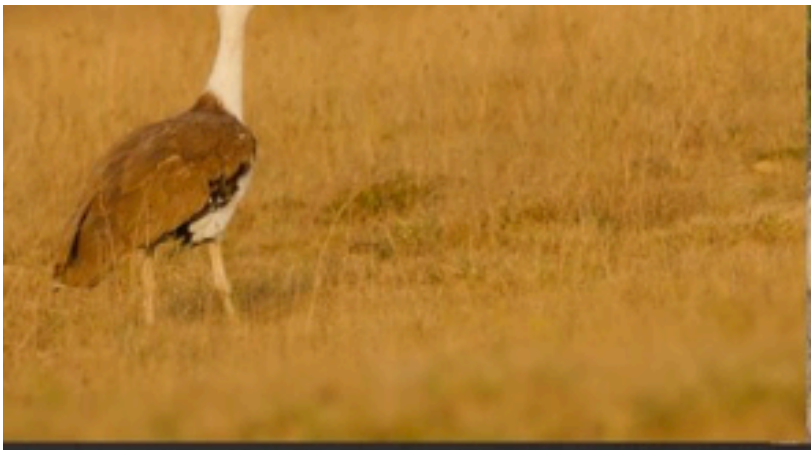

Geography of Rajasthan

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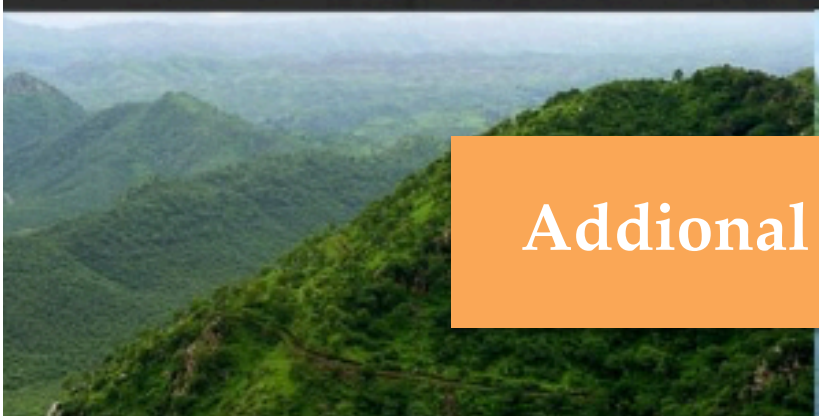
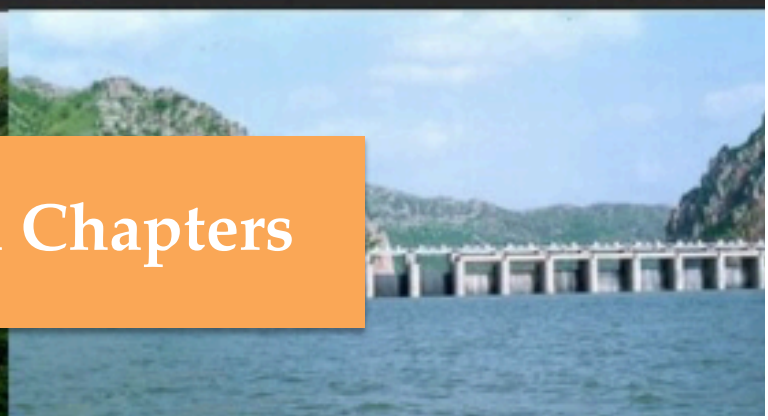




Addional Chapters

Note to Readers

The first PDF book on Geography of Rajasthan was published more than a year back, since then, we have updated few of the chapters as new government information was released and also we have written acrticles on some of the geography related topics.

At this time, 13 June 2019, we have complied all this information, in a separate PDF and have released it as this eBook. If you have purchased Geography of Rajasthan PDF prior to this date, then you can download this PDF as supplementary PDF.

For users, who are purchasing the Geography of Rajasthan PDF after 13th June 2019, the downloaded PDF is already updated.

For maximum benefit of aspirants & to avoid any undue inconvenience, this PDF has been kept as FREE of COST.

Index

Geology of Rajasthan

Rajasthan forms north-western part of the Indian Shield. The State exposes a variety of lithological and tectonic units ranging in age from Archaean to Recent times. Rajasthan is endowed with a continuous geological sequence of rocks from the oldest Archaean Metamorphic, represented by Bhilwara Supergroup (>2500 m. y.) to sub-recent alluvium & wind blown sand. The geological sequence of the state is highly varied and complex, revealing the co-existence of the most ancient rocks of the Pre-Cambrian age and the most recent alluvium as well as windblown sand.

GEOLOGY

Archaean

BHILWARA SUPERGROUP

Sand Mata Complex, Mangalwar Complex, Hindoli Group

Proterozoic

BHILWARA SUPERGROUP

Rajpura-Dariba Group, Pur-Banera Group, Jahazpur Group, Sawar Group; Ranthambor Group

ARAVALLI SUPERGROUP

Debari Group, Udaipur Group, Bari Lake Group, Kankroli Group; Jharol Group, Dovda Group, Nathdwara Group; Lunavada Group

DELHI SUPERGROUP

Railo Group; Alwar Group, Ajabgarh Group, Gogunda Group, Kumbhalgarh Group, Sirohi Group; Punagarh Group, Sindreth Group

VINDHYAN SUPERGROUP

Lower Vindhyan Group, Upper Vindhyan Group

MALANI IGNEOUS SUITE

MARWAR SUPERGROUP

Jodhpur Group, Bilara Group, Nagaur Group

Palaeozoic

Mesozoic and Cenozoic

Deccan Traps; Tertiary Alkaline Complex; Sedimentaries; Quaternary

The basement rocks - the Sandmata Complex, Mangalwar Complex and Hindoli Group of Bhilwara Supergroup - occupy central and south-eastern plains. They are Archaean in age and comprise in general, granulite-gneiss; amphibolite, metapelite, paragneiss, calc-silicate rocks and greywacke (the older granite-greenstone belt) and metavolcanic, metagreywacke (the younger granite- greenstone belt) respectively.

The Lower Proterozoic supracrustal rocks of the Jahazpur, Rajpura-Dariba, Pur-Banera and Sawar Groups of Bhilwara Supergroup rest on the basement rocks of the Mangalwar Complex and host a number of lead, zinc and copper deposits.

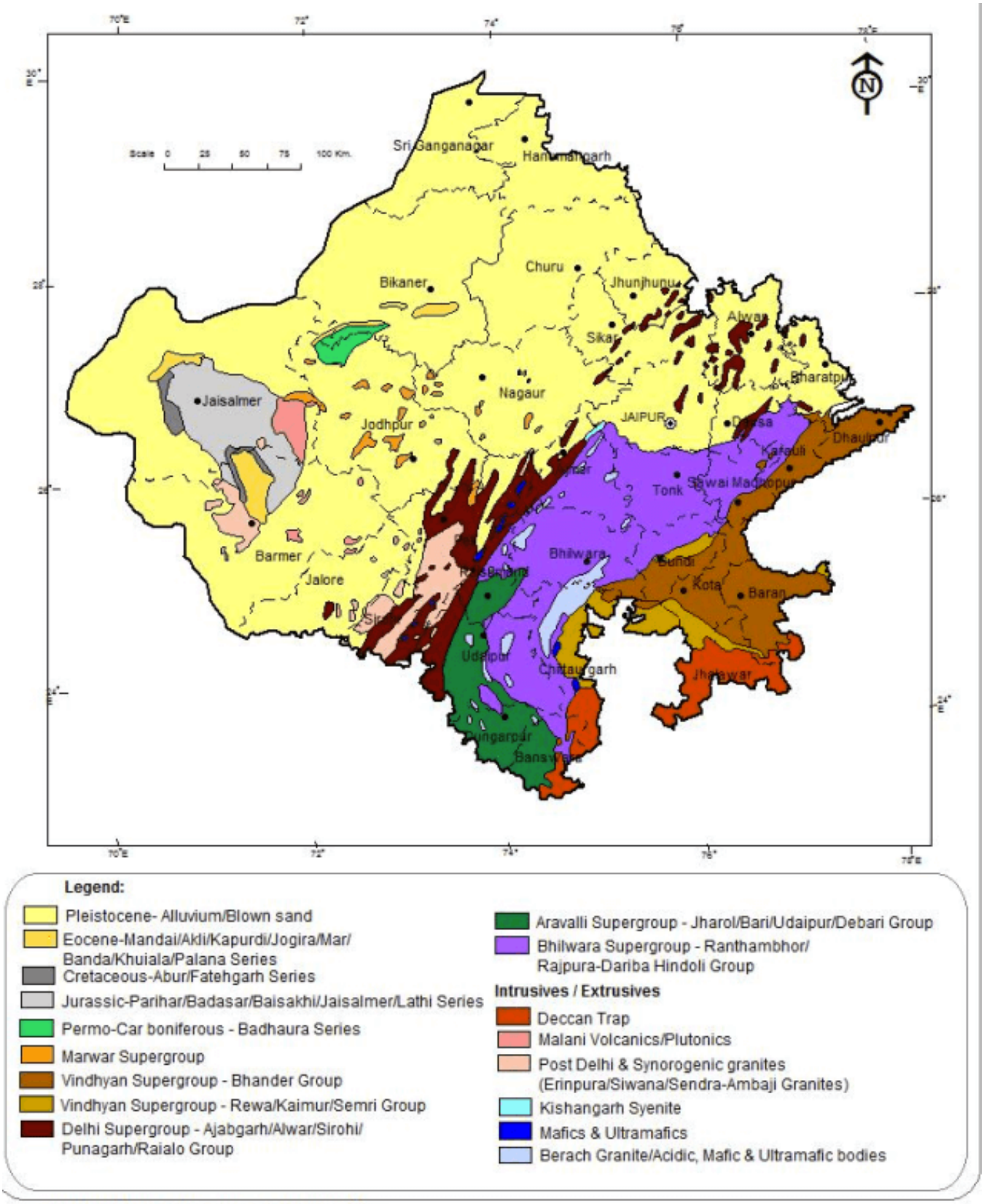
The Proterozoic fold belts, viz., the Aravalli fold belt (the Aravalli Supergroup) and the Delhi fold belt (the Delhi Supergroup) occupy the southern and south- eastern, and south-western and north-eastern Rajasthan respectively. The Aravalli Supergroup is represented by metamorphosed and complexly folded clastic sediments with minor chemogenic and organogenic assemblages with interlayered basic volcancics, whereas the Delhi Supergroup comprises mainly carbonates, metavolcanics, metasammites and metapelites, intruded by magmatic rock of Phulad Ophiolite Suite and syn-orogenic granites of Sendra- Ambaji, Bairath, Dadikar, Harsora, etc. A number of base metal deposits are located in these belts as also other minerals.

