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Land Use and Cropping Pattern in Rapti River Basin: Uttar Pradesh (India)

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Abstract: ***Uttar Pradesh spans a vast area of 24.12 million hectares, ranking as the fourth largest and most densely populated state in India, with a population of approximately 199.81 million. This state's population density is nearly twice that of the entire country, as recorded in the 2011 Census. It boasts an abundance of water resources, fertile soil, and a climate that is conducive to agriculture. The state's river basins are primarily agricultural, with the Rapti Basin being a major area for growing rice and wheat, although other crops like oilseeds, pulses, vegetables, and trees also contribute significantly to the region's food security and economy. Sugarcane is another key crop in the Rapti Basin, with a majority of it being grown for local consumption, though there are also large - scale commercial sugarcane plantations in the northern regions. The total landuse suitable for cultivation in the Rapti Basin is 75.17% besides rice and wheat account for about 42.76% and 43.40% of the total cultivated land, respectively, with sugarcane being grown on a perennial basis for about 4.0% as far as the cropping pattern is considered.***

Keywords: Uttar Pradesh, Rapti Basin, Landuse, Cropping Pattern

1. Introduction

The amount of available land in a nation is fixed and limited by its natural borders. The demand for land to fulfil the requirements of various sectors, such as industry and urban development, is often so high that it necessitates reducing the land allocated for farming. This situation makes it difficult to increase the land available for agriculture. On the other hand, the demand for food crops is constantly rising due to population growth, shifts in consumer tastes and preferences driven by higher incomes, and the influence of the globalized economy. While some might argue that producing crops domestically is not as crucial in a globalized world, in a developing country like India where most people rely on subsistence farming for their survival, supporting agricultural production is essential. This support includes policy interventions such as providing credit and extension services. The commercial feasibility of farming has become especially important in the globalized economic landscape. Consequently, a variety of factors highlight the need to understand the factors affecting how land is used overall and specifically the patterns of crop production. The current section aims to explore the two key themes of land use and cropping patterns in the context of the Rapti Basin.

Basin Setting:

The entire Rapti Basin spans from East longitudes 81°35’ to 83°52’ and North latitudes 26°18’ to 28°35’, covering an extensive area of 23, 237.51 sq. km, as illustrated in **Figure 1**. Within Uttar Pradesh and Nepal, this area is divided into several sections. The part of the Rapti Basin located in Uttar Pradesh is bounded by East longitudes 81°35’ to 83°49’ and North latitudes of 26°18’ to 27°59’, encompassing a total area of 14, 658.20 sq. km. It is surrounded by the Ghaghra Basin from west, east and north directions. The Rapti Basin is further divided into four main sub - basins: Burhi Rapti, Rapti, Rohin, and Ami, each with a drainage area of 2, 904.88 sq. km (19.72%), 7, 877.61 sq. km (53.70%), 2, 140.84 sq. km (14.66%), and 1, 734.88 sq. km (11.92%) respectively, all within the state of Uttar Pradesh. List of the major tributaries of the Rapti River within the Indian system (**Table 1**). This basin encompasses 10 partial districts and 79 blocks (49 fully and 30 partially) of Uttar Pradesh. It is home to 41 towns, with 29 being Statutory Towns and 12 being Census Towns. Among these, Deoria and Gorakhpur are the two towns with populations between 1 to 10 lakhs. The Rapti River, previously referred to as Iravati, begins its journey in the Siwalik Himalaya of Nepal, rising to a height of 3, 050 meters. It then makes its way through Nepal before reaching Eastern Uttar Pradesh in Chanda Pargana, located east of the village of Kundwa in Bahraich district. The river meanders in a winding path with relatively shallow waters, leading to significant flooding in the surrounding areas of Eastern Uttar Pradesh. It traverses through the regions of Bahraich, Balrampur, Shrawasti, Basti, and Gorakhpur before merging with the Ghaghara River on its left side, near the town of Barhaj in Deoria district. The total length of the river from its point of entry into India to its meeting with the Ghaghra is approximately 560 kilometers. The area of land that drains into the Rapti River in India is around 14, 658.20 square kilometers. Just before the river makes a sharp turn just beyond the border with Nepal, it continues in a southeasterly direction, flowing through various lakes, swamps, and some dried - up rivers The distribution of district area within the Rapti Basin and the coverage of each district by the basin are detailed in **Figure 2**. The climate in the Rapti Basin is characterized as sub - tropical and monsoonal. The winter season (October to February) is cool and dry, with occasional fogs and light showers, while the summer season (March to early June) is hot and dry, and the monsoon season (middle June to September) is warm and humid, marked by frequent heavy rains. The average annual rainfall in the basin is 1093.44 mm. It's evident that the majority of rainfall in the Rapti Basin comes from the monsoon season (87.5% of the total rainfall), with July and August being the wettest months, accounting for 65% of the monsoon rainfall and 57% of the total rainfall. The warmest month is June (35.64 °C), and the coldest is January (10.85°C). The month with the highest evaporation rate is May (275 mm, 8.87 mm/day), and the lowest is January (31 mm, 1.00 mm/day).

