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FOREWORD

This is another addition to the Series that the National Book Trust has planned on "India—the Land and People."

The origin of the Series is the result of a discussion that I had with the late Prime Minister, Pandit Jawaharlal Nehru. When I first put the idea before him, he not only heartily approved it but gave many suggestions for making it more complete and attractive. It was his opinion that such a Series of books on India will form a permanent library of knowledge on every aspect of this country and is sure to make constructive contribution for national advancement in knowledge and education.

The Series proposes to cover every aspect of the country and will deal with its geography, geology, botany, zoology, agriculture, anthropology, culture, language, etc. Its ultimate aim is to create a kind of comprehensive library of books on India. We have endeavoured to have the books written by acknowledged authorities on various subjects and in a scientific way. Every effort is being made to see that they are easily understandable by the ordinary educated reader. The factual knowledge regarding the various subjects concerning India would be available to any ordinary reader who is not a specialist and who would like to have a knowledge of the subject in a relatively simple language.

We have been fortunate in getting the guidance of leading experts and scientists in various fields for this Project. In fact without their active cooperation it would not have been possible to plan the Series. We are thankful to our Board of Honorary Editors who are eminent specialists and leaders in their field for helping us in producing the volumes for the benefit of the ordinary reader.

One of the objects of the Series is to make it available in as many Indian languages as practically possible. The work of translating them in various languages will be taken up as soon as the original books are ready. In fact a few volumes might be originally written in some of the languages.
FOREWORD

We have received full support from the Ministry of Education of the Government of India and the State Governments. They are lending their help in many ways not the least by permitting scientists working under them to write for the Series. I would like to take this opportunity of thanking them. Without their help it would not have been possible to undertake this enterprise of national utility.

I am very grateful to my colleague, Professor M. S. Thacker, Member of the Planning Commission, for agreeing to be Co-Chief Editor. His enthusiastic collaboration has greatly helped in planning the Series successfully.

New Delhi
February 20, 1967

B. V. KESKAR
PREFACE

THE GEOGRAPHY OF RAJASTHAN is one of the series of books on "India—the Land and People", being published by the National Book Trust, India. Rajasthan is a land of extremes and the present study indicates the great variety in relief, climate, soil, vegetation, agricultural activity and mineral deposits.

There can be two ways of writing a book on any state; one, the descriptive method; the other, the functional method. The first being descriptive becomes encyclopaedic in scope. In the second the emphasis is on analysis, co-relation and appraisal. In the present work, the functional method has been followed, which is by no means easier; but it seems to be the only one, which furnishes dependable results. The aim of this book is comprehension and understanding through functional co-relation. Detailed information is furnished for the purpose of illustrating a point and general functional relationship.

The subject has been treated in its regional aspects and an attempt has been made to preserve a balance between the physical, human and economic aspects in this book. In a book dealing with a State such as Rajasthan where agriculture, animal husbandry and mining industry are of paramount importance, it is natural that much space has been devoted to these aspects of economic geography.

Numerous maps and illustrations have been especially prepared for this book. It is expected that these will prove to be a valuable and attractive feature of this book. Various data obtained from Government publications like Census of India Reports and Rajasthan Statistical Abstracts for different years, have been frequently quoted and used, without always citing references.

The outline maps of Rajasthan in this book have been adapted from the School Atlas. First Edition (reprint, 1964) published on behalf of the Ministry of Education, Government of India under the direction of the Survey of India, Dehra Dun and from the 40 mile Map of India and Adjacent Countries, published by the Survey of
India, Dehra Dun. Figure 2 showing the Geology of Rajasthan has been adapted from the Geological Map of Rajasthan and Ajmer published by Deputy Director, Geological Survey of India (Memoirs Vol. 86), Calcutta, 1958. Similarly Figure 17 showing Distribution of Minerals is based on the map published in the Report on the Ceramic Industry in Rajasthan by the Department of Mines and Geology, Udaipur, 1960 and Figure 21 showing Roads and Railways is based on the 40 mile Map of India and Adjacent Countries, published by Survey of India, Dehra Dun and the Road Map of India, 1960.

I take this opportunity to express my deep gratitude to the following: to Prof. George Kuriyan, Ph.D., of the Madras University for going through the manuscript in detail and for valuable suggestions; to Prof. W. D. West, D.Sc., Head of the Centre of Advanced Research in Geology, University of Saugar for the detailed checking and for comments on the geology section; to Dr. S. P. Raychaudhuri, Ph.D., of the Land Resources Division of the Planning Commission, New Delhi, for materials on the soils of the State; and to Prof. S. P. Chatterjee, D.Litt., Director, National Atlas Organization, Calcutta, for suggestions.

I am grateful to all those who have directly and indirectly aided in the preparation of this book; to the Director, Central Arid Zone Research Institute, Jodhpur; to the Director, Public Relations Department, Jaipur, and C.A.Z.R. Institute, Jodhpur, for photographs which have been of great help in illustrating this book and to all my colleagues in the Department of Geography, University of Jodhpur, for supplying literature which has been helpful in completing this book. My thanks are due to Shri K.P. Dhurandher, Shri R. P. Arya and Shri P. S. Chauhan for their assistance in completing this work.

JODHPUR

February, 1967

V. C. MISRA
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Based upon Survey of India map with the permission of the Surveyor General of India. © Government of India Copyright, 1962.
CHAPTER I

INTRODUCTION

RAJASTHAN,¹ situated in the northwestern part of India between 23°03' N and 30°12' N latitudes and 69°30' E and 78°17' E longitudes, covers an area of about 342,274 sq kilometres.² The western and northern boundaries are marked by the eastern boundary of West Pakistan. The rest of the boundary in the north, east and south is marked by other states of India. In the north and northeast it is bounded by Punjab and Uttar Pradesh, in the east and southeast by Madhya Pradesh and in the southwest by Gujarat. In terms of area this State is the second³ largest State in the Indian Union. In shape it is an irregular rhomb with north-south and east-west diagonals, the former about 784 km and the latter about 850 km long.

It is in Rajasthan that the desert belt girdling half around the world merges into India's rainfed centre. This has resulted in amazing variations in soil, climate, population and vast agricultural, mineral and industrial potentials. The Kota district in southeastern Rajasthan conforms more or less to the pattern of tropical humidity similar to what is found in other parts of India. On the other hand, in the western part of the State, particularly in the western part of Jaisalmer, Bikaner and Barmer, relief is marked by sand dunes and sand storms blow through the scorching summer, while the winter mornings are quite frosty.

FORMATION OF RAJASTHAN

Rajasthan is the collective and classical denomination of western

¹ Raj (Regal); sthan (dwelling)
² Census of India, 1961, Vol. I Part II–A (i) p. 84, figures by the Surveyor General of India. Area of Rajasthan 341,595 sq km by the State Survey Department.
³ The largest being Madhya Pradesh with an area of 443,452 sq km according to the Surveyor General of India. According to the State Survey Department, area being 437,820 sq km, ibid, p. 71.
India, which for centuries remained as the territory controlled, ruled and predominantly inhabited by (Rajpoot) princes. Locally this region has been known as Rajwarra which latter came to be designated as Raet’hana and subsequently during the British period the Rajpoot principalities came to be known as Rajpootana. Before 1956, Rajasthan consisted of nineteen princely states and three chiefships. These states varied largely in area, population, levels of economic development and resources, social heritage and administrative organisation.

The present State of Rajasthan is the product of successive mergers commencing since 17 March 1948 up to 1956 with the promulgation of the States Reorganisation Act. After independence, the nucleus of the present Rajasthan can be found in the merger of the princely States of Alwar, Bharatpur, Dholpur, Karauli and the Chiefship of Neemrana which joined on 17 March 1948 as one territorial unit known as Matsya Union. On 25 March 1948 other adjoining states namely Kota, Bundi, Jhalawar, Banswara, Dungarpur, Kishengarh, Pratapgarh, Shapura and Tonk also merged with this Union. This resulted in the formation of the former Rajasthan. A month after the formation of the Matsya Union, Udaipur joined the Union. By 30 March 1949 other States like Bikaner, Jaipur, Jaisalmer and Jodhpur joined the former Rajasthan, bringing into existence the united States of Greater Rajasthan. In the sixth stage a part of Sirohi State was also merged with it. However, even at this stage, Ajmer State enjoyed a separate entity as one of the part ‘C’ states in India. In 1956 with the promulgation of the States Reorganisation Act, Ajmer State along with Abu Road Taluka of the former Bombay State, and the Sunel Tappa region of the former Madhya Bharat merged with Rajasthan and Sironj sub-division of Kota district was transferred to Madhya Pradesh (Appendix A). Thus integration and the States Reorganisation Act of 1956 brought into existence the present State of Rajasthan.

1 A list of covenancing States together with relevant details is given in Appendix A.
INTRODUCTION

INTERNATIONAL BOUNDARY WITH PAKISTAN

Along the western boundary of Rajasthan, India and West Pakistan, face each other across the international boundary for about 1,070 kilometres. This boundary separates the Indian districts of Ganganagar, Bikaner, Jaisalmer and Barmer of Rajasthan State from the Pakistani districts of Bahawalpur, Khairpur and Mirpur Khas. Before partition it was the provincial boundary demarcating the princely states of Rajputana namely Bikaner, Jaisalmer and Marwar from the Bombay Presidency and the Punjab State. The partition of India made this boundary an international boundary. The basis for the partition of the territory in 1947 lay in the religious majority represented in each area.

An international boundary may be of various sorts: natural, cultural, mathematical and complex. The boundary between Rajasthan and West Pakistan is basically natural as it passes across the bleak, inhospitable and arid wastelands, known as the Indian or the Thar Desert. The international boundary runs across the Sandy Arid Plains (Marusthali) of the western Rajasthan. The sandy and arid desert, through which the boundary passes, stretches well beyond the Indian border in the west into Pakistan in the districts of Bahawalpur, Khairpur and Mirpur Khas.

This boundary line runs from about 10 km south of Fazilka in the north to southwest well beyond west of Shahgarh, and then swings towards southeast to join the northeastern end of the Rann of Kutch. Beyond this, the international boundary with India is marked by the northern boundary of Gujarat State. The boundary between Rajasthan and West Pakistan had remained peaceful and politically stable and had not posed any great problem between the two countries up to September 1965.

The physiography of the land through which this boundary passes is covered with vast expanse of sand, sand dunes and at places exposed rock surfaces. The rainfall is less than 10 cm per year and transport is difficult. The nature of physiography, climate and aridity has made this area inhospitable for large human settlements. Due to scarcity of water, high temperatures and sandy tracts, the people in the area have adopted the nomadic way of life.
At times, difficulties and controversies have arisen due to this way of life but they have not been of a very serious nature. Since the boundary across the desert, could very well serve as barrier between the two countries, the natural barrier frontiers have had a very real defensive value in the past. In the present age of technology, although such frontiers have lost some of their defensive utility, as long as they retain their barrier aspect, they make good boundaries. The international boundary in western Rajasthan passes through such tracts that there is likelihood of little contact between the people across the international border with the least possible amount of friction.

The conflict between India and Pakistan in 1965 has very well demonstrated that this boundary although natural, could be crossed with modern machines of transport. It is also true that a long land border with other countries like Pakistan, China, Nepal, and Burma cannot be guarded very closely, because of the expenses involved. The sanctity of the international boundary can be maintained on the basis of good relations with the neighbouring countries. It is, however, desirable that the areas adjoining the boundary must have a good system of roads and railways, so that during emergency, supplies in respect of men, material and equipment could be transported to counter any threat from across the border.

The relief features are marked by the Aravalli Ranges which run across the State from northeast to southwest for nearly 692 kilometres. These are one of the oldest mountain ranges, not only in India but in the whole world which have passed through several cycles of erosion and still retain the characteristic form of mountains. The area lying west of the Aravallis is covered by vast stretches of sand, at places interrupted by rock outcrops and inliers. The sand dune deposits in the west have greatly affected the habitat and economy in this area. East of the Aravallis, the topography is marked by the Eastern Plain (The Banas Basin) and the Southeastern Pathar which include the Vindhyan Scarpland and the Deccan Lava Plateau.

The regional drainage is largely determined by the great Indian watershed which divides the drainage into the Bay of Bengal and
the Arabian Sea. The watershed runs for considerable distance across the Aravalli axis. The western and southern part of the Aravalli is drained by small streams and their tributaries like the Luni, Sukri, Banas, Sabarmati and Mahi, while the eastern part is drained by the Banas river with its tributaries and the Chambal river.

Extremity of climate is characteristic of Rajasthan. The 50 cm rainfall line divides this State into two distinct climatic regions. The area west of the Aravallis has long periods of severe drought accompanied by high wind velocity and low relative humidity. East of the Aravallis, the amount of rainfall and temperature distribution show considerable variations. The winter is cold; on the western side, at places the temperature falls below freezing point and frost occurs. All over the State during summer, heat is intense and scorching.

The relief and climatic conditions in Rajasthan have greatly influenced the natural vegetation, soil and agricultural operations. The vegetation in the western arid region is scanty while deciduous and sub-tropical evergreen forests are found in the east and south-east of the Aravallis. The area under forests constitutes about 12.7 per cent of the total area in this State.

Soils are one of the most important natural resources in this State. The western part is characterised by vast stretches of sand deposits. The soil gradually improves towards the east and north-east. It varies from desert soil in the west to medium black soil in the east and alluvial soils in the north and northeast.

The State possesses a large variety of mineral deposits but these resources have not yet been able to change its basic agricultural economy. Nearly four-fifths of the people are engaged in agricultural activities. The land use and crop distribution pattern for 1960-1, indicate the influence and control imposed by relief, temperature, rainfall and soil conditions. Nearly two-fifths of the total area is under crop cultivation, 15.2 per cent is barren and uncultivated and 20.2 per cent is culturable waste. The average agricultural productivity as compared to the all-India average is low. The western sandy plain region is not completely infertile. Desert soils, grey
and brown soils and alluvium are good, but lack of moisture, poor and insufficient facilities have resulted in low yield. Here, the percentage of net sown area decreases so much that in Bikaner and Jaisalmer districts, it is about 9 per cent of the total area. Bajra, millets and pulses are the important crops. In the east of the Aravalli ranges, crops like wheat, maize, cotton, sugarcane and oilseeds are quite common. Among the various irrigation projects, the Rajasthan Canal Project in the northwest and the Chambal Project in the southeast have a significant place in the agricultural development of these regions. The Rajasthan Canal Project proposes to transform into agricultural land, an area over 525 km long and 45 km wide, in the vast arid stretch of the Indian Desert in the northwestern part of the State.

The use of minerals is as old as human civilization itself, but in recent years, the way of their use has changed considerably. At present, the larger part of the minerals is used in the construction and operation of power driven machines. In Rajasthan, before the First Five Year Plan, mining was mostly confined to building stones. Though some mining was done earlier, this industry came to be properly organised only after the integration of States in 1956. Rajasthan produces a large variety of minerals with little coal and iron ore. In the case of minerals like bentonite, fuller’s earth, gypsum, lead-concentrates, silica, steatite and zinc-concentrates, it is the leading producer in the country. But the nature of the reserves, occurrence in different parts of the State, their marginal deposits and above all, lack of coal and iron ore, came in the way of its becoming the leading industrial state in the country. Among the major industries, cotton, wool, sugar, cement, glass and salt are the most important. The first three are agro-based industries while cement and glass industries are based on the mineral deposits available within the State. The salt industry occupies an important place among the large scale industries in Rajasthan. All the salt works are inland and contribute about 10 per cent of the total salt produced in India.

The State covers nearly one-tenth of the total area of the country but supports only 4.6 per cent of the total population. It has a
population of 20.16 million (1961) spread over an area of 342,274 sq kilometres. The average density of population is 59 persons per sq km which is the lowest in the country, except for Jammu and Kashmir, where it is only 25 persons per sq kilometre. The relief and climatic conditions have greatly influenced the distribution of population in this State. The larger aggregations of population are found in the level tracts with better water supply and fertility of the soil, and therefore, a greater capacity for food production. There is a higher concentration of population in the river valleys in the eastern plain area and to some extent in the Luni basin and the sub-montane zone in the west.

The western arid and semi-arid part of this State is an important area in livestock production. This industry provides subsidiary occupation to the desert inhabitants, particularly, the nomadic tribes who depend for their livelihood on their livestock. The State has 9.9 per cent of the livestock wealth of the country. In 1961 it accounted for 18.2 per cent sheep, 13.2 per cent goats, 7.9 per cent buffaloes, 7.4 per cent cattle and more than half of the country's camel population. The State has rather a monopoly in camels and for draught animals of the Rathi, Hariana, Tharparkar, Mewat, Gir and Nagauri breeds.

Means of communication and systems of transport serve as an index to measure the degree of economic development and prosperity of any area. This State is poorly served by railways and roads. It has only 6,227.5 km of railways and 25,554 km of roads. The existing transport system of roads and railways has several tasks to perform. All the surplus agricultural products like foodgrains, cotton, oilseeds, etc., have to be transported by the roads and railways. Apart from farm products, mineral producing areas and various developing and growing industries in the State also need and depend on railways and roads.

The State has been divided into seven geographical regions on the basis of physiography, climatic conditions, soils, vegetation and economic activity. These different regions vary greatly in size, human activity and natural resources. In addition, man-made factors like irrigation facilities, industrial development and means
of communication also show great disparity between different regions. All the environmental conditions distinguish between different areas and regions but the degree of their influence on social life differs from place to place.
CHAPTER II

GEOLOGY AND PHYSIOGRAPHY

GEOLOGY

The chief characteristic of the geology and rocks of Rajasthan is noticed in its remarkable succession of pre-Cambrian rocks which go far down towards the base of the Archaean. This sequence commences from the Bundelkhand gneiss, which is one of the oldest granites exposed anywhere upon the earth’s surface. The early geologists call it a ‘fundamental gneiss’ of the horizontal and unaltered, but unfossiliferous sediments of the Vindhyan system. There are in all, seven formations, if Bundelkhand gneiss is also included, and these are separated by erosion unconformities. Among the formations the Vindhyan and the Malani Volcanics just enter the area.

In Rajasthan the Aravalli range runs from northeast to southwest. It is considered to be the oldest folded range in the world which still remains in the form of ranges. This mountain chain was peneplaned in Palaeozoic times and was subsequently re-uplifted in the Mesozoic Era and this uplifting shows its physical effects in the exceptional local steep folding and faulting of the Vindhyan along the Great Boundary Fault, a thrust which has been traced for about 480 kilometres.

Across the Aravalli range is noticed a great variation in the degree of metamorphism of the rocks of the three systems, of which it is composed, namely the Aravallis, the Raialos and the Delhis. Both the pre-Aravalli formations, namely, the Banded Gneissic Complex and the Bundelkhand Gneiss are older than the Aravallis, and they rest upon them with a profound erosion unconformity. The junction of both pre-Aravalli formations is concealed at great depths and the relation between the two is not clear. It can, however, be said with certainty that the Banded Gneissic Complex and the Bundelkhand Gneiss are the most ancient rocks in India
over which the Aravallis and subsequent latter rock formations and structures have been built. The geological succession of Rajasthan is the most complex rock structure in solid geology. The following geological formations have been traced out in sequence.

**GEOLOGICAL SUCCESSION OF RAJPUTANA SHIELD**

<table>
<thead>
<tr>
<th>Age (in million years)</th>
<th>Era</th>
<th>Period, Geological Formations and Associated Economic Deposits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Birth of Himalaya; Final Wreck of Gondwanaland</td>
<td>Tertiary</td>
<td>Eocene : Nummulitic limestone, fuller's earth and sub-bentonite of Western Rajputana, and lignite in Bikaner and Jodhpur.</td>
</tr>
<tr>
<td>1</td>
<td>Mesozoic</td>
<td>Cretaceous (Weald): Himmatnagar sandstone (Idar), Barmer sandstone (Jodhpur). The sandstone is used as building stone and millstone.</td>
</tr>
<tr>
<td>60</td>
<td>Mesozoic</td>
<td>Jurassic (Md); Limestone and sandstones of Jaisalmer.</td>
</tr>
<tr>
<td>145</td>
<td>Mesozoic</td>
<td>Jurassic (Md); Limestone and sandstones of Jaisalmer.</td>
</tr>
<tr>
<td>170</td>
<td>Mesozoic</td>
<td>Upper Carboniferous: Ice transported boulder beds near Bap in Jaisalmer.</td>
</tr>
<tr>
<td>240</td>
<td>Palaeozoic</td>
<td>Cambrian : Upper Vindhyan : Sandstones, limestones and shales, to the east and to the west of the Aravallis. The sandstones are prized as building stone and the limestones as a source of lime for cement, calcium carbide, etc. Lower Vindhyan: Limestone and shale: and Malani series: Mostly acid flows and tuffs and granite, west of the Aravallis, Wolfram deposits of Rewat hill, Marwar, probably derived from the granite in which traces of several rare earths and minerals also occur.</td>
</tr>
<tr>
<td>500</td>
<td>1 Adapted from Dr. A. M. Heron and Sir C. Fox.</td>
<td></td>
</tr>
</tbody>
</table>
Based upon Survey of India map with the permission of the Surveyor General of India. © Government of India Copyright, 1962.
<table>
<thead>
<tr>
<th>Age (in million years)</th>
<th>Era</th>
<th>Period, Geological Formations and Associated Economic Deposits</th>
</tr>
</thead>
<tbody>
<tr>
<td>610–725</td>
<td>Algonkian or Proterozoic</td>
<td>Delhi system: Mainly quartzite and impure calcareous rocks, and large masses of Erinpura granite form the core of the Aravalli Range. Deposits of barytes, mica, beryl, rare-earth minerals, felspar and metallic ore deposits, e.g. copper etc., occur in the eastern sector of Rajputana. Raiarlo series: Mainly limestone and marble, partly dolomitic. Marbles of excellent quality are quarried at Makrana on the east flank of the desert and at Rajnagar, Sarangawa etc., east of the Aravalli range; steatite at Dogetha (Dagota) 2-1/2 miles northeast of Raiarlo (27°0.5' : 76°0.17') in Jaipur State.</td>
</tr>
<tr>
<td></td>
<td>Archaean</td>
<td>Aravalli system: Phyllites, slates, including roofing slates and minor quartzites and dolomitic limestone, found on the flanks of the Aravallis; also form the basement of the Vindhyan and later formations in Western Rajputana. Deposits of silver-lead-zinc at Zawar in S. Mewar, and of asbestos, and soapstone in the eastern sector of Rajputana. Banded Gneissic complex and Bundelkhand granite: Outcrops are seen both to the east and to the west of the Aravallis.</td>
</tr>
</tbody>
</table>

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**Bundelkhand Gneiss**

This formation is the oldest in India and extends from eastern Rajasthan across Bundelkhand for about 610 km in length and for about 210 km in width. This Bundelkhand gneiss has been recognised as 'fundamental gneiss' and its formation has been accounted for, as a consolidation of the first sial crust of the earth and upon this, the banded Gneissic Complex has been deposited. It is like a huge batholith, extending from eastern Rajasthan to a length of about 610 km and 210 km from north to south. Over a large part of the area this formation is more of a granite than a gneiss and
resembles the post-Dharwarian granites of south India. An erosion unconformity between this formation and the Aravalli rocks is found to exist and for this reason it is classified among the pre-Aravalli formation. The Bundelkhand gneiss is mostly a normal granite in composition and varies from pink to reddish in colour, medium grained, non-foliated and non-porphyratic, with quartz, orthoclase and subordinate microcline and some ferro-magnesian minerals, mostly biotite, as the chief constituents. It is also traversed by veins of aplite, microgranite and quartz and dolerite dykes.

Banded Gneissic Complex

The rock formation is also classed as belonging to pre-Aravalli rocks and in age belonging to the Bundelkhand gneiss. The outcrops of this gneissic complex are not extensive and in position underlie the alluvial plains of Rajasthan. This formation shows great variability from one point to another and the complex is characteristic of the older Archaean in other parts of the world also. This formation is best exposed in south Mewar, where rocks of an intimate mixture of various types of intrusions, highly sheared and foliated are observed. In south Mewar, the Banded Gneissic Complex has attained its greatest complexity. In field, the rock structure is very distinct from the Aravallis which rest on it, with a clear erosion unconformity, accompanied by thick conglomerates and great series of basic lava deposits. In the east of Udaipur city, the gneisses are comparatively simpler in composition. These gneissic formations are described as composite gneisses, essentially a mixture of biotite-schist and white or pink aplite and microgranite injected along the foliation, with intrusive bodies of all sizes of grey-foliated biotite-granite.

In north Mewar and plains of Ajmer the gneisses are characteristically more heterogeneous with granitoid and banded types occurring. The rocks are dark schists and granulites, often garnetiferous, with intrusions of all sizes of dark coloured porphyritic biotite-granite, varying from granitoid to strongly banded resulting in the formation of composite gneisses. Among other varieties, the most
characteristic occurrence found is that of bead gneiss, in which feldspar phenocrysts are strung out along lines in the dark biotitic-matrix. This structure also occurs in the Central Plains of Mewar and the formation swings towards east into Banswara.

Apart from the above varieties, another type of ancient gneiss is also found in the northwest of the Great Delhi Synclinorium, mostly in the plains along the foothills of the Aravalli range. It is a grey, rather fine-grained rock of granitic composition and texture, mainly homogeneous, but sometimes variations occur and rocks are foliated. The basal conglomerate of the Alwar series rests upon it with an erosion unconformity and to some extent is composed of its debris, but its relation with the Aravallis is not certain. It has been recognised as older than the Aravallis, or it may be intrusive in them, but it is unlike the granite which invades them on the other side of the Delhi synclinorium and the range.

The Banded Gneissic Complex was originally a sedimentary formation. It is confirmed by the existence of two oval domes of massive quartzites located northwest and west of Amet (25°19' N : 73°56' E) which cover an area of about 20 sq km respectively. These different rock structures do not occur separately but there is a gradual transition of the one into the other; Epidiorite and hornblende rocks, which are altered basic igneous rocks, are also found in the Banded Complex.

**Aravalli System**

The Aravalli system has great thickness of argillaceous rocks. This rock formation has undergone metamorphic changes and is most clearly marked from east to west. In the east, one finds shales and towards the west one passes through slates and phyllites to fine mica schists with garnet and magnetite. In some area, alteration with acid granite has occurred resulting in the formation of composite gneisses. Generally it is found that igneous intrusions other than white quartz veins are not particularly common in the Aravallis.

In Rajasthan the general sequence of rock formation is as follows:
(i) Volcanic beds (local),
(ii) Basal quartzites, grits and local conglomerates,
(iii) Phyllites, cherty limestones, quartzites and composite gneisses, and,
(iv) Ranthambhor quartzites and Binota shales.

In south Alwar, one finds the northern exposures of the Aravallis. The beds of rocks occur as interrupted outcrops, irregular in nature and extend southwest up to the plains of Gujarat. They also cover a large part of Mewar and Ajmer-Merwara, interrupted by irregular outcrops of the pre-Aravalli gneisses. Other rocks of this system chiefly, arkose, grits and quartzites which represent the basal beds, rest upon the Bundelkhand gneiss, or the gneissic complex, with an erosion unconformity. The injection of granitic materials into the schists and composite gneisses is also noticed. In this formation, gneisses have developed extensively and the diversity of types characterises the formation. Argillaceous limestone is found in Bundi and eastern Mewar and a black, massive limestone bed of a few hundred feet thickness around Udaipur city also represents the Aravallis. In the Aravallis, the limestones are poorly developed in eastern Mewar. Just east of the Great Boundary Fault, the Aravallis occur with brown and olive shales, with ferruginous and clay concretions. These formations are known as the Binota shales and Kanoj grits. On the western side of the Boundary Fault the Aravallis are represented by slates and impure limestones frequently intruded by dolerites. The Ranthambhor quartzites and sandstones occurring in Ranthambhor and Sawai Madhopur represent such formations which belong to the youngest part of the Aravallis system.

**Raialo Series:** This Raialo Series occur in between the Aravallis in the lower part and overlain by the Delhi system. In both cases the junction is marked by erosion unconformity. The Raialos have been separated from the Delhi system and grouped as a separate series. Generally white and crystalline limestone with an average thickness of about 612 metres constitute the main rock of this series. At the base of limestone deposits, conglomerates and sandstone and quartzite deposits are found and the limestone
rests directly on the Aravallis, the Bundelkhand Gneiss, or the Banded Gneissic Complex. This series is found in widely separated areas such as Jodhpur, eastern and central Mewar. The Raialos are exposed in the intricately folded syncline which emerges from below the base of the Delhi system north of Udaipur city and extends towards the northeast beyond Nathdwara and the Raj Samand lake at Kankroli. In these areas the basement rock is a boulder conglomerate, at some places 9.2 metres thick, and at other places, a thin formation of quartzite. A pure white crystalline dolomite of varying thickness is quarried at Rajnagar near Kankroli. The famous Makrana marble outcrops are exposed from the sandy alluvium in narrow ridges for a distance of about 80 kilometres. In this exposure only the more resistant rocks are visible while the actual thickness is estimated to be much more. The rock is white, slightly clouded with pale grey but pure white also occurs. Apart from these, rose, pink and blue grey varieties are also found.

A much varied type of limestone, almost with complete sequence, is found in the southwest near Ras. The rocks are exposed for about 80 km with a width of about 1.6 kilometres. The main varieties are coarse, white calcite marble, with diopside and white mica interbedded with bands of finer, blue-grey sandy limestone. The pre-Aravalli gneiss surrounds generally the limestone ridges and is exposed in the valleys between them.

The impenetrable nature of the rock is indicated by the fact that this is free from igneous intrusions. In Makrana quarries a few dykes of pegmatite are seen but such occurrences are rare and sometimes are also found on the ridges between Kankroli and Sardargarh.

**Delhi System**

The Purana rocks of Rajasthan have undergone more intense folding as well as greater amount of igneous intrusion and it is in these characteristics that these rocks differ from rocks of the same age in other parts of India. In Rajasthan these are known as the Delhi system. Their extensive development has taken place in eastern Rajasthan and they extend from Delhi in the northeast to
Idar in the southwest. The best formation of these is developed in the main Rajputana synclinorium of Ajmer–Merwara and western Mewar. The folded rock structures in Alwar and Jaipur are connected with those of Ajmer and Mewar by several ridges of conglomerates and quartzites. These rocks belong to the lower part of the Delhi system.

In Ajmer, the synclinorium consists of two synclines with a long tongue of the pre-Aravalli gneiss between them. On the outer flank of the two geosynclines, their unconformable relation to the gneiss is clearly indicated by the great development of boulder conglomerates and arkose at Barr (26°05' N; 74°06' E) and Srinagar (26°24' N : 74°46' E). On each side of the medial tongue of the gneiss towards the inside, shearing along the contact has reduced the basement beds to feldspathic granulites. The northwestern syncline is greatly affected by the igneous intrusions of Erinpura granite and of epidiorite, much more than the other. Towards the southwest, beyond Ajmer, this increases to such an extent that one finds complete disappearance of sedimentary rocks in Jodhpur. The other syncline becomes very narrow and at the southern tip of the narrow extension of Ajmer between Udaipur and Jodhpur near Dewair (25°25' N : 73°49' E) it is about 10 kilometres. The syncline in this part is simple and the breadth of 10 km is maintained for about 66 km south of this, the syncline becomes broader, additional folds appear and culminate in the Alwar series. Towards the southwest the Erinpura granite increases. In the east of the main synclinorium there are several lineally arranged outliers in which only Alwar series, basement arkose grits and quartzites are present, dipping steeply eastwards and inverted under the Aravallis and pre-Aravalli gneiss to the east.

The unconformity between the Delhis and the Aravallis is not local. It has been traced from Alwar in the northeast to Idar in the southwest. The Delhi sedimentaries rest upon the Aravalli schists or the pre-Aravalli gneisses and the granites. Sometimes, at the base is found an arkose grit, derived from the disintegration of granites and pegmatites in the pre-Aravalli complex, or a feldspathic quartzite with inculcations of biotite schists derived from the
softer Aravalli rocks.

The rock formations of the Delhi synclinorium are as follows:

Ajabgarh Series

6. Upper phyllites
5. Biotitic limestone, calc-gneiss and calciphyres
4. Calcareous shales and impure limestones
3. Phyllites and biotite-schists
2. Arkose grits and conglomerates

Alwar Series

1. Quartzites

The distribution of the above formations between Ajabgarh and Alwar series is in accordance with the succession in Jaipur and Alwar. The Alwar series is not uniformly developed throughout its formation. It is well developed in the north and south while in the middle it almost disappears. In the north, the Alwars rest unconformably on the pre-Aravalli gneisses. The quartzites as well as the arkose grits are seen, the latter being represented by coarse conglomerates at Barr and Srinagar. In the southern part of the synclinorium, where the Delhi's have been deposited on the Aravallis, the rocks are fine grained quartzites with intercalations of biotite schists.

