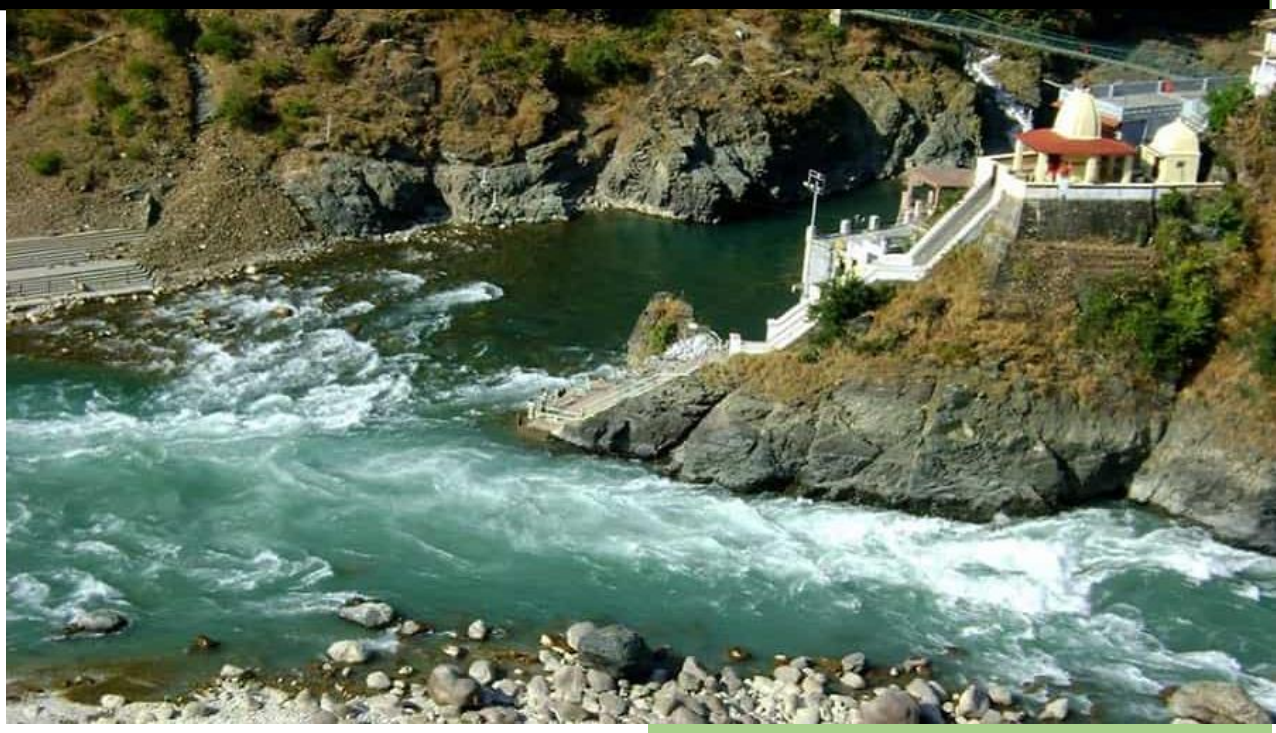
Arth Ganga Project: District Rudraprayag



February 2022

Submitted to

National Mission for Clean Ganga (NMCG)

Submitted by:

IIM Lucknow

IIT Roorkee

TABLE OF CONTENTS

EXECUTIVE SUMMARY

Rudraprayag, a district in the state of Uttarakhand, with rich biodiversity, high literacy rate, and high sex ratio is a part of Kumaon Himalaya-North. The district receives excess rainfall and the rivers embracing the district are, Mandakini, Alaknanda, and Vasuki Ganga.

The total geographical area of the district is 1984 Km^2, out of this the permanent pastures are 430800 ha, the Cultivable wasteland is 300400 ha, and the Land under Misc tree crops and groves is 1160000 ha. The barren and uncultivable land constitutes 725700 ha. The major soil types are brown forest and residual sandy loam soil. With the net sown area of 19500 ha and gross cropped area of 28000 ha, the Cropping intensity of the district is 143.6%. The irrigated land account for only about 12.4%. The major crops types are Paddy, Wheat, Finger millet, Barley, pea, soybean, etc. Among the horticulture crops are apple, peach, plum, citrus fruits, dry fruits, etc. along with vegetables, medicinal and aromatic plants, and spices. Total fertilizers use almost is 0.41 kgs/ha of GCA which indicates chemical-free farming and according to a study, the area under organic farming in the state was about 18% of the net sown area in 2019. The livestock consists of cattle (dairy and plowing animals), buffalos, goats, sheep; along with poultry. The share of the primary sector went down from 20.95% in 2011-12 to 17.56% in 2016-17, whereas the tertiary sector's share went up from 54.27% to 57.74% The district economy grew at the rate of 7.24 percent per year. Agriculture increased by 7.68 percent per year during 2011-12 to 2016-17 with its increased share from 50% to 40%. The share of livestock rose from 36.65% to 41.30% with a growth of 1.77% per year. The fishery was the second-highest growing sub-sector in the district and Mining and Quarrying showed a growth rate of 135.41%.

The total forest cover of the district is 57.57%, constituted by very dense, moderately dense, and open forests covering 252 Km^2, 580 Km^2, 310.17 Km^2 areas respectively. Cropland area is reduced from 4.30 percent to 3.75 percent. Forest area slightly increased to 81.95% during 2010- 2020, both open forest which is increased from 15.87 % to 17.03 %, and dense forest, which increased from 53.99% to 54.08%. The forest plantation slightly reduced from 11.39% to 10.84%. The share of forestry and logging has reduced from 28.47% to 26.92% with a growth of 2.03% per year during 2011-17. There are a total of 386 flora and fauna and a total of 227 different species present in the district. The district has three altitude wetlands and there are no artificial wetlands. Rudraprayag Forest division has managed to store 10 million liters of water within 330 hectares of forest. Kedarnath wildlife sanctuary, Mandakini Valley, etc. are hotspots of biodiversity and tourism. There are many temples like Chamunda Devi, Shree Tungeshwar Mahadev, etc. are places for tourist attraction. Various fairs and festivals are celebrated in the district. The district is well connected through roads, railways, and airways to different places nearby and far away.

The major source of lightning is electricity (91.94%) whereas, in the case of cooking fuel, it is firewood (60%) followed by LPG/PNG (37%). There is an ample amount of biomass present in form of agricultural and animal waste and forest residues thus the biogas potential of the district is pretty high. Biogas potential from animal waste is calculated approximately as 32 lakh m^3/year and 77 lakh m^3/year from agricultural waste. There are many developing hydropower projects and a few ongoing projects on the river Mandakini. Two types of schemes solar energy schemes and solar thermal energy schemes are adopted in the state. Various solar appliances are used or have been targeted to be installed.

Promoting eco-tourism, cluster formation, mixed farming, water harvesting, creating awareness for use of renewable energy, encouraging locals for active participation and practices like bio-composting and bio-farming and vermicomposting, oak silk, polyhouse, and greenhouse farming, monitoring forest fires, advertising local celebrations, etc. like measures might aid the development of the district.

1 DISTRICT OVERVIEW

1.1 INTRODUCTION

District Rudraprayag is part of Kumaun Himalaya-North. It lies between the 29º 55’ 37" to 31º 27’ 3" north latitude and 78º 54’ 3" to 80º 2’ 3" east longitude. It lies in the extreme north of the state covering an area of 1984 sq km, out of which 484 sq km is covered by forests. Rich forests are available in the district. According to the 2019 assessment, the district has 57.57% area under forest out of the total geographical area and this ratio is quite reasonable for eco balance. Mixed jungles along with Himalayan ranges comprise pine teak, sheesham, sal, tur, banj, burash, khair and ringal. Medicinal plants are also available in the district. The district falls under the administrative jurisdiction of Garhwal division.

Level land being very scarce, cultivation is generally in terraced fields. As in the plains, the hill areas also have three harvests, Kharif, Rabi and Zaid. But the climate being cooler in the hills the crops need a longer period to ripen. As a result they are sown somewhat earlier and reaped later than in the plains. In the Kharif, the main crops grown are paddy, mandua, kaundi, jhangora, maize and potato. Chuwa or phaphar (amaranth) is a common crop in the northern part of the district and it is the only Kharif crop grown at levels higher than 1,830 m. above the sea level. In the lower regions tur (a kind of pulse) takes the place of arhar of the plains with which it resembles. In the Rabi, wheat, barley, masur, mustard and rape-seed are the chief crops grown. In the still higher snow-covered valleys which are close to the glaciers, a fine species of wheat, locally known as Napal, is grown as Kharif crop. The district is scantily industrialized. But the district is rich in mineral resources. Granite, hyalites, quartzite, etc. are commonly found mineral resources in the district.

According to the 2011 census Rudraprayag district has a population of 242,285. This gives it a ranking of 585th in India (out of a total of 640). The district has a population density of 119 inhabitants per square kilometre . Rudraprayag has a sex ratio of 1120 females for every 1000 males, making it the 6th highest in the country as per 2011 census and a literacy rate of 82.09%. A total of about 46.7 percent of the total population of the district is workers. The proportion of males as workers is about 45.7 percent and about 47.5 percent in case of females. Among workers about 32.59 percent are main workers and about 14.02 percent marginal workers. In total, of 113,032 in the district 83,155 (73.57 percent) are cultivators and 24,565 (21.73 percent) are other workers.

Figure 1 Map of the district

1.2 DEMOGRAPHIC PROFILE OF RUDRAPRAYAG

Geographic area: 1984 Km^2
Altitude: 895 m
Rainfall: 1725.8 mm
Forest area: 1142.17 Km^2
Rivers: Mandakini, Alaknanda, Vasuki Ganga

Administrative Divisions:

District Headquarter	Rudraprayag
No. of Subdivisions	3
No. of Blocks	3
No. of Villages	688

Demographic and Socio-economic Parameters:

Population	2,42,285
Population Density	122 / Km^2
Sex Ratio	1114
Literacy	81.3% 4
Occupation/Livelihood	Agriculture

Table 1 demographic overview

The economy of the district is mainly dependent on agriculture. Most of the lands in the district are used for agricultural purposes. More than half of its population are engaged in agriculture in order to earn their livelihood. The chief agricultural products in the district are rice, wheat, potato, pulses, vegetables, millets, etc. In the year 2016-17 the gross domestic product in the district was Rs. 2,51,040 lakh at current price and Rs. 2,02,279 lakh at constant prices in the year 2011-2012. The net domestic product in the district during the period 2016-17 was Rs. 2,21,131 lakh at current price and Rs. 1,76,779 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 83,521 at current price and Rs. 66,770 at constant prices in the year 2011-2012 (District Webdata).

