Arth Ganga Project: District Lakhi sarai

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EXECUTIVE SUMMARY

Lakhi sarai, a city in the state of Bihar, is historically rich and religiously diverse. The city is traversed by Ganges, Kiul and Harohar.

The total geographical area of the district is 1286.40 km^2. The primary sector contributes, on average, 20.70% to the district GDP with a negative growth of 0.11% per annum during 2007-08 to 2013-14. Its share steeply declined from 27.30% in 2007-08 to 15.73% in 2013-14. The share of the secondary sector increased from 20.56% in 2007-08 to 30.62% in 2013-14, with an average annual growth rate of 16.75%. The tertiary sector occupies, on average, 53.15% share in the district economy. It's share went up from 52.16% in 2007-08 to 53.65% in 2013-14. Overall, the district economy grew with an average annual growth rate of 8.80% during the study period.

Lakhisarai is categorized under Agro-climatic zone III A i.e. the Southern east zone. The district has sandy loam , clay loam, loam, clay types of soil with pH between 6.5-8.0.The cropping intensity of the district is 147.66%. Major crop types are wheat, rice, maize, pulses like a variety of gram, lentil, etc. along with oilseeds, mustard, etc. The livestock consists of cattle (indigenous and crossbred), buffalos (indigenous and crossbred), pigs (indigenous and crossbred), goats; poultry, and fisheries. The total number of cattle increased in the district from 113 thousand in 2003 to 140 thousand in 2019, a net increase of 23.96%. a net increase of 120% in the total number of sheep from 2003 to 2019 whereas increase in number of goats was of 11.62%. Total pigs decelerated from 7.5 thousand in 2003 to 1.29 thousand in 2019, a net decrease of 82.8%. The total livestock population increased in the district from 266.29 thousand in 2003 to 301.64 thousand in 2019, a net increase of 13.27%. In 2019-20, district's percentage of the net and gross irrigated areas increased from 70.81% and 65.82% in 2011-12 to 71.37% and 79.19%, respectively.

The share of cultivable wasteland and barren and uncultivable land remained constant at 0.54% and 5.44% respectively, during 2011-12 to 2019-20. The fallow land significantly increased from 15.32% in 2011-12 to 31.96% in 2019-20. the net sown area decelerated from 56.45% in 2011-12 to 39.11% in 2019-20. The area for non-agricultural use increased from 11.43% to 12.13% in 2018-19. The nitrogen and potassium share decreased to 75.31% and 2.34%, respectively, while the phosphorus share increased to 22.32%. The use of nitrogen is more than the recommended ratio, while the Phosphorous and potassium usage is less than the recommended ratio. Although the overall use of chemical fertilizers decreased in the district from 121.22 kg/ ha GSA in 2013-14 to 114.34 kg/ ha GSA in 2019-20.

According to the 2021 Forest survey, forests cover of the district is 14.94% out of the total geographical area. With respect to 2019 forest assessment there has been increase in the forest area of the district by 3 sq. km. The district has a total of 183.41 sq. km. under the forests out of which 17 sq. km. is under dense forests, 143.5 sq. km. under moderately dense forests and 22.91 sq. km under the open forests. The district has 4.8 sq. km. of land under scrubs The area under trees and gardens also went up slightly from 0.23% in 2011-12 to 0.31% in 2019-20.

Lakhisarai is a well-developed and progressive district with the combination of spiritual and traditional ethnicity. Lakhisarai tourism ensures a network of full-fledged facilities for all types of transportation and communication. Some significant temples and religious spots within the district are Ashokdham, Bhagwati Mandir of Barahiya, Sringi Rishi, Jalappa Asthan, Abhainath Asthan on Abhaipur Mountains, Maharani Asthan of Abhaipur, Govindbaba Asthan (Mandap) Rampur and Durga Asthan Lakhisarai etc.

Kerosene, as a source of lightning is the top priority in the district, as 71.50% of the households depend on it. The next important source of lightning is electricity, with 27.10% households dependent upon it. Around 0.90% of the households are dependent upon solar energy. 39.50% of the households use cow dung, 30.20% of the households use fire-wood, 19.90% of the households use crop residue, and 7.90% of the households use LPG/PNG for cooking.

The total number of wetlands existing in the district is 194 consisting of both Man-made and Natural. Most of them are river/streams and waterlogged. The district's biodiversity data includes various crop production, livestock population, bird species, and forest cover with 323 bird species and 19 threatened/rare species of bird in the district. Biogas potential from animal waste is calculated approximately as forty-nine lakh m^3/year and one crores m^3/year from agricultural waste. No hydropower plant exists in the district.

To promote sustainable development creating awareness, educating people about renewable energies, sanitation, maintaining decorum of the properties by not destroying or keeping them clean, Adopting Public-Private partnerships, upgrading staff and facilities, etc. Drip and Sprinkler irrigation, introducing Vermicomposting, use of high-yielding seeds, micro-irrigation, constructing and maintaining harvesting structures, adopting greenhouse farming with organic farming, and encouraging farmers for adapting different crop cultivation and various irrigation methods, adopt resources conservation technologies, Various measures such as eco-tourism should be taken to improve tourism and enhance the use of renewable energy especially by creating awareness. Along with focusing on agriculture practices Bee culture, dairy, poultry, fisheries, etc. needs encouragement as they have high economic potential. Monitoring and training programs and awareness and introducing Pradhan Mantri Matsya Sampada Yojana, KVKs instruction, subsidized crop insurance system, branding effort under the National Organic Foods Market, etc.

1. DISTRICT OVERVIEW

1.1 INTRODUCTION

Lakhisarai district is one of the thirty-eight districts of Bihar state, India. Lakhisarai town is the administrative headquarters of this district. Lakhisarai district is a part of Munger Division. Geographically the district lies between 25º to 25º20' north Latitude and 85º55' to 86º25' east longitude. The district occupies an area of 1,228 km2 (474 sq mi). On 3 July 1994 this district was carved out from Munger district, which comprised the erstwhile Lakhisarai sub-division of the undivided district. The district consists only one sub-division Lakhisarai, which is divided into Seven developmental blocks, namely, Lakhisarai, Surajgarha, Barahiya, Halsi, Pipariya, Ramgarh Chowk and Chanan. According to the 2011 census Lakhisarai district has a population of 1,000,912. This gives it a ranking of 445th in India (out of a total of 640). The district has a population density of 815 inhabitants per square kilometre (2,110/sq mi). Its population growth rate over the decade 2001-2011 was 24.74%. Lakhisarai has a sex ratio of 900 females for every 1000 males, and a literacy rate of 64.95%.

The Ganges, Kiul and Harohar are the main three rivers flowing through the district. The Ganges fixes the north east border, while Harohar separates Diyara reigon from the other parts of the district and Kiul river almost bisects the whole district. The climate of the district is somewhat extreme in nature, i.e., quite hot during the summer and fairly cold during the winter. January is the coldest month when the mean minimum temperature comes down to approximately 4ºC. The temperature starts rising from March and reaches its peak in May when the mercury touches about 45ºC. Rain starts sometime in mid June and lasts till mid September.

The agroclimatic condition of the district favours the plantation of various crops. Paddy, Wheat, Maize are the main cereal crops of the district. Different cropping patterns are adopted by the cultivators in different areas. In Taal area pulses like Gram and Masoor occupy maximum area, while in Ganga region Wheat, Maize, Mustard, Pea, Green Vegetables are the main crops. In Hilly area and other parts of the district Paddy is the main crop. In few areas Potato and Onion are also cultivated.

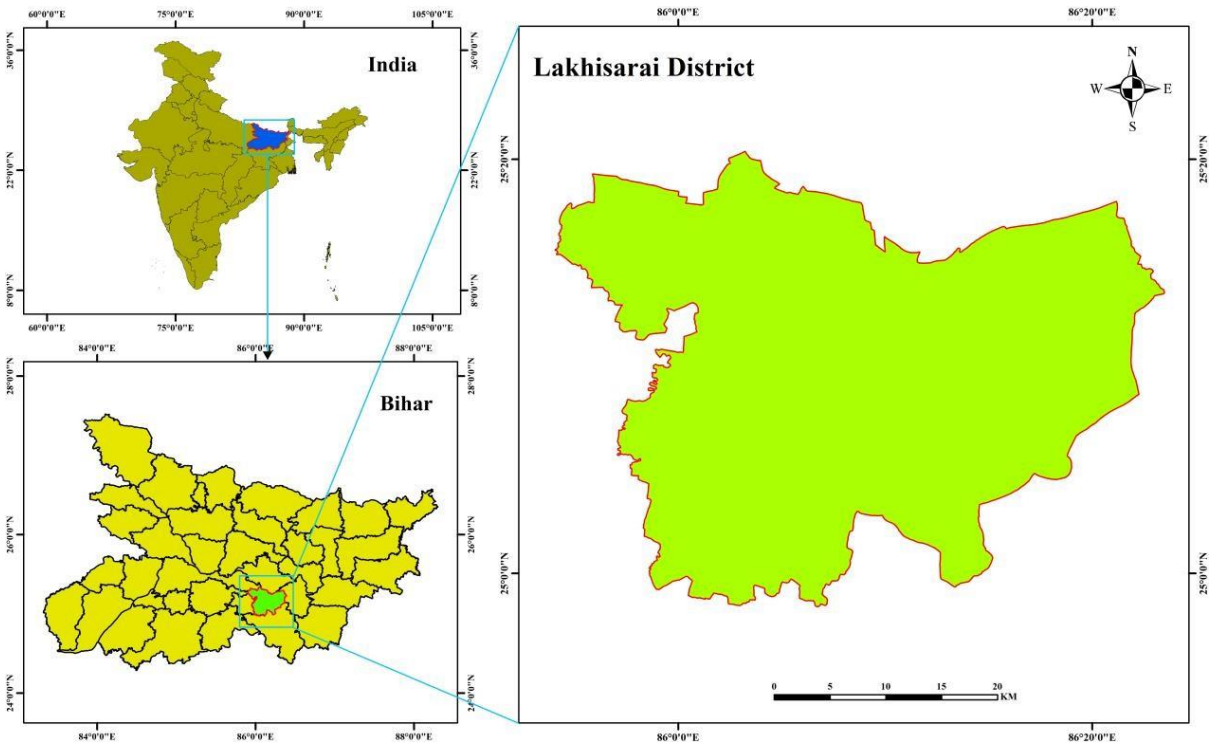


Figure 1 Map of the district

1.2 DEMOGRAPHIC PROFILE OF LAKHI SARAI

On 3rd July 1994, Lakhisarai district was came into existence, before that it was a sub-division under Munger district. The district lies between latitude 25º to 25º 20' North and longitude 85º 55' to 86º 25' East. The aggregate area of the district is 129397 hectares. The district is surrounded by Munger in the East, Sheikhpura in the South, Begusarai in the West and Patna in the North. Lakhisarai district has three land types; hilly areas in the region of Kachhua hills, Kajra mountains, Abhiapur and Jaynagar mountains and forest areas, flood hit areas in the block of Pipariya and some region of Barahiya and this region is also known as the stock of food grains in regards to cultivation and agricultural activities, and the third is plain area which is green and cultivable land. There are seven blocks in the district namely; Sadar Lakhisarai, Barahiya, Pipariya, Halsi, Chanan, Ramgarh Chowk, and Surajgarha.

According to Census 2011, the aggregate population of the district is 1000912 and 95.55% of the population is Hindu. Out of the total population 52.58% is males, which is around 526345 people and the rest 47.41% is female, which is around 474567 people. The district has a sex ratio has improved from 900 in the year 2001 to 912 females per thousand males in the year 2011. It has a population

density of 815 people per square kilometre. The literacy rate of the district is 62.42% as of 2011 Census and has improved from 47.96% as of Census 2001.

One of the important trading centres in Bihar is Lakhisarai. The main goods which are exported and imported in the district are silk, kaleen, agricultural goods, dari, and Banarasi sari. The major cereal crops in the district are wheat, maize, and paddy. Crop rotation and improved scientific techniques could advance the crop production in the district.

1.3 ECONOMIC PROFILE OF LAKHI SARAI

The primary sector contributes, on average, 20.70% to the district GDP. It observed a negative growth of 0.11% per annum during 2007-08 to 2013-14. Moreover, its share steeply declined from 27.30% in 2007-08 to 15.73% in 2013-14 because of higher growth in the non-farm sectors. The share of the secondary sector increased from 20.56% in 2007-08 to 30.62% in 2013-14, an impressive average annual growth rate of 16.75%. The tertiary sector occupies, on average, 53.15% share in the district economy. It grew by 9.25% annually, and its share went up from 52.16% in 2007-08 to 53.65% in 2013-14. Overall, the district economy grew with an average annual growth rate of 8.80% during the study period. The secondary and tertiary sectors have performed well during the time of the study. Steps should be taken to increase the growth in the primary sector.

Table 1: Trends in Gross District Domestic product in Lakhisarai at Constant Prices (base 2004-05), Millions in Rs

Year	Sector-wise GDDP				Annual Growth Rates			
	PRIMARY SECTOR	SECONDARY SECTOR	TERTIARY SECTOR	TOTAL GDDP	PRIMARY SECTOR	SECONDARY SECTOR	TERTIARY SECTOR	TOTAL GDDP
	2211	1665	4225	8100	-	-	-	-
2007 -08	(27.30)	(20.56)	(52.16)	(100)				
	2177	1949	4623	8748	-1.54	17.06	9.42	8.00
2008-09	(24.89)	(22.28)	(52.85)	(100)				
	1742	2284	5126	9152	-19.98	17.19	10.88	4.62
2009 -10	(19.03)	(24.96)	(56.01)	(100)				
	2085	3078	5471	10633	19.69	34.76	6.73	16.18
2010-11	(19.61)	(28.95)	(51.45)	(100)				
	2199	2938	5748	10885	5.47	-4.55	5.06	2.37
2011 -12	(20.20)	(26.99)	(52.81)	(100)				
2012 -13	2258	3566	6603	12428	2.68	21.38	14.87	14.18

	(18.17)	(28.69)	(53.13)	(100)				
	2101	4090	7167	13358	-6.95	14.69	8.54	7.48
2013-14	(15.73)	(30.62)	(53.65)	(100)				
Average Growth Rate					-0.11	16.75	9.25	8.80

Source: http://data.icrisat.org/district-level-data/
Note: Figures in Parenthesis are percentage share of total GDDP

2. Quantitative Data Analysis

2.1 Agriculture and Allied Activities

The total declared area of the district is 1286.40 sq. km². The share of cultivable wasteland remained constant at 0.54% between 2011-12 to 2019-20. The share of barren and uncultivable land remained constant (5.44%) over the years. The fallow land drastically increased over the years, from 15.32% in 2011-12 to 31.96% in 2019-20. It is a matter of concern for the district economy. Moreover, the net sown area (NSA) decelerated from 56.45% in 2011-12 to 39.11% in 2019-20. The area for non-agricultural use increased from 11.43% to 12.13% in 2018-19 (Table 2). The area under trees and gardens also went up slightly from 0.23% in 2011-12 to 0.31% in 2019-20, which is good for the district, keeping in mind the sustainable development goals. Overall, the land use pattern shows that the area under fallow land is quite high and varies substantially across years. The NSA declined over the years with high variability across years.

Table2: Trends in land use pattern in Lakhisarai (as % of the total reported area)

Year	TOTAL REPORTED AREA (in 1000 Ha)	AREA UNDER FOREST	CULTIVABLE WASTELAND	TOTAL FALLOW	BARREN AND UNCULTIVABLE LAND	LAND OTHER THAN AGRICULTURE	PASTURE LAND	AREA UNDER TREES AND GARDENS	NET SOWN AREA
1	2	3	4	5	6	7	8	9	10
2011-12	128.6	10.42	0.54	15.32	5.44	11.43	0.08	0.23	56.45
2012-13	128.6	10.42	0.54	14.62	5.44	11.51	0.08	0.23	57.08
2013-14	128.6	10.42	0.54	35.07	5.44	11.82	0.08	0.31	36.31
2014-15	128.6	10.42	0.54	38.96	5.44	11.90	0.08	0.31	32.35
2015-16	128.6	10.42	0.54	36.94	5.44	11.90	0.08	0.31	34.37
2016-17	128.6	10.42	0.54	31.49	5.44	11.90	0.08	0.31	39.74
2017-18	128.6	10.42	0.54	27.60	5.44	11.90	0.00	0.31	43.70
2018-19	128.6	10.42	0.54	22.94	5.44	11.90	0.00	0.31	48.37
2019-20	128.6	10.42	0.54	31.96	5.44	12.13	0.00	0.31	39.11

Source: http://dse.bihar.gov.in/ and http://data.icrisat.org/district-level-data/

2.1.2 Trends in Operational Land Holdings

In Lakhisarai district, the total number of operational farms decreased from 147 thousand in 2010-11 to 145 thousand in 2015-16, a net decrease of 1.36%. While in the state, their numbers increased from 16191 thousand in 2010-11 to 16412 thousand in 2015-16, a net increase of 1.36%. Most land positions in the district are marginal and small. These two size categories comprised 93.6% of the total land holdings in the district in 2015-16, while the corresponding proportion in the state was 96.96% (Table 3). The table shows a significant decline in the percentage share of the marginal land holding, while the share of the small, semi-medium, and medium land holdings increased between 2010-11 and 201516.

Table3: Distribution of Operational Holdings by Size-categories of farms (in %) in Lakhisarai

	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 ('000 No.)
Lakhisarai	2010-11	93.66	5.33	0.98	0.03	0	147
	2015-16	83.78	9.82	4.63	1.72	0.05	145 [-1.36]
Bihar	2010-11	91.06	5.86	2.56	0.5	0.02	16191
	2015-16	91.21	5.75	2.52	0.5	0.02	16412 [1.36]

Source: Compiled from https://agcensus.nic.in/. Figures in [] are percentage increase/ decrease in 2015-16 over 2010-11.

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

2.1.3.1 The Trend in Cropping Patterns

Rice and wheat dominate the agriculture of the district. Table 4 shows the area devoted to various crops over the last seven years. In 2019-20, rice made up the highest share of GCA (48.05%), followed by wheat (29.40%). These two crops constitute around 77.45% of the GCA. The area shared by the total cereals increased from 74.31% in 2013-14 to 82.95% in 2019-20. Gram, Masoor (lentil), and Khesari (Lathyrus) are the main pulses produced. The total pulses acreage significantly declined from 22.12% in 2013-14 to 12.35% in 2019-20. The food grain acreage also decreased slightly from 96.43% in 2013-14 to 95.30% in 2019-20. Moreover, the food grains cover a majority (average, 96%) of the GCA. Mustard is the only major oilseeds crop produced, and the total oilseed acreage increased from 3.43% in 2013-14 to 3.76% in 2019-20. The cultivation pattern shows no significant change during the study period. The average cropping intensity in the district is 147.66.