In the lowest division of the Ajabgarh series a great thickness of biotite schists largely injected with pegmatites and aplites is found in great dykes and veins. In these rocks, the minimum state of metamorphism observed is that of phyllites. The graduation from phyllites and biotite schists to a composite gneiss has also been found. The calc-schists are banded and flaggy, the banding being due to the alteration of dark silicates like biotites and antinolite with pale silicates like diopside, tremolite and feldspar. These are greatly intruded by large sills and dykes of pegmatite and aplites. The biotite-limestone, banded and siliceous, constitutes the elongated plateau commencing in the vicinity of Beawar and continues to the southwest upto Mewar.

The Delhi rocks are comparatively thinner and less metamorphosed in eastern Mewar. Sawa grits, shales and Jiran sandstones are the main rocks of this formation. The Sawa grits comprise
coarse, white sandstone and conglomerates exhibiting ripple marks and current beddings, while on the other hand, the Jiran sandstone is hard compact, grey quartzite often stained purple.

Igneous Rocks: Ultrabasic Rocks—Intrusive igneous rocks in the Aravallis comprise granite and ultrabasic rocks. The ultrabasic rocks are largely developed in Dungarpur and Idar State in the south. These rocks have been assigned a post-Aravalli but pre-Delhi age.

Post-Delhi Igneous Rocks: The Delhi system is intruded by Erinpura granite which is the main intrusive rock. The xenoliths, preserved in the Erinpura granite, prove that originally it consisted of varied assortment of basic intrusive, mainly basalts. This has been metamorphosed to epidiorites and hornblende schists along the northwestern flank of the Delhi synclinorium. This formation also confirms the existence of volcanic activity prior to Erinpura intrusion. The outcrops of Erinpura granite, at places isolated, are found extending from Ajmer to Beawar in the north-east to Palanpur and Idar in the southwest. The Erinpura granite and other formations like pegmatites and aplites show the widest variations in texture, grain and degree of foliation and are found to exist in varying forms and sizes of intrusive bodies.

MALANI SERIES

The maximum development of the Vindhyans occurred on the eastern flank of the Aravallis while in the western desert region, it occurred in lesser form in detached outcrops. Rocks which may be correlated with this system are composed of a group of rhyolitic lavas including felsites with such pyroclastic material. All this rests unconformably on the Aravalli schists. All these igneous deposits are termed as the Malani series named after the place near Jodhpur. In western Rajasthan, they occupy an area of about 240 km long and 190 km wide. In this area bosses of granites, which supplied the magmatic material of the eruptions, have been exposed by denudation. Here two types of granites are found: Jalor granite (hornblende-biotite granite) and Siwana granite (hornblende granite). These granite bosses rise to about 920 metres above sea
level and show intrusive features to both the Malani and the Aravalli schists. The volcanic activity of the Malani period did not result in the uplifting of the Aravalli mountains which occurred later in its complicated history. The Malani granites and porphyries cut the consolidated Erinppura granites. Thus the Malani series are also included in the Puranas.

**Vindhyan Series**

The culmination of the Vindhyan period after the Delhi system brought an end to the most complex and unique sequence of Archean and Purana sedimentary deposition in the Rajputana synclinorium. The Vindhyan system constitutes a vast sedimentary formation of sandstone, shales and limestones having a thickness of about 12,844 metres. They occupy a large extent of the country from Sasaram and Rohtas in west Bihar to Chittorgarh on the Aravallis with the exception of a central tract in Bundelkhand and cover an area of about 104,000 sq kilometres.

Geologically, Rajasthan has experienced much more violent earth movements than any other part of India. In Rajasthan, the Vindhysans were deposited in two separate basins mainly on both sides of the Delhi synclinorium. The outcrops of western Rajasthan form two arcs, semi-circular in shape and joining near Jodhpur city. They are much interrupted by alluvium and consist of scattered patches of the Upper Vindhyan rocks with a thickness of about 92 metres. This formation rests, either on Malani rhyolites, or the Aravalli slates.

In eastern Rajasthan, especially in southeastern Mewar, the Vindhyan rock structure is well developed. This sedimentary material was deposited in a large basin extending from Karauli and Dholpur in the northeast to Nimbahera and Suket in the southwest. The northeasast and southwest outcrops are connected by narrow, disconnected patches extending from Sawai Madhopur to Bundi. In eastern Rajasthan, the Vindhysans have been divided into the following sub-divisions.¹

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<table>
<thead>
<tr>
<th>Upper Bhandar sandstone</th>
<th>Rewa shales</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sirbu shales</td>
<td>Kaimur sandstone</td>
</tr>
<tr>
<td>Bhandar limestone</td>
<td>Suket sandstone</td>
</tr>
<tr>
<td>Ganurgarh shale</td>
<td>Nimbahera limestone</td>
</tr>
<tr>
<td>Rewa sandstone</td>
<td>Khori Malan conglomerates</td>
</tr>
</tbody>
</table>

In eastern Rajasthan, in the southwest of the Vindhyan basin, the formation has a thickness of about 4,600 metres, the lower and upper divisions being 930 metres and 3,670 metres thick. It is concluded that probably, dry conditions existed during the deposition of the Upper Vindhyans in eastern and western Rajasthan. In Suket shales in the east, organic remains have been noticed. The Vindhyans have been affected by overthrusts from the west resulting in the formation of the Great Boundary Fault. This has a length of about 805 km with a throw of about 1,530 metres. This Fault has resulted in bringing the Upper Vindhyans against the highly folded Aravallis.

**Jurassic**

The most ancient, fascinating and complex geological history of Rajasthan came to a close after the culmination of the Vindhyan Era. Rajasthan experienced no sedimentary deposition especially between the end of the Vindhyan period and the beginning of the Jurassic period. During this period, the geological history of Rajasthan is obscure. At the beginning of the Gondawana era, it is considered that the presence of boulders of Malani rhyolites amongst the Salt Range glacial deposits indicate the existence of glaciers in Rajasthan. Western Rajasthan at one time was covered by the sea which extended from the southwesterly direction during the Jurassic period. The nature of the deposition of rocks consisted of alterations of compact, buff, light brown, or yellow limestones and grey and brown sandstones and grits. The rocks in western Rajasthan are largely covered by the wind blown sand, but at a few places as in Bikaner and Jaisalmer, these rocks are exposed at the surface. These rocks have also been correlated with the rocks of Kutch which belong to the same formation. The following are
the rock types found at Jaisalmer.¹

<table>
<thead>
<tr>
<th>Abur beds</th>
<th>Limestone and shale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parihar sandstone</td>
<td>Feldspathic sandstone</td>
</tr>
<tr>
<td>Badasar beds</td>
<td>Ferruginous sandstone</td>
</tr>
<tr>
<td>Jaisalmer sandstone and limestone</td>
<td>Fossiliferous sandstone and limestone</td>
</tr>
</tbody>
</table>

Thus the Jaisalmer limestone is overlain by a series of rocks which may be referred to three distinct stages in succession, Abur beds, Parihar sandstone and Badasar beds.

**Deccan Trap**

Towards the end of the Cretaceous period, the central and western India experienced a fissure eruption of great magnitude, comparable in magnitude with the fissure eruptions which occurred in Oregon and Colorado in North America, in Patagonia in South America, in Hebrides, etc. now largely beneath the Atlantic, and in Siberia. Part of the area covered, latter known as the Deccan Trap, covers an area of about 520,000 sq km in all, which extends from southern Rajasthan to Dharwar and almost from coast to coast. The southeastern part of Rajasthan is covered by the trap and this magmatic material covered the older formations like the pre-Aravalli gneiss, Aravallis and Vindhyan. The vast area covered by the Deccan trap in the past cannot be measured by the present distribution since erosion and denudation have been at work cutting through the basalt and giving rise to a number of outliers separated from the main area by wide distances. The basalt rocks are uniform over wide areas. The basalt rock weathers with spheroidal exfoliation and gives rise to rounded boulders.

**Tertiary System**

In modelling the surface features of the Indian region and the whole of Rajasthan, the Tertiary system is the most important. In the middle of the Eocene, commenced an era of earth move-

ments which greatly altered the old geography of the Indian region. In Rajasthan also, the influence of this system is clearly marked. In western Rajasthan, especially west of the Aravalli range, rocks of the Tertiary system are associated with the Jurassic and Cretaceous rocks of Bikaner, Jodhpur and Jaisalmer. In this system, large tracts of western Rajasthan was covered by the sea, resulting in the deposition of thick beds of white and pale, buff, fossiliferous limestone. Eocene beds correlated to the Laki series are seen in Bikaner and Jaisalmer. North of Jaisalmer, the Jurassic is overlapped by nummulitic limestone which gradually thins out in the east and is overlain by laterite at places. This outcrop which may be related with the main exposures at Bikaner, covers an area of about 650 sq kilometres.

PLEISTOCENE SYSTEM

The Rajasthan desert (the Thar), being of aeolian accumulations, was formed in the same age as the Indo-Gangetic alluvium. This desert stretches from the west of the Aravallis to the basin of the Indus and from southern Punjab plains to the basin of the Sutlej. The desert is not a flat level waste of sand, but at several places, numerous rocky structures are exposed at the surface.

PHYSIOGRAPHY

Rajasthan covers the territory which has a very mature topography, developed during the long years of denudation and erosional processes. The present physiography and the drainage system in this State have been greatly influenced and determined by the geological formations and structure. The present landforms are the product of the past fluvial cycle of erosion and the recent desert cycle of erosion.

Structurally, the State can be divided into two major divisions. The line demarcating the division runs along the western edge of the Aravalli range which runs from northeast to southwest. The southwestern part of this line is covered by the northwestern exten-
sion of the Peninsular Block. The northwestern is also an extension of this block structurally; while surface features indicate rock outcrops at different places, the greater part of the surface is covered by shifting as well as fixed sand deposits.

Physiographically, Rajasthan stretches into two of India's major physiographic divisions, namely the Great Plains and the Central Highlands. The area lying west of the Aravallis known as Western Sandy Plains occupies the western part of the Great Plains, while the area east of the Aravallis falls in the northern part of the Central Highlands. Both these major divisions in Rajasthan are marked by a variety of physiography and relief features. On the basis of the existing relief features, this State has been divided into the following physiographic divisions (Map 3).

1. **Western Sandy Plains**
   
   (a) Sandy Arid Plains (Marusthali)
   
   (b) Semi-Arid Transitional Plains (Rajasthan Bagar)
   
   (i) Luni Basin (Godwar Tract)
   
   (ii) Plain of Interior Drainage (Sekhawati Tract)

2. **Aravalli Range and Hilly Region**
   
   (a) Aravalli Range and Bhorat Plateau
   
   (b) Northeastern Hilly Region

3. **Eastern Plains**
   
   (a) Banas Basin
   
   (b) Chappan Plains

4. **Southeastern Rajasthan Pathar (Hadoti Plateau)**
   
   (a) Vindhyan Scarpland
   
   (b) Deccan Lava Plateau

1. **Western Sandy Plains**

   The Western Plain in the west and the northwest of the Aravalli axis covers a large part of Rajasthan. The eastern boundary of this plain is marked by the western submontane zone of the Aravalli
range up to the northern point of Udaipur district beyond which the
boundary is marked by the 50 cm rainfall line, as well as by the
great Indian watershed. Thus the eastern boundary of the western
plain is partly climatic. The western boundary is marked by the
international boundary between India and West Pakistan. The
northern boundary is marked by the Punjab and the southwest by
Gujarat.

Generally it is called a plain but the structural geology of western
Rajasthan has little effect on surface topography, as a large part
of the surface is covered with vast stretches of sand inter-
rupted occasionally by rocky protrudings right up to the Pakistan
border. The Northwestern division is sandy, poorly watered and
sterile.

The Rajasthan desert in the west has been subdivided into several
natural regions of northeast to southwestern belts. The controlling
feature for such a division is the Aravalli hills and the rocky terrain
of Barmer–Jaisalmer–Bikaner tract. The western-most belt, the
great Desert is covered by sand dunes and runs from the Great
Rann along the Pakistan border to the Punjab. Next to this belt
is the rocky Barmer–Jaisalmer–Bikaner tract which is dune-free,
and there are a large number of exposed rocky formations belong-
ing to Jurassic to Eocene marine formations. Due to sedimentary
formations in this tract, underground water is also found. Further
east of this belt, lies the little desert which starting from the Great
Rann, meets the Great Desert north of Bikaner. Then comes the
semi-arid region where drainage system of the River Luni is the
most characteristic feature and further north are the salt lakes of
Didwana, Sambhar and others.

The whole of western Rajasthan is not covered by sand dunes
but the degree and the extent of sand dunes greatly influence the
economic activity in this area. Map 4 broadly indicates the
distribution of sand dunes in this region. Of the total area of
Rajasthan, nearly 63 per cent is covered with blown sand of varying
degree. The large-sized dunes are concentrated in the western part
of the desert in the districts of Barmer, Jaisalmer and Bikaner.
Plate 1—Embryonic Sand Dune near Chohtan (Barmar)—A Typical Sand Dune Landscape in Western Rajasthan. Vegetation—Capparis decidua-calligonum polygonoides. (See page 25)
'Plate 2—Longitudinal Sand Dune at Udramsar, Bikaner. *Calligonum Polygonoides* bushes in the front. (See page 26)
Plate 4—Stabilised Sand Dune near Chohtan, Barmer. Numerous Euphorbia Caducifolia Clumps on the Hill extending on the Dune. Foot-Hill is covered by Prosopis Spicigera—Calligonum Polygonoides. (See page 27)

Plate 5—Dune with Active Crest at Udramsar, Bikaner. Salvador Oleoides—Calligonum Polygonoides—Panicum Turgidum. (See page 27)
Plate 6—Camel browsing on Kappari Decidua in Western Rajasthan.
(See page 56)
The extent of sand dunes is given in the following table.¹

**DEGREE AND EXTENT OF SAND DUNES IN WESTERN RAJASTHAN**

<table>
<thead>
<tr>
<th>Extent of dunes</th>
<th>Area sq kilometres</th>
<th>percentage of total area</th>
</tr>
</thead>
<tbody>
<tr>
<td>No dunes</td>
<td>85,659.81</td>
<td>41.5</td>
</tr>
<tr>
<td>0 to 20 per cent of the area affected</td>
<td>24,856.60</td>
<td>11.5</td>
</tr>
<tr>
<td>20 to 40 per cent of the area affected</td>
<td>10,164.91</td>
<td>4.8</td>
</tr>
<tr>
<td>40 to 60 per cent of the area affected</td>
<td>34,322.11</td>
<td>14.7</td>
</tr>
<tr>
<td>60 to 80 per cent of the area affected</td>
<td>39,782.25</td>
<td>18.6</td>
</tr>
<tr>
<td>80 to 100 per cent of the area affected</td>
<td>18,902.85</td>
<td>8.9</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>213,688.53</strong></td>
<td><strong>100.0</strong></td>
</tr>
</tbody>
</table>

The Western Sandy Plains are further subdivided into two units:

(a) Sandy Arid Plains (Marushtali), and

(b) Semi–Arid Transitional Plain (Rajasthan Bagar) divided into

(i) Luni Basin (Godwar Tract)

(ii) Plain of Interior Drainage (Sekhawati Tract) and

(iii) Ghaggar Plain.

The line dividing the Sandy Arid Plains and the Semi-Arid Transitional Plain is climatic, i.e. 25 cms rainfall line

(a) **SANDY ARID PLAINS (MARUSTHALI)**

This region covers the greater part of the plain of Marwar and it includes the districts of Bikaner, Jaisalmer, Churu, part of western Nagaur and western two-thirds of Barmer and Jodhpur districts. The sandy and arid desert further west is referred to as the Thar Desert. It also stretches beyond the Indian border into Pakistan, mainly in parts of Bahawalpur, Khairpur and Thar Parkar districts.

There are vast stretches of sand and rock outcrops are also common features. The outcrops mainly of Aravalli gneiss, schists,

Malani granite and Vindhyan sandstones are exposed in the Thar area. In the northwest, extensive slightly elevated areas of Jurassic and Eocene rocks, mainly limestones are found in Jaisalmer, Barmer, Bikaner, Churu and Ganganagar districts. That old rocks protrude through the sandy surfaces indicate and confirm that the Thar is part of the western extension of the Peninsular block.

The erosional topography is evident in Barmer, Jalore, Jaisalmer and other areas where rock outcrops are exposed at the surface. A characteristic erosional topography is seen in such areas in the form of round bosses and tors with wind polished surfaces. In the Abu-Idar region are noticed the formation of caves and rounded hollows. These hollows might have been formed due to abrasive action of wind blown sand grains, or due to riverine gravels. Potholes generally develop along the banks of mountain streams and after the disappearance of the water may be left along the walls. Along the whole submontane zone has also developed the gullying of alluvial scree, talus, fans and terraces. All these erosional features explain that degradation process of the submontane zone is going on.

The dune formation in western Rajasthan is a very characteristic geomorphic feature (Map 4). On the basis of their shape, size, wind direction and vegetative material, generally three types of dunes have been recognised—(i) Longitudinal Dunes, (ii) Barchans, and, (iii) Transverse Dunes. The longitudinal dunes run northeast to southwest, parallel to the prevailing winds. Such dunes occur in the western and the southern part of the plain. In such dunes, the longer axis is parallel to the direction of the wind. Another type of sand deposition takes place in the form of ‘barchans’ in which the concave side faces the wind in the interior. The transverse dunes are formed across the wind direction and are commonly found in the eastern and northern part of the plain. In such dunes, the longer axis is at right angles to the direction of the wind. The windward side is long, gently sloping, while the leeward side is steep and abrupt. Oldham (1893) has explained that longitudinal dunes occur where winds are strong. The transverse dunes are in fact U-shaped dunes, coalescing into a rake like
Based upon Survey of India map with the permission of the Surveyor General of India. © Government of India Copyright, 1962.
shape and the concave side of the original U-shaped dunes faces the wind. These are not ‘barchans’ whose concave sides are leeward. It has been noticed that such U-shaped dunes develop in semi-arid conditions when they get stabilised by the growth of vegetation. It is also noticed that big trees grow on the leeward side of the transverse dunes which indicate that the dunes have been stabilised for a considerable time.

(b) SEMI-ARID TRANSITIONAL PLAIN (RAJASTHAN BAGAR)

The semi-arid plain runs in a northeast to southwest direction. The western boundary is marked by the 25 cm isohyetal line and the eastern by the western edge of the Aravalli range upto the northern part of Udaipur while further north the 50 cm isohyetal line is the eastern limit. The eastern part of the plain is covered with superficial sand deposits. In this zone the older rocks protrude above the surrounding sandy surface more frequently than in western arid plains. This plain is further subdivided into three smaller physiographic units (i) Luni Basin (Godwar Tract), (ii) Plain of Interior Drainage (Sekhawati–Tract), and (iii) Ghaggar Plain in the north. The line demarcating the first two units is the one which demarcates the Luni Basin in the south from the northern Plain of Interior Drainage.

(i) Luni Basin (Godwar Tract): The Luni river rises from the Aravalli hills southwest of Ajmer and flows towards the southwest. It has a large number of small tributaries all draining the steep northwestern slope of the Aravallis and joining the Luni on the left bank. The Luni and its tributaries drain the southeastern border of Jodhpur district, Pali, Jalore and Sirohi districts. This basin is drained by this river and various small streams which receive their water from the run-off from the Aravalli hills during the monsoons. Except the Luni catchment area, the rest of western Rajasthan is an area of inland drainage. Along the range, the rainfall is about 65 cm per year and this decreases to about 25 cm on the western border of the basin.

The sand blown by the strong wind from the west and southwest from the Rann of Kutch is unchecked by the small streams and the
lack of vegetation which is characteristic of this Basin. La Touche has described the sand in western Rajputana as 'derived by the southwesterly gales which blow across the desert for several months of the year and unimpeded in its advance by streams of running water, it has encroached upon the land until no district is entirely free from it, except those lying immediately at the foot of the Aravalli Range, or where the number of water courses descending from the hills, although they contain running water for only short periods are able to sweep back the sand blown into them.'

Gullying in the submontane Aravalli region has given rise to the formation of conglomerate, which is either cemented or un-cemented. This conglomerate may occur in different horizons with intercalations of aeolian sands. They are composed of local rocks, sometimes well rounded water-worn pebbles. In this area even in the rainy season, the rivers are so choked with sand that they cannot move anything bigger.

The topographic features of the area, lying south of the Luni river and its tributaries Khari and Jawai, suggest that the initial geomorphic processes were fluvial which dissected the sedimentary rocks of this area. But in due course, the area experienced arid conditions and land features at present are the product of water as well as arid cycle of erosion. At present the wind action is more predominant although occasional floods are also caused in these streams.

The topography is marked by hills with steep slopes and extensive alluvial plains. The western alluvial plains and the southwestern portion of the foothills are covered with aeolian sand deposits. This area is drained by eastwest flowing river Khari and Jawai, both tributaries of the Luni river. These streams follow the domal structural trend of the sub-surface rocks which is formed by granite and rhyolite rocks.

The present topography is thus the product of the earlier water erosion and the sub-aerial denudation which have completely eroded the Vindhyan sandstone from this region. The existing hills consist of hard resistant rock masses which are surrounded by

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alluvial plains. Gradually the arid conditions became more prominent and the southwesterly winds eroded and deposited sands on the alluvial plains and against the hill slopes. The arid conditions combined with wind action removed the traces of earlier landforms and the work done by the fluvial cycle of erosion and deposition. Gradually the surface was covered with sand dunes resulting in the hummocky appearance of the topography.

The Luni basin covers the fertile area between the foot of the Aravallis and the Luni river. The water lies near the surface where well irrigation is possible. But further west, loam at several places yields to sandy waste (the Thar) and gradually the water table sinks to a much lower level. At Bikaner, water is sometimes available at a depth of about 110 to 125 metres and it is often brackish.

(ii) Plain of Interior Drainage (Sekhawati Tract): North of the Luni Basin up to Rajasthan border within the semi-arid transitional Plain (Map 3), is the plain area of interior drainage. The eastern boundary is marked by the 50 cm isohyetal line. The Aravalli is not a continuous range northeast of Ajmer. It is broken and full of wind gaps as at Sambhar Lake, east of Sikar and between Ajmer and Beawer where the sand dunes extend for several kilometres over the eastern plain. The sand blown across these gaps extends right up to Jaipur city and the surrounding areas north and south of it.

This Plain is full of sand hills typical of this area and the landscape is full of several low depressions. The rainfall in this area is between 25 cm in the west to 50 cm in the east. After the rare, heavy showers, rain water is accumulated in innumerable local depressions amongst the sand hills. The whole of this northern section is an area of inland drainage. Several small basins are found around the Jaipur–Jodhpur saddle. The temperature being high, the evaporation of the saline flood water results in the deposits of salt and soda at different places in these depressions. The important salt lakes in this region are the lakes of Sambhar, Degana, Kuchaman and Didwana. Sambhar Lake, the largest in the area is about 65 km west of Jaipur. When the lake is full, it is about
25 km long and 10 km wide and stretches in an east-west direction. It is very shallow and during summer months, the area shrinks in size and the lake at many places becomes muddy. The salt contents in the lake are confined mainly in the upper 3.7 metres. The average salt (sodium chloride) content in this upper layer of the lake is about 50 million tons. The average production is about 250,000 tons of salt per year. At this rate, it is presumed that the supply of salt from the lake is well assured for a long time to come. The salt is derived from the Rann of Kutch by the south westerly winds during hot and dry weather. The small rainfall that occurs in these areas, mainly washes down the salt particles and deposits in these shallow depressions. The salt lakes of Didwana are located about 3 to 5 km southeast of Didwana, while the partially dry Kuchaman salt lake is located about 8.5 km south of Kuchaman. Apart from these lakes, the whole area is full of several salt deposits which during the hot season becomes completely dry, leaving a salt crust in the upper layer of the mud.

2. ARAVALLI RANGE AND HILLY REGION

The Aravalli range is the principal and the dominant mountain range of Rajasthan. This range, though not of uniform width, runs diagonally across the State from northeast near Delhi and extends to southwest upto the Plains of Gujarat, for a distance of about 692 kilometres. Within Rajasthan, the range runs from Khetri in the northeast to Khed Brahma in the southwest for a length of about 550 kilometres. The Aravalli range is remarkable in being perhaps the oldest folded mountain range, not only in India, but in the world. Structurally, it is composed of rocks belonging originally to the Delhi system, folded in a synclinorium occupying the site of a geosyncline, which have been deeply eroded, but still with several summits of over 1,225 m in height, appear still as a range. The range is said to be identified with the ‘apocopi monte, deorum poena appelati’ of Ptolemy and with the Paripatra of the Vishnu Purana.¹

From Delhi, the ridges extend to the southwest, but near Khetri in Jaipur they become more prominent and appear in the form of well marked ranges. Towards the southwest, the ranges become more prominent and peaks like Babai (780 m), Kho (920 m), Raghunathgarh (1,055 m) and Taragarh (873 m) can be located. These ranges pass west of the Sambhar lake and cover a much wider area. From Ajmer onward several parallel ranges become conspicuous. The Aravalli hills beyond Merwara occupy a width of about 50 km and begin to spread out to the south and southeast towards Udaipur and Dungarpur. Here the elevation is much lower and the principal range extends to the southwest, up to the southeast corner of Sirohi district. Gurushikhar (1,727 m) the highest peak in Rajasthan is located in this hill region in the Mt. Abu batholith.

The geological history of the Aravalli range can be traced back probably to the close of the Dharwar times. The range has been peneplaned and again uplifted in the Cambrian period. The Aravalli range was upfolded in the pre-Vindhyan times, and it is suggested that the Vindhyan was partly derived from its denudation. At the close of the Vindhyan period this mountain range was in existence and separated the two Vindhyan areas. The first peneplanation of the Aravalli range took place during the Mesozoic period at some time not very much earlier than the Cretaceous times. The peneplane has been warped in such a way that its central part near Udaipur city is about 1,225 m above sea level and the northeastern section near Delhi is 306 m and the southwestern in Gujarat is about 306 m high. Heron has assumed that since peneplanation, the uplift of the range has been some 92 m to 122.3 m at its ends and about 1,070 m in the central section. Thus the Aravalli range was peneplaned in the Mesozoic period, re-elevated before the beginning of the Tertiary and its southern prolongation which is now under the sea was let down during the Tertiary, after the accumulation of the Deccan Trap. It is generally considered that the re-elevated Aravalli peneplane underwent a second peneplanation during the Tertiary period. This has been noticed by the differences in the erosional surfaces on the softer rocks, phyllites,
schists, gneisses and some of the granite areas. These surfaces are best developed on the plains east of the Aravallis. Rising above it, one finds not only the great even topped ridges of Alwar quartzites, truncated by the Mesozoic peneplane but many residual resistant masses formed due to the harder epidiorites and granites, quartzrefts, limestones and such less easily eroded rocks. Its considerable area is covered with superficial deposits of no great depth through which the streams have cut down to sub-surface rocks. It is a series of planes at slightly different levels, falling in steps from the centre of the range to the plains surrounding it. The elevation of these plains has been influenced by two major factors, firstly the character of the rocks of which they are composed and secondly, the amount of erosion which could effectively take place. At most of the places, due to these factors three stepped planes have developed from them; calc-gneisses and limestones being the highest, which form long narrow plateaus along the heart of the range, flanked by shelves cut out in the calc-schists and bounded by lower belts along the micashists. Sometimes the differences of 15 to 30 m have been noticed between the levels of the three planes and the present rivers have incised these plains. There is a third peneplane which was formed during the Pleistocene or sub-recent age. In the centre of Rajputana, mainly in the north where it meets the peneplane of the Tertiary age, the alluvial peneplane rises to about 430 m and on the western side of the Aravalli range it lies at about 306 metres. The sand hills of western Rajasthan are accumulated on this peneplane mostly in the desert areas.

In the Aravallis nearly all the ridges which run along the strike are composed of massive quartzites. The rocks of the Delhi system were deposited in a geosyncline, lying unconformably upon either the pre-Aravalli Banded Gneissic Complex—the Aravalli system, or the Raialo series at different sections of its length. In plan, the Delhi synclinorium appears like a double fan. Where the handles of the two fans meet, it is about 10 km wide and is a simple syncline. This narrow width is maintained for about 65 km and then at both the ends, it spreads into two separate fans. By the thickening of some of the formations, additional folds appear and in the central
core higher beds emerge due to deeper folding. This is more clearly marked south of Desuri where it fans out into numerous folds, forming narrow valleys and long bold ridges developed by quartzites and micaschists of the lower portion of the Delhis, while much dissected plateaus mark the less complicated structure of the limestone, calc-schists and calc-gneisses of the upper Delhis.

The whole of this Aravalli range and Hilly Region has been further sub-divided into two smaller physiographic units.

(a) ARAVALLI RANGE AND BHORAT PLATEAU

This division constitutes east Sirohi, nearly the whole of Udaipur except a narrow belt in the east and whole of Dungarpur district. The great Indian watershed line runs from north of Udaipur district to southwest before turning to east, beyond Udaipur (Map 3). Fermor regarded the Aravalli tract as a horst bounded in the east by a fault of some 1,530 maximum uplift, i.e. the Great Boundary Fault of Rajputana. He pointed out that the western side is also marked by a fault of some magnitude but the existence of this fault has not been established due to wide stretches of alluvium. In the absence of such a fault, the western limit of the Aravalli tract is marked by a tilt.

The general dominant structure of the fold is noticed in the northeast to southwest strike of isoclinal folds with their axial planes inclined to the northwest or even vertical. At some places mainly south of Gogunda, in the ridges of Alwar quartzites which form the eastern base of the synclinorium, the strike is more in a north–south direction.

The highest section of the Aravalli range lies northwest of Udaipur between Kumbhalgarh and Gogunda. Locally this section is also known as 'Bhorat' Plateau, the average elevation of this plateau is 1,225 metres. Around Udaipur in the southeast, the hills are characterised in a great node of spurs and curving ridges. From the Bhorat Plateau prominent strike ridges of Alwar quartzites with almost level tops rise to about 300 m and some of the peaks to more than 1,225 m above sea level.

Under extreme arid conditions of great heat and dry climates,
the granitic rocks in this part of the Aravalli range have developed typical morphological features of ‘jagged outline with the smooth desert patina covering their cracked interiors, while the granites are exfoliated and honey-combed into domes and tors, with perched blocks and boulders like cannon balls and sacks. This is specially the case with Erinpura granite, post Delhi but pre-Malani in age, which around Mt. Abu and Erinpura gives rise to a tract of detached hills separated from the main Aravalli range and culminating in Guru Shikhar, 1,727 metres.\textsuperscript{11}

In the southeastern part of the Aravallis, the prominent ridges are composed of strong quartzites. From a distance these ridges indicate their long level tops and are characterised by wall like appearance. It is quite clear that when the whole range is considered these level summits appear remnants of a greatly dissected peneplane. Hardly any peak can be noticed above the local general level except the granitic batholith mass of Mount Abu.

In this physiographic division the important denudation agents are diurnal range of temperature and the deflation of sand laden winds. Due to change in temperature, cracks are formed in rocks mainly on exposed hill tops and on the sides of detached hill blocks. About the geomorphic features in the Aravalli region, La Touche has described that, ‘the highly inclined schists and quartzites of the Aravalli system are formed into long hog-backed ridges with an equal slope of talus on either side; the undulating sheet of Malani lava form conical hills or long ridges with steeply scarped sides and rugged contours, with a talus or exceedingly sharp angular fragments at the foot of the scarps, the more homogeneous bosses of granites have their outer surfaces tripped off in concentric layers and form hummocky dunes with steeply smooth sides, while the granite fragments are quickly broken up by the action of the weather into a loose gravelly sand, little or no talus is formed at the foot of the hills composed of the rocks; and lastly the almost vertical scarps,

wherever they rise to any appreciable height above the plain.¹

(b) **Northeastern Hilly Tract**

This physiographic division is bounded in the southwest by the northern edge of Bhorat Plateau. North of Kumbhalgarh, the elevation varies between 550 m to 670 m specially in the Alwar hills. Further north and northeast, the hills are broken and their elevation decreases in the final extension of hills south of Delhi to about 306 m above sea level. This level is about 60 m to 90 m above the surrounding plain.