1.3 AGRO CLIMATIC PROFILE OF THE DISTRICT

1.4 ECONOMIC PROFILE OF RUDRAPRAYAG

The primary sector of the district economy has constantly been declining in recent years in terms of its share in the GDDP. The share went down from 20.95% in 2011-12 to 17.56% in 2016-17. However, the primary sector grew with an annual average growth rate of 4.6 percent. The secondary sector share has remained almost the same during the same period. It grew at an average annual growth rate of 7.10%. The tertiary sector's share went up from 54.27% to 57.74% during the same period, with an annual growth rate of 8.55%. Overall, the district economy grew at the rate of 7.24 percent per year. All three sectors contributed to the overall growth of the district economy. Unlike other hill districts, this district achieved remarkable growth in the primary sector.

The real per capita income in the district went up from Rs.58106 in 2011-12 to Rs.76401 in 2016-17, with an annual growth rate of 5.7% per annum. The tertiary sector has constantly replaced the gradual decline in the primary sector as the secondary sector did not make any change during the period.

Table 1: Trends in Gross District Domestic Product and Per Capita DGDP in Rudraprayag 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	29596	34995	76653	141244	-	-	-	-	58106	-
	(20.95)	(24.78)	(54.27)	(100)						
2012-13	34602	38003	80094	152698	16.91	8.60	4.49	8.11	61727	6.23
	(22.66)	(24.89)	(52.45)	(100)						
2013-14	43654	39889	91283	174825	26.16	4.96	13.97	14.49	69611	12.77
	(24.97)	(22.82)	(52.21)	(100)						
2014-15	35735	42046	100904	178685	-18.14	5.41	10.54	2.21	70510	1.29
	(20.00)	(23.53)	(56.47)	(100)						
2015-16 RE	34482	45848	106687	187017	-3.51	9.04	5.73	4.66	72908	3.40
	(18.44)	(24.52)	(57.05)	(100)						
2016-17 PE	35037	49288	115232	199557	1.61	7.50	8.01	6.71	76401	4.79
	(17.56)	(24.70)	(57.74)	(100)						
Average growth rate					4.61	7.10	8.55	7.24		5.70

Source: UKDES

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

Since our focus is on agriculture and allied activities, we further disintegrate the primary sector GDP to know which sub-sector is laggard and which one is driving the growth of the primary sector. Table 2 shows the sub-sectoral trends in the primary sector. The sector is divided into agriculture & allied activities and mining & Quarrying (M&Q).

As far as sub-sectoral growth of agricultural and allied sectors is concerned, we observe that agriculture, including horticulture, increased by 7.68 percent per year during 2011-12 to 2016-17. Consequently, the share of the agriculture sector went up approximately from 50% to 40% during the period. Contrary to this, the share of livestock rose from 36.65% to 41.30% during the same period. Livestock evinces a positive growth of 1.77% per year. The share of forestry and logging has reduced from 28.47% to 26.92% during the same period. It grew by 2.03% per year. Though fishery has a negligible share in the total GDP of agriculture and allied sectors, it is the second-highest growing sub-sector in the district. Thus all the activities are growth-driven and M&Q has an impressive growth rate of 135.41%. The high growth of M&Q has some implications for the fragile ecosystem of the district.

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

Year	Agriculture	livestock	Forestry & logging	Fishery	Total Agri, & allied	Mining & Quarrying	Primary Sector
	9906	9410	7696	20	27032	2564	29596
	(36.65)	(34.81)	(28.47)	(0.07)	(100)		
2011-12	-	-	-	-	-	-	-
	13892	11566	7637	20	33116	1486	34602
	(41.95)	(34.93)	(23.06)	(0.06)	(100)		
2012-13	[40.24]	[22.91]	[-0.77]	[0.00]	[22.51]	[-42.04]	[16.91]
	11388	10450	8439	15	30292	13362	43654
	(37.59)	(34.50)	(27.86)	(0.05)	(100)		
2013-14	[-18.02]	[-9.65]	[10.50]	[-25.00]	[-8.53]	[799.19]	[26.16]
	14237	9510	7897	21	31665	4070	35735
	(44.96)	(30.03)	(24.94)	(0.07)	(100)		
2014-15	[25.02]	[-9.00]	[-6.42]	[40.00]	[4.53]	[-69.54]	[-18.14]
	12796	9728	8185	23	30732	3751	34482
2015-16	(41.64)	(31.65)	(26.63)	(0.07)	(100)		
RE	[-10.12]	[2.29]	[3.65]	[9.52]	[-2.95]	[-7.84]	[-3.51]
	12963	9953	8448	23	31387	3649	35037
2016-17	(41.30)	(31.71)	(26.92)	(0.07)	(100)		
PE	[1.31]	[2.31]	[3.21]	[0.00]	[2.13]	[-2.72]	[1.61]
Average growth	7.68	1.77	2.03	4.90	3.54	135.41	4.61

Source: Compile from UKDES

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

1. Figures in [ ] are annual growth rates.

Can crop and horticulture sectors be the district's rural economy's growth drivers? Or should a sustainable development model for the growth of the district economy rely more on livestock, forestry and fishery? Can the organic farming initiative taken by the government through PKVY and Namami Gange programmes revitalise 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 answer 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 55.90-57.76% share within the secondary sector, while construction's share ranged from 10.64 to 9.61%. The electricity, gas and water supply sub-sector is the second-highest contributor (about 33% of the total) to the secondary sector's GDDP. The average annual growth rate is observed highest in manufacturing (7.85%), followed by electricity gas and water supply (6.59%) and construction (5.44%)

Within the tertiary sector, trade, hotels and restaurants constituted the highest share (30.82%) in 2016-17, followed by other services (20.48%), transport, storage and communication (17.84%) and public administration (16.53%). The average annual growth rate is observed highest in other services (12.89%) followed by transport, storage and communication (9.04%), Financial Services (8.50%) public administration (8.26%), trade, hotels and restaurants (8.03%) and least in Real estate & professional (6.56%). Overall, the district economy is driven by the growth of both agriculture and non-agriculture sectors as both sectors achieved positive growth.

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

Year	manufacturing	Electricity, gas, water supply	Construction	secondary	Transport, storage, communication	Trade, repair, hotels and restaurant	Financial services	Real estate, & professional services	Public administration	Other services	Tertiary
2011-12	55.90	33.46	10.64	100	17.41	31.50	6.61	8.50	18.99	16.99	100
2012-13	57.42	33.12	9.45	100	18.23	33.00	6.82	8.84	12.93	20.18	100
2013-14	56.74	31.84	11.42	100	17.31	31.46	6.55	7.58	16.29	20.81	100
2014-15	56.36	32.66	10.97	100	17.35	30.46	6.58	7.87	17.59	20.16	100
2015-16	57.55	32.29	10.16	100	17.88	30.76	6.75	7.79	17.38	19.45	100
2016-17	57.76	32.62	9.61	100	17.84	30.82	6.60	7.72	16.53	20.48	100
Average annual Growth (%)	7.85	6.59	5.44	7.10	9.04	8.03	8.50	6.56	8.26	12.89	8.55

Source: Estimated from Statistical Handbooks of Government of Uttarakhand

1.5 The Livelihood Status

Table 4 shows the livelihood status of the workforce in Rudraprayag district and Uttarakhand. In 2017, 72.1% of workers were self-employed, while the corresponding figure for the state is 56.9%. The major difference is observed in the case of regular employment, which was much higher in Uttarakhand (24.2%) than Rudraprayag district (15.4%). Casualization of the workforce is also much lesser in Rudraprayag (12.5%) than the state average (18.9%). Thus, the quality of livelihood is relatively poor in Rudraprayag when compared to the state as a whole. Sectoral distribution of employment again reveals that in terms of workforce, the district economy is dominated by the primary sector as against 39.3 workers engaged in the primary sector in the state, the corresponding percent is 72.3% in the district. Contrary to this, the secondary sector contributes only 7.9% to the total workers, while its share in the state is 24.4%. 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 Rudraprayag (2017)

Employment Status			Sectoral distribution of employment			Distribution of workers by Skills		
	Rudra-prayag	Uttara-khand		Rudra-Prayag	Uttara-khand	Skill	Rudra-prayag	Uttara-khand
Self-employed	72.1	56.9	Primary	72.3	39.3	Low	12.7	24.9
Regular	15.4	24.2	Secondary	7.9	25.4	Medium	79.9	65.5
Casual	12.5	18.9	Tertiary	19.8	35.3	high	7.4	9.6
Total	100	100		100	100	Total	100	100
Poverty status	18.3	15.6	Inequality (Gini Coeff.)	0.281	0.308			

Source: Uttarakhand Human Development Report

The distribution of workers by their skills-set indicates that only 7.4% 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 also higher 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 72.3% workforce engaged in it, although its contribution to the district GDP is less than 18%.

All the sectors recorded positive GDP growth from 2011 to 2017.

Mining & Quarrying recorded massive growth of 135.41% during the period, thus implying environmental sustainability of the ecologically sensitive district of the state.

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

In the case of the tertiary sector, other services recorded the highest growth (12.89%), followed by transport, storage, communication (9.04%).

Manufacturing contributes 57.76% of the secondary sector's GDP and its share has increased marginally over the period.

Electricity, gas, water supply contributes slightly over 32% of the secondary sector's GDP and Construction contributes less than 10%.

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

2 QUANTITATIVE DATA ANALYSIS

2.1 Agriculture and Allied Activities

2.1.1 Trend in Land Use and Land Cover

To understand the trends in land-use and land-cover, we analyze two types of data--GIS-based and statistical data compiled from the District statistical handbooks of Rudraprayag. As per the GIS-based data (see Figure I and Table-5), between 2010 and 2020, the area under snow and glacier as a percentage of the total geographical area is the same for 2010 and 2020, which is 2.93 percent. This finding seems to be significant in the context of the general perception that the Himalayan glaciers are shrinking. Moreover, the same area under snow and glacier also indicates almost no harm in the district's ecosystem services. Cropland area is reduced from 4.30 percent to 3.75 percent. Forest area slightly increased from 81.25% in 2010 to 81.95% in 2020, both open forest which is increased from 15.87 % to 17.03 %, and dense forest, which increased from 53.99% to 54.08%. Though the forest plantation slightly reduced from 11.39% to 10.84% during the same period. This large percent of forest area shows that the district's ecosystem is very good. The scrubland is slightly reduced from 11.50 percent to 11.33. The built-up area is slightly increased from 0.02 percent to 0.04 percent. This shows lesser development of the district. However, it is difficult to get any conclusive evidence in this regard.