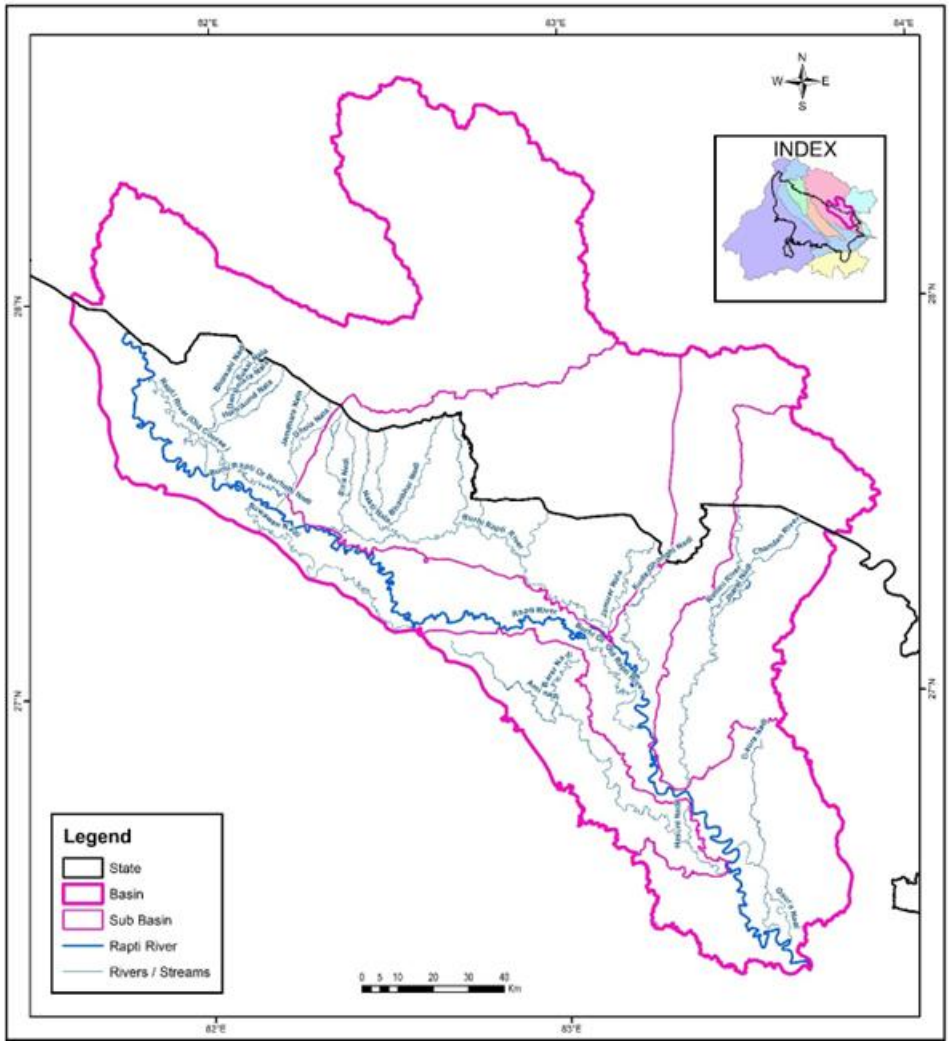

Figure 1: Location map of Rapti Basin
Source: SWRA Uttar Pradesh 2020

Table 1: List of the major tributaries of the Rapti River within the Indian system.

S. No.	Name	Approx. Length (in km)
1	Rapti river	560
2	Kondara	46
3	Payas	11
4	Ghonghi	44
5	Ami river	245
6	Garra	44
7	Bathwanala	26
8	Pharend Nala	39