The Aravallis in this part are composed of phyllites with quartzites which, when continuous and thick, help in the building up of the mountains. Other rocks of the Delhi system are limestones generally altered to calc-gneisses. Being very hard, they form elevated plains or high valleys between the quartzite ridges. The amount of metamorphism and the intensity of igneous intrusion in the Delhi are much higher than in the Aravallis. This is mainly due to the fact that Delhi is in the synclinorium have been more deeply folded into crust than the Aravallis on the flanks. This has helped in their reaching lower zone of greater temperature and pressure and more intense igneous intrusion.

**3. Eastern Plains**

The Eastern Plain covers the area northeast, east and southeast of the Aravalli range. The western boundary is marked by the eastern edge of the Aravalli up to north of Udaipur and further north the 50 cm isohyetal line limits the Plain. The southeastern limit of the Plain is marked by the Vindhyan Plateau. This Plain is further subdivided into two physiographic units—(i) The Banas Basin, and (ii) The Chappan Plain.

(a) **Banas Basin**

From Udaï Sagar, east of Udaipur the great watershed of India runs in an easterly direction. The watershed forms the

southern boundary of the Mewar Plains and south of this watershed lies the Chappan Plain. The Mewar Plain, a dissected plain of Archaean gneiss, covers the eastern part of Udaipur, western Chittorgarh, Bhilwara, Tonk, Jaipur, Western Sawai Madhopur and the southern part of Alwar. This area consists of a gneissic plain, quite irregular, which slopes gradually towards the east from the eastern foot of the Aravalli range. The maximum height of the plain in the west where Aravallis are also exposed, is about 582 m near Deogarh. In Udaipur region the higher hummocky portions are bare of deposits of alluvium. The soil is thin and stony and the yearly rainfall is about 73 cm. It is in this region that the topography of the area is marked by various types of erosional features, produced in the granite and gneiss rocks.

The plain slopes gradually towards the northeast from the foot of the Aravalli range. The Mewar plain is drained by the river Banas and its tributaries like Khari, Sodra, Moshi and Morel joining on the left, while Berach, Bajaen and Golwa join on the right. The river Banas is a tributary of the river Chambal which ultimately joins river Yamuna in Uttar Pradesh. The alluvium deposits become scanty towards the west where the plain is higher and more irregular, while in the east the alluvium increases covering larger parts of Kishengarh and burying most of the gneiss rocks below the alluvium.

(b) Chappan Plains

This plain lies south of the great Indian watershed in southeastern Udaipur, Banswara and the southern part of Chittorgarh district. The area is drained by the tributaries of the Mahi river which ultimately reaches the Arabian Sea through the Gulf of Cambay. The gradient of the Mahi tributaries is much steeper, i.e. about 8 m to 12 m per kilometre. This has resulted in greater erosion of the gneissic plain in the south than in the north of the watershed.

The Chappan area presents an entirely different set of landforms as compared with the northern plain of Mewar. The land in the south is deeply and intricately dissected resulting in the formation
of separate hillocks. This plain in the south is not identical as the Mewar plain in the north. This deeply dissected area is locally known as ‘bagar’ and includes the hilly tracts of Banswara and Dungarpur.

4. SOUTHEASTERN RAJASTHAN PATHAR
(HADOTI PLATEAU)

This Plateau in Rajasthan covers the eastern part along the Chambal river, southeast of the Mewar plains. It is bounded in the northwest by the Great Boundary Fault of the Aravallis and extends eastward across the Rajasthan border till one comes across the sharply defined scarp overlooking Bundelkhand. The greater part of this area is drained by the river Chambal and its right bank tributaries like Kali Sindh, Parwan and Parbati. Physically this Plateau has been divided into two smaller well defined units—(a) Vindhyan Scarpland, and (b) Deccan Lava Plateau.

(a) VINDHYAN SCARPLAND

These scarplands have an average elevation between 350m to 580 m and are formed in massive sandstones separated by shales. The scarps are facing towards the south–southeast between the Banas and the Chambal and extend towards the east over Bundelkhand. In the northwest there is a strong scarp-feature flanking the left bank of the Chambal. Beyond this lies a scarp block which occupies the areas of Dholpur and Karauli. In this section the horizontal Vindhyan are folded and faulted, probably by the rigid Aravallis, which are overthrust on them along the boundary fault. The warping of the Mesozoic peneplane in the Aravallis may be the result of this contact. The displacement of the boundary fault is of the same magnitude, i.e. 1,225m to 1,530 metres.

(b) DECCAN LAVA PLATEAU

The western part of the Vindhyan Plateau of Madhya Pradesh extends as a triple plateau of three concentric scarps formed by the outcrops of three strong sandstones with intervening shales. This physiographic unit of southeastern Rajasthan is known as ‘pathar’
(stony) or 'uparmal' (higher plateau). It is a wide and stony upland and also includes Kota-Bundi plateau section. The three broken scarps render the transportation difficult. In the Plateau area occasional tracts of deep black soil are found in river valleys. The Deccan Trap lava flooded the land up to the base of the Vindhyan scarp. The erosion is exposing the old land surface which indicates that the relief of the older pre-trap surface was much the same as the one in existence at present.

The Chambal and its tributaries Kali Sindh and Parbati have formed a triangular alluvial basin of 210m–275m in Kota. Gullying above the narrow trough of the lower Chambal banks indicate that it has been subjected to slight recent rejuvenation.

**Drainage System**

The drainage system in Rajasthan is greatly influenced by its geological history and the existence of the Aravalli axis and the location of the great Indian watershed. The great Indian watershed divides the drainage to the Bay of Bengal on one side and the Arabian Sea on the other. This watershed runs along the Aravalli axis from the Sambhar lake southward to Ajmer. From here the line runs to southwest, a few kilometres east of Beawar and to Deograh and Kumbhalgarh before proceeding towards the southwest of Udaipur city. It further extends to the west, past Udaipur Sagar and then swings towards the southeast to Bari Sadri, from where it leaves the hills and runs to southeast and south from Choti Sadri to Pratapgarh in Chittorgarh.

The west and south of the Aravalli axis is drained by smaller streams and their tributaries upto the Arabian Sea. Among these rivers Luni, Sukri, Banas, Sabarmati and Mahi are the most significant. Most of these streams are joined by seasonal nullahs which drain out water during the rainy season. On the eastern side of the watershed, the Banas river along with its main tributaries like Khari, Moshi and Morel on the left bank and Berach, Bajasen, and Golwa on the right, flows towards the east to join the Chambal river which ultimately joins the river Yamuna in Uttar Pradesh.
## Area Under Different Catchments in Rajasthan

<table>
<thead>
<tr>
<th>Catchments and sub-catchments</th>
<th>Area in sq kilometres</th>
<th>Percentage of total area</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. The Yamuna–Ganga catchment</td>
<td>5,126.49</td>
<td>1.5</td>
</tr>
<tr>
<td>2. The Chambal catchment (72,032.05 sq km or 20.9 per cent)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(a) The Kul catchment</td>
<td>2,943.90</td>
<td>0.8</td>
</tr>
<tr>
<td>(b) The Kali Sindh and Parwan Catchment</td>
<td>11,444.72</td>
<td>3.3</td>
</tr>
<tr>
<td>(c) The Chambal catchment</td>
<td>18,446.45</td>
<td>5.4</td>
</tr>
<tr>
<td>(d) The Bansi catchment</td>
<td>33,760.05</td>
<td>9.8</td>
</tr>
<tr>
<td>(e) The Morel catchment</td>
<td>5,436.93</td>
<td>1.6</td>
</tr>
<tr>
<td>3. The Mahi catchment</td>
<td>16,551.18</td>
<td>4.8</td>
</tr>
<tr>
<td>4. The Luni catchment (34,866.40 sq km or 10.3 per cent)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(a) The Sagi catchment</td>
<td>3,327.46</td>
<td>1.0</td>
</tr>
<tr>
<td>(b) The Jawai catchment</td>
<td>8,866.88</td>
<td>2.6</td>
</tr>
<tr>
<td>(c) The Sukri and Bandi catchment</td>
<td>22,672.06</td>
<td>6.7</td>
</tr>
<tr>
<td>5. The Sabarmati catchment</td>
<td>3,288.68</td>
<td>1.0</td>
</tr>
<tr>
<td>6. The Banas catchment</td>
<td>2,837.81</td>
<td>0.9</td>
</tr>
<tr>
<td>7. Zone of Inland Drainage (385,587.21 sq km or 60.2 per cent)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(a) The Kanti basin</td>
<td>4,667.80</td>
<td>1.4</td>
</tr>
<tr>
<td>(b) The Sota and Sahibi basin</td>
<td>5,793.88</td>
<td>1.7</td>
</tr>
<tr>
<td>(c) The Barah basin</td>
<td>3,516.50</td>
<td>1.0</td>
</tr>
<tr>
<td>(d) The Ramganga basin</td>
<td>6,742.57</td>
<td>2.0</td>
</tr>
<tr>
<td>(e) The Misfit streams</td>
<td>157,272.42</td>
<td>46.0</td>
</tr>
<tr>
<td>(f) The Misfit streams of the Luni basin</td>
<td>27,594.04</td>
<td>8.1</td>
</tr>
</tbody>
</table>

The most characteristic feature of the drainage system of Rajasthan is that nearly 60.2 per cent of the area of the State has an inland drainage system. Nearly all this area lies west of the Aravalli divide. In this part are found a large number of separate drainage basins like Kanti basin, Sota and Sahibi basin, Barah basin, and misfit streams in the Luni basin. The water in all these basins sinks into the desert tract, in the western part of the State.

---

The only significant water course in this area is the Luni river which rises at Ana Sagar at Ajmer and flows towards the southwest for a distance of about 32 km through the districts of Jodhpur, Barmer, and Jalor in the semi-arid tract west of the Aravalli range. At the source, the river has a small catchment area of about 32 sq km at Talod Road formed of murram and laterite. After receiving a small tributary from the Pushkar valley, the basin of the river widens. Near Ajmer, the river flows down the Aravalli slope and after 10 km flows towards the southwest. This river drains the total catchment area of about 34,866.40 sq kilometres. The bed of this river is dry for the larger part of the year. Being purely a rain-fed stream, it has water only during the rainy season and even at that time the river is choked with advancing sands at many places. Even during the monsoon season when the river is carrying maximum water it is not able to cut the aeolian deposits. It receives many smaller hill torrents from the western slope of the Aravalli range, like Lalri, Ghuhia, Bandi, Sukri, Jawai, Jojri and Sagai, all joining on the left bank. All these streams contribute to the sub-soil within its bend. The water of Luni river is sweet as far as Balotra but lower down it becomes more and more saline till the river ends itself in brine near the Rann of Kutch. In Jodhpur district, the Luni river increases in width rather than deepening the bed. This is because the floods develop so quickly due to the nature of rainfall that the river has no time to scour the bed. During the rainy season, rather than following the course of its valley, the Luni river spills over the country and occasionally damages the railway line to which it actually runs parallel from Luni Junction to Gole.

The southern and the eastern part of Rajasthan, south, southeast and east of the Aravalli range receives more than 80 cm of rainfall and has some important streams. The Chambal river is the largest stream and is joined by some tributaries like the Banas, the Kali Sindh, and the Parbati. It is the only stream which has water for the whole year while other tributaries occasionally turn completely dry and exhibit their stony beds.

The river Chambal rises from the northern flanks of the Vindhyan
scarps near Manpur (884.4 m) in the south of Mhow. For about 325 km it runs through a long narrow and steep gorge which overhangs the valley on both the sides rising about 60 m to 90 m above the valley floor. The river falls from 884.4 m at its source to 505 m near Chaurasigarh where it enters the gorge again for about 113 km from Chaurasigarh to Kota. The stream runs north for about 257 km and enters Rajasthan after crossing a gorge near the historic fort of Chaurasigarh. After flowing some distance the river turns northeast, flows past Kota and is joined by its first major tributary the river Kali Sindh near Nonera village. Another tributary Parbati joins about 48 km downstream. Taking a straight course for about 212 km, it bends southeast at Pinahat and flows to join the river Yamuna near Muradganj, after a total run of about 965 kilometres. For a length of about 153 km the river flows entirely in Rajasthan. Further northeast from Palia to Pinahat for about 241 km the river forms the boundary between Rajasthan and Madhya Pradesh. Before joining the river Yamuna in Uttar Pradesh it forms the boundary between Madhya Pradesh and Uttar Pradesh. In Rajasthan two other tributaries Kurai and Banas join the Chambal river on the left bank.

The Banas river flows through the heart of the Mewar Plains. Its chief tributaries are Berach, Kothari, Khari, Dhoond and Morel. The river Banas rises from the catchment area lying between Kankroli and Nathdwara and flows towards the east as far as Mandalgarh and further it flows towards the northeast up to Tonk where it again turns towards the east and finally this river turns at right angles and flows south to join the river Chambal. The upper reaches of this stream are hilly and have good rainfall.
CHAPTER III

CLIMATE

The climate of any region can be considered as one of the most important geographical factors which influence the distribution and activities of man or man-land relations. The study of the climate of a region is a vast subject but, within the limited space and the scope of this book only major facts of the climate of Rajasthan have been considered. Climate is generally defined as the average state of the weather. The elements to be considered are the same while studying the climate or the weather conditions of a place, the difference lies in the length of the time considered. Weather refers mainly to short periods like a day, week, a month or longer, while climate is concerned with average conditions determined by observations made over extended periods.

The study of the climate includes a number of elements or component parts like temperature and humidity of the air, the rainfall, the wind velocity, the duration of sunshine and many other elements of lesser significance. In their turn these elements are the products of several determining causes or factors. Among the important factors governing the climate of Rajasthan, as for any other region, are latitude, position relative to water, mountain barrier, altitude, prevailing winds, prevalence of cyclonic storms and continentality. Among various factors, primarily latitude is such, which greatly controls and determines the length of the day during the year. Since it is a mathematically controlled factor, it is considered as a reliable element. Latitude also influences the duration of the sunshine and the temperature variations.

The Rajasthan State stretches between 23°3' N to 30°12' N latitudes and 69°30' E to 78°17' E longitudes. Some other countries located between these latitudes are north Arabia, part of Egypt and Liberia, northern Sahara and part of Mexico. Although located in the same latitudes the climatic conditions here are not so severe as occurring in some of these countries. The southern
part of Rajasthan is about 225 km from the Gulf of Kutch and about 400 km from the Arabian Sea. The northern part extends up to Delhi. The elevation of the land surface ranges between 214 m to 1,375 m at few places in the Aravallis, while the larger part of the State is less than 370 m in altitude. The latitudinal location determines to a great extent the amount of insolation and the direction of the prevailing winds in the Tropics. The Aravallis stretching from northeast to southwest are the most conspicuous physiographic feature in the State. The eastern section of the Aravallis is the meeting place of Supan's broadly classified Indus and Indo-Australian Monsoon climatic provinces. The Indus Province is remarkable for great dryness and heat while the other in the east is characterised by strong periodical rains, temperature being fairly uniform. In general, the climate of Rajasthan west of the Aravallis, as of other desert and semi-desert regions, is characterised by great extremes of temperatures and long periods of severe drought accompanied by high wind velocity and low relative humidity to semi-arid conditions. The winter is quite cold and at many places the temperature sometimes falls below freezing point and frost occurs. On the other hand, the heat during the summers is intense and scorching. The arid region in western Rajasthan is the hottest region in India. East and south of the Aravallis there is considerable variation in the amount of rainfall and temperature distribution.

India has a great variety of climatic variations but the influence of monsoonal changes in this sub-continent has resulted in some form of unity in the climatic conditions. The study of the climate of Rajasthan is based on the seasonal variations and the main features of the climatic changes have been followed for each month.

Climatically, the year in Rajasthan has been divided into three major conventional seasons as follows:

1. The Hot-Weather Season (March to mid-June)
2. The Season of General Rains (mid-June to September)
3. The Cold Weather Season (October to February)

The Meteorological Department of India has again sub-divided
the Cold Season into two divisions, *i.e.* (a) The Season of Retreating Monsoon (October to December), and (b) The Cold Season (January and February). These seasonal variations have been broadly based on the temperature and rainfall conditions in different months. Temperature and rainfall are the most important elements, which have been frequently observed in the study of the climate of any region. Other factors like the amount of sunshine, cloudiness and humidity have also their influence on the climate of this region.

1. **Hot-Weather Season**

   In Rajasthan, the hot weather season is initiated in the month of March and it prevails from April to June. The northward migration of the sun results in a rise of temperature, first on the Deccan Plateau and then gradually in the north, northwest and western parts of India. The temperature rise during this month is somewhat uniform in the whole of Rajasthan. Due to increase in temperature, the atmospheric pressure falls subsequently over the heated land. In April, the winds are from west to east. As they come after crossing the heated Thar Desert, they are characteristically dry and warm. In the months of April and May the sun is almost overhead, the diurnal range of temperature increases more and the days become hotter. In the western part of Rajasthan mainly at Bikaner, Phalodi, Jaisalmer and Barmer, the maximum daily temperature goes upto 40° C to 45° C during these months.

   The Thar Desert in the west is one of the hottest regions in India and because the diurnal range is large, the minimum daily temperature drops down considerably. There is intense heat and glare during the day. The humidity drops down to about 1 per cent. The surface is covered with loose sand, occasionally level and mostly in the form of dunes. There is no live or green vegetation except cactii or only those plants capable of growth in the typical desert conditions. The annual range of temperature is between 14°C to 17°C but the diurnal range of temperature is much and in fact the difference between day and night temperatures at
trict. In May, the maximum average monthly temperature of 36°C occurs at Kota. The trend of isothermal lines in this State is no indication of the amount and intensity of aridity. The amount of rainfall also determines to a great extent the dry and sub-humid conditions in both these areas. The average rainfall (June to September) in Jaisalmer, Phalodi, Bikaner and Ganganagar ranges between 12 cm to 25 cm while in Kota it is 70 cm for the same period. Thus the rainfall conditions influence greatly the conditions in both these regions making the former region, as the dry arid region and the latter, a sub-humid region. The 32°C isotherm runs for a long distance along the western edge of the Aravallis and the line passes west of Ajmer and Jaipur and runs towards the north.

In the hot and rainy season winds generally move between southwest and west. During summer months, hot and dust raising wind is the common phenomenon. Violent dust storms are the most common phenomena in the western arid regions and the number of such storms gradually decreases over the semi-arid region and regions with higher rainfall. Ganganagar in the north has about 27 days of dust storms and Bikaner 18 days. At Jodhpur the number of storm days is about 8 and this progressively decreases towards the east and the southeast. June has the maximum number of dust storms in the northwestern districts while in southeastern areas they occur in May. In the northwest such storms continue even up to September.

2. SEASON OF GENERAL RAINS

The temperature, pressure and wind conditions in June indicate that the existing conditions have become more intensified. The northern, northwestern and western India continue to get heated till the onset of the monsoon by the middle of June. The monsoon current coming across the Indian Ocean is divided in two branches, namely the Bay of Bengal Branch and the Arabian Sea Branch. Since their goal is towards the low pressure of Sind, Rajasthan, due to its location, experiences the indraft of both monsoon currents. The ascensional movement however does not lead to heavy rainfall.
RAJASTHAN
RAINFALL
(JUNE - SEPTEMBER)

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SCALE

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In spite of the monsoon currents towards the western part of Rajasthan, there is considerable decrease in rainfall. This is mainly due to a variety of factors. The air currents from the southeast already give up their moisture in their passage up the Ganga Plains. The currents coming from the southeast, after crossing the warm sea come over an intensely heated land; thus the relative humidity decreases from 90 per cent to 50 per cent. Ordinarily, even this percentage of relative humidity would cause rainfall if the air current rises to about 920 m but due to the existence of an upper current of hot dry air from further west, most of the moisture is absorbed by this wind and the skies, again become cloudless. Ultimately, ‘the clear, cloudless air and the scorching rays of the vertical sun of the sandy desert conspire to maintain that dryness of the air which makes rainfall almost an impossibility'\(^1\)

The Aravalli range lying in the northeast to southwest direction shows a marked influence on the rainfall during this period. The average elevation of these hills in the southwest is about 920 m which declines gradually till in the northeast, the hills peter out into scattered rocks around Delhi region. The result is that the onset of the monsoon showers brings relief after the prolonged heat of the summer season only to the southwest. But in the northwestern part of the desert area, temperature, as high as 46°C has been recorded.

The distribution of rainfall (June–September) is shown in Map 6. The general trend of the isohyetal lines during this period is from northeast to southwest. There is a very rapid and marked decrease in rainfall west of the Aravallis making western Rajasthan the most arid part in India.

The rainfall during June to September decreases most markedly from east to west in this State. The 50 cm isohyetal line divides the State into two sections. West and south of this line there is increase in rainfall. Mt. Abu in the south receives about 149.3 cm of rainfall, the highest in Rajasthan. East of the Aravallis, nowhere rainfall increases more than 76.2 centimetres. Kota has about

69.1 cm of rainfall in this season. The arid west has a mean rainfall of less than 25.4 centimetres. The rainfall is associated with the rare depressions from the plains in the north and also with easterly winds. Part of it occurs due to local thunderstorms.

**Percentage of Monsoon Rainfall (June-September)**

**To Total Rainfall in Rajasthan**

<table>
<thead>
<tr>
<th>Stations</th>
<th>Annual in cm</th>
<th>June-September in cm</th>
<th>June-September percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ganganagar</td>
<td>25.9</td>
<td>18.7</td>
<td>72.1</td>
</tr>
<tr>
<td>Bikaner</td>
<td>29.2</td>
<td>24.0</td>
<td>82.5</td>
</tr>
<tr>
<td>Jodhpur</td>
<td>38.1</td>
<td>32.1</td>
<td>88.8</td>
</tr>
<tr>
<td>Barmer</td>
<td>30.0</td>
<td>26.3</td>
<td>87.5</td>
</tr>
<tr>
<td>Jaipur</td>
<td>61.0</td>
<td>54.0</td>
<td>88.5</td>
</tr>
<tr>
<td>Ajmer</td>
<td>52.8</td>
<td>46.5</td>
<td>88.1</td>
</tr>
<tr>
<td>Kota</td>
<td>75.0</td>
<td>69.1</td>
<td>91.9</td>
</tr>
<tr>
<td>Brijrajnagar</td>
<td>92.6</td>
<td>86.0</td>
<td>92.9</td>
</tr>
<tr>
<td>(Jhalawar)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Abu</td>
<td>156.4</td>
<td>149.3</td>
<td>95.4</td>
</tr>
<tr>
<td>Phalodi</td>
<td>20.5</td>
<td>17.8</td>
<td>81.8</td>
</tr>
<tr>
<td>Jaisalmer</td>
<td>15.4</td>
<td>15.1</td>
<td>98.0</td>
</tr>
</tbody>
</table>

The thunderstorms are the phenomenon, associated more frequently with the eastern part of the State than the western arid areas. Jhalawar and Jaipur have 40 to 45 days of thunderstorms in a year while Ajmer and Kota have 30 to 35 days, Jodhpur about 20 days and Bikaner and Barmer about 10 days. Ganganagar has very rare thunderstorms. These storms generally occur during May to September, particularly in June and July.

**3. Cold Weather Season**

The Cold Weather Season has been further divided into two sub-divisions, i.e. (a) The Season of the Retreating Monsoon (October to December), and (b) The Cold Season (January and February).

(a) The Season of the Retreating Monsoon (October to December): After the retreat of the intertropical front and southwest
RAJASTHAN

ISOTHERMS
(JANUARY MEAN)

INDEX

°C and Above

°C

°C

Less than °C

SCALE

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monsoon from the Indian climatic scene, there is slight increase in temperature for sometime and then there is gradual decrease to the winter minimum. In those areas where there has been much rain, the high temperature combined with greater persisting humidity results in sultry weather. In the months of October and November in Rajasthan where half the State has less than 25.4 cm of rainfall, greater evaporation and the absence of water logging results in the best weather conditions. The temperatures in October in the whole of Rajasthan are fairly uniform, the maximum being between $33^\circ.3$ C to $36^\circ.1$ C and minimum $17^\circ.7$ C to $21^\circ.1$ C at various stations. November is slightly cooler, as maximum and minimum ranges of temperature at various stations indicate. Mt. Abu is considered as a separate case. The temperatures at Mt. Abu are much lower than in the surrounding areas since it is located at a much higher altitude. During these months due to the withdrawal of the monsoon, the winds die down considerably and are very light and highly variable.

(b) The Cold Weather Season (December to February): During these months, the sun migrates to the southern hemisphere and the sub-tropical anti-cyclonic cell extends from the west with its axis near the base of the Peninsula. This controls the pressure gradient, temperature and wind conditions over the Indian region. In the northern part of the State, light northwesterlies and in the south and southeast, northeasterlies are caused due to the anticyclonic cell of India. The result is that cold weather cyclones travel across Rajasthan from west to east.

During this period there is a gradual decrease in temperature all over the region and off shore winds give either little or no rainfall. The sky is totally clear and hardly any clouds can be seen in the region. The western disturbances characterised by shallow depressions cause an important interruption in the weather of the northern plains. These depressions have little effect in the weather conditions of this State.

The isotherms for the month of January indicate a marked contrast from that of May isotherms. These lines run approximately parallel to the latitudes from west to east with
slight variation while crossing the Aravalli hills (Map 7). The average mean temperature for the month of January ranges from 12°C in the northern part of the State to 16°C in the south. The January mean monthly range of temperature at different stations is between 14°C to 17°C, the range at Mt. Abu being the smallest, i.e. 7°.8 C in the State. The temperature gradient to the north is steep, i.e. approximately 1°C for every degree of latitude and since Rajasthan stretches between 23°.3′N to 30°.12′N latitudes the temperature difference between the south to north is about 7°C. These isotherms while crossing the Aravallis dip gradually towards the south just as an indication that slight lower average temperature is found over the Aravallis at a southern latitude. In the southern part of Rajasthan mainly in the districts of Kota, Jhalawar, Jodhpur, Barmer and part of Udaipur, the mean monthly January temperature is about 16°C. Mt. Abu located on a hill has the lowest average, i.e. 14°.6C in January. In this cold weather month, winds are generally light and variable but northwesterly and northerly winds are more frequent than those from other directions.

HUMIDITY

Blanford (1876) has commented about the Indian desert that 'the term desert conveys an imperfect idea for the tract. It is neither barren nor inhabited; it is covered with bushes and shrubs in general, and in places small trees are found; moreover, although the population is thin, villages are scattered throughout and large herds of camel, cattle, sheep and goats are kept and pastured. The desert is in fact a great sandy tract entirely destitute of streams of water, with but few rocks and a large portion of the surface consisting of sand hills.' Description given by Glennie (1932) and Sir Aurel Stein (1942) about the condition in the desert conforms to a great extent with that of Blanford. Stein has commented that the climate of the Indian desert is far removed from that extreme aridity of the true desert of Chinese Turkistan. The air over the Indian desert is not very dry and it contains some, though a small quantity of moisture.

The relative humidity is minimum in the hot weather months
of March, April and May and maximum during the monsoon months of July, August and September, being lowest in April and highest in August. The moisture content of the air is lowest during the cold season. During the hot season, humidity ranges between 35 per cent to 60 per cent in the morning hours and 10 per cent to 30 per cent in the afternoon hours. In the cold season, mainly December to February, humidity ranges between 50 per cent to 60 per cent in the morning and 25 per cent to 35 per cent in the afternoon hours. Ganganagar records a slightly higher humidity percentage, mainly due to irrigation and appreciably lower dry bulb temperature prevailing during these months of the year. The humidity is lowest at Jodhpur and compared with the values of vapour pressure, it will be seen that Jodhpur is drier than other stations. During the monsoon season there is a marked increase in humidity. This increase is less marked in the west and the northwest of the Aravallis as compared to the areas lying to the east and southeast where rainfall is much higher. After the withdrawal of the monsoon, there is rapid decline in relative humidity and sometimes the percentage is much lower than that of the cold weather season.
CHAPTER IV

VEGETATION AND SOILS

RAJASTHAN has a great variety of natural vegetation ranging from scanty vegetation in the western arid region to mixed deciduous and sub-tropical evergreen forests in the east and southeast of the Aravalli range. Various types of forests cover about 43,382 sq km of area, which constitutes about 12.7 per cent of the total area of the State. The area under forests falls short in meeting the State's requirement of fuel and industrial wood. Ordinarily one-fourth to one-third of the total area should be under forests. Of the total area under forests, nearly 14,245 sq km are fully stocked and the rest of the area is very sparsely stocked consisting more or less of bare rocks or partially fixed sand dunes.

The need for the preservation of the forests was realised only in the beginning of the twentieth century, when some of the rulers of the princely states reserved some areas as hunting lands. In about 1910, Jodhpur State had its first scheme of the preservation of the forests. Similarly the Tonk State enacted a Shikar Act in 1901 which took into consideration both the forest and the wild life. Udaipur had also forest working scheme by about 1936. Other steps towards the progress of forest conservancy in Rajputana were the Marwar shooting rules, 1921, Kota forest rules, 1924 and Jaipur shooting rules 1931. In none of the princely states, the forest department was a separate department. The management of forests in different states formed part of the Shikar Department, with Customs, Excise, Agriculture, Mines or some other departments. It was only after the establishment of a unified Forest Department in 1949, that the forests in this State were brought under regular working. The little significance attached to the forests in all the preceding years adversely affected their condition.

FACTORS AFFECTING VEGETATION

The location and distribution of natural vegetation including
forests have been greatly influenced by (i) physical factors like relief and soil, (ii) climatic factors, and (iii) biotic factors.

(i) Physical Factors: The Aravalli axis is the principal and the most dominant mountain range in the State. Running northeast to southwest the range runs for a length of about 692 km dividing the State into two distinctive physiographic divisions—northwest and southeast. The ranges are higher in the southwest where Gurushikhar (1,727m), the highest peak in the State is located in the Mt. Abu batholith. The northwestern and western part of the State is a wide expanse of wind blown sand. This sand conceals beneath it a good deal of the solid geology. The surface is not altogether flat. The monotony is broken by the presence of a number of low rocky projections. The winds have formed a number of sand ridges, dunes and hillocks. The eastern and southeastern part of the State is more fertile, better watered and more habitable. Here one comes across the plateau section in the southeast and the Banas Plains in the east. These physical features have resulted in different types of vegetation.

The flora in the east and southeast of the Aravalli is well developed and shows central Indian affinities. It has a larger number of trees than the western flora. The vegetation around Mount Abu is the richest due to heavy annual rainfall of about 150 centimetres. The western part of Rajasthan is much drier and except along the foot of the Aravallis, where some of the trees of the eastern part occur, the vegetation is dominated by shrubs. The relief is much flatter with numerous sand dunes, sandstones and granitic hills. Further westward as the aridity increases, trees get stunted and still further in the Barmer, Jaisalmer, Bikaner and western Jodhpur, trees disappear and shrubs become dominant.

(ii) Climatic Factors: The climate has the greatest effect on the vegetational distribution in different parts of the State. The rainfall varies from 100 cm in the southeast to only 10 cm or even less in the extreme western areas. There is a great variation in rainfall at many places and in some cases, it is equal to, or even more than its average value. This State presents large extremes, not only in rainfall but in temperature distribution also. Koppen and Geiger
have indicated that the rainfall is insufficient to support vegetation if it is less than T+14 measured in cm, where T is the mean annual temperature measured in degree C. The mean annual temperature of Rajasthan is 26°.5C and according to the above criteria, the value equals to 40.5 centimetres. Thus the western half of the State is arid and the rest lying between T+14 and 2T+28 is semi arid.

A large part of the rainfall occurs in the months of July and August although some of it may occur in winter also. Uncertainty is the chief characteristic of this rainfall. Secondly, very high temperatures are recorded at different places. Relative humidity is high in the morning hours and decreases considerably in the afternoon hours. The entire area is windy and in the western plains gales in hot weather sometimes blow at a speed of 30 km or even more. The relationship between the rainfall and the different types of vegetation that exists in different part of the State is well marked. Mount Abu has a rainfall of more than 120 cm and the chief species constituting the top canopy are Mitragyna parvifolia, Eugenia jambolina and Anogeissus acuminata. There exists the middle and the shrub layer. Apart from this a large variety of grasses also exists in this area. The Banswara and Baran regions in eastern Rajasthan have an annual rainfall of 80 cm and have pure formations of Tectona grandis with admixture of Anogeissus latifolia and Madhuca indica and some grasses also grow. In areas with a range of rainfall between 40 to 80 cm, (except in Chittorgarh area) and in localities where the soil is good, Anogeissus pendula occurs in pure stands. In Chittorgarh area with a rainfall between 60 to 80 cm, poles and saplings of Santalum alpum are found to exist.

