 250 KW in Srinagar and 50 KW in Tehri.

An article in PV magazine reads "Solar-plus-storage at a hilltop ashram". According to this article- Loom Solar has installed a solar plus storage system at a small ashram in the hills of Tehri Garhwal, Uttarakhand. The system comprises 6x440W Shark Super high-efficiency PV panels, a 5kWh (100Ah/51.2V) Atom lithium battery, and a 5kVA high-frequency design (string) inverter. On the challenges faced in installation, Loom Solar co-founder and director Amol Anand told **pv magazine**, the location being a hilly area, it was a challenge to carry the products on foot from the delivery location to the installation site. The distance was about 1.5 km, and it took approx. 30 minutes (to and fro) to bring the product to the site."

Despite having difficult terrain, the district has been quite progressive in the solar energy sector.

5.5.2. Biomass Energy

The district Tehri Garhwal has not witnessed much development in the biomass energy sector, but has a lot of products ine forests caus the form of pine forests. Often it has been in the news that there have been forest fires in these pining a lot of destruction.

A news article in The New Indian Express, reads "Uttarakhand forest fire: IAF's helicopter participates in fire fighting operation in Tehri Garhwal". According to this news article the fire broke out in 62 hectares of forest area.

There have been a lot of forest fires in the district which cause a lot of pollution. Also to avoid these wild fires these are burnt every year in winters. So an alternate way is to utilize these for bioenergy production which would not only help in saving the environment but also provide a lot of locals with employment. Bioenergy could be generated using both the agro wastes and the forest wastes.

5.5.3. Biogas Energy

Under the scheme, the National Biogas and Manure Management Programme eighty-eight biogas plant of capacity 3 m^3 has been installed from the year 2014 to 2020.

5.5.4. Hydropower Energy

In 2006, the Tehri dam in northern India was opened to produce water for electrical generation, agriculture, and drinking water. It was meant to counterbalance 150 years of sedimentation and has a 95% sediment trap effectiveness. The primary strategy for minimizing silt intake into the Tehri reservoir is watershed management.

The Tehri Dam is a rock and earth-fill embankment dam on the Bhagirathi River in Tehri, Uttarakhand, India. It serves as the major dam for THDC India Ltd. and the Tehri hydropower complex. The first phase was finished in 2006. The Tehri Dam has a reservoir for agriculture, urban water supply, and hydroelectric power generating 1,000 megawatts (1,300,000 hp). The dam's 1,000 MW variable-speed pumped-storage project is now under development and is scheduled to be completed in 2025.

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. The district is known for its adventures and trek spots. The district has a long history. The data gathered and analyzed demonstrates the region's Production and potential products derived from the raw product. The list of sources and the possible products are mentioned below:

- The flora of the district may be divided into six main botanical divisions : (1) the tropical dry deciduous forests, (2) the sal forests, (3) the chir forests, (4) the deodar, fir and spruce forests, (5) the oak forests and (6) the Alpine pastures.
- The chir, oaks, conifers, sal, deodar, haldlu. yew, cypress, rhododendron, birch, horse chestnut, cycamore, willow, and alder are fodder-rich trees.

- Various types of fruit trees like cornel, figs, kaiPhal, mulberry, kingora, raspberry, blackberry, currants, medlars, gooseberries, hazelnuts, apples, pears, cherries, apricots, plums, peaches, oranges, limes, bananas, pomegranates and walnuts are found in the district
- a variety of herbal plants, bushes, scrubs, and grass for ayurvedic medicinal plants.

The Jalkur, Aglar, Bhillangana, Bhagirathi (the Ganga) and Alaknanda abound in the larger fish.

4 ACTION PLAN DEVELOPMENT

4.1 AGRICULTURE

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4.2 FORESTRY

Neighboring state Himachal Pradesh has a great forest scheme: 'Van Samridhi Jan Samridhi Yojana.' This scheme enables locals to earn money by growing medicinal plants. This same type of scheme can be implemented throughout the patch of Ganga River meandering through dense forest rich areas. Tehri Garhwal is one of such areas where important medicinal and aromatic plants and agroforestry practices exist. These species yield high value in the pharmaceutical industry. Similar schemes if implemented in the district can create competitive market and livelihood opportunities. The network of collection centers can be established in each gram panchayat, these collection centers will provide the monetary benefits along with technical support. These gram panchayats can also start e-commerce and export of medicinal plants to required customers. Establishing the district collection and information center where industry-local citizen seminars & interaction can happen.