Table 4: Trends in cropping pattern (as % GSA) and Cropping Intensity							
Crop/Year	**2013-14**	**2014-15**	**2015-16**	**2016-17**	**2017-18**	**2018-19**	**2019-20**
Rice	21.57	23.80	24.69	32.40	41.01	45.38	48.05
Wheat	46.29	44.46	46.12	40.72	38.42	32.42	29.40
Other Cereals	6.46	7.63	7.30	6.59	3.10	8.24	5.50
Total Cereals	74.31	75.90	78.11	79.71	82.54	86.04	82.95
Gram	6.18	5.54	5.75	5.19	4.66	3.96	4.16
Masoor (Lentil)	7.14	6.14	6.37	5.52	4.53	3.85	4.30
Khesari (Lathyrus)	4.40	3.59	3.73	3.37	3.10	2.20	2.68
Other Pulses	4.40	4.49	1.55	2.31	1.16	0.99	1.21
Total Pulses	22.12	19.76	17.39	16.39	13.45	10.99	12.35
Total Foodgrains	96.43	95.66	95.50	96.10	95.99	97.03	95.30
Mustard	3.43	3.89	4.04	3.67	3.49	2.86	3.62
Other Oilseeds	0.00	0.45	0.47	0.21	0.26	0.00	0.13
Total Oilseeds	3.43	4.34	4.50	3.88	3.75	2.86	3.76
Net Sown Area	64.15	62.28	68.63	71.67	72.70	68.35	67.52
Gross Sown Area (in 1000 Ha)	72.80	66.80	64.40	71.30	77.30	91.00	74.50
Cropping Intensity	155.89	160.58	145.70	139.53	137.54	146.30	148.11
Source: Compiled from http://dse.bihar.gov.in/ and http://data.icrisat.org/district-level-data/							

2.1.3.2 Trends in per hectare yield of principal crops

Table 5 shows that the yield per hectare of most crops varies across the years. Rice and wheat are the major crops. However, their per hectare yields were quite low at 23.16 qtls and 29.27 qtls, respectively, in 2019-20. Per hectare yield of total cereals decreased from 28.41 qtls in 2013-14 to 26.54 qtls in 2019-20, majorly due to a significant decrease in wheat yield. Similarly, the per hectare yield of total pulses decreased from 16.96 qtls in 2013-14 to 7.28 qtls in 2019-20. The yield of total oilseeds also decreased from 16.40 qtls in 2013-14 to 10.71 qtls in 2019-20. Moreover, the yield of total food grains decreased slightly from 25.78 qtls in 2013-14 to 24.04 qtls in 2019-20. In summary, all crop yields show year-over-year fluctuations, with a significant fall observed in the yield of pulses and oilseeds in the latter years of the study. The volatility in yields makes farmers' income riskier and more unstable, requiring a solid insurance protection measure.

Table 5: Trends in yield of Principal Crops in Lakhisarai District (in Qtl per Ha)							
Crop/Year	**2013-14**	**2014-15**	**2015-16**	**2016-17**	**2017-18**	**2018-19**	**2019-20**
Rice	21.34	36.79	42.64	32.27	33.85	23.54	23.16
Wheat	32.79	22.66	23.64	27.99	29.63	29.63	29.27
Total Cereals	28.41	27.12	28.85	29.51	31.41	26.25	26.54
Gram	17.56	10.81	10.81	12.61	13.06	13.61	8.06
Masoor (Lentil)	18.85	7.80	10.24	11.74	11.71	12.57	6.25
Khesari (Lathyrus)	17.81	4.17	10.00	10.56	11.67	10.00	6.50
Total Pulses	16.96	8.41	10.45	11.65	12.12	12.30	7.28

Total Foodgrains	25.78	23.26	25.50	26.46	28.71	24.67	24.04
Mustard	16.40	11.15	10.00	12.55	12.96	14.23	10.74
Total Oilseeds	16.40	11.03	9.66	12.35	12.76	14.23	10.71
Source: Compiled from http://dse.bihar.gov.in/ and http://data.icrisat.org/district-level-data/							

2.1.3.3 Trends in Production of Principal Crops

Table 6 shows the trends in the production of the main crops over the years. Rice and wheat dominate the production. In 2019-20, rice (82.9 thousand tonnes) and wheat (64.1 thousand tonnes) formed a major part of the total cereal production (164 thousand tonnes). Moreover, there has been an increase in total cereals production from 153.7 thousand tons in 2013-14 to 164 thousand tons in 2019-20, mainly because of an increase in land area under total cereals. Coming to pulses, Gram, Masoor (lentil), and Khesari (Lathyrus) occupied the highest production, with their production being 2.5 thousand tons, 2 thousand tons, and 1.3 thousand tons, respectively, in 2019-20. Although these pulses show variation in the production across years, they still represent 86.56% of the total pulse production. Mustard production was 2.9 thousand tons, representing 96.66% of the total oilseed production in 2019-20. Looking at the annual production data of various crops, we find that production of cereals increased, on average, during the period, while the production of pulses and oilseeds declined. Proper insurance arrangements are required to get assured farm income, take more risk and diversify production.

Table 6: Trends in Production of Principal Crops in Lakhisarai District (in 1000 Tons)

Crop/Year	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
Rice	33.5	58.5	67.8	74.5	107.3	97.2	82.9
Wheat	110.5	67.3	70.2	81.3	88	87.4	64.1
Other Cereals	9.7	11.7	7.1	11.9	5.1	20.9	17
Total Cereals	153.7	137.5	145.1	167.7	200.4	205.5	164
Gram	7.9	4	4	4.7	4.7	4.9	2.5
Masoor (Lentil)	9.8	3.2	4.2	4.6	4.1	4.4	2
Khesari (Lathyrus)	5.7	1	2.4	2.5	2.8	2	1.3
Other Pulses	3.9	2.9	1.1	1.8	1	1	0.9
Total Pulses	27.3	11.1	11.7	13.6	12.6	12.3	6.7
Total Foodgrains	181	148.6	156.8	181.3	213	217.8	170.7
Mustard	4.1	2.9	2.6	3.3	3.5	3.7	2.9
Other Oilseeds	0	0.3	0.2	0.1	0.2	0	0.1
Total Oilseeds	4.1	3.2	2.8	3.4	3.7	3.7	3
Source: Compiled from http://dse.bihar.gov.in/ and http://data.icrisat.org/district-level-data/							

2.1.3.4 Variability assessment in the area, production, and yield

To understand the variability across the years (Table 7), we calculated the mean, standard deviation (SD), and coefficient of variation (COV) of the area, production, and yield of the main crops. Among different crops, the lowest variability in the area is observed in Mustard (2.63%), followed by gram

(11.14%) and wheat (12.11%), and the highest in rice (41.54%). The variability in the area under total pulses (19.98%) is much higher than in the area under total cereals (16.49%).

Table 7: Variability in Area, Production, and Yield of Principal Crops (2013-14 to 2019-20)

	Area (1000 Ha)			Production (1000 Ha)			Yield (Qtl/Ha)		
Crop	**Average**	**SD**	**COV**	**Average**	**SD**	**COV**	**Average**	**SD**	**COV**
Rice	25.63	10.65	41.54	74.53	24.64	33.06	30.51	8.04	26.35
Wheat	29.03	3.52	12.11	81.25	16.07	19.78	27.94	3.59	12.85
Total Cereals	59.40	9.79	16.49	167.70	26.24	15.65	28.30	1.83	6.48
Gram	3.70	0.41	11.14	4.67	1.64	35.09	12.36	2.95	23.90
Masoor	3.93	0.65	16.65	4.62	2.46	53.21	11.31	4.04	35.69
Khesari	2.40	0.40	16.67	2.53	1.54	60.88	10.10	4.29	42.46
Total Pulses	11.68	2.33	19.98	13.62	6.43	47.20	11.31	3.14	27.73
Total Foodgrains	71.09	8.73	12.28	181.32	26.20	14.45	25.49	1.79	7.01
Mustard	2.62	0.07	2.63	3.28	0.52	15.96	12.58	2.22	17.64
Total Oilseeds	2.77	0.16	5.78	3.42	0.45	13.24	12.45	2.30	18.47

Source: Compiled from http://dse.bihar.gov.in/ and http://data.icrisat.org/district-level-data/

The variability of production depends on the variability of the cultivated area and the variability of the yield. The highest variability in production is observed in Khesari (60.88%), followed by Masoor (53.21%), Gram (35.09%), and Rice (33.06%). The variability in the production of total oilseeds is 13.24%. Improvement in crop insurance conditions and better market accessibility can lower this variation. Variability is lowest in total food grains (14.45%), followed by total cereals (15.65%) and Mustard (15.96%).

In the case of yield, the highest variability is estimated in Khesari (42.46%), Masoor (35.69%), and rice (26.35%). Yield variability in total pulses (27.73%) is much higher than in total cereals (6.48%). Several factors, such as climate change, market prices, rainfall patterns, etc., influence the variability in agricultural production.

2.1.4 Consumption of Chemical Fertilizers

Table 8 shows the trends in the use of chemical fertilizers in agriculture. The recommended nitrogen to phosphorus and potassium ratio is 4:2:1, which is not maintained in the district. For example, in 2013-14, nitrogen represented 83.91% of the total fertilizers used, while the proportions of phosphorus and potassium were 13.56% and 2.51%, respectively. In 2019-20, however, the nitrogen and potassium share decreased to 75.31% and 2.34%, respectively, while the phosphorus share increased to 22.32%. The use of nitrogen is more than the recommended ratio, while the Phosphorous and potassium usage is less than the recommended ratio. The table also shows that fertilizer consumption varies yearly, which can be due to several factors such as rainfall and cultivation patterns, etc. Although the overall use of chemical fertilizers decreased in the district from 121.22 kg/ ha GSA in 2013-14 to 114.34 kg/ ha GSA in 2019-20, still the authorities can take steps to reduce their consumption further as the

chemicalization of agriculture degrades soils and water resources. There is a need to incentivize the farmers to use organic and bio fertilizers.

Table 8: 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**	**2019-20**
Nitrogen	101.72	113.01	116.74	79.48	81.80	81.07	86.12
Phosphorous	16.44	29.07	33.84	18.78	18.34	18.03	25.53
Potassium	3.05	6.63	3.91	2.50	4.31	1.27	2.68
Total	121.22	148.71	154.47	100.77	104.45	100.37	114.34
GSA (1000 Ha)	72.8	66.8	64.4	71.3	77.3	91	74.5
Source: Compiled from http://dse.bihar.gov.in/ and http://data.icrisat.org/district-level-data/							

2.1.5 Irrigation Structure and Status

2.1.5.1 Source-wise area under irrigation

Canals and groundwater (GW) are the primary sources of irrigation in the district. The canal's share in the NIA (average, 23.86%) and the share of wells and tube wells in NIA (average, 75.82%) remained almost consistent over the years. However, the district is more dependent on groundwater for irrigation purposes. It can have serious environmental issues if such a pattern continues in the long run. The district's percentage of the net and gross irrigated areas increased from 70.81% and 65.82% in 2011-12 to 71.37% and 79.19%, respectively.

Table 9: Source-wise Area under Irrigation in Lakhisarai (in % of NIA)									
Source/Year	**2011-12**	**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17**	**2017-18**	**2018-19**	**2019-20**
CANALS	23.87	23.85	23.86	23.87	23.87	23.87	23.85	23.73	23.96
Wells and Tube Wells	75.82	75.82	75.82	75.83	75.83	75.82	75.83	75.79	75.77
Other Sources	0.31	0.32	0.32	0.30	0.30	0.30	0.32	0.48	0.28
NIA (1000 Ha)	51.41	52.61	34.58	30.00	30.00	29.70	31.53	41.30	35.90
GIA (1000 Ha)	68.58	66.27	49.00	45.13	44.69	53.53	61.61	71.40	59.00
% of NIA	70.81	71.68	74.05	72.12	67.87	58.12	56.10	66.40	71.37
% of GIA	65.82	66.14	67.31	67.56	69.39	75.08	79.70	78.46	79.19
Source: Compiled from http://dse.bihar.gov.in/ and http://data.icrisat.org/district-level-data/									

2.1.6 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 transition period for the full conversion from conventional to organic is considered three years. During this period, crop yield, on average, is expected to decline by 10—15 percent. However, after three years, it may reach its original level. Financial assistance received by the beneficiary farmers seems to be adequate to compensate for the yield losses and motivate them to do organic farming.

Organic/natural/zero budget farming provides ecological services in terms of soil, human and animal health, water-saving, biodiversity protection, etc. A long-term system of payments for ecological services may be evolved to retain the existing farmers and motivate others to move towards this sustainable farming system. There is no assured market for these products, and farmers do not get premium prices. Certification and quality check and monitoring mechanisms are yet to be set up. Monitoring of the project should be periodically done through MIS, Geo-tagging, and monthly physical and financial reports.

Table 10 shows the details of establishing organic clusters under the PKVY and Namami Gange scheme in the district. The district has 40 groups in six development blocks. The highest number of groups are in Barahiya (18), followed by Pipariya (8) and Lakhisarai (6). Significantly high variation can be seen in the district's number of farmers per group. It is reported that the maximum limit of land under a cluster per farmer is 2.00 hectares. Hence, the majority of the beneficiary farmers are small and marginal. Farmers should be encouraged to form more organic farming groups.

Table 10: Status of Organic Farming PGS Groups under PKVY and Namami Gange Schemes in Lakhisarai (as on June 6, 2022)

S. No.	Block	Scheme	No. of groups	No. of farmers in groups			
				Total	Average	Median	SD
1	**Barahiya**	Namami Gange	18	357	19.83	19	10.95
2	**Channan**	PKVY	1	28	28	28	0
3	**Lakhisarai**	PKVY	6	167	27.83	28	6.27
4	**Pipariya**	PKVY	1	26	26	26	0
		Namami Gange	7	119	17	18	9.53
5	**Ramgarh Chowk**	PKVY	5	151	30.2	30	2.28
6	**Surajgarha**	PKVY	2	55	27.5	27.5	2.12
7	**District Total**	PKVY	15	427	28.46	29	4.2
		Namami Gange	25	476	19.04	19	10.45
		Total	40	903	22.57	21.5	9.74

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

A gradual shift of farmers from conventional to organic farming systems is likely to positively impact water quality, soil health, and farming sustainability. However, organic farming being a knowledge-intensive system, farmers need proper training to know the practical details of the integrated sustainable farming system. Since economies of scale in both production and marketing matter in organic farming, there is a need for some institutional framework in the forms of SHGs/ farm cooperatives/PFOs/contract farming, etc. Organic farming could be an economically viable option if the government builds strong marketing networks linking farmers, processors, and distributors with the easy certification process and minimizes farmers' risk by protecting their farm income through payments of ecosystem services. A long-term system of incentives and regulation needs to evolve to retain the existing farmers and motivate others to move toward a sustainable farming system in the district.

The major problem for the growth of organic farming observed are:

1. The major problem of the farmers was poor marketing and the inability to fetch a premium. The problem of marketing is even more severe in the case of perishable vegetable crops. Contract farming companies and Farmer Producers' companies can be encouraged.
2. Scaling up the organic production is another problem.
3. Although organic farming clusters are formed, the farmers allocated a part of their lands to organic farming and practiced conventional farming in the rest of the area, which may fail the purpose of the cluster approach.
4. The knowledge and awareness level of farmers about organic farming practices is inadequate.

2.1.7 Trends in Livestock Sector

The total number of cattle increased in the district from 113 thousand in 2003 to 140 thousand in 2019, a net increase of 23.96%. However, the number of adult male cattle decreased from 24 thousand to 1 thousand in the same period. The increase in total cattle has been due to an increase in adult female cattle (from 40 thousand to 71 thousand) and young cattle (from 49 thousand to 67 thousand). Cattle represent 67.27% of the total large ruminants. Moreover, cattle's share in large ruminants went up from 68% in 2003 to 71% in 2019. Similarly, total buffaloes increased from 53 thousand in 2003 to 57 thousand in 2019, a net increase of 6.8%. This increase is due to an increase in adult female buffaloes from 26 thousand in 2003 to 29 thousand in 2019 and young buffaloes from 26 thousand in 2003 to 27 thousand in 2019. Buffaloes comprised 32.7% of the total large ruminants. Moreover, total sheep increased from 0.1 thousand in 2003 to 0.22 thousand in 2019, a net increase of 120%. Total goats increased from 93 thousand in 2003 to 104 thousand in 2019, a net increase of 11.62%. Total pigs decelerated from 7.5 thousand in 2003 to 1.29 thousand in 2019, a net decrease of 82.8%. The total livestock population increased in the district from 266.29 thousand in 2003 to 301.64 thousand in 2019, a net increase of 13.27%.

Notably, the number of female cattle and buffaloes substantially increased over the period, indicating the growth of livestock products, including milk. The substantial decline in the number of male cattle and buffaloes indicates the rising farm mechanization and declining relevance of animal power, mainly because of their high maintenance cost.

Table 11:Trends in Livestock population (in 1000 numbers) in Lakhisarai

Category	2003	2007	2012	2019
CATTLE TOTAL	112.59	111.27	126.09	139.57
CATTLE ADULT MALE	23.62	14.3	9.9	1.46
CATTLE ADULT FEMALE	39.99	43.04	68.65	71.37
CATTLE YOUNG TOTAL	48.98	53.93	47.54	66.73
CATTLE SHARE IN LARGE RUMINANT (Percent)	67.92	61.76	68.36	71.06
BUFFALO TOTAL	53.19	68.9	58.35	56.85
BUFFALO ADULT MALE	1.23	1.47	1.06	0.33
BUFFALO ADULT FEMALE	26.24	31.92	34.83	29.16

BUFFALO YOUNG TOTAL	25.72	35.51	22.46	27.36
BUFFALO SHARE IN LARGE RUMINANT (Percent)	32.08	38.24	31.64	28.94
SHEEP TOTAL	0.1	0.08	1.4	0.22
SHEEP SHARE IN SMALL RUMINANT (Percent)	0.11	0.14	1.29	0.21
GOATS TOTAL	92.91	57.97	107.36	103.71
GOATS SHARE IN SMALL RUMINANT (Percent)	99.89	99.86	98.71	99.79
PIGS TOTAL	7.5	6.47	4	1.29
LIVESTOCK TOTAL	266.29	244.95	298.88	301.64
Source: http://dse.bihar.gov.in/ and http://data.icrisat.org/district-level-data/				

2.1.8 Trends in Fishery Production

Table 12 shows the trends in Fish Production in Lakhisarai compared to the total fish production in Bihar. Fish Production was 2.7 thousand tons in 2011-12 in Lakhisarai, which increased to 6.75 thousand tons in 2017-18. Lakhisarai represented 0.78% of the total fish production in Bihar in 2011-12. However, its share increased to 1.14% in 2017-18.