In the west of the Aravallis in Ajmer–Pali–Sirohi area up to Jodhpur, vegetation of the transition type occurs where the vegetation of the eastern and western types occur. In this part the vegetation becomes thinner and more sparse. The main trees in this part are Anogeissus pendula, Acacia senegal and Prosopis spicigera. Towards Jodhpur there is the occurrence of Tecornella undulata, Prosopis spicigera and Acacia senegal. This indicates the greater sign of aridity in the west.
The area in the northwest covered by Jaisalmer, Gadra Road, parts of Barmer and Ganganagar has an annual rainfall of less than 20 centimetres. The larger part of the area is covered by sands. There is very little vegetation and that too occurs at considerable intervals. The *prosopis juliflora* has very successfully grown in the arid and semi-arid regions. It has remarkable power of drought resistance and has grown well on sheer rock and has also phenomenal capacity of coppicing and throwing root suckers.

(iii) *Biotic Factor*: The biotic factors have adversely affected the vegetation in the State. The indiscriminate grazing by large flocks of sheep, goats and other cattle including camels, the unregulated cutting of trees and periodical clearance of land for cultivation, are the main causes for the destruction of the natural vegetation. The activities of the nomadic tribes with their migratory herds of sheep and goats have also contributed to the devastation of forests.

**Forest Types**

The forests of Rajasthan have been classified into the following seven types.

(i) Dry Teak Forests
(ii) Anogeissus Pendula Forests
(iii) Mixed Deciduous Forests
(iv) Boswellia Forests
(v) Butea Monosperma Forests
(vi) Tropical Thorn Forests
(vii) Sub-Tropical Evergreen Forests

(i) *Dry Teak Forests*: These forests, located in the southern part of the State in Banswara Forest Division, cover an area of about 5,200 sq kilometres. Teak is the most common tree and forms about 60 to 90 per cent of the vegetation. It generally occurs in pure stands but it is also found in mixture with other trees in parts of Chittorgarh, Udaipur and Barran Forest Division. The northern limits of teak in the western Aravallis are 24°42' N latitude in Udaipur, and 25°12' N latitude in Barran in Kota district. The climate of the tract is characterised by cold winter
and very hot and dry summers. Annual rainfall varies from 73.0 cm to 110.0 cm while three-fourths of it occurs in July and August. The height of teak trees appears to depend on the soil condition in different areas. The depth of the soil varies from very shallow on higher slopes and plateau areas to good depth along the base of the hills and in the valleys. The average elevation of the areas where teak trees are found varies from 245 m to 490 metres. The height of the trees ranges between 9 m to 13 m, which is due to mal-treatment in the past. The occurrence of occasional fires has greatly depleted the growing stock and lowered the site quality. The site is capable of producing only small size timber.

These forests provide some timber for furniture, panels for doors, windows and house construction and poles for fencing and roofing.

Apart from forest trees, shrubs and grasses of different varieties grow in this region. Bamboo is found only in patches in the interior part of the forests in some of the more moist and more remote localities. In most of the open areas of their occurrence, due to indiscriminate felling, only poles and saplings are found to exist.

(ii) Anogeissus Pendula Forests: These forests cover about 26,418 sq km of area located mainly in the southeastern part of the Aravalli hills between 270 m to 770 m of elevation. Anogeissus pendula is a tree of dry hot regions. This tree is most commonly found on the lower and gentler slopes, though its occurrence is also noticed on small hillocks and low ridges. The average height of the tree is between 6 m to 7.5 m but, where the soil is deep and water supply is good, the height of 14 m is not uncommon. The average annual rainfall of this area varies between 50 cm to 95 cm and temperature varies from 19.1°C minimum in winter to 46.7°C maximum in summer. These forest areas are found either on the rocks of the Aravalli system mainly composed of phyllites with intercalated quartzites, or on those of the Vindhyan system consisting of sandstone and limestone.

The wood of this tree is hard and strong and has a certain amount of elasticity. It provides good firewood and makes excellent charcoal. The wood is also used for making agricultural imple-
ments and big trees produce good rafters.

(iii) Mixed Deciduous Forests: The occurrence of deciduous trees is most common in Udaipur and in some parts of Kota, Bundi, Chittorgarh and Sirohi. These forests cover an area of about 9,065 sq kilometres. The average annual rainfall in this part of the State is about 35 cm and the temperature variations are almost the same as in the preceding region. These forests occur at elevations of 300 cm to 1,200 m and mostly occupy the plateau section and the gentle slopes where the soil is poor.

The wood from these forests is used for small timber, fuel and charcoal. In some favourable localities where rain and soils are good, teak can be successfully introduced.

(iv) Boswellia Serrata Forests: This type of forests covers an area of about 10,360 sq km and occurs in Alwar, parts of Chittorgarh, Udaipur, Sirohi, Ajmer, Jodhpur and Jaipur. The trees most commonly grow in the upper slopes of the Aravallis ridges in pure form on shallow bouldery strata. The annual rainfall in these areas varies from 50 cm to 95 centimetres. This tree grows at altitudes of 430 m and above and attains a height from 12 m to 15 metres.

The trees are straight-grained and thus provide suitable timber for use as packing material. In areas of deep soils, grasses are fairly dense while in rocky soils practically no grass grows. These forests have not been properly exploited.

(v) Butea Monosperma Forests: These forests are characteristic of black clayey soils and occur mainly in all the valleys where teak occurs. The total area under this variety is very small compared to total forest area in the State.

(vi) Tropical Thorn Forests: These thorny trees grow mostly in the lower hill slopes and in undulating terrain in Jodhpur, Jaipur and Ajmer districts where the average rainfall is between 25 cm to 50 centimetres. The trees vary in height from 4.5 m to 6 metres. In areas covered by this forest, there is good growth of grasses of various species. The timber of *Prosopis* is the useful tree specie of this tract. It is used as fuel and produces good charcoal.

(vii) Sub-Tropical Evergreen Forests: The area under these
forests is about 52 sq km located round about Mount Abu at elevations of 1,070 m to 1,375 metres. In this area the average annual rainfall is about 150 centimetres. The common trees on the slopes of Mount Abu are *Magnifera indica* and *Syzgium cuminic*. The area under such forests being small, they do not have any commercial significance. These forests have recreational value to the tourists visiting Mount Abu as a health resort.

**Vegetation in the Western Arid Region**

The extreme western part of the State comprising Jaisalmer, Gadra Road (Barmer), Bikaner and part of Ganganagar has rainfall of 20 cm and even less. This rainfall is generally erratic. The whole of this area is very sandy. The vegetation is very sparse and only few trees can be observed dotting the land at considerable intervals. Broadly the vegetation of the area varies from a spiny scrub jungle to dry deciduous forest type, consisting of various species of trees.

In this part *Acacia arabica* (babul), *Acacia senegal*, *Prosopis spicigera*, and *Prosopis juliflora* are the most common trees. Out of all the trees grown *Prosopis juliflora* is the most successful. It is one of the best fodder trees of the region and it can grow under varied climatic and soil conditions and topography. This tree has the importance of not only providing a shelter belt but also stabilising the sand dunes. It is not native to the area. Among the native species, *Prosopis spicigera* grows right from the semi-arid region to the driest part of the desert as far as Jaisalmer. It also grows with success on rocks and sandy surface. Its rate of growth is slow but this drawback is compensated by its good timber quality. In the arid and semi-arid region *Prosopis juliflora* has grown very well. It has remarkable powers of drought resistance and grows easily on sheer rock. These are a few edaphic formations which are found in depressions and ‘ranns’ of the arid and semi-arid regions specially where salinity is very high. In places like Pachpadra, Sanwarla, Kanod and Biramasar, halophytic plants are common.

The Rajasthan desert is not comparable with the Sahara desert.
There are quite extensive areas between Pokran and Jaisalmer which are covered with various species of grass particularly by an association of the two species of grass known as *Eleonurus hirsutus* and *Pacium turgidum*. These two species are found in the driest part of the desert. This indicates that the western arid plain must have a tolerably high local water level and this region can be turned into a good pastureland. Both the above species have been found as suitable fodder for cattle and sheep. The animal husbandry in the arid regions of western Rajasthan depends on the proper cultivation of various grasses. If the position of fodder supply can be improved in these arid lands, a prosperous dairy industry can be developed.

**SOILS**

From time immemorial, mankind has depended on soil for food, whether it is obtained from forests or from agriculture. Hence it is one of the most important natural resources. The importance of soil for agriculture cannot be over-emphasised. An intimate knowledge of soil is a pre-requisite for all agricultural operations and planning.

As seen in the chapter on Physiography, the western part of Rajasthan is a vast sandy plain including isolated hills and rock out-crops at places. The whole of the tract, west of the Aravallis is sandy but the soil improves in fertility from west and northwest towards east and northeast. In many parts the soils are saline or alkaline with unfavourable physical condition and high pH values.

**SOIL TYPES**

On the basis of their occurrence, chief characteristics and suitability for cultivation, the soils of this State have been divided into the following seven groups.¹

1. Desert Soil
2. Grey and Brown (Desert) Soil
3. Red and Yellow Soil
4. Ferruginous Red Soil
5. Mixed Red and Black Soil
6. Medium Black Soil
7. Alluvial Soils

1. Desert Soil: This desert soil occupies the largest area in Rajasthan. The whole of the State west of the Aravallis up to the State's border with Pakistan in the west (Map 8) is covered by sand, hillocks and rock outcrops. The whole of this tract is ill-watered and unproductive. The soils contain about 90 to 95 per cent sand and about 5 to 7 per cent clay. This wind blown sand, which has hindered soil growth, is derived partly from the surface rocks and a large part of it is blown in from the coastal regions. This soil contains a high percentage of soluble salt and has high pH value; it has varying percentage of calcium carbonate and generally is poor in organic matter. The greatest limiting factor is the scarcity of rainfall, since all this area gets the annual rainfall of less than 10 centimetres.

In the case of most of the aeolian sand, the CaO content varies from 1.0 to 1.5 per cent. CaO is less in the sand dunes of the stabilised sandy areas as at Jodhpur and some parts of Jaipur. In such areas it is noticed that CaO content decreases downwards resulting in CaCO₃ accumulation or kankar bed formation. The soil profiles in the stabilised sandy areas have developed under comparatively protected condition where rain water had sufficient time to leach the calcium from top layers down into the subsoil. The calcium content in the subsoil is nearly ten times that of the top soil. In most of the desert soils nitrogen is low, mostly ranging between 0.02 to 0.07 per cent. This deficiency is balanced to some extent by the presence of high available nitrogen in the form of nitrates. Thus the phosphates together with nitrates have made these desert sands fertile for agricultural crops and plants where water supply is regular.

2. Grey Brown (Desert) Soil: This group of soils covers an area
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of about 36,400 sq km and occurs in the districts of Barmer, Jalore, Jodhpur, Sirohi, Pali, Nagaur, Sikar and Jhunjhunu. The whole of this area lies west of the Aravalli axis and is characterised by vast stretches of sandy plain including hillocks and rock outcrops. The fertility of this soil increases towards the east and northeast. The soil is saline and alkaline and has a high pH value. There is a general shortage of water and ground water occurs at a depth of 30 m to 122 metres. The soil has a high phosphate content and at places it stands as high as in the alluvial soils. The pH of the soils and sands ranges between 7.2 and 9.2 and they are calcareous in nature. The soil fertility is enhanced due to the presence of nitrogen in the form of nitrates.

The soil in Pali district (Sumerpur) shows much variations. It is primarily alluvial and calcareous and also contains gravels. The texture is medium to heavy. The hilly areas in the south have heterogeneous distribution of soils, whereas towards the north somewhat more uniform and heavier soils are found. In this area various soil classes like coarse light soils, soils of the rocky areas, dark medium heavy soils, yellowish-brown medium soils and brown medium soils have been recognised.

3. Red and Yellow Soil: This soil occurs in the western part of the districts of Udaipur, Bhilwara and Ajmer. Red and yellow soils occur together in this area. The yellow colour is probably due to the higher degree of hydration of ferric oxide. Silty loams to silty clay loams are common. The soils are poorer in carbonate and humus content. The pH ranges from 5.5 to 8.5. This soil has good moisture holding capacity. In the northern part of this area mainly in Ajmer, it is sandy and the clay content varies between 3 and 9 per cent. Calcium carbonate is absent. The salt content is low. Nitrogen and organic carbon contents vary from 0.006 to 0.016 per cent and 0.057 to 0.126 per cent respectively.

The surface texture of soils at Pisangan in Ajmer district varies from sandy to sandy loam and loam. The calcareous horizon is a common feature. Sometimes ferruginous concretions are also found. The surface colour of the soil varies from light yellowish, through brown yellowish and yellowish-brown to dark brown. In
this area the following soil classes have been recognised.¹

(i) **Sandy Soil.** The landscape is much interrupted due to hills, rocky outcrops and sand dunes. The soil is sandy to loamy sand (75 to 90 per cent sand), light pale yellow to light yellow, with ill developed granular structure. The soil is open, soft and friable. The soluble salt percentage is low. At places, the soil is excessively drained.

(ii) **Shallow Soil:** Such soil occurs in areas of rock and rocky outcrops. This is a shallow soil of 30 to 120 cm depth lying over rocky strata. The surface topography is uneven and broken. The soil is loamy sand to sandy loam (65 to 85 per cent sand), light brown to yellowish brown with weakly developed granular to crumbly structure.

(iii) **Dark medium heavy Soil:** This soil is fairly deep and is sandy loam to loam (45 to 65 per cent) yellowish–brown to dark light brown with well developed columnar blocky structure. The soil is quite hard and firm, imperfectly to moderately drained.

Other classes of soil found are medium to reddish–brown medium soils.

4. **Ferruginous Red Soil:** This soil occupies the central and southern part of Udaipur district and the whole of Dungarpur district. This red soil has been formed from ancient crystalline and metamorphic rocks. When compared with the heavy and medium black soils, this soil has a smaller content of lime, potash, iron oxide, and phosphorus. On an average this soil is poorer in nitrogen, phosphorus and humus. In different areas the red soil greatly differs in depth and fertility, the characteristics of lighter texture, porus and friable structure and it is invariably free from ‘kankar’ nodules.

5. **Mixed Red and Black Soil:** This soil is found in the eastern parts of the districts of Udaipur, Chittorgarh, Dungarpur, Banswara, and Bhilwara. The pH of the soil is neutral to alkaline.

6. **Medium Black Soil:** This soil is most commonly found in

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the districts of Kota, Bundi and Jhalawar in the southeastern part of the State. Soil in this region is black and deep and some illuviation of finer particles is noticed. Vertical cracks of varying sizes are present and the internal drainage is fairly good. In such soil calcareous lower horizons are always present.

On the basis of the colour of the surface, the soils in this region have been broadly grouped into following classes:

(i) **Heavy Soil**: Grey–brown to dark grey–brown deepening in the middle and becoming yellowish–brown to brown in the lower most horizon. The soil is clayey on the surface and is followed by clay loam layers.

(ii) **Medium Heavy Soil**: The surface colour of the soil ranges from grey–brown to brown and at places it is followed by deeper tinges. The surface texture is usually normal.

(iii) **Yellow and Red Light Soil**: This soil shows a mosaic of yellow, red and black colour deepening with depth. The texture is loam to clay loam (15 to 20 per cent). In this soil calcareous concretions are present (1 to 6 per cent).

In most of the above soils the presence of organic carbon and nitrogen are low to medium.

7. **Alluvial Soils**: Alluvial soil occupies the northeastern part in this State mainly the district of Alwar, Bharatpur, Jaipur and Sawai Madhopur and the central part of Ganganagar district. This soil is red coloured and deficient in lime, phosphoric acid and humus. It varies from clayey to sandy loam in texture. The top soils are generally deficient in phosphate and calcium with variable contents of nitrogen. In some parts it contains kankar which lie either on sands or sandy clays, sometimes holding gravel. This soil produces a wide variety of crops including wheat, rice, cotton and tobacco.
CHAPTER V

AGRICULTURE AND IRRIGATION

This State, like the rest of India, is basically agricultural and rural. Although rich in minerals, the resources have not been developed fully as to change the basic agricultural economy of the State. About 70 to 80 per cent of the population is engaged in agricultural and allied activities. The land use and crop distribution pattern indicate great influence and control imposed by temperature, rainfall distribution, physiographic and soil conditions. The following table shows the land use pattern in the State. Out of the total area of 33.8 million hectares, nearly 38.8 per cent is the net sown area.

**LAND USE IN RAJASTHAN**

<table>
<thead>
<tr>
<th>Land Use</th>
<th>Hectares</th>
<th>Percentage of total area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rajasthan (Surv. Gen. India)</td>
<td>34,227,000</td>
<td>—</td>
</tr>
<tr>
<td>Rajasthan (Village Papers)</td>
<td>33,842,000</td>
<td>100.0</td>
</tr>
<tr>
<td>FORESTS</td>
<td>814,000</td>
<td>2.2</td>
</tr>
<tr>
<td>Not available for Cultivation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Land put to non-Agricultural</td>
<td>1,095,000</td>
<td>3.2</td>
</tr>
<tr>
<td>Barren and uncultivated land</td>
<td>5,153,000</td>
<td>15.2</td>
</tr>
<tr>
<td>Other Uncultivated Excluding Fallow Pastures and Grazing Lands</td>
<td>1,685,000</td>
<td>5.0</td>
</tr>
<tr>
<td>Mis. Tree Corps and Groves</td>
<td>16,000</td>
<td>0.04</td>
</tr>
<tr>
<td>Fallow Land</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Culturable Waste</td>
<td>6,840,000</td>
<td>20.2</td>
</tr>
<tr>
<td>Fallow other than current Fallow</td>
<td>3,105,000</td>
<td>9.2</td>
</tr>
<tr>
<td>Fallow Land</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current Fallow</td>
<td>2,022,000</td>
<td>6.0</td>
</tr>
<tr>
<td>NET AREA SOWN</td>
<td>13,112,000</td>
<td>38.8</td>
</tr>
<tr>
<td>AREA SOWN MORE THAN ONCE</td>
<td>901,000</td>
<td>2.3</td>
</tr>
<tr>
<td>TOTAL CROPPED AREA</td>
<td>14,013,000</td>
<td>41.1</td>
</tr>
</tbody>
</table>

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A large part of the area cannot be used for agricultural purposes due to limitations imposed by relief and aridity. Nearly 15.2 per cent of the area was barren and uncultivated, 20.2 per cent was classified as culturable waste, about 9.2 per cent area was fallow other than current fallow and 6 per cent under current fallow in 1960-1. Thus nearly half of the area of the State is not utilised for agricultural activities (Map 9). Even in the area under cultivation, the productivity is much lower than in some other parts of India. This low productivity is due to the arid and semi-arid conditions of the west and the agricultural negative zone created by the stretch of the Aravalli range. The 50 cm rainfall line divides the State into two distinct climatic regions, arid and semi-arid regions of the west and the sub-humid region of the east. The western region, which covers the whole of the Western Sandy Plain is not altogether infertile. Various soils like desert soils, grey and brown soils, and undifferentiated alluvium of this region are good, but lack of moisture and poor and insufficient irrigation facilities have resulted in poor agricultural conditions. These two regions clearly show different patterns of crop distribution. In the western arid and semi-arid region, the percentage of net sown area to total area decreases, so much so, that in Bikaner and Jaisalmer district which lie on the western margin, it is only 9.1 per cent of the total area of the districts. Even a greater part of this area is devoted to the cultivation of bajra and other crops like millets and pulses. In the eastern humid region, crops like wheat, maize, cotton, sugarcane and oilseeds are more predominant. Ganganagar, although it falls in the dry region, due to better irrigation facilities has a high percentage of sown area devoted to cash crops.

The average size of the holdings in Rajasthan is large, and more so in the arid region of the west. The land in this area cannot be cultivated intensely and thus only those crops are grown which require less moisture, which can survive arid and semi-arid conditions. These crops are more hardy and require comparatively little attention and labour than the crops of the eastern region.

The average yield of crops like wheat, barley and cotton in both the regions, and rice, maize, bajra and sesamum in the eastern
wet region is higher, the yield of bajra, jowar and small millets being much lower in the dry region as compared to the average yields in India. The percentage of secondary cereals, pulses and small millets is much larger (about two-third of the total cropped area) which consequently reduces the productivity of agriculture in this State. These crops are grown on the low rainfall that occurs, or under poor and insufficient irrigation facilities available within the area. Another factor which adversely affects the crop yield is the high temperature and low rainfall during the summer season, especially in the Western Sandy Plains. The high summer temperature increases greatly the rate of evaporation which ultimately results in increasing the moisture requirement for the crops in this region. In spite of great water deficiency in the districts of Nagaur, Bikaner, Barmer, Churu, Jodhpur and Jaisalmer, large areas have been brought under cultivation which are not warranted by geographical factors. This has resulted in low yields, per acre far less than those in the eastern, more humid parts of the State.

The density of agricultural population in Rajasthan is low as compared to other parts of India. It is 69 persons per 100 hectares in the eastern humid region, while in the western sandy plain area it is 22 persons per 100 hectares. In India the overall average is 101 persons per 100 hectares of land available for agricultural and allied uses. A large part of Rajasthan has arid and semi-arid conditions with sandy soil resulting in low fertility. This has further resulted in low population pressure and large tracts of agricultural negative areas in the western part of the State, the natural outcome of which is the large sized holding in the west. Production being low, the farmers have to cultivate a much larger area, so that the production may be up to a level which can suffice for their livelihood.

The low productivity in Rajasthan can also be ascribed to the little use of fertilisers and poor and primitive agricultural practices in the area.

CROPPING PATTERNS

Agricultural geography in the first place is concerned with the distribution of crop systems. The crop system of Rajasthan is so
RAJASTHAN

DISTRIBUTION OF CROPS 1961-62

INDEX

1. Bajra
2. Wheat
3. Jowar
4. Maize
5. Barley
6. Millets
7. Gram
8. Pulses
9. Oilseeds
10. Sugarcane
11. Cotton
12. Others

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AGRICULTURE AND IRRIGATION

varied and complex that the distribution of particular types can only be shown on very large scale maps of land use. Such maps would be very detailed and the pattern would be complicated. Various maps, which are prepared after incorporating all the conceivable facts about different crops, do not build up into simple, large-scale patterns. When dealing with such a large area as Rajasthan, it would be appropriate to formulate and select as criteria, some main characteristics common to farming of large areas. The variations may be indicated within the major regions.

In the following pages the study of various agricultural crops has been attempted on a statistical basis (Map 10). The crops have been grouped under the food crops like cereals and pulses, and commercial crops like oilseeds, sugarcane and cotton. The various crops have been described on the basis of acreage devoted to them in each district and then each crop area as the percentage of the total cropped area in the district. Both these criteria clearly indicate the heavy concentration of different crops in different parts of the State.

Agriculture in Rajasthan is marked by certain characteristics which are lacking in industrialised regions. Its main features are as follows:

1. Aridity and topographic features have played an important role in the agriculture of this State. 25 cm rainfall line divides the State into two major divisions, (i) the western arid and semi arid sandy plains, and (ii) the eastern Aravalli hilly region, the Banas Basin and Plateau area where the rainfall is up to 200 centimetres.

2. Nearly two-fifths of the total area of the State is devoted to farming.

3. A large part of the area devoted to farming, i.e. about 90 per cent is under food crops. Of this nearly 65 per cent is devoted to cereals and 25 per cent to pulses. Bajra alone occupies about 30.8 per cent of the area under crops.

4. About 45 per cent area of the State is covered by the districts of Bikaner, Jaisalmer, Barmer, Jodhpur, Nagaur and Churu, all lying in the western half of the State. The total cropped area in all these districts is about 26 per cent, while almost an equal area
is classified as culturable waste. About seven-tenths of the total cropped area in these districts is under bajra.

### Area and Production of Different Crops in Rajasthan\(^1\) (1961-2)

<table>
<thead>
<tr>
<th>Crops</th>
<th>Area</th>
<th>Production</th>
<th>Percentage to Total Area</th>
<th>Total Production</th>
<th>Percentage to Total Production</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Food Crops</td>
<td>11,482,400</td>
<td>81.9</td>
<td>5,439,200</td>
<td>81.9</td>
<td></td>
</tr>
<tr>
<td>Bajra</td>
<td>4,325,400</td>
<td>30.8</td>
<td>1,056,800</td>
<td>15.6</td>
<td></td>
</tr>
<tr>
<td>Gram</td>
<td>1,572,000</td>
<td>11.2</td>
<td>967,700</td>
<td>14.5</td>
<td></td>
</tr>
<tr>
<td>Wheat</td>
<td>1,260,500</td>
<td>8.8</td>
<td>1,234,800</td>
<td>18.6</td>
<td></td>
</tr>
<tr>
<td>Jowar</td>
<td>1,191,700</td>
<td>8.5</td>
<td>296,500</td>
<td>4.4</td>
<td></td>
</tr>
<tr>
<td>Maize</td>
<td>668,300</td>
<td>4.6</td>
<td>694,800</td>
<td>10.4</td>
<td></td>
</tr>
<tr>
<td>Barley</td>
<td>550,800</td>
<td>4.0</td>
<td>666,300</td>
<td>10.3</td>
<td></td>
</tr>
<tr>
<td>Rice</td>
<td>98,100</td>
<td>0.7</td>
<td>103,200</td>
<td>1.2</td>
<td></td>
</tr>
<tr>
<td>Millets</td>
<td>83,700</td>
<td>0.6</td>
<td>36,900</td>
<td>0.5</td>
<td></td>
</tr>
<tr>
<td>Tur</td>
<td>22,600</td>
<td>0.1</td>
<td>9,000</td>
<td>0.1</td>
<td></td>
</tr>
<tr>
<td>Other Pulses</td>
<td>1,709,300</td>
<td>12.2</td>
<td>373,200</td>
<td>5.6</td>
<td></td>
</tr>
<tr>
<td>Non-Food Crops</td>
<td>2,530,600</td>
<td>18.1</td>
<td>1,198,500</td>
<td>18.1</td>
<td></td>
</tr>
<tr>
<td>Sesamum</td>
<td>509,100</td>
<td>3.2</td>
<td>67,800</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>Groundnut</td>
<td>120,500</td>
<td>0.8</td>
<td>62,700</td>
<td>0.9</td>
<td></td>
</tr>
<tr>
<td>Linseed</td>
<td>85,800</td>
<td>0.6</td>
<td>19,500</td>
<td>0.2</td>
<td></td>
</tr>
<tr>
<td>Sugarcane</td>
<td>32,900</td>
<td>0.2</td>
<td>719,300</td>
<td>10.9</td>
<td></td>
</tr>
<tr>
<td>Cotton</td>
<td>236,300</td>
<td>1.7</td>
<td>168,400</td>
<td>2.6</td>
<td></td>
</tr>
<tr>
<td>Other Non-Food</td>
<td>1,556,000</td>
<td>11.6</td>
<td>160,800</td>
<td>2.5</td>
<td></td>
</tr>
<tr>
<td>Foods and Non-Food Crops</td>
<td>14,013,000</td>
<td>6,637,700</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

5. Bikaner and Jaisalmer districts lie in the driest part and cover about one-fifth of the total area of the State. About 8.8 per cent of this area is under crops of which three-fifths is under bajra cultivation. About 54.2 per cent of the area of these two districts is classified as culturable waste.

6. No separate specific crop is grown as fodder in this State.

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\(^1\) Ibid., pp. 53-64.
7. The yield per acre is low and in most of the crops, the average yield is much lower than that of India.

8. Over large parts of India, the fields produce two, or more crops in a year. But here, due to aridity, high summer temperatures and large sandy stretches in the west, the double cropped areas are only about 6.8 per cent of the net sown area.

9. In farming, there is little use of fertilizers and manures. Animal refuse which could be used as good manure is mostly burnt.

10. Very little cropped area is devoted to commercial crops; cotton and sugarcane occupy about 1.7 per cent and 0.6 per cent of the total cropped area respectively.

11. The district of Ganganagar, located in the north of the State, mainly because of the facilities for irrigation, grows nearly 32 per cent of the gram acreage, 11 per cent of wheat and barley, 16.6 per cent of sugarcane and about 30 per cent of the cotton acreage of the State.

**AREA AND PRODUCTION\(^1\) OF IMPORTANT CROPS IN RAJASTHAN AND IN INDIA (1961-2)**

<table>
<thead>
<tr>
<th>Crops</th>
<th>Area in hectares</th>
<th>Percentage of 3 to 2</th>
<th>Production in tons</th>
<th>Percentage of 6 to 5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>India</td>
<td>Rajasthan</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wheat</td>
<td>13,457,700</td>
<td>1,260,500</td>
<td>9.3</td>
<td>11,620,000</td>
</tr>
<tr>
<td>Barley</td>
<td>3,220,600</td>
<td>550,800</td>
<td>16.5</td>
<td>3,067,000</td>
</tr>
<tr>
<td>Bajra</td>
<td>10,942,100</td>
<td>4,325,400</td>
<td>39.5</td>
<td>3,502,000</td>
</tr>
<tr>
<td>Jowar</td>
<td>17,438,800</td>
<td>1,191,700</td>
<td>6.8</td>
<td>7,664,000</td>
</tr>
<tr>
<td>Maize</td>
<td>4,470,000</td>
<td>668,300</td>
<td>14.9</td>
<td>4,000,000</td>
</tr>
<tr>
<td>Gram</td>
<td>9,707,700</td>
<td>1,572,000</td>
<td>16.2</td>
<td>5,854,000</td>
</tr>
<tr>
<td>Other Pulses</td>
<td>11,724,200</td>
<td>1,709,300</td>
<td>14.5</td>
<td>4,332,000</td>
</tr>
<tr>
<td>Sesamum</td>
<td>2,251,000</td>
<td>509,100</td>
<td>24.6</td>
<td>366,000</td>
</tr>
<tr>
<td>Groundnut</td>
<td>6,416,000</td>
<td>120,500</td>
<td>1.8</td>
<td>4,682,000</td>
</tr>
<tr>
<td>Sugarcane</td>
<td>2,405,600</td>
<td>32,900</td>
<td>1.3</td>
<td>96,021,000</td>
</tr>
<tr>
<td>Cotton*</td>
<td>7,575,000</td>
<td>236,300</td>
<td>3.1</td>
<td>4,500,000</td>
</tr>
</tbody>
</table>

*Cotton production in bales of 392 lbs each.

Prior to the reorganisation of this State in 1956, it had been a deficit area in the production of food grains. It is only after a large number of development schemes have been implemented that this State has not only achieved self-sufficiency in food grains but has also shown a sizable surplus. Due to the vagaries of the monsoon, yearly agricultural production shows marked variations. During the Third Plan period (1961-6) a large number of schemes were operated, which resulted in increased agricultural production. In this Plan, great emphasis has been given on the use of land according to its capability. It has been observed that land has been indiscriminately broken up for cultivation. There has been no appreciable increase in the area under pastures and forests. This indicates defective land use. It is essential to locate the maladjustment and to take prompt measures to improve it. The crop patterns are also to be evolved according to the capacity of the land. In this connection the following measures are necessary.

(i) Location of exploitable waste land and its utilisation in such a way as to achieve a better balance between forestry, arable farming and pastures.

(ii) Determination of suitable cropping patterns, mainly for the areas which have been recently reclaimed or brought under controlled irrigation or which are going to be so reclaimed or commanded by irrigation.

In the Third Plan, about 101,215 hectares of additional land has been brought under food crop cultivation. The total area under food crops has increased from 1,117,410 hectares in 1960-1 to 1,222,672 hectares in 1965-6.

