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Indian Geography, Polity and Economy



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1 CHAPTER

Geographical Knowledge in Ancient India

Development of Geographical Ideas in Ancient India

The oldest knowledge of the world is found in Indian texts. From the Ramayana and Mahabharata periods to the twelfth century, many Indian scholars have described different geographical aspects in their respective texts. In ancient times, there was no separate subject called geography, but the study related to the surface and celestial bodies was prevalent as a field science.

That is why geography and astronomy (astrology) were considered related to each other. Mathematical geography and astronomical geography were the major aspects of ancient geography. Along with this, regional descriptions of physical and human facts were also included in them.

1. Solar System Knowledge:-

- In many mantras of Rigveda, Yajurveda and Atharva Veda, there are episodes of the relationship between the sun, moon and earth, changes of seasons, day-night, ushah, midday afternoon, etc.
- The descriptions of the earth, space and the Vedas and cosmic texts of twenty-seven constellations like Mrigshira, Krittika, Chitra, Revati etc. can be read.
- Equinox Day is mentioned in many places in the Vedas.
- Vedic astrology was presented on the basis of calculations of solar year, solar month, etc., movements of twenty-seven constellations and calculations of sun constellations.
- From the fifth to the seventh century AD, Indian scholars like Aryabhatta, Varahamihira, Brahmagupta, etc. made a lot of progress in astronomical geography. Among the principles propounded by him, 'Surya Siddhanta' is prominent.
 - A total of 14 chapters and 500 verses have been written in Sanskrit language in Surya Siddhanta.
 - In all the chapters, an attempt has been made to explain astronomy.
 - In this book, the entire solar system, planets, earth, zodiac signs, mathematics etc. have been told.
 - In the Surya Siddhanta, the origin and cataclysm of the universe, the motion and direction of the planets, time, distance and diameter, the occurrence and estimation of eclipses, zodiac signs and their effects, the Surya Siddhanta Panchang, trigonometry, gravitational force, the lines and poles of the

earth etc. are detailed.

- The origin of the earth is also highlighted in ancient Indian texts. According to the mantras of the Rig Veda, the Aryans imagined the molten form of the earth.
- There are episodes of earthquakes and volcanoes in Ramayana-Mahabharata. The Mahabharata discusses the rise of the volcanic mountain- "The earth rose with its seven continents, along which mountains, rivers, forests, etc. also rose high. "
- In the Puranas, the origin of continents and mountains is imagined- 'The earth floats in the ocean like a great boat. Brahma leveled the earth and divided it into seven islands. This suggests an ideology equivalent to the current concept of the Continental Drift (continents made of Sial float on Sima).
- The age of the earth has also been imagined in ancient Indian texts.
 - 'Manusmriti' mentions that the earth has so far completed 1,96,91,03,000 years. Contemporary scholars also estimate the age of the earth to be about two billion.
- Solar eclipse and lunar eclipse are also discussed in Ramayana. The reasons for this are Rahu-Ketu.
- Other planets of the solar system – Mars, Mercury, Jupiter, Venus, Saturn, etc. are also discussed at many places.

2. Atmospheric Knowledge:-

- According to the Rigveda, the Aryans had good knowledge about the atmosphere.
 - There is a mention of only five seasons in Rigveda, but in other Vedas, Upanishads, Ramayana, Mahabharata, Puranas and other ancient texts, the description of 6 seasons is found. These 6 seasons are summer, rain, hemant, autumn, shishir, and spring.
 - These texts describe in detail the atmospheric conditions of each season and their effects on vegetation, agriculture and human life.
- The Puranas, especially the Vayu Purana, Shiva Purana, Skanda Purana and Bhagavata Purana, describe in detail the amount of sunshine and rainfall, types of clouds, summer dryness, rainy rains and storms, winter snowfall and frostfall, and pleasant seasons of autumn and spring. Spring season has been called 'Rituraj'.
- Clouds are described in Valmiki's Ramayana. It discusses three types of clouds and seven types of wind.
- Mahakavi Kalidas, in his famous work 'Meghdoot', has described the causes of the arrival of the rainy

season, ten types of clouds and their characteristics, the amount of rainfall, etc.

○ He has also described the beautiful seasons at many places in a book called 'Raghuvansh'.

- In the twelfth century, Bhaskaracharya gave mathematical measurements of the layers of the atmosphere in his astrological book 'Siddhanta Shiromani'.
- Kautilya's Arthashastra explains the distribution of rainfall in different regions which is compatible with today's distribution.
 - Establishing the relationship between agriculture and rainfall, Kautilya has written that there are some clouds which rain for seven days respectively, 80 which receive less rainfall, 60 which make the fields ploughable. Kautilya also designed a rain gauge.
- Bhuvankosa explains, among other things, climatology and meteorology, and the Buddhists present a very good knowledge of ancient geography.

3. Hydrological knowledge:-

- The oceans are described in the Vedic mantras. In Samaveda and Atharvaveda, the number of oceans is stated to be 4, but in other Vedas their number is stated to be 7.
- In the Samaveda, there is a description of the rise of water in the oceans, from which the tides can be imagined.
- In Ramayana, tides are mentioned in many places, the reason for this is said to be the moon.
- In Kautilya's Arthashastra, there is a discussion of

coral, pearls found from the ocean floor and their deposits are also described.

4. Lithospheric Knowledge:-

- Indian scholars of ancient times had accurate knowledge of topography, morphology, flora, fauna, natural resources, agriculture and other socio-economic activities of India and surrounding countries.
- Ramayana lists 'mountains, rivers', plateaus and important places.
- The epic of Mahabharata can serve as an encyclopedia of geographical knowledge.

(i) Physical geography-

○ Continent-

- The Puranas describe the Saptadwip (seven plots). Each island or land segment represents the vast mass of a continent or a continent. These seven plots (islands) are spread around Mount Meru like the petals of the lotus flower. These seven islands are-
 - ✓ Jambudwip,
 - ✓ Plaksh Island,
 - ✓ Shalmali Island,
 - ✓ Kush Island,
 - ✓ Crounch Island,
 - ✓ Saka Island
 - ✓ Pushkar Island
- These islands are named after their respective principal trees (Jambu, Plaksh and Shalmali), grass (Kush) and mountains (Kraunch and Pushkar).



Mythological Seven Islands

- Jambu Island mentioned in the Puranas has been described as the most prominent and largest island which encompasses the Eurasian landmass.

- There are 9 subdivisions (years) of Jambu Dweep- Ilavarta Varsha, Ketumal Varsha, Bhadrashva Varsha, Bharatvarsha, Kimpurusha Varsha, Hari Varsha, Ramyaka

Varsha, Hiranyamaya Varsha and Uttara Kuru Year.

✓ These years are separated from each other by mountain ranges.

■ In the middle of the Jambu Dweep, the best of the mountains is Meru (Sumer), which is currently known as Pamir. Large mountain ranges stretch from here towards different directions.

✓ The higher region adjacent to Meru is called Elavrta Varsha and the land lying west of Meru is called Ketumal Varsha.

✓ To the south of Meru are Bharatvarsha, to the east are Kimpurusha Varsha (Tibet) and Bhadrashva Varsha (Mongolia and China), to the north are Ramyak Varsha (Central Asia), Hiranmaya Varsha (Northern Sinkiang) and North Kuru (Siberia).