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

LULC classes	Area(km^2) Year-2010	Area(km^2) Year-2020
Crop land	86.43 (4.30)	75.36 (3.75)
Forest plantation	229.10 (11.39)	218.09 (10.84)
Open forest	319.2 (15.87)	342.4 (17.03)
Dense forest	1085.82 (53.99)	1087.69 (54.08)
Scrubland	231.18 (11.50)	227.8 (11.33)

Built-up land	0.46 (0.02)	0.85 (0.04)
Snow and glacier	58.91 (2.93)	58.91 (2.93)
Total Geographical area	2011.10	2011.10

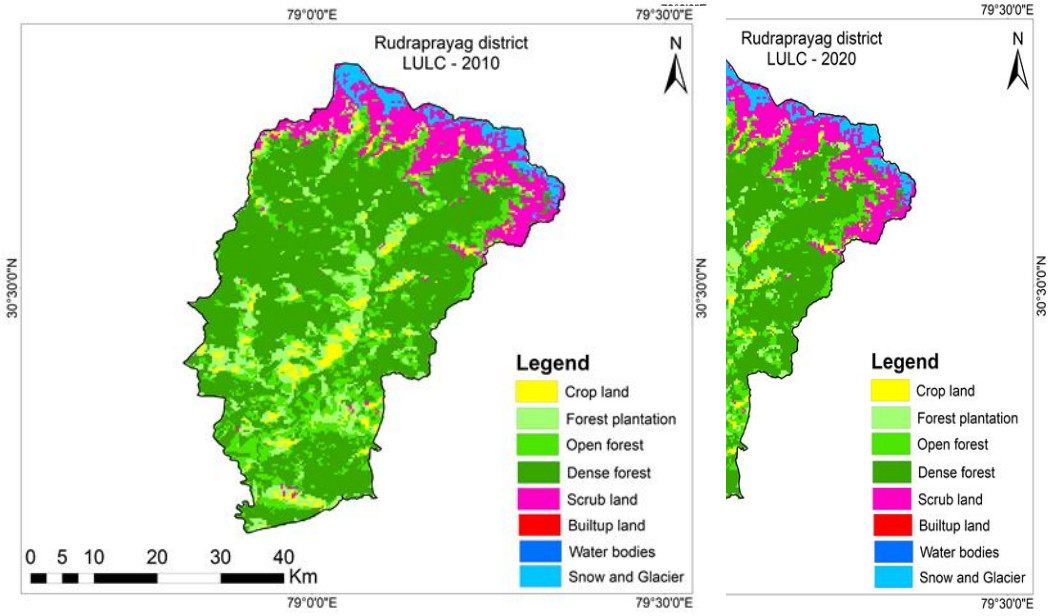


Figure I- LULC map for Rudraprayag District for the years 2010 and 2020

We notice some discrepancies when the GIS-based data are compared with the data compiled from the district statistical handbooks. The GIS-based map shows 2011.10 square kilometres geographical area of the district, while the handbook shows 2347.96 sq.km reported area of the district. Forest area constituted 76.82% of the total reported area, and it remained constant during the period. Areas under permanent pastures and trees and gardens decreased in 2012-13. The net sown area has increased from 0.88 percent to 8.57 percent during 2010-11 to 2012-13 (Table 6). Overall, the land-use pattern does not manifest any visible change during the period.

Table 6: Trends in Land-use Pattern in Rudraprayag (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
2010-11	234796	76.82	1.08	0.07	-	-	-	1.97	6.73	0.88
2011-12	234796	76.82	1.09	0.47	-	-	-	1.97	6.74	8.38
2012-13	234796	76.82	1.20	0.15	-	-	-	1.19	6.06	8.57

Source: Prepared from District Statistical Handbooks of Rudraprayag

2.1.2 Trends in Operational Land Holdings

In Rudraprayag district, the total number of operational holdings has decreased from 27093 in 2010-11 to 21798 in 2015-16, a net decrease of 19.54 percent. Also, in the state, the number has declined from 912650 in 2010-11 to 881305 in 2015-16, a net decline of 3.43%, but it is less compared to Rudraprayag district. The majority of land holdings in the district are marginal and small. These holding categories constituted 92.91% in 2015-16, while the corresponding percentage in the state was 91.67% (Table 7).

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

	Agri, Census	Marginal Holdings (0-1 ha)	Small Holdings (1-2 ha)	Semi-Medium Holdings (2-4 ha)	Medium Holdings (4-10 ha)	Large Holdings (10 & above, ha)	Total Holdings (Nos.)
Rudraprayag	2010-11	70.72	22.07	6.53	0.68	0.00	27093
	2015-16	65.97	26.94	6.47	0.61	0.01	21798
							[-19.54]
Uttarakhand	2010-11	73.65	17.24	7.1	1.9	0.12	912650
	2015-16	74.78	16.89	6.59	1.64	0.1	881305
							[-3.43]

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

2.1.3. Trends in Area, Production, and Yield of Principal Crops

i- Trend in 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 2010-11 to 2012-13. Rice, wheat and Saava together comprise the largest share in the gross cropped area (GCA). The area under these crops marginally increased from 70.24 percent in 2010-11 to 70.54 percent in 2012-13. 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 96 percent of the GCA of the district. Pulses consisted of about 1 percent share in the total cropped area. Overall, food grains shared over 96 percent of GCA in 2012-13. The share of oilseeds is only 1.62 percent. In addition to food gains and oilseed, Potato is another important crop.

Crop/Year	2010-11	2011-12	2012-13
Rice	29.62	29.76	28.77
Wheat	32.14	31.83	32.32
Barley	3.24	3.73	3.60
Maize	0.58	0.58	0.59
Ragi	2.12	2.09	2.38
Saava	8.48	8.79	9.45
Total Cereal	95.42	95.54	96.48
Urad	0.71	0.70	0.88
Masoor	0.13	0.09	0.10
Matar	0.03	0.02	0.00
Arhar	0.14	0.31	0.32
Total pulses	1.01	1.14	1.31
Total Food Grains	96.43	96.68	97.79
Mustard	0.82	0.97	1.28
Net Til	0.02	0.04	0.08
Soybean	0.17	0.12	0.26
Total Oilseeds	1.01	1.13	1.62
Potato	0.65	0.35	0.67
Net Sown Area	63.28	64.95	62.47
Gross Sown Area (ha)	32835	30302	32211
Cropping Intensity	158.04	153.96	160.08
Source: Estimated from District Statistical Handbooks.			

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

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 13.52 qtls/ha in 2012-13 and as high as 15.32 qtls/ha in 2010-11. Similarly yield of wheat ranges between 15.49 to 15.62 qtls/ha during 2010-11 to 2012-13. A more or less similar pattern is also observed in the case of all the cereal crops. Table 9 depicts that maize yield has reduced across years. It is significant to note that the average productivity ragi has been higher than that of Rice. Relatively being a high-value crop, it can raise the farmers' income if proper marketing support is provided to the farmers. Another high nutrition and value crop is saava, which also has a higher yield than

Rice, as is demonstrated by Table 9. Marketing support and R&D intensification can make these crops more remunerative for farmers.

Among pulses, per hectare yield is higher in Arhar than other crops. Arhar constituted the highest GCA among all pulses and also has the potential for raising farmers' income. Among oilseeds, soybean is the essential crop. Its yield ranges between 9.57 to 8.25 qtls/ha. Since per quintal prices of soybean are higher than that of Rice and wheat, its cultivation can provide better return to the farmers. Potato is another high-value crop in the district. Its yield ranges between 91.46 to 88.8 qtls/ha. Thus, ragi, saava, Arhar, soybean and Potato are promising crops for farmers of the district

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

Crop/ Year	2010-11	2011-12	2012-13
Rice	15.32	14.04	13.52
Wheat	15.49	14.89	15.62
Barley	14.83	16.25	14.23
Maize	11.94	10.93	9.32
Ragi	16.99	14.85	14.97
Saava	14.18	16.08	15.87
Total Cereal	15.55	14.71	14.81
Urad	3.91	4.08	5.44
Masoor	8.18	6.09	8
Matar	6.67	7.08	8
Arhar	8.73	9.29	8.37
Total Pulses	6.23	6.79	6.29
Total Food Grains	15.48	14.58	14.59
Mustard	5.31	5.25	5.27
Net Til	1.67	2.22	3.41
Soybean	9.57	9.53	8.25
Total Oil Seeds	5.98	5.79	5.91
Potato	91.46	85.14	88.8
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 (16129 tons), followed by Rice (11612 tons) and ragi (11464 tons). These three crops had 85.46 percent share in the total cereal production in 2017-18.

Among pulses, urad had the highest share (60.94%) in the total pulses production. In the case of oilseed production, mustard and soybean are the main crops, which comprised about 95.99 percent share in the total oilseed production in 2012-13. Potato is another important crop in the district. Its production was highest (1948 tons) in 2010-11 and lowest in 2012-13(580 tons).

Table 10: Trends in Production of Principal Crops (in metric tonnes)

Crop/ Year	2010-11	2011-12	2012-13
Rice	14897	12658	11612
Wheat	16347	14363	16129
Barley	1578	18352	1680
Maize	228	191	158
Ragi	11832	9392	11464
Saava	3950	4281	4830
Total Cereal	48832	42720	45873
Urad	91	87	181
Masoor	35	16	28
Matar	35	16	28
Arhar	39	87	84
Total Pulses	171	194	297
Total Food Grains	49003	42914	46170
Mustard	143	154	194
Net Til	1	3	13
Soybean	55	35	117
Total Oil Seeds	199	192	324
Potato	1948	911	580
Source: Estimated from District Statistical Handbooks.			

We have calculated crop-wise average, standard deviation (SD) and coefficient of variation (COV) in the area, production, and yield to understand variability across years. In the case of area under different crops, the lowest variability is observed in Rice (3.85%), closely followed by Total cereals (4.29%), barley (4.38%) and wheat (4.80). It is observed highest in peas (75.78%), followed by Net til (65.66%), soybean (40.41%), Potato (34.85%) and total oilseeds (26.63%). Overall, the area under oilseed has more variability than the area under cereals and pulses (Table11).

Table 11: Variability in Area, Production and Yield of Principal Crops (2010-11 to 2012-13)

Crop/ Year	Area			Production			Yield		
	Av	SD	COV	Av	SD	COV	Av	SD	COV
Rice	9337.00	359.50	3.85	13055.67	1678.22	12.85	14.29	0.93	6.48
Wheat	10203.00	489.36	4.80	15613.00	1088.01	6.97	15.33	0.39	2.54
Barley	1117.67	48.99	4.38	7203.33	9655.16	134.04	15.10	1.04	6.87
Maize	185.33	8.96	4.84	192.33	35.02	18.21	10.73	1.32	12.32
Ragi	698.22	66.69	9.55	10896.00	1315.43	12.07	15.60	1.20	7.71
Saava	2830.67	193.90	6.85	4353.67	444.48	10.21	15.38	1.04	6.77
Total Cereals	30453.33	1307.29	4.29	45808.33	3056.51	6.67	15.02	0.46	3.05
Urad	243.33	36.61	15.05	119.67	53.15	44.42	4.48	0.84	18.73
Masoor	34.00	8.19	24.07	26.33	9.61	36.49	7.42	1.16	15.60
Peas	5.33	4.04	75.78	26.33	9.61	36.49	7.25	0.68	9.39
Arhar	81.00	31.58	38.98	70.00	26.89	38.41	8.80	0.46	5.27
Total Pulses	365.67	48.58	13.29	220.67	67.10	30.41	6.44	0.31	4.78

Total Food Grains	30819.00	1320.64	4.29	46029.00	3046.95	6.62	14.88	0.52	3.47
Mustard	324.67	75.80	23.35	163.67	26.84	16.40	5.28	0.03	0.58
Net Til	15.00	9.85	65.66	5.67	6.43	113.45	2.43	0.89	36.55
Soybean	59.67	24.11	40.41	69.00	42.76	61.96	9.12	0.75	8.24
Total Oil Seeds	399.33	106.35	26.63	238.33	74.27	31.16	5.89	0.10	1.63
Potato	179.00	62.39	34.85	1146.33	713.72	62.26	61.83	45.96	74.34
Source: Source: Estimated from District Statistical Handbooks.									