The measures which have been adopted for improving agriculture during the Third Plan period in the State would be reflected in the changed crop pattern and the yield per acre of these crops. The area under paddy and wheat is likely to increase from 80,972 hectares and 1,214,575 hectares to 202,430 hectares and 1,993,930 hectares by 1965-6. The following figures also indicate the general rise in the average yield per acre in respect of most of the crops and mainly in rice, wheat, maize, groundnut, sugarcane and cotton.
### Area and Production of Crops in Rajasthan

<table>
<thead>
<tr>
<th>CROPS</th>
<th>1960—1</th>
<th>1965—6</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Area in hectares</td>
<td>Production in tons</td>
</tr>
<tr>
<td>A. FOOD GRAINS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(i) Cereals</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rice</td>
<td>81,000</td>
<td>107,000</td>
</tr>
<tr>
<td>Jowar</td>
<td>1,050,000</td>
<td>290,000</td>
</tr>
<tr>
<td>Bajra</td>
<td>3,970,000</td>
<td>875,000</td>
</tr>
<tr>
<td>Maize</td>
<td>607,000</td>
<td>595,000</td>
</tr>
<tr>
<td>Wheat</td>
<td>1,214,000</td>
<td>1,071,000</td>
</tr>
<tr>
<td>Barley</td>
<td>607,000</td>
<td>670,000</td>
</tr>
<tr>
<td>Small Millets</td>
<td>81,000</td>
<td>36,000</td>
</tr>
<tr>
<td>(ii) Pulses</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gram</td>
<td>1,740,000</td>
<td>960,000</td>
</tr>
<tr>
<td>Rabi Pulses</td>
<td>20,200</td>
<td>9,000</td>
</tr>
<tr>
<td>Kharif Pulses</td>
<td>1,820,000</td>
<td>422,000</td>
</tr>
<tr>
<td>B. COMMERCIAL CROPS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oilseeds</td>
<td>1,030,000</td>
<td>276,000</td>
</tr>
<tr>
<td>Cotton</td>
<td>260,000</td>
<td>100,000</td>
</tr>
<tr>
<td>Sugarcane</td>
<td>32,400</td>
<td>90,000</td>
</tr>
</tbody>
</table>

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CROP CULTIVATION

WHEAT

Wheat is one of the most important food grains in India. It is grown primarily for direct human consumption. It is preferred as a staple food by a large section of the population.

Wheat cultivation in India is confined mainly to two species, *i.e.* Triticum vulgare generally known as common wheat and Triticum durum known as macaroni wheat. By far the largest area under wheat cultivation in India (including Rajasthan) is under vulgare. The vulgare specie of wheat consists of a number of types botanically known as varieties. In a particular species, varieties differ from one another in certain characters. Vulgare wheat has the largest number of varieties which run into thousands. In these varieties there are various degrees of development of the awns, fully bearded to beardless, different colours of awns, white, red and black, different shapes of ears, different colours of glumes, different degrees of hairiness on the surface of the glumes, felted or non-felted, different colours of the grains—white, red, amber and various sizes and shapes of grains and different degrees of hardness of the kernels soft powdery to hard-flinty.

The following table gives the varieties of wheat which are more suitable for cultivation in different parts of Rajasthan.

**Some Improved Varieties of Wheat and Their Main Characteristics Suitable to Rajasthan**

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Variety</th>
<th>Origin</th>
<th>Suitability of conditions</th>
<th>Main characters</th>
</tr>
</thead>
</table>

---

<table>
<thead>
<tr>
<th>S. Variety No.</th>
<th>Origin</th>
<th>Suitability of conditions</th>
<th>Main characters</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. N.P. 718</td>
<td>N.P. 52XN.</td>
<td>Sandy loams and black cotton soils.</td>
<td>Like N. P. 710. Does not have top dense ears. Maturity early. Resistant to brown and yellow rusts and to lodging. Highly resistant to loose smut.</td>
</tr>
<tr>
<td></td>
<td>P. 165</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>P. 165</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>P. 165</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>N.P. 4.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. C. 591</td>
<td>8.B X Type 9</td>
<td>Light alluvial loams. Responds well to manuring and irrigation.</td>
<td>Like C. 518 but the glumes are a little less hairy and straw weaker than C. 518, Susceptible to black and brown rusts and to loose smut.</td>
</tr>
</tbody>
</table>

Although wheat is grown under a great variety of climatic conditions, primarily it is grown in areas with moderate temperature and sub-humid and even semi-arid conditions. In Rajasthan it is grown under high temperature but this period should not coincide with period of high atmospheric humidity. Both these conditions at one and the same time are injurious to wheat plant.
It grows successfully in a cool, moist climate and warm dry climate is favourable for the ripening of the crop. The winter temperature should be between $10^\circ$ C to $15^\circ$ C and the summer temperature between $21^\circ$.1 C to 26.6 C. The annual rainfall of 50 cm to 75 cm is optimal. Wheat is grown under a wide variety of soils. The best wheat soils are fertile, having good water-holding capacity permitting fair to good drainage. In view of this, the extremely sandy soils of western Rajasthan are not good for wheat cultivation. Too much saline and alkaline soils are also not suitable for this crop. For good soil, some organic matter is desirable since it promotes good tilth. A moderate liberation of nitrogen is also useful as it stimulates growth and also helps in the production of high quality wheat.

Wheat occupies nearly as much acreage as the gram crop, i.e. 1.3 million hectares or 8.8 per cent of the total cropped area (1961–2). The largest concentration of this crop is found in Ganganagar and the eastern and southeastern part of the State. Nearly 85 per cent of the wheat acreage is found in the Luni basin, Aravalli Range and Hilly Region, Marwar Plain and in the Deccan Lava Plateau. The large part of this area receives more than 50 cm of rainfall which is ideal for the wheat crop. The only exception is Ganganagar where its cultivation is largely based on irrigation. The soil here is a fertile alluvium, suitable for the crop. This district constitutes nearly 11 per cent of the total cropped area under wheat. The western sandy plain produces very little of it as the area is too dry and the irrigation facilities are lacking. As in other parts of India, wheat is a winter crop in this State also since only during winter the temperature is suitable for its cultivation.

Generally, the soil preparation takes place between September 15 to November 15 each year. When the monsoon rains are over and about three weeks have passed, i.e. when the nights have become cool and dew is formed in the fields about the middle of October, the sowing period begins and continues till the middle of November. The fields, in which wheat is grown, remain fallow in the preceding summer. During this period some manure is added to the soil. Wheat is sown in drills carefully prepared by ploughing. Since irri-
igation is an important factor in wheat cultivation, regular watering becomes an essential part of it. Watering is done five times, for this crop, preferably at the end of the months of December, January and February and twice in March. Moisture is essential to the plant in its early growth and the cool temperature of December helps in tillering and there is full vegetative growth of the plant during this period. In the beginning of March, grain is formed in the plant and at the same time, temperature increases. This helps in the ripening of the crop. The harvesting begins by April 10 in the dry parts and continues up to the middle of May. The temperature rises high within a few days. This results in the quick maturing of the grains. The dry winds start blowing, which also help in the quick drying of the grain. This type has shrivelled grains unlike the rounded grains of those countries where the change in temperature is gradual.

MAIZE

Maize covers nearly 668,300 hectares (1961–2) which form about 4.6 per cent of the total cropped area in the State. This is considered to be an inferior grain. The cultivation is concentrated in areas of fertile soil, mainly loam. The greatest concentration is in the Aravalli range, Hilly region and the Banas basin. The districts in these regions cover nearly 90 per cent of the maize acreage. About three-fourths of the crop is produced in the districts of Udaipur, Dungarpur, Banswara, Bhilwara, Chittorgarh and Ajmer.

The soil for the crop is prepared by the end of March up to the end of April. The sowing takes place between mid-June to mid-July especially with the first summer rains. The harvesting starts by the end of September and continues up to the middle of November. In this State early maize is sown under irrigation in April and May. Its stalks are used for fodder.

The maize plant is quite sensitive to water requirements. If the rains come late, the crop is adversely affected. The water requirements during the vegetative growth of the plant is critical. The crop is equally damaged if there are long intervals between the rainy periods.
BARLEY

In this State, 550,800 hectares, i.e. 4 per cent of the total cropped area was under barley in 1961-2. It is a winter crop which ranks along with wheat and gram as staple food grain. Nearly 90 per cent of the acreage is found in the district of Udaipur, Bhilwara, Ajmer, Pali, Tonk, Jaipur, Sikar, Sawai Madhopur, Bharatpur, Alwar and Ganganagar. All these districts except Ganganagar are located east of the 50 cm rainfall line. In this State dry, sandy or moist clayey areas, as well as those, where irrigation facilities are lacking, are devoted to this crop.

The soil is prepared for it from 10 September to mid-November. The sowing takes place between mid-October to mid-December. The watering of this crop is necessary in the beginning of January, middle of February and in early March. The harvesting takes place by the end of March up to the middle of April.

BAJRA

If acreage is the criteria then bajra is the most important food crop in Rajasthan. Out of the total cropped area of 14.01 million hectares in the State about 4.3 million hectares is under this crop (1961-2). This constitutes 30.8 per cent of the total cropped area.

Bajra crop is grown under poor climatic and soil conditions. Nearly 75 per cent of its acreage lies in the western part of the State, i.e. in the districts of Barmer, Jodhpur, Nagaur, Sikar, Jhunjhunu, Ganganagar, Bikaner and Jaisalmer (Map 11). The main bajra cultivation is confined to the western sandy plains. The whole of this area is the driest part of Rajasthan where the annual rainfall is less than 50 centimetres. The soil in the greater part of this area is a desert soil except in the eastern margin where it is partly grey, brown and undifferentiated. In this area, except Ganganagar, the percentage of bajra acreage of the total cropped area of the districts varies between 35 to 90 per cent. This percentage increases towards the west so much so that in Jaisalmer, the driest part of Rajasthan, nearly 90 per cent of the cropped area is under bajra. The smallest area devoted to this crop lies in the southeast where with higher rainfall and better soil, the land is used for other crops.
RAJASTHAN

AREA UNDER BAJRA
ONE DOT REPRESENTS 1,000 HECTARES

Based upon Survey of India map with the permission of the Surveyor General of India. © Government of India Copyright, 1962.
Thus three-fourths of the bajra acreage in the State lies in the western sandy arid and semi-arid plains.

For bajra crop the soil preparation takes place by the end of March up to the end of April, while sowing starts with the first fall of regular rains. The actual sowing takes place between 25 June to 20 July. The harvesting of bajra takes place from the end of September to the end of October. Irrigation is not needed for this crop. Only one watering is done in September in Ganganagar Canal Colony. The threshing of bajra is done after rabi sowing.

JOWAR

Jowar is one of the most widely grown dry zone food grains in India. In Rajasthan it occupies about 6.8 per cent of India’s acreage and production was about 3.8 per cent in 1961-2. This crop grows well in areas of even low rainfall and its ability to withstand considerable drought makes it an ideal crop for cultivation over large areas which mainly depend upon rainfall.

There is great scope in the cultivation of jowar because of the existence of several varieties which thrive equally well both in dry and wet areas. The utility of this crop increases since it can be grown both for fodder and grain.

Jowar in Rajasthan occupies nearly 1.2 million hectares which comes to 8.8 per cent of the total cropped area. In acreage it covers nearly as much as the wheat crop. This crop is grown as a kharif crop.

Jowar is a staple crop and its cultivation is widespread mainly in the central and eastern part of the State. Nearly 90 per cent of the acreage is concentrated in this region. The five districts of Jodhpur, Nagaur, Pali, Ajmer and Tonk contribute nearly half of the jowar acreage. The preparation of the soil for the cultivation of this crop takes place between the end of March and the end of April. The sowing period commences from the end of June and lasts till mid–July. The harvesting of this crop takes place from mid-November to mid–December. Jowar is also grown for fodder. In that case it is always sown in April–May and harvesting of fodder takes place at the end of May. In areas where rainfall is
less than 50 cm irrigation is necessary.

The crop is largely associated with the black cotton soil but it grows in other soils also. Stony, gravelly and other rough soils are not suitable for its cultivation. The crop grows best on clay loams, whether red or black in colour. In irrigated areas it requires adequate drainage.

**Gram**

Gram comes only next to bajra in acreage, as nearly 1.6 million hectares, *i.e.* about 11.2 per cent of the total cropped area was under this crop in 1961-2. It is one of the winter crops. Nearly one-third of the gram acreage in the State is confined to Ganganagar district in the north. Better irrigation facilities available from the Rajasthan Canal Project have resulted in this heavy concentration of gram acreage. Within the district the largest acreage under gram is in dry, sandy or moist areas as well as in those areas where irrigation facilities are lacking. It is also grown in the northeastern part of the State, *i.e.* the districts of Churu, Jhunjhunu, Alwar, Bharatpur, Jaipur, Tonk, Sawai Madhopur and Ajmer. These districts along with Ganganagar cover nearly four-fifths of the cropped area under gram. In the districts of Alwar, Bharatpur, Dungarpur and Banswara nearly 20 to 30 per cent of the cropped area is under gram. It is grown very little in the dry western part of the State.

The soil preparation starts by the end of September and continues up to the middle of October. The sowing period extends from 1 to 20 October. The harvesting takes place between 20 March to 15 April. Irrigation is done twice in Ganganagar, the first at the time of sowing and, the second by the end of January, when it is flowering time.

**Pulses**

The cultivation of pulses occupies quite a large part of the total cropped area in Rajasthan. Except for gram, other pulses occupy
AGRICULTURE AND IRRIGATION

about 1.7 million hectares (1961–2) *i.e.* 12.1 per cent of the total cropped area. If gram is also included, then nearly one-fifth of the total cropped area is under pulses. Thus the cultivation of bajra and pulses cover nearly half the total cropped area.

The greatest concentration of acreage under pulses is found in the arid and semi-arid regions of the State. Nearly 85 per cent of the area under pulses is in the districts of Jaipur, Jhunjhunu, Sikar, Nagaur, Jodhpur, Bikaner and Churu. The last four districts cover nearly half of the acreage under pulses in the State.

**SESAMUM AND GROUNDNUT**

Among the oil seeds, sesamum (til or gingelly) and groundnut are the most important crops grown in Rajasthan. Sesamum oil seeds furnish one of the most important oils for domestic consumption both in this State and in the south. Its upper grade oil is used as a medium for cooking, while the lower grades of oil are used for manufacture of soap. The seed is also used directly as human food.

In Rajasthan it is sown as a *kharif* crop. Its cultivation is confined to the plains as well as the elevated sections of land. Sesamum thrives best where temperatures in the warmer months is 21°C and more. It is grown as a rainfed crop in tracts where rainfall in the crop season is more than 50 centimetres. The crop takes about 3 to 4 months to grow. For both the crops, the preparation of soils takes place with the first fall of regular rains mainly by the end of June and beginning of July. The sowing period extends from mid-July to mid-August. The harvesting starts at the end of September and lasts up to late October.

Both these crops cover nearly 4 per cent of the total cropped area in the State. Sesamum covers nearly 509,100 hectares (3.2 per cent) while groundnut about 120,500 hectares (0.8 per cent) of the acreage (1961-2). Rajasthan grows nearly 10 per cent of India’s sesamum. Nearly three-fifths of the area under sesamum is found in the districts of Pali, Nagaur, Jalore, Sirohi, Banswara and Ajmer. Most of the groundnut acreage, *i.e.* nearly four-fifths is in the dis-
districts of Chittorgarh, Sawai Madhopur, Jaipur, Udaipur; Bhilwara, Bharatpur and Jhalawar.

COTTON

Cotton producing areas in Rajasthan do not form part of the major cotton producing regions in India. This crop covers nearly 236,300 hectares in 1961-2 which constitute about 1.7 per cent of the total cropped area of the State and about 3.1 per cent of the cotton acreage in India. Ganganagar alone accounts for about 30 per cent of the area under cotton, while nearly three-fifths of the acreage is concentrated in the southeastern districts of Udaipur, Chittorgarh, Bhilwara, Ajmer and Jhalawar. Like the major cotton producing regions of India, the cotton cultivation is very closely related to soil distribution. The above areas have either red and yellow soils, or mixed red and black soils, or medium black soils.

The soil is prepared for cotton cultivation in the month of April. The sowing begins from the second week of April and continues up to mid-June. The water requirements of the cotton plants are to be spaced properly. The watering of the crop is done four times, i.e., twice in the beginning and end of May and likewise twice again in June and if there is no rain then the fifth watering is done at the end of October. The picking of cotton depends on the variety and time of sowing. Generally the picking starts from the end of September and continues up to the end of December. In the cultivation of cotton the soil and water supply, either through rain or irrigation, are of great significance. Too heavy a rainfall results in excessive vegetative growth and fruit growth is hampered.

IRRIGATION METHODS AND PRACTICES

In Rajasthan, irrigation can play a major role in any agricultural development programme. Nearly half the area in the western part
Plate 7—Furrowing the field in Eastern sub-humid region for sowing. (See page 75)

Plate 8—Seed plantation in Eastern Rajasthan. (See page 75)
Plate 9—Picking Cotton by Hand. (See page 80)

Plate 10—Kota Barrage on River Chambal. Water used for Irrigation. (See page 84)
of the State receives a rainfall less than 25 centimetres. About one-third of the area, mostly east of the Aravallis has a rainfall of 50 cm to 75 centimetres. The western part has also high temperatures and both these factors have created the arid and semi-arid conditions there, under which agricultural activity is very limited. In fact, the Western Sandy Plain of Rajasthan has to a great extent become a negative area for crop farming and other agricultural activity.

The irrigation facilities are very restricted and limited in the eastern part as well. This State has about 1.65 million hectares of irrigated area (Map 12), which is about 11.02 per cent of the total cropped area; Nearly three-fifths of this area lie in the districts of Alwar, Bharatpur, Jaipur, Sawai Madhopur, Ajmer, Tonk, Bhilwara, Pali Udaipur and Chittorgarh districts. The above area comes mostly in the Aravalli range and the Mewar Plains in the east (Map 13). The rainfall in this region is between 40 cm to 80 centimetres. It has about 73.5 per cent of the total double cropped area in the State.

In Rajasthan there are three main sources of irrigation (Map 13).
1. Canals
2. Tanks
3. Wells and tube wells

Among the various sources of irrigation, wells and tube wells irrigate nearly 55 per cent of the total irrigated area. 21.4 per cent of the area is irrigated by tanks and about 23.7 per cent by Canals. On an average, nearly three-fifths of the cotton acreage in the State is irrigated. Ganganagar accounts for one-third of the area under cotton out of which nearly three-fourths is canal irrigated. The other three districts of Bhilwara, Chittorgarh and Pali have 30 per cent of the cotton acreage. In these districts about 93 per cent of this crop is irrigated. In the eastern region, Jhalawar district has about 14 per cent of the cotton acreage. The rainfall here is about 90 cm and cotton crop does not require irrigation.

1. CANAL IRRIGATION

In Ganganagar district, all the irrigation is done by the canals.
The scope for canal construction in the Aravalli and Mewar Plain area is limited due to the nature of the rainfall and physiographic conditions. The amount of rainfall in the Aravalli region is between 50 cm to 90 cm per annum. A large part of this rainfall, on an average about 90 per cent, occurs within a short period of 2 to 3 months. On the other hand, the soil over which the drainage lines have been formed is light, unconsolidated and sandy. This permits a large amount of percolation during the run-off period. The temperature also is high mainly in the Mewar Plains. This causes greater amount of evaporation. In addition the rock structure is such that it does not provide natural reservoirs. All these factors have resulted in a lesser development of canals in this region. However, attempts are being made to utilise all the rain water available for irrigation. Even in the areas where canals have been constructed, the shortage of water is frequent. This is caused due to irregular rainfall, loss of water in transportation, higher seepage, greater evaporation due to high temperatures prevalent in the area, defective field channels and water courses and poor system of the distribution of water among the farmers. Under this undependable water supply in the canals, it is difficult for the farmers either to change the crops or to adopt intensive agricultural practices. Moreover, the irrigation farming is expensive which is another restrictive factor in its future development and adoption in the area.

Thus, for optimum results in terms of agricultural production through irrigation, corrective measures are imperative. Among these should be, regular and increased supply of water to those areas where irrigation is needed. The distribution system needs improvements by reducing seepage by lining of canals, and slope correction, improving the drainage system and by making the commanded areas more compact. These methods would ensure better distribution and would certainly help in increasing the farm output.

2. Tank Irrigation

Bharatpur district in the northeast and Pali on the western part
of the Aravalli range have the largest area under tank irrigation. Both these districts account for nearly 56 per cent of the tank irrigated area in Rajasthan. The districts of Alwar, Bharatpur, Jaipur, Sawai Madhopur, Ajmer, Tonk, Bhilwara, Pali, Udaipur and Chittorgarh have together, nearly 95 per cent of the tank irrigated area. In these districts wells and tubewells are also common sources of irrigation. Nearly three-fourths of the area irrigated by wells and tubewells is found in this region. This method is very common in the districts of Jaipur, Ajmer, Bhilwara, Udaipur and Chittorgarh.

3. WELL AND TUBEWELL IRRIGATION

Wells and tubewells are another source of irrigation in this State. About 55 per cent of the irrigated area is covered by this source. Well irrigation has several advantages over canal irrigation in many areas. The crop pattern is better developed in areas irrigated by wells due to regular and dependable supply of water and the average yield per hectare is also higher. They are less expensive as compared to canal irrigation. Wells can be dug at convenient points and water distribution also is better than by other irrigation methods. Nevertheless, well irrigation has its own problems as well. Power shortage for lifting water from the wells is the most important. In many places bullocks are used for this purpose. But their capacity being limited full water supply cannot be assured and the full use of the wells cannot be made in many areas.

Apart from this, adequate water supply from underground sources can also be made available for irrigation in the State.

MAJOR IRRIGATION PROJECTS

1. CHAMBAL PROJECT

In earlier years the three princely States of Kota, Mewar and Indore had prepared separate schemes for harnessing the water of the Chambal river for generation of electricity and using water
for irrigation but the schemes could not be materialised. After the formation of Rajasthan and Madhya Bharat (now Madhya Pradesh) a comprehensive joint multipurpose project called, 'The Chambal Valley Development Scheme' was formulated and included in the development plan of the country. Both these States agreed to share the cost equally and to use the water and power equally.

The project was approved by the Planning Commission. It included the following works—

(i) Construction of three dams and three power houses, one each at the foot of each dam,

(ii) Barrage construction near Kota,

(iii) The construction of canals on both sides of the river for irrigation, and,

(iv) A network of high tension transmission lines and substations in both the States.

The Project was to be completed in three stages. The first stage included the construction of Gandhisagar Dam for conservation of water near Chaurasighat where the Rajasthan boundary meets Madhya Pradesh, a power house at the dam site, the Kota Barrage in Rajasthan with two canals of 261 km length in Rajasthan and 641 km in Madhya Pradesh to irrigate, 440,000 hectares divided equally in both the States. The dam, barrage, power station and canals for irrigation have been completed at a cost of Rs. 640 million. The power house just near the dam site generates about 80 Kw of power which is delivered at important grid stations located in Rajasthan and Madhya Pradesh.

The Gandhisagar Dam is constructed at the head of the Chambal gorge. It is a straight gravity stone masonry dam, 514 m long at the top, rising 65 m above the deepest foundation. The dam is 381 m long at the river bed and 51 m wide and tapers at the peak to carry a road ridge of 4.6 m width. This dam is designed to store water of two successive monsoons from the catchment of 22,533 sq km above the dam site. Since the water in the river is dependent on the monsoons which are quite uncertain, to maintain a regular supply of water of the power station at the dam site and also for irrigation at Kota, the Sagars maintain the minimum store of water
for use in years when rainfall is much below average.

The second stage of the Project included the construction of the following:

(i) **Rana Pratap Sagar Dam:** The dam is located at Rawat Bhatta immediately upstream of the Chulia falls and about 35.5 km down stream of Gandhisagar Dam. The main dam is about 38.2 m high above the foundation and 1,100 m long at the crest.

(ii) **Power Station at Rana Pratap Sagar Dam:** The power station is to be constructed just below a saddle dam, across the Pandajornalla, a small tributary which joins Chambal below Chulia falls. In this way 12.2 m waterfall at Chulia in the bed level of the Chambal river would be utilised. The station will generate 160,000 Kw of energy.

(iii) Additional transmission lines and substations for additional power generated, and,

(iv) Extension of distributary system of the canals.

It is expected that this dam would be completed by 1968 and the canals would irrigate additional 121,000 hectares.

The third stage, in the completion of the Project includes the construction of Kota Dam on the river Chambal about 32 km downstream of Rana Pratap Sagar Dam. This dam is to serve the purpose of a lifting dam with a very little reservoir capacity. It would be located just upstream of the back waters of the Kota Barrage. The dam site has been selected where the rock foundation is strong. It would be a short one about 336 m in length at the top. The Kota Barrage is located at the end of the gorge section of the Chambal river near Kota city. This barrage is to regulate discharges from the Chambal power station and distribute the water for irrigation on both sides of the river.

2. **RAJASTHAN CANAL PROJECT**

The proposed Rajasthan Canal, when completed, will be one of the largest irrigation projects not only in India but in the whole world. The Project proposes to transform an area over 525 km long and 45 km wide of the vast arid stretch of the Indian desert in
the northwestern part of Rajasthan. The agricultural produce would increase by 2.7 million tons valued at about Rs. 660 million per year.

The physiography of the area where the canal is to be constructed is typical of the Great Indian Desert. The surface feature is characterised by vast stretches of undulating wind-blown sand dunes occasionally rising to about 60 m with extensive sandy flat area. After the canal enters the Rajasthan territory the land is fairly flat for about 65 km with scattered sand dunes. Further southward for about 115 km up to Suratgarh the dunes become larger in size with extensive flat lands. The land features are more prominently undulating between 115 km to 470 kilometres. Further southward up to 507 km the land is flat and at places the surface topography is characterised by low rocky ridges in Jaisalmer. The area is not drained by any river. The Ghaggar river enters Bikaner from the northeast but disappears in sand only a few km below Hanumangarh. The rain water collected in tanks is the only source for drinking water. During summer people have to travel miles to fetch drinking water.

The climate has made this area highly inhospitable. The summer temperature goes upto 49°C and during winter there are occasional frosts. The average annual rainfall varies between 10 cm to 25 cm. The rainfall is too scanty and that too spreads over two to three months with very high temperatures during summer, making this area unsuitable for large scale agricultural operations.

The genesis of the Rajasthan Canal Project can be traced back in the Report (1948) on ‘Water Requirements of Bikaner’ prepared by Shri Kanwar Sain, the then Chief Engineer (Irrigation) in Bikaner State. The Report pointed out ‘although the soil is sandy and undulating, it is capable of yielding good produce, but due to scanty rainfall and lack of means of artificial irrigation, its productiveness is greatly handicapped.’ In later years the feasibility of the project was accepted in two reports published in 1951 by the Central Water and Power Commission, after conducting proper surveys. The reports accepted the practical aspect of the project in view of the past prosperity of the area when the Ghaggar river
flowed through it and the success of the Gang Canal in similar conditions. During 1954 and 1956 the Rajasthan Government conducted detailed surveys and approved the project in 1957.

Main features of the Project: The Rajasthan Canal takes off from the Harike Barrage at the confluence of the Sutlej and the Beas river in Punjab. Work was started on the 110 miles of feeder canal in the Punjab in 1958 and it has been completed. This canal flows through the Punjab following the alignments of the Ferozepore Feeder up to mile 11 and beyond that along the Sirhind Feeder. The Canal enters Rajasthan territory near Jandwala Village in Hissar district at mile 110. Beyond this the canal runs along the Punjab—Rajasthan border for about 23 miles. It will follow an average distance of 24 miles from the Pakistan border and will run through the districts of Ganganagar, Bikaner and Jaisalmer in the northwestern arid tract of Rajasthan. The main canal branches off into the Liluah Branch at 292 miles of the Rajasthan portion and thus it will complete a total length of about 425 miles from the Harike Headworks.

The total canal system will consist of the main canal, nine branches, three lift channels and twenty-one direct distributaries and a large number of small channels. The canal system excluding the field channels will add to a total length of about 6,142 kilometres. The field channels will have a total length of about 64,400 kilometres.

This Project also includes the construction of related works on the rivers above the Harike Barrage. These works include a link between the Ravi and the Beas rivers at Madhopur, a link between the Beas and the Sutlej rivers and storage reservoirs on the river Beas above the Bhakra Dam. The first link has already been completed.

Along the main canal at a few places big falls are available which would be used for the generation of the hydro-electric power. A total of about 22,000 Kw is expected to be generated from these sources and the power would be utilised for lift irrigation to cover the high level areas on the left side of the canal.

The feeder part of the canal in the Punjab and 37 km in Rajasthan
has been provided for as a lined canal and further 22.5 km of the headreach of the main canal is also to be lined. Lining of the whole main canal in Rajasthan would undoubtedly help in conserving valuable water for irrigation.

The Project is to be completed in two stages. The first stage covers the construction of the main canal up to mile 121.8 including the Naushera Branch. This work is to be completed by the end of the Third Year Five Plan in 1966. The second stage proposes to construct the canal up to mile 291.8 including the Liluah Branch and the work is to be completed by the end of the Fourth Five Year Plan in 1971. The Punjab section of the Canal will serve only as feeder and no irrigation is to be done on that side. On the right side of the canal in Rajasthan, the land will be served by flow irrigation due to prevailing slope of the land towards Pakistan border. The left side, due to high level land, will have only limited irrigation in small patches along the main canal and that too would be possible only by the mechanical lifting of water to the land level.

Full development of irrigation would be possible in about six years in the area of Ganganagar and Bikaner while in other areas it may take up to ten years. The following table indicates the importance of Rajasthan Canal in this State.

**Irrigation Capacities of Different Projects in Rajasthan**

<table>
<thead>
<tr>
<th>Project</th>
<th>Estimated cost in million Rs.</th>
<th>Net irrigated area (Acres)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Gang Canal</td>
<td>31.0</td>
<td>583,133</td>
</tr>
<tr>
<td>2. Bhakra Project</td>
<td>227.5</td>
<td>570,000</td>
</tr>
<tr>
<td>3. (a) Chambal Project</td>
<td>164.8</td>
<td>700,000</td>
</tr>
<tr>
<td>(b) Rana Pratap Sagar</td>
<td>80.2</td>
<td></td>
</tr>
<tr>
<td>4. Jawai Project</td>
<td>30.0</td>
<td>46,000</td>
</tr>
<tr>
<td>5. Rajasthan Canal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(a) Rajasthan Portion</td>
<td>1,125.5</td>
<td>3,629,100</td>
</tr>
<tr>
<td>(b) Related works (Approx)</td>
<td>870.0</td>
<td></td>
</tr>
</tbody>
</table>

**3. Mahi Project**

This project includes the construction of a masonry dam across the river Mahi and the Canal system to provide irrigation to 30,800
hectares in Banswara district. Some water will be supplied to Gujarat State through hydel channel and 29,000 Kw of power will be generated for use in Rajasthan. The Project is to cost about Rs. 233.6 million. The work on the canal system is in progress.

4. **Banas Project**

This project could not be started due to change in the site of the dam from Khakhunda in Bhilwara to Bilaspur in Tonk district. The estimated cost of the project is Rs. 100 million.

Apart from these major irrigation projects, quite a large number of medium irrigation projects have also been undertaken during the Second Plan Period. Among these are Jawai, Meja, Parbati, Godha, Gadola, Gambhiri, Sureti, Khari, Galwa, Mashi and many others.
CHAPTER VI

ANIMAL HUSBANDRY

ANIMAL HUSBANDRY occupies an important place in the economy of Rajasthan. Since more than half the area of this State is arid and semi-arid, the livestock production forms the main occupation of quite a large number of people. This industry provides subsidiary occupation to the desert inhabitants, particularly the nomadic tribes, who primarily depend upon livestock for their livelihood. Apart from this, in this State as well as in other parts of India, the livestock constitute the wealth of a cultivator. It naturally follows that in the whole of Rajasthan—in the western arid region as well as in the sub-humid regions east of the Aravallis the cultivator’s capacity for sound economic life depends primarily on the number and quality of cattle he possesses.

The livestock population is large in this State as compared to other States in India. Out of the country’s total livestock wealth of about 336.5 million heads, it contributes about 9.9 per cent. In 1961, Rajasthan accounted for about 18.2 per cent sheep, 13.2 per cent goats, 7.9 per cent buffaloes, 7.4 per cent cattle and more than half of the country’s camel population. It has a monopoly in camels, supply of goats for mutton to other parts of India and draught animals of Rathi, Hariana, Tharparker, Mewat, Gir and Nagauri breeds. The following figures indicate the livestock wealth in Rajasthan and the State’s share in respect of India’s total wealth.

Animal husbandry is not subsidiary to agriculture in this State. It is one of the major economic activities in some parts, while in others, it is the main supplementary source of income to a large proportion of the population. In the western sandy plain area, livestock rearing and trading are the main occupations and the principal source of livelihood for the people. It is only next to agriculture, in the eastern and southeastern areas which are relatively wet, where mixed farming is the most common economic activity.
In such areas livestock rearing helps in agricultural activity and supplements the farmer’s income. Livestock wealth also supplies raw materials for some of the State’s small scale industries like dairying, carpet-weaving, bone crushing and tanning.