○ **Mountain-**

■ According to the Puranas, all the mountain ranges of the world go around the Pamir (Meru). Mountains are divided into five types:

✓ Central Mountain (Meru)
✓ Vishakambha Mountains (which extend around Meru)

✓ Varsha Mountains (main mountain ranges of different countries)

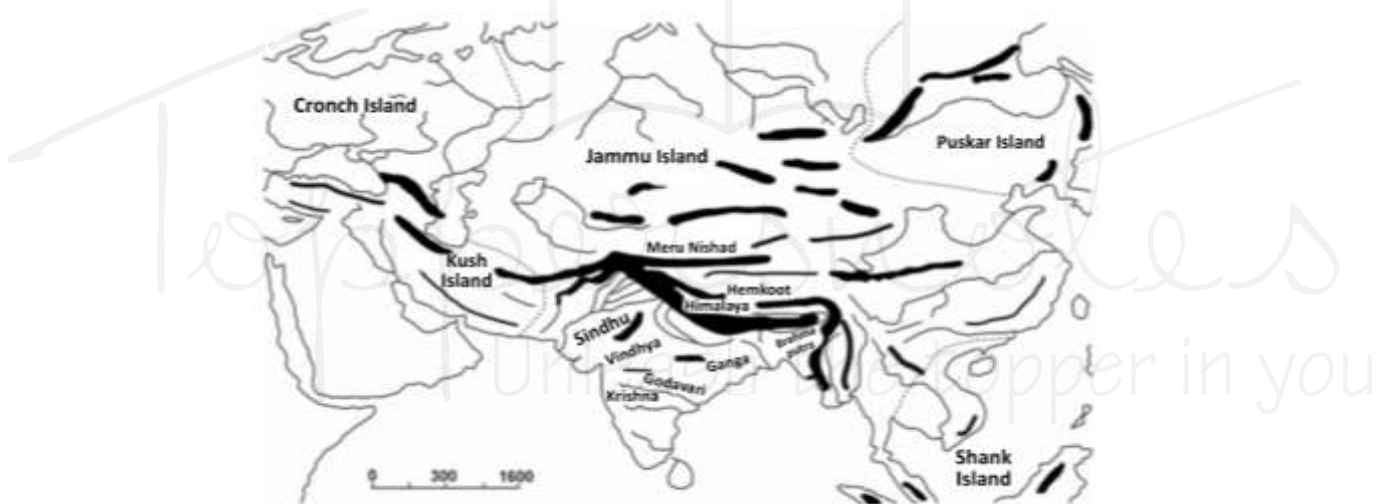
✓ Maryada Parvat (mountain on the border)

✓ Kesarachal Mountains (Intercontinental)

■ The mountains of India are described in detail in the Puranas. Among them, Mahendra (Eastern Ghats), Malay (southern part of Western Ghats), Sahya (northern part of Western Ghats), Riksha (Middle Vindhya), etc. are prominent.

■ The Varsha described in the Rigveda extended from present-day Afghanistan in the west to Ganga-Yamuna in the east and from Meru (Pamir) in the north to Kutch in the south.

✓ It mentions the Sharanyawat (Kashmir), Susoma (west of the Jhelum River), Yujwat (Gandhara) and the Sulaiman and Saline ranges (Afghanistan).



Mountains and Rivers of the Legendary Jambu Island

■ The details of the major mountains mentioned in the Puranas are as follows:

✓ **Mount Meru** – It is said in the Vishnu Purana that Jambudwip is located in the center of all the islands and in the middle of it is located the golden mountain of Meru whose shape is like a lotus.

✓ **Himwan** – This is the ancient name of the Himalayas.

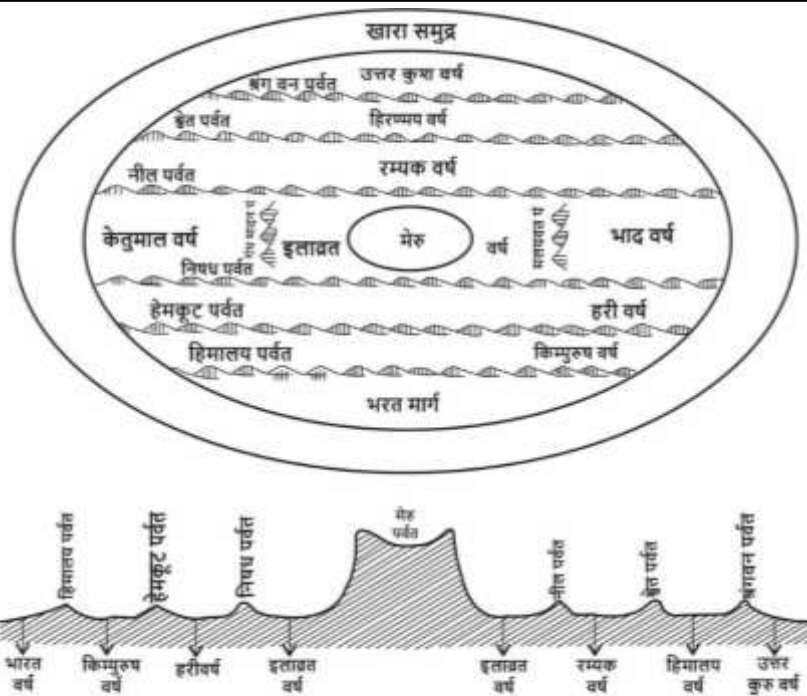
✓ **Malyavan** – Located in the west of Mount Meru, this mountain is called Malyavan in Vishnu Purana and Hans Mountain in Vayu Purana.

✓ **Nishadh** – The mythological name of the Hindu Kush Mountain is Nishadh, which had three major peaks and Brahma, Vishnu and Shiva resided on them.

✓ **Gandhamadana** – This is a range of Mount Meru which has been called 'Merumdar' in the Bhagavata Purana.

✓ **Hemkoot** – The mythological name of the present Kailash Mountain is Hemkoot.

✓ **Neel Parvat** – Located in South India, this mountain is known by the names of Nilgiri, Malayagiri, Malayachal etc.



गौराणिक जम्बूद्वीप का आरेखीय प्रदर्शन (एस. एम. अली के अनुसार)

○ Rivers-

- There are detailed descriptions of rivers in the Vedas.

- ✓ The Vedas and Upanishads describe the rivers of Afghanistan, Punjab and the Ganga-Yamuna region.
- ✓ The 75th Sukta of the 10th Mandala of the Rigveda is called 'Nadi Sukta', in which rivers are described in all the mantras.

☞ The fifth mantra of the Rigveda's Nadi Sukta means- "Ganga, Yamuna, Saraswati, Shutudri (Sutlej), Parusni (Ravi), Ashkin (Chenab), Maruddha, Vitasta (Jhelum), Armikia (Vyas) etc. rivers are associated with Uttam Soma." "

- ✓ In the Vedas, the region inhabited by the Aryans has been called **Sapta Saindhava** (country of seven rivers).

☞ It includes the Indus and its tributaries: the Sutlej, the Beas, the Ravi, the Chenab, the Jhelum, the Drishadvati (Ghaghghar) and the Saraswati.

- The last two rivers dried up and became invisible in later ages.

- ✓ In the Upanishads and Puranas, the characteristics of rivers like Indus, Sutlej, Rabi, Chenab, Beas, Jhelum,

Ganga, Yamuna, Saryu, Gandak, Kosi, Lohit (Brahmaputra), Son, Chambal etc. of northern India and Mahanadi, Narmada, Tapti, Godavari, Krishna, Tungabhadra, Kaveri etc. of southern India and their catchment areas have been described.

- According to the Puranas, rivers flow in the directions of Meru (Pamir).