Overall, variability in the production of different crops is higher than in the area under these crops. Barley has the highest COV in production (134.04%), followed by Net til (113.35%), Potato (62.26%), soybean (61.96%) and urad (44.42%). 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, wheat, Ragi, Saava, urad and Potato), while in some crops, it is lower than that in area (for example, peas, Net til, and arhar). Several factors, such as market prices and rainfall patterns affect the variability in agricultural production.

iv- Consumption of Chemical Fertilizers

It is significant to note that per hectare use of chemical fertilizers is almost negligible. The table shows that the use of nitrogen ranges between 0.29 kgs/ha to 0.27 kgs/ha of GCA. Phosphorous use ranges between 0.15 khs/ha to 0.12 kg/ha of GCA. The use of potassium is almost zero. Total fertilizers use almost the same 0.41 kgs/ha of GCA (Table 12). It can be inferred from the fertilizers consumption data that the district's agriculture is 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	2010-11	2011-12	2012-13
Nitrogen	0.29	0.28	0.27
Phosphorous	0.15	0.12	0.12
Potassium	0.03	0.00	0.02
Total	0.41	0.39	0.41

Source: District Statistical Handbooks

v- 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. The table shows that there is not much progress in the addition of the length of canals across years. The length ranges between 483.31 to 507.54 kilometers. The number of water tanks has increased from 1088 in 2011-12 to 1217 in 2013-14, a net increase of 129 tanks (Table 13).

Agriculture in the district is mostly under rain-fed conditions. The net cultivated area under irrigation ranges between 9.98 to 13.20 percent. There is slight progress in bringing more area under irrigation. Gross irrigated areas as a percentage of GCA is also quite low (12.57-16.86%)

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

Name/Year	2010-11	2011-12	2012-13	2013-14
Length of Canals (KM)	-	486.8	507.54	483.31
No. of Groudlevel Pumpset	-	-	-	-
No. of tanks		1088	1197	1217
Gool in KM	-	-	-	-
% of NIA	9.98	13.43	13.20	-
% of GIA	12.57	16.86	15.87	-

2.1.4 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, the nature of out-migration has been gradually changing from seasonal or temporary to permanent, having far-reaching consequences for the rural economy. The exodus makes it difficult for the remaining people to do farming as cultivated land intersperses with inactive uncultivated land. There is a vicious cycle between out-migration and agriculture. Since agriculture is not remunerative and can generate gainful employment (see table above), the youths out-migrate in search of better livelihood options. This 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 and fruits and other food items from the local farmers. It may be relevant to mention that the floating population in the district may be even more than the actual population. This population needs different kinds of agro-products that the local market can supply. Diversifying agriculture and allied activities toward low volume and high-value agro-products would check the out-migration and work as a multiplier in the local economy, generating additional employment avenues in the non-farm activities. There are three deterrents—out-migration, the menace of wild animals and interspersing of cultivated landholding with inactive and abandoned landholding. The possibility of evolving an economically viable model of convergence of MGNREGA activities with the concerned line departments would be explored to promote HVCs and improve people's livelihood. Uttarakhand Human Development Report (2018) shows that about half of the total first-time migrants in Rudraprayag migrated alone and about one–fourth with family members (Table 14).

Table 14: Process of Migration (First Migration) in Rudraprayag (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
Rudraprayag	46.3	25.9	23.1	3.7	0.0	1.0	100
UK	72.1	18.0	6.6	2.6	0.1	0.6	100

Source: Uttarakhand Human Development Report

2.1.5 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 incentivised to form groups to do organic farming and sell their products with PGS certification. The state set up the Uttarakhand Organic Commodity Board (UOCB) in 2003 as a nodal agency to facilitate organic clusters and provide technical support to promote organic farming. The area under organic farming is the state was about 18% of the NSA in 2019 (https://www.downtoearth.org.in/blog/agriculture/how-indian-states-are-promoting-organic-natural-farming-73306). Uttarakhand is the first state of India which enacted Organic Farming Act in 2020 and declared 10 of its blocks fully organic. The hill districts of the state, including Rudraprayag, have a natural advantage in organic farming as per hectare use of chemical fertilizers is quite low (less than one percent).

Table 15 shows the status of organic farming PGS groups constituted under PKVY and Namami Gange schemes. As on June 30, 2021, there are total 314 organic farming groups with 17145 registered farmers in the district. Out of these groups, about 67.2% constituted under the PKVY and 32.8% under the Namami Gange. The median number of farmers per group is 50 under PKVY and 61 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 Augustmuni (91 and 4517), followed by Jakholi (72 and 3649), and lowest in Ukhimath (48 and 2431).

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

Sl No	Block	Scheme	No of Groups	No of Farmers in Groups			
				Total	Average	Median	SD
1	Augustmuni	PKVY	91	4517	49.63	50	3.36
		Namami Gange	88	5799	65.89	63	32.54
2	Jakholi	PKVY	72	3649	50.68	50	4.39
		Namami Gange	6	299	49.83	47.5	32.96
3	Ukhimath	PKVY	48	2431	50.64	50	5.38
		Namami Gange	9	450	50	45	28.48
4	Total District	PKVY	211	10597	50.22	50	4.25
		Namami	103	6548	63.57	61	32.44
		Total	314	17145	54.6	50	19.86

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

. The highest number of groups under the Namami Gange scheme is in Augustmuni (88), distantly followed by Ukhimath (9). Since economies of scale in both production and marketing matter in organic farming, possibilities of some institutional framework may be in the forms of SHGs/ farm cooperative/PFOs/contract farming, etc. be designed. Organic farming could be an economically viable option in the district if the govt. builds strong marketing networks linking farmers, processors and distributors with the easy certification process and minimizing farmers' risk by protecting their farm income by way of payments of ecosystem services. Organic farming Act is a good initiative and its provisions should be effectively enforced. A long-term system of incentive as well as regulation may be evolved to retain the existing farmers and motivate others to move towards the sustainable farming system in the district.

The major problem for the growth of organic farming are:

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

Highlights-2

NSA in the district is less than 10% of the total reported area, indicating less potential of development of crop sector.

The area under forest is more than 76% of the total reported area. Forest-based livelihood activities have the potential for income generation in the district.

Marginal and small farmers constituted about 92.91% of the total farmers of the district.

The agriculture of the district is dominated by food grains which comprise 97.79% of the GCA. Three cereal crops-wheat, Rice and Saava together constituted 70.54% of the GCA.

Ragi, saava, arhar, soybean and Potato are promising crops in the district. Marketing support and R&D intensification can make these crops more remunerative for farmers.

Variability in 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. In some crops, variability in yield is higher than that in the area, while in some other crops, it is lower than that in area

Per hectare 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. Net cultivated area under irrigation is less than 14%.

There are three deterrents in the promotion of 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

2.2 Trends in Livestock

Livestock has an important place in the rural economy. Data on livestock come from the livestock census, which is conducted periodically. Table16 shows that the total number of cattle (cows and bulls) has increased from 100554 in 1998 to 102428 in 2007 and 105033 in 2012 and further declined to 74237 in 2019. During 1998 and 2019, there has not been much decline in the number of female cattle, but the number of male cattle has drastically declined, probability due to lack of

demand for animal power. In the case, Buffalo of both male and female decreased. Comparing 1998 and 2019 data, we observe that numbers of cattle have increased up to 2007 and after that their numbers declined substantially, particularly the male ones and buffaloes it is continuously decreasing both male and female. The number of sheep shows ups and downs during the entire period. It was highest in 2012 (15636) and then declined to 13084 in 2019. Also, the number of goats has decreased during the period. The number of pigs in the district is quite low. This shows that overall, livestock is in decreasing trend.

Table 16 Trends in Livestock population (in numbers) Rudraprayag

Livestock	Category	1998	2003	2007	2019
Indigenous Cattle	Total Male	52871	53077	54806	28786
	Total Female	47045	47089	47881	42491
	Total	99916	100166	102687	71277
Exotic Cattle	Total Male	240	1055	816	307
	Total Female	398	1207	1530	2653
	Total	638	2262	2346	2960
Total Cattle	Total Cattle	100554	102428	105033	74237
Buffalo	Total Male	6792	5436	6496	430
	Total Female	42681	31786	35870	30685
	Total	49473	37222	42366	31115
Sheep	Total Indigenous Sheep	12932	14961	12499	12265
	Total Exotic Sheep	1065	675	700	819
	Total Sheep	13997	15636	13199	13084
Goat	Total Male	-	-	-	6464
	Total Female	-	-	-	21899
	Total	39949	39974	28986	28363
Pig	Total Indigenous Pig	57	72	40	44
	Total Exotic Pig	-	-	-	-
	Total Pig	67	72	40	44
Total Livestock		22106	196823	197276	-
Total Poultry		-	-	-	-
Source: Compiled from District Statistical Handbook and http://dahd.nic.in/animal-husbandry-statistics					

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 17 shows the percentage share of major fruit crops in the total cropped under fruits. In 2013-14, lemon constituted the highest share (24.12%), followed by mango (15.46%), and apple (13.02%). The total area under fruits shows less variation across years.

Table 17: The percentage share of major fruit crops in the total cropped under fruits

Crop/Year	2011-12	2012-13	2013-14
Apple	13.05	13.01	13.02

Pear	6.47	6.37	6.09
Peach	5.54	5.71	5.61
Plum	4.20	4.05	3.90
Apricot	1.55	1.49	1.47
Walnut	8.54	9.03	11.22
Lemon	24.99	25.00	24.12
Mango	13.70	6.11	15.46
Litchi	0.93	0.90	0.86
Other Fruits	21.03	20.28	19.52
Total fruits (ha)	2905.0	3012.2	3150.2
Source: District Statistical Handbooks of Rudraprayag			

Production of lemon ranges from 782.80 tons in 2013-14 to 1820 tons in 2011-12. Its production has steeply declined. Production of almost all fruits massively declined in 2012-13 when compared to 2011-12. Total production of fruits has declined from 5977 tons in 2011-12 to 2581 tons in 2013-2014 (Table 18).