**LIVESTOCK AND POULTRY\(^1\) IN RAJASTHAN**

(1960-1)

<table>
<thead>
<tr>
<th>Livestock and Poultry</th>
<th>INDIA (in thousands)</th>
<th>RAJASTHAN</th>
<th>Percentage of Rajasthan in India</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>LIVESTOCK</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Cattle</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. Males over 3 years</td>
<td>72,500</td>
<td>3,970</td>
<td>5.5</td>
</tr>
<tr>
<td>b. Females over 3 years</td>
<td>54,300</td>
<td>4,935</td>
<td>9.4</td>
</tr>
<tr>
<td>c. Youngstock</td>
<td>48,900</td>
<td>4,237</td>
<td>8.6</td>
</tr>
<tr>
<td><strong>TOTAL CATTLE</strong></td>
<td>175,700</td>
<td>13,142</td>
<td>7.4</td>
</tr>
<tr>
<td>2. Buffaloes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. Males over 3 years</td>
<td>7,700</td>
<td>100</td>
<td>2.1</td>
</tr>
<tr>
<td>b. Females over 3 years</td>
<td>25,000</td>
<td>2,096</td>
<td>8.4</td>
</tr>
<tr>
<td>c. Youngstock</td>
<td>18,400</td>
<td>1,762</td>
<td>9.5</td>
</tr>
<tr>
<td><strong>TOTAL BUFFALOES</strong></td>
<td>51,100</td>
<td>4,020</td>
<td>7.9</td>
</tr>
<tr>
<td>3. Sheep</td>
<td>40,300</td>
<td>7,360</td>
<td>18.2</td>
</tr>
<tr>
<td>4. Goats</td>
<td>60,800</td>
<td>8,052</td>
<td>13.2</td>
</tr>
<tr>
<td>5. Horses and Ponies</td>
<td>1,300</td>
<td>93</td>
<td>7.1</td>
</tr>
<tr>
<td>6. Other Livestock</td>
<td>7,300</td>
<td>840</td>
<td>11.6</td>
</tr>
<tr>
<td><strong>TOTAL LIVESTOCK</strong></td>
<td>336,500</td>
<td>33,516</td>
<td>9.9</td>
</tr>
<tr>
<td><strong>POULTRY</strong></td>
<td>116,900</td>
<td>718</td>
<td>0.6</td>
</tr>
</tbody>
</table>

**COMPOSITION OF LIVESTOCK**

The cattle population numbering about 13.14 millions in 1960-1, constitutes 39.2 per cent of the State’s total livestock. Nearly 24 per cent consists of goats while sheep constitute about 21.7 per cent.

of the State's total. The average livestock density is about 100 heads per sq km which is slightly lower than the country's total average. The livestock population in Rajasthan exceeds the human population. According to the 1961 Census, there were 1,662 livestock heads for 1,000 persons in the State. This is mainly due to the fact that the large part of the State west of the Aravalli consists of arid sandy plain with little agricultural value where the human population is sparse.

Within the State nine distinct breeds of cattle, eight famous breeds of sheep, six renowned breeds of goats and four breeds of camels are found, distributed in well demarcated areas and tracts. Apart from these, fine breeds of horses are found which are well known in the whole country. The breeders are a class in themselves. The professional nomadic breeders as well as ordinary farmers possess the knowledge of livestock rearing. These persons have also great experience as they have been practising this trade for generations.

NORTHWESTERN DIVISION

More than half of the area of the State lies in the northwestern part of the Aravallis. The land is sandy, ill-watered having high temperatures and mostly unproductive. Agriculture is developing in the northern areas primarily in Ganganagar district, where irrigation is possible. Occasionally the land is dotted with limestone ridges as one proceeds from semi-arid to arid lands further west. The rainfall in the whole of this area is less than 35 centimetres.

The desert in this part is marked by parallel sand hills some of them over two kilometres long and about 150 m to 300 m high. The side of these hills are water-marked. In the rainy season stunted shrubs and green tufts grown here form the main feed of the livestock. In such areas are reared Rajasthan's best cattle, sheep, goats and camels. The scarcity of drinking water keeps the breeders and persons, engaged in the livestock rearing, moving from one village to another. It is only for about three months during the meagre rains that the area has the required feed, available for the livestock. In this period good quality sevan grass grows in the
Thar area. This grass is very nutritive on which depends the great livestock wealth of this State. The semi-arid tract adjoining west of the Aravallis produces the best horses known as Mallani or Marwari.

It is in this region the famous Rath (three-fourths Sahiwal) breeds of cows are found and obtain their feed from the extensive pasture lands. The Tharparkar breed of cows and the Kankrej (Sanchoore) cows are also found here. The nomadic breeders are engaged in cattle rearing in this region. The milk production is much but the population being sparse, nearly all the milk is used for 'ghee' extraction. On an average each family owns about 100 to 200 cows and 4 to 5 families grouped together own about 1,000 heads of cattle.

In this area sheep rearing is also important. The area is famous for Bikaneri, Jaisalmeri, Marwari, and the Puggal sheep which produce the best quality of wool. The camel rearing is a monopoly of this region. Two main breeds, i.e. the Jaisalmeri and Bikaneri are exported from this tract in thousands to different parts of India. The Lohi and Marwari breed of goats are also bred in this region.

The belt, that stretches along the Pakistan and Gujarat State border for about 366 km with a width of about 80.5 km, is ideal for cattle, sheep, goat and camel husbandry.

Southeastern Division

The southeastern division comprises of the land that lies south and east of the Aravalli range in Rajasthan. This division is more diversified as regards relief, temperature, rainfall, soil and vegetation conditions. It has extensive ranges, vegetation and long stretches of forests, often broken by rocky un-cultivated land. The area has many rivers and small tributaries and the river banks have good soils. The Mewar Plateau gives way to Kota Plateau and this gives way to hilly and rugged region of Karauli and the flat plains of the Trans-Jamuna tract. The annual rainfall varies from 55 cm to 100 cm. This region has about two-thirds of the State population. The dual purpose breeds of cattle like the
Haryana, the Mewat, and the Rath, and the draught type, the Malvi, the pure milk type and the Gir are most common. Variety of grasses like 'anjan', the 'khabal' and the 'chimber' are found to cover the grazing lands and pastures. Among goats, the Jamnapari, the Barbari and the Sirohi are the important breeds. Murrah buffalo from the Punjab has made this area its home and this variety is spreading in different parts of the State.

Various breeds of cattle, buffaloes, camels, goats, sheep and horses and their regional distribution have been determined on the basis of the survey conducted in this State. The State has been divided into ten tracts (Map 15).

1. The Rathi Tract

This tract comprises of a part of Bikaner, Ganganagar and Jaisalmer districts in the western part of the State. Animal husbandry is the main economic activity in this region. Milk is used for the production of 'ghee' and people consume milk of camel, goats and sheep. The wool production is about 17,000 mds, goats and camel hair are also exported. Sheep and goats are exported for slaughter purposes. The cattle trade is carried on through 'banjaras' who roam in villages, making their purchases and driving them into herds to other areas and other adjoining States.

2. The Sanchore or the Kankrej Tract

The economy in this tract is also centred mainly on livestock. The sale of cattle, sheep, goats and camels and their products are the only source of income of the people engaged in animal husbandry. The Kankrej bullocks are important in this area since they are of very heavy type. These are meant for pulling very heavy weights. Wool, camel and goat hairs form another important commodity for export. The individual herds comprises of 100 to 300 cows. Several families group together and form villages. The disposal of wool, ghee, hides and skin is done in the same way as in the Rathi tract. Bullocks are sold in cattle fairs and dealers come from adjoining states like Madhya Pradesh, Gujarat and Saurashtra.
### Tractwise Distribution of Livestock in Rajasthan

<table>
<thead>
<tr>
<th>Tracts</th>
<th>Cattle</th>
<th>Buffaloes</th>
<th>Sheep</th>
<th>Goats</th>
<th>Camels</th>
<th>Horses</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Rath Tract</td>
<td>244,200</td>
<td>75,000</td>
<td>346,800</td>
<td>138,800</td>
<td>36,400</td>
<td>1,800</td>
</tr>
<tr>
<td>2. Sanchore or Kankrej Tract</td>
<td>1,136,400</td>
<td>243,700</td>
<td>1,342,000</td>
<td>1,169,100</td>
<td>29,700</td>
<td>7,300</td>
</tr>
<tr>
<td>3. Tharparkar Tract</td>
<td>573,400</td>
<td>14,900</td>
<td>741,800</td>
<td>692,800</td>
<td>58,400</td>
<td>1,800</td>
</tr>
<tr>
<td>4. Canal Irrigated Tract</td>
<td>157,200</td>
<td>61,000</td>
<td>161,700</td>
<td>89,000</td>
<td>37,300</td>
<td>1,700</td>
</tr>
<tr>
<td>5. Nagaur Tract</td>
<td>1,202,100</td>
<td>201,000</td>
<td>1,477,600</td>
<td>684,700</td>
<td>64,200</td>
<td>3,100</td>
</tr>
<tr>
<td>6. Great Hariana Tract</td>
<td>2,546,000</td>
<td>739,700</td>
<td>1,627,100</td>
<td>1,956,700</td>
<td>187,600</td>
<td>11,300</td>
</tr>
<tr>
<td>7. Mewat Tract</td>
<td>1,319,400</td>
<td>726,400</td>
<td>176,400</td>
<td>842,200</td>
<td>13,700</td>
<td>16,900</td>
</tr>
<tr>
<td>8. Rath Tract</td>
<td>154,200</td>
<td>738,600</td>
<td>72,700</td>
<td>113,800</td>
<td>8,500</td>
<td>500</td>
</tr>
<tr>
<td>9. Malvi Tract</td>
<td>4,074,500</td>
<td>1,153,300</td>
<td>877,800</td>
<td>2,483,200</td>
<td>29,700</td>
<td>62,800</td>
</tr>
<tr>
<td>10. Gir Tract</td>
<td>822,200</td>
<td>210,700</td>
<td>710,500</td>
<td>649,100</td>
<td>8,200</td>
<td>7,110</td>
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</table>

### Sale of Livestock and Livestock Products in Different Tracts of Rajasthan

<table>
<thead>
<tr>
<th>Items of sale</th>
<th>Units</th>
<th>Rath Tract</th>
<th>Sanchore or Kankrej Tract</th>
<th>Tharparkar Tract</th>
<th>Canal Irrigated Tract</th>
<th>Nagaur Tract</th>
<th>Great Hariana Tract</th>
<th>Mewat Tract</th>
<th>Rath Tract</th>
<th>Malvi Tract</th>
<th>Gir Tract</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Cattle</td>
<td>Thousands</td>
<td>16.4</td>
<td>56.6</td>
<td>41.2</td>
<td>7.8</td>
<td>84.3</td>
<td>128.6</td>
<td>75.9</td>
<td>7.7</td>
<td>125.4</td>
<td>28.0</td>
</tr>
<tr>
<td>2. Buffaloes</td>
<td></td>
<td>1.9</td>
<td>72.6</td>
<td>3.0</td>
<td>5.7</td>
<td>22.0</td>
<td>20.6</td>
<td>2.9</td>
<td>29.9</td>
<td>4.6</td>
<td></td>
</tr>
<tr>
<td>3. Horses</td>
<td></td>
<td>91.0</td>
<td>341.0</td>
<td>195.0</td>
<td>441.6</td>
<td>2,996.0</td>
<td>42.5</td>
<td>20.0</td>
<td>251.0</td>
<td>185.0</td>
<td>1.6</td>
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<td>4. Sheep</td>
<td></td>
<td>.7</td>
<td>6.1</td>
<td>11.7</td>
<td>.7</td>
<td>12.8</td>
<td>3.7</td>
<td>2.7</td>
<td>1.7</td>
<td>5.6</td>
<td>1.6</td>
</tr>
<tr>
<td>5. Camels</td>
<td></td>
<td>27.5</td>
<td>243.3</td>
<td>144.6</td>
<td>144.6</td>
<td>410.0</td>
<td>179.4</td>
<td>22.0</td>
<td>521.6</td>
<td>137.3</td>
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</tr>
<tr>
<td>6. Goats</td>
<td></td>
<td>.5</td>
<td>2.5</td>
<td>2.6</td>
<td>1.7</td>
<td>6.5</td>
<td>2.8</td>
<td>--</td>
<td>4.8</td>
<td>1.3</td>
<td></td>
</tr>
<tr>
<td>7. Donkeys</td>
<td></td>
<td>16.9</td>
<td>65.5</td>
<td>36.8</td>
<td>7.3</td>
<td>72.3</td>
<td>79.4</td>
<td>8.8</td>
<td>42.8</td>
<td>34.7</td>
<td></td>
</tr>
<tr>
<td>8. Ghee</td>
<td>Thousands mds.</td>
<td>95.0</td>
<td>513.0</td>
<td>274.0</td>
<td>4,250.0</td>
<td>735.6</td>
<td>140.0</td>
<td>38.5</td>
<td>671.4</td>
<td>242.5</td>
<td></td>
</tr>
<tr>
<td>9. Wool</td>
<td></td>
<td>22.9</td>
<td>112.5</td>
<td>60.0</td>
<td>11.0</td>
<td>104.3</td>
<td>201.3</td>
<td>91.5</td>
<td>11.2</td>
<td>245.2</td>
<td>67.7</td>
</tr>
</tbody>
</table>

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1 Based on the Livestock Wealth and its Role in Building the Economy of Rajasthan, Government of Rajasthan, Jaipur.
3. THE THARPARKAR TRACT

This tract is small but the Tharparkar breed is renowned in the country mainly for its milk strain. The cows on an average give 20 to 25 lb of milk per day. Under stall fed conditions the cows are capable of yielding milk upto 30 to 40 lb. These are also in the hands of nomadic breeders who keep moving in search of new pastures and water. The *sevan* grass with its high nutritive value is the main fodder and these cattle thrive best on this grass. The annual production of milk is about 4.18 million mds and from the bulk of this milk, ‘ghee’ is extracted. There is no local market except Jodhpur town and all the ‘ghee’ trade is in the hands of local businessmen who export the product to other states after proper tinning and sealing.

The camels are either the *Jaisalmeri* breed (riding camels) or resembling the type of the *Bikaneri* breed (baggage). They are also maintained in herds and the breeders are engaged in the export trade. Cattle fairs provide the marketing facilities. The sheep are also of good variety namely, *Jaisalmeri* and *Marwari* with fine and large production of wool. The goats are mainly *Marwari* and the *Lohi* type. These are important for the supply of mutton, but the yield of milk is only sufficient to rear the young ones. Wool production is about 36,800 kgs per year. Nearly all the wool is sent to Bombay for exportation to other countries.

4. THE CANAL IRRIGATED TRACT OF THE NORTH

This tract mainly covers the irrigated areas of the Ganganagar district in the north of the State. The irrigation facilities available from the Gang Canal have converted this district into a good agricultural land. In an area of about 278,760 hectares intensive agriculture is practised. In the irrigated lands farmers have adopted mixed farming. Besides the cultivation of cash crops, the fodder is also produced as feed for their livestock. The livestock supply milk, mutton, wool, hides and skin and also manure for the fields. Camels, horses and donkeys are used for transporting farm products to the market places. In this tract agriculture and animal husbandry are dependent on each other. Out of the exports of
Plate 11—Camel—Ship of the Desert. Camel is the common means of transport in arid regions. (See page 96)

Plate 12—Donkey used for transporting water pots in desert areas. (See page 98)
Plate 13—Flock of Sheep in Western Rajasthan Desert. (See page 98)
RAJASTHAN
CATTLE DISTRIBUTION
ONE DOT REPRESENTS 5,000 HEADS
1961

Based upon Survey of India map with the permission of the Surveyor General of India. © Government of India Copyright, 1962.
livestock and the livestock products, the ‘ghee’ and wool exports are the main items and next in importance are the hides, skins and bones. The buffaloes are obtained from Nili-Ravi and the Murrah tracts and cows from the Hariana and Rathi tracts within the State. Jaisalmeri and Bikaneri, both types of camels are common in this tract. The large wool markets are at Hanumangarh, Suratgarh and Ganganagar in this State and Abohar and Gidderbah in the Punjab State.

Under stall fed conditions buffaloes are more common than cows. The ‘ghee’ is produced mainly from buffaloes milk. The sheep are mostly reared on the stubbles of the crops harvested. Small scrub jungles provide good browsing lands for goats. The grazing areas are scanty and this has resulted in the predominance of buffaloes over cows in this tract.

5. THE NAGAUR TRACT

This tract is important for the production of livestock and livestock products. Nearly 90 per cent of the economy of the tract is based on livestock alone. Animal husbandry is the main occupation of the people in this region. The Nagaur breed of cattle, famous throughout the country comes from this tract. Apart from this, Marwari sheep and goats, the Mallani horses and Bikaneri camels are of equal importance and are in great demand in all parts of the country. Among the grasses anjan (Hardwickia bipinnata) and pala (Zizyphus numularia) are highly nutritious. The sheep and goats are reared on dhak (Butea frondesa) tree leaves. Camels obtain their feed from khejra (Prosopis spicigera), neem (Melia indica) and shisham (Dalbergia latifolia) trees as well as from dhak leaves.

The bullocks of this tract are well built hardy and they fetch high prices. These are good for ploughing even in the hard loamy soil. They are used in the persian wheels, in the ‘kolhus’ and in the bullock carts.

The Marwari sheep of this tract is famous for its fineness and good yield of wool and mutton. This breed of sheep thrives on coarse grass and goes without water for a few days and hence their domi-
nance in Rajasthan, and this has resulted in a greater production of wool.

The livestock is well bred and well reared. The flocks of sheep vary from 100 to 300 sheep and goats are found in small flocks of 50 to 100. The camel herds range between 10 to 20 animals. The livestock trade is carried on in the three important cattle fairs. These fairs attract the people from distant parts of the country.

6. THE GREAT HARIANA TRACT

It is the largest tract in this State and extends from the northeastern to southeastern division of the State. It is in this tract that the famous Hariana breed of cows are bred and reared in the Rathi, Tharparkar and Kankrej areas, where the grazing lands are extensive. The best nutritive grasses like anjan, the bhurut, the chimber and khabbal are found in this tract. There are no large herds of cattle but on an average individual farmers keep about 10 to 20 cows and from them are raised the bullocks which are used for agricultural operations within the region and also for exporting to other areas (Map 16). The bullocks are exported to Uttar Pradesh, Madhya Pradesh, Bihar, West Bengal and even Assam. The buffaloes are reared for milk production from which 'ghee' is obtained.

Among sheep the Chokla, the Nali and the Marwari breeds are the most famous. The Chokla is in much demand for the fineness of its wool. The Sikar district is the chief breeding centre of this variety of sheep.

The goats are mainly for milk production. The chief breeds are the Jamunapari, the Barbari, the Alwari and the Sirohi. These sheep thrive well on the green vegetation and the scrub jungles.

The Mallani breed of horses is famous in this tract. The surplus stock is exported to Uttar Pradesh, Delhi and Punjab.

The livestock has an important place in the economy of the people of this tract. Livestock trade on a large scale is carried on in the cattle fairs which are held here in large numbers.

7. THE MEWAT TRACT

This tract is located in eastern Rajasthan adjoining Delhi and
Uttar Pradesh. The *Mewati* breed is famous and has been evolved by breeders suited to their soil and natural conditions. The *Mewati* cow yields on an average 10 to 15 lb of milk per day; it produces the sturdy Hariana breed of cattle. The bullocks are in much demand from Madhya Pradesh and Uttar Pradesh. *Murrah* buffaloes and goats (*Alwari* and *Barbari*) constitute an important livestock wealth in this tract. Due to heavier rainfall, there is plenty of vegetation and both the species of animals, thrive well. The people are engaged in intensive agriculture. There is little scope for sheep rearing on a large scale.

8. THE RATH TRACT

This tract adjoins the Punjab in the northeastern Rajasthan. This tract specialises in the *Rath* breed of cattle, more suitable for ploughing in small holdings. The cows are small and yield about 12 to 15 lb of milk per day. The people are engaged in intensive agriculture, the fields are small and this leaves little scope for cattle rearing on a large scale as is being practised in some other parts of the State. *Murrah* buffaloes are reared primarily for milk yield. The goats mainly of the *Alwari* type are in much demand not only in this State but also in Delhi, Uttar Pradesh and Madhya Pradesh.

9. THE MALVI TRACT

This tract, adjoining the State of Madhya Pradesh, is next to Hariana tract in importance. It is noted for its popular *Malvi* breed of cattle—a draught type sturdy bullock very good for the stony soils. This animal being sturdy is quite suitable for pulling fairly heavy weights. This tract has good rainfall and the farmers are engaged in intensive agriculture. The area has good forests and grazing pastures. Buffaloes are important in this tract. These are slightly inferior to *Murrah* breed in milk yield but the fat percentage in milk is high. The ‘*dhak,*’ is an ideal food for them and it helps in increasing butter fat. This tract has about 2.48 million goats, 880,000 sheep and nearly 29,700 camels. All these animals are seen in large flocks and herds. Nearly half the economy of this tract is based on the production of livestock. The sheep are of
the *sonadi* breed, noted for their mutton and high percentage of fat in their milk. The goats resemble the *Sirohi* type and the milk yield is good. The camels are mostly of baggage type. This tract exports mainly hides, skins and bones. Due to the large home market, nearly all the milk and ‘ghee’ produced is consumed locally.

10. THE GIR TRACT

It is a small tract located in the middle part of the eastern Rajasthan. The *Gir* breed of cattle is famous for milk yield and the number of cattle in the Tract is gradually increasing. With proper feeding facilities, it makes a fine dairy animal. The bullocks are also good for use as draught animals. They are good for ploughing fields, for pulling carts and also for drawing water from wells for irrigating the fields. The cow on an average gives 16 to 20 lb of milk per day under stall fed conditions. The number of buffaloes in this tract is also increasing. The local breed have sickle shaped horns and replacing the Murrah breed of the Punjab. The *Marwari* breed of sheep is popular in this area. Among the goats the mixed breed are found. They give good milk and can commonly be seen in flocks of 100 to 300 animals. Camels are used on a fairly large scale both for agricultural purposes and for transporting goods. For all this work the camels are imported from the western tracts, more famous for camel breedings. The donkeys and horses are quite small in number and no famous local breeds are found. These animals are now reared and bred by the farmers although they are in the early stages. The *Gir* breed is also the creation of nomads. The best animals of this breed are found in the Nazirabad tahsil, Ajmer district and also in the hands of nomads around Kota town. At these places they find good markets for the disposal of their milk and ‘ghee’. The production of milk has increased considerably and there are good prospects of starting milk powder factories or creameries in this tract.
CHAPTER VII

MINERAL RESOURCES

RAJASTHAN possesses a veritable range of mineral deposits and it is an important mining State in India. Before the First Five Year Plan, mining was mostly confined to building stones. Mica mining started a few years before independence. The mining industry in the State has been properly organised only after the integration of the princely States.

Among the large variety of minerals it produces or has reserves, the important ones are building stones and road metals, barytes, bentonite, calcite, china-clay, lignite, gypsum, lead-ore, limestone, feldspar, manganese ore, mica, salt and zinc ore. Although it produces such a vast and diversified range of minerals, the nature of their reserves, distribution in different parts of the State and their marginal deposits, have not made this area as the leading mineral producing area in our country. The State's present importance as a mineral producing State is largely in relation to its resources of non-ferrous minerals like lead-zinc-silver ores, copper ore, strategic minerals like tungsten ore and industrial minerals such as mica, steatite and gypsum. The lack of coal and iron ore has not only hindered the State in her mining industries in the past, but it will have influence even in its future development.

The mineral statistics of Rajasthan in terms of value and production indicate the place of this State with other States in India. In 1960, minerals worth Rs. 60.7 million were produced in Rajasthan, while Bihar, West Bengal and Madhya Pradesh produced minerals worth Rs. 1,098.5 million which accounted for 68.5 per cent of the country's total sale value of minerals. Rajasthan contributed about 3.7 per cent of India's total value of minerals. Nearly 95 per cent of the State's mineral production came from building stones (37.0 per cent), salt (12.9 per cent), lead and zinc concentrates (12.8 per cent), mica (12 per cent) and gypsum (9.5
per cent). The value of minerals in terms of national output is low (3.8 per cent in 1960) but the State is a leading producer of minerals like marble, lead, zinc and emerald and a major producer in gypsum, fuller’s earth, steatite, feldspar, quartz, silica and asbestos (Map 17). Since various industries based on minerals found within the State or brought from elsewhere have not developed due to lack of coal and iron ore, it is found that the exploitation is mainly concentrated on building stones to meet the local demand. Minerals like lignite, limestone and some quantities of gypsum, glass-sand and waste mica are consumed within the State. The rest are sent to other states or sent abroad. Mica and lead concentrates are sent to Bihar and zinc to Japan. Iron ore and manganese are also exported abroad.

In this State out of the total population of 20,155,602 (1961) nearly 941,288 persons are engaged in manufacturing and allied industries, such as mining, quarrying, livestock, forestry and manufacturing industries including household industry. Thus, nearly 4.6 per cent of the population is engaged in industries, being much less than the Indian average which is 10.5 per cent for 1961. This indicates that the industrial occupations are less important in terms of employment and as a source of wealth in this State. Out of the total of 941,288 workers in the State, nearly 40 per cent belong to the districts of Jaipur, Pali, Bundi, Ajmer, Kota and Bhilwara where most of the industries of the State are located.

During the Third Five Year Plan period (1961–6) Rs. 36.5 million were provided for the scheme of mineral development. The largest amount was to be spent on the formation of Rajasthan State Mining Corporation (Rs. 27.5 million). The next scheme was the intensive prospecting and mineral survey and re-organisation of the Department of Mines and Geology (Rs. 6.5 million) and then came quarry improvement (Rs. 2.0 million) and loans to small scale mining leases. During this Plan (1961-6) it was proposed to carry out intensive and extensive programme of prospecting and exploration of minerals. It was planned to carry out this work in three directions:

(i) Reconnaissance of minerals in those districts where indications
and evidence of mineral deposits exist.

(ii) Detailed geological mapping of the selected mineral bearing areas and their preliminary examination, and,

(iii) Detailed prospecting and exploration of selected mineral deposits which show promising occurrences.

During the Fourth Five Year Plan it is proposed to spend about Rs. 77.5 million on mineral development schemes. Out of this amount Rs. 13.5 million would be spent on intensive prospecting, mineral survey and the reorganization and expansion of Mines and Geology Department. It is proposed to set up a mobile demonstration-cum-training unit to give quarry owners an idea of modern methods of quarrying.

MINERAL FUELS

LIGNITE

The State is poor in coal resources but it produces brown coal, often referred to as lignite. The lignite is characterised by its friability and higher percentage of sulphur. Unlike anthracite and bituminous coals, lignite is not suitable for coke.

The main lignite producing belt in Rajasthan is located in Bikaner division and stretches east-west, just south of Bikaner town. In this belt lignite producing areas are located in Palana, Khari, Channeri, Ganga Sarowar and Mundh. The other area where it is produced, outside this belt, is Ganga in Jodhpur division. Among all these areas, Palana is the leading lignite producing area in Rajasthan. The Palana mines are located near Bikaner city and have been well known among the Tertiary coal deposits of India. The coal field is situated about 23 km southwest of Bikaner. The Palana railway station lies on the Bikaner—Jodhpur railway and is connected by a good road with Bikaner city. The presence of coal in this part of Rajasthan was discovered in 1898 by some villagers when they were sinking a well in that area. The occurrence was noted at a depth of about 61 m from the surface; the ground water level being 45 m further below the lignite horizon. The discovery attracted much interest since the State has been poor in coal resour-
ces and coal from Bengal and Madhya Pradesh is costly. Later, in this area exploration and mining operations were started to determine and win the mineral. The method of mining consisted of sinking shafts for the purpose of determining coal reserves and later these were used for raising coal to the surface. The reserves were ascertained from year to year and coal was produced to meet the requirements of the power houses and for other minor uses.

The Palana field is located in the desert area. The surface is covered with aeolian sand deposits with no geological formation exposed at the surface. This sand varies in thickness from 66 cm to 3 metres. Beneath the sand, up to 21 m in depth, kanker beds have been found generally in association with ferruginous nodules. They are followed by weathered sandstones and clays of about 6 to 13 m thickness. Then comes hard, compact and buff coloured limestone, underlain in order of sequence by nummulitic limestone shales, impure ferruginous limestone, clays and about 15 m thick fullers earth. It is followed by 3 to 9 m thick incomplete section of bluish grey and pink shales, and a thin band of friable sandstone and lignite seam. There is an occurrence of 66 cm to 1.3 m band of soft clay grading into a crumbling sandstone.

Since 1900 a large number of shafts have been dug and lignite has been obtained in this area from the workable seams. These shafts have been abandoned due to collapse of roof or fires in the mines. The lignite being of inferior type, and the market being limited to power houses only and as superior coal from other parts of India could be obtained at a cheaper rate, there has been a lethargy in the development of lignite extraction in the Palana fields. The lignite mining industry received great impetus after the Second World War when coal from Bihar was more expensive. Secondly, the transport bottlenecks also made it necessary to improve the mining methods of this area and for further exploration in other areas.

At present the lignite is recovered from the mines by underground and stall method. Shafts are sunk for winning the coal and for raising and lowering men and material to the working face of the mines. Galleries 2 m high and 2 m wide are first driven
through the seams near the floor and are supported at intervals varying from 0.6 m to 1.6 m by timber props of 10.2 cm to 15.2 cm in diameter. This helps in supporting the overlying strata and the galleries require skin to skin timbering. There is great disadvantage in this method of mining. In this method it is not possible to extend the workings far to the interior since there is always danger of roof falls, premature collapse and fires, due to the soft and friable nature of the lignite. Hence only one-fifth of the lignite is mined from the seams. It is estimated that since the mining operations started for lignite, about 12 million tons of it has been left underground. Such a large amount of lignite has been left underground and the low extraction is mainly due to bad roof condition which did not permit an extraction in some cases of more than 15 per cent of the available coal. Palana lignite producing area has a total reserve of about 20.5 million tons. In recent years, to increase the higher percentage of lignite from the mines, other methods like sand-stowing by hand has also been taken up. In this method to avoid the collapse, fire etc., sand is brought from the surface and filled in the worked out areas. In these mines steam power is used to hoist lignite from the mine as well as to lift cages used by the miners. Electric power is also used for providing ventilation and for winding engines.

Some preliminary investigations and sinking of prospecting shafts have indicated the occurrence of lignite at other places. Such places are Khari, Channeri, Ganga Sarowar, Mundh and Napasar. The lignite occurs at depths of 32 m to 67 m below the surface. It has not been determined yet whether the above centres have reserves which could be worked on a commercial scale. If the reserves prove to be large, they will to a great extent solve the power problem in Rajasthan.

The importance of lignite as a fuel cannot be emphasised. Coal from Bihar and Madhya Pradesh is uneconomical due to the greater cost of transportation, whereas cheap power is needed for the industrial development of Rajasthan. At present lignite is used in Bikaner and Ganganagar for the generation of steam for electric power. After test and research, it has been found that Palana lig-
nite can be successfully treated in a low temperature carbonizer to yield valuable by-products, such as tar, oil, benzene etc., and semi-coke. The semi-coke after binding would become a fuel, high in calorific value and this would not contain any objectionable material like sulphur.

**Lignite Production in Rajasthan 1951–63**

<table>
<thead>
<tr>
<th>Year</th>
<th>Tons</th>
</tr>
</thead>
<tbody>
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<td>33,076</td>
</tr>
<tr>
<td>1952</td>
<td>45,133</td>
</tr>
<tr>
<td>1953</td>
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<td>25,500</td>
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<td>1956</td>
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<td>1957</td>
<td>17,553</td>
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<td>12,540</td>
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<td>24,810</td>
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<tr>
<td>1960</td>
<td>24,270</td>
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<tr>
<td>1961</td>
<td>58,640</td>
</tr>
<tr>
<td>1962</td>
<td>37,220</td>
</tr>
<tr>
<td>1963</td>
<td>40,350</td>
</tr>
</tbody>
</table>

It seems that Palana lignite deposits in the past have been worked out of necessity in a wasteful manner. At present with much emphasis on industrialisation, such a large amount of lignite cannot be left unutilised. With the adoption of open pit mining method, all the unworked lignite can be extracted. The lignite resources need full development in Rajasthan as this would provide power for industrial development. The Palana lignite can be briquetted and can be utilised as a good source of fuel and it can also be employed as an excellent raw material for carbonization and production of other important distillation products.
MINERAL RESOURCES

METALLIC MINERALS

IRON ORE

In iron ore, Rajasthan is poor, in production, quality of ore and also in reserves, quite dissimilar to the iron ore deposits of Bihar, Orissa and Madhya Pradesh. In this State the occurrences are in small deposits of variable grades of ore. All the ore produced is of hematite type and at few places, the ore is found in association with quartzite. Some magnetite is also found at scattered places.