- ✓ River Ganga towards the south
- ✓ Eye River on the west side
- ✓ Sita River on the east
- ✓ Bhadrason River on the north

- There is a detailed description of Indian rivers in the Markandeya Purana.

- ✓ There is a detailed description of the origin of Ganga.
- ✓ Among other rivers, Yamuna, Godavari, Narmada, Indus, Kaveri, Krishna and Tamraparni have special descriptions.

○ Vegetation-

- Different types of vegetation are described in the Markandeya Purana. There is also a description of the crops of the time.

- There is a reference to the milk tree (rubber) in Shiva Purana.

(ii) Knowledge of Human Geography-

- The Rigveda describes the residence of five types of people on earth. These include

Asuras and Das.

- The Vajasneyi Samhita mentions four varnas: Brahmandas, Kshatriyas, Vaishyas and Shudras.
- There are descriptions of many Indian primitive castes in Ramayana. Among them, Rakshasa, Vanara, Nishad, Kinnar, Savar, Gandharva, Naga, Asur, Dev, etc. castes are the main ones. Among the foreign castes, the Sakas and the Yavanas are called the Gaura varna castes. The color of the demons is said to be black and the appearance is terrifying.
- In the Mahabharata too, there are descriptions of many castes, their appearance, marriage, family relations etc.
- In Manu's Dharma Shastra, eight types of marriages have been described: Brahma, Daiva, Arsha, Prajapatya, Asur, Gandarva, Paishacha and Rakshasa. Six of these had social support.
- Kautilya has also discussed the system of marriage and remarriage of women.

(iii) Knowledge of cultural geography.

- **Agriculture-**
 - The Atharvaveda describes what precautions are required in agriculture.
 - The Rigveda commands to plough the field.
 - Patanjali's Mahabhashya describes methods of sowing crops, agricultural areas, storage of seeds and grains.
 - ✓ Panini Pranjali and Manu have also classified the land.
 - ☞ **Wasteland** – land unusable by flood affected land
 - ☞ **Transit** - Land used for pastoralism
 - ☞ **Silya** - Ploughable Land
 - ✓ Patanjali has also described the regional distribution of crops.
 - ✓ The means of irrigation are also highlighted. Wells and ponds were the main means of irrigation.
- **Endeavour-**
 - Various industries in ancient India were also in a fairly developed stage.
 - ✓ Industries related to barn, cloth making, coins, jewellery etc. are described in the Vedas.
 - ✓ Building construction, wood craft, clay craft, iron craft were also at the peak of their progress at this time.
 - ☞ The rustless iron pillar installed

near Qutub Minar in Delhi, which is said to have been built in the Gupta period, is a testimony to the efficiency of Indian iron craftsmen.

○ **Transport-**

- Transport routes were also in good condition in ancient India.
- The Brahmanda Purana describes ten types of roads:
 - ✓ Directions
 - ✓ Village Route
 - ✓ Border Routes
 - ✓ Raj Path
 - ✓ Shakha Rathya
 - ✓ Rathoparthy
 - ✓ Uparathy
 - ✓ Janghath
 - ✓ Grihantpath
 - ✓ Dhriti Marg

○ **Trade-**

- Foreign trade is also an Indian specialty since ancient times.
- Kamboja horses are mentioned in Vishnu Purana and Kambals of Nepal are mentioned in Matsya Purana.

○ **Dwelling-**

- Domicile knowledge is also derived from ancient Indian literature.
- The excavations at Mohenjodaro and Harappa introduce ancient Indian town planning and building construction.
- Human settlements are classified in 'Mayamatam'.

(iv) Knowledge about political and regional geography-

- There are descriptions of Indian district territories in Vedic literature. Among them were Kashi, Kosala, Magadha, Panchal, Vidarbha, Saurashtra and Andhra were prominent.

Geographers of Ancient India

Kautilya

- Kautilya, also known as Chanakya, was the guru and prime minister of Chandragupta Maurya (reigned 322-298 BCE), the founder of the Maurya Empire in the 4th century BCE.
- Kautilya wrote a famous treatise called 'Arthashastra' in which the geographical discussion of the trade and political relations of northern and southern India has been given.
- This book describes the agricultural system, industrial progress, trade and trade routes etc. of ancient India.
- Important information related to political geography is obtained in 'Arthashastra'. In this, geographical and

political description of many cities like Pataliputra, Ujjain, Taxila etc. has been given.

Aryabhata

- Aryabhata, the most prominent astronomer of ancient India, was born in Pataliputra in the fourth century.
- Arya Bhatta described the shape of the earth as spherical and calculated the diameter and circumference of the earth.
- He put the circumference of the Earth at about 24,835 miles, which is almost equal to the current estimate (24,901 miles).
- Aryabhata explained the reason for solar eclipse and lunar eclipse to the changing positions between the sun, moon and earth and propounded that a lunar eclipse is visible when the shadow of the earth falls on the moon on the full moon night.
- Aryabhata's major work is 'Arya Bhattiyam'. He was the first to discover that the sun is stationary and the earth rotates on its axis.

Varahamihira

- Varahamihira was a contemporary of Chandragupta Vikramaditya (reigned 375-415 AD) and was the second famous astronomer of the Gupta period
- He wrote a book called 'Panchadantiva' in which five methods of astronomy have been explained. He was familiar with the method of finding the latitude of a point on the earth.
- He made Indians aware of the use and importance of decimal in mathematics. 'Brihajataka', 'Brihatsamhita' and 'Laghujataka' are other major texts of Varahamihira.
- Varahamihira proved that the moon revolves around the earth and the earth revolves around the sun.
- He also used many Greek works to study planetary movements and other astronomical problems.

Brahma Gupta

- The third major astronomer of the Gupta period, Brahmagupta was a contemporary of Varahamihira.
- He wrote books called 'Brahmasiddhanta' and 'Khanda Bhojan' in which facts and principles related to astronomical geography are given.
- Brahma Gupta has also described some instruments rotating with oil, water and mercury.
- Brahma Gupta had described the diameter of the earth as 1581 yojanas (7905 miles), which is almost the

same as the actual diameter of the earth (7925 miles).

Kalidasa

- The great poet of Sanskrit literature, Kalidasa is considered a contemporary of Chandragupta Vikramaditya.
- There was a congregation of nine scholars in the court of Chandragupta Vikramaditya, which has been called 'Navratna'. Kalidasa was the foremost among those Navrats.
- Kalidasa has composed 7 texts which are as follows - Raghuvamsa, Kumarasambhava, Meghadoot, Ritusanhara, Malavikagnimitram Vikramorvasiyam and Abhijnana Shakuntalam In which along with nature depictions, the details of places and routes are found.
- The season is described in the massacre. The geographical description of the cloud path is found in Meghdoot.

Dhanvantari

- Dhanvantari was a prominent Ayurvedacharya and a renowned scholar of medical science.
- He was one of the nine jewels of Chandragupta Vikramaditya's Rajya Sabha.
- He has described the characteristics of different types of flora and their usefulness for the purpose of medicine.

Bhaskaracharya

- In the twelfth century there was a great mathematician and astronomer known as Bhaskaracharya
- He wrote two famous texts named 'Siddhanta Shiromani' and 'Karankutuhah'.
- 'Siddhanta Shiromani' gives information related to arithmetic, algebra, geometry and astrology.
- Some of the major explorations are described in 'Karankutuhah'.
- Bhaskaracharya had told that the earth is round and there is gravitational force in it, due to which it attracts objects towards it.
- He divided the earth into 360° and used them to determine the location of cities by latitude and longitude.
- Bhaskaracharya had done all the calculations considering the earth as round.