Table12: Trends in fish production (1000 tons) in Lakhisarai				
District/Year	**2011-12**	**2013-14**	**2015-16**	**2017-18**
Lakhisarai	2.7	4.43	7.9	6.75
Bihar	344.47	432.29	506.88	587.85
Source: http://dse.bihar.gov.in/ and http://data.icrisat.org/district-level-data/				

2.2 FORESTRY

Baseline Data

According to the Forest Survey 2021, the total Forest Cover in the State is 7380.79 sq km which is 7.84 % of the State's geographical area. The state has 333.42 sq. km. under very dense forests, 3285.83 sq. km. under moderately dense forests and 3761.54 sq. km. under open forests. In recent years, massive plantation programs have been taken up in the State to increase the forest & tree cover.

According to the 2021 Forest survey, forests cover of the district is 14.94% out of the total geographical area which is 1228 sq. km. With respect to 2019 forest assessment there has been increase in the forest area of the district by 3 sq. km

The district has a total of 183.41 sq. km. under the forests out of which 17 sq. km. is under dense forests, 143.5 sq. km. under moderately dense forests and 22.91 sq. km under the open forests. The district has 4.8 sq. km. of land under scrubs as depicted in Fig. 1.

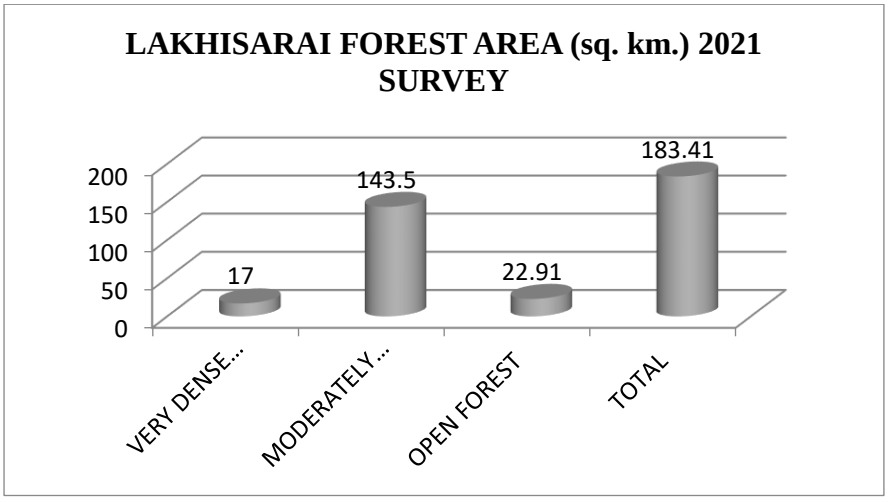


Fig. 1

The district has 200 ha of cultivable wasteland, 19100 ha of current fallow and 11 ha of other fallow land.

2.2.1. Biodiversity

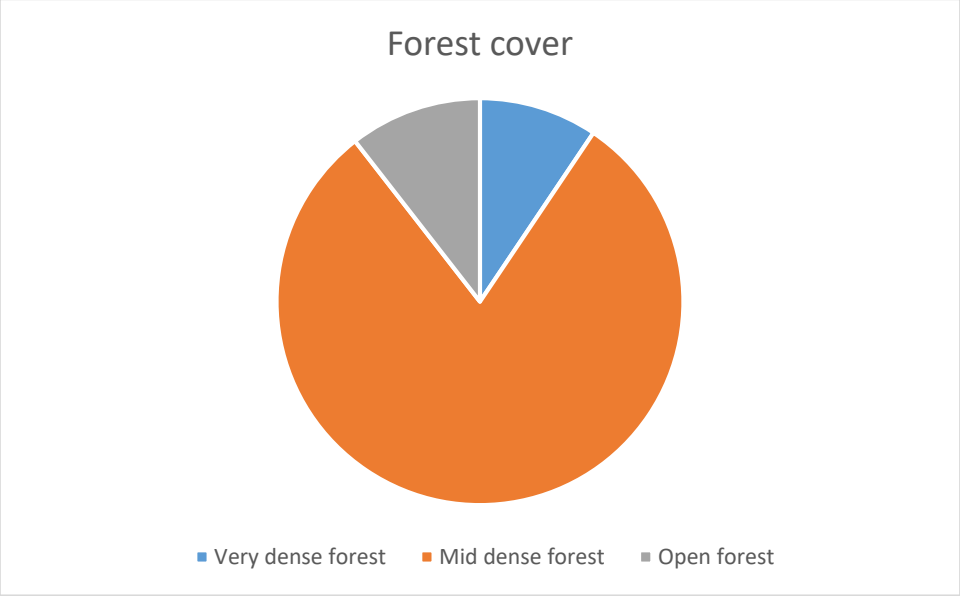
The district's biodiversity data includes crop production, livestock population, bird species, and forest cover. The district has a forest area of 180.41 square km, in which 80% area is mid-dense forest, 9% very dense forest and 11% area is open forest.

Table 1 Bird species recorded in the district.

Number of species	323
Number of rare/accidental species	19

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**
1228	17	144.42	18.99	180.41	14.69	-2.59	5.49



2.3 TOURISM

BIHAR: YEAR WISE TOURIST ARRIVALS (2001 TO 2020)

Tourism is one of the latest growing industries in the state of Bihar. The tourism influx is very irregular in terms of Domestic as well as of Foreign in the Bihar. In one year region witnessed a very huge tourist influx and in very next year number of tourists decreased suddenly owing to prediction of heavy flood, Crime and poor infrastructure facilities. Tourism has been worst hit in **2020 covid Pandamic** ravaged Bihar, caused a steep fall of **-83.03%** in tourist traffic.

Table: 2 Bihar: Year Wise Tourists Arrivals (2001 to 2020)

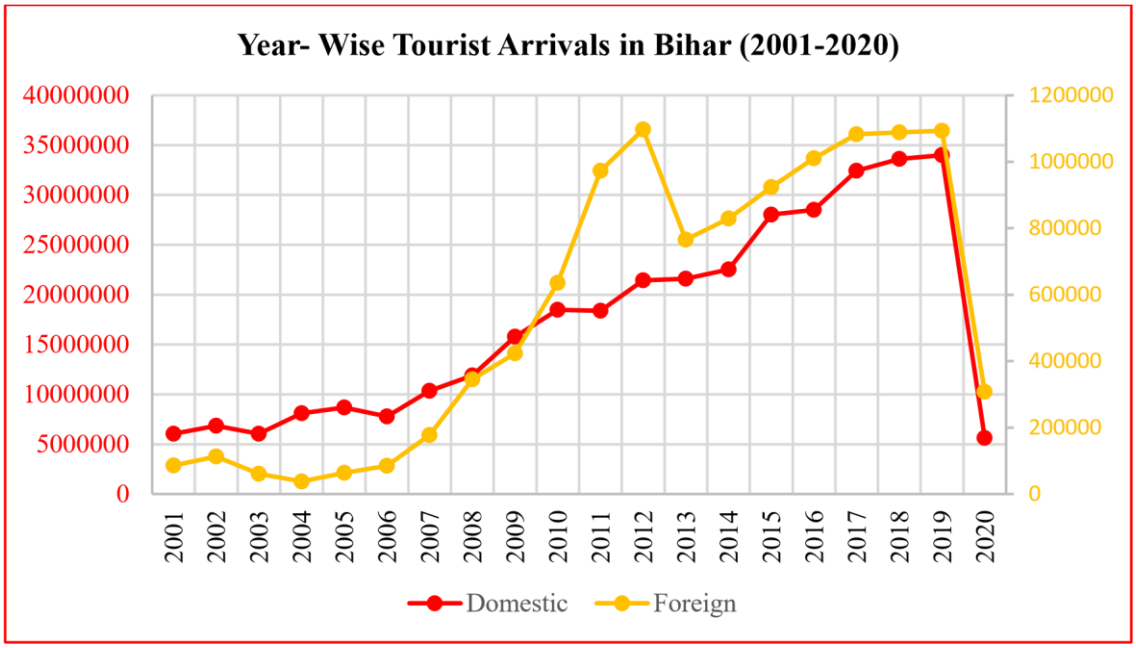
Year	Domestic	Growth	Foreign	Growth	Total	Overall Growth
2001	6061168	0.00%	85673	0.00%	6146841	0.00%
2002	6860207	13.18%	112873	31.75%	6973080	13.44%
2003	6044710	-11.89%	60820	-46.12%	6105530	-12.44%
2004	8097456	33.96%	38118	-37.33%	8135574	33.25%
2005	8687220	7.28%	63321	66.12%	8750541	7.56%
2006	7774732	-10.50%	84942	34.15%	7859674	-10.18%
2007	10352887	33.16%	177362	108.80%	10530249	33.98%

2008	11889611	14.84%	345572	94.84%	12235183	16.19%
2009	15784679	32.76%	423042	22.42%	16207721	32.47%
2010	18491804	17.15%	635722	50.27%	19127526	18.01%
2011	18397490	-0.51%	972487	52.97%	19369977	1.27%
2012	21447099	16.58%	1096933	12.80%	22544032	16.39%
2013	21588306	0.66%	765835	-30.18%	22354141	-0.84%
2014	22544377	4.43%	829508	8.31%	23373885	4.56%
2015	28029118	24.33%	923737	11.36%	28952855	23.87%
2016	28516127	1.74%	1010531	9.40%	29526658	1.98%
2017	32414063	13.67%	1082705	7.14%	33496768	13.45%
2018	33621613	3.73%	1087971	0.49%	34709584	3.62%
2019	33990038	1.10%	1093141	0.48%	35083179	1.08%
2020	5644524	-83.39%	308080	-71.82%	5952604	-83.03%

- ***Source: Data Compiled from dse.bihar.gov.in***

In Bihar there was an increase of **33.96% of Domestic Tourists in 2004**. This growth sharply declined in **2006** and accounts **-10.50%.** However, it again increases up to **33.16%** in **2007**. Talking about Foreign tourist arrival in Bihar, **Foreign Tourists** increase up to **31.75%** in **2002** and **108.80%** in **2007.** However, we witnessed a very huge decreased in the number of foreign tourist suddenly owing to prediction of natural catastrophe, poor infrastructure and experieces of tourists. Like in the year **2013 and 2020** Foreign Tourist decline **-30.18% and -71.82** respectively.

- **Figure: 1 Bihar: Year Wise Tourists Arrivals (2001 to 2020)**



- **Figure: 2 Bihar: Year Wise Domestic Tourists Arrivals (2001 to 2020)**

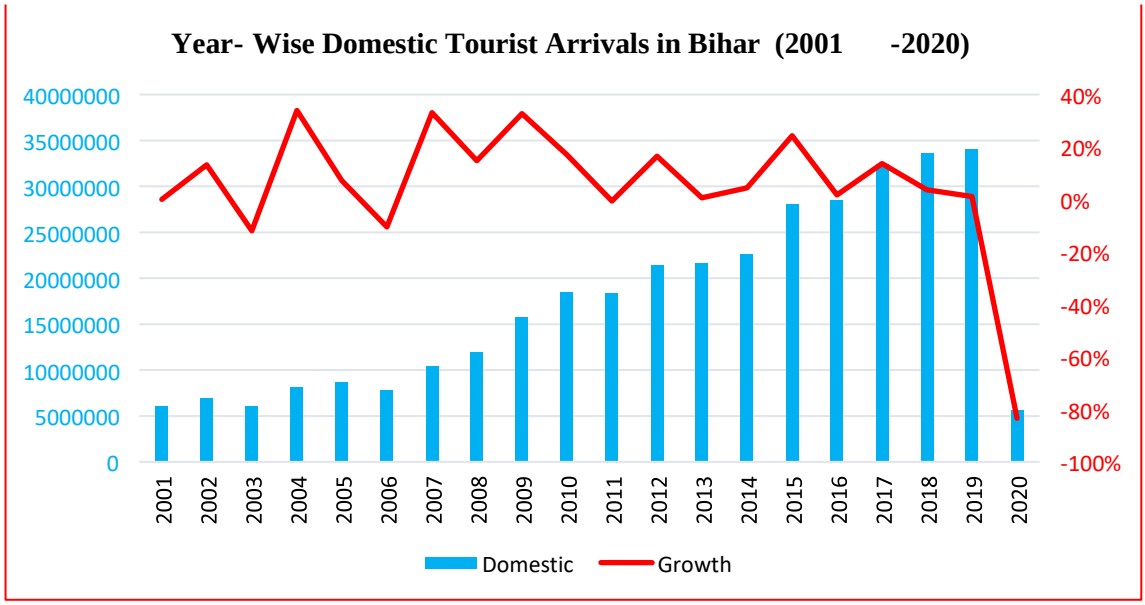
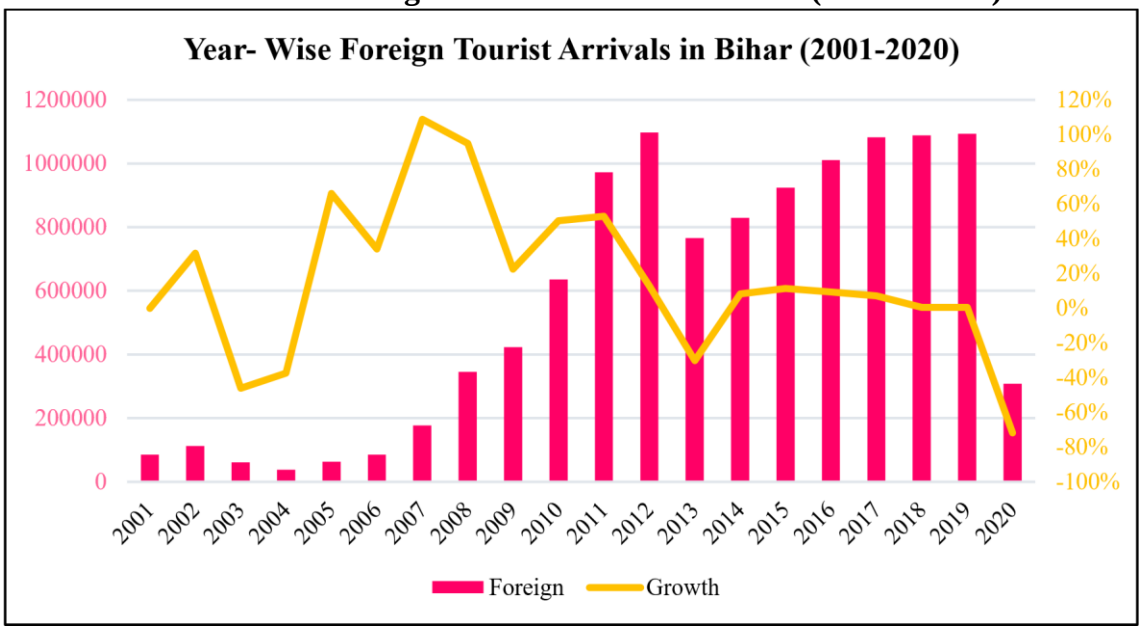


Figure: 3 Bihar: Year Wise Foreign Tourists Arrivals in Bihar (2001 to 2020)

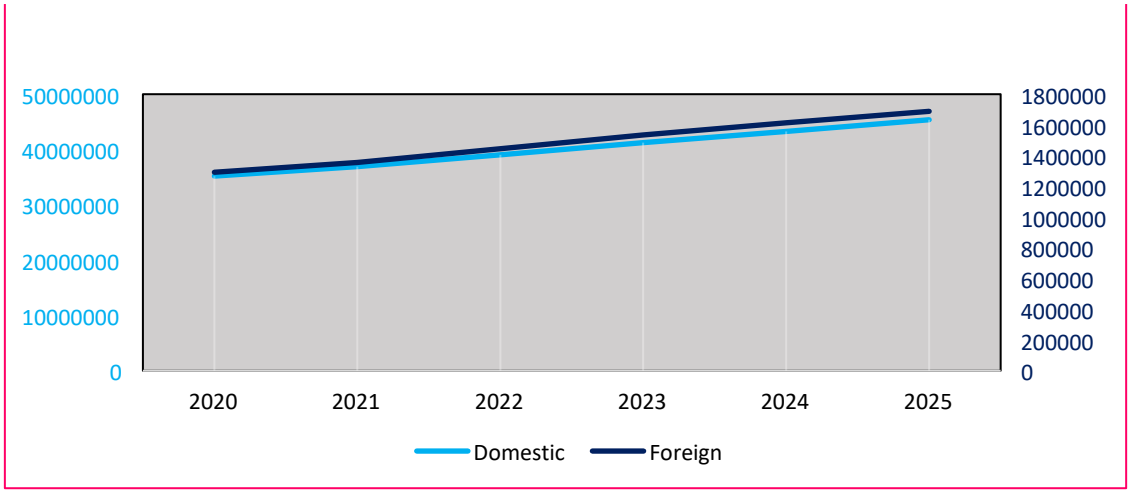


- **Table: 3 Bihar: Year Wise Tourists Arrivals (2020 to 2025) Forecast**

Year	Domestic	Foreign	Total
2020	35185067	1291658	36476724
2021	36910980	1355501	38266481
2022	39061662	1444141	40505803
2023	41247899	1533826	42781725
2024	43268513	1614654	44883168
2025	45375097	1688413	47063510

Source: Data Compiled from Tourism Department of Bihar

- **Figure: 4 Bihar: Year Wise Tourists Arrivals (2020 to 2025) Forecast**



Tourist Arrivals in Bihar (FORECAST)

BIHAR: SECTORAL CONTRIBUTION TO GSDP (1999-2000 TO 2006-2007)

Bihar is one of the fastest growing economies in India. It is largely service based, with a significant share of agricultural and industrial sectors. The sectoral contribution to the state GDP, the contribution of tertiary sector accounts **(53.88%)** in **1999-2000** increases to **(56.65%)** in **2003-2004**. The contribution of Primary sector is accounts between **(33.69%)** in **1999-2000** to **(36.80%)** in **2002-2003** and again decrease to **(30.77%)** in **2006-2007**. Meanwhile, contribution of Secondary sector is **(12.43%)** in **1999-2000** to **(16.31%)** in **2006-2007**. Moreover, the contribution of Trade, repair, hotel, and restaurant to tertiary Sector accounts **(27.89%)** in **1999-2000** while crossed **(40.62%)** in **2006-07**. Therefore, Bihar has great potential to contribute to the economy, Tourism and Hospitality sector in the state can further be promoted to harness its growth through providing world class infrastructure facilities, establishing tourism centres across the state, adopting disaster management policy, Law and Order.