The first production of iron ore started since 1953 when about 7,500 tons of ore was exported through Bombay and Kandla ports. The following figures show the production of iron ore in different years:

<table>
<thead>
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<td>128,399</td>
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<tr>
<td>1957</td>
<td>99,354</td>
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<tr>
<td>1958</td>
<td>106,309</td>
</tr>
<tr>
<td>1959</td>
<td>84,595</td>
</tr>
<tr>
<td>1960</td>
<td>128,136</td>
</tr>
<tr>
<td>1961</td>
<td>95,980</td>
</tr>
<tr>
<td>1962</td>
<td>65,000</td>
</tr>
<tr>
<td>1963</td>
<td>34,000</td>
</tr>
<tr>
<td>1964</td>
<td>37,500</td>
</tr>
</tbody>
</table>

The production of iron ore has declined in recent years. There are two main reasons for this decline. The iron ore deposits in Rajasthan are remotely located and the distance from Bombay and Kandla ports is about 800 km and 960 kilometres. This distance increases the transport charges considerably. Secondly,
Japan and Czechoslovakia are the two main importers of iron ore from India. They require ore of a high grade, for blending with their domestic inferior grade ores, and ore with 63 to 65 per cent iron content alone is fit for export. The mining of a exclusively high grade ore requires selection and rejection of a fairly large quantity of the total production.

Nearly all the iron ore deposits are located either on or east of the Aravalli range. The iron ore occurrences in the State are located in northeastern and southeastern part of the State.

(i) North–eastern Fields

1. Morija–Banol Area: The iron ore in this area is known as the Morija–Banol deposits. The ore occurs about 8 to 10 km east of Chomu Samod railway station in Amber Tahsil of Jaipur district. This is the most important ore deposit in the State. Within this area there are a number of working mines like Toda Chiplata, Thoi, Bania-ka-Bas, Tateri, Bagawas and Bhato-ki-Gali. In this area iron ore occurs as hematite bands and lenses which unconformably rest over the Aravalli and Pre–Aravalli gneiss and schists. In Morija, a regular iron ore band of about 10 m thickness extends for a distance of over one kilometre. A band of hematite quartzite of about 3 m thickness extends over the hills. The iron is of good quality and it has a mineral content of 68 per cent.

2. Nimla–Raisalo Area: The iron ore in this area occurs in and around Neemla village about 65 km northeast of Jaipur and about 24 km north of Dausa railway station. Other occurrences in this area are at Bhangarh, Ratanpura, Rajgarh, and Tehla. The important ore body is located about one km east of Neemla. The lens like ore bodies scattered in the surrounding area do not appear to be deep seated. The present workings reveal that the individual pockets are 3 to 8 m deep but even 24 to 30 m deep ore lenses have been worked near Neemla, Gola-ka-bas. The iron content of the ore is about 67.5 per cent.

3. Dabla–Singhana–Neem–ka–Thana Area: The hematite ore deposits found in association with quartzite are located east of Khetri on the border of Rajasthan and the Punjab. In this area
several ore deposits are located about 10 to 13 km west of Dabla railway station, in Khetri tahsil of Jhunjhunu districts. In Sior and Nai Dhani areas few pockets of iron ore occur but larger deposits are located near Taonda and Kali Pahari. In Taonda continuous lenses of ore occur for a distance of about 150 m along the western slope of the hill having an average width of about 22 metres. Neem-ka-Thanha iron ore deposits occur in two horizons. (a) Bagoli–Sarai–Pachlangi about 11 km west of Neem–ka–Thana railway station, and (b) Raipur–Nanawas–Toda Chipilata area which is about 18 km to 30 km east of Neem–ka–Thana railway station in Sikar district. In most of these occurrences the ore is of inferiør type and has a high phosphorus content.

(ii) SOUTHEASTERN FIELDS

These iron ore deposits occur in scattered form in a concentric curve southeast of the Aravalli range. A line drawn from Bundi to Banswara past Bhilwara, Kankroli west of Udaipur city and Dungapur largely determines the location of mining areas in this region.

1. Nathra–ka–Pal: These deposits are located about 61 km southeast of Udaipur city and 13 km west of the Dhebar Lake near the village of Thana in Sarda tahsil. The ore body consists of a series of lens like bodies at least five to six in number striking in a northwest to southeast direction, occurring as hematite schists containing some magnetite also along the top of the ridge. The reserve ore is about 2 million tons up to a depth of about 30 metres.

2. Thur–Hunder: These deposits are located 20 km northwest of Udaipur station. The ore is hematite and the iron content is about 58 per cent. The reserves are about 50,000 tons.

3. Other Areas: Iron ore occurrences have been reported in various areas but the mineral has not been recovered on any appreciable scale. These occurrences are located at Loharpura and Indergarh (Bundi district) Kamalpura and Lampa (Bhilwara district), Talwara, Khameria and Loharia villages (Banswara district), Padarpal, in Dungarpur district and Dag in south Jhalawar district.
LEAD AND ZINC CONCENTRATES

Rajasthan produces all the lead and zinc concentrates of India and has complete monopoly over both these minerals. On an average about 6,400 tons of lead concentrates (1964) and 10,850 tons of zinc concentrates (1964) are produced here. In addition to this, the silver content in lead and zinc concentrates is about 25.3 oz and 5.6 oz per ton.

PRODUCTION OF LEAD AND ZINC CONCENTRATES IN RAJASTHAN 1955–64

<table>
<thead>
<tr>
<th>Year</th>
<th>Lead concentrates Tons</th>
<th>Zinc concentrates Tons</th>
</tr>
</thead>
<tbody>
<tr>
<td>1955</td>
<td>3,062</td>
<td>4,865</td>
</tr>
<tr>
<td>1956</td>
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<tr>
<td>1959</td>
<td>7,450</td>
<td>10,810</td>
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<td>9,340</td>
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<tr>
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<td>6,460</td>
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<tr>
<td>1963</td>
<td>5,900</td>
<td>10,600</td>
</tr>
<tr>
<td>1964</td>
<td>6,400</td>
<td>10,850</td>
</tr>
</tbody>
</table>

The distribution of lead and zinc concentrates is confined to two areas.

1. Southeastern Region.  2. Northeastern Region.

1. SOUTHEASTERN REGION

The most important Zawar deposits are situated about 40 km southeast of Udaipur, close to Zawar village. Frequent appearances of slag heaps and the presence of several zinc retort furnace sites in ruins give ample evidence of the fact that the smelting industry flourished here in ancient times. The abandoned village known as Zawarmala has many features of evidence to prove
that the area was quite prosperous. The present mines are located at the Mochia Magra hill and their output ranges between 200 to 300 tons per day and on an average carries about 5 per cent of lead and 7 per cent zinc. Lead concentrates (70 per cent lead and 7 per cent zinc) are sent to Bihar for smelting at Tundco, while zinc concentrates (50 per cent zinc and 5 per cent lead) are exported to other countries. It is proposed to start the production of zinc in this State during the Third Five Year Plan. With the commissioning of zinc smelter based on zinc concentrates from the Zawar mines within the State, nearly 15,000 tons would be produced. It would also be equipped to operate a by-product sulphuric acid plant based on the smelter gases which will be used for the manufacture of phosphatic fertilisers. In 1954 about 100,000 ozs of silver was also recovered from the lead concentrates. At present the entire need of the country with regard to this vital metal is met along with foreign exports and Zawar, lead–zinc mines would go a long way to meet the country's requirements.

Other places in this area are Rikhabdeo and Debari in Udaipur district, Ghughra and Mando in Dungarpur district and Wardalia in Banswara district.

2. NORTHEASTERN REGION

In this region there are two areas namely: Chauth–ki–Barwara in Sawai Madhopur district and Gudha Kisoridas in Alwar district. At present India imports large quantities of zinc to meet the country's demands. The proper recovery from these mines would certainly make our country self-sufficient in these minerals.

BERYLLIUM

This mineral occurs in hexagonal crystal shape and is a silicate of beryllium and aluminium. It is found in several colours like green or light green, yellow, white or pale. The occurrence of this mineral is confined mostly in granites, pegmatites (igneous rock) and metamorphic rocks. It is mostly confined to about 15 to 18 m depth. The beryl ore of Rajasthan contains about 11.5 per cent to 14 per cent of beryllium oxide content. This mineral is consi-
dered to be of good quality. Beryllium compounds are used in electrical and ceramic industries.

Rajasthan has several beryl producing areas, but those of Udaipur and Jaipur district are the most important. Others are located at Bhilwara, Sikar, Tonk and Alwar districts.

1. Udaipur District: The beryl producing area lies in the north of the district just south of Amet. Important occurrences are at Bari Sikarbari, Selaka Gudha, Champa—Gudha and Ran Amet. The first three are located about 5 to 7 km from Charbbuja Road railway station. Beryl has not been recovered from these places continuously for a number of years. Some of the mines due to poor mineral and uneconomic conditions have ceased production.

2. Jaipur District: In this district, two occurrences of importance are located at Gujarwara and Bander Senri. The Gujarwara mines are located about 50 km southeast of Kishangarh railway station. Here quartz, feldspar and beryl are found in a hillock which runs in a northeast to southwest direction. Beryl occurs at a depth of about 15 metres. The second beryl deposits are found in a quartz hillock about 20 km from Kishangarh at Bander Senri. The main beryl quarries are about 9 to 12 m in depth.

3. Other areas: Beryl also occurs at Torda, Buchara, Churla, and Sanwalpura in Sikar district, Madhorajpura, Sankarwara and Dholi in Tonk district and Deora, Tillali and Gudha deposits of Bhilwara district.

In most of the mines, this mineral is not worked in underground mines and ore is won mostly by manual labour. After the inclusion of this metal in the list of fissionable elements, its importance has increased considerably. With the availability of cheap hydro-electric power from the Chambal valley project, beryllium extraction plant can be located in the State itself.

Copper

Copper mines are located at several places in Rajasthan but Khetri-Singhania area in Jhunjhunu district, and Kho-Dariha in Alwar district are the most important. The mineral found is mostly copper iron sulphide, which is usually found disseminated in the
Plate 14—Indigenous Method of Extracting Butter from Milk.
(See page 100)
Plate 15—Sandstone Quarries, Jodhpur.  (See page 102)

Plate 16—Palana Coal Mins, Bikaner.  (See page 104)
schists and phyllites. In 1962, the State produced about three tons of copper ore as the commercial mining started from 1960.

1. Khetri–Singhana: These copper mines are located about 23 km from Maonda railway station. Copper ore is found at (a) Kolhan and Mandhan old workings near Singhana (b) Khetri area (c) Akhwali mines west of Paparna (d) Old workings west of Babai, and (e) Barkhera mines. In most of these mines the copper ore occurs in shales, schists, and quartzites. Ore bearing rocks run northeast to southwest for about 24 km and 3.2 to 5.0 km in width. The beds are dipping steeply westward.

2. Kho–Dariba: The mines are located about 48 km southwest of Alwar city. Mineral occurs in phyllites and quartzite rock. Some ore is also mined from the hillocks south of Dariba village. The ore occurs as lodes or veins in most of the phyllites along the contact plane separating them from the quartzites.

3. Delwara Kerovli: These mines are situated about 30 to 40 km from Udaipur. In this area copper ore has been found in a large number of villages. Like other places it occurs in association with quartzites and schists.

4. Other areas: Copper ore is also found in Debari in Udaipur district and also at various scattered spots in Bhilwara, Churu and Jhalawar districts. These areas are still in the prospecting stage. Copper being an important metal, it is hoped that some day, with proper transport facilities and more use of mechanical power, these mining areas will develop into leading copper ore producing areas. The development of copper industry in this State can be undertaken on a commercial basis. The power requirement for this industry in the Khetri–Singhana region can be supplied from the Bhakara–Nangal grid. There is great shortage of electrolytic copper in our country and the production of such copper can be started in this State.

NON-METALLIC MINERALS

GYPSUM

A survey of the gypsum producing areas in the State was undertaken in 1949. This mineral is needed mainly to feed the ferti-
lizer factories and for various other purposes. Rajasthan is very rich in gypsum production and out of the country’s total production of 1,178,000 tons its share was about 750,000 tons in 1964. This constitutes about 64 per cent of the country’s total production.

**Production of Gypsum in Rajasthan 1955–64**

<table>
<thead>
<tr>
<th>Year</th>
<th>Tons</th>
</tr>
</thead>
<tbody>
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<td>1955</td>
<td>637,695</td>
</tr>
<tr>
<td>1956</td>
<td>720,350</td>
</tr>
<tr>
<td>1957</td>
<td>864,750</td>
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<td>1958</td>
<td>729,130</td>
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<td>1959</td>
<td>753,470</td>
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<tr>
<td>1960</td>
<td>923,380</td>
</tr>
<tr>
<td>1961</td>
<td>813,760</td>
</tr>
<tr>
<td>1962</td>
<td>1,058,000</td>
</tr>
<tr>
<td>1963</td>
<td>1,075,800</td>
</tr>
<tr>
<td>1964</td>
<td>750,000</td>
</tr>
</tbody>
</table>

Although the gypsum producing areas are widely distributed throughout the State, the main areas are located in its northern and western part. A line drawn from Rajgarh to Mount Abu in the south indicates that the areas are located mostly in the west of this line. Gypsum producing areas of the State can be grouped under three areas.

1. Nagaur fields,
2. Bikaner—Ganganagar and Churu fields, and,

1. **Nagaur Fields:** Nagaur is very rich in gypsum deposits. Gypsum areas have not been worked out fully but it is estimated that out of the country’s total reserves of gypsum (468 million tons) this area has two-thirds of it. Gypsum beds are found in depths ranging from 60 m to 125 m in different areas. The important
MINERAL RESOURCES

fields of the area are located at Nagaur, Bhadwasi, Manglod, Khairat, Dhakoria, Bhadana, Malgu and Jodhiasi.

2. Bikaner, Ganganagar and Churu fields: All these fields are located in the northern part of the State. Among these areas Bikaner has the largest estimated gypsum reserves which constitute about 17 per cent of the country’s reserves and 19 per cent of the State’s reserves. Jamsar village in Bikaner is the largest gypsum deposit in the State. This deposit runs for about 4 km east to west and about 920 m to 1,225 m north to south. These fields lie on the railway route which connects Bikaner to Bhatinda. Gypsum beds are buried under overburden material, namely sand, ranging from 0.3 to 1.5 metres. Nearly all the gypsum needed for Sindri Fertilisers and Chemicals Ltd., is supplied from these mines. At present its manual extraction has been completely changed and mechanical methods of mining have been introduced. This mineral is quarried to a depth of about 11 m beyond which sand again appears.

Lunkaransar, another gypsum producing area in Bikaner is located on the railway line about 52 km north of Jamsar. The beds are about 1 m thick and cover an area of 5.2 sq kilometres. In these mines, selenite, i.e. the crystalline variety of gypsum is found. The mineral is recovered by washing and screening. Other deposits in the district are located at Dhireva, Jaisalmar., Kaoni, Dholeran, Bharru and Harkasar.

In Churu district, the chief mining area is about 104 sq km and extends northeast and southeast of Tarananagar. The main occurrences in this area are Bhalan, Bhanin, Jagasari, Bhadi Baen, Deogarhia and Sathoon. The gypsum bed in these places ranges from 8 cm to 150 centimetres.

3. Jaisalmer, Barmer, Pali and Jodhpur: In Jaisalmer, gypsum is found in Mohangarh, Hamirwali, Dhani and Lakha. The thickness of the beds ranges between 0.6 m to 1.3 m and the gypsum content is 80 per cent.

In Jodhpur, the deposits are located at Phalsund about 48.3 km south of Pokaran. The beds are about one metre thick and overburden material is about 0.3 to 1.0 m thick.
it is estimated that gypsum reserves are about 9 per cent of the States reserves.

Other gypsum mining occurrences are Kawas, Kurla, Sheokar, Uatarlai and Par-ki-Dhani in Barmer and Khutani in Pali district. The thickness of the strata in these occurrences ranges between 15 cm to 2.7 metres.

Gypsum, at present in our country, is used in several ways. It is used as a retarding constituent in cement making, in the manufacture of ammonium sulphate fertilizer and plaster of Paris. Gypsum is used as a raw material in the manufacture of fertilizers, sulphuric acid, cement and wall board.

MICA

Rajasthan stands next to Bihar in the production of mica in India and its output was 5,300 tons (Map 18) out of the country's total production of 24,800 tons in 1963. Even in the State, in terms of value, mica shares about 12 per cent of the total mineral value of all the minerals of Rajasthan. Mica consists of silicate of aluminium, potassium, and hydrogen along with iron and magnesium in the dark varieties such as biotite. It is one of those minerals which does not require treatment in smelter, but is readily put to various uses.

Production of Mica in Rajasthan 1955–64

<table>
<thead>
<tr>
<th>Year</th>
<th>Tons</th>
</tr>
</thead>
<tbody>
<tr>
<td>1955</td>
<td>2,350</td>
</tr>
<tr>
<td>1956</td>
<td>2,200</td>
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<tr>
<td>1957</td>
<td>1,770</td>
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<tr>
<td>1963</td>
<td>5,300</td>
</tr>
<tr>
<td>1964</td>
<td>5,600</td>
</tr>
</tbody>
</table>
The most prominent mica producing belt in Rajasthan stretches in a northeast to southwest direction with a curve towards the southeast in the middle of the belt. This belt can be divided into two areas, *i.e.* Northeastern Mica Belt (in Tonk and Jaipur districts) and the Southwestern Mica Belt (Bhilwara and northern Udaipur). Apart from these, there are other scattered mining areas in Dungarpur, Bundi, and Sikar.

1. **Northeastern Mica Belt:** This mica belt covers part of the district of Tonk and southern Jaipur. The chief mica mines of the district are located in Barla, Mankhand, Sankarwara, Barchola, Miron, Dholi, Baroni and Palri mines. In Jaipur, mica is now obtained from Banjari and Laxmi mines; others located at Bhojpur Madhorajpura and Karanwa-ka-bas in Phagi Tahsil, at present have ceased operation. Some of these mine operations, mainly in Barla mines, are well mechanised and electrified. Mica is obtained from mines up to the depths of about 12 m to 27 metres. Todaraisingh railway station serves in the transportation of this mineral from the mining areas.

2. **Southwestern Mica Belt:** This belt includes the mica mines of Bhilwara and Udaipur districts. Bhilwara is very rich in mica deposits and the main belt in the district runs from northeast to southwest. The chief mines are Nat-ki-Neri, Toonka mine, Sidirias, Chapri, Ratangabha, Mankiya, Banjari, Ghogas, Gorkhan Bemali, Kocharia, Gokulpura and Dhawmand mines. From some of these mines mica has been removed up to the depth of about 60 metres. The main mica bearing rock is pegmatite. In some mines like Mankiya mine, the pegmatites occur as lenses arranged as chains. The orientation and the direction of each chain is different, while mostly the chains are connected with each other. In other mines like Gorkhan Bemali mines, the pegmatites are of massive variety and mica appears on the footwall side of the hills. This mica is slightly black spotted and copper stained. In Udaipur important mines are Champa Gudha, Dhola Metra and Galwa. Nearly all of them are located in the northeastern border of Udaipur and the belt is in continuation of Bhilwara mines further north. Most of the mines have been worked underground.
At present the mica mining has declined due to lack of financial resources and proper equipment needed for this industry.

3. *Other areas*: These include the mica mines of Sikar, located in the northeast of the district along the Punjab border. The mica bearing rocks are associated with the schistose formations of Delhi system as compared with schists of the Aravalli system. The chief mines are located at Kacharda, Makri, and Moonda in Torawati tahsil. The mica in these mines is of green variety.

The bulk of the export from this State consists of sickle dressed block mica. Some quantity of knife dressed block and film mica is also despatched to Bihar, from where, nearly all the mica is exported. If splitting of mica is developed in this State, it is likely that direct exports may increase from this State to foreign countries.

**Feldspar**

Ordinarily, feldspar includes a group of alkali alumina silicate minerals of which microcline, orthoclase and albite are the most important. Commercial feldspar rock is a mixture of potash spar and soda spar. This mineral is used in ceramic and glass industries.

**Production of Feldspar in Rajasthan 1955-64**

<table>
<thead>
<tr>
<th>Year</th>
<th>Tons</th>
</tr>
</thead>
<tbody>
<tr>
<td>1955</td>
<td>6,200</td>
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<tr>
<td>1956</td>
<td>7,980</td>
</tr>
<tr>
<td>1957</td>
<td>6,180</td>
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<tr>
<td>1958</td>
<td>7,490</td>
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<tr>
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<td>1963</td>
<td>12,500</td>
</tr>
<tr>
<td>1964</td>
<td>12,000</td>
</tr>
</tbody>
</table>
Feldspar occurs in pegmatites which are intruding the Aravalli or the Delhi system. This mineral is found in association with mica bearing pegmatites. Hence all the mica and beryl mines produce a large quantity of feldspar in Udaipur and Jaipur. The recovery of this mineral is in the form of a by-product from the mica mines.

The main occurrences are in Dungarwara, Dadiya, Bander Benri, Gujarwara in Jaipur district, Chaondiya, Pratapgarh, Dingor, Phulad, Bara in Pali district and many small occurrences in Tonk, Sikar, Udaipur, Dungarpur and Banswara district. The production during 1964 was 12,000 tons.

Asbestos

The chief characteristic of asbestos as a heat resistant has made it an important mineral for commercial and industrial use. The main physical characteristics of this mineral are the strength, flexibility and length of the fibre and toughness, fineness and fusibility. Asbestos is used in the manufacture of special types of cement for heat insulation (asbestos cement sheets) and lining in automobiles and in chemical processing industries. Commercial asbestos is found in two major groups, namely, chrysolite and amphibole. These in turn have several varieties of this mineral. Amphibole groups of mineral is the inferior type which is found in Rajasthan. In amphibole, three varieties namely tremolite, actinolite and asbestos are the most important. The chemical composition and the appearance of these three varieties is very much identical except that the fibres of asbestos are much longer and can be separated even by hand. Tremolite variety occurs in metamorphic rocks in long, stiff, blade like crystals of dark grey colour and also in long thin fibrous and columnar masses.

Rajasthan produces about two-fifths of the total Indian production of asbestos. The State produced about 2,000 tons of asbestos in 1964. The main areas of production are located at Khewana and Rikhabdeo in Udaipur district. In addition other scattered and smaller areas are located near Nathdwara, Kuanthali, Asind, Declia, Salumber, Barna and Gujam.
Apart from these areas, some chrysolite producing areas are located in Ajmer, Udaipur and Jodhpur.

**Production of Asbestos in Rajasthan**
**1955–64**

<table>
<thead>
<tr>
<th>Year</th>
<th>Tons</th>
</tr>
</thead>
<tbody>
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</tr>
<tr>
<td>1956</td>
<td>433</td>
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<tr>
<td>1957</td>
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<td>1962</td>
<td>1,290</td>
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<td>1963</td>
<td>2,200</td>
</tr>
<tr>
<td>1964</td>
<td>2,000</td>
</tr>
</tbody>
</table>

In Rajasthan the work in the quarries is carried out by primitive methods. Fibre separation work is done by soaking the mineral in water for about 24 hours and then by a circular millstone operation in a groove. Finally the mineral is dried in the sun in the powdered or in the fibre form.

**Barytes**

The occurrence of barytes as a commercial mineral is confined to the districts of Alwar and Bharatpur. Other small occurrences in Ajmer, Bikaner and Sikar districts have not been worked out since the mining operations would be uneconomical.

This mineral occurs in two distinct zones in Alwar district. One zone runs from the northeast to southwest from Jhakra to Ladia and Sabravali in Rajgarh tahsil. In this zone the mineral has been worked out at Gwara, Jamroli, Khora Makrora and Babeli–Bhagat–ka–Bas. The other zone runs from the northeast to southwest from Sainpuri to Akbarpur in Alwar tahsil with
deposits at Sainpuri, Dholidhup, Burasindh, Bhankhera and Umrain. In Bharatpur district, barytes is known to occur in Hathori village to 10 km of Wair which is about 18 km northwest from the Railway station at Bayana.

The barytes occurrences are confined to the formations of quartzites, phyllites and shale of the Alwar series and are found as fissure and cavity fillings and disseminated replacement deposits. These deposits have so far not been worked to a greater depth than 30 m and their continuity in depth has not been determined.

**Production of Barytes in Rajasthan 1955-64**

<table>
<thead>
<tr>
<th>Year</th>
<th>Tons</th>
</tr>
</thead>
<tbody>
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<td>12</td>
</tr>
<tr>
<td>1956</td>
<td>205</td>
</tr>
<tr>
<td>1957</td>
<td>1,109</td>
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<td>2,317</td>
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<tr>
<td>1959</td>
<td>2,627</td>
</tr>
<tr>
<td>1960</td>
<td>3,106</td>
</tr>
<tr>
<td>1961</td>
<td>1,240</td>
</tr>
<tr>
<td>1962</td>
<td>2,070</td>
</tr>
<tr>
<td>1963</td>
<td>5,600</td>
</tr>
<tr>
<td>1964</td>
<td>5,100</td>
</tr>
</tbody>
</table>

Barytes mineral is used in several ways after grinding. It is used as a pigment or extender in paints, in heavy muds used in oilwell drilling, as an inert filler in the manufacture of oil cloth, linoleum, paper and plastics. It is also used as a flux in brass smelting. In chemical industry it is used for making barium compounds such as barium chloride, barium nitrate, barium carbonate, barium hydroxide and barium sulphide. These compounds find important uses in industry. A medium scale industry based on barytes as basic raw material can be very well located at Alwar. This centre
is ideally located near the market as well as for the supply of raw material.

EMERALD

Emerald is one of the important gemstones, others being diamond, ruby, sapphire, topaz etc. These stones are characterised by their optical and physical characteristics, i.e. colour hardness, specific gravity and refractive index. All these stones occur in raw form and before use they are cut and faceted. Emerald is a velvety green variety of beryl, a silicate of beryllium and aluminium. Emerald crystallizes in hexagonal prisms and is commonly found with flaws. Pure and fine emeralds are very expensive. This stone is found in association with metamorphic rocks in most of the countries of the world. In Rajasthan at Kalaguman and Tikhi it is found with metamorphosed ultra basic rocks of probably pre-Raialo age. The emerald producing areas are mostly confined to the pre-Aravalli banded gneissic complex.

Rajasthan is the only State in India which produces emerald. Its production is about 80,000 carats per year. Nearly all the emerald occurs in the north of Udaipur district in a narrow belt that stretches between Deogarh in the north to Kankroli in the south along the Mavli-Marwar junction railway. In this stretch, three occurrences of importance are as follows:

1. Kalaguman fields: The emerald producing quarries are located about 12 km west of Amet station and about 2 km from Kalaguman village. In this area, emerald has been formed by contact metamorphism due to basic intrusions.

2. Tikhi fields: These fields are about 24 km northeast of Amet station and about 7 km southeast of Deogarh Station. The mines are located about 1.6 km southeast of Tikhi village. Here emerald is found mostly in biotite schists, quartz–schists and actinolite.

3. Gamgudha fields: These occurrences are about 26 km northwest from Nathdwara station.

The size of emerald crystals in these occurrences varies from that of a pea to an inch. Over an inch the size is considered
unusual. The crude emerald ore is washed, cleaned and finally undergoes cutting and dressing by expert cutters.

**Fuller’s Earth**

This mineral is a kind of clay which consists of hydrated silicate of aluminium with veritable amount of iron oxide, lime, magnesia and alkalis. The importance of this clay is mainly due to its physical characteristics rather than the chemical constituents. It is light grey to brown when freshly quarried and creamy white to yellowish white when dry.

This state is the leading producer of this clay mineral in India. The annual production is about 9,000 tons which constitute about 90 per cent of the total country’s produce.

**Production of Fuller’s Earth in Rajasthan 1955–64**

<table>
<thead>
<tr>
<th>Year</th>
<th>Tons</th>
</tr>
</thead>
<tbody>
<tr>
<td>1955</td>
<td>7,838</td>
</tr>
<tr>
<td>1956</td>
<td>6,032</td>
</tr>
<tr>
<td>1957</td>
<td>6,110</td>
</tr>
<tr>
<td>1958</td>
<td>7,310</td>
</tr>
<tr>
<td>1959</td>
<td>6,100</td>
</tr>
<tr>
<td>1960</td>
<td>10,470</td>
</tr>
<tr>
<td>1961</td>
<td>8,800</td>
</tr>
<tr>
<td>1962</td>
<td>8,400</td>
</tr>
<tr>
<td>1963</td>
<td>8,900</td>
</tr>
<tr>
<td>1964</td>
<td>9,200</td>
</tr>
</tbody>
</table>

The important occurrences of this clay are located in Palana, Kesardesar and Mund in Bikaner district; Kapurdi, Alamaria, and Sheo in Barmer district and Mandha in Jaisalmer district. Out of all these places Palana deposits are the most extensive. Here it is not exposed over the surface but the clay is found about 46 m below the surface. The sequence at Palana is alluvium, kanker
and hard soil, clay, grit etc. and finally fuller’s earth, inculcated with nummulitic limestone. These deposits are about 23 km from Bikaner city. Here 3 m to 9 m below the fuller’s earth, a lignite formation occurs. Sometimes when the shafts dug for lignite are unsuccessful, fuller’s earth is quarried by underground methods. The deposit here is about 6 km in length and one km in width. The underground mining methods increase the cost of production. The estimated reserves of this mineral are about 85 million tons.

Mundh deposits are about 11 km from Sri Kolayarjt railway station. Here the mineral is mined by open pit method because it is exposed at the surface. Clay is also of good quality. Kesardeser deposit in this district has not been worked out at present due to the higher cost in mining operations.

Kapurdi deposit in Barmer district is located about 23 km north of the Uttaralai railway station. Due to the dipping nature of these beds, the mineral is obtained by underground methods. Apart from this Alamsaria and Sheo deposits are also located in this district.

In Jaisalmer district this mineral is found in Mandha and Mandai deposits. The great distances from the railway has made these deposits uneconomical since the long distance transportation by road increases the cost of this mineral.

Fuller’s earth after activation is used for bleaching vegetable oils. Due to activation this mineral acquires bleaching properties. The vegetable oils are left in contact with this mineral and it helps in decolouring them. This mineral is also used in petroleum refinery for filtering and colouring petroleum products, mainly the lubricants. Apart from this, it is also used for water purification, detection of colouring agents in food products, cosmetics, removal of greasy matter from clothes and as dusting powder for insecticides etc.

SOAPSTONE, TALC AND STEATITE

In Rajasthan, these three minerals are called by the common name of soapstone. Soapstone generally includes soft and compact talcose rocks which could be worked and sawn and have a soapy
touch. It is medium to fine grained, bluish-grey, greenish-grey, generally massive variety of talc mineral. Steatite is a coarse to fine grained massive variety of talc. This State is rich in high grade steatite mineral and shares about 85 per cent of the India’s total annual production. Steatite and other allied minerals have great potentialities for the development of such industries which are mainly based on talc and steatite as raw material. The production of soapstone was 111,600 tons in 1964. Compared to 1959 production, the increase has been 110 per cent.

**Production of Soapstone in Rajasthan 1955–64**

<table>
<thead>
<tr>
<th>Year</th>
<th>Tons</th>
</tr>
</thead>
<tbody>
<tr>
<td>1955</td>
<td>33,380</td>
</tr>
<tr>
<td>1956</td>
<td>37,185</td>
</tr>
<tr>
<td>1957</td>
<td>36,810</td>
</tr>
<tr>
<td>1958</td>
<td>42,940</td>
</tr>
<tr>
<td>1959</td>
<td>53,630</td>
</tr>
<tr>
<td>1960</td>
<td>80,280</td>
</tr>
<tr>
<td>1961</td>
<td>84,990</td>
</tr>
<tr>
<td>1962</td>
<td>95,510</td>
</tr>
<tr>
<td>1963</td>
<td>100,620</td>
</tr>
<tr>
<td>1964</td>
<td>111,600</td>
</tr>
</tbody>
</table>

These minerals are distributed all over the State and quarries of various sizes are found in large numbers but the following three areas are the most important where it is found to occur in association with dolomite.