2 CHAPTER

Shree Anna (Millets)

- Shree Anna (Millets) is a nutritionally rich, drought tolerant crop grown mostly in the arid and semi-arid regions of India.
- It is a type of grass with small seeds.
- It is an important source of food and animal fodder for farmers and plays an important role in the ecology and economic security of India.
- Shree Anna (Millets) is also known as "coarse grain" or "poor man's grain".
- Major types of grains include jowar, bajra, and ragi/mandua, and minor types include kangani/kakun, china, kodo, sava/sawa/jhangora, kutki, and two pseudo-grains – kuttu and amaranth.
- India is one of the top 5 exporters of grains (millets) in the world.

Area, Production and Yield Trends

- Despite the immense benefits of Sri Anna, there has been a slow but steady shift in the dietary preferences of Indians towards rice and wheat over the last six decades
- Grains were marginalized after the Green Revolution, leading to emphasis on large-scale cultivation of rice and wheat using high-yielding seed varieties.
- As a result, the share of grain in Indian food products has declined from 20% in 1965-1970 to 6% only, with the area under grain cultivation declining by 33.9% between agricultural year 1951 and 2022.

Figure: State-wise area under grain cultivation in the agricultural year 2022 (thousand hectares)

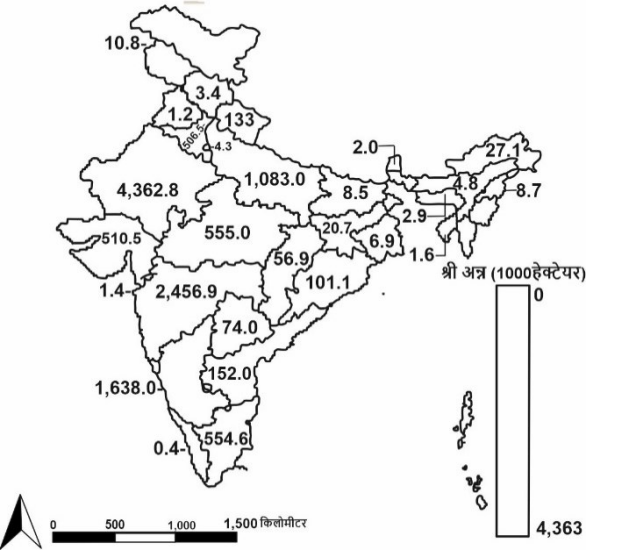
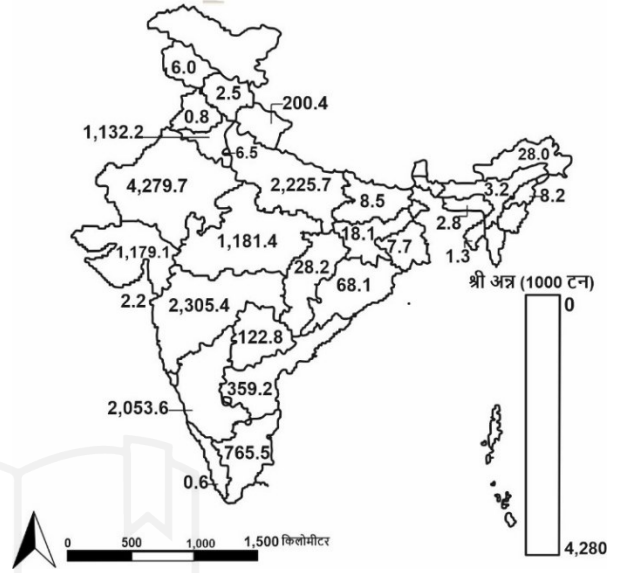


Figure: State-wise grain production (thousand tonnes) in the agricultural year 2022.



Area & Production

- India is the largest producer of grains in the world with 44% share, followed by China (~9%) and Niger (~7%)
- Grains in India are predominantly kharif crops, grown mostly under rain-fed conditions, and have lower demands on water and agricultural inputs than other major crops.
- Although the area under grain production declined by one-third between agricultural year 1951 and 2022, production has increased slightly (CAGR 1.7%) as a result of improvement in yield due to the adoption of better agricultural practices [at Compound Annual Growth Rate (CAGR) 0.2%].

Figure: Highest and lowest producing states in terms of grain yield in agricultural year 2022 (kg per hectare)

	Shree Anna	Jowar	Bajra
Highest	Andhra Pradesh: 2,363	Andhra Pradesh: 3,166	Madhya Pradesh: 2,533
Second Highest	Gujarat: 2,310	Madhya Pradesh: 1,941	Gujarat: 2,368
Lowest	Chhattisgarh: 495	Haryana: 527	Maharashtra: 903

Figure: State-wise yield difference in grain production (%)

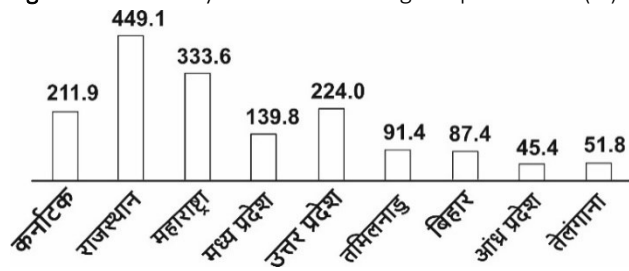
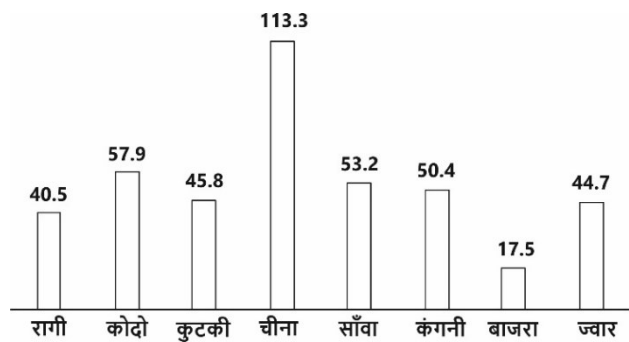


Figure: Yield difference (%) in the production of grain according to the type of grain.



What are millets and how are they beneficial?

- Millets are part of a group of small-grained cereal crops used as both food and fodder.
- Experts believe them to be one of the oldest foods known to humans and the first among cereals to be cultivated for domestic purposes. There is even evidence of the consumption of millet in the Indus Valley civilisation.
- Millets were earlier referred to as “coarse cereals” or “cereals of the poor”.
- The Union government renamed these as “nutri-cereals” owing to their high nutritional value.
- Millets offer more than one nutrient to the diet and are considered more nutritious than rice and wheat.
- Millets are rich in iron, dietary fibre, calcium, magnesium, potassium, zinc and vitamins such as thiamine, riboflavin, folic acid, and niacin.
- These grains contain 7-12% protein, 2-5% fat, 65-75% carbohydrates and 15-20% dietary fibre.
- Millets are also gluten-free.
- Growing millets is also beneficial for farmers since this rain-fed crop requires less fertile land and water, growing fairly well on dry land.
- They have a short growing season as compared to other major crops and can be grown in intercropping or under mixed cropping with pulses and oil seeds.
- With a low carbon and water footprint, millet crops can be cultivated without extensive use of fertilisers and pesticides and can survive extreme weather.
- Presently, millets are grown in more than 130 countries and consumed as a traditional food by over half a billion people across Asia and Africa.