Table 18: Total Production of Major Fruit Crops in Rudraprayag (in tons)

Crop/Year	2011-12	2012-13	2013-14
Apple	634	188	190
Pear	550	201	205
Peach	296	151	155
Plum	286	131	133
Apricot	127	61	62
Walnut	87	44	45
Lemon	1820	781.80	782.80
Mango	391	184	487
Litchi	6	3	10
Other Fruits	1780	501.20	511
Total	5977	2246	2581
Source: District Statistical Handbooks of Rudraprayag			

Table 19 shows that the per hectare yield of almost all crops has declined during 2012-13 and 2013-14. The productivity of apple decelerated from 1.67 tons in 2011-12 to 0.46 tons in 2013-14. Per hectare yields of all fruits except mango and litchi have declined during 2012-13 and 2013-14. Overall, productivity went down from the peak of 2.06 tons/ha in 2011-12 to 0.82 tons/ha in 2013-14. The above analysis indicates the dismal scenario of fruits production in the district. The reasons for this dismal condition of horticulture in the district need to be explored.

Table 19: Per hectare yield of Major Fruit Crops in Rudraprayag (tons)

Crop/Year	2011-12	2012-13	2013-14
Apple	1.67	0.48	0.46
Pear	2.93	1.05	1.07
Peach	1.84	0.88	0.88
Plum	2.34	1.07	1.08
Apricot	2.82	1.36	1.34
Walnut	0.35	0.16	0.13
Lemon	2.51	1.04	1.03
Mango	0.98	1.00	1.00
Litchi	0.22	0.11	0.37
Other Fruits	2.91	0.82	0.83
Total	2.06	0.75	0.82
Source: District Statistical Handbooks of Rudraprayag			

Area, production, and yield of almost all fruits evince a magnitude of variability as indicated by COV values. In the area, the highest COV is in mango, followed by mango walnut distantly followed by peach and apple. In the case of production, COV is highest in apple, followed by pear, Litchi, and Lemon. In the case of yield, the highest variability is observed in apples, followed by pear and walnut. A perusal of Table 20 reveals that the variability in production is higher than yield and area. The high variability in production is more due to variability in area than due to the variability in yield.

Table 20: Variability in Area, Production and Yield of Principal Crops (2011-12 to 2013-14)

Crop/ Year	Area (ha)			Production (tons)			Yield (tons/ha)		
	Av	SD	COV	Av	SD	COV	Av	SD	COV
Apple	393.73	15.67	3.98	337.33	256.92	76.16	0.87	0.69	79.56
Pear	190.67	2.31	1.21	318.67	200.35	62.87	1.68	1.08	64.21
Peach	169.93	8.10	4.77	200.67	82.59	41.16	1.20	0.55	46.33
Plum	122.27	0.46	0.38	183.33	88.92	48.50	1.50	0.73	48.71
Apricot	45.40	0.69	1.53	83.33	37.82	45.38	1.84	0.85	46.24
Walnut	291.13	55.24	18.98	58.67	24.54	41.83	0.21	0.12	56.41
Lemon	746.27	17.88	2.40	1128.20	599.12	53.10	1.53	0.85	55.75
Mango	356.33	155.74	43.71	354.00	154.85	43.74	0.99	0.01	1.02
Litchi	27.00	0.00	0.00	6.33	3.51	55.45	0.23	0.13	55.45
Other Fruits	612.33	2.31	0.38	930.73	735.50	79.02	1.52	1.21	79.22
Total	3022.47	122.92	4.07	3601.27	2064.24	57.32	1.21	0.74	61.04
Source: Estimated from District Statistical Handbooks									

2.4 Trends in Area, Production and Yield of Vegetable Crops

Table 21 shows the trends in the area, production, and per hectare yield of total vegetable crops. It is evident from the data shown in the table that the area, production, and yield of vegetables in the district have slightly increased during 2013-14. The per hectare yield has gone down from 5.08 tons/ha in 2011-12 to 2.54 tons/ha in 2013-14. Similarly, total production steeply declined from 4997 tons in 2011-12 to 2671 tons in 2013-14, a net decline of 46.55. The area is increased from 983ha in 2011-12 to 1050.7 ha 2013-14. The area under Potato slightly increased from 677 ha to

682 ha. As a result, the production increased from 7183 tons to 7628 tons. The yield of Potato slightly increased from 10.61 tons/ha in 2011-12 to 11.18 tons/ha in 2013-14.

Table 21: Area, Production and Yield of Vegetable Crops in Rudraprayag

Crop/Year		2011-12	2012-13	2013-14
Total Vegetables	Area (ha)	983	987	1050.7
	Production (tons	4997	2992	2671
	Yield (Tons/ha)	5.08	3.03	2.54
Potato	Area (ha)	677	681	682
	Production (tons	7183	7228	7628
	Yield (Tons/ha)	10.61	10.61	11.18
Source: District Statistical Handbooks, Rudraprayag				

Overall, the state of horticulture in the district is dismal. Agriculture and allied sectors can improve rural livelihood through diversification into areas such as horticulture, aromatic and medicinal plants, animal husbandry, including dairy, fisheries, sericulture, bee-keeping, mushroom production, etc. Fruits, vegetables, potatoes, mushrooms, spices, medicinal plants, and flowers can provide remunerative returns to farmers as their demand is income-elastic. It is significant to note that the state government has initiated the consolidation of land holdings in the hilly region.

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 2012 over 2007.

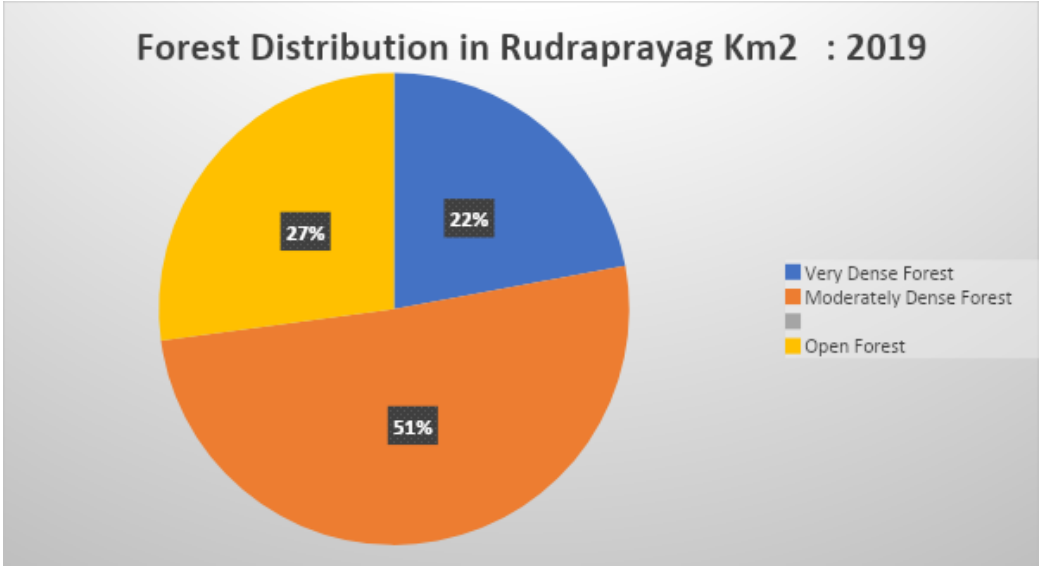
The district has a high potential for horticulture development. With policy support and a well-designed action plan, this sector can be the growth driver for the agriculture sector.

In 2018-19, the area under lemon constituted the highest share (24.12%), followed by mango (15.46%), and apple (13.02%). The total area under fruits shows high variation across years mainly due to a steep decline in the share of area under lemon crop.

On average, the production of most fruit crops has declined over the period due to reducing in yield

2.3 Forestry

Total geographic area of the district is 1984 Km^2. As per 2019 Forest survey of India assessment, the district has a total 57.57% of forest area of total geographic area. The total forest cover in the district is 1142.17 Km^2. From this total area, 252 Km^2 comes under very dense forest (VDF) category, 580 Km^2 is moderately dense forest (MDF), and 310.17 Km^2 area is open forest (OF) (FSI, 2019).



Forest Survey of India 2019 Uttarakhand vs Rudraprayag Comparative Assessment						
Area	Geographical Area	Very Dense Forest	Moderately Dense Forest	Open Forest	Total	%of Geographical Area
Rudraprayag	1984	252	580	310.17	1142.17	57.57%
Uttarakhand	53483	5046.76	12805.24	6451.04	24303.04	45.44%

2.3.1. Biodiversity:

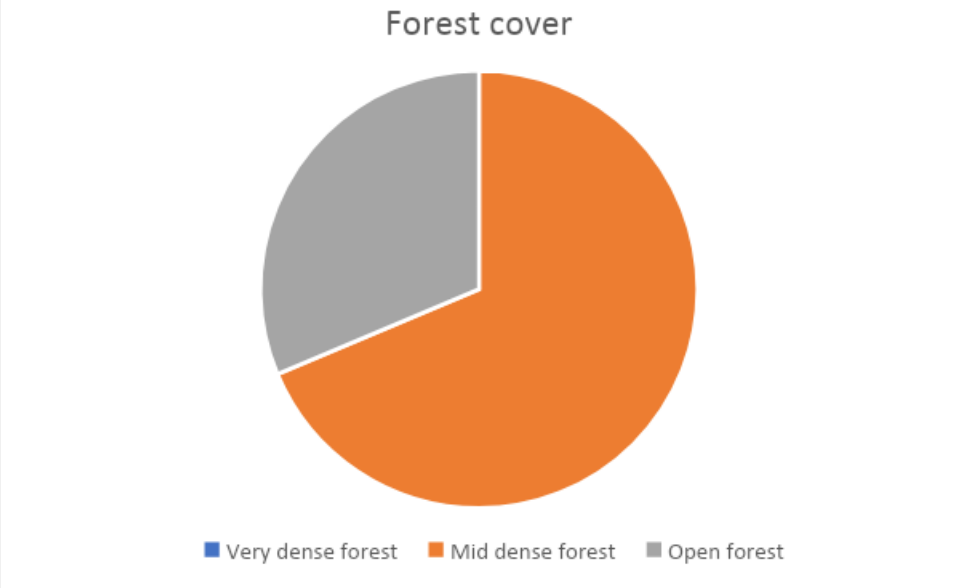
The district's biodiversity data includes crop production, livestock population, bird species, and forest cover. Umbrella project biodiversity of Uttarakhand reports the biodiversity data of the Rudraprayag district. As per the data, 386 flora and fauna have been observed till now. A total of 227 species are present in the district, of which 35.24% are insect, 24.67% plant species, 0.44% amphibian, 3.52% mammal species, 25.99% birds, and 0.88% reptiles.

Table 1 Bird species recorded in the district.

Number of species	553
Number of rare/accidental species	2
https://avibase.bsc-eoc.org/checklist.jsp?region=INggupah	

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
1984	252	580	310.17	1142.17	57.57	1.17	9.00



2.4 Tourism

2.5 Wetlands

The district does not consist of many wetlands. The district consists of areas like the Devariya/deoria Tal and Vasuki Tal, some of the large size water bodies present in the district. Table 1 represents the number of wetlands and their area representation in the district. There are around three wetlands less than 5 Ha in size.