The isolated hillocks of western Rajasthan constitute the Upper Proterozoic Malani Igneous Suite and the Erinpura Granite pluton. Eastern Rajasthan is characterised by the vast sedimentary stretch constituting the Vindhyans, which is juxtaposed against the rocks of the Bhilwara Supergroup along the Great Boundary Fault.

The northern and north-western parts of the State exhibit Upper Proterozoic-Early Cambrian rocks of the Marwar Supergroup which are overlain by sedimentary rocks of different ages of Palaeozoic and Mesozoic Era. Many industrial mineral deposits are found in these rocks. The Deccan Traps are restricted to the south-eastern part of the State in Chittaurgarh- Banswara area.

The Cenozoic rocks are manifested in Barmer and Jaisalmer basins in the west and Ganganagar-Palana shelf in the north.

The Quaternary sediments of aeolian and fluvial origin constitute the Thar Desert of Rajasthan.



Source: Ground Water Atlas of Rajasthan, 1999

Earthquake Hazard in Rajasthan

According to GSHAP data, the state of Rajasthan falls in a region of moderate to high seismic hazard. As per the 2002 Bureau of Indian Standards (BIS) map, Rajasthan falls in Zones II, III & IV. Historically, parts of this state have experienced seismic activity in the M 5.0 range.

Classification of districts of Rajasthan according to seismic zones:

S. No.	Seismic Zone	Intensity (MSK)	Magnitude	District
1	IV [High Damage Risk Zone]	VII-VIII	6.0 - 6.9	Some parts of Barmer [Chohtan Block], Jalore [Sanchore Block] Alwar [Tijara Block], and Bharatpur [Block Nagar, Pahari]
2	III [Moderate Damage Risk Zone]	VI-VII	5.0 - 5.9	Some parts of Udaipur, Dungarpur, Sirohi, Barmer, Jaisalmer, Bikaner, Jhunjhunu, Parts of Sikar, Jaipur, Dausa, and Bharatpur.
3	II [Low damage Risk Zone]	IV-VI	4.0 - 4.0	Ganganagar, Hanumangarh, Churu, Jodhpur, Pali, Rajasamand, Chittorgarh, Jhalawar, Baran, Kota, Bundi, Sawai Madhopur, Karauli, Dholpur, Banswara, some areas of Bikaner, Udaipur, Jhunjhunu, Sikar, and Jaipur.

Largest Instrumented Earthquake in Rajasthan

- 15 August 1906 - Thar Desert, Rajasthan, Mw 6.2
- This event was located along the India-Pakistan border, in the vicinity of Janpalia, Rajasthan which is located north-northwest of Bakhasar.

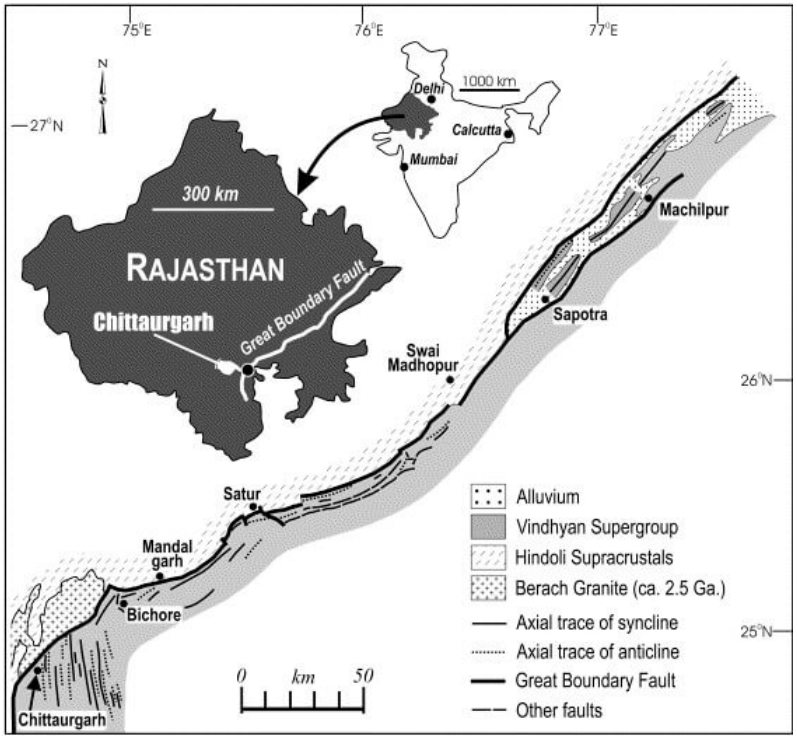
Seismic Faults in Rajasthan

Several faults have been identified in Rajasthan, out of which many show evidence of movement during the Holocene epoch.

- The **Cambay Graben** terminates in the south-western part of the state.
- The **Konoi Fault** near Jaisalmer trends in a north-south direction and was associated with the 1991 Jaiselmer earthquake.

Several active faults criss-cross the Aravalli range and lie parallel to each other.

- The most prominent of them is the north-south trending **Sardar Shahar Fault** and
- The **Great Boundary Fault** which runs along the Chambal River and then continues in the same direction into Uttar Pradesh.



Water Resources of Rajasthan

Rajasthan faces one the greatest scarcity of water resources in the country. It has 13.88% of India's cultivable area, 5.67% of population and about 11% of country's livestock but it has only 1.16 % of surface water and 1.70% of ground water. Thus, Rajasthan a state with about 10% of land area has only around 1% of country's water resources.

Water Resources of Rajasthan:

The State's water resources are categorised in following terms:

1. Surface Water (SW):

1.1 Surface water (stream flows) generated from within Rajasthan boundaries:

- The surface water potential of the state from internal sources comprising 14 Rainfed river basins is estimated at 15.86 million acre feet.

(2010) Status of available surface water and storage created in Rajasthan

River Basin	Available Yield (in MCM)	Storage created (in MCM)
Shekhawati	104.7	89.72
Ruparail	179.5	101.64
Banganga	449.2	412.26
Gambhir	353.3	231.56
Parvati	138.1	157.28
Sabi	168.3	107.65
Banas	4039.3	3639.76
Chambal	5203	2906.77
Mahi	3149	2726.59
Sabarmati	799.9	200.09
Luni	451.8	1136.66
West Banas	406.1	79
Sukli	111.7	44.29
Other Nallah of Jalore	31.6	0
Outside Basin	468	9

Source: Irrigation Department, Government of Rajasthan, Jaipur.

- Surface Water Sources: Covered in Next Chapter.

1.2 Imported Surface Water:

- Imported water delivered to Rajasthan from other states by means of several projects under relevant inter-state agreements.