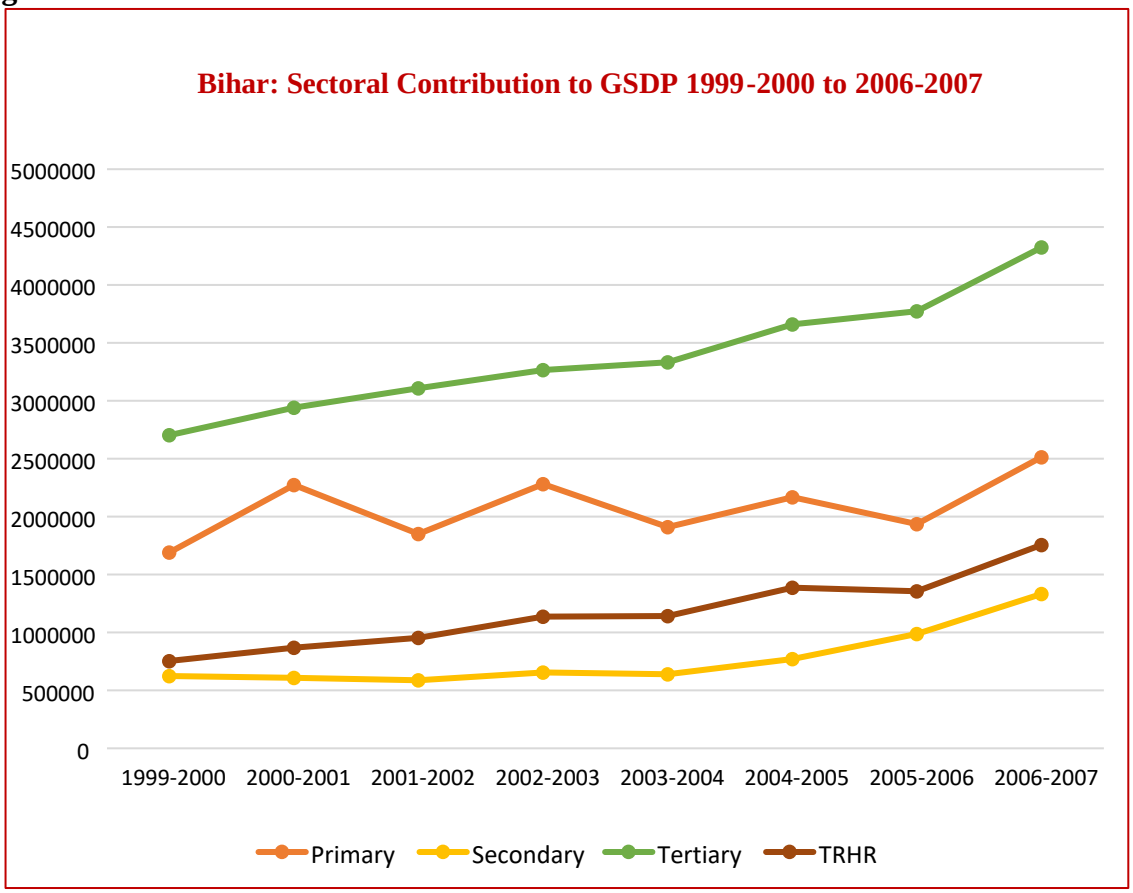
- **Table: 4 Sectoral Contribution to GSDP Bihar 1999-2000 to 2006-2007**

Year	Primary	Secondary	Tertiary	TRHR as % of Tertiary
1999-2000	1690440 (33.69%)	623589 (12.43%)	2703347 (53.88%)	754097 (27.89%)
2000-2001	2272675 (39.03%)	609252 (10.46%)	2940338 (50.50%)	870083 (29.59%)

2001-2002	1850242 (33.36%)	587654 (10.59%)	3108764 (56.05%)	952986 (30.65%)
2002-2003	2282622 (36.80%)	654300 (10.55%)	3265587 (52.65%)	1135730 (34.78%)
2003-2004	1911225 (32.49%)	639591 (10.87%)	3332491 (56.64%)	1142426 (34.28%)
2004-2005	2167878 (32.85%)	770771 (11.68%)	3660900 (55.47%)	1388261 (37.92%)
2005-2006	1937233 (28.92%)	986505 (14.73%)	3774182 (56.35%)	1356901 (35.95%)
2006-2007	2514504 (30.77%)	1332672 (16.31%)	4324459 (52.92%)	1756746 (40.62%)

Source: Data Compiled from dse.bihar.gov.in

Figure: 5 Sectoral Contribution to GSDP Bihar 1999-2000 to 2006-2007



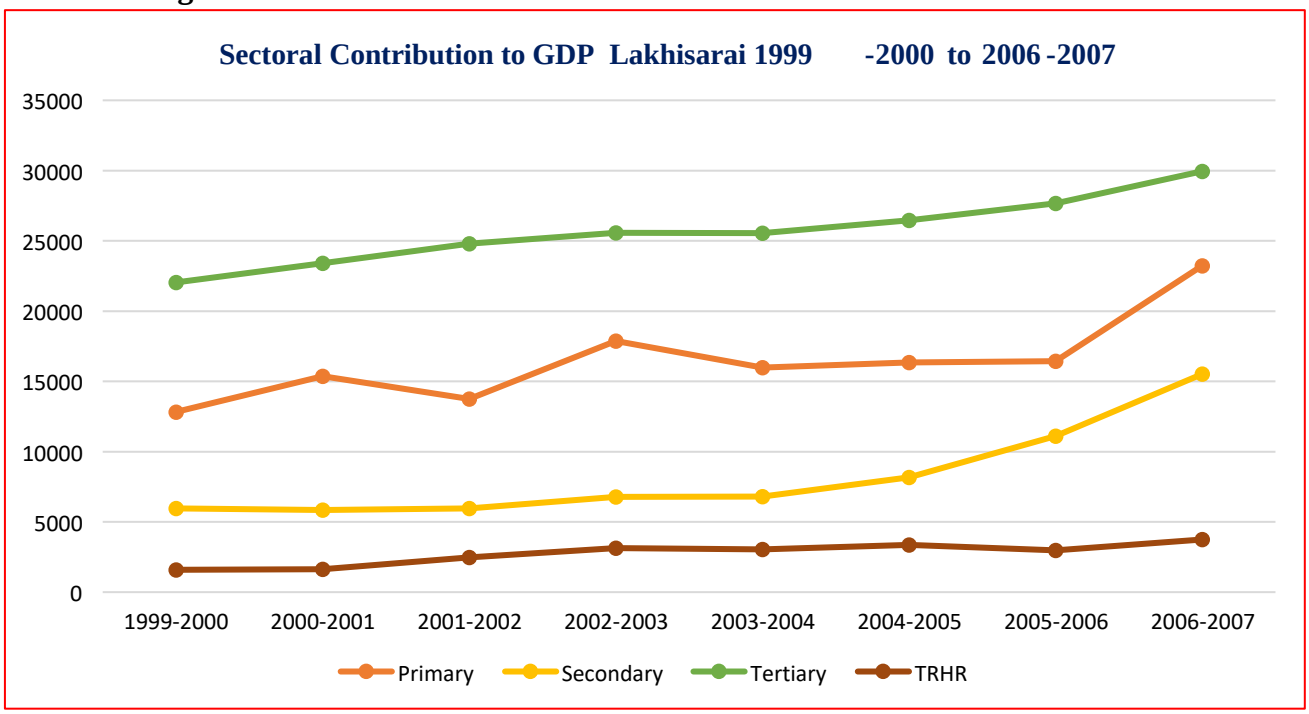
LAKHISARAI: SECTORAL CONTRIBUTION TO GSDP (1999-2000 TO 2006-2007)

Like Bihar as a state, the District of Lakhisarai has potential for Archeological, Religious and Ecotourism etc. Comparing the sectoral contribution to the state GDP, the contribution of tertiary sector in **Lakhisarai** is **(53.99%)**, whereas for the state it is **(53.88%)** in **1999-2000** while it exceeds to **(55.71%)** and **(56.05%)** in **2001-2002** respectively. Moreover, the contribution of Trade, repair, hotel, and restaurant **(7.22%)** outperforms in comparison to the state counterpart **(27.89%)** in **1999-2000**, however this gap further strengthen during **2006-2007** were Lakhisarai accounts **(10.76%)** that of state (**40.62%)**. Thus, the contribution of Lakhisarai's Tertiary sector shows increasing manner and similarly with trade, repair, hotel, and restaurant.

Table: 5 Sectoral Contribution to GDDP Lakhisarai 1999-2000 to 2006-2007

Year	Primary	Secondary	Tertiary	TRHR as % of Tertiary
1999-2000	12827 (31.42%)	5959 (14.60%)	22042 (53.99%)	1591 (7.22%)
2000-2001	15356 (34.43%)	5845 (13.10%)	23402 (52.47%)	1628 (6.96%)
2001-2002	13756 (30.90%)	5962 (13.39%)	24805 (55.71%)	2485 (10.02%)
2002-2003	17882 (35.59%)	6776 (13.49%)	25583 (50.92%)	3133 (12.25%)
2003-2004	15993 (33.07%)	6811 (14.08%)	25559 (52.85%)	3045 (11.91%)
2004-2005	16358 (32.08%)	8175 (16.03%)	26451 (51.88%)	3362 (12.71%)
2005-2006	16443 (29.79%)	11107 (20.11%)	27665 (50.10%)	2976 (10.76%)
2006-2007	23230 (33.81%)	15517 (33.81%)	29951 (43.60%)	3745 (12.50%)

- **Figure: 6 Sectoral Contribution to GDDP Lakhisarai:1999-2000 to 2006-2007**



Lakhisarai has great potential to contribute to the economy. Hence, tourism and hospitality sector in the district can be promoted to harness its growth and benefits to the district economy. However, promoting tourism sector by considering its economic contribution may lead to bad policy decisions without noting the natural disaster as well as tourism infrastructure and crime and implementation policy. Moreover, development of projects and strong research is mandatory to know the detailed information on disaster, Crime, tourism infrastructure, tourist foot fall etc.

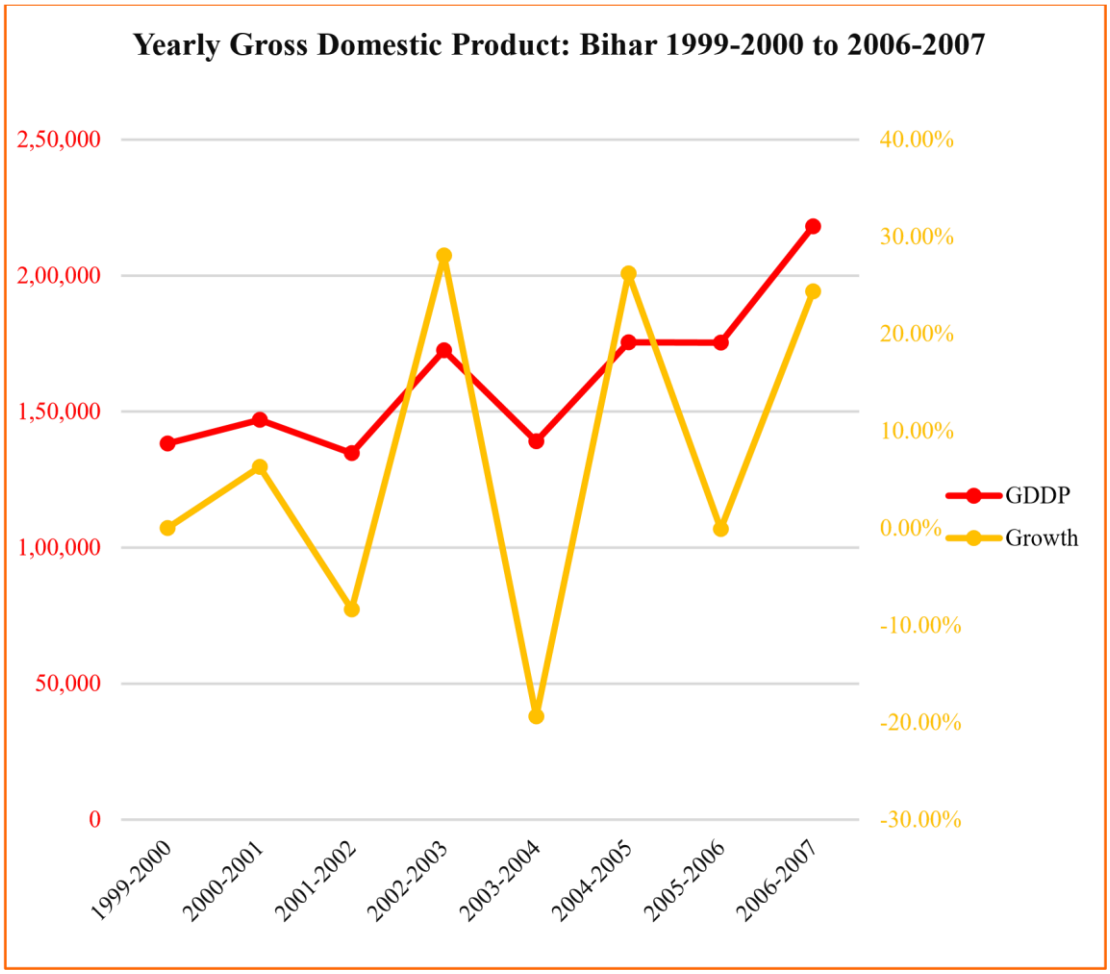
BIHAR: GSDP GROWTH RATE AT CONSTANT PRICE (1999-2000 TO 2006-2007)

The impact of the Disaster, High Crime rate, Poor Infrastructure, Under-investments, Poor Economic Policy, and Poor Political Vision etc. has been reflected in terms of reducing the annual growth rate of the state from (**16.04%)** in **2000-2001 to (-4.73%)** in **2001-2002**. While the state annual growth was again rise to **(11.82%)** in **2002-2003** affected during **2003-2004 (-5.15%)** which is the lowest growth rate during a 5-year period; the effect of the disaster and economic policy has negatively affected the district annual GDP growth rate for subsequent years. However, we can see a huge growth during **2006-2007** when GDDP accounts 8171635 i.e. **22.00%** of growth. This states that disaster and economic policy largely has a micro regional impact, hence disaster and development related policies must be made be made considering micro regional contexts and be site specific.

Table: 6 GSDP Growth Rate at Constant Price: Bihar 1999-2000 to 2006-2007

Year	**GDDP**	**Growth**
1999-2000	5017376	0
2000-2001	5822265	16.04%
2001-2002	5546660	-4.73%
2002-2003	6202509	11.82%
2003-2004	5883306	-5.15%
2004-2005	6599549	12.17%
2005-2006	6697921	1.49%
2006-2007	8171635	22.00%

- **Figure: 7 GSDP Growth Rate at Constant Price: Bihar 1999-2000 to 2006-2007**



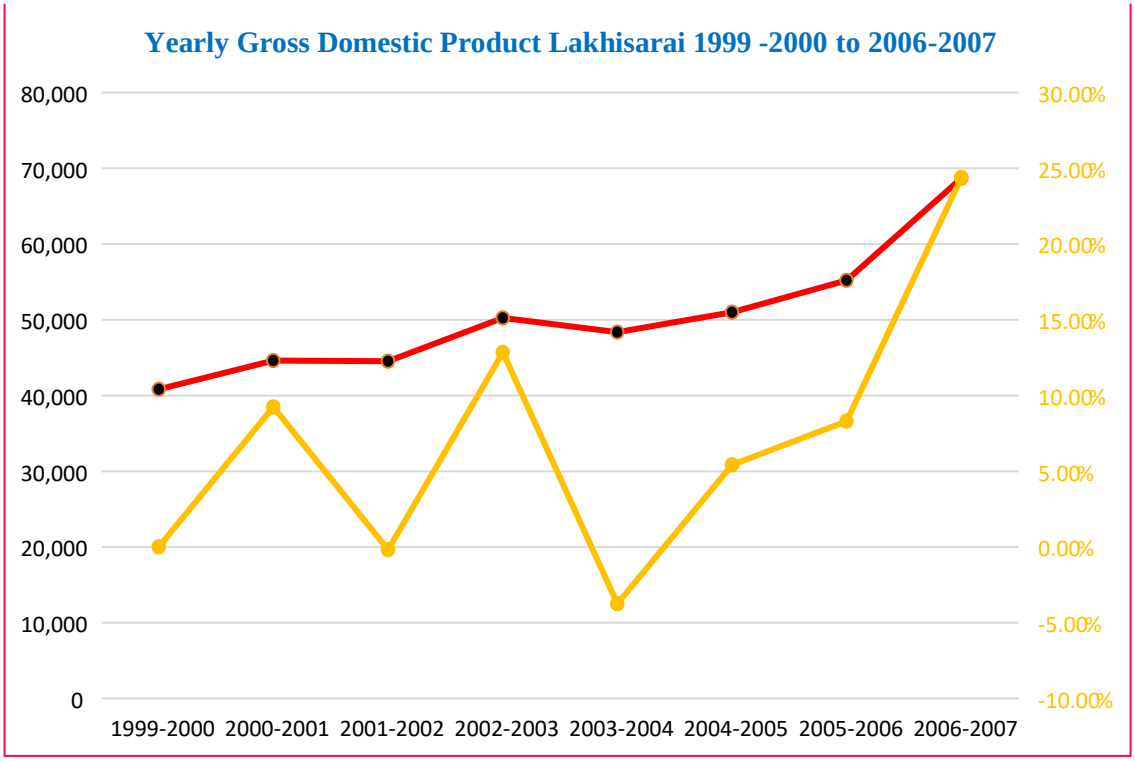
Lakhisarai: GDDP Growth Rate at Constant Price (1999-2000 to 20062007)

The impact of the Disaster, High Crime rate, Poor Infrastructure, Under-investments, Poor Economic Policy and Poor Political Vision etc. has been reflected in terms of reducing the annual growth rate of the district from (**9.25%)** in **2000-2001 to (-0.18%)** in **2001-2002**. The district annual growth was again rise up to **(24.40%)** in **2006-2007**. This states that impact of the Disaster, High Crime rate, Poor Infrastructure, Underinvestments, Poor Economic Policy and Poor Political Vision etc. largely has severe regional impacts in reducing the annual growth rate of the district, hence disaster and development related policies must be made taking into account micro regional contexts and site specific.