Table 1: Wetland Data of Rudraprayag District

Wetland Types	Total Number of												
	Wetlands:			Area (ha)									Aquatic Vegetation
Natural Wetlands	**NRCD**	**NWIA**	**Diff.**	**<2.25**	**<5**	**<10**	**<20**	**<50**	**<200**	**<500**	**<1000**	**>1000**	
Lake/ponds	0	0	0	0	0	0	0	0	0	0	0	0	0
Ox-bow lakes/cut off meanders	0	0	0	0	0	0	0	0	0	0	0	0	0
High altitude Wetlands	1	1	0	0	1	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	1	1	0	0	0	0	0	0	0	0	0	0
Man-made Wetlands	**NRCD**	**NWIA**	**Diff.**	**<2.25**	**<5**	**<10**	**<20**	**<50**	**<200**	**<500**	**<1000**	**>1000**	**AV**
Reservoirs/Barrages	0	0	0	0	0	0	0	0	0	0	0	0	0
Tanks/ponds	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 (3)	1	2	1	1	1	0	0	0	0	0	0	0	0

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

- The district comprises three wetlands; two are high altitude wetlands and rivers/streams.
- No artificial wetlands are available in the district.
- No wetlands have aquatic vegetation.

2.6 Energy

2.6.1. Solar Energy

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

The graph represented by Fig. 1 represents the percentage of households using different sources for lightning. This data is according to the 2011 census. It is very clear that more than 90% households use electricity, 7% use kerosene and only 0.52% households use solar as the main source of lightning.

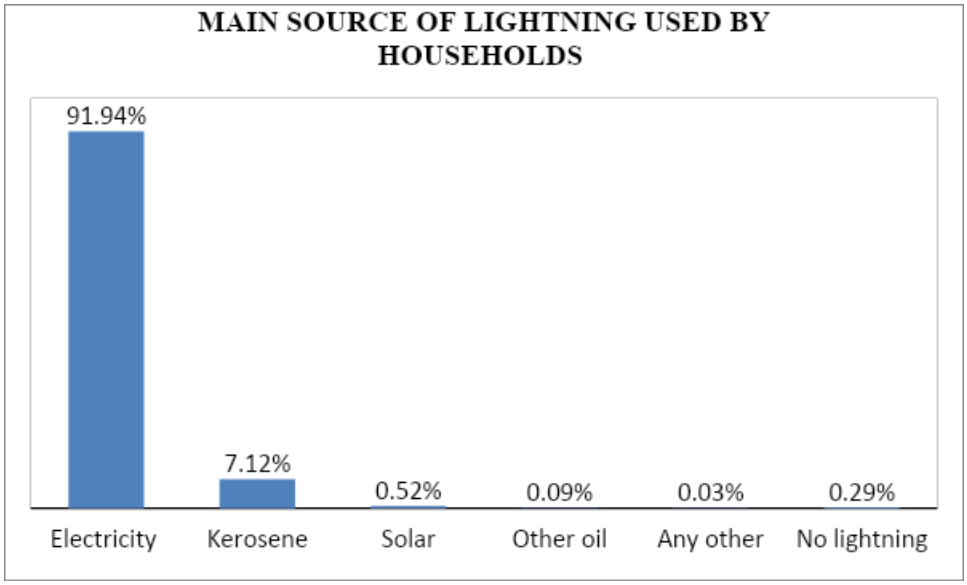


Fig. 1

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

In the district Rudraprayag 517 Dish solar cookers under Mid Day Meal and Market Mode Programme upto 2015-2016 have 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.

In the district Rudraprayag, the main source of income is from agriculture. The net sown area of the district is 19500 ha while the gross sown area is 28000 ha. This leads to a good cropping intensity of the district of 143.6%. The main crops grown in the district and their productivity are given in Table 1.

CROP	PRODUCTIVITY (Qt./ha)
Lentil	14.500
Wheat	12.050
Soyabean	19.790
Jhingora	12.152

Mandua	14.675
Maize	12.750
Rice	13.100
Brinjal	10.453
Onion	11.562
Cabbage	10.392

Table: 1

The district reports 57.57% as the forest area out of the total geographical area which accounts to 1142.17 sq. km. 252 sq. km. of the forests are very dense, 580 sq. km. are moderately dense and 310.17 sq. km. area comes under open forests. The district has a good cover of pine forests as well which is a good source of biomass. According to Kumar et. al. (2019) the district Rudraprayag produces 180.87 t/ha of biomass of *Pinus roxburghi.*

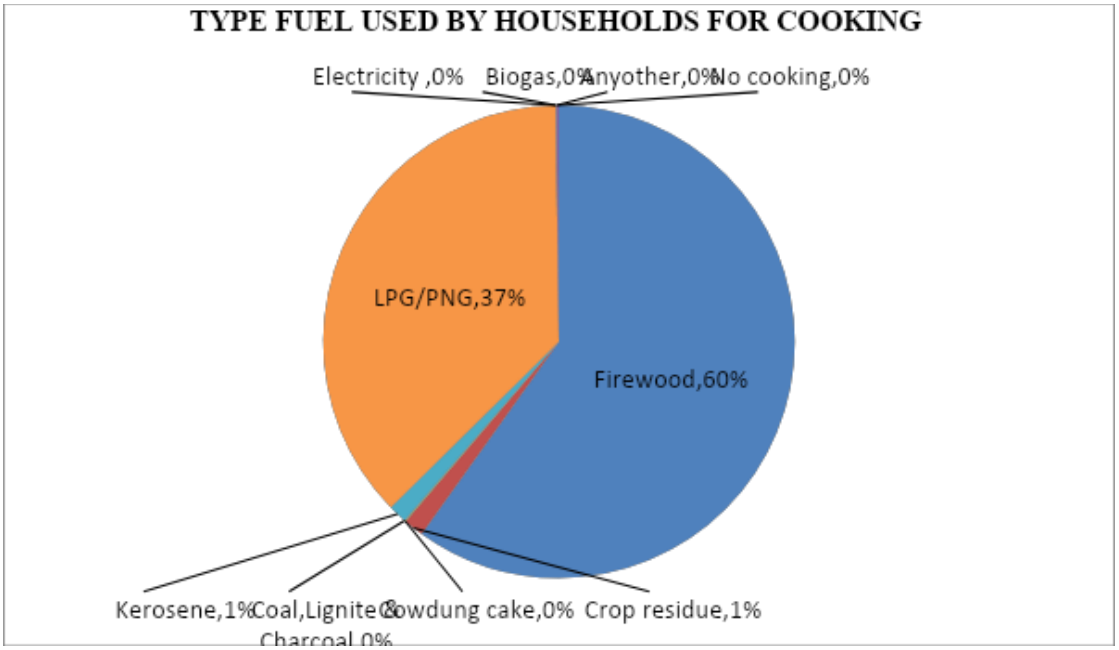


Fig. 1

Fig. 1 is a pie chart representing the type of fuel used by the households in the district according to 2011 census. It is clearly depicted that most of the households use firewood followed by LPG/PNG.

Although the district is agrarian in nature and has a good forest cover but does not reports any biomass plants. The district's main source of biomass is in form of agriculture and forest residue

The state government has the biomass energy scheme and the Pirul based energy scheme of which probably people are not aware of.

2.6.3.Biogas Energy

Five family-sized biogas plants have been installed in the district between the years 2009 to 2019. Biogas potential has been evaluated by average livestock and agricultural waste production. Biogas potential from animal waste is calculated approximately as thirty-two lakh m^3/year and seventy-seven lakh 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 river Mandakini, which is the most important river coming down from the slopes of Kedarnath peak, joins the Alaknanda at Rudraprayag. The river actually originates from the springs fed by melting snow of Charabari glacier about one km above Kedarnath temple.

Name of project	Installed capacity (MW)	Stream/river	Developer	Status
Gaurikund	19	Mandakini	Lanco Kondapall	Under construction
Kedarnath	2*0.1	Mandakini	UREDA	In operation
Lashkargad-I	3	Mandakini	-	
Lashkargad-II	2	Mandakini	-	
Singoli-Bhatwari	60	Mandakini	L&T	Under construction
Rambara	24	Mandakini	Lanco Kondapall	Under construction
Phata byung	11	Mandakini	Lanco Kondapall	Under construction
Mandakini-I	8	-	-	
Mandakini-II	8	-	-	
Mandakini-III	8	-	-	
https://www.iitr.ac.in/wfw/pdf/Hydropower_stations_in_operation_and_under_construction_in_uttarakhand.pdf				

3 QUALITATIVE DATA ANALYSIS

3.1 AGRICULTURE, ALLIED ACTIVITIES,

3.2 FORESTRY

The chief variety of timber trees found in the groves of the district are pine, tun, deodar and many varieties of walnut. The timber of the deodar tree is considered to be sacred and is noted for durability and resisting insect, pest and dry rot. It is great demand for making doors and roof of temples. In the warm valleys of the extreme southern part of the district some species of the trees of the plains such as mango, jamun, pipal, banyan and shisham grow here. Chir wood is also found in the district at the altitude of 1200m to 1800m; The Chir wood is commonly used for building purposes in the district, and its logs and sleepers are floated down the Alaknanda to the plains. Chir is also tapped for resin but quantity of turpentine produced in the district is small (MSME).

Environmental Information Service has enlisted major medicinal plants found in the district (ENVIS).

Sr. No.	Local Name	Medicinal Use
1	Latjira	piles, cough, asthama, snake bite
2	Maurya Shikha	Skin disease, diabetes, fever
3	Hansraj	Eye ailment
4	Chua seeds	Veterinary disease
5	Gojha	Snake bite, Urinary disorder
6	Jawaridhun	Indigestion, Jaundice, cold
7	Kachnar	Diarrhoea, Indigestion
8	Bhang (Cannabis)	Fever, diarrhoea, skin disease, asthma
9	Bethu	Stomach ulcers
10	Bel	Body pain, burns, eye disease, headache, hair loss
11	Dhatura	Asthma, skin disease, boils, sores

Recently, the Rudraprayag Forest division has managed to store 10 million litres of water within 330 hectares of forest. This campaign was carried under the guidance of IFS Vaibhav Singh. Rudraprayag district is prone to the forest fires because of the presence of the Chir Pine groves (The Daily Guardian, 2021). During the campaign funds from Compensatory Afforestation Fund Management and Planning Authority (CAMPA) and Namami Gange were used.

For the real time monitoring of forest fires, Rudraprayag forest division launched a mobile app. the application will help officials monitor such incidents better with real time location of active fires on Google Map. Using the application, people can report forest fires through geo-tagged images (Hindustan Times, 2021).

5 Schools in the district have been identified under the scheme of School Nursery Yojana.

3.2.1. Biodiversity

In the Garhwal Himalaya, the famed Kedarnath Kasturi Devi Vihar (Century) is located in Mandakini Valley and spans 967 kilometers. Many deer live in Mandakini Valley, including musk deer, reindeer, chital, Swam deer, Thar Goral, Bharhel, Himalayan fox, and mountain goat. Bears, wild pigs. The district's primary area is dominated by snow beer, wild cat, and other similar items. The district is home to a variety of bird species, including rabies, Kingfisher, Koyal, Chakore, Snokok, Wood Pigeon, and others. The Mandakini valley is home to a plethora of flowers, flowers, and trees in a variety of colors and scents. The state flower of Uttarakhand is the Brahma Kamal, which grows in the district's high Himalayan highlands. Buransh-covered trees and flowers draw everyone's attention.