9	Rohin	129
10	Mahwa Nala	39
11	Chandan	47
12	Bahela river	29
13	Teler Nala	17
14	Jamuaar Nala	53
15	Banganga	23
16	Ph_Ghonghi	41
17	Burhi Rapti	181

Source: SWRA Uttar Pradesh 2020

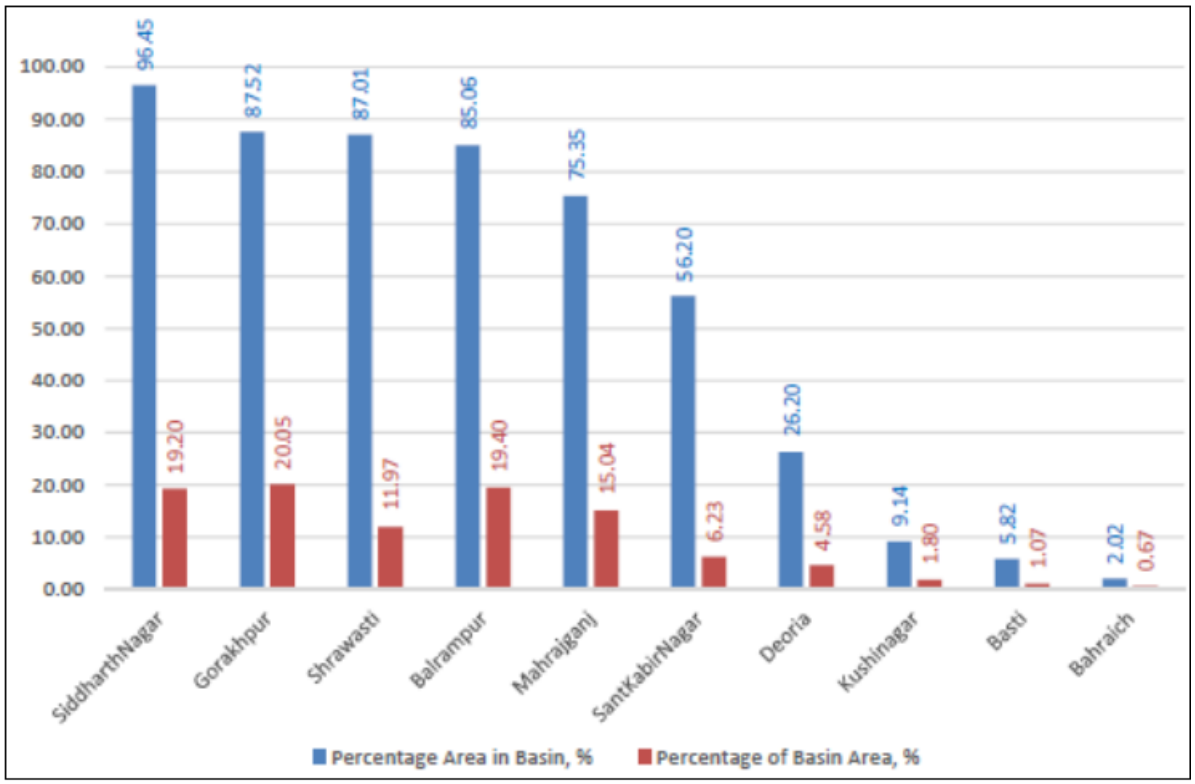

Figure 2: Districts Falling in Rapti Basin
Source: Census of India, 2011 and Basin/Sub Basin Delineated using 90m SRTM DEM