Major millets in India

Jowar

- It is also known as sorghum, serves as the primary food crop cultivated in semi-arid regions of central and southern India.
- It exhibits low dependence on irrigation, particularly in rainfed conditions south of the Vindhyas, leading to lower yields in this area. Southern states sow Jowar during both Kharif and Rabi seasons, whereas in northern states, it predominantly serves as a fodder crop during the Kharif season.
- Optimal soils for Jowar cultivation include clayey deep regur and alluvium, and it can thrive on gentle slopes up to an elevation of 1,200 meters. However, it does not fare well in regions with rainfall exceeding 100 cm.

Bajra

- Also called as pearl millet, ranks as the second most crucial millet, fulfilling both food and fodder needs in arid regions of the country.
- This rainfed Kharif crop is resilient in the dry and warm north-western and western parts, demonstrating resistance to frequent dry spells and drought.
- Bajra can be successfully cultivated in poor light sandy soils, black and red soils, requiring an annual rainfall of 40-50 cm, with an upper limit of 100 cm. It is commonly sown either as a pure crop or mixed with cotton, jowar, and ragi.
- It is also known as finger millet, is primarily cultivated in the drier regions of south India, specifically in Karnataka, as a rainfed Kharif crop.
- It thrives in warm climates with 50-100 cm of rainfall. Ragi can be grown in various soils, including red, light black, sandy, and well-drained alluvial loams.
- Karnataka holds the position of the largest producer, with Uttarakhand and Tamil Nadu being other significant contributors to ragi production.

Millet production and food security

- India is the largest producer of millet in the world with a share of 41% in 2020, as per FAO.
- Nine types are grown as kharif crops in over 20 States in the country.
- Major millets include finger millet (ragi or mandua), pearl millet (bajra) and sorghum (jowar) and minor millets include foxtail millet (kangani or kakun), barnyard millet (sawa or sanwa, jhangora), little millet (kutki), kodo millet (kodon), proso millet (cheena) and browntop millet.

- Rajasthan, Karnataka, Maharashtra and Andhra Pradesh are leading producers.
- Though productivity has increased over the years, the area under cultivation of millets declined, especially after the Green Revolution, with a policy thrust on other grains.
- This gradually impacted the expansion of millets production in the country.
- In 2019, India accounted for 80% of the total production of these grains in Asia and 20% globally — around 170 lakh tonnes from 138 lakh hectares of land
 - providing yield per hectare greater than the global average, FAO data shows.
- India is also among the top five exporters— India exported millets worth \$64.28 million in 2021-22 and \$59.75 million in 2020-21, according to the Agricultural and Processed Food Products Export Development Authority.
- Despite offering high benefits to both the consumer and producer, millets are not very popular mainly due to a lack of awareness.
- But at a time when the world is battling a pandemic and climate change, and faces a significant challenge of food security, the nutri-cereal can play a significant role if marketed well, focusing on their high nutritional value, low input and maintenance requirements and climate-resilient nature.
- Problems of unavailability of good quality seeds, restricted cultivation, the low shelf life of grains, lack of research, absence of machinery for processing and market gaps also need to be addressed to tap into their true potential to increase farmers' income, generate livelihoods and ensure food and nutritional security.

The global push

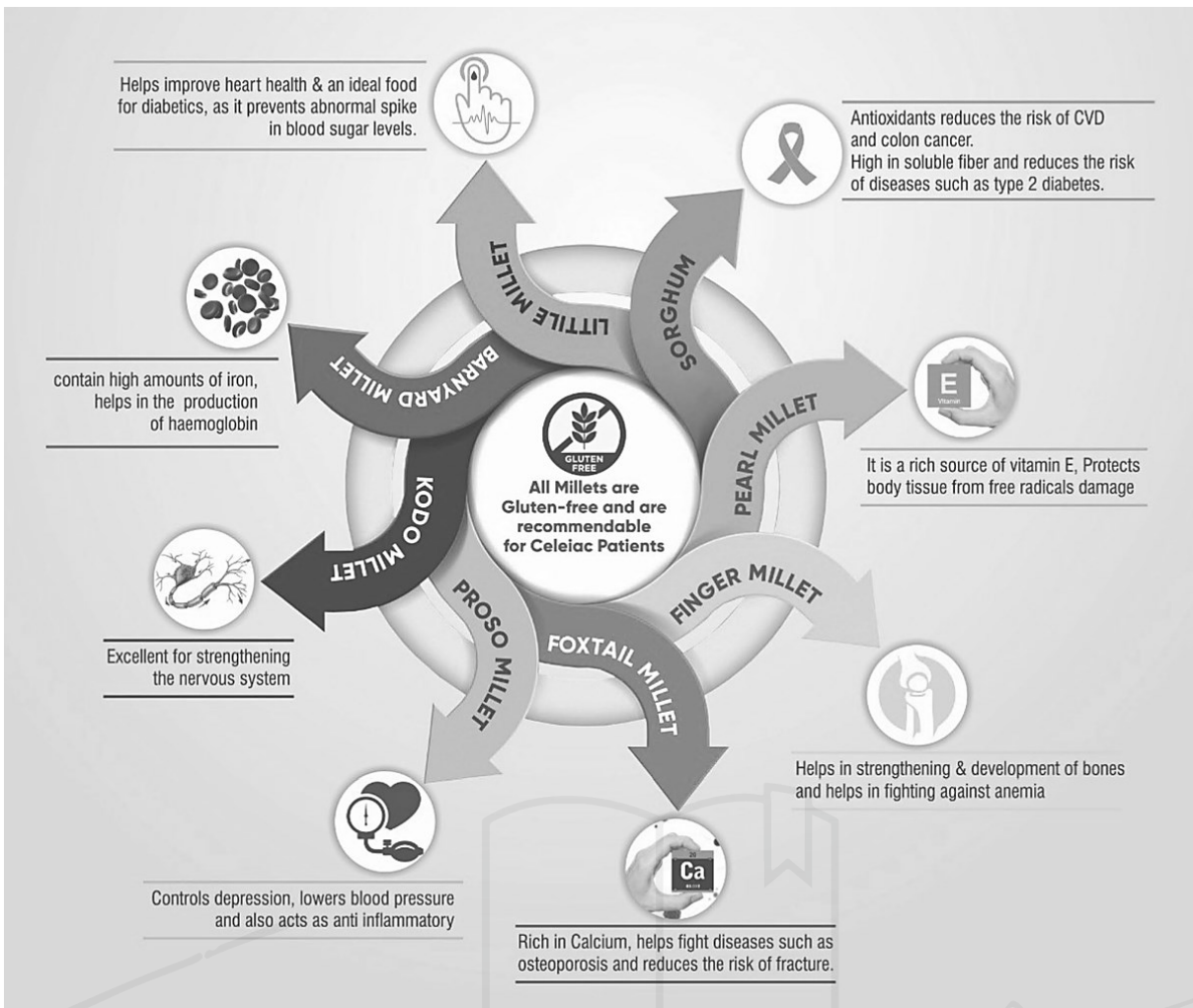
- An ongoing war between Russia and Ukraine, climate change, and trade restrictions among other factors have jeopardized global food security.
- As per the latest State of Food Security and Nutrition in the World report, the world is moving backwards in its efforts to end hunger, food insecurity, and malnutrition.
- Faced with the growing challenge of food and nutritional security, the United Nations General Assembly (UNGA) declared 2023 the International Year of Millets to spread awareness about millets — a more affordable, sustainable, and nutritious alternative. The resolution was unanimously adopted by the UNGA in March 2021 after India proposed the initiative.
- The UN's Food and Agriculture Organisation (FAO) has termed the initiative as an opportunity to "raise

awareness and direct policy attention to the nutritional benefits of millets and their suitability for cultivation".