The share of Rajasthan in out of State rivers as per various inter-State agreements

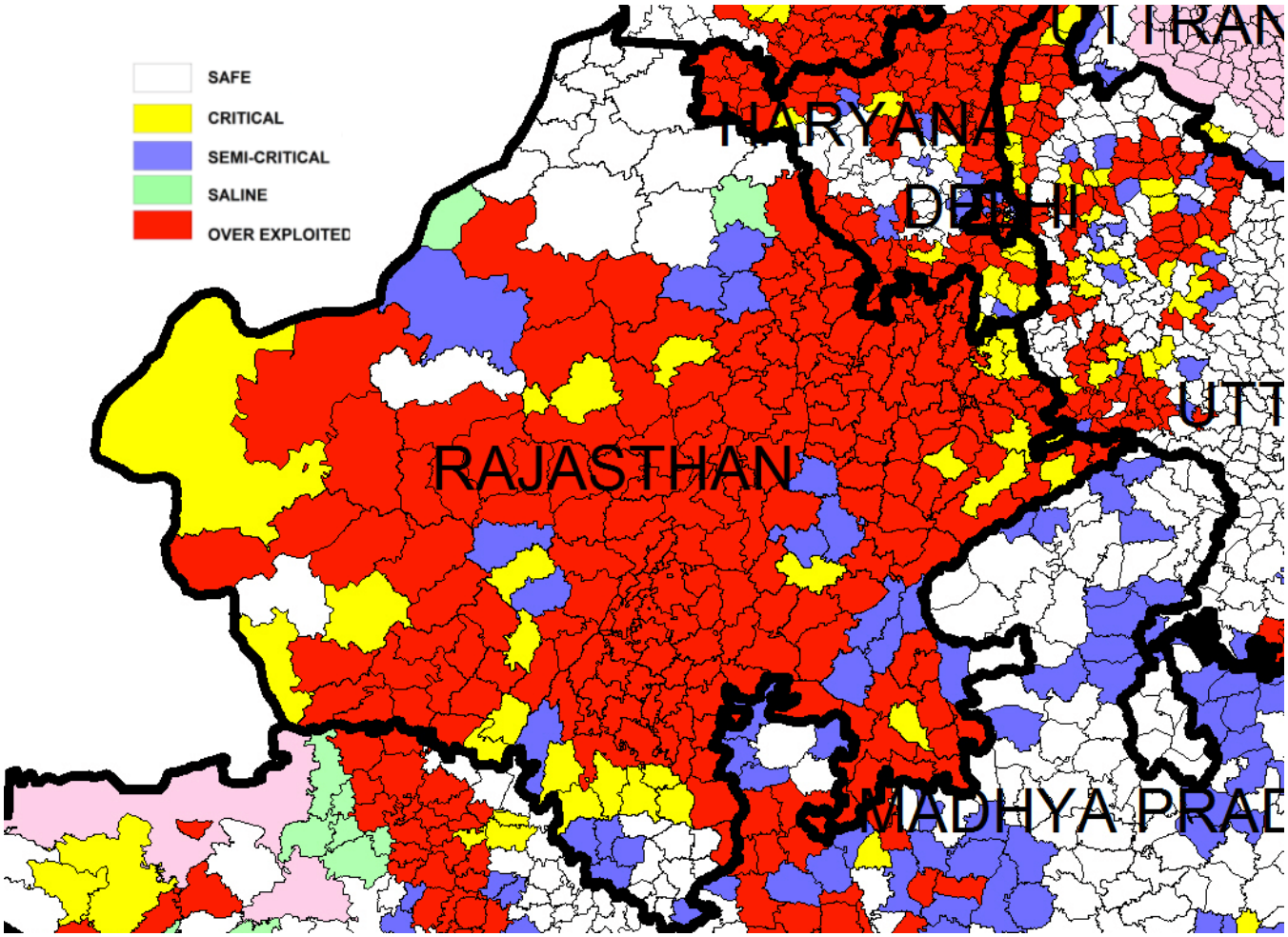
S.No	Resource	Allotted Water in MAF (Million Acre Feet)
1	Gang Canal	1.11
2	Bhakra Canal	1.41
3	Narmada	0.5
4	Ravi-Beas	8.6
5	Yamuna Water	0.91
6	Mahi Water	0.37
7	Chambal/Kota Barrage	1.6
	Total	14.5

2. Ground Water (GW):

- Groundwater availability in Rajasthan is highly variable, depending on hydrological conditions.
- The limited ground water resources in Rajasthan are increasingly being exploited for irrigation, Industrial and domestic uses.
- In 2011, out of 243 Blocks. the ground-water status was as follows:

Parameter	No. of Blocks
1. Over Exploited (greater than 100%)	172

2. Critical (90% - 100%)	25
3. Semi- critical (70%-90%)	20
4. Safe (Less than 70%)	24
5. Saline Water Blocks	2
Total	**243**



Source: Central Ground Water Board

Major Issues related to Water in Rajasthan:

Scarcity of surface and groundwater

Rajasthan is the driest state with nearly 70 percent (2/3rd) of the area classified as arid and semi arid region. The annual average demand in 2010 in the state was of 31333.74 million cubic meter (MCM) with an availability of 10448.59 MCM annual average surface water (having 75% dependability) and 10563.01 MCM of annual average ground water. Hence there is gap of around 30% in demand and availability.

Uranium Contamination in Ground Water in Rajasthan

A recent news article published in *the Hindu & Times of India*, highlights a a study conducted by researchers at the *Duke University in North Carolina, United States, and the Central Groundwater Board of India*. The report raises concerns over presence of high uranium levels in their groundwater of State of Rajasthan along with 16 other north-western states including Punjab, Haryana etc.

The Problem:

Uranium levels in 75 out of 226 wells in Rajasthan and five out of 98 wells tested in Gujarat exceeded the WHO provisional health guidelines. According to WHO the safe drinking water standards are 30 micrograms of uranium per litre. As mentioned in the study India extracts more than a third of world wide groundwater resources and more than 90% of this is being used for irrigation. Long term exposure to uranium in drinking water can cause **kidney deceases**.

Causes of Uranium Contamination:

The main source of uranium contamination was "natural," but human factors such as declining ground water table and rising nitrate pollution contributes significantly to the rise in contamination.

It is demonstrated in the paper that the combination of different factors, like aquifer rocks containing uranium (granitic rocks or sediments derived from weathering of granitic rocks), oxidizing conditions that leach out uranium from the rocks and make it soluble, and the groundwater chemistry with high bicarbonate in which uranium is attached and thus become mobile, all contribute to the high uranium in groundwater in India.

Possible solution to Uranium Contamination:

- The first step towards solution could be first monitoring, than avoiding (using other water source) or treatment (RO desalination).

- Including uranium in the list of contaminants monitored under the Bureau of Indian Standards' Drinking Water Specifications.

Water use priority:

According to the document State Water Policy (SWP), February 2010, State Water Resources Planning Department, Rajasthan, Jaipur, water allocation priorities for water resources management and planning purposes, are as follows:

1. Human Drinking Water
2. Livestock drinking
3. Water other domestic,
4. Commercial and municipal water uses
5. Agriculture
6. Power generation Environmental and ecological
7. Industrial
8. Non-consumptive uses, such as cultural, leisure and tourist uses
9. Others

The above water allocation priorities were followed while carrying out water supply and demand balance block-wise and micro watershed wise.

Ground-Water Quality Issues:

Rajasthan is over-dependent on groundwater. The major problems associated with groundwater quality are fluoride, nitrate, and salinity. The worst affected districts with 50 percent or more concentrations are:

Fluoride:

- Tonk, Jaipur, Nagaur, Ajmer, Bhilwara, Sirohi, Bundi and Pali
- **Causes of High Flouride:**

- Presence of rocks like Pegmatite , Gabbros etc. containing minerals like Fluorspar, Fluorite, Lepidolite, Tremolite.
- Presence of calcite and dolomite which accelerate the leaching of fluoride to the groundwater.
- The arid climate with high evaporation and insignificant natural recharge increase fluoride concentration in the groundwater.

Nitrate > 100 ppm:

- Churu, Nagaur, Jhunjhunu

Total Dissolved Solids (TDS) > 2000 ppm:

- Churu, Barmer, Bharatpur

Iron > 1ppm:

- Bhilwara, Jodhpur, Baran, Jaipur

Surface Water Quality Issues:

- The two major causes of surface water pollution are sewage water and industrial effluent.
- Rajasthan has clusters of textile printing units emitting wastewater containing dyes leading to heavy metal pollution of surface and groundwater.
- Industrial water pollution in the state is mainly con ned to Kota, Alwar, Udaipur, Jodhpur, Pali, Balotra, Sanganer, Bhilwara, Jhotwara, and Bagru areas.