- **Table: 7 GDDP Growth Rate at Constant Price: Lakhisarai 1999-2000 to 2006-2007**

Year	GDDP	Growth
1999-2000	40827	0
2000-2001	44603	9.25%
2001-2002	44523	-0.18%
2002-2003	50241	12.84%
2003-2004	48362	-3.74%
2004-2005	50984	5.42%
2005-2006	55222	8.31%
2006-2007	68698	24.40%

Figure: 8 GDDP Growth Rate at Constant Price: Lakhisarai 1999-2000 to 2006-2007



LAKHISARAI: CONTRIBUTION OF TRHR TO THE GDDP AT CONSTANT PRICE (1999 TO 2025)

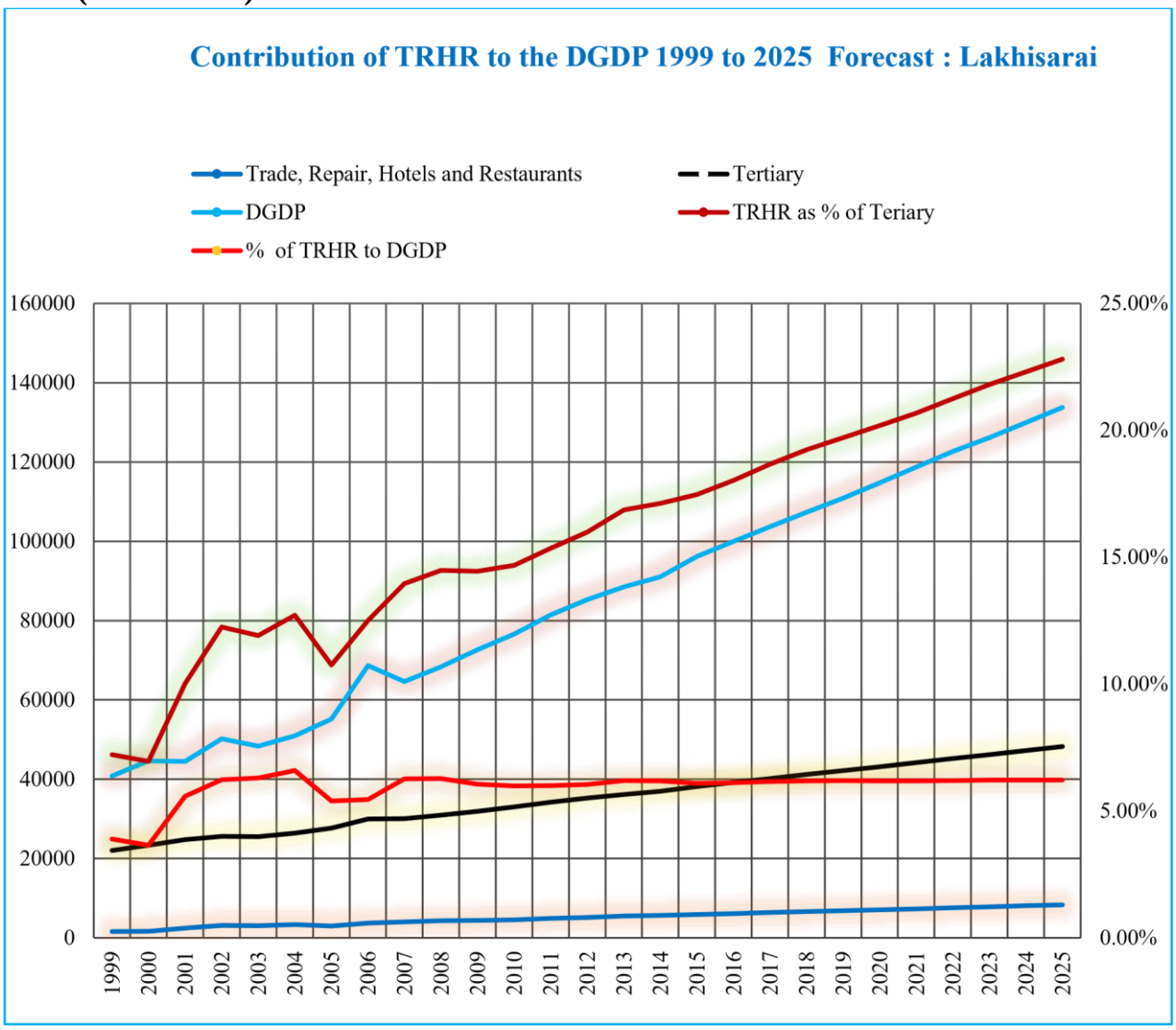
Table: 8 Contribution of TRHR to the GDDP at Constant Price Lakhisarai (1999 to 2025)

Year	Trade, Repair, Hotels and Restaurants	Tertiary	TRHR as % of Tertiary	DGDP	% of TRHR to DGDP
1999	1591	22042	7.22%	40827	3.90%
2000	1628	23402	6.96%	44603	3.65%
2001	2485	24805	10.02%	44523	5.58%
2002	3133	25583	12.25%	50241	6.24%
2003	3045	25559	11.91%	48362	6.30%
2004	3362	26451	12.71%	50984	6.59%
2005	2976	27665	10.76%	55222	5.39%
2006	3745	29951	12.50%	68698	5.45%
2007 Forecast	4051	30053	13.96%	64666	6.26%
2008	4291	30939	14.48%	68353	6.28%

2009	4401	31894	14.44%	72676	6.06%
2010	4586	33021	14.68%	76589	5.99%
2011	4891	34229	15.36%	81484	6.00%
2012	5161	35237	15.99%	85332	6.05%
2013	5481	36137	16.86%	88491	6.19%
2014	5631	36980	17.12%	91064	6.18%
2015	5861	38153	17.47%	96171	6.09%
2016	6114	39196	18.02%	99996	6.11%
2017	6386	40209	18.66%	103674	6.16%
2018	6637	41185	19.23%	107346	6.18%
2019	6867	42161	19.71%	110929	6.19%
2020	7102	43181	20.19%	114756	6.19%
2021	7338	44221	20.67%	118717	6.18%
2022	7599	45252	21.25%	122633	6.20%
2023	7845	46233	21.80%	126188	6.22%
2024	8085	47237	22.31%	129963	6.22%
2025	8323	48250	22.81%	133774	6.22%

- ***Source: Data Compiled from dse.bihar.gov.in***

Figure: 9 Contribution of TRHR to the GDDP at Constant Price Lakhisarai (1999 to 2025)



2.4 WETLANDS

The district has vast wetlands; the majority of them are river/streams and waterlogged. Table 1 shows the number of wetlands and their area representation in the district.

Table 1: Wetland Data of Lakhisarai district

	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	1	1	0	0	0	1	0	0	0	0	0	0	1
Ox-bow lakes/cut off meanders	2	3	1	0	0	0	2	0	0	0	0	0	0
High altitude Wetlands	0	0	0	0	0	0	0	0	0	0	0	0	0
Riverine Wetlands	4	4	0	0	2	1	1	0	0	0	0	0	0
Waterlogged	2	2	0	0	0	1	0	1	0	0	0	0	1
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	1	0	0	0	1
Tanks/ponds	5	49	44	0	0	5	0	0	0	0	0	0	19

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 (194)	**15**	**71**	**56**	**123**	**2**	**8**	**3**	**1**	**1**	**0**	**0**	**0**	**22**

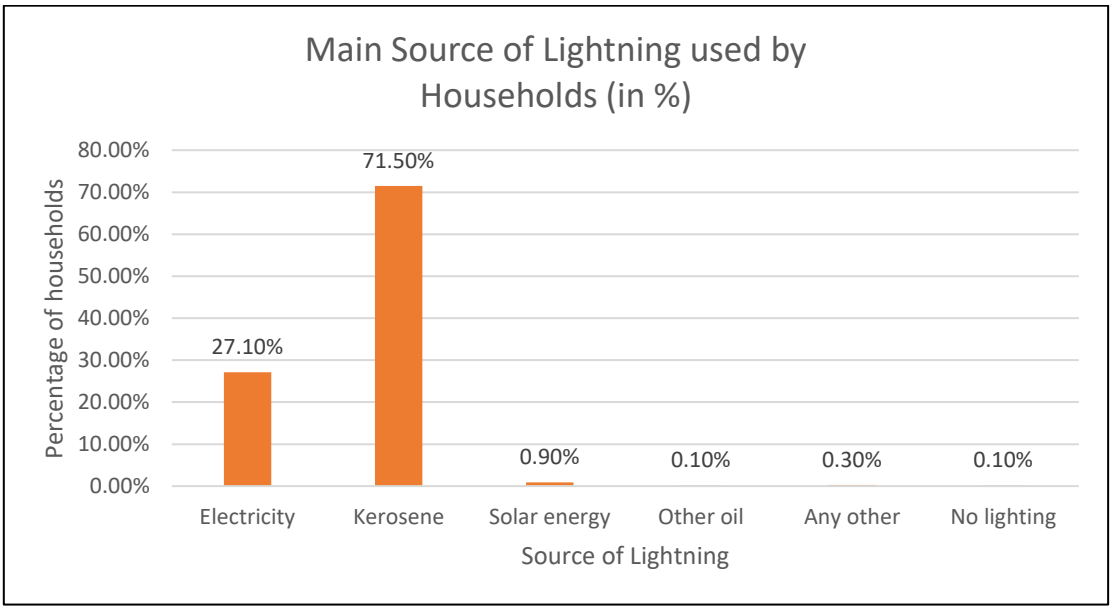
Source: National River Conservation Directorate (NRCD), National Wetland Inventory and Assessment (NWIA) Atlas

2.5. ENERGY

2.5.1. Solar

In Bihar, the non-conventional energy schemes are being taken care by the Bihar Renewable Energy Development Agency (BREDA). The prime objective of BREDA is to provide rural electrification.

On the basis of the data of main sources of lightning consumed by the household according to the Census 2011, the figure has been made. Kerosene, as a source of lightning is the top priority in the district, as 71.50% of the households depend on it. The next important source of lightning is electricity, with 27.10% households dependent upon it. Around 0.90% of the households are dependent upon solar energy. The households dependent on other oil and other sources of lightning are 0.10% and 0.30% respectively. Moreover, 0.10% of the households does not have any source of lightning.



In Lakhisarai, solar energy needs to be exploited because only National Thermal Power Corporation Limited (NTPC) power plant is the nearest power plant to the district, which is at a distance of 50-60 km, located at Barh city in Patna.

2.5.2. Biomass

Bihar Renewable Energy Development Agency (BREDA) has the sole authority in the state of Bihar to promote renewable energy and to execute electrification program in the villages of the state.

The net sown area of Lakhisarai district is 77200 hectares, area sown more than once is 50900 hectares, and gross cropped area is 128100 hectares. The cropping intensity of the district is 166%. The total forest area is 10600 hectares.

The major crops grown in the district are rice, maize, wheat, chick pea, and oilseeds. Maize has the highest productivity in the district.

Crop	**Productivity (kg/ha)**
Rice	2014
Maize	3977
Wheat	2205
Chick Pea	224
Oil Seeds	147

Table 1

According to Census 2011, the pie-chart has been made for the type of fuel used by households for cooking. 39.50% of the households use cow dung, 30.20% of the households use fire-wood, 19.90% of the households use crop residue, and 7.90% of the households use LPG/PNG for cooking.

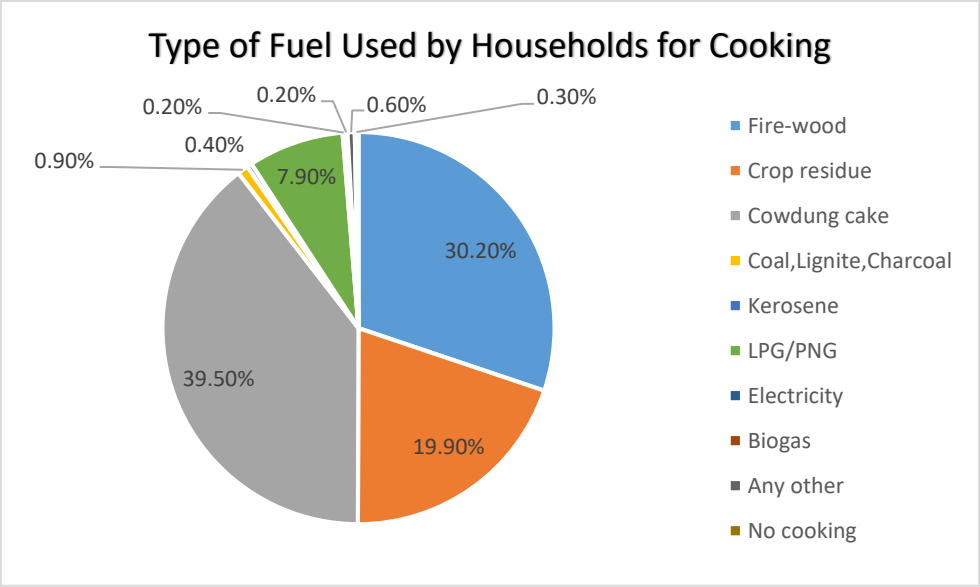


Fig. 1

The normalised value of total available biomass potential in the district is 0.1718 (D, K, Mishra, & Bhattacharyya, 2016).

2.5.3. Biogas

Either the biogas data is not available for the district, or no plants exist in the district. Biogas potential has been evaluated by average livestock and agricultural waste production. Biogas potential from animal waste is calculated approximately as forty-nine lakh m3/year and one crores m3/year from agricultural waste. This amount of biogas generation can efficiently complete the energy demand of the district.

2.5.4. Hydro Power

The Ganga, Gandak, Bagmati, Kamala, and Koshi rivers run through the area. These rivers can be a source to produce electricity through turbines. However, no hydropower plant exists in the district; nor any project sites have been identified for small hydropower projects.

3 QUALITATIVE DATA ANALYSIS

3.1 FORESTRY

The alluvial plain extending up to the foothills of Lakhisarai ranges is extensively cultivated. Rice, wheat, pulses are the chief crops and the area is dotted with bamboo clumps and mango orchards. The Forests found in the Lakhisarai hills have suffered indiscriminate felling of trees in the recent past. The plateau is generally covered with long grasses, viz. Kush and khas. Sal trees of poor quality and vast stretches of bamboo are also found. Firewood, Tendu leaf and Chiraunji are the important forest products.
Lakhisarai is categorized under Agro-climatic zone III A i.e. the Southern east zone. The district has sandy loam , clay loam, loam, clay types of soil with pH between 6.5-8.0.

3.1.1 Biodivesity

From 2001 to 2021, Lakhisarai lost 33ha of tree cover, equivalent to a 0.45% decrease in tree cover since 2000, and 12.4kt of CO_2e emissions. Between 10th of June 2019 and 6th of June 2022 Lakhisarai experienced a total of 138 VIIRS Alerts fire alerts. The forest range Lakhisarai, which has 50 percent habitat variability, maintains the sanctuary's greatest avian density (6,428 individuals/km2). The alluvial plain that stretches all the way up to the slopes of the Lakhisarai mountains is heavily farmed. The main crops are rice, wheat, and legumes, and the landscape is peppered with bamboo clumps and mango orchards. The forests of the Lakhisarai hills have recently been subjected to uncontrolled tree felling. Long grasses, such as Kush and Khas, cover most of the plateau. There are also some low-

quality sal trees and long areas of bamboo. The main forest products are firewood, Tendu leaf, and Chiraunji.

The quantity of animals and game birds has decreased dramatically as the area under agriculture has grown due to improved irrigation infrastructure.

3.2. ENERGY:

3.2.1. Solar

The state government has set up a target of achieving 2969 MW of renewable energy requirements through solar energy, by incentivising the firms, government entities, institutions etc. through grid connected solar. Through that scheme, the excess electricity generated through solar plants could be sold off to the DISCOMS through net metering, and gross metering has also been emphasised.

According to 'The Times of India', the government of Bihar has announced to build solar power plants where earlier the land was obtained to install thermal power plants in Kajra village in the district of Lakhisarai.

According to 'The New Indian Express', Lakhisarai and Bhagalpur will install 500 MW of solar energy plants and the process will get started by June 2023. The solar energy generated could also be utilised to supply water through turbines and other energy related works.

3.2.2. Biomass

The total Biomass rice husk potential in Lakhisarai district is 9204 MT/Year (The World Bank, 2014)

During the year 2006-09, MNRE has assisted Biomass and Bagasse based power plants in the 18 villages of Lakhisarai district, West Champaran district, and Samastipur district of Bihar. 20 off-grid Biomass gasifier systems accompanied with 100% producer gas engines were installed having an overall capacity of 0.64 MW (Varshney, Bhagoria, & Mehta, 2010).

The majority of the households in the district are dependent on cow dung, fire-wood and crop residue for the fuel used for cooking, these all could be a great source of biomass energy, if they could be transported to the biomass factories. However, due to unawareness and limited subsidies knowledge prevent the reduction of usage of traditional biomass. A study by Namita Kumari and Pushpa Sinha,

revealed that traditional biomass increases the home air pollution and also increase in death rate. If LPG connection is given to the households through Pradhan Mantri Ujjwala Yojana (PMUY), these problems can be reduced (Kumari, Sinha, 2022). The excess biomass raw materials could be used to generate energy through advanced methods, which do not produce green house gases.

The major cause of low intake of renewable energy in Lakhisarai district is that the renewable resource potential is not sufficient and the technical support is not present in the district (D, K, Mishra, & Bhattacharyya, 2016).

3.2.3 Biogas:

The district has a lot of potential to generate bioenergy through biogas plant based on animal or agricultural waste. However, there is no data showing installation of biogas plant in the district.

3.2.4. Hydropower:

The primary three rivers that travel through the area are the Ganges, Kiul, and Harohar. The Ganges forms the district's north-eastern boundary, while the Harohar River divides Diyara reigon from the rest of the district, and the Kiul River virtually cuts the district in half. Lakhisarai district is rich in agriculture and forest because of these rivers. These rivers bring wealth to the residents and contribute significantly to the district's significance and uniqueness. River Kiul also contributes to the district's economy by depositing high-quality sand, as well as providing work opportunities. No hydroelectric power plant exists in the district, nor the site has been identified.