Kedarnath wildlife sanctuary (KWS) has over 1100 plant species, which are divided into five major forest types. Nearly 173 communities are located on the sanctuary's outskirts, with residents relying largely on KWS resources for their daily nutrition and livelihood.

3.3 ENERGY

As per the data of the year 2013, Rudraprayag district energy consumption is around 51 TJ/year and 5.5 GJ/capita/year. GHG emission of 3,436 Ton CO_2 equivalent and 0.369 Ton CO_2 equivalent/capita has been evaluated for the district.

5.5.1. Solar

The state government has two types of schemes one is solar energy schemes and the other are solar thermal energy schemes. The quantitative data collected gives a glimpse of solar energy development in Rudraprayag. According to an article in India Today Solar street lights have been installed in four villages in Rudraprayag district by the Border Security Force, which now plans to extend the benefit to seven other villages located in the Kalimath Valley. Each identified village will be allotted 20 to 30 solar lamps.

Another article in Hindustan Times- 'Uttarakhand sees light in Manoj Bhargawa's solar power packs' is about The Uttarakhand government is distributing power packs for providing off grid power to households in remote areas. The Corporation has set a target to provide electricity to one lakh households located at border areas, scattered villages and those divided by forests in

Uttarkashi, Rudraprayag, Chamoli and Pithoragarh districts. In remote locations where power grids cannot reach, the power department is installing solar power systems and providing power packs.

Indian American businessman and philanthropist Manoj Bhargava is providing the 300-watt power packs through Hans Foundation in the state. As per reports, each power pack costs Rs 14,500. Coming with a 12-year warranty, the device can run small appliances like fans, mobiles and bulbs. It can be recharged with the help of solar energy.

5.5.2. Biomass

The district Rudraprayag witnesses large forest fires every year. This leads to a lot of destruction of both the flora and the fauna. Mostly it is the pine needles and other forest wastes which are the cause of these forest fires.

According to an article in The Times of India, there have been forest fires in Uttarakhand which led the state to lose over 56000 trees in around 235 wildfire incidents and controlling these fires caused a loss of Rs. 9.71 lakh to the exchequer. In all maximum forest cover has been devastated in Pauri (115.6 ha), Almora (61.5 ha), Bageshwar (47.27 ha), Uttarkashi (38.8 ha), Pithoragarh (22.6 ha), and Rudraprayag (8.5 ha).To deal with the forest fires the district should utilize the forest waste in biomass energy production.

The district is agrarian in nature, hence the crop residue produced should be utilized for some productive purpose. The district Rudraprayag has a lot of potential in the form of agricultural residue, forest residue, etc. but still there has been no evident advancement in biomass energy sector. If everything is planned well then the district then this sector could be a boon for the district.

5.5.3. Biogas

Three biogas plants of two cubic meters were installed in the district in 2014 and 2015.

5.5.4. Hydropower

Larsen & Toubro announced its 99 MW power facility in Rudraprayag, Uttarakhand, to ReNew power, marking the company's foray into the hydropower industry under Sumant Sinha's leadership.

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 has the presence of many minerals like asbestos, magnesium, copper iron, graphite, lead and sandstone. The district is known for its religious values with pilgrimage spots like Ukhimath, guptkashi, Kedarnath and many more and for Alaknanda and Mandakini's confluence. 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:

- Badhani tal is famous for its colorful fish species.
- Production of ayurvedic medicinal plants is reasonably high like Atisas, kutki, vajradanti, Daru Haldi, cinnamon, salam panja
- Forest products play an essential role in the economy of the district. Besides supplying fuel, fodder they also yield a variety of products like Jhulla ghas, Lisa, Kingora, Hinsar, Bhamora, Kappahl, Farad, Chora
- Mandakini valley has innumerable flowers like Brahma Kamal. Trees are covered with buransh, foliage flowers. Semel, sarasu, dhak, baanj, chid, cedar, reetha, walnut are valuable trees found in the district.

4 ACTION PLAN DEVELOPMENT

4.1 AGRICULTURE

.

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. Rudraprayag is one of such areas where important medicinal and aromatic plants 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.

Cluster formation is another approach for collective efforts. Apart from medicinal products, Rudraprayag has seen production of resin, timber, and forest fruits. The locals who are into similar

production can come together and have the common production and packaging facility. These clusters can produce high quality resins, forest honey, bamboo-based products, wooden furniture and toys, jam, and pulps, selling directly to the customers. District government can facilitate emporiums similar to South Indian states (Karnataka, Kerala state emporium), where profit is directly made by the producer. These shops can have subsidized products to foster the rural economy.

Pharmaceutical firms and other agencies can adopt stands of particular tree species such as timber tree or medicinal tree through e-tendering process. In this system local employment also gets employment opportunities and companies can directly benefit from the raw material availability. Local governments can provide e-tendering systems and ease of business support so companies can also start manufacturing and export from local to global level. Potential companies can be Dabur, baidyanath, Himalaya, zandu, and other furniture, timber-based companies.

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.

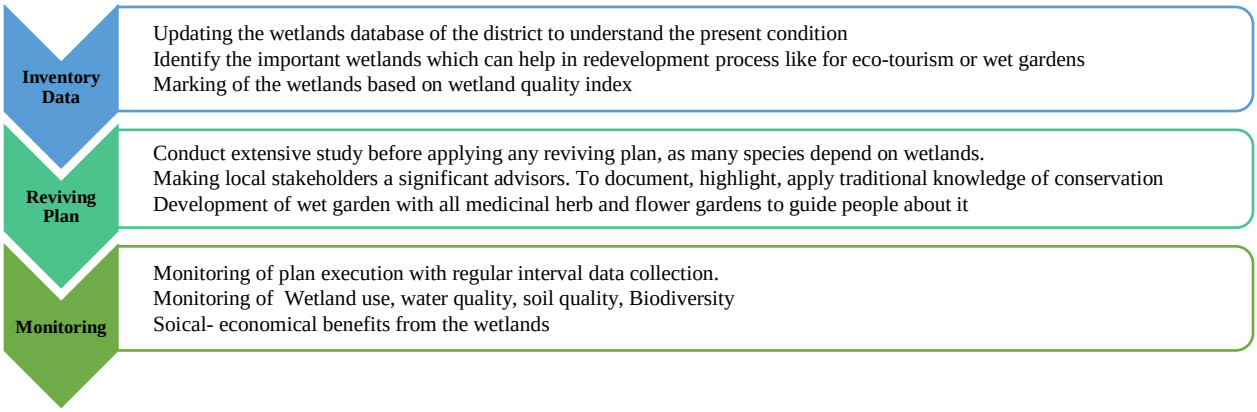
4.2.1. Biodiversity

The district is rich in biodiversity and has a vast forest area. Government should promote the Kedarnath wildlife sanctuary to support eco-tourism.

4.3 TOURISM

4.4 WETLANDS

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



4.5 ENERGY

4.5.1 Solar

The district Rudraprayag has not witnessed much development in the solar energy sector. Neither the photovoltaic nor the thermal energy systems have been installed in an appreciable number. In the district Rudraprayag, awareness needs to be spread about solar energy and the different forms it can be utilized. People should be made aware about the different policies of the government in this sector. Agriculture is the main economic activity and in order to develop the district, powering agriculture with solar energy is important. The Kusum Yojana of the central government should be adopted in the district on a large scale, along with Mukhyamantri Saur Swarojgar Yojana. Both the schemes can together lead to the development of the district. Component C of Kusum Yojana should be implemented, i.e. solarization of segregated feeders should be done. This will remove the burden on the discoms and they could supply uninterrupted electricity to the farmers. The Mukhyamantri Saur Swarojgar Yojana can help those whose land does not yield much. Thus this agriculture dependent district can prosper using its own resources. This way an additional capital would be added to the farmers income providing security to them. Next to this is promotion of grid connected solar rooftop panels under the National Solar Mission especially in the urban areas of the district to support the discoms in providing full-fledged electricity supply. Since the winters are severe in the district, solar thermal energy should also be promoted. Use of solar cookers and solar water heaters should be encouraged. Use of solar room heaters should be encouraged in hotels, restaurants and guest houses. Solar water heaters should be used in industries wherever required. The remote areas of the district should be provided with the benefit of financial assistance for the off grid connections so that the development in these areas is also powered by solar energy.

PROJECTION AND MONITORING MATRIX

Firstly, awareness about solar energy and the policies made by the government is important. When people will know about it then only they would get inclined towards solar energy.

Secondly, under the Kusum Yojana solarisation of agricultural feeders should be done so that farmers are supplied with uninterrupted power supply. Therefore it becomes important to develop a proper infrastructure.

Thirdly, policies should be formulated aiming at the progress of solar energy in the remote areas where electrification has not been done yet. Providing them with the financial assistance for the off grid connections would be a great step towards development of these areas.

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

Lastly, solar thermal energy should be promoted in the district for heating purposes especially at the hotels, restaurants etc.

4.5.2 Biomass

Rudraprayag should collect the pine needles and use it for biomass energy generation instead of burning it every year to avoid forest fires. The locals and the natives should be given more access to the forests probably by improving the transportation system for this purpose.

The district should also pay attention to generating biomass energy using the crop residue since the district's economy is agriculture dependent. For this purpose an assessment of the district is required to figure out the land and other resources availability. Once all the information is collected it would become easy for the entrepreneurs to invest and set up the biomass based gasifiers and the co-generation plants.

A well-developed transportation should also be planned along with the storages. This way when there will be an already developed base it would be attractive for the investors to invest.

All this can be done only when people are aware of the biomass potential of their district. Then only development in this sector is possible. These sets would surely create employment for the people in the district.

Wastes from urban areas should also be utilized, especially the used cooking oil for producing biofuel from it. The used cooking oil is not good for health and if thrown away is not good for the environment; hence it can be utilized for preparing 2G ethanol.

PROJECTION AND MONITORING MATRIX

First of all, awareness programs should be conducted. People should be made aware of the district's potential of biomass energy.

Secondly, pine needle based biomass gasifiers should be set up by the government to avoid burning of these. If pine needles are not burnt manually during the winters then they lead to forest fires. The only way left is to collect them and remove it from the jungle area.

Thirdly, Biomass based gasifiers should also be set up and more and more entrepreneurs should be encouraged to establish such plants. This can be made easy when the government makes resource availability easier.

Fourthly, a district oriented survey should be done which makes the transport system easier and approachable to any kind of biomass based plant.
Lastly, 2G ethanol production should also be given importance.

4.5.3 Biogas

Livestock and agricultural data show that the district has a lot of potential for generating biogas. Therefore, the government should construct a biogas plant of 80-100 m3 in cities or village areas.