Steps taken to Improve Water Resources of Rajasthan

Water Vision 2045

Water Resource Vision 2045 has been prepared to highlight the short term (upto 2015) and long term (upto-2045) thrust areas and action plan which are pre-requisites for successful implementation of the State Water Policy and Plan and achieving the objective of optimum use of every drop of scarce and precious utilisable water resource.

Government Organisations

- Water Resources Department
- Rajasthan River Basin & Water Resources Planning Authority
- Command Area Development & Water Utilization Department
- Rajasthan River Basin & Water Resources Planning Authority
- Ground Water Department
- Watershed Development and Soil Conservation Department
- Rural Development & Panchayati Raj Department
- Public Health Engineering Department (PHED)

Schemes to improve water availability

- Mukhya Mantri Jal Swavlamban Abhiyan
- Interlinking of Rivers
- Rooftop Rain Water Harvesting
    - Roof Top RWH has been made mandatory in State owned buildings of plot size more than 300 Sq.m with effect from 03.01.2006.
- Under the Mahatma Gandhi National Rural Employment Guarantee Act (MNREGA) the activities related to water conservation and rain-water harvesting, drought proofing, construction of irrigation canals, rejuvenation of traditional water bodies and developing drainage in the waterlogged areas are being taken up.
- Construction of Dams & Reservoirs.
- Watershed development:

- There are various programs in the state under which watershed development is done are: The Drought Prone Area Program, Desert Development Program, Integrated Wasteland Development Program (Plain), National Watershed Development Program for Rain-fed Areas, Pushkar Gap Project, Peoples Action For Watershed Development Initiatives, Combating Desertification Project and Integrated Wasteland Development Program.

Water Resource Management

Traditional Methods of Rain-Water Harvesting in Rajasthan

The traditional sources of water in Rajasthan include Nadi, Tanka, Johad, Bandha, Sagar, Samund and Sarovar. The large public wells known as Kohar, Jhalra, Baori, Beri, Saagar were owned by the community.

Lakes/Talaab

In Rajasthan traditionally, maximum conservation of water is in the form of lakes. Few of the lakes in Rajasthan that are world famous lakes include Lalsagar (1800), Kailana (1872), Takhatsagar (1932), and Ummedasagar (1931) Balsamand lake of Jodhpur; Jaisamand, Udai Sagar, Fateh Sagar, Rajsamand and Pichhola of Udaipur; Anasagar lake, Pushkar lake of Ajmer and Mansagar lake of Jaipur . These lakes conserved large quantities of water which is used for drinking, religious and recreational purposes.

A reservoir area of less than five *bighas* is called a *talai*; a medium sized lake is called a *bandhi* or *talab*; bigger lakes are called *sagar* or *samand*.

Bawari

In Rajasthan, Step wells are locally known as Bawari and jhalara. These are sweet water aquifers getting a regular recharge through rain water. Bawaris were mainly set up in cities and big towns to provide a water supply to the community through conservation of rain water. Bawaris and Sarovar have remained important sources of drinking water and irrigation respectively since ancient times.

Naadi & Pokhar

One of the oldest and still prevalent storage structure for rainwater harvesting is naadi or dug-out village pond or tank (Pokhar). Their Agor (catchment area) is also large. The water stored in a naadi acts as a source of groundwater recharge through seepage and deep percolation and is generally used for drinking by livestock and human beings. Naadi construction is more prevalent in the western Rajasthan.

Tanka

The tanka is circular or rectangular shape pond with a life span of 3-4 years, normally on bare ground to which surface runoff can be diverted. The area around it is a clean catchment. The traditional tanka is constructed with lime plaster and thatched with bushes. Ranisar and Padamsar tanks of Jodhpur, forest tanks of Ranthambore, Sukhsagar Tank and Kalasagar tank and Padmini tank are few famous ones.

Khadeen

It was first developed in the 15th century in the Jaisalmer district, Khadeen is a most multi-purpose method of water conservation. The run-off from upland and rocky surfaces is collected in a khadeen from the adjoining valley against an embankment having a masonry water barrier for outflow of runoff excess. The standing water in a khadeen assists continuous groundwater recharge. On the Khadeen bed at least one crop is cultivated even in the arid region as it retains moisture and contains fine and fertile soil. In the immediate vicinity downstream the sub-surface water is extracted through bore wells.

Kui

To minimize the wastage of water, small well known as Kui or Beri is constructed near a water leaking and oozing tank. At Bikaner, Jaisalmer and Jodhpur 'Kui' are found in a large number. Its opening is covered by strips of wood and mostly they remain kaccha. Kuis or beris are normally 5 metres (m) to 12 m deep. Six or ten of kui's when constructed together constitute a ***PAAR System***. Rainwater harvested through PAAR technique is known as Patali paani.

Jhalras

The water of Jhalras was used in religious ceremonies, community bath and such other functions. Jhalras in Man Mandir at Jodhpur are well known. They do not have their own catchment area rather, the water reservoirs receive water from soakage of tanks or lakes situated at a higher level.

Johad

Johads are small earthen check dams that capture and conserve rainwater, improving percolation and groundwater recharge. Starting 1984, the last sixteen years have seen the revival of some 3000 *johads* spread across more than 650 villages in Alwar district, Rajasthan.

Traditional Roof-Water Harvesting

The houses in western Rajasthan during ancient times were constructed with stone and lime and the roof water was diverted to Tankas. The housing complexes and institutional buildings in urban areas have large roofs and the roof-top rainwater can be conserved and used for recharge of groundwater. Here an outlet pipe from the roof top to divert the water to the existing wells or special recharge wells in urban areas.

Modern Methods of Rain-Water Harvesting in Rajasthan

Rajasthan has a tradition of building, and maintaining rainwater harvesting (RWH) structures such as johad, kuis, and kunds. Traditionally, these structures supported life in this water stressed region, and were well supported in turn by a system of community ownership. Excessive reliance on government run systems has led to the gradual neglect of these structures and disintegration of the entire support mechanism. The relevance of RWH in addressing today's water crisis is unquestionable; however implementation models, design norms, and funding vary. The lack of financial models and capital limitations at the user end pose challenges in the rural individual context. In the urban setting, enforcement of RWH norms for large buildings has been a challenge. With the advancement of technology and increasing need for water new methods are adopted to conserve water using scientific techniques.

Water Harvesting Dams or Nalla bunds:

In ravine lands, a series of small barriers are constructed across selected Nalla sections of second order streams so as to obstruct the flow of surface water in the stream channel and water is retained on the surface for a longer period. These check dams act as a mini percolation tank which helps retention of the silt load, supplement irrigation, contributes groundwater recharge and enhances the overall biomass production of the system. These Water harvesting dams are promoted under the Watershed Management Program in Rajasthan.

Ditch and Furrow Method

In areas with irregular topography, flat bottomed, shallow and closely-spaced ditches or furrows there is maximum water contact area to recharge water from source stream or canal. This technique is less sensitive to silting.

Anicuts

A small water harvesting masonry dam constructed across a stream to hold sufficient water and submerge the upstream area during the rainy season is known as an Anicut. The stored water is used for drinking and recharging groundwater in adjacent wells. Lift irrigation is also practiced. Like in a khadin, if the submerged area is large then bed cultivation is practiced using the stored soil profile moisture.

Percolation Tanks

Percolation tanks are recharge structures for impounding surface runoff constructed on small streams with adequate catchment. These tanks are more feasible in hard rock regions which are highly

fractured and weathered to quickly recharge the groundwater due to low evaporation losses. They can be dug in alluvial rock formations as well.

Sub-Surface Barriers

In the sandy bed of an ephemeral desert streams the sub-surface barrier is a suitable artificial recharge structure. It is constructed below the river bed on impermeable sub-surface strata and so the structure is secure from flooding and does not require periodic de-silting and has limited evaporation.

Harvesting and Conservation of Flash Floods:

Flash floods occur in response to very high rainfall or a cloudburst of short duration. Over-topping of defined courses of streams and spreading into flood plains causing immense damage are their characteristic features. These waters can be allowed to percolate inside the already existing aquifers of the water is diverted towards the run- off storage tanks. The water can be later put to agricultural or domestic purposes after basic purification.

In-situ Water Harvesting and Moisture Conservation:

In-situ water harvesting and moisture conservation is very useful in drought mitigation and in enhancing land productivity, which are field based, cost effective, location-specific soil and water conservation technology. Under this technique, Contour furrowing is practiced on mild slopes. Also, a large numbers of mini-storages are created across the slope which alleviate drought.