Population:
According to the 2011 census, the overall number of people living in the Rapti Basin stands at 1, 39, 15, 226, with 15, 73, 599 (11.3%) residing in urban areas and 1, 23, 41, 627 (88.7%) in rural regions. Among these, 71, 39, 631 (51.3%) are males and 67, 75, 595 (48.7%) are females. The distribution of the population across the sub - basin level, along with additional information, is presented in **Table 2**.

Table 2: Population distribution in Rapti Basin (Census 2011)

	Sub Basin	Urban	Rural	Total	Male	Female	Sex Ratio	Population Density, Person/sq. km	Literacy Rate, %
1	Ami	73298	1846309	**1919607**	971980	947627	975	1106	67.0
2	Burhi Rapti	121140	1865353	**1986493**	1022400	964093	943	684	54.1
3	Rapti	1283803	6694242	**7978045**	4096957	3881088	947	1013	63.7
4	Rohin	95358	1935723	**2031081**	1048294	982787	938	949	63.4
Basin Total		**1573599**	**12341627**	**13915226**	**7139631**	**6775595**	**949**	**948**	**62.7**

Source: Census of India, 2011

Land Holdings:
A significant portion of the land owned by workers is classified as marginal, with agricultural plots covering less than 1 hectare. The share of marginal plots accounts for 84.58% of all agricultural plots, surpassing both the state's average of 77% for marginal plots and the national average of 63%. On the other hand, plots of 1 to 2 hectares, which make up 10.98% of the total agricultural area, are less common than both the state's average of 14.44% and the national average of 18.88%. This suggests a prevalence of smaller farm lands in the region, which contributes to a lower level of mechanization in agriculture, less diversification and intensification of crops, and slower economic development. Such conditions could also lead to additional negative outcomes, including reduced farmer incomes, subsistence farming, degradation of soil health due to continuous cycles of rice and wheat, and more. The details of land ownership by sub - basin are presented in **Table 3**.

Table 3: Land Holdings in Rapti Basin

	Below 1.0 ha		1.0 - 2.0 ha		2.0 - 4.0 ha		4.0 - 10.0 ha		10.0 ha & Above		All Classes	
	Number	Area	Number	Area	Number	Area	Number	Area	Number	Area	Number	Area
Ami	206010	74987	24488	33742	7860	20999	1475	8015	63	869	239896	138612
	85.87%	54.10%	10.21%	24.34%	3.28%	15.15%	0.61%	5.78%	0.03%	0.63%		
Burhi Rapti	266092	104996	42347	58393	14229	37498	3005	15992	109	1555	325782	218435
	81.68%	48.07%	13.00%	26.73%	4.37%	17.17%	0.92%	7.32%	0.03%	0.71%		
Rapti	813096	300203	107089	147904	36239	95642	6793	36063	250	3662	963467	583474
	84.39%	51.45%	11.11%	25.35%	3.76%	16.39%	0.71%	6.18%	0.03%	0.63%		

Rohin	251198	86179	25504	33758	8772	23181	1773	9324	75	1174	287322	153616
	87.43%	56.10%	8.88%	21.98%	3.05%	15.09%	0.62%	6.07%	0.03%	0.76%		
Rapti Basin	**1536395**	**566365**	**199428**	**273798**	**67101**	**177320**	**13046**	**69395**	**497**	**7260**	**1816467**	**1094136**
	84.58%	**51.76%**	**10.98%**	**25.02%**	**3.69%**	**16.21%**	**0.72%**	**6.34%**	**0.03%**	**0.66%**		