- Last month, the FAO launched the IYM in Italy and highlighted that the promotion of millets aligns with Sustainable Development Goals (SDGs) — zero hunger, good health and well-being, decent work and economic growth, responsible consumption and production, climate action and life on land.
- Millets are incredible ancestral crops with high nutritional value. Millets can play an important role and contribute to our collective efforts to empower smallholder farmers, achieve sustainable development, eliminate hunger, adapt to climate change, promote biodiversity, and transform agri-food systems

India's efforts to promote millet

- The Union government promoted millets under the Initiative for Nutritional Security through Intensive Millets Promotion (INSIMP), as a sub-scheme of Rashtriya Krishi Vikas Yojana (RKVY) between 2011 and 2014.
- In the following years, NITI Aayog worked on a framework to introduce millets under the public distribution system for "nutritional support".
- The Union government declared 2018 as the 'national year of millets' to trigger an increase in demand. In the same year, these grains were officially rebranded as a nutri-cereal. The programme under INSIMP was merged with the National Food Security Mission (NFSM) as NFSM-Coarse Cereals and implemented in 14 States.
- Several States led separate missions to promote millets. In 2021, the Centre approved the Pradhan Mantri Poshan Shakti Nirman (PM POSHAN), earlier known as the mid-day meal scheme, in government and government-aided schools and advised State governments to include millets in the midday meal menu to enhance the nutritional outcome.
- India's efforts to promote the consumption and production of millet got a boost when the UNGA accepted the country's proposal and dedicated 2023 to spreading awareness about these grains.
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3

CHAPTER

IRRIGATION

- Irrigation is the practice of applying controlled amounts of water to land to help grow crops, landscape plants, and lawns. Irrigation has been a key aspect of agriculture for over 5,000 years and has been developed by many cultures around the world.
- There has been rapid development of irrigation facilities in India since 1951.
- It has undoubtedly played a crucial role in increasing food production, from around 50 million tonnes in 1951 to 206 million tonnes fifty years later.
- The increase has been achieved principally through improvement in the productivity of land, since the area under crops has increased only marginally.
- The liberal use of chemical fertilizers, the steady increase in the use of certified/quality seeds, and the extensive use of electricity in agriculture are among the other factors that have helped the rapid growth of agricultural production.

Irrigation Resources of India

- the annual precipitation including snowfall, which is the main source of water in India, is estimated to be in the order of 4 000 km³. The annual potential evapotranspiration in the country is 1 775 mm, but it varies from a minimum of 1 239 mm in Jammu and Kashmir to a maximum of 2 052 mm in Andhra Pradesh.
- The minor irrigation works include dug-wells, tube-wells, tanks, etc. Minor irrigation structures are created through tank, surface percolation wells, tube-wells and fluxial wells.
- The water source for a minor irrigation project could be either surface flow or ground water storage.
- While tank and pond irrigation are examples of surface flow, construction of wells is an example of ground water storage.
- Big dams and barrages built across rivers are sources of major and medium irrigation.
- Major irrigation done through canal draws their water from rivers or from artificial storage

The primary means of irrigation in India

Canals:

- Canals are artificial watercourses designed for water supply and irrigation. They are categorized into

Inundation Canals, which are derived from rivers without regulating systems, and Perennial Canals, sourced from perennial rivers with constructed barrages.

- Canal irrigation is most prevalent in areas with low relief, deep fertile soils, and a consistent water supply. While absent in rocky peninsular plateaus, coastal and delta regions in South India have some canals.
- The percentage of canal irrigation has decreased over the years, with the northern plains states such as UP, Punjab, Haryana, Rajasthan, and Bihar contributing the majority.

Advantages:

- Perennial water source
- Drought protection
- Deposits fertile sediments
- Economical for large areas

Disadvantages:

- Waterlogging and salinization
- Wastage of water

Wells (and Tube Wells):

- Wells, holes dug in the ground for subsoil water, have been used historically, with various lifting methods like the Persian wheel and dhinghly.
- Tube wells, deeper wells lifted by electric or diesel-powered pumps, are becoming more prevalent.
- Well irrigation is suitable where sweet groundwater is available, especially in areas with permeable rock structures like alluvial and regur soils.

Advantages:

- Simplicity and affordability
- Independent water source
- No salinization or flooding issues

Disadvantages:

- Limited irrigable area
- Not suitable for dry regions
- Overuse can lower the water table

Tank Irrigation:

- Tanks are reservoirs created by damming stream valleys to retain monsoon rain for later use. This method is prominent in the peninsular plateau, particularly in Andhra Pradesh and Tamil Nadu, due to challenges like undulating relief and hard rocks that make canal and well construction difficult.

Advantages:

- Natural tanks with no construction costs
- Independent source for individual or small groups of farmers
- Longer life span and dual use for fishing

Disadvantages:

- Dependence on rainfall
- Silting of beds
- Large area requirements
- Evaporation losses and potential need for water lifting to the fields

TYPE OF IRRIGATION

Various types of irrigation techniques differ in how the water obtained from the source is distributed within the field. In general, the goal is to supply the entire field uniformly with water, so that each plant has the amount of water it needs, neither too much nor too little.

The various irrigation techniques are as under:

1. **Surface Irrigation:** In surface irrigation systems, water moves over and across the land by simple gravity flow in order to wet it and to infiltrate into the soil. Surface irrigation can be subdivided into furrow, border strip or basin irrigation. It is often called flood irrigation when the irrigation results in flooding or near flooding of the cultivated land.
2. **Localized Irrigation:** Localized irrigation is a system where water is distributed under low pressure through a piped network, in a predetermined pattern, and applied as a small discharge to each plant or adjacent to it. Drip irrigation, spray or micro-sprinkler irrigation and bubbler irrigation belong to this category of irrigation methods.
 - **Drip Irrigation:** Drip irrigation, also known as trickle irrigation, functions as its name suggests. Water is delivered at or near the root zone of plants, drop by drop. This method can be the most water-efficient method of irrigation, if managed properly, since evaporation and runoff are minimized. In modern agriculture, drip irrigation is often combined with plastic mulch, further reducing evaporation, and is also the means of delivery of fertilizer.
 - **Sprinkler Irrigation:** In sprinkler or overhead irrigation, water is piped to one or more central locations within the field and distributed by overhead high-pressure sprinklers or guns. A system utilizing sprinklers, sprays, or guns mounted overhead on permanently installed risers is often referred to as a solid-set irrigation system.

- **Sub-Irrigation:** Sub-irrigation also sometimes called seepage irrigation has been used for many years in field crops in areas with high water tables. It is a method of artificially raising the water table to allow the soil to be moistened from below the plants' root zone. Often those systems are located on permanent grasslands in lowlands or river valleys and combined with drainage infrastructure.
- Sub-irrigation is also used in commercial greenhouse production, usually for potted plants. Water is delivered from below, absorbed upwards, and the excess collected for recycling.