Contour bunding is recommended in the semiarid region of the state for soil and water conservation in rain-fed farming regions. Locally adapted, native, fast-growing perennial grasses with extensive root systems are planted against the slopes to act as Contour vegetative barrier. These grasses and shrubs form a dense hedge and conserve soil and water. This cheap and environmental friendly measure improves land productivity.

Recharge Shaft

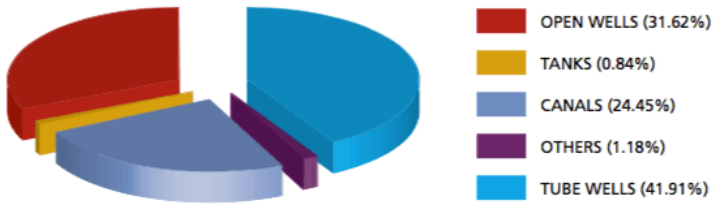
In the areas where source of water is only seasonally available the recharge shaft allows water to stand in it for longer time and allowing it to percolate to recharge a nearby well or other water body. The recharge shaft is efficient and cost effective structure to recharge the aquifers directly

Irrigation in Rajasthan

Rajasthan has Net Cropped area of 183.49 Lac hectares, out of this, approximately 75% of area is rain-fed (116.88 lac hectares) and only 25% is irrigated area (66.61 lac hectares) (1). However, this 25% irrigated area contributes more than 50 percent of agricultural output. Main sources of irrigation in Rajasthan are:

Net Irrigated Area in Rajasthan by Source

- Open Wells: 31.62%
- Tube-wells: 41.91%
- Canals : 24.45%
- Tanks: 0.84%
- Other sources: 1%

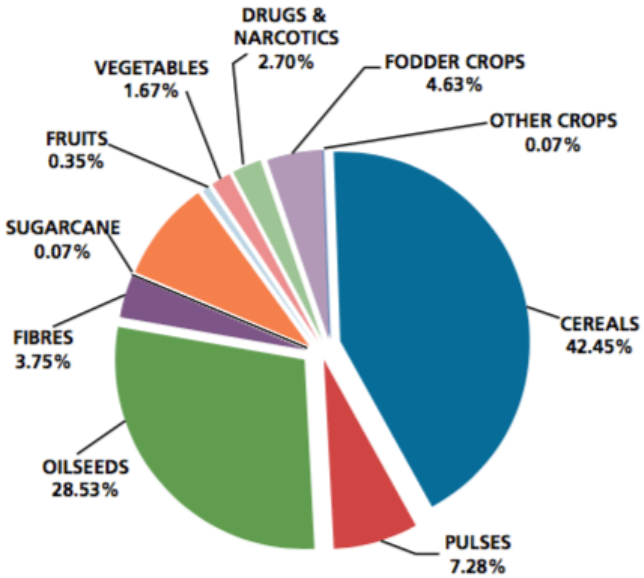


Source: Agricultural Statistics of Rajasthan 2010-11, Directorate of Economics and Agriculture

As can be seen above, 73% of irrigation is through tube-wells and wells placing enormous stress on groundwater. It is particularly alarming that share of tube-wells over the last four decades has shot up from 1 percent in 1967-68 to 39 percent.

Irrigation in Rajasthan by Crops:

- Of the total irrigated area, 35.79 percent is under wheat, 23.65 percent under rape seed and mustard, and 5.8 percent under grams.



Rajasthan Irrigation Potential

The state's estimated irrigation potential is 5.1 million hectares, of which 3.1 million hectares is already achieved. This gap of two million hectares cannot be further addressed by groundwater, which is fully exploited.

Acts related to Irrigation:

- The Rajasthan Irrigation and Drainage Act, 1954

Organisations related to Irrigation:

- Irrigation Management & Training Institute, Kota
- Watershed Development and Soil Conservation Department
- Command Area Development & Water Utilization Department
- Indira Gandhi Nahar Department

Major Canal Irrigation Projects of Rajasthan

Irrigation is an important input by itself for agriculture like fertilisers, improved seeds etc which imparts confidence to the farmers to adopt improved agricultural practices. The State government has given high priority to the development of surface water resources during the last four decades of planned development. A large number of irrigation projects have been planned and executed in different parts of the State.

Major Canal Irrigation Projects in Rajasthan:

Indira Gandhi Nahar Pariyojana (INGP)

Indira Gandhi Nahar Pariyojana (IGNP) started in 1958 and the irrigation facility started in 1961. The area of the project spans over four districts of Rajasthan, namely - Ganganagar, Bikaner, Hanumangarh and Jaisalmer. Its main aim is to assist in agricultural activities and provide drinking water, but it also envisages regional development and ecological improvement by arresting desertification.

- Read in Detail about: Indira Gandhi Nahar Pariyojana in Next Chapter

Bhakra Nangal System

The Bhakra Nangal system is a complex system of several dams, reservoirs, inter-basin transfer linkages, powerhouses and a vast canal network. Sutlej waters were distributed between Punjab and Rajasthan as per the Bhakra Nangal Agreement 1959 with Rajasthan's entitlement at 15.22 percent.Forty-nine percent of the project's canal command area (CCA) is in Haryana, 35 percent in Punjab, and 16 percent Rajasthan. In Rajasthan, this translates to 372,000 hectares or 1.45 percent of state's cultivable area, served by the 1,219 km long Bhakra-Sirhind canal distribution system. Only two districts of Sriganganagar and Hanumangar are covered by the project.

Bikaner / Gang Canal

The 114 km-long Gang Canal was the rst to come into existence and became fully operational in 1928, with a 1,251 km long distribution system to serve Sri Ganganagar district. Along with the Bikaner feeder, it provides water to a command area of 300,000 hectares with 65 percent intensity.

Chambal Valley Project

The Chambal Valley Project is a major multipurpose project, constructed across the river Chambal by the State of Rajasthan and Madhya Pradesh for irrigation and hydro - power generation. The Project includes:

- Jawahar Sagar Dam Project
- Rana Pratap Sagar Dam
- Kota Barrage

Chambal command area in Rajasthan is spread over six panchayat samitis (groups of villages) in Kota, Bundi and Baran districts.

Gurgaon Canal Project:

To utilize 500 cusecs of Yamuna Waters through Agra Canal during the rainy season for irrigation Gurgaon Canal Project is being constructed. This will facilitate the irrigation of Kharif crops in 185 villages of Deeg and Kaman tehsils of Bharatpur district. The States of Uttar Pradesh, Haryana, Rajasthan and Delhi have signed an agreement regarding the sharing of Yamuna waters.

Sidhmukh Nahar Project

Sidhmukh Nahar Project is for providing irrigation facilities to Sidhmukh Nohar areas in northern part of the state. The project is undertaken with the assistance of European Economic Community.

Eastern Rajasthan Canal Project: ERCP

In Rajasthan Budget 2018. the Chief Minister has announced several schemes to the tune to Rs 52,000 crore, including development of the Eastern Rajasthan Canal Project (ERCP) at cost of Rs 37,500 crore (1). The detailed project report for the ERCP has been sent to the Centre and Central Water Commission (CWC) has already approved its working.

Background of Eastern Rajasthan Canal Project: ERCP

The surface water of Rajasthan has been divided into 15 River basins and one outside basin area. It is estimated that out of fifteen river basins surplus water is available only in *Chambal and Mahi* basin. Within Chambal basin, during rainy season Kunnu, Kul, Parbati, Kalisindh, Mez, and Chakan sub-basins are also having surplus yield, while Banas, Banganga, Ghambhiri and Parbati sub-basins are deficit in yield.

Hence, Eastern Rajasthan Canal Projects (ERCP) is planned to harvest surplus yield available in the Southern Rajasthan rivers and transfer to deficit basins in South-Eastern Rajasthan.

Eastern Rajasthan Canal Project: ERCP

- The project will link the Kalisindh, Gambhiri and Parbati rivers
- ERCP is planned to meet the Drinking / Irrigation and Industrial water needs of the 13 districts of Southern & South Eastern Rajasthan viz. Jhalawar, Bara, Kota, Bundi, Sawai Madhopur, Ajmer, Tonk, Jaipur, Dausa, Karauli, Alwar, Bharatpur and Dholpur of Rajasthan for Humans and Live stock till year 2051.
- The project will help to irrigate nearly 10 lakh acres of land, giving a boost to agriculture in the state,
- Additional Benefits:
  - Will enhance availability of surface water & Ground water in the region.
  - Will also take care of Flood / Drought situation in the area.
  - Would also boost the Delhi-Mumbai Industrial Corridor (DMIC) in Alwar district and generate employment for youths of the state.
- The state is likely to seek 60 percent financial assistance from the Centre to the project under national project scheme.
- The Project will be executed in three phases.