With a great amount of inland water surfaces and dense forests, eco-tourism is another commercial option for this sector. Eco-tourism can include forest trails, National parks, and sanctuaries. Orchid conservation center, Herbal Garden can also be important milestones in these tours. These tours will bridge the forest, tourism, and service industry and can help to boost local employment.

4.2.1. Biodiversity

Precaution, reducing human-caused fires by education and environmental change, such as agricultural operations, engineering projects, public engagement, and so on, will aid in the control of forest fires. Government should provide funds for installing new technology and research to prevent forest fires.

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 revitalize extant and extinct wetlands.

Inventory Data	Updating the wetlands database of the district to understand the present condition Identify the important wetlands which can help in redevelopment process like for eco-tourism spot. Marking of the wetlands based on wetland quality index
Reviving Plan	Conduct extensive study before applying any reviving plan, as many species depend on wetlands. Making local stakeholders a significant advisors. To document, highlight, apply traditional knowledge of conservation Development of wet garden with all medicinal herb and flower gardens to guide people about it
Monitoring	Monitoring of plan execution with regular interval data collection. Monitoring of Wetland use, water quality, soil quality, Biodiversity Soical- economical benefits from the wetlands

4.5   ENERGY

4.5.1   Solar

The district Tehri Garhwal has a good potential of solar energy. It can use solar energy in both ways, that is- photovoltaic and thermal. The solar thermal energy can be used in hotels, restaurants, hospitals in the form of solar water heaters, solar rooms heaters, etc. This will decrease their dependency on the utility supply to operate the heating appliances.

The state has recently launched a scheme called Mukhyamantri Saur Swarozgar Yojana, which benefits those people who are unemployed. The people in the district should be made aware about it. This will provide the people with a source of income and decrease the burden of discoms. Other than this, there is Kusum Yojana, of central government, under which solar feeder segregation can be of great help to the farmers. This will ultimately bring advancement in the farming techniques as there will be proper supply of power to their fields.

Also a research in this field in the institutes of the district would not only help the district to bring advancement in the techniques but also increase the standards of these institutes. The district is in

a hilly terrain, so a research on easy installations of the solar panels in the difficult terrain would be of great help.

PROJECTION AND MONITORING

First thing that needs to be done is to spread awareness in those parts of the district where solar energy has still not made its place. People should be made aware about the different policies of the government.
Secondly, to increase employment and the source of income of the farmers, the Mukhyamantri Saur Swarozgar Yojana should be made easily available to the beneficiaries. Also the solar feeder segregation under Kusum Yojana should be elaborated in the district.
Thirdly, infrastructurally backward areas should be provided with financial assistance for off grid solar panels, so that they do not lag behind due to unavailability of power.
Fourthly, use of solar thermal energy should be also encouraged, especially in hotels, hospitals, restaurants, schools, etc.
Lastly, so a research on easy installations of the solar panels in the difficult terrain- may be by altering the design, technology, etc.

4.5.2   Biomass

The main economic activity of the district Tehri Garhal is agriculture, which is a good source of biomass. The district needs to make its people aware about biomass energy. The district can take example from the other fellow districts in the state which have been producing bioenergy from the agro based residues and the used cooking oil. Other than making people aware, the authorities should make a proper channel of biomass transport so that the farmers and the other beneficiaries get the correct price and also that they do not charge in excess from the biomass plant owners. A proper planning is also required for a well-connected transport and storage system, so that the sellers do not have to hustle for these things.
The district Tehri Garhwal also deals with the problem of forest fires. These forest fires harm the wildlife and cause pollution as well. In order to avoid these forest fires, every year the pine needles are burnt in the jungles before the summer season. So by both ways there is harm to the environment. Hence attention should be paid on producing energy from pine needles. The state government has a policy of setting up pine needles based biomass gasifiers. To incline more and more people towards this, the government should make rules to ease setting up the biomass plants. This would give a chance to the fresh entrepreneurs. Also those involved in collecting these needles should be given proper wages and provided with safety measures.
This altogether will lead to increase in employment opportunities in the district and there will be development in a sustainable manner.