Source: Agriculture Census, 2010 - 11

Food and Agriculture:

According to the 2011 Census, in the Rapti Basin, 44.28% of the workforces are employed in agricultural labor, and 28.03% are farmers, indicating that 72.31% of the labor force in the Rapti Basin is engaged in farming. The information on workers by sub - basin is presented in **Table 4.**

Table 4: Workers Population in Rapti Basin

	Agricultural Labourers	Agricultural Labourers in % of Total Workers	Cultivators	Cultivators in % of Total Workers	Total Workers
Ami	253656	41.8	179281	29.5	607511
Burhi Rapti	332196	46.5	236552	33.1	714812
Rapti	971669	37.7	701953	27.2	2580132
Rohin	379381	51.1	165497	22.3	742117
Rapti Total	**1936902**	**44.28**	**1283283**	**28.03**	**4644572**

Source: Census of India, 2011

Land Use Pattern/ Culturable Area Available:

The present arrangement of how land is used in the Rapti Basin and its smaller areas is depicted in **Table 5** and **Figure** 3. This table indicates that within the Rapti Basin, the area dedicated to net sowing amounts to 10.64 lakh hectares, which represents 71.10% of the entire area. The total area that is suitable for cultivation (including Barren Cultivable Waste, Land Currently Not Cultivated, Other Not Cultivated Land, and the Area Dedicated to Sowing) stands at 11.37 lakh hectares, or 75.94%.

Table 5: Land Use Pattern in Rapti Basin (2014 - 2015)

Sub Basin Name	Land Use	Forest	Barren Cultivable Waste	Present Fallow Land	Other Fallow Land	Barren Uncultivable Land	Land put to Non - agriculture Use	Pastures	Area under Misc. Tree & Grove	Net Area Sown
Ami	Area, ha	3317	2429	9894	4045	2134	28980	261	1724	149541
	% of Total Area	1.64%	1.20%	4.89%	2.00%	1.05%	14.32%	0.13%	0.85%	73.91%
Burhi Rapti	Area, ha	35101	1888	6809	2045	2597	37842	466	3814	194900
	% of Total Area	12.30%	0.66%	2.39%	0.72%	0.91%	13.26%	0.16%	1.34%	68.28%
Rapti	Area, ha	76331	5530	22139	8137	6201	96516	678	6969	577820
	% of Total Area	9.54%	0.69%	2.77%	1.02%	0.77%	12.06%	0.08%	0.87%	72.20%
Rohin	Area, ha	30054	1696	5825	2024	1290	25164	159	613	142206
	% of Total Area	14.38%	0.81%	2.79%	0.97%	0.62%	12.04%	0.08%	0.29%	68.03%
Rapti Basin	Area, ha	**144803**	**11543**	**44667**	**16251**	**12222**	**188502**	**1564**	**13120**	**1064467**
	% of Total Area	**9.67%**	**0.77%**	**2.98%**	**1.09%**	**0.82%**	**12.59%**	**0.10%**	**0.88%**	**71.10%**