- Net irrigated area (%) of India has increased from nearly 18 to 48% (2017-18) in recent times due to government interventions at various levels
- Punjab is the only State which has nearly achieved 100 per cent net irrigation followed by Haryana. Uttar Pradesh, Madhya Pradesh, and West Bengal are among the five top States with more than 50 per cent net irrigated area.
- The rate of extraction of groundwater is more than 100 per cent in Delhi, Haryana, Punjab and Rajasthan. Economic Surveys and experts have been suggesting that increased coverage under micro-irrigation can be the most effective mode of water conservation and these States need to focus on both medium and long-term groundwater recharge and conservation plans.
- In States like Maharashtra, the local government is focusing on building new dams but has not taken care of building a canal network to take the water to farms.
- In 2022-23, of the 141 million hectares of gross sown area in the country, nearly 73 million hectares, or 52%, had irrigation access- NITI Aayog
- In Madhya Pradesh, 21 prioritised irrigation projects have been identified under PMKSY-AIBP. Out these, 17 projects have been completed, increasing the state's irrigation cover by 16%
- Out of the total irrigated area in the country, 40% is currently watered through canal networks, while 60% through groundwater, which in several states has plunged to severely depleted levels, the data show.
- Conventional surface irrigation provides only 60% efficiency but drip irrigation has nearly 90% efficiency,"
- The country can create irrigation potential in about 60% of its arable land and 40% of the cultivable area will remain dependent on rains because it is not possible to create irrigation networks in certain regions due to hydrological and geographical reasons, according to a document of the Jal Shakti ministry.

- Although government has given much emphasis on improving canal system in various five year plans but it has declined over the years (Fig. 1). People have identified groundwater irrigation as much reliable and independent source of irrigation. Groundwater irrigation has taken quantum jump since 1965.
- Since 1950-51, the government had given considerable importance to the development of

command area under canals. As a result presently, India has gross irrigated area of 96.46 Mha, net irrigated area 68.38 Mha and food grain production of 275.11 million tonnes in 2016-17

- States with the highest dependency on ground water for irrigation include Punjab (79% of the area irrigated is by tube-wells and wells), Uttar Pradesh (80%) and Uttarakhand (67%).

Irrigation cover improves

52% of gross sown area now has access to assured irrigation

8 out of 73 million hectares have micro irrigation facilities through sprinklers and drip systems

40% out of total irrigated area are watered through canal networks; the remaining through groundwater

BENEFIT OF INCREASED AREA UNDER IRRIGATION

Mitigating increasing impacts of drier summers and patchy monsoons that are partly linked to the climate crisis.

6 SCHEMES WHICH DROVE SURGE IN IRRIGATION COVER SINCE 2017

1 Pradhan Mantri Krishi Sinchai Yojana

2 Har Khet Ko Paani-Surface Minor Irrigation

3 PMKSY-ground-water projects

4 Special package for Maharashtra

5 Rajasthan and Srihind feeder

6 Shahpur-Kandi project

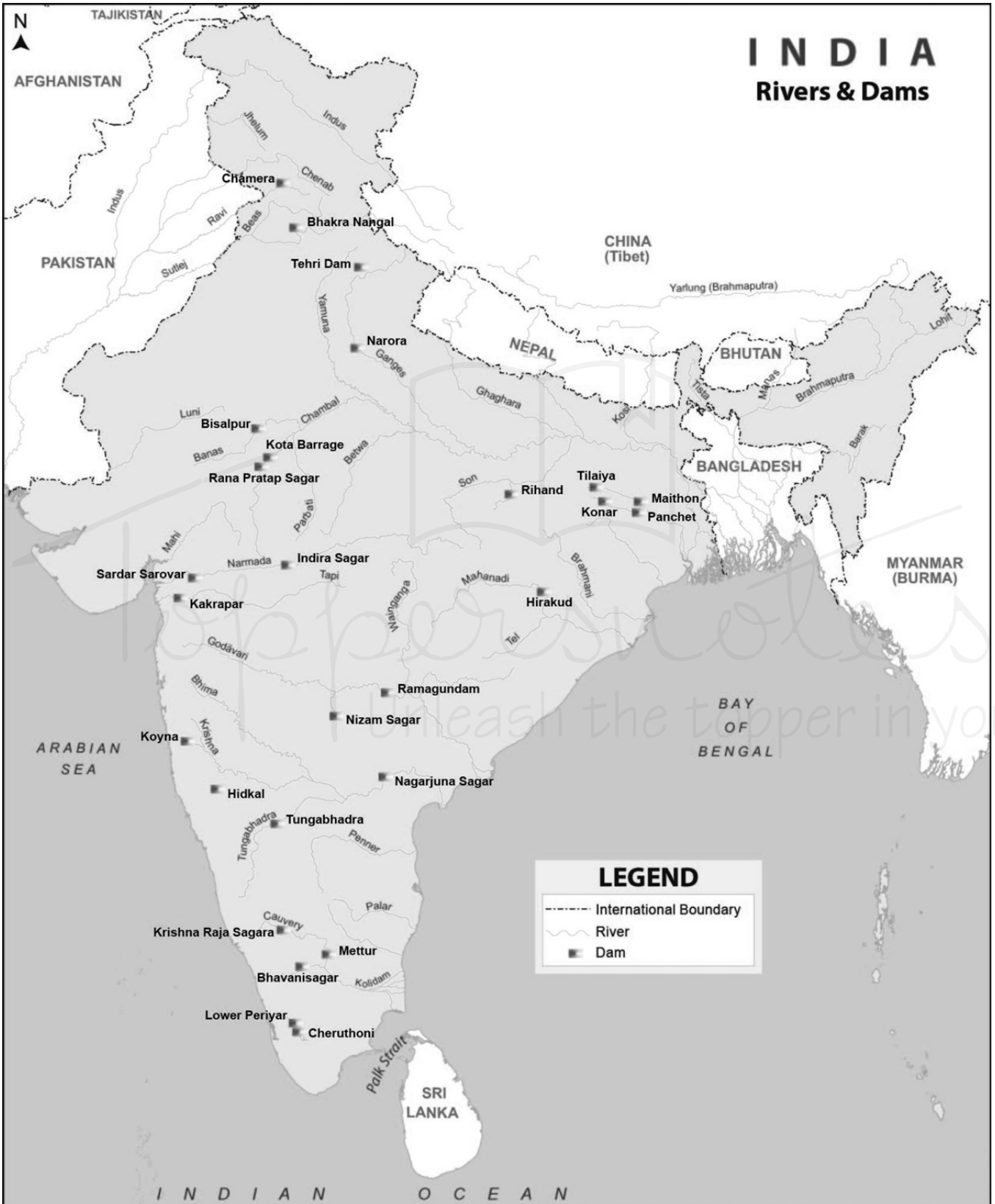


Multi Purpose Projects in India

Multipurpose Project	River	State
Bansagar Project	Son	Bihar, Uttar Pradesh, Madhya Pradesh
Bargi Project	Bargi	Madhya Pradesh
Beas Project	Beas	Haryana, Punjab, Rajasthan
Bhadra Project	Bhadra	Karnataka
Bhakhra Nangal Project	Sutlej	Punjab, Himachal Pradesh, Haryana, Rajasthan
Bheema Project	Pawana	Maharashtra
Chambal Project	Chambal	Rajasthan, Madhya Pradesh
Damodar Ghati Project	Damodar	Jharkhand, West Bengal
Dulhasti Project	Chenab	Jammu & Kashmir
Durga Barrage Project	Damodar	West Bengal, Jharkhand
Farakka Project	Ganga, Bhagirathi	West Bengal
Gandak Project	Gandaki	Bihar, Uttar Pradesh