3.3 TOURISM

Lakhisarai, The Land of the Pal Dynasty, is a beautiful and important tourist place in the state of Bihar. Lakhisarai is a well-developed and progressive district with the combination of spiritual and traditional ethnicity. Lakhisarai tourism ensures a network of full-fledged facilities for all types of transportation and communication. Lakhisarai had a glorious past which attracts tourists to indulge in learnings of a different kind. (*Lakhisarai Tourist Attraction*, n.d.)

Lakhisarai was a religious and administrative centre when this area was ruled by Pal dynasty. The Chinese traveler Hiuen Shung described this place as it has 10 Buddha mathas and four hundred Buddhist residents. Ten Hindu temples can also be found. The mathas of the Buddhists were on the southern part of the Ganges. The ruler of Pal Bans was Buddhist. The Sen Dynasty ruled for a time in the 11th century. This place is mentioned as the basis of "Mrittika Mudra'' which is kept at Nalanda. Krimila (Kiul Basti) was one of the centers of the Buddhist learning. Lord Buddha himself stayed here on Chaliya Mountain for at least three years. He delivered his speeches on the

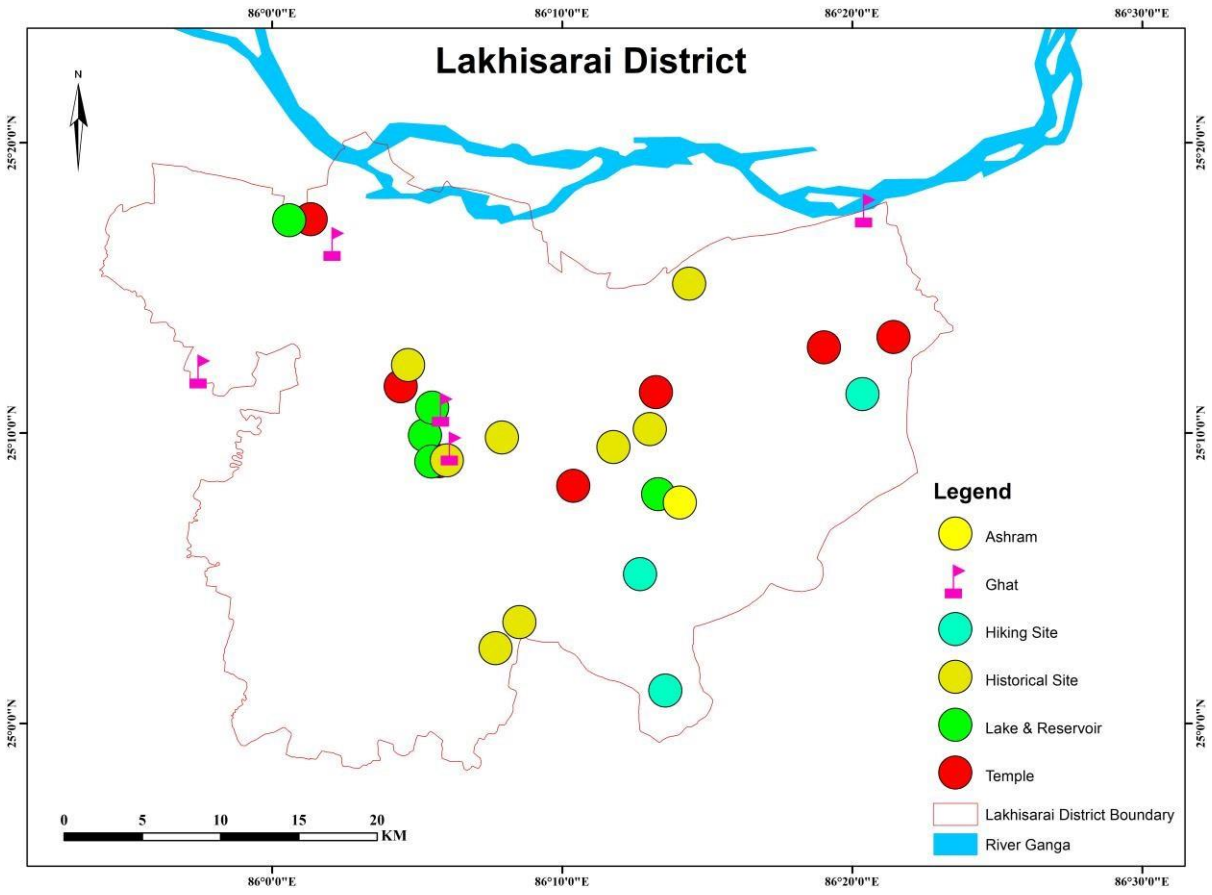
banks of the river Krimikala. Sher Shah Suri ruled this place in the 15th century. (*Lakhisarai*, n.d.)

As per the historians, Lakhisarai was a reputed religious centre for the Hindus in the period of Pal dynasty. The ruler of that time was fond of making Temples and other religious spots. It is one of the reasons that there are so many temples and other religious places within this region. Some significant temples and religious spots within the district are Ashokdham, Bhagwati Mandir of Barahiya, Sringi Rishi, Jalappa Asthan, Abhainath Asthan on Abhaipur Mountains, Maharani Asthan of Abhaipur, Govindbaba Asthan (Mandap) Rampur and Durga Asthan Lakhisarai etc. (*Lakhisarai History*, n.d.)

The Ganges, Kiul and Harohar are the main rivers of Lakhisarai which also form the gridiron of its tourist attractions. There are places which have widely researched and known excavation sites and their contribution towards understanding history of India is undeniable. While industrial activity remains low in Lakhisarai, small-scale businesses have made it a popular trading center for sand, carpets and sindur. The passage of the Ganges, Kiul and Harohar rivers has given rise to densely forested areas and lush cultivable lands. Once home to 52 ponds and teeming flora and fauna, Lakhisarai has recently witnessed a surge in cultivation that is now becoming an issue for its natural wealth. But its countless temples continue to keep Lakhisarai on Bihar's pilgrimage map. (Lakhisarai Tourism, n.d.)

The Bihar State Tourism Development Corporation Ltd. is the agency that is responsible for all tourism activities in the state. Though there is not much evidence from the state tourism department that shows the tourist in-flow to Lakhisarai, there is a promising tourism in Lakhisarai. The tourism potential is yet to be tapped by the Government. Lakhisarai district has a lot of potential for Religious, Archaeological and Eco tourism. There are number of heritage structures present in the district. These structures include Archaeological sites and temples. Incentive based policy should be formulated to protect these structures from further decay. The district has an immense scope for tourism, the historical significance of Lakhisarai has contributed a lot to the growth and development of Lakhisarai tourism. Therefore, Lakhisarai district can be promoted as a popular destination for tourist from all over the world.

Map: 2 Tourism Sites of Lakhisrai District



Source: Prepared by Author

ARCHAEOLOGICAL AND HISTORICAL TOURISM

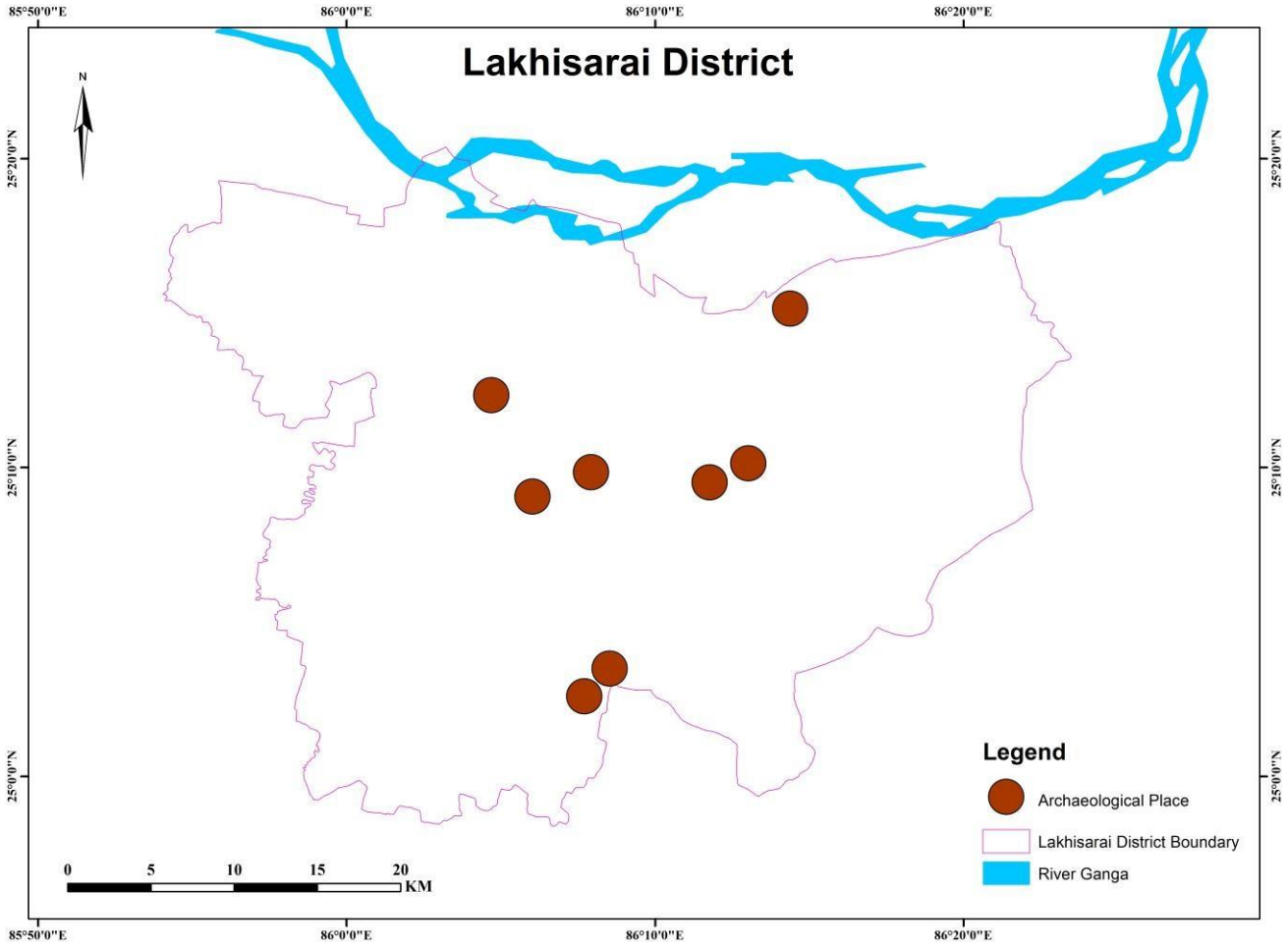
Lakhisarai district was a religious and administrative centre when this area was ruled by Pal dynasty. The Chinese traveler Hiuen Shung described this place as it has 10 Buddha mathas and four hundred Buddhist residents. Ten Hindu temples can also be found. The mathas of the Buddhists were on the southern part of the Ganges. The ruler of Pal Bans was Buddhist. The Sen Dynasty ruled for a time in the 11th century. This place is mentioned as the basis of "Mrittika Mudra'' which is kept at Nalanda. Krimila (Kiul Basti) was one of the centers of the Buddhist learning. Lord Buddha himself stayed here on Chaliya Mountain for at least three years. He delivered his speeches on the banks of the River Krimikala. Sher Shah Suri ruled this place in the 15th century. (*Lakhisarai Tourism*, n.d.); (*Lakhisarai*, n.d.)

★ **Lal Pahari Site:** This archeological site is located in Jainangar, Lakhisarai district. Lal Pahari is a major tourist destination. In the Red Hill we get to see the ancient Buddhist Viharas. These Buddhist viharas were built in the second century. Excavation was done here. After that these Buddhist viharas came to be known. These Buddhist viharas have been preserved here. (Lakhisarai Tourist Places, n.d.).

- ★ **Ghosikund Buddhist Monastry Site:** This Buddhist monastery perhaps dating back to early medieval period (600-1550AD) period. The place is located around 125km east of Patna. This site is located in Ghosikund village of Chanan area in Lakhisarai.
- ★ **Urain Site:** It is located in Jainangar, Lakhisarai district.
- ★ **Krimila or Kiul Basti:** Lakhisarai was once powerful Buddhist centres named Krimila (Kiul) during the Pala period.
- ★ **Suryagarha or Surajgarha:** Surajgarha was also an important place for Shaiva sect. One beautiful Shiv Mandir was there and large number of people gathered there for worship of Lord Shiva with religious devotion. Suryagarha saw the Great War between Mughal emperor Humayan and Sher Shah Suri.
- ★ **Satsanda Hills known as Nonghar Site:** Nongarh is located 18 km away from the Lakhisari and is an excavation site that showcases ancient Indian history. Idols of the goddess and God carved out of sandstone have been recovered from the site, which clearly show that the city of Nongarh has witnessed many battles. The village of Nongarh is famous for Abhinath Sthan, a mountainous temple built in honor of a local

  saint who was believed to cure the diseases of the villagers. (*Lakhisarai Tourist Attraction*, n.d.)
- ★ **Balgudar Ghar Site:**
- ★ **Bichwa Hills Site:**
- ★ **Lai Hills Site:**

- **Map: 3 Archaeological & Historical Tourism Sites of Lakhisrai District**



Source: Prepared by Author

RELIGIOUS & SPIRITUAL TOURISM

Lakhisarai is a deeply religious setting in the state of Bihar, shaped to a large extent by its former rulers of the Pal dynasty, who were so passionate about Hindu temples that they ended up creating most of the town's religious spots. Ashok Dham, arguably the most famous temple here, must be seen for its huge black Shivlingam which rests behind a beautiful white façade. Bhagwati Mandir, Maharani Sthan and Sringi Rishi Ashram are other sacred spots in the district.

★ **Ashok Dham Mandir:** Ashok Dham Mandir also known as Indradamneshwar Mahadev Mandir is located in Lakhisarai district, Bihar. On 7 April 1977, a boy named Ashok discovered the Giant Shivlingam beneath the ground while playing

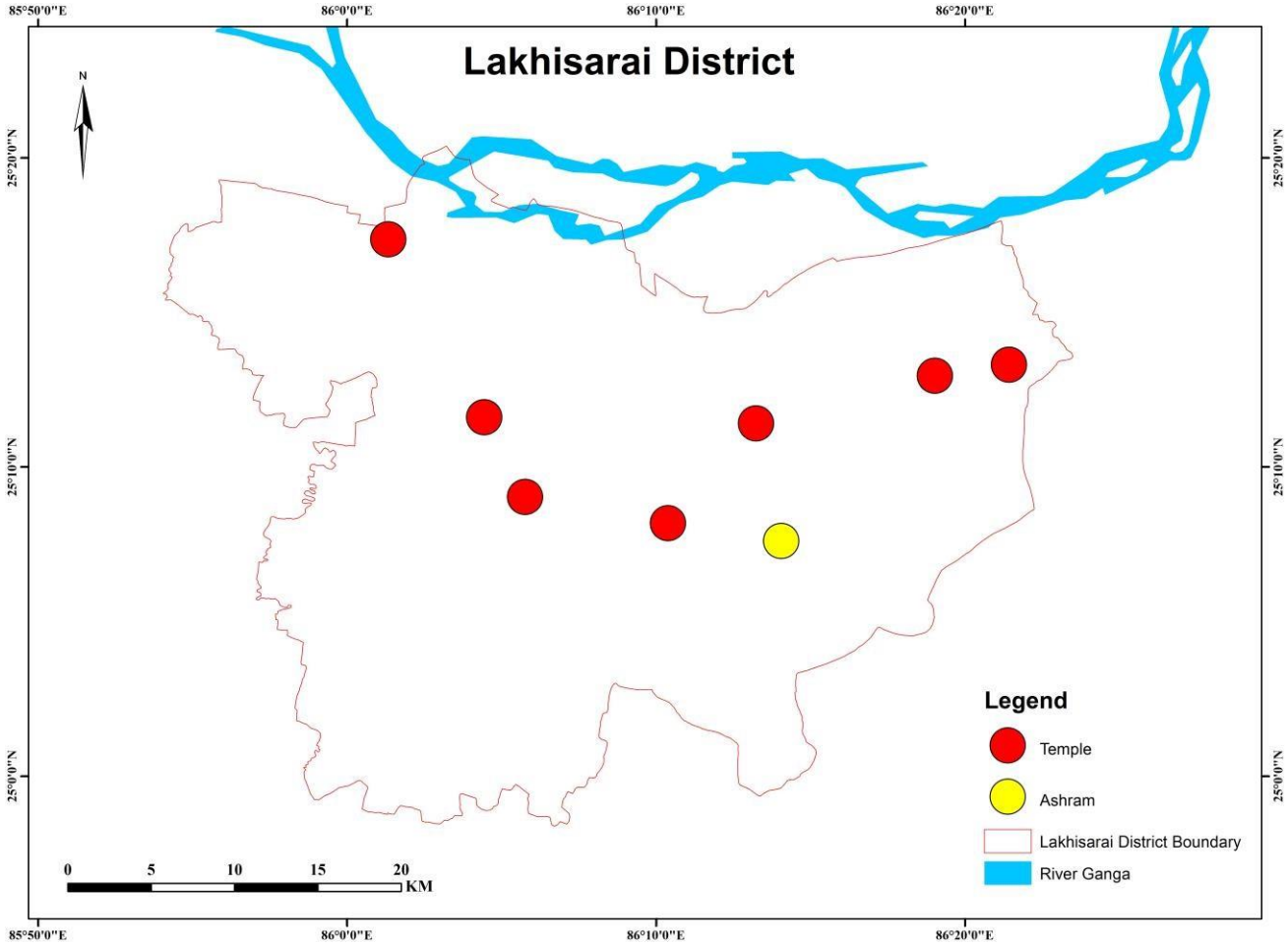
tradition Gilli-danda game. On 11th Feb 1993, the Shankaracharya of Jagannathpuri inaugurated the restructure of the temple complex. This temple of Lord Shiva which is an esteemed one among the people of this place. The main attraction of the temple is the construction style. It is done upon the mythological structures of the Lord Shiva. The temple has beautiful location with marvelous surroundings. (Lakhisarai Tourist Attraction, n.d.)