Source: UP Agriculture Department, 2014 - 15

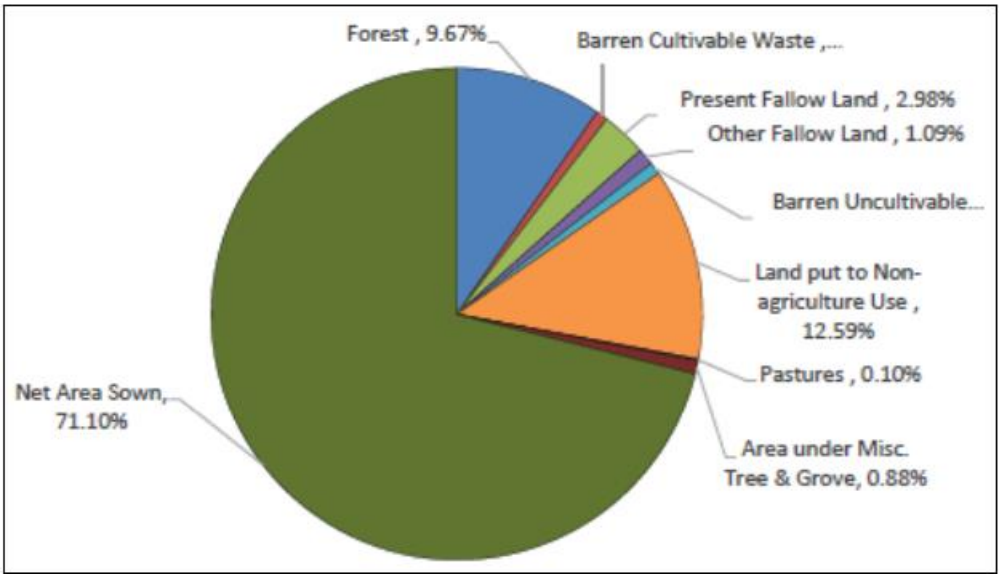

Figure 3: Land Use Pattern in Rapti Basin (2014 - 2015)

Cropping Pattern:

The cropping pattern describes how much land is used for different crops at various times. It shows the sequence and distribution of crops across a specific region. Any alteration in the cropping pattern leads to a shift in the amount of land dedicated to various crops. Data on farming methods and crop distribution is available for every district, at the block level, spanning from 1993 - 94 to 2015 - 16. This data has been examined to understand the overall cropping pattern and its various trends. Among the total crops, 11 major crops from different seasons were chosen based on the current cropping pattern, their suitability for cultivation, and their importance. The remaining 29 crops were grouped together to represent a category of other crops grown in both the kharif and rabi seasons. The selected crops include: Wheat, Rice for the kharif season, Sugarcane, Maize for the kharif season, Arhar, Jwar, Bajra, Gram, Barley, Potato, Pea, and Other Kharif Crops and Other Rabi Crops. Wheat and Rice together account for approximately 42.76% and 43.40% of the total cultivated area in the Rapti Basin. The continuous cultivation of sugarcane takes up about 4% of the entire area, while other crops grown in the kharif season make up 0.6% of the cultivated area, and other crops grown in the rabi season cover 5.9% of the cultivated area, as illustrated in **Table 6** and **Figure 4**.

Table 6: Cropping Pattern in Rapti Basin (2014 - 2015)