Ganga Sagar Project	Chambal	Madhya Pradesh
Ghatprabha Project	Ghatprabha	Karnataka
Girna Project	Girna	Maharashtra
Hasdeo Bango Project	Hasdeo	Madhya Pradesh
Hidkal Project	Ghatprabha	Karnataka
Hirakud Project	Mahanadi	Orissa
Idduki Project	Periyar	Kerala
Indira Gandhi Canal Project	Sutlej	Rajasthan, Punjab, Haryana
Jawahar Sagar Project	Chambal	Rajasthan
Jayakwadi Project	Godavari	Maharashtra
Kakrapara Project	Tapti	Gujrat
Kangsawati Project	Kangsawati	West Bengal
Kol Dam Project	Sutlej	Himachal Pradesh
Kosi Project	Kosi	Bihar & Nepal
Koyana Project	Koyana	Maharashtra
Krishna Project	Krishna	Karnataka
Kunda Project	Kunda	Tamil Nadu
Let Bank Ghaghra Canal	Ganga	Uttar Pradesh
Madhya Ganga Canal	Ganga	Uttar Pradesh
Mahanadi Delta Project	Mahanadi	Odisha
Malprabha Project	Malprabha	Karnataka
Mandi Project	Vyas	Himachal Pradesh
Matatilla Project	Betwa	Uttar Pradesh, Madhya Pradesh
Mayurakshi Project	Mayurakshi	West Bengal
Minimato Bango Hasdeo Project	Hasdeo Bango river	Madhya Pradesh
Muchkund Project	Muchkund	Odisha, Andhra Pradesh
Nagarjunsagar Project	Krishna	Andhra Pradesh
Nagpur Power Project	Koradi	Maharashtra
Narmada Sagar Project	Narmada	Madhya Pradesh, Gujarat
Nathpa Jhakri Project	Sutlej	Himachal Pradesh
Panam Project	Panam	Gujarat
Panama Project	Panama	Gujarat
Panchet Project	Damodar	Jharkhand, West Bengal
Pong Project	Beas	Punjab
Poochampad Project	Godavari	Andhra Pradesh
Purna Project	Purna	Maharashtra
Rajasthan Canal Project	Sutlej, Vyas, Ravi	Rajasthan, Punjab, Haryana
Ramganga Project	Ramganga	Uttar Pradesh
Rana Pratap Sagar Project	Chambal	Rajasthan
Ranjeet Sagar Project	Ravi	Punjab
Rihand Project	Rihand	Uttar Pradesh
Salal Project	Chenab	Jammu & Kashmir
Sardar Sarovar Project	Narmada	Madhya Pradesh, Maharashtra, Rajasthan
Sarhind Project	Sutlej	Haryana
Sharawati Project	Sharawati	Karnataka
Sharda Project	Sharda, Gomti	Uttar Pradesh
Shivsamundram Project	Kaveri	Karnataka
Sutlej Project	Chenab	Jammu & Kashmir
Tawa Project	Tawa	Madhya Pradesh
Tehri Dam Project	Bhagirathi	Uttarakhand
Tilaiya Project	Barakar	Jharkhand

Tulbul Project	Chenab	Jammu & Kashmir
Tungabhadra Project	Tungabhadra	Andhra Pradesh, Karnataka
Ukai Project	Tapti	Gujarat
Upper Penganga Project	Penganga	Maharashtra
Uri Power Project	Jhelum	Jammu & Kashmir
Umiam Project	Umiam	Shillong (Meghalaya)
Vyas Project	Vyas	Rajasthan, Punjab, Haryana, Himachal Pradesh



1. Damodar Valley Multipurpose Project

- This is the first multipurpose project of independent India. Damodar Valley Corporation was established in 1948 for the joint development of the Damodar Valley spread over the states of Jharkhand and West Bengal on the basis of the Tennessee Valley Project (1933) of the United States of America.
- Damodar River originates from the hills of Chhota Nagpur and joins the Hooghly River in West Bengal. In this, dams have been built on Tilaiya, Konar, Maithan and Panchet hills and thermal power plants have been built in Bokaro, Durgapur, Chandrapur and Patratu.

2. Bhakra Nangal Multipurpose Project

- This is the country's largest multipurpose project built on the Sutlej River in Punjab-Himachal Pradesh. Bhakra Dam is the world's tallest gravity dam (226 metres).
- The name of the lake formed behind this dam is Govind Sagar Lake (Himachal Pradesh). Himachal Pradesh, Punjab, Haryana, Rajasthan and Union Territory Delhi have benefited from this multipurpose project.

3. Rihand Dam Project

- It is built on its tributary Rihand in the Son Valley in Uttar Pradesh. An artificial lake named 'Govind Ballabh Pant Sagar' has been created behind this dam, which is the largest artificial lake in India. It is situated on the border of Madhya Pradesh and Uttar Pradesh.

4. Hirakud Dam Multipurpose Project

- It is built on the Mahanadi near Sambalpur in Orissa. This is the longest dam in the world.

5. Gandak Project

- This project has been completed with the cooperation of Nepal. The main canal in this is the Valmiki Canal built on Gandak.

6. Kosi Project

- It has been completed in the state of Bihar with the cooperation of Nepal. Kosi is called the 'sorrow of Bihar' due to devastating floods. This project controls the incidence of floods in Kosi River. The main canal is taken out from Hanuman Nagar Barrage (Nepal) built on Kosi.

7. Indira Gandhi (Rajasthan Canal) Project

- In this project, water from Ravi and Beas rivers has been brought to Sutlej River. A dam named Pong has been built on the Beas River. The water collected behind the Pong Dam is transported to many parts of Rajasthan through the Indira Gandhi Canal. Its main objective is to make new areas cultivable by irrigating them.

- This is the longest canal in the world, through which Ganganagar, Bikaner and Jaisalmer districts of northwestern Rajasthan can be irrigated. The main canal is known as Indira Canal.

8. Chambal Project

- This project has been jointly built in Madhya Pradesh and Rajasthan to utilize the water of Chambal River, a tributary of Yamuna. Under this project, Gandhi Sagar Dam has been built in Madhya Pradesh and Rana Pratap Sagar Dam, Jawahar Sagar Dam and Kota Barrage in Rajasthan. The main objective of this multipurpose project is to make the soil fertile in the Chambal River basin.

9. Nagarjuna Project

- It is built on the Krishna River in Andhra Pradesh. It was named 'Nagarjuna Sagar' after the Buddhist scholar Nagarjuna.

10. Tungabhadra Project

- This dam has been built near Mallapuram on the Tungabhadra River, a tributary of Krishna, with the cooperation of the states of Andhra Pradesh and Karnataka.

11. Mayurakshi Project

- Jharkhand is being benefited from electricity and West Bengal from irrigation canals by building a dam at a place called Mensajor on Mayurakshi, a small river in the north-eastern part of Chhota Nagpur plateau. It is also called 'Canada Dam'.

12. Sharavati Project

- This project is built on India's highest Jog Falls or Gandhi Falls in Karnataka. From here, electricity is also sent to the industrial areas of Bangalore and the states of Goa and Tamil Nadu.

13. Koyna Project

- The project is on Koyna, a tributary of Krishna in Maharashtra. Electricity is sent to Mumbai-Pune industrial area from here.

14. Baglihar Project

- It is a 450 MW hydro-electric project on the Chenab River in Jammu and Kashmir. Pakistan considers the construction of this dam as a violation of the Indus Water Agreement of 1960 AD.
- This agreement was brokered by the World Bank, which recently accepted India's stand and asked to reduce the height of the dam by 1 meter.

15. Kishanganga Project

- It is a 330 MW hydro-electric project on the Jhelum River in Jammu and Kashmir. India wants to send the water of this branch of Jhelum River to another branch.
- For this 21 km. India plans to build a long underground tunnel. Pakistan considers this a violation of the Indus Water Agreement of 1960 AD.