- The first phase of the project will extend from Galwa Dam to Dholpur,
- The second phase will extend from Galwa to Bisalpur-Isarda,
- The third phase will extend from Galwa to Alwar

Time Schedule:

- The project is proposed to be completed in three phases in seven years from year 2017 to 2023.
- First Phase of about 18474.0 crore is proposed to be completed in five year from year 2017 to 2021

Land Use pattern of Rajasthan

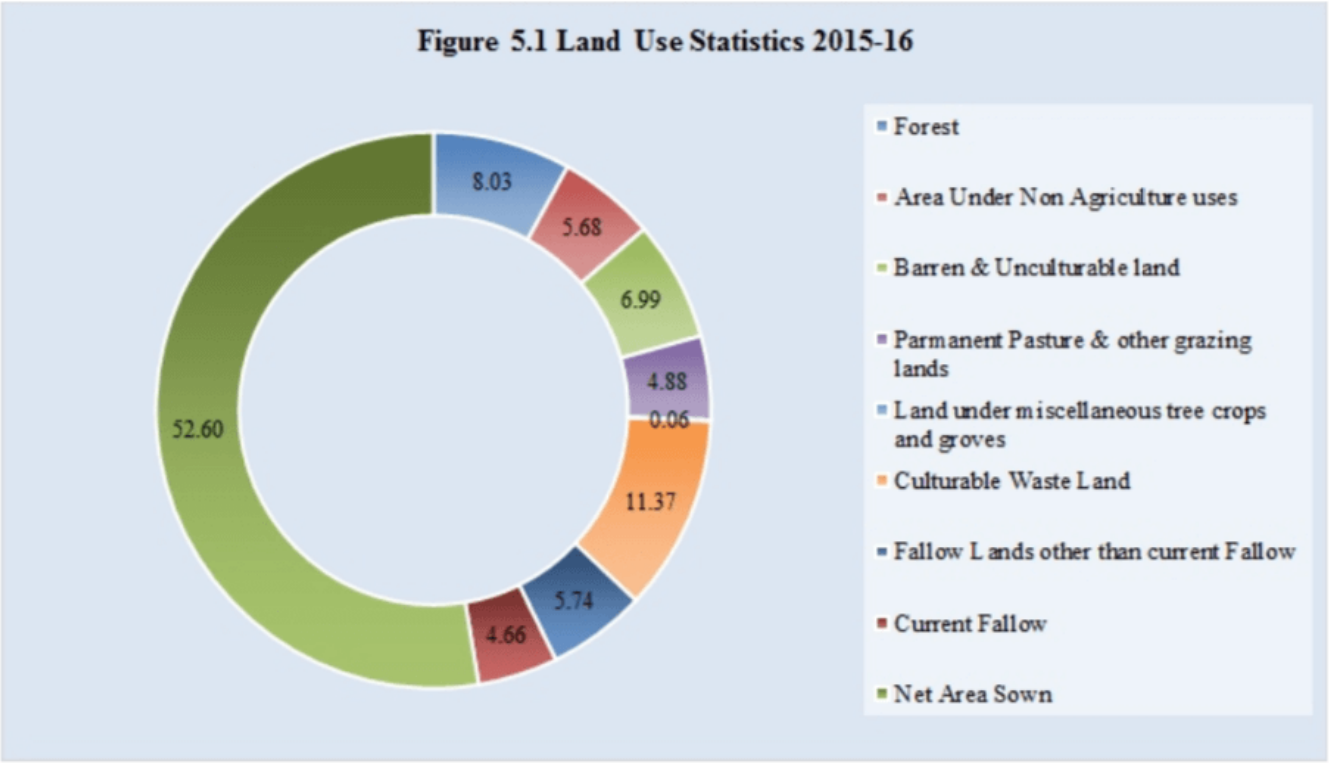
Land use pattern of an area affects vegetation, land quality, local weather and quality of life. It is very important to understand the land use pattern of any area and the dynamics of its shift overtime. This determines the ensuing per unit load on agriculture land, forest land, periphery areas to cities and factors responsible for land degradation. The land use pattern of a region determines the ecological balance in the region and helps to understand the environmental status as well.

Located in north-west part, Rajasthan is the largest state of country, having a geographical area of 3,42,239 hectares which constitutes 10.41% of area of the country. Land use pattern in Rajasthan is as follows:

Land Use Pattern in Rajasthan

S.NO	Land Use	Area(in Lakh Hectare)	Percentage
1	Net Sown Area	180.24	52.60
2	Area under Forests	27.52	8.03
3	Non Agricultural Uses	19.45	5.68
4	Permanent Pastures & other grazing land	16.72	4.88
5	Land under misc trees & grooves	0.21	0.06
6	Culturable Wasteland	38.95	11.37
7	Fallow Lands (other than current fallow)	19.66	5.74
8	Current Fallows	15.97	4.66
	Reporting Area for Land Utilization	3,42,670	100
	Total Geographical area of Rajasthan	3,42,240	-

** *As per GOR, Economic Review 2017-18, Page 49.*



Land use pattern in Rajasthan: Analysis

Net-Sown Area:

- More than half of the total report area is under agriculture operation which proves that Rajasthan is still essentially an agricultural state.
- The high density (above 50%) districts are Alwar, Jaipur, Bharatpur and Tonk in eastern Rajasthan and Churu , Jalore, Jhunjhunu, Sikar, Nagaur and Ganganagar, Hanumangarh in western Rajasthan.

Area under Forests:

- Area under forest in Rajasthan is small, the concentration of forests being more in the districts adjoining Aravallis — like Ajmer, Banswara, Bundi, Chittorgarh, Pali, Sawai Madhopur, Sirohi, Udaipur and Kota.
- Due to low rainfall and aridity forest areas are few and almost negligible in the arid zone districts of Barmer, Bikaner , Churu, Sri Ganganagar, Jaisalmer, Jalor and Jodhpur.

- In rest of the districts the area under forest varies from 1 to 2% and are concentrated in the favourable locations of foothill slopes.

Non Agricultural Uses

- These include settlements, building, roads, other lands appropriated for non-agricultural use — like mountains and shifting dunes, etc.

Permanent Pastures & other grazing land

- The availability of permanent pasture and grazing land determines the status of livestock economy in the regions. It constituted about 5 per cent of the reporting area in Rajasthan.
- In Irrigated North Western Plain, the grazing land is also found negligible.
- The Sub humid Southern Plain is endowed with pastures and grazing lands in one-tenth of the reporting area. Largely, it constituted about 4 to 7 per cent across the zones.
- Hanumangarh and Ganganagar have the least area whereas Barmer, Jodhpur and Bhilwara have the largest area under this category.

Land under misc trees & grooves

- Area under fruit crop fall under this category of land use.
- In Rajasthan, the area under fruit crops is also negligible i.e. less than one per cent.
- Churu and Rajsamand districts have no land under miscellaneous trees, crops and groves. Districts Nagaur, Jalore and Hanumangarh cover the least whereas Dungarpur, Ganganagar and Jhalawar cover the maximum area under the same category.

Culturable Wasteland

- Culturable wastelands are wastelands that can be brought under cultivation by providing irrigation.
- Culturable Wasteland is highest in Ajmer, Alwar and Jaisalmer and minimum at Hanumangarh, Jhunjhunu and Bharatpur.

Fallow Lands:

- A *fallow* field is *land* that a farmer plows but does not cultivate for one or more seasons to allow the field to become more fertile again.
- Fallow lands includes two types of fallow lands - Current fallow lands & Other fallow (*long-fallow*) lands.
- Current year fallow are the lands that have been left fallow for the current year, while other fallow lands include lands that have been left fallow for more than a year.
- In arid regions, except in the districts where irrigation is practised the extent of such fallow land is very high; Barmer, Bikaner, Jaisalmer, Jodhpur dominate this category.

Change in land use pattern in Rajasthan:

- In general there is an increase in total area under cultivation in Rajasthan.
- Permanent pastures and grazing lands and miscellaneous trees and grooves are declining having serious unfavorable implications for the ecology of Rajasthan.
- Although growth in forest area is positive in all the regions of Rajasthan still forest area is only 7.8% of total geographical area, which is well below the minimum norms of 33% of geographical area under forests as set under the National Forest Policy (1952).
- There has been declining growth in barren and other unculturable lands. Land that is being released from barren and unculturable land is shifting towards non-agricultural sector.

Natural Vegetation-Forests of Rajasthan

The forests of Rajasthan cover approximately an area of **32,737 sq km** which is **9.57**% of the total geographical area of the state. The state has teak forests, which is northern most limit of teak zone in India. Apart from meeting the fuelwood and fodder demand, forest resources of Rajasthan contribute Rs.7160 million to the state domestic product (SDP).