Crop in Ami Sub Basin	Area, ha	% of Gross Area Sown	% of Net Area Sown	Crop in Burhi Rapti Sub Basin	Area, ha	% of Gross Area Sown	% of Net Area Sown
Wheat	104706	47.69	70.02	Rice	138859	44.99	71.25
Rice	96678	44.03	64.65	Wheat	112455	36.43	57.70
Sugarcane	4353	1.98	2.91	Sugarcane	18292	5.93	9.39
Pea	2208	1.01	1.48	Masur / Lentil	14163	4.59	7.27
Other Vegetables	2131	0.97	1.43	Lahi / Sarson / Mustard	10444	3.38	5.36
Arhar / Pigeon Pea	2097	0.95	1.40	Arhar / Pigeon Pea	5529	1.79	2.84
Lahi / Sarson / Mustard	2064	0.94	1.38	Maize	1792	0.58	0.92
Potato	1707	0.78	1.14	Other Vegetables	1651	0.53	0.85
Maize	945	0.43	0.63	Pea	1474	0.48	0.76
Total Fodder	886	0.40	0.59	Potato	1184	0.38	0.61
Masur / Lentil	727	0.33	0.49	Alsi	971	0.31	0.50
Gram	424	0.19	0.28	Total Fodder	753	0.24	0.39
Barley	268	0.12	0.18	Urad	639	0.21	0.33
Alsi	127	0.06	0.08	Gram	286	0.09	0.15
Onion	105	0.05	0.07	Onion	131	0.04	0.07
Til	53	0.02	0.04	Groundnut	31	0.01	0.02
Groundnut	30	0.01	0.02	Barley	5	0.00	0.00
Urad	29	0.01	0.02				
Koda	16	0.01	0.01				
Moong	4	0.00	0.00				
Bajra / Millet	2	0.00	0.00				
Turmeric	1	0.00	0.00				
Sunflower	1	0.00	0.00				
Crop in Rapti Sub Basin	Area, ha	% of Gross Area Sown	% of Net Area Sown	Crop in Rohin Sub Basin	Area, ha	% of Gross Area Sown	% of Net Area Sown
Wheat	376297	43.24	65.12	Rice	116396	46.38	81.85
Rice	363862	41.81	62.97	Wheat	111829	44.56	78.64
Sugarcane	37384	4.30	6.47	Sugarcane	5986	2.38	4.21
Masur / Lentil	28116	3.23	4.87	Masur / Lentil	5640	2.25	3.97
Maize	13965	1.60	2.42	Other Vegetables	3194	1.27	2.25
Lahi / Sarson / Mustard	13260	1.52	2.29	Lahi / Sarson / Mustard	1975	0.79	1.39
Other Vegetables	8779	1.01	1.52	Potato	1947	0.78	1.37
Arhar / Pigeon Pea	8371	0.96	1.45	Groundnut	1756	0.70	1.23
Potato	4815	0.55	0.83	Pea	534	0.21	0.38
Pea	4195	0.48	0.73	Maize	407	0.16	0.29
Groundnut	3521	0.40	0.61	Total Fodder	368	0.15	0.26
Total Fodder	2942	0.34	0.51	Arhar / Pigeon Pea	306	0.12	0.22
Urad	1343	0.15	0.23	Onion	139	0.06	0.10
Barley	1065	0.12	0.18	Til	119	0.05	0.08
Gram	717	0.08	0.12	Alsi	95	0.04	0.07
Onion	451	0.05	0.08	Barley	94	0.04	0.07
Til	377	0.04	0.07	Sunflower	92	0.04	0.06
Alsi	347	0.04	0.06	Gram	38	0.02	0.03
Sunflower	216	0.02	0.04	Moong	22	0.01	0.02
Bajra / Millet	64	0.01	0.01	Turmeric	21	0.01	0.01
Moong	47	0.01	0.01	Urad	19	0.01	0.01
Jwar / Sorghum	40	0.00	0.01	Bajra / Millet	9	0.00	0.01
Turmeric	28	0.00	0.00	Sanva	3	0.00	0.00
Koda	13	0.00	0.00	Jwar / Sorghum	1	0.00	0.00
Sanva	7	0.00	0.00				