- ★ **Surya Mandir:** It is a temple from Lakhisarai. Many people from this place and outside from several other places came to visit the temple. This temple is well known for its carvings on the interiors and temple walls. It is dedicated to the Sun temple. (*Lakhisarai*, n.d.)
- ★ **Shringi Rishi Ashram:** The Shringi Rishi Ashram is popular attraction of spiritualism situated in Suryagarha block of Lakhisarai district of Bihar. The place is devoted to the famous and popular Hindu saint Shingiri. According to belief, king Dashratha had performed a yajna here to get a son and after the incarnation of the four sons (Rama, Lakshmana, Shatrughna and Bharata) all four of them were also shaved here. The hills, waterfalls, and pool of Shringi Rishi are the centre of attraction. (*Lakhisarai Tourist Attraction*, n.d.)
- ★ **Bhagwati Asthan:** Bhagwati Asthan has a prominent pilgrimage for the devotees of Maa Bhagwati. The place attracts many tourists because of its spiritual importance as well as its serene location, on the mountaintop. During Nag Panchami the place exhibits a spirit of joy.
- ★ **Abhinath Asthan Mandir:** Abhinath Asthan is an alluring place in Nongarh, which is situated in the mountains. According to the mythological accounts, and the common belief Abinath Baba was the disease healer. He supplied antidotes to the people of Nongarh all through his life. A temple has been built for the people who wish to pay their respects to him. (*Lakhisarai Tourist Attraction*, n.d.)
- ★ **Jalappa Asthan Temple:** Jalappa Asthan Temple is located near Chanan village in Lakhisarai. This temple is ancient. One gets to see the natural scenery around the temple. Here you get to see a beautiful view of the hill. Milk is offered to all the deities in the temple. It's nice to be here. (Lakhisarai Tourist Places, n.d.).
- ★ **Maa Jagdamba Maharani Temple:** This Temple is located at Barhiya in Lakhisarai. This temple is also known as Maa Bala Tripura Sundari Mandir. Here people from far and wide come to see the mother. This temple was established by the great saint Shridhar Ojha. Here we get to see the mother in the form of Pindi. This temple is built in a very grand way. All types of facilities are available in the temple. It feels great to

come here and get peace. (Lakhisarai Tourist Places, n.d.). This temple is famous for another reason. It is said that if any poisonous snake or poisonous creature bites you, then it is treated here. (Lakhisarai Tourist Places, n.d.)

- ★ **Rajuana Shivling:** Rajuana as described by traveller Huen Tsang was an important place for Buddhists and was home to some Buddha Maths. The city was the capital of Indradaman, the last emperor of Pals. Rajauna has a distinct glorious past as evident by the ruins and evidence found. Rajauna village is known for the unique shivling, which is made of black stone. Rajuana village was once a thriving center of Buddhism. Ruled by Emperor Indradaman, it saw the creation of many Buddhists maths. The village is today prominent for Buddhist ruins and a black Shivlingam. (*Lakhisarai Tourist Attraction*, n.d.)
- ★ **Maa Manokamna Durga Temple:** This temple is situated on Red Hill Hasanpur Lakhisarai. People believe that whoever here will ask for their wishes his wish is definitely fulfilled.

Map:4 Religious Tourism Sites of Lakhisarai District



Source: Prepared by Author

- **5. ADVENTURE, NATURE & ECO TOURISM**

Physiographic and the natural surroundings along the river Ganga in Lakhisari are part of the natural heritage of Lakhisarai. The Lakhisarai is surrounded by river Ganges on

the north side and by river Kiul in the East central side. These rivers impart prosperity to the people and play an important role in making this district significant and unique. Old Lakhisarai was also known for its fifty-two ponds, few of them are still in frequent use. Some of them are Ashtaghatti, Sansar Pokher, Ojhba Pokher, Sonia Pokher etc. These ponds were used as a water container for the purpose of agriculture as well as for bathing. Along with the Hills, Lakes and water bodies both natural and artificially created also form an intrinsic part of the natural heritage of the district. Lakhisarai have a great potential for features like; entertainment complexes such as Hills, Lakes, Ponds, water parks etc. Lakhisarai's rich natural scenery, Hills, Ponds, Diara and Rivers make it an important destination for nature tourism which has huge potential fo ecotourism and providing opportunities for tourists to indulge in the activities.

★ **Shringi Rishi Reservoir:** Shringi Rishi Reservoir is a major site located in Lakhisarai. Here you get to see a huge reservoir. This reservoir is situated at the foot of hills. This reservoir is very beautiful. This reservoir is situated on the road leading to Shringi Rishi Ashram. By reaching here, you can see the beautiful view of this reservoir. (Lakhisarai Tourist Places, n.d.)

★ **Bada Talab Barahiya**

★ **Astaghatti Pond**

★ **Ojhba Pokhar**

★ **Sonia Pokhar**

★ **Lathiya Hill (Hiking Site)**

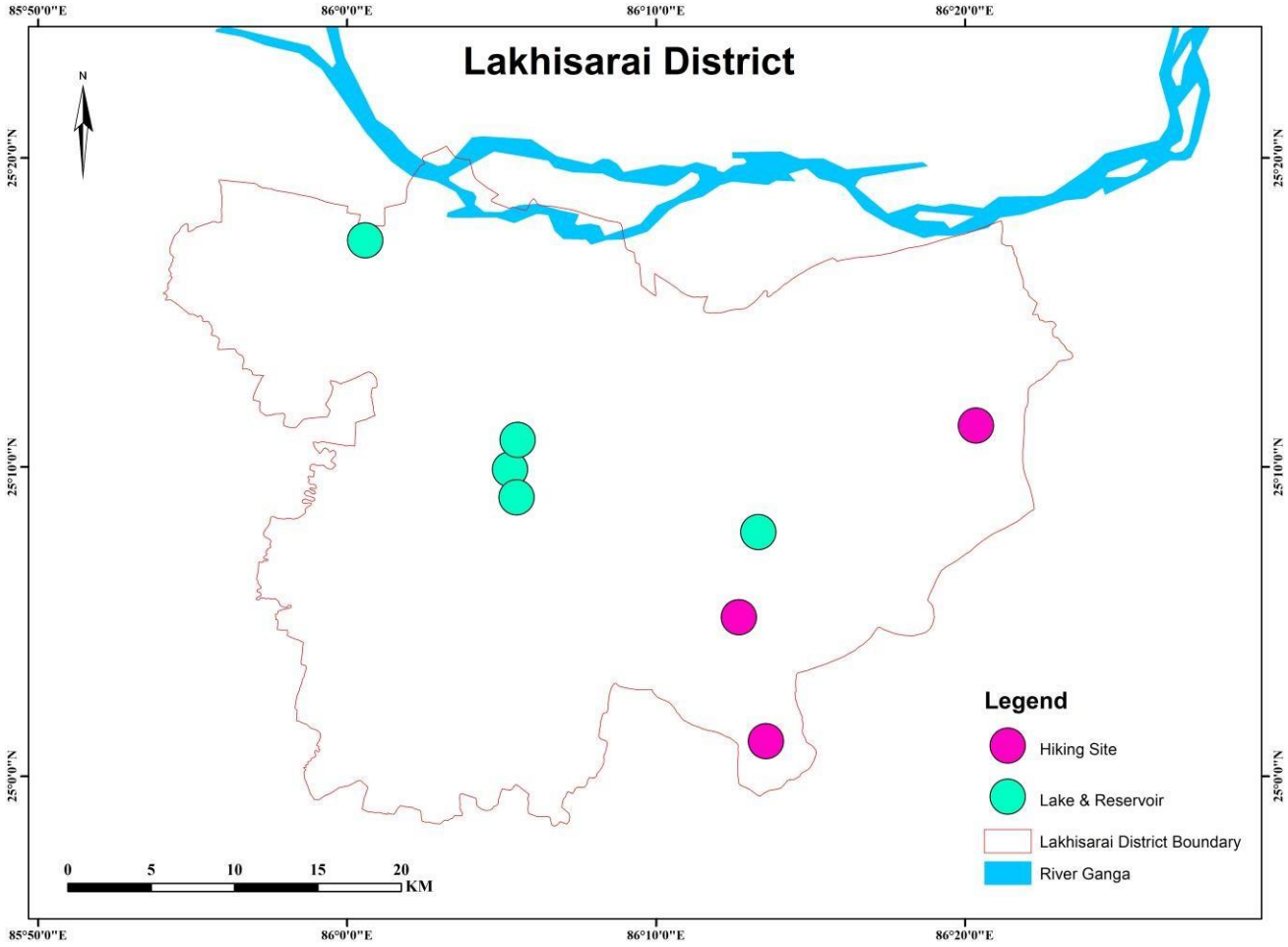
★ **Jankidih (Nature view and Hiking Site)**

★ **Kundar Jangal (Hiking Site)**

★ **Sansar Pokhar Lake**

★ **Lakhisarai Lake**

- **Map: 5 Adventure, Nature and Eco Tourism Sites of Lakhisarai District**



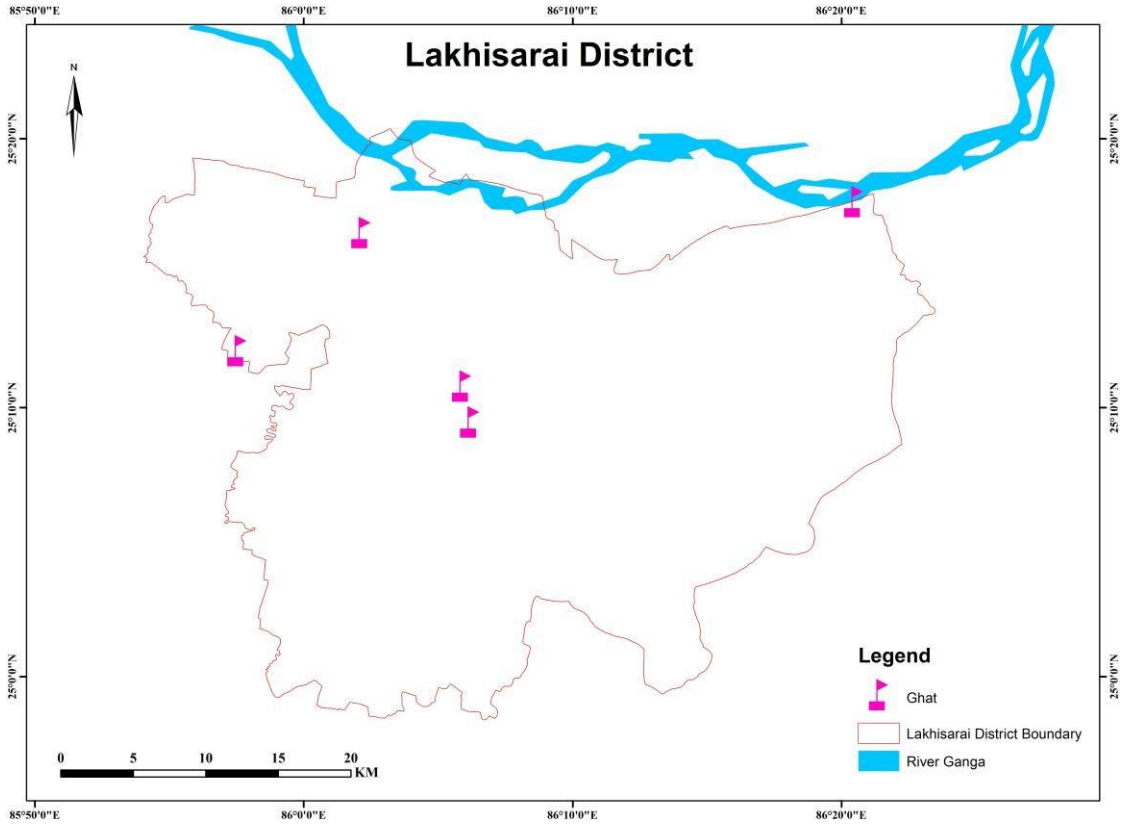
Source: Prepared by Author

GHAT TOURISM

Every city has some specialty that is engraved in the heart of it. A visit to Lakhisari cannot be complete without a visit to the ghats running along river Ganges. As a dip in Ganga is considered holy in the Hindu religion, most of the ghats are dedicated to religious rituals. One of the more visually spectacular ghats is the Tajpur Ghat, Indupur Ghat and Ajni Ghat etc. Ghats in Lakhisarai are riverfront steps leading to the banks of the river Ganges and Sone. Most of the ghats are bathing, Puja ceremony ghats and cremation site. Earlier Morning boat ride on the Ganges across the ghats is a popular visitor's attraction.

- ★ **Tajpur Ghat**
- ★ **Indupur Ghat**
- ★ **Ajni Ghat**
- ★ **Suryadev Ghat**
- ★ **Vinoba Bhave Ghat**

Map: 6 Ghat Tourism Sites of Lakhisarai District



Source: Prepared by Author

CULTURE & ARTS TOURISM

Lakhisarai is an ancient place with rich cultural heritage. Every portion of this district has its own story to narrate. From ancient bhuddhist monastery to ancient temples we can find all and more in this district of Bihar. The feeling of cultural ambiance can be witnessed in spiritual atmosphere of Lakhisarai where Hindus, Buddhist and Muslims the followers of several other religions live together in harmony.

- ★ **Arts and Products:** Lakhisarai is one of the best trading centres in Bihar. Lots of items being traded here. Banarasi Sari, Silk, Kaleen, Dari and Agricultural produces are the main articles, which are traded in and out of the district. Vermilion or Sindur is the widely know product of Lakhisarai Tor the last 100 years. From the small sector finished Iron products and vermilion is exported from here. Besides Lakhisarai is the market for adjoining areas of Chanan and other village areas.
- ★ **Fair:** Kiul Mahotsav and Sherwani Mela
- ★ **Festival:** Local festival are an integral part of Culture and traditional heritage of the district. Chatth Puja, Makar Sankranti, Dussehra and Holi are famous festivals of Lakhisarai district. *Chhath Puja:* New paddy, sweets and fruits are offered in worship Associated with the worship of Sun God mostly women of Lakhisarai.

3.4. WELANDS:

The wetlands create a unique ecosystem that supports many species simultaneously like aquatic, terrestrial, and human beings. Local stakeholders directly or indirectly depend on the wetland for their income and small-scale business. The district has a close connection with Hindu devotees, and the district is also known for Mithila paintings and the Maithili language. The data collected and analyzed shows the region's production and possible product that can be derived from the raw product. The list of sources and the possible products are mentioned below:

- Cereals, oilseeds, pulses and horticultural crops are the main crops grown in the region
- The region is flood-prone

4 ACTION PLAN DEVELOPMENT

4.1 FORESTRY

- The district has large chunks of cultivable waste lands and fallow lands, which can be planted under the National Afforestation Mission (NAP). NAP is being implemented for afforestation of degraded forest lands. The overall objective of the National Afforestation Programme (NAP)

scheme is ecological restoration of degraded forests and to develop the forest resources with peoples' participation, with focus on improvement in livelihoods of the forest-fringe communities, especially the poor. The afforestation done could be kept under check using technologies such as GPS, geotagging, etc.

- The district should practice agroforestry and people should be made aware in accordance with the State's Agroforestry Policy, 2018. It is recommended that for agro-silviculture in non-flood affected areas Poplar, Shisham, Gamhar, Melia, Chah, Eucalyptus, Kadam, Semal, Ulmus, Sagwan, Toon, Bamboo, Casurina etc. and in the flood affected areas Eucaluptus, Kadam, Semal, Chah, Arjun, Salix, Jamun etc. can be grown. If farmers want to take up agro-horticulture then Mango, Litchi, Jamun, Kathal, Barhar, Guava, Bel, Ber etc. is recommended. Apart from major fruit crops like Mango, Guava, Litchi, Banana etc., Makhana, Pineapple, Betelvine can also be included under agroforestry systems. Medicinal plants like Kalmegh, Aswagandha, Sarpgandh, Satawar, Lemon grass, Safedmusli etc. can be grown along with tree component. The aromatic plants like Japanese Mint, Lemongrass, Pamaroja, citronella etc. may also be included. Agroforestry can create opportunities for setting up agri-based small enterprises such as pickle production, and juice/pulp extraction of these fruits.
- One thing which is very important is making people aware about the need of forests and trees. Educating them about the policies and how planting trees can be beneficial in both the ways, i.e. environmentally as well as economically. People dependent on NTFP such as tendu leaves for their earnings should be provided with the required facilities so that they can improve their livings.

4.1.1 Biodiversity –

- Plantation is receiving special attention from the state government to improve green cover. The government has created the Jal-Jeevan-Hariyali initiative to help with this.

4.2 TOURISM

Lakhisarai is a well-developing and progressive district with a spiritual and ethnically diverse population. Lakhisarai tourism provides a comprehensive network of fullservice transportation and communication options. Lakhisarai has a storied heritage that draws visitors looking for unique learning experiences. (Tourist Attractions in Lakhisarai, n.d.). During Pal Bansh's golden time, Lakhisarai was a well-established governmental and religious centre. In ancient times, this location of Lakhisarai was known as a site of rocks, mountains, and statues of various Hindu and Bhuddhist gods and goddesses. Even in Buddha literature, this location was referred to as "Anguttri," implying that it was a district. As a separate district from Munger, this lovely area was given the name Lakhisarai. (Tourist Attractions in Lakhisarai, n.d.).

Lakhisarai district has enormous potential for Archaeological, Religious and Eco tourism. The history of Lakhisarai indicates a rich heritage inherited from various dynasties & great personalities. The district has an abundance of Archeological Sites, Religious Places, and Eco Tourism which can be suitably renovated and opened up for tourism. The archeological & historical value of this heritage still remains to be explored & recognized in the international. The Hills, Ponds, Lakes & Riverfront hold vast potential for nature-based eco-tourism. The river Ganga and Kiul all along its stretch offers potential for water-based sports & riverfront activities. These features have a great potential in Lakhisarai as they will introduce a variety of recreational facilities to tourists and will lead to water-based tourism (water Parks, riverfront development, water transport etc.). But the tourism potential of the Lakhisarai for generating much needed income & employment remains under utilized.

Lakhisarai has good potential for the development of tourism in the district. Though the district has high tourism potential, owning to lack of infrastructure facilities such as, tourist information Centre, transport, communication facilities, accommodation and other tourism supported facilities, most part of it remains unexplored by the tourist. In the high flood prone and minimum opportunities for other industries, tourism could be the best way for economic growth and employment generation in the district. There is a need to minimize the hurdles and threats by developing good governance. Many destinations in the district are still unexplored and reason behind is infrastructure problem. Lack of adequate infrastructure deprives them from fulfilling their desire of leisure and rest. This has adversely affected the perception of the district as a tourist destination. It is expected that if the infrastructure is improved and the introduction of more activities at the site and to the excursion point can increase the duration of stay and lure more tourists. For many places of interest accessibility and accomodation is a huge problem whereas for others condition of roads needs to be vastly improved.