1. Dagotha Jharna (Jaipur)
2. Ghewaria and Chandpura (Bhilwara)
3. Deopura (Udaipur)

1. **Dagotha Jharna (Jaipur):** These deposits are located about 26 km north of Dausa railway station and the quarries are connected by metalled road. The talc formation occurs in dolomites of the Raialo series and the basic intrusions are also found in the
localities. Here in more than a dozen places steatite is quarried. Most of the quarries have been developed straight from the outcrops and have shown regular beds or lenticular deposits. Apart from this area, other occurrences are located at Khawa, Geejgarh and Gari Mora.

2. Ghewaria and Chandpura (Bhilwara): Ghewaria deposits are known for the last forty years and the quarries are located about 32 km east of Bhilwara railway station. It is connected by fair weather road. The occurrence of the mineral is confined in lenticular masses or large pockets in dolomite. The mineral is compact and white in colour. Chandpura quarries are located about 48 km northeast of Bhilwara. Both these deposits are quite large, although the extent of the reserves has not been properly estimated.

3. Deopura (Udaipur): Deopura, Lakhawali, Lohagarh, Salog, Bhungawat, Devla, Nathra–ka–pal, Rikhabdeo and various other quarries are found in Udaipur. Deopura deposits of soapstone are the largest and are located about 50 km south of Udaipur. The mineral occurs in association with dolomite belonging to the Aravalli age. The deposits are located about 92 m high on the flanks of the hills. The width of the deposit at few places is more than 18 metres. Lohargharh and Saloj quarries are located about 130 km and 127 km respectively southeast of Udaipur.

4. Other areas: Apart from the above quarries, this mineral occurs in several other localities such as Dariba (Sikar) Niwai (Tonk), Narawali (Banswara), Jakol and Khemra (Dungarpur).

**Marble**

The world famous Makrana marble comes from Nagaur district of Rajasthan and is ranked as the best marble produced in India. This State accounts for nearly all the marble produced in the country and the average annual production is about 40,000 metric tons.
PRODUCTION OF MARBLE IN RAJASTHAN
1955-64

<table>
<thead>
<tr>
<th>Year</th>
<th>Tons</th>
</tr>
</thead>
<tbody>
<tr>
<td>1955</td>
<td>19,800</td>
</tr>
<tr>
<td>1956</td>
<td>20,620</td>
</tr>
<tr>
<td>1957</td>
<td>23,950</td>
</tr>
<tr>
<td>1958</td>
<td>39,760</td>
</tr>
<tr>
<td>1959</td>
<td>29,430</td>
</tr>
<tr>
<td>1960</td>
<td>33,360</td>
</tr>
<tr>
<td>1961</td>
<td>32,640</td>
</tr>
<tr>
<td>1962</td>
<td>54,450</td>
</tr>
<tr>
<td>1963</td>
<td>41,800</td>
</tr>
<tr>
<td>1964</td>
<td>44,730</td>
</tr>
</tbody>
</table>

The marble producing areas in this State are located at Nagaur, Sikar, Jaipur and Alwar districts in the northeast and Udaipur, Jalar and Sirohi districts in the southwest. Some marble is also quarried in the southwest of Jaisalmer town.

1. Makrana Deposits: Makrana is a word for quality marble. Many multistoreyed buildings of our own time and many mosques, mausoleums and other monuments of medieval splendour are built of this quality marble quarried from this small town of Makrana. The world famous mausoleum, Taj Mahal (built by Emperor Shahjahan) is built of this marble. Pure white marble from this area was also carried all the way to Calcutta for building the Victoria Memorial.

These deposits are located close to Makrana railway station (Map 20) in the northeast of Nagaur district. The marble bearing hill hardly 30 m high runs in a northeast to southwest direction from Mata–ji–ka Temple in the east to Kala Dungri in the west of Makrana town, for about 20 km almost parallel to the railway line. These deposits represent the typical outcrops of the crystalline limestones of Raialo series. Different grades of marbles are found to occur in alteration with each other. Marble has been worked out only in those areas where it outcrops or is exposed at
the surface. In the Kumari group of hills, the lower beds are mostly exposed. This group includes Chari Hills, Mania-ki-Bhanikri, Kumari Dungar and Dholi Dungri. Near Borawar the marbles are composed of coarse grained blue grey inferior marbles while the ridge including Martin's old quarries and the Bhulla ridge overlying it to the east, produce best quality white marble. In lower beds some pink marble is also found in Kala Dungri. Marble from Makrana is largely coarse grained but in some quarries fine grained varieties are also obtained in various shades. Makrana marble contains very little percentage of impurities compared to Italian and Grecian marble. It contains about 98 per cent calcium carbonate. In this area about 200 quarries are being worked. Nearly all the quarries are worked by open quarry method. Marble has been quarried to varying depths. At many places the depth has reached about 30 m to 45 metres.

The marble supply from these quarries seems inexhaustible despite the fact that quarries have been worked for centuries. All along the ridge one finds a large number of openings of various sizes some reaching up to 70 m in depth from places where marble has been removed.

During the full season, about 8,000 workers are employed on cutting and blasting operations. As this work is still done by hammer and chisel, a good amount of marble is wasted in making marble blocks. For pulling the heavy slabs, cranes are employed at the ridges. Transportation from the mines to the saw mills is still by bullock carts.

The town of Makrana has a population of 17,270 (1961) and almost the entire population make a living out of marble. After independence, there has been a great demand for this marble which has resulted in increasing rates.

Other occurrences of marble are found in Maonda (Sikar district), Kishangarh (Jaipur district) and Jiri and Dadampeer (Alwar district). The marble outcrops at Kishangarh are the continuation of the Makrana marbles of Nagaur district. Marbles of various colours like, white, pink, black, striped, green etc. are found in these quarries. Alwar marbles are characterised by their
Plate 17—World Famous Makrana Marble Mines, NAGAUR. (See page 126)
Plate 18—Railway Negotiating A Bend in the Chambal Forests.  
(See page 150)

Plate 19—Road Building Requires Large Number of Labourers as it is Cheap.  (See page 152)
white crystalline texture used for building purposes.

2. Other marble quarrying areas are located in Devimata and Rajnagar in Udaipur district, Bhatana in Sirohi district and Rupi in Jalore district. Devimata and Rajnagar quarries produce pink colour marbles used mostly for building purposes. Devimata quarries are located about twenty-four km southeast of Udaipur town. Bhatana quarry in Sirohi district is located about 32 km west of Abu Road railway station at Bhatana village. Rupi produces little marble for local use.

3. Jaisalmer marble is slightly different. It is a yellow shelly limestone of the Jurassic age containing fossils. The presence of these fossils present unique patterns after polishing. It is a good ornamental stone. It is commonly used for toys and decorative pieces along with white and other shades of marbles for producing different patterns. The quarries are about 115 to 130 km to the nearest railway station Phalodi. Lack of transport facilities has been a drawback in the development of these quarries.

Recently some marble with all the seven colours of the spectrum has been found in Khandra village on the Pali–Abu highway. The marble is of adequate hardness and is found in fairly large blocks. If this stone could be quarried on a commercial scale, it would have a good market not only in India but also in some foreign countries.
CHAPTER VIII

INDUSTRIES

The State is industrially less developed as compared to some other States of the Indian Union. The industrial occupations are relatively less important in terms of employment and as a source of output. In the field of heavy industries, it would be difficult for the State to catch up with other parts of India which are more developed. The small princely states, though rich in potential resources, were not in a position to undertake large scale industrial development of their respective States. Many big industrialists of India hail from this State but none could develop industries within the State. The main reasons may be said to be the lack of congenial atmosphere in the princely states and the lack of facilities for any industrial development. Among these are the scarcity of water, shortage of power, lack of transport facilities and trained man power. At the time of the formation of the present Rajasthan State, there were very few industries established in the State.

In the early years of the formation, this State was faced with a number of administrative and financial problems. It had limited financial resources and that too could not be used for industrial development. Effective steps could not be taken for this and other socio-economic development before the beginning of the Second Plan period. However, there were about 905 industrial units of different sizes, not by any means, a large number for a State of the size of Rajasthan.

Up to 1949, most of the industrial goods were imported from other States in India. The industrial raw materials found within the State were exported to other States for processing. From the industrial aspect, the developable potentialities of the State had not even been surveyed and there were very few industries in the State.

The programme of industrial surveys could not be conducted
even in the First Five Year Plan period. During the Second Plan period great emphasis was laid on it. The Directorate of Economics and Industrial Survey conducted detailed investigation in the districts of Ajmer, Sirohi, Bundi, Jhalawar, Banswara and Dungarpur. Similarly, the Directorate of Small Industries Service Institute conducted industrial surveys of Pali, Bhilwara, Dholpur (tehsil), Sikar, Bharatpur, Alwar, Udaipur, Nagaur, Ganganagar and Churu districts. Apart from this, the State Government constituted Project Committees for preparing reports on the development of sugar, paper, card-board, cement, glass and glass industries in the State.

COTTON INDUSTRY

The cotton textile industry is one of the oldest forms of manufacturing and even at present it ranks among the most important industries in the world. In India also, it occupies an important place in terms of number of people employed, gross value of output and share in the foreign trade. This industry is one of the important large scale industries in Rajasthan.

There are eleven factories in this State out of which the one at Jaipur is only a spinning unit while the rest are composite ones. Of the remaining ten factories, three are located at Beaver (Ajmer) and one each at Pali, Bhilwara and Ganganagar (Map 19). Four factories located at Kishangarh, Bijainagar, Bhilwara and Kota, have been closed. The value of gross output is high in all the factories. In terms of employment and wages paid, this industry continues to hold the second position while in terms of total productive capital employed, it ranks third amongst all the industries in the State.

In general, the factors affecting the localisation of the cotton textile industry are complex. In the location and development of this industry, each region has its history. In many instances the older areas continue to grow even when the original causes for the establishment of the industry do not exist today. Among the
important factors which affect its localisation are the supply of raw material, fuel, chemicals, machinery, labour, transport facilities, market, and capital. Any of these factors may be responsible in the location and development of this industry provided it gives a decided advantage in competing with other textile centres. Viewing from this angle the location of this industry in Rajasthan can be ascribed to the supply of raw material, viz., cotton and the vast market. Cotton is grown here in 236,000 hectares which constitute about 3 per cent of the total cultivated area. Ganganagar accounts for about 30 per cent of the total cotton acreage and produces about 89,700 bales of cotton, i.e. nearly half of the total cotton produced in the State. Medium and short stapled cotton is produced in this area. This large supply of irrigated cotton crop is the main factor in the location of one factory at Ganganagar. This mill has about 25,300 spindles, 380 looms and 1,353 workers. Other cotton producing districts are Ajmer, Bhilwara, Jhalawar, Chittorgarh and Jaipur. With the availability of irrigation from Mahi Project, there is scope for increasing cotton producing area and improving the staple length of cotton in Banswara district which accounts for the location of three cotton manufacturing mills in this area. Beaver (Ajmer) has 57,000 spindles, 1,428 looms and 3,000 workers. Cotton for these centres is available within the State but it is also obtained from Berar and other cotton producing areas in India. The greatest factor in the development of this industry is the size of the home market. Coal is used as fuel and is obtained from distant places. This industry also helps in absorbing excess rural population. For developing an area where other industries cannot be located, the textile industry is frequently chosen as the first industry. This helps in providing a basic human need and it requires only an absolute minimum of technically trained personnel for its implementation. The labour force includes men, women, children and even the aged. In many instances this industry is associated with other types of manufacturing in which men are employed in the heavier industries and the women work in the textile factories. Along with the supply of raw cotton and market for the manufactured goods,
RAJASTHAN
LOCATION OF MAJOR INDUSTRIES

Based upon Survey of India map with the permission of the Surveyor General of India. © Government of India Copyright, 1962.
there are many other factors which influence the location and development of the textile industry. Among these can be mentioned the climatic conditions, availability of soft water, coal and land use conditions limiting the economic opportunities in a particular region. Climatic conditions are no barrier at present since, in most of the factories, installation of artificial humidifiers is a necessity. There is plenty of land in and around most of the textile centres. In Rajasthan most of these centres have not been running efficiently and the industry as a whole passed through a difficult period in which it has not been easy for these factories to compete in quality production of goods with other centres in the country. There has been a downward trend in production since 1956 and the next five years have been critical for the industry. The main reason for such a decline has been the use of old and uneconomic machines. This industry is now being assisted by government financially for modernisation. It has been also found necessary to equip it for dyeing, printing and bleaching, as this would help the industry to compete better with other centres.

**Production of Cloth and Yarn 1951-9**

<table>
<thead>
<tr>
<th>Year</th>
<th>Cloth (million yards)</th>
<th>Yarn (Million lb)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1951</td>
<td>50.1</td>
<td>30.0</td>
</tr>
<tr>
<td>1952</td>
<td>56.6</td>
<td>33.2</td>
</tr>
<tr>
<td>1953</td>
<td>52.2</td>
<td>31.7</td>
</tr>
<tr>
<td>1954</td>
<td>52.9</td>
<td>35.4</td>
</tr>
<tr>
<td>1955</td>
<td>53.9</td>
<td>36.3</td>
</tr>
<tr>
<td>1956</td>
<td>61.2</td>
<td>33.8</td>
</tr>
<tr>
<td>1957</td>
<td>57.6</td>
<td>34.4</td>
</tr>
<tr>
<td>1958</td>
<td>53.7</td>
<td>33.5</td>
</tr>
<tr>
<td>1959</td>
<td>52.2</td>
<td>29.8</td>
</tr>
</tbody>
</table>

It is proposed to start a new spinning mill at Udaipur with a capacity of 15,000 spindles. About 121,460 hectares of land may
be brought under cotton cultivation. This would be possible with the completion of Bhakra and Chambal projects. Cotton cultivation based on irrigation would give a more regular supply of cotton for the mills located in this region. Since there is no great difference between the cost of transporting raw cotton or manufactured cotton products, there is a likelihood of this industry to be located at centres which are near the market with a well developed transport system.

WOOLLEN INDUSTRY

Rajasthan produces some of the best wool in India. There are nearly 7.5 million sheep in the State which produce about 29 million pounds of wool per year. The following table\(^1\) shows different quantities and qualities of wool produced in different districts.

<table>
<thead>
<tr>
<th>Quality</th>
<th>Diameter in microns</th>
<th>Fineness counts</th>
<th>Location</th>
<th>Production in million lbs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fine</td>
<td>26-30</td>
<td>52s-56</td>
<td>Jhunjhunu, Sikar, part of Jaipur, Churu and Nagaur</td>
<td></td>
</tr>
<tr>
<td>Fine-medium</td>
<td>31-35</td>
<td>46s-50</td>
<td>Bikaner, Ganganagar, Jodhpur, Alwar, Bharatpur, Sawai Madhopur and part of Jaipur</td>
<td>17.5</td>
</tr>
<tr>
<td>Coarse-medium</td>
<td>36-40</td>
<td>36s-40</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coarse</td>
<td>41-50</td>
<td>Less than 36</td>
<td>Tonk. Kota and part of Jaipur</td>
<td>1.5</td>
</tr>
<tr>
<td>Very Coarse</td>
<td>51-70</td>
<td>Less than 36</td>
<td>Udaipur Division</td>
<td>2.5</td>
</tr>
</tbody>
</table>

Most of the wool produced in this State has been classified as carpet wool and nearly all of it is exported. Recent experiments

---

have indicated that this wool is of good quality and can be safely utilised for the manufacture of clothes. It is estimated that about 7.5 million lbs of fine wool will be available for the combing industry, 17.5 million lbs for the manufacture of medium woollens and 4.5 million lb of coarse and very coarse for the manufacture of carpets and felts.

SUGAR INDUSTRY

Like the rest of India, in this State also sugar is manufactured from sugarcane. It constitutes the basic raw material for this industry. Other materials needed for it are fuel, limestone and sulphur. Among the raw materials sugarcane is largely a weight loosing material. On an average about 9 to 12 per cent of the finished product in the form of sugar, is available from the total weight of the cane. In Rajasthan, the averages are 9.66 per cent in the Ganganagar and 9.8 per cent in the Bhopalsagar mills.

The cane being bulky, is difficult and expensive to transport over long distances. Besides, the sucrose content of the cane also deteriorates rapidly after the cane has been cut from the field. For the better recovery of its content, quickness is advisable, i.e. within a day or so after the cane has been separated from the root, the juice should be extracted. These factors render this industry incapable of greater dispersion.

The cost of sugarcane on an average is also slightly more than half the cost of white sugar. This makes it still more necessary to establish the industry near the raw material. The proper supply of cane, to a great extent, is dependent on the regional supply of cane from the producing areas. This crop covers nearly 1.2 per cent of the Indian acreage and produces about 62 per cent of the finished product.

During 1961-2, nearly 32,900 hectares was under sugarcane cultivation in this State which produced about 236,000 tons of sugarcane, and about 15,500 tons of sugar. Its regional concentration indicates that nearly three-fourths of the acreage is found
<table>
<thead>
<tr>
<th>Year</th>
<th>Tons</th>
</tr>
</thead>
<tbody>
<tr>
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<td>14,424</td>
</tr>
<tr>
<td>1956</td>
<td>17,680</td>
</tr>
<tr>
<td>1957</td>
<td>13,712</td>
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<tr>
<td>1958</td>
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<td>12,300</td>
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<td>1960</td>
<td>18,200</td>
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<td>1961</td>
<td>14,200</td>
</tr>
<tr>
<td>1962</td>
<td>15,500</td>
</tr>
<tr>
<td>1963</td>
<td>16,320</td>
</tr>
</tbody>
</table>

in the districts of Udaipur, Bharatpur, Bhilwara, Bundi, Chittorgarh, Jhalawar, Kota, Sawai Madhopur and Tonk. These districts account for 80 per cent of the sugarcane production. It may be observed that all these districts lie in the eastern part of the State. The concentration is so great that only Bharatpur and Udaipur account for nearly one third of the State production while the district of Ganganagar shares about 17 per cent. The eastern districts and the district of Ganganagar account for about 93 per cent of the acreage and also produce 92 per cent of the cane. Therefore the sugar industry in this State is localised (Map 19) in the districts of Ganganagar and Bhopalsagar (Udaipur) with crushing capacity of about 1,000 tons per day. These two districts alone account for about 40 per cent of the total area under sugarcane in the State. The Ganganagar area has the advantage of perennial canal irrigation provided by the Gang Canal. This secures an assured sugarcane yield for the mill in the area. The sugarcane production is not only sufficient for this mill but it can feed one more mill. The fields in Ganganagar have a level surface and they are in compact blocks. This enables the sugar mill to get fresh cane supplies from the fields. The fuel supply in both the mills is met by the use of bagasse a waste product of cane, after
crushing. Coal and occasionally electricity is also used to meet the additional requirements. Both these mills have the advantage of cheap labour force and ample supplies of water. The market factor has a limited value at present since it is a government controlled commodity and the exports are also increasing. However the sugar industry has a large market in the near future in this State as well as in the country. There is enough scope for its future development. The districts of Kota, Bundi and Bharatpur produce cane, but there is no large mill to utilise all the products. The average annual production of sugar cane is about 700,000 tons. Assuming that about 25 per cent of the cane would be used for other purposes, it leaves about 525,000 tons. On an average one mill requires about 125,000 tons of cane for economic functioning. Thus, either the production capacity of the existing mills should be increased, or two new mills in the eastern cane growing areas be started, at places like Bharatpur and Bundi. Small scale units with a crushing capacity of 20 to 30 tons can also be established. Since the sugarcane acreage is well distributed in the eastern plain area, the small scale units have more scope for development.

CEMENT INDUSTRY

Cement occupies an important place in the basic materials for the construction works. The development of the cement industry is of recent origin in India. Increased building activity and new uses of concrete have resulted in greater use of cement in recent years.

In Rajasthan, there are two cement factories located at Lakheri (Bundi district) and at Sawai Madhopur on the Kota line of the Western Railway (Map 19). Both these are about 40 km apart. Limestone and gypsum are the main raw materials used in the manufacture of cement. Cement is produced by heating raw materials in a rotary kiln under very high temperatures of 2,400°F. to 3,000°F. Coal is the most important fuel used in this industry. The amount of coal needed, varies with the efficiency of the kiln. On an average
120 pounds of coal is needed to produce one barrel of cement.

The cement industry is one of the largest consumers of bulk raw materials. Ordinarily, to produce 1,000 barrels of cement, each barrel weighing 376 pounds, the amount of raw material and fuel used is about 225 tons of limestone, 75 tons of clay or shale, 60 tons of coal and 5 tons of gypsum. In this way about two tons of raw material and fuel is to be assembled to produce about one ton of cement. In Rajasthan quite a good proportion of the limestone available, contains nearly all the ingredients in correct proportions. At Lakheri the use of clay is not necessary, the correct proportion being obtained by mixing different grades of limestone. While in other cases some clay is added in the limestone. Gypsum constitutes about 5 per cent of the raw material. At both these centres, abundant supply of limestone is available and since this forms a large part of the raw material, the mills are located near the quarries. Gypsum is brought from the eastern part and the railways provide the transport facilities. Both these mills have the advantage of being located near the raw material but this natural advantage is counterbalanced by the great distance from where the coal is obtained. This industry uses fuel worth Rs. 209,570 per year of which 98.3 per cent is constituted by coal. Since Rajasthan has no coal resources it is brought from the Madhya Pradesh mines. Lubricating oil forms 1.0 per cent of the fuel used in this industry.

It may be observed that out of all the raw materials, the supply of limestone exerts the greatest influence on cement plant location. Ordinarily, clay or shale is available in many localities. This constitutes about one-third of the total weight of the raw material. Even if it is not available in the nearby areas, it is moved towards the plant location. Coal is transported towards the limestone since the weight of coal needed, is much less than limestone and clay.

In 1962 India produced about 8.3 million tons of cement, of which Rajasthan produced about 1.08 million tons. This constituted about 13.3 per cent of country's total production. The Lakheri factory has a production capacity of 1,200 tons per day while another at Sawai Madhopur produces about 2,700 tons of
cement per day. This factory is one of the biggest units in Asia. The production of cement has definitely increased in the last decade.

**Cement Production in Rajasthan 1954–62**

<table>
<thead>
<tr>
<th>Year</th>
<th>Production in tons</th>
<th>No. of workers</th>
</tr>
</thead>
<tbody>
<tr>
<td>1954</td>
<td>575,290</td>
<td>3,518</td>
</tr>
<tr>
<td>1955</td>
<td>523,840</td>
<td>3,810</td>
</tr>
<tr>
<td>1956</td>
<td>527,010</td>
<td>4,347</td>
</tr>
<tr>
<td>1957</td>
<td>648,110</td>
<td>4,677</td>
</tr>
<tr>
<td>1958</td>
<td>778,000</td>
<td>5,285</td>
</tr>
<tr>
<td>1959</td>
<td>938,000</td>
<td>4,638</td>
</tr>
<tr>
<td>1960</td>
<td>962,000</td>
<td>5,230</td>
</tr>
<tr>
<td>1961</td>
<td>1,086,000</td>
<td>..</td>
</tr>
<tr>
<td>1962</td>
<td>1,075,000</td>
<td>..</td>
</tr>
</tbody>
</table>

In 1961 the cement industry consumed raw materials worth Rs. 36.02 million of which 1.56 million metric tons of limestone and 67,340 metric tons of gypsum accounted for Rs. 141,530. It may be interesting to note that the packing material which mainly consists of gunny bags valued even more than the value of main raw materials.

The limestone formation around Chittorgarh is of the Vindhyan age and belongs to the Nimbahera stage. It rests conformably on the Nimbahera shale and has a thickness of about 153 m in different localities. The limestone is generally seen outcropping at places but it does not rise more than a few metres above the plain area. The limestone rock in this area is characterised by pale bluish to greenish grey in colour, frequented by occasional layers of brown, pink and red. It is fine grained and non-crystalline, hard, smooth and compact. The limestone beds are fairly thick varying between 30 cm to 75 cm thick.

Chittorgarh has all the conditions favourable for the location of cement manufacturing industry. The area has large reserves of
limestone. Portland cement is a product obtained by pulverising clinker consisting essentially of hydraulic calcium silicate to which no additions have been made subsequent to calcination other than gypsum, or water, or both. It derives its name from the fact that it resembles in colour to a stone that is obtained from Portland in England.

At Chittorgarh, there would be ample supply of raw material for the cement industry in the form of local supply of limestone. It has plenty of level land, and a good climate; locally labour is available and transport facilities also exist in the area. Electric power can be supplied from the Chambal power grid and a regular supply of water can be assured from the Gambhiri river by constructing a dam across it. Gypsum would be available from within the State, and coal would be obtained from Bihar or Madhya Pradesh coal fields as in the case of the other two cement manufacturing centres at Lakheri in Bundi district and at Sawai Madhopur.

It is planned to establish three new cement factories in Rajasthan and Chittorgarh may be one of them.

**GLASS INDUSTRY**

Glass manufacturing is also of recent origin in India. This State is famous for glass sand production and in 1964 it produced about 140,000 tons of glass sand. At present there is only one factory located at Dholpur, (Map 19) in Bharatpur district. This factory employs about 725 people annually and the total amount of investment is about 1.26 million rupees. There is a large market and raw materials are also easily available. Among the most important raw materials, is the silic sand. All sands are not suitable for glass manufacture. Some sands of a degree of purity required for glass making are available in Sawai Madhopur district. Among the chemicals soda ash, sulphur and manganese oxide are important. All these are obtained locally for the Dholpur glass factory. Supply of cheap coal is also necessary. The purity of raw material is of great importance since it determines to a great extent the quality of the finished product.
INDUSTRIES

Glassware Production in Rajasthan
1958-62

<table>
<thead>
<tr>
<th>Year</th>
<th>Laboratory wares</th>
<th>Bottles, penicillin vials etc.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1958</td>
<td>10,674</td>
<td>202,064</td>
</tr>
<tr>
<td>1959</td>
<td>11,330</td>
<td>203,870</td>
</tr>
<tr>
<td>1960</td>
<td>16,346</td>
<td>93,050</td>
</tr>
<tr>
<td>1961</td>
<td>13,777</td>
<td>170,023</td>
</tr>
<tr>
<td>1962</td>
<td>18,786</td>
<td>6,833</td>
</tr>
</tbody>
</table>

The Dholpur factory has a specialised line of production. It produces about 400 tons of scientific glassware. Among other items are penicillin vials, bottles and flasks.

Salt Industry

The salt industry occupies an important place among different large scale industries in Rajasthan. All the salt works in this State are inland and contribute about 10 per cent of the total salt produced in India.

Salt Production in Rajasthan
1955-61

<table>
<thead>
<tr>
<th>Year</th>
<th>Tons</th>
</tr>
</thead>
<tbody>
<tr>
<td>1955</td>
<td>291,568</td>
</tr>
<tr>
<td>1956</td>
<td>289,836</td>
</tr>
<tr>
<td>1957</td>
<td>342,849</td>
</tr>
<tr>
<td>1958</td>
<td>300,960</td>
</tr>
<tr>
<td>1959</td>
<td>289,560</td>
</tr>
<tr>
<td>1960</td>
<td>366,430</td>
</tr>
<tr>
<td>1961</td>
<td>229,330</td>
</tr>
</tbody>
</table>

During the middle of the nineteenth century, salt manufacturing was limited to indigenous methods and various salt works were located
at places like Kacho, Rewassa, Bharatpur, Lunkaransar, Kanod and Luni salt tract. The closure of these works dates back to the year 1870 when the British Government commenced working the three salt sources of Sambhar, Didwana and Pachpadra and in order to avoid illicit manufacture of salt and consequent evasion of excise duty, the remaining works were suppressed by them.

The three major salt works are located at the Sambhar salt lake, Didwana and Pachpadra while a number of minor salt works are located at Phalodi, Kuchaman, Pokaran, and Sujangarh. Among all these sources the Sambhar lake is the largest and the most important single salt source in the State. Here, salt is extracted with the help of modern mechanical devices while at the other sources, due to small potentialities and little outturn, work is done in the old style.

The salt industry being an extractive industry is basically localised in areas where the raw material is available. Among the important factors which have helped in the location of this industry in this State can be mentioned, adequate transport facilities, cheap labour, assured supply of commercial salt and the availability of fresh water in the working area.

**SAMBHAR LAKE SOURCE**

This is the single largest inland salt source in the country and accounts for about 8.7 per cent of the total salt produced in India. The Sambhar lake source has a distinct advantage over others, since its salt deposits are inexhaustible with large annual production and the salt produced is also of good quality.

The Sambhar lake, about 60 km west of Jaipur on Jaipur–Jodhpur railway line, occupies a depression in the Aravalli schists and gneisses at a height of about 360 m above mean sea level. It stretches between 26° 53' N to 27° 1' N latitudes and 74° 54' E to 75° 14' longitudes (Map 20). The Lake is a basin filled up by the alluvial saliferous silt and is estimated to contain 65 million tons of salt. All along the southwest and northwest of the lake, the Aravalli spurs form a natural barrier protecting it from being filled up with aeolian desert sand. It is intermittent, containing water
during the rainy season and when full, the depth in the central section ranges between 18 m to 321 metres, and covers an area of about 234 sq kilometres. During summers, the area shrinks to 130 sq km only and water remains in small pools in different parts of the lake. The lake also receives water from the four small seasonal streams named Menda, Rupnagar, Kharian, and Khandel which form a total catchment area of about 5,720 sq kilometres.

The salt basin is situated in the area of inland drainage where climatic conditions are quite favourable for the manufacture of salt. In the semi-arid tract the rainfall is light and often irregular and occasionally torrential in character. The annual rainfall at Sambhar town is 50 cm and at Nava 42 centimetres. The rainfall variation is great and ranges between 13 cm to 70 centimetres. The summer months are very hot and the average summer temperature ranges between 40° C to 45° C. The average humidity is as low as 27 per cent and evaporation is about 110 centimetres.

The area surrounding the lake is sandy and sterile. There are two small towns—Sambhar with a population of 14,139 (1961) at the eastern end and Nava (population 8,097) on the northern shore of the lake. Both the towns are engaged in the salt trade and salt manufacturing.

The salt layer accumulates on the top of the lake. After the monsoon when water evaporates from the lake, the brine in the silt rises to the surface by capillary action. The surface evaporation results in drying out the brine. By this process, the salt layer accumulates each year on the top of the lake.

The salt is manufactured by solar evaporation method from March to July. Enclosed reservoirs have been constructed for the collection of the brine from the main lake. The fresh water at first quickly takes up salinity from the lake silt with a density of 3° to 5° Be.¹ The brine is then pumped to the main reservoir and when the density rises to 15° to 16° Be. it is pumped to the manufacturing units (kayars) which are complete with their own set of small reservoirs, condensers, crystallizing pans and some area for storing the

¹ Be—Beaume, a measure of brine.
bitterns. There are six ‘kayars’ covering an area of about 8 sq kilometres. The salt extraction process begins when the brine in crystallising pans has attained the density of 25° to 26° Be, and there is a sufficiently thick crust of salt present in the pans. The salt produced in this way is called ‘kayar’ salt.

Another form of salt produced at Sambhar is wind swept known as ‘reshta’ salt. It is collected as tiny crystals along the edges of the crystallising pans and is considered to be of good quality, highly suitable for industrial purposes.

Some salt is also obtained by percolation canals into separate pans. The canal brine is whiter and contains higher percentage of sodium chloride content. It is known as pan salt. The improvement in the quality of ‘kayar’ and pan salt can be effected by treating the salt through a process of mechanical washing.

Evaporation is the chief operation in the concentration of weak brine to saturation and the evaporation in turn is affected by temperature, humidity, rainfall, direction and velocity of winds, and the extent of cloudy days. The yield of salt is directly influenced by the amount and duration of rainfall.

**Pachpadra Salt Source**

The Pachpadra salt producing area is located about 128 km southwest of Jodhpur. The salt source consists of a depression with an area of about 83.2 sq kilometres. The rain water leaches out the salts from a catchment area of about 910 to 1,040 sq km and carries them to sub-soil in this depression. The largest number of salt pits are in the western part of the depression and the salt works are located at Hiragarh and Bara Sambra. Other salt works are at Posali and Chota Sambra in the eastern section. The salt at Pachpadra corresponds more to the sea salt. Here also the climatic and physical conditions favour salt manufacturing. The summers are