4.5.4 Hydropower

The district has enough hydropower plants to serve electricity for the district. Government should now only focus on installing small hydropower projects of 2-3 MW capacity in village areas.

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 and educational services. For eco-tourism small cottages on homestead land can be constructed under convergence.

- The government horticulture and forest departments should take uncultivated and barren lands on lease from those individual farmers who do not want to do farming due to various reasons. The departments can do large-scale horticulture and agroforestry activities under MGNREGA convergence. These departments can set up horticulture and agroforestry zones and prepare the DPRs under the convergence framework, with detailed techno-economic feasibility and socio-economic and environmental impact analysis. Wire fencing of these zones can be done by the departments to protect the crops and plantations from the wild animal. Such fencing would be more cost-effective as compared to the fencing of individual farmers' land.

- Agriculture in the district is almost chemical-free, and farmers have a natural advantage to do organic farming. However, there are three deterrents—out-migration, the menace of wild animals, and interspersing of cultivated landholding with inactive and abandoned landholding. The possibility of evolving an economically viable model of convergence of

MGNREGA activities with the concerned line departments would be explored to promote HVCs and improve people's livelihood.

- The area under forest is more than 76% of the total reported area. Forest-based livelihood activities have the potential for income generation in the district.

- Agriculture R&D and extension services need to be reinvigorated and oriented toward sustainable agricultural practices suited to the hill areas in the case of HVCs, horticulture, livestock, and agroforestry.

- Water use efficiency and crop yield could be improved by implementing drip and sprinkler irrigation for vegetables and fruits farming.

- Tea has a high export potential to nearby states and other nations, which can be planted in the cooperative farming model in the district.

- Through proper training of cultivation of turmeric, garlic, ginger, and large cardamom can be cultivated by the farmers, and market access should also be provided for the farmers.

- There is ample scope for the cultivation of aromatic plants like marigold and damask rose, which will provide good returns to the farmers.

- Cold storage facilities must be built to prevent post-harvest losses of fruits.

- There is scope for accelerating mushroom production, and their primary processing for small farmers would provide additional income to farmers, but proper training is required.

- Commercial poly house and greenhouse farming for high-value crops like vegetables, medicinal and aromatic plants, flowers will provide good returns to the farmers. Though the district has already started the poly house and greenhouse cultivation in two villages, i.e., Dewar and Okhimath, there is a need to increase the numbers.

- There is a huge scope for commercialized honey production.

- The district has excellent scope for oak silk at the lower altitude and foothills and mulberry production at the higher altitude of the district.

- Application of vermicompost and bio-composting will boost soil fertility and crop productivity. Hence, more awareness and training facilities should be provided to the farmers through KVKs and NGOs.

- There is a need for some regional level mandis to establish links between producers and buyers, as well as to encourage farmers to continue farming.

- The farmers of the district are advised for mixed farming, which will provide additional income to the farmers.

- A three-tier framework of agro-processing (primary, secondary and tertiary processing) can be set up to reduce post-harvest losses and generate value addition and local employment. Primary processing can be done at the cluster level, secondary at the local town, and tertiary at SIIDCUL and be well-integrated with the supply chain network.

- A new institutional framework needs to be set up at the district level where the concerned line departments' technical, human and financial resources may be pooled or converged together to provide customized solutions to the farmers related to technology, training, marketing needs, and other advisory services.

- The farmers should provide high-yielding varieties and be encouraged to use bio-fertilizer and bio-pesticides in control to improve productivity.
- There is a need for the construction of rainwater harvesting and conservation structures, like water harvesting tanks, roof top harvesting, trenches etc.
- There is a need for increasing cropping intensity so that the croplands will be utilized well and also increase farmer's income.
- Water use efficiency and crop yield could be improved by implementing drip and sprinkler irrigation for vegetables and fruits farming.
- Tea has a high export potential to nearby states and other nations which can be planted in the cooperative farming model in the district.
- Through proper training turmeric, garlic, ginger and large cardamom can be cultivated by the farmers and market access should also be provided for the farmers. would provide more returns to the farmers.
- There is ample scope for the cultivation of aromatic plants. like marigold and damask rose which will provide good returns to the farmers.
- Cold storage facilities must be built to prevent post-harvest losses of fruits.
- There is scope for accelerating mushroom production and their primary processing for small farmers would provide additional income to farmers, but proper training is required.
- Commercial poly house and greenhouse farming for high-value crops like vegetables, medicinal and aromatic plants, and flowers will provide good returns to the farmers. Though the district has already started the poly house and greenhouse cultivation in two villages i.e., Dewar and Okhimath, there is a need to increase the numbers.
- There is a huge scope for commercialized honey production.
- The district has excellent scope for oak silk at the lower altitude and foothills and mulberry production at the higher altitude of the district.
- Application of vermicompost and bio-composting will boost soil fertility, as well as crop productivity. Hence, more awareness and training facilities should be provided to the farmers through KVK's and NGOs.
- There is a need for some regional level mandis to establish links between producers and buyers, as well as to encourage farmers to continue farming.

- The farmers of the district are advised for mixed farming, which will provide additional income to the farmers.

5.2. Forestry

- Rudraprayag 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 governments 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.

5.2.1 Biodiversity

It is recommended to promote ecotourism in the district for its beautiful landscape and forest area. Through religious places like Kedarnath, people should make aware of the importance of biodiversity and its importance.

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 tourism attraction points like fish park
- 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 to promote eco-tourism in the region as the region can be developed with a wet garden with medicinal herbs around the wetlands area and biodiversity.
- It is recommended that government institutions collect the forest products available to small industries to develop eco-friendly products like shampoo and soap.

5.5. Energy

5.5.1. Solar

- The government policies such as the Kusum Yojana, Mukhyamantri Saur Swarojgar Yojna and the National Solar Mission should be popularized among the people.
- Wherever infrastructural development is required should be done..
- Since the district experiences severe winters, use of solar thermal energy should be encouraged.
- The district has a good potential to develop itself into a solar energy hub, it will only be possible if measures are taken by the concerned authorities.

5.5.2. Biomass

- People should be made aware of biomass energy and its benefits. Awareness can be spread through various mediums.
- a 2G ethanol producing plant, especially from the used cooking oil, should be set up by the government, so that both the health of the people and the environment is not harmed.
- Pine needle based biomass plants are a must for the district.
- Since the district mainly cultivated rice, wheat, soyabean, etc. bagasse based power plants and biomass based gasifier plants, co-generation plants should be encouraged to be set up by small start-ups.

5.5.3. Biogas

- Less biogas plants have been installed as compared to other districts. Therefore it is recommended to install more biogas plants by implementing GOBAR-Dhan, and National Biogas and Manure Management Programme. Incentives and awareness should be spread among local people. Government should install a biogas plant in Kedarnath to set an example.

5.5.4. Hydropower

- It is recommended to maintain and complete under-construction hydropower projects and build only small hydropower projects in the district.

6. Discussion during the Report Presentation

- The district up numerous interventions shared in the presentations.
- The training on Natural Farming has been provided by the District Agriculture Department.

- The detailed report will be taken up for the review and will be discussed in future DGC meetings.
- The IIML Report for Arth Ganga should be a regular Agenda item for next 6-8 DGC meetings.
- Hon'ble PM during the post-Budget webinar on Tourism had spoken about market potential of destination weddings. It was suggested that suitable Ashrams in Ganga Basin may be identified for such purpose to promote blissful experience, cost reduction, livelihood opportunities and better upkeep.
- Allocate separate space for Namami Gange Awareness and Jalaj Marketing kiosk in Melas/Congregatios/Fairs for providing better marketing opportunities to the Jalaj products.
- As Dilli Haat Centre – Namami Gange Awareness and Marketing Centre – is being launched soon, it was requested that every district to identify niche products with a creative story and link it with Jalaj in their area.
- To identify Arth Ganga Tourist Trails and organize Ganga Guide training
- Promotion of Natural Farming in Ganga Basin and training workshops should be organized on a regular basis. NMCG is supporting this initiative in coordination with MoA& FW and NCOF.
- Make plans for reuse of treated waste water for agriculture, industrial etc. purpose and also the sludge.
- Training of volunteers for Ganga awareness & Aarti workshops to promote regular aartis on Ghats.

7 REFERENCES

https://censusindia.gov.in/2011census/dchb/0503_PART_B_DCHB_RUDRAPRAYAG.pdf
https://censusindia.gov.in/2011census/dchb/0503_PART_A_DCHB_RUDRAPRAYAG.pdf
https://ureda.uk.gov.in/dpages/solar-tharmal-schemes
https://www.indiatoday.in/india/north/story/uttarakhand-villages-solar-power-lights-flash-floods-rudraprayag-bsf-174993-2013-08-26

https://www.hindustantimes.com/dehradun/uttarakhand-sees-light-in-manoj-bhargawa-s-solar-power-packs/story-GUK0SWOcmbw3hWyKC5vf2J.html
https://censusindia.gov.in/2011census/dchb/0503_PART_B_DCHB_RUDRAPRAYAG.pdf
https://censusindia.gov.in/2011census/dchb/0503_PART_A_DCHB_RUDRAPRAYAG.pdf
https://agricoop.nic.in/sites/default/files/UKD10-Rudraprayag-10.07.14.pdf
https://fsi.nic.in/isfr19/vol2/isfr-2019-vol-ii-uttarakhand.pdf
https://rudraprayag.kvk4.in/district-profile.html
https://ureda.uk.gov.in/dpages/bio-energy-schemes
https://www.researchgate.net/profile/Munesh-Kumar/publication/332950051_Above-And_Below-Ground_Biomass_Production_in_Pinus_roxburghii_Forests_along_Altitudes_in_Garhwal_Himalaya_India/links/5cd315d4458515712e9b4f15/Above-And-Below-Ground-Biomass-Production-in-Pinus-roxburghii-Forests-along-Altitudes-in-Garhwal-Himalaya-India.pdf
https://timesofindia.indiatimes.com/city/dehradun/winter-wildfires-in-uttarakhand-gut-5000-trees/articleshow/80108639.cms

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/m^3)	Biogas potential (m^3/yr)
Cattle	Manure	93967	10	34,29,79,550	257234662.5	51446932.5	25	2057877.3
Buffalo	Manure	32659	15	17,88,08,025	134106018.8	26821203.75	25	1072848.15
Sheep	Manure	15453	1	56,40,345	4230258.75	846051.75	25	33842.07
Goat	Manure	37164	1	1,35,64,860	10173645	2034729	25	81389.16
Pig	Manure	56	2.5	51,100	38325	7665	25	306.6
Poultry	manure	28,116	0.1	10,26,234	769675.5	153935.1	25	6157.404
Total		**2,07,415**						**3252420.684**

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**	916	1.5	1374	961.8	15	817.53	800	654024
Wheat	**straw**	11605	1.5	17407.5	12185.25	30	8529.675	800	6823740
Rice	**husk**	11586	0.25	2896.5	2027.55	80	405.51	750	304132.5
Total		**24107**							**7781896.5**