Source: UP Agriculture Department, 2014 - 15

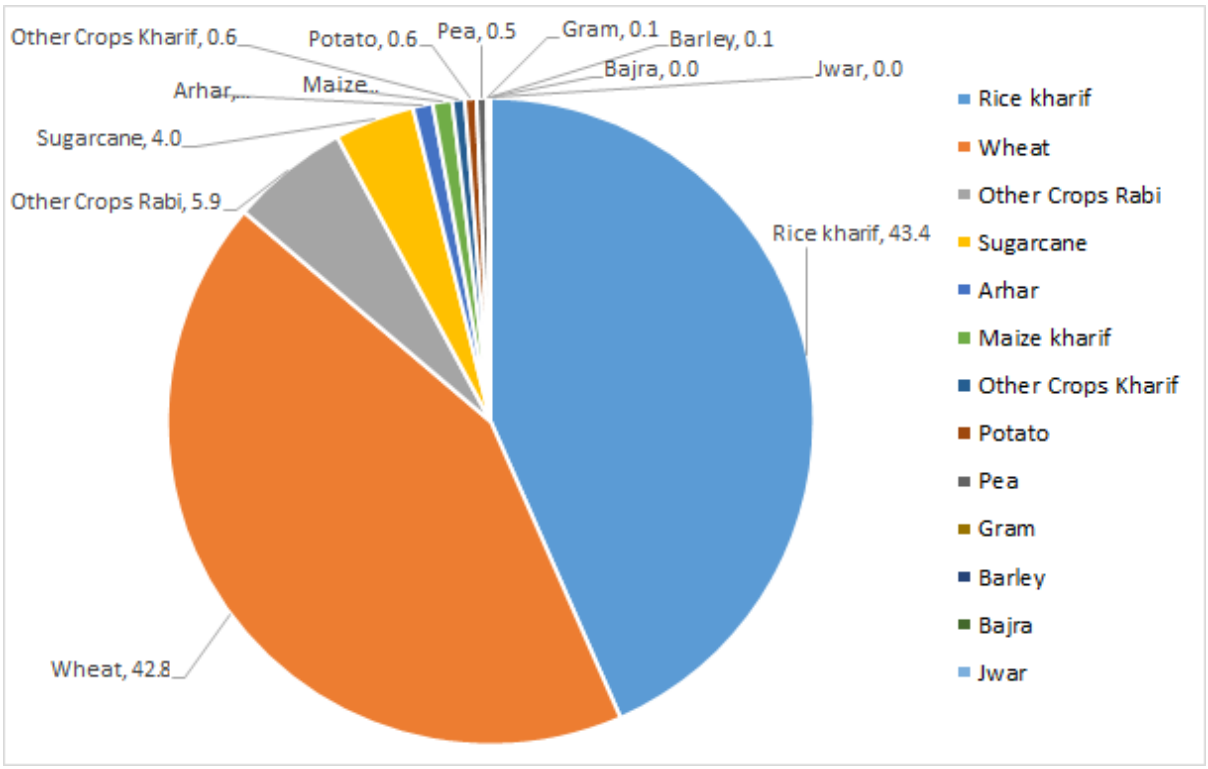

Figure 4: Crop Distribution as Percentage of Total Cultivated Area, 2014 – 15

2. Conclusion

The Rapti Basin primarily focuses on growing Rice - Wheat, but it also cultivates a variety of other crops like oilseeds, pulses, vegetables, and trees, which are crucial for providing nutrition to the population and generating income. Sugarcane is the next significant crop in the basin. In most regions, it's grown locally for personal consumption, while a large portion in the north is used for commercial purposes. According to the Agriculture Census 2010 - 11, 84.58% of agricultural fields in the basin are marginal, surpassing the state average of 77% and the national average of 63%. A significant portion of the land, 75.17%, is dedicated to cultivation, with Rice and Wheat accounting for about 42.76% and 43.40% of the cultivated area, respectively. Sugarcane is grown on a smaller scale, covering 4.0% of the land. The layout of crops in the basin has remained relatively unchanged over the past few years. The staple crops that continue to be grown are rice and wheat. Given that the Rapti Basin is susceptible to flooding, it is recommended that steps be taken to encourage the use of varieties of rice and other crops that are resistant to flooding and water logging. Crops that are less resistant could be planted during the non - flood seasons. The forested area could be expanded by converting a portion of the land previously used for fallow and another portion of land used for agricultural waste into forestland. This could be achieved by establishing Joint Forest Management Committees, which would include farmers from the lower - income peasantry class and representatives from the forest department and land use committee. A support cell should be established to provide financial and infrastructure support, enabling them to acquire suitable plant varieties, protection methods, and to market forest products. Additionally, the development of these forests should be integrated with the management of watersheds in the region. To achieve this, a unit of between 500 to 1000 hectares should be selected for the management of micro - watersheds. With the forested area shrinking, there is a need to severely limit the increase in land allocated for non - agricultural purposes. If not, it will be challenging to convert the available land for non - agricultural use into forest plantations. Barren and unproductive land could be utilized for the expansion of residential areas, playgrounds, and the construction of communal facilities such as schools or panchayat bhawans. If agricultural cultivation is not feasible, the land could be used for social forestry or developed into pasture and grazing areas.

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