The forests of Rajasthan are spread unequally in Northern, Southern, Eastern and South Eastern parts, and the western region of Rajasthan is devoid of any forest cover. Most of the forests are in hilly regions of Udaipur, Rajasamand, Kota, Baran Sawai Madhopur, Chittorgarh, Sirohi, Bundi, Alwar, Jhalawar and Banswara districts.

However, The extent of **Natural Forests** in Rajasthan is not only one of the lowest in the country but also in terms of productivity of forest, it is the lowest. On the contrary The State is endowed with the largest chunk of wasteland which is about 20% of the total wastelands of the country.

The forests of Rajasthan can be divided into four broad forest types.

- Tropical Thorn Forests,
- Tropical Dry Deciduous Forests,
- Bamboo-Forests
- Central India Sub-tropical hill forests.
- Mixed Miscellaneous Forests

Tropical Thorn Forests of Rajasthan

- Tropical thorn forests are found in arid and semi-arid regions of western Rajasthan, namely Jodhpur, Pali, Jalore, Barmer, Nagaur, Churu, Bikaner etc.
- These extend from western Indo -Park border and gradually merge with the dry deciduous mixed forests of the Aravalli hills and the south-eastern plateau.
- The main species found in this kind of forests are ***Acacia nilotica , Acacia leucophloea, Prosopis cineraria, Capparis aphylla, Zizyphus spp., Flacourtia spp.*** etc.

Tropical Dry Deciduous (Dhol) Forests

- These forests are mostly found in small patches in few parts of the state. the northern and eastern slopes of aravalli ranges, mostly in Alwar, Bharatpur and Dholpur districts, are covered with this type of forests.
- Sporadic growth of certain species of dry deciduous forests is found along the dry river beds of Jalore, Nagaur, Ganaganagar and Bikaner, districts.
- The main species found in this kind of forests are ***Babul***

Bamboo Forests

- Bamboo covers about 2.5% of the area occurring mostly in Chittorgarh, Udaipur, Kota & Abu hills.

Central Indian Sub - tropical Hill Forests

- These forests which are most abundant in central India, as in Madhya Pradesh, parts of Gujarat and Maharashtra, are found in Sirohi district of Rajasthan also, mostly on the hills girding Mt. Abu.
- These forests have **semi-evergreen** and some evergreen species of trees.
- The vegetation of Mt. Abu consists of many plants which are similar to the sub - tropical region of Himalayas. Around Mt. Abu, they are well represented between 700 to 800 m altitudes.

Mixed Miscellaneous Forests

- These forests are mostly found in south-eastern and eastern part of Rajasthan including Chittorgarh, Kota, Udaipur, Sirohi, Banswara, Dungarpur, Baran and Jhalawar districts.
- Average rainfall in these forest is more than 60cm and cover approximately 20% of the forest cover.

- These Forests mainly have ***Anogeissus pendula, Anogeissus latifolia, Terminalia tomentosa, Terminalia arjuna, Terminalia chebula, Albizia lebbeck, Dalbergia paniculata*** etc. and its associates.

Administrative Classification of Forest of Rajasthan

As per Forest Survey of India, *State of Forest report 2017*, Rajasthan has recorded forest area of about **32,737 square kms**. This forest area forms **9.57**% of state's geographical area and about **4.28**% of India's forest area. On the basis of Legal status, the Government has classified this forest area into three types:

- Reserved Forests - 12,475 Sq. Kms
- Protected Forests - 18,217 Sq. Kms
- Unclassified Forests - 2,045 Sq. Kms

Reserved Forest:

- These forests are under the direct supervision of the government.
- No public entry is allowed for collection of timber or grazing of cattle.
- Rajasthan has 12,475 sq kms or 38% of forest as Reserved Forest.

Protected Forest:

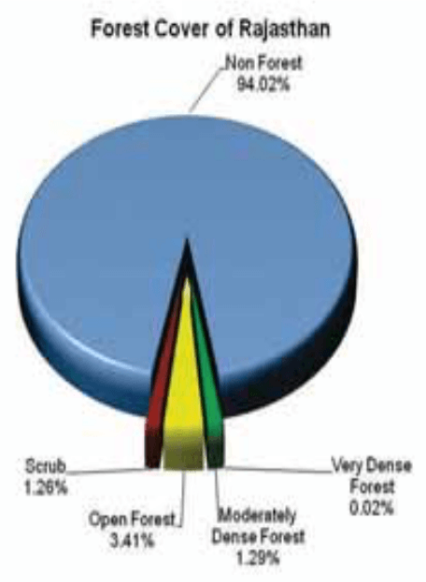
- These forests are looked after by the government, but the local people are allowed to collect fuel-wood / timber and graze their cattle without causing serious damage to the forests.
- Rajasthan has 18,217 sq kms or 55% of forest area under Protected Forests.

Unclassified Forest:

- The unclassified forests are those in which there is no restriction on the cutting of trees and grazing of cattle.
- Rajasthan has 2045 sq kms or 7% of area has Unclassified forests.

The Forest Survey of India (FSI), brings out bi-annual state of forests report. In the report, the FSI classifies forest as:

- Very Dense Forests (VDF) - 0.02%
- Moderately Dense Forests (MDF) - 1.29%
- Open Forests (OF) - 3.41%
- Scrubs - 1.26%
- Non-Forest Area- 94.02%



Very Dense Forests (VDF):

- The Lands with forest cover having a canopy density of 70% and more are called Very Dense Forests (VDF).
- In Rajasthan, there are only **27** Sq kms of very dense forests.
- Percentage VDF: 0.02%

Moderately Dense Forests (MDF):

- The Land with forest cover having a canopy density of 40-70% is called the Moderately Dense Forest (MDF).
- In Rajasthan, there are only **2341** Sq kms of moderately dense forests.
- Percentage MDF: 1.29%

Open Forests (OF):

- The Lands with forest cover having canopy density of 10-40% are called Open Forests.
- In Rajasthan, there are only **6505** Sq kms of open forests.
- Percentage OF: 3.41%

Scrubs:

- The degraded forest lands which have a Canopy density of less than 10% are called Scrubs.
- In Rajasthan, there are about **22286** Sq kms of scrubs.

- Percentage Scrubs: 1.26%

Non-Forest Area:

- Rest of the area, included all other lands except forest area.
- Percentage Non-Forest: 94.02%

The report also identifies, variation of forests with altitude.

Table 7.23c : Altitude-wise Forest Cover of Rajasthan

Altitude-wise Forest Cover				(Area in km²)
Altitude Zone	VDF	MDF	OF	Total
0-500m	26	2,628	9,036	11,690
500-1000m	50	1,681	2,589	4,320
1000-2000m	0	117	44	161
Total	76	4,426	11,669	16,171

(Based on SRTM, Digital Elevation Model)

Important Terms to understand:

Forest Cover:

- Forest Cover All lands which are more than 1 hectare in area and with a Canopy density of more than 10% irrespective of the ownership and legal status is called Forest Cover.

Recorded Forest Area:

- The area recorded as "forests" in the Government records is called Forest Area or Recorded Forest Area.

Canopy and Canopy Density

- The cover of branches and Foliage formed by the crown of trees is called Canopy. The percentage area of land covered by the canopy of trees is called Canopy density.

Top 5 Districts with Forest Cover:

1. Udaipur
2. Chittorgarh
3. Baran
4. Karauli
5. Alwar

Last 5 Districts with Forest Cover:

- Churu
- Hanumangarh
- Nagaur
- Jodhpur
- Dausa

District-wise Forest Cover

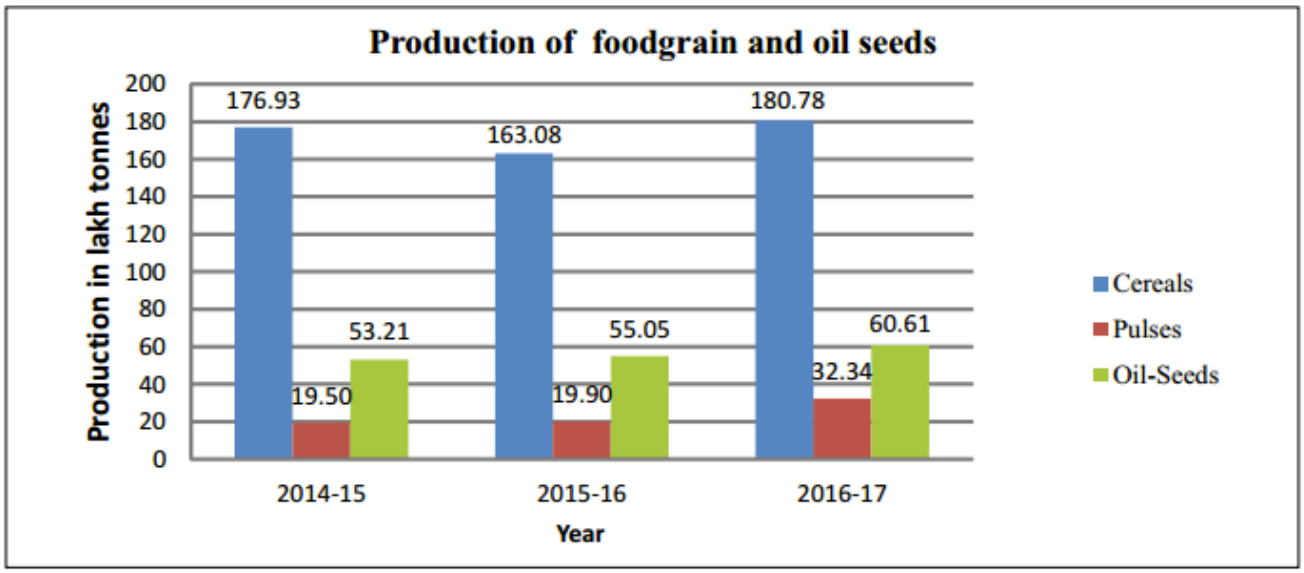
S. No.	Name of District	Reserved Forest	Protected Forest	Unclassified Forest	Total
1	**Ajmer**	194.99	418.09	0.02	**613.10**
2	**Alwar**	1,006.06	636.83	141.25	**1,784.14**
3	**Banswara**	0.00	1,236.67	0.00	**1,236.67**
4	**Baran**	0.00	2,226.74	12.58	**2,239.32**
5	**Barmer**	0.00	568.33	44.77	**609.10**
6	**Bharatpur**	0.00	369.57	12.82	**382.39**
7	**Bhilwara**	437.80	289.62	66.77	**794.18**
8	**Bikaner**	0.00	234.29	1014.45	**1,248.73**
9	**Bundi**	837.29	706.65	16.04	**1,559.98**
10	**Chittoragarh**	1,584.70	1,181.36	0.56	**2,766.62**
11	**Churu**	7.20	10.84	53.18	**71.22**

12	**Dausa**	133.37	148.69	0.57	**282.63**
13	**Dholpur**	7.92	597.78	32.75	**638.45**
14	**Dungarpur**	251.29	433.25	8.71	**693.25**
15	**Ganganagar**	0.00	50.65	582.79	**633.44**
16	**Hanumangarh**	0.00	113.25	126.21	**239.46**
17	**Jaipur**	679.34	263.10	5.63	**948.68**
18	**Jaisalmer**	0.00	199.77	383.52	**581.29**
19	**Jalore**	122.24	298.05	30.40	**450.68**
20	**Jhalawar**	413.45	930.62	5.73	**1,349.79**
21	**Jhunjhunu**	6.02	392.57	6.77	**405.36**
22	**Jodhpur**	4.68	175.52	62.70	**242.89**
23	**Karauli**	62.99	1,675.55	64.27	**1,802.81**
24	**Kota**	874.83	412.58	22.63	**1,310.04**
25	**Nagaur**	0.80	206.23	33.89	**240.93**
26	**Pali**	819.45	141.62	2.51	**963.58**
27	**Rajsamand**	277.44	119.14	0.000	**396.58**
28	**Sawai Madhopur**	792.88	154.16	6.67	**953.71**
29	**Sikar**	9.92	619.18	8.59	**637.68**
30	**Sirohi**	866.60	749.75	22.30	**1,638.65**

31	**Tonk**	101.42	230.75	3.80	**335.97**
32	**Udaipur**	2,961.25	1,626.17	0.00	**4,587.42**
	Total	**12,453.92**	**17,415.96**	**2,768.86**	**32,638.74**

Agriculture Snapshot of Rajasthan

- **75 per cent** population of the State resides in the rural areas and about **62 per cent** depend on agriculture and allied activities for their livelihood.
- Snapshot of production of foodgrain and oil-seeds in Rajasthan:
    - Cereals: 180.78 Lakh tonnes
    - Pulses: 32.34 Lakh tonnes
    - Oil-Seeds 60.61 Lakh tonnes



Monsoon

Agriculture in Rajasthan is primarily rain-fed and the period of monsoon is short. As per information of Indian Meteorology Department, the rainfall patterns indicate that during current monsoon season, the Onset of monsoon had 7 days delay than its normal date of **15 June**. It covered the entire State by 30 June 2017.

During the period 1 June to 30 September, 2017 State witnessed 455.00 mm rainfall, which is 8.5 per cent excess than the normal rainfall of 419.00mm. Rajasthan had received excess rainfall in the monsoon season in 9 districts Barmer, Jaisalmer, Jalore, Pali, Sirohi, Jodhpur, Udaipur, Dungarpur and Rajsamand.

Agricultural Production

- As per preliminary forecast for the year 2017-18, the total food-grain production in the State is expected to be 225.82 lakh tonnes, which is showing a decrease of 2.26 per cent as compared to the production of 231.04 lakh tonnes during the previous year.
- The kharif **foodgrain** production in the year 2017-18 is expected to be 89.47 lakh tonnes and the Rabi rabi foodgrain production is expected to be 136.35 lakh tonnes.
- Production of **kharif cereals** during the year 2017-18 is expected to be 70.53 lakh tonnes and Production of **rabi cereals** is expected to be 119.99 lakh tonnes
- Production of **kharif pulses** is estimated to be 18.94 lakh tonnes during the year 2017-18.
- Oilseeds including Groundnut, Sesamum, Soyabean and Castor seed are grown in kharif season and Rape & Mustard, Taramira and Linseed in rabi season. The production of oilseeds during the year 2017-18 is estimated at 57.44 lakh tonnes
- Production of Sugarcane is likely to be 4.04 lakh tonnes during the year 2017-18
- The production of Cotton is likely to be 17.28 lakh bales during the year 2017-18

Crops produced in Kharif Season:

Food Crop (Cereals)	Area Under Crop	Max. Production District	Productivity Maximum
Rice	Bundi	Bundi	Hanumangarh
Jowar	Ajmer	Ajmer	Kota
Bajra	Jodhpur	Alwar, Jaipur	Alwar, Dholpur
Maize	Bhilwara	Bhilwara, Chittore	Bundi
Small Millets	Dungarpur	Dungarpur	Udaipur

Pulses	Area Under Crop	Max. Production District	Productivity Maximum
Tur	Banswara	Ganganagar	Ganganagar
Moong	Nagaur	Nagaur	Tonk
Moth	Churu	Churu	Sikar
Urad	Bundi	Bundi	Kota
Chowla	Sikar, Jhunjhunu	Jhunjhunu, Sikar	
Oil Seeds	**Area Under Crop**	**Max. Production District**	**Productivity Maximum**
Groundnut	Bikaner	Bikaner	Bikaner
Caster Seed	Jalore	Jalore	Hanumangarh
Seasumum	Pali	Pali	Ajmer
Soyabean	Baran	Baran	S.Madhopur
Cash Crops	**Area Under Crop**	**Max. Production District**	**Productivity Maximum**
Bt-Cotton	Hanumangarh	Hanumangarh	
Guar	Bikaner	Bikaner	
Sugarcane	Ganganagar, Chittore, Bundi	Ganganagar	
Sanhemp	S.Madhopur	S.madhopur	

Chillies	S.Madhopur	S.Madhopur	

Crops Produced in Rabi Season:

Food Crop (Cereals)	**Max. Area**	**Max. Production District**	**Productivity Maximum**
Wheat	Ganaganagar, Hanumangarh	Ganaganagar, Hanumangarh	Dholpur
Barley	Ganganagar, jaipur	Jaipur	Alwar
S. Millets	Jalore, Sirohi	Jaore, Sirohi	Sirohi
Pulse	**Max. Area**	**Max. Production District**	**Productivity Maximum**
Gram	Bikaner, Churu	Bikaner	S. Madhopur
Masoor	Bundi	Bundi	
Matar	Jaipur	Jaipur	Sikar
Batla	0	0	0
Sunflower	0	0	0
Oil Seeds	**Max. Area**	**Max. Production District**	**Productivity Maximum**
Caster Seed			
Tarameera	Nagaur	Nagaur	Sikar

Rape & Muster	Tonk, Alwar	Alwar	Baran
Lineseed	Tonk	Tonk	
Mustard	Tonk, Alwar	Alwar	Dholpur
Cash Crops	**Max. Area**	**Max. Production District**	**Productivity Maximum**
Tobaco	Jalore, Alwar	Jalore	

The data has been combined from: Agriculture Ministry, Rajasthan (in 2018), taking into account information shared by them for 2016-17. Now this data is subjected to vary on year-basis, as crop production changes.