PROJECTION AND MONITORING MATRIX

The first thing which needs to be done is to make people aware of biomass energy and how they can benefit from it. Also farmers should be educated about how they can add to their income.

Secondly, the government should plan a proper channelized system for transportation and also conduct a district based survey to set up storage houses for the agricultural residues.

Thirdly, encouraging more and more firms to set up pirul based biomass plants is also important because this will not only keep the environment safe but also provide employment and clean and green power to the district.

Fourthly, district oriented research work is required so that the district can flourish and improve its livelihood in a sustainable manner.

4.5.3 Biogas

To provide decentralized energy sources, the government should support and focus on installing family size biogas plants in rural areas of the district.

4.5.4 Hydropower

A decent number of hydropower plant exist in the district. However, small hydropower can be installed in many rural areas to reduce water scarcity and provide electricity.

5 RECOMMENDATIONS

5.1. Agriculture and allied sectors

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

- Some landowners migrated and settled elsewhere and kept 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 government horticulture and forest departments should take uncultivated and barren lands on lease from such absentee farmers. 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.

● The departments can do wire fencing of these zones to protect the crops and plantations from wild animals. Such fencing would be more cost-effective than the fencing of individual farmers' land.

● Ragi, saava, urad kulthi, Mustard, Soybean and Potato, turmeric, ginger, chilies, garlic, and onion, Mushrooms, kiwi, and capsicum, and medicinal crops like Dandelion, rosemary, lavender, and kutki are promising crops in the district. Marketing support and R&D intensification can make these crops more remunerative for farmers.

● Horticulture Mini Mission and Apple Mission programmes have been introduced in the district to boost fruits and vegetable production. These types of more programme should be implemented for other fruits and vegetables.

● There is a huge scope for animal husbandry, such as cattle and poultry for allied income activity of the farmers.

● Agriculture in the district is almost chemical-free, and farmers have a natural advantage to do organic farming. However, the three deterrents—out-migration, the menace of wild animals, and interspersing of cultivated landholding with inactive and abandoned landholding are to be addressed.

● 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. The R&D and extension services need to be oriented toward HVCs, horticulture, livestock, and agroforestry.

● The area under forest is about 66% of the total reported area. Forest-based livelihood activities have the potential for income generation in the district.

● 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.

● 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. Training for vermicompost, bio-fertilizers, and bio-pesticides production and use should be provided to the farmers to commercialize organic foods on a large scale.

- There is a need to construct small water harvesting structures, drip and sprinklers irrigation systems, and Poly-houses and greenhouses to up-scale and commercialize the off-season organic vegetable crops.

- The district's farmers benefit from weather forecasting services provided by GKMS, KVK, and ATMA. However, there is a need for more farmer participation and awareness.

- There is an immediate need to scale-up agricultural and allied activities, small scale and medium scale agro-based enterprises to generate the livelihood of the rural people to prevent the migration to the other states.
- There is a need to improve the agricultural productivity of crops by introducing high yield seeds, application of organic fertilizer and pesticides, and improving pre and post-harvest management techniques.
- There is a need to construct some water harvesting structures to promote Off-Season Vegetable cultivations under favorable hilly climatic conditions.
- There is a need to encourage the farmers to adopt drip and sprinkler irrigation which will save precious water resources and also increase crop production.
- Training for vermicompost uses should be provided to the farmers.
- There is a need to commercialize organic foods on a large scale.
- The district has a huge scope for the cultivation of medicinal crops like Dandelion, rosemary, lavender, and kutki for commercial purposes.
- Horticulture Mini Mission and Apple Mission programmes have been introduced in the district to boost fruits and vegetable production. This type of programme should be implemented for other fruits and vegetables.
- There is a huge scope for the promotion of spice crops cultivation such as turmeric, ginger. These crops require less irrigation and provide a good return to the farmers.
- Farmers could grow chilies, garlic, and onion as cash crops under the irrigation facility.
- There is a huge scope for animal husbandry, such as cattle, poultry for allied income activity of the farmers.
- High-value crops like mushroom, kiwi, and capsicum cultivation should be promoted.
- Farmers in the district benefit from weather forecasting services provided by GKMS, KVK, and ATMA. However, there is a need for more farmer participation and awareness.
- There is a scope for expansion of Poly house and greenhouse for the off-season vegetable cultivation, which could generate more income for the farmers.