- **Religious Tourism:** Lakhisarai is a deeply religious setting in the state of Bihar, shaped to a large extent by its former rulers of the Pal dynasty, who were so passionate about Hindu temples that they ended up creating most of the town's religious spots.
- **Archaeological Tourism:** Lakhisarai district was a religious and administrative centre when this area was ruled by Pal dynasty. The Chinese traveler Hiuen Shung described this place as it has 10 Buddha mathas and four hundred Buddhist residents. At Present in the district of Lakhisarai there are lots of Archaeological sites which has huge potential to explored and developed as a tourism spot.
- **Waterfront Tourism:** The river 'Ganges' offers potential for development of waterbased sports & activities along its stretch. Riverfront development has to be undertaken in the Lakhisarai district to promote tourism.

- **Adventure, Nature and Eco Tourism:** Lakhisarai's rich natural scenery, Hills, Ponds, Diara and Rivers make it an important destination for nature tourism which has huge potential fo ecotourism and providing opportunities for tourists to indulge in the activities.
- **Ghat Tourism:** Lakhisarai district has huge potential for water-based tourism spot. The Lakhisari Ganga and Kiul ghats has great potential of been a source of inspiration for artists, film-makers, photographers, writers and musicians for centuries. One of the more visually spectacular ghats is the Tajpur Ghat, Indupur Ghat and Ajni Ghat etc.
- **Festival:** Local festivals is integral part of Culture and traditional heritage of the district. Chatth Puja, Makar Sankranti, Dussehra and Holi are famous festivals of Lakhisarai district. *Chhath Puja:* New paddy, sweets and fruits are offered in worship Associated with the worship of Sun God mostly women of Lakhisarai.

SWOT ANALYSIS: LAKHISARAI DISTRICT

STRENGHT

- ★ Lakhisarai's natural features (Rivers, Lake/Pnds and Hills dominate the landscape) and unique ecosystems are valuable scenic and recreational resources and can contribute to environmental services.
- ★ There are various religious spots, Archaeological sites and eco tourism areas around the district.
- ★ Cohesive Community and residents who are passionate and involved.
- ★ Financial institutions / willingness to invest in the district.

WEAKNESSS

- ★ Lack of tourist information centre, thus an inadequate infrastructure facility for the tourists.
- ★ Poor maintenance of heritage structures and lack of awareness among local population about their heritage value.
- ★ Lack of desire of skilled work force to stay in the district, lack of accountability of service delivery, Lack of Leaders and Entrepreneurs in the community and Lack of developable land in and around the district.
- ★ No maintenance of natural heritage leading to loss of valuable recreational space that can act as tourist destinations.
- ★ The district has no airport with the nearest being in Patna and Gaya.

- ★ District are facing problem of Poor drainage system and sewerage system, Solid waste collection transportation and disposal, Pollution, connectivity, open space and parks.
- ★ Lack of recreation, sports facilities, moreover large area of the district has poor building quality and unhygienic living conditions.

OPPORTUNITY

- ★ Ongoing, committed, and proposed development projects.
- ★ Potential for growth in Religious, Historical, Eco tourism, Film and Ghat Tourism.
- ★ A wide scope for river front development along river Ganga and Kiul.
- ★ Encourage Public – Private partnership for provision of infrastructure services.
- ★ Potential for growth in Religious, Archaeological and Eco tourism.

THREAT

- ★ Tourism industry is underdeveloped. At present Tourism has very little contribution towards economic generation of the district.
- ★ Lack of tourism infrastructure and tourist information centers.
- ★ The district is prone to different kinds of disasters, which include floods and earthquakes etc. Incorporating disaster mitigation measures within the infrastructure planning process.
- ★ Across the district the rise of crime including, robbery, snatching, drugs, and murder etc.
- ★ Political stability, Naxalism and Corruption, the district is surrounded by Naxal affected areas.
- ★ Lack of governmental response towards tourism infrastructure such as tourism centre, tourism promotion and tourism accommodation.
- ★ Poor Infrastructure facilities for tourists in Lakhisarai.
- ★ Too much dependence on single economic sector.
- ★ Lack of desire of skilled work force to stay in the district.
- ★ Inadequate infrastructure for sorting, grading, packing, etc., in addition to the high cost of raw material (at processor's level).

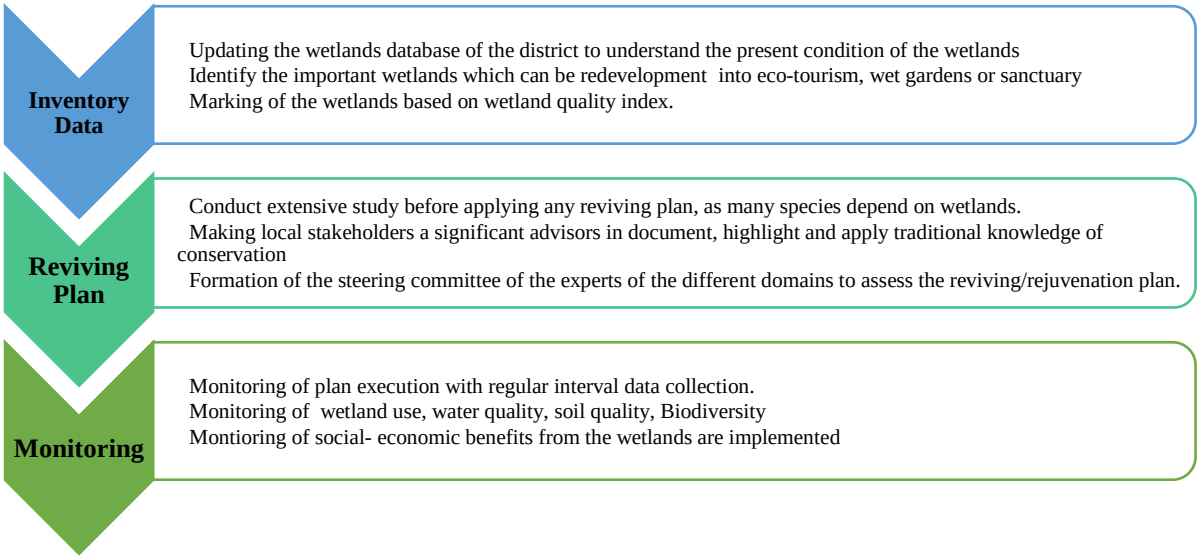
PROJECT DEVELOPMENT

- Project on development of tourist information centres at all important places of Lakhisarai district.

- In order to maximize the use of the Ganga and Kiul River flowing through the district, Ganga riverfront development would be a great potential for Boating, Public Promenades, Religious Facilities, Cruise etc, making it the vibrant heart of the urban fabric.
- Landscaping and flood protection along Ganga River front through Meditaion park and Millenium Park.
- Development of Parks and playgrounds, development of Recreational Facilities of higher order Strengthen the existing Tourism spots and infrastructure, Create the new tourism attraction points and recreational centers.
- Till now, no religious and historical tourism circuit are found in the Lakhisarai district. Therefore, new projects to diversify the tourist inflow, emphasis on promotion of tourism activities like, fair & festivals, waterfront development, Ghat tourism etc.
- Development of combined projects involving Tourism department/ Ministry, Disaster management department and Environment, forest, and climate change section/Ministry. Stakeholder consultation & Participatory management and involvement of Municipality, and local communities from Ganga villages and tour operators to build ecotourism options and choosing adventure and religious tourism sites.

4.3 WETLANDS

Some of the known wetlands in the district need to be taken care and action on different fronts must be taken. The action plan below gives a glimpse of the action and development required to protect, conserve, and rejuvenate the wetlands existing and extinct.



4.4. ENERGY

4.4.1. Solar

Absence of technical support for solar plants is one of the reasons of poor performance of solar in the district (D, K, Mishra, & Bhattacharyya, 2016). Here state government could conduct training sessions for the people, which would help with the maintenance of the solar plants and also would raise awareness among the population of the district to purchase solar plants.

Further, only 10% of the cultivable land is irrigated through Kiul minor irrigation and Shringi Rishi Dam and the rest is through private irrigation systems by the farmers like boring, ponds, hand pumps, etc. According to CEEW, solar-based irrigation could be used, where water as a service model could be used, since most of the farmers in the district are small and marginal. This model would help improve the irrigation in the district and farmers could also save cost of establishing a full-fledged solar pump by themselves.

Moreover, if solar pumps are installed in the district, then it would achieve various agricultural policy objectives (CEEW, 2020). According to the Input Survey of 2016-17, out of total net sown area 51649 hectares, only 23735 hectares of land is irrigated and the rest 27914 hectares of net sown area is unirrigated. According to CEEW, solar in agriculture would help in achieving the objective of Har Khet ko Pani, doubling farmer's income through improving crop intensity and diversification, and for promoting NMOOP (National Mission for Oilseeds and Oil Palm), because if the irrigation improves then it would automatically improve the other factors.

Moreover, if component B of the KUSUM scheme needs to be implemented here subsidies from the government could be a solution, since the proportion of the district consist of small and marginal farmers (CEEW, 2020).

PROJECTION AND MONITORING MATRIX

Firstly, awareness needs to be made to the farmers and rural people about the solar energy.

Secondly, training programs could enhance the skills of the rural people which could help in maintaining the solar plants.

Thirdly, subsidies need to be given or financial credit system should be strengthened in the district in order to help farmers to avail credit for installing solar pumps.

Fourthly, state government has started establishing solar power plants in the district and more encouragement is needed for other stakeholders in the district to utilise solar energy.

4.4.2. Biomass

The potential of biomass in the district has not been able to be fulfilled. The awareness programs need to be conducted by the government, to increase the uptake of the biomass energy. A proper mechanism of transporting excess biomass from the farmers to the biomass plant holders is missing and a storage facility for the farmers is also necessary. Moreover, the people of the district are not technically skilled to be able to carry the task of energy generation through biomass plants or help in the maintenance of the biomass plants. Further, there should be subsidies given for LPG so that the households could shift their fuel dependence from traditional biomass, which is polluting to LPG which are not. And they could sell off their biomass wastes to the companies for energy generation, which is needed in the district.

PROJECTION AND MONITORING

Firstly, it is essential that people become mindful of using traditional biomass at their homes for cooking, which are not good for their health.

Secondly, there should be a financial assistance and subsidies from the government for the households as well as for potential biomass plant owners.

Thirdly, management of biomass raw materials is required, to be able to utilise it to generate energy efficiently.

Lastly, the skills of the rural people of the district needs to be enhanced, to be able to carry out simple tasks in the biomass gasifier factories. It would also generate employment opportunities and also the incomes of the people would increase.

4.4.3. Biogas:

The government should conduct a program to encourage or educate people to install at the household level; all the incentives or subsidy schemes should be told to local people and make them aware of the benefit of installing the biogas plant.

4.4.4. Hydropower:

The state plans to establish huge hydropower projects and pumped storage systems with the help of bilateral and international finance agencies, joint partnerships with government entities like the National Hydro Power Corporation (NHPC), and even private sector participation.

5 RECOMMENDATIONS

5.1 AGRICULTURE AND ALLIED SECTORS

- The number of Mandis and marketing facilities for agricultural products should be increased.
- Micro-irrigation should be promoted on a large scale for vegetable and fruits cultivation, increasing water use efficiency.

Water harvesting structures such as ponds should be constructed (mainly in Ramgarh and Halsi blocks) to facilitate the irrigation supply and groundwater recharge.

- Farmers in the district should be encouraged for Natural farming and the Jaivik corridor to promote organic farming.
- Vermicompost production training should be introduced to boost soil health.
- There is a need to extend advanced technologies in the agriculture sector, such as happy seeder, mulching, and zero tillage.
- The cultivation of medicinal crops such as mentha, ashwagandha, and others should be introduced in the district.
- Farmers should be encouraged for large-scale vegetable and cash crops cultivation.
- Mushroom cultivation should be introduced in the district and provide market facilities.
- Fruits cultivation such as mango, banana, and guava should be encouraged.
- The district has ample scope for the tomato processing units, which will help in good price realization by farmers. Good transportation and export facilities will improve the farmers' income.
- More farmers should join and follow the weather-based agro advisory services.
- Beekeeping should be encouraged in the district under proper training.
- The district has a scope for low-cost semi-intensive poultry farming, which should be encouraged.
- The district has scope for dairy-based processing units and fish culture.

5.2 FORESTRY

People should be made aware of the importance of forests. The large chunks of fallow land should be planted with trees under the National Forest Mission. Agro-forestry is highly recommended for the district. Administration should act in accordance with the State’s Agroforestry Policy, 2018.

5.2.1 Biodiversity

- Implementation of climate smart agriculture approach.
- It is recommended to conduct afforestation program and strict law regarding illegal green tree cutting as data shows decrease in forest area.

5.3 WETLAND

The wetlands need to be intact, but at the same time, they need to be planned wisely to support the district economically, socially and environmentally, which will lead to indirectly relieving of stress from the Ganga River to a large extent. It will also lower the local people's dependence on the Ganga River for their small-scale industry or basic daily needs. The following recommendation and interventions are required to get valuable products and solve the issues/ challenges faced by the local people of that region.

- It is recommended to introduce improved cultivars and production technologies for oilseeds.
- It is recommended to develop flower gardens and wet gardens around the wetlands. These wetlands can be turned into an eco-tourism site.
- Small-scale industries like boat making and net making should be promoted under the schemes by the Ministry of Micro, Small & Medium Enterprises.
- It is recommended to create awareness about the Fisheries and Aquaculture Infrastructure Development Fund (FIDF) scheme and Pradhan Mantri Matsya Sampada Yojana (PMMSY).

5.4 ENERGY

5.4.1. Solar

- ❖ The people in the district should be aware about the positive impact of the solar energy.
- ❖ Courses related to solar energy should be given to the young people of the district.
- ❖ The district needs planning of solar energy in agriculture sector, which has a huge potential.
- ❖ Credit assistance should be improved.

5.4.2. Biomass

- ❖ Awareness is needed for biomass energy in the district.
- ❖ Subsidies from the government is needed to be reached to the beneficiaries.
- ❖ Proper management of the biomass is required
- ❖ Skills of the people especially in the rural areas need to be developed.

5.4.3. Biogas

- A centralized biogas plant for the district should be constructed for the treatment of organic fraction of municipal solid waste.
- A biogas can be constructed using cattle dung as feedstock in different gaushala such as Sri Lakhisaray Charitable Society.
- 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.

5.4.4. Hydropower

- It is recommended to build multipurpose canal and dam in the district for electricity and irrigation purpose.
- Hydel energy awareness program should be spread from tourist places such as Kabaiya, Nongarh, Barahiya and Shringirishi by poster or pamphlets.

5.5. TOURISM

SUGGESTIONS AND INTERVENTIONS

- Establish Tourist Information Centre in the District Headquarters. Tourist information centres will be equipped with the modern information and communication technology devices.
- Developing Tourism circuits through the Integration of Religious, Archaeological, Eco tourism and Ghat by development of capacity building, engagements with local stakeholders.
- Provide adequate Park and Open Spaces/ Recreational Facilities, Eco Park, Water Park, Water Sport and Riverfront development etc. around the tourism sites and along Ganga ghats to attract all type of tourism.
- Development of tourist facilities and overall improvement of infrastructure facilities for tourists in places of tourist attractions.
- To strengthen the tourism and attract large number of tourists, Tourism Product Diversification/Improvement is needed like, Promotion and packaging of tourist resources, Upgradation of identified tourist spots, Quality accommodations, Tourist Information Centre, Road and public transportation and Road furniture and signages etc.
- Maintenance of law and order, deploying tourist police force, disposing grievances, enacting suitable rules, regulation and laws for tourism development and Standardizing quality of tourism product and services.
- Empowering and Sensitizing Ganga Ghats (Cleaning of garbage and waste management at each Ghats sites) to make tourism compatible, environment friendly and sustainable. For example: Development of boating and cruise facility in existing Ghats.
- Stakeholder consultation & Participatory management and involvement of Municipality, Disaster management authority and local communities from Ganga villages and tour operators to build ecotourism options and choosing adventure and religious tourism sites.

CHALLENGES AND THREATS

- ★ Crime and social amenities (including, robbery, snatching, drugs, and murder etc.) being one of the biggest challenges in the district tourist development, have been neglected.
- ★ The water bodies and open spaces are used as the dumping areas in the district.
- ★ There are chances of epidemic due to lack of sewage and solid waste disposal system for the core city area particularly in slums. These increase losses during disasters. Thus, a disaster mitigation plan should be prepared for the city and whole district.
- ★ Tourism industry is underdeveloped. At present Tourism has very little contribution towards economic generation of the district.
- ★ Lack of tourism infrastructure and tourist information centers.
- ★ The district is prone to different kinds of disasters, which include floods and earthquakes etc. Incorporating disaster mitigation measures within the infrastructure planning process.
- ★ The problems being faced by pilgrims while taking dip during the ongoing festivals like: Chath Puja is a matter for serious concern.
- ★ Inadequate and inappropriately located facilities for garbage collection, inadequate fire services due to congested lanes, storm water, and sewerage connections has led to overall deterioration of the urban fabric.
- ★ Strategies for Social Infrastructure, Environment & Tourism Encroachments, inadequate municipal services and insensitive building control mechanisms are leading to the chaos in the urban landscape in the Lakhisarai.
- ★ Too much dependence on single economic sector and Competing cities for external investments in the vicinity.

6 Discussion during the Report Presentation

- The Natural Farming trainings will be planned with Namami Gange.
- The scope for tourism is limited but the Jalal model could be explored more for increasing local livelihood.
- 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 1 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)**	**m3/day**
Cattle	Manure	126085	10	46,02,10,250	345157687.5	69031537.5	25	2761261.5	7565.1
Buffalo	Manure	58352	15	31,94,77,200	239607900	47921580	25	1916863.2	5251.68

Sheep	Manure	1401	1	5,11,365	383523.75	76704.75	25	3068.19	8.406
Goat	Manure	107363	1	3,91,87,495	29390621.25	5878124.25	25	235124.97	644.178
Pig	Manure	4002	2.5	36,51,825	2738868.75	547773.75	25	21910.95	60.03
Poultry	manure	37,902	0.1	13,83,423	1037567.25	207513.45	25	8300.538	22.7412
Total		**3,35,105**						**4946529.348**	

Table 2 Biogas potential from agricultural waste.

Crop	**residue type**	**Total crop production (tons) (2006-2007))**	**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)**
Rice	husk	56289	0.28	15760.92	11032.644	30	7722.8508	800	6178280.64
wheat	straw	74091	1.5	111136.5	77795.55	80	15559.11	750	11669332.5
Total		**130380**							**17847613.14**