5.2. Forestry

- Tehri Garhwal 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 famous for religious places and dense forests. Eco-tourism combined with marketing of the local NTFP products can be beneficial for the district economy.
- Many farmers in the district practice Agroforestry in the district. With the help of market and production machinery government can help local people with fruit and agriculture production and increase livelihood opportunities.

5.2.1. Biodiversity

- It is recommended to intensify and strengthen the patrolling to prevent criminal operations such as poaching and forest fire.
- As most human leopard conflicts happen in the district, preventing measures such as patrolling regularly and installing cameras on places that villagers use to collect forest resources.

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.

- Preservations of the tals present in the district and develop them as tourist attractions like fish parks.
- Training the local people about organic farming to build small farms of medicinal plants and herbs

- 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 that government institutions collect the forest products make available to small industries to develop eco-friendly products like handicraft products.
- It is recommended to improve the cultivation of fishes in the region to boost the fishery.

5.5. Energy
5.5.1. Solar

- People should be made aware about the different policies of the government, especially the Mukhyamantri Saur Swarozgar Yojana.
- Kusum Yojana should be promoted among farmers and they should be made aware about its different components. Solar feeder segregation should be given importance.
- Attention should be paid on infrastructure development so that the National Solar Mission is able to render its benefits to the people.
- If proper steps are taken then the district can make itself better in the solar energy sector and enhance the livelihood of the people.

5.5.2. Biomass

- People should be made aware about biomass energy and the policies related to it.
- Attention should be paid to increasing biomass energy production from the pirul based plants, so that the environment remains safe.
- A proper transport and storage system should be developed to encourage people to incline towards biomass energy.
- The local governments should come forward with the people and set up biomass based gasifiers.

5.5.3. Biogas

- It is recommended to construct more family-size biogas plants by implementing the GOBAR-Dhan scheme, which focuses on cleaning villages, increasing rural households' income, and generating biogas and organic fertilizer from cattle waste.

5.5.4. Hydropower

- It is recommended to build a green belt to check soil erosion and resultant siltation around the reservoir, protect and regenerate vegetation, and increase the landscape's natural beauty.

6. Discussion during the Report Presentation

- The place holds a great opportunity for homestays and eco-tourism near Tehri Lake.
- The farmers are being trained on sustainable farming system.
- The Jalaj model of Tehri-Garhwal is involved in training locals for production of multiple local produce which can be associated with the Delhi Haat.
- There will be regular coordination SPMG for further implementation of the interventions.
- 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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8 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/m³)	Biogas potential (m³/yr)
Cattle	Manure	100186	10	36,56,78,900	274259175	54851835	25	2194073.4
Buffalo	Manure	91350	15	50,01,41,250	375105937.5	75021187.5	25	3000847.5
Sheep	Manure	43323	1	1,58,12,895	11859671.25	2371934.25	25	94877.37
Goat	Manure	125899	1	4,59,53,135	34464851.25	6892970.25	25	275718.81

Pig	Manure	609	2.5	5,55,713	416784.375	83356.875	25	3334.275
Poultry	manure	58,941	0.1	21,51,347	1613509.875	322701.975	25	12908.079
Total		**4,20,308**						**5581759.434**

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	3449	1.5	5173.5	3621.45	15	3078.2325	800	2462586
Wheat	straw	31581	1.5	47371.5	33160.05	30	23212.035	800	18569628
Rice	husk	18694	0.25	4673.5	3271.45	80	654.29	750	490717.5
Total		**53724**							**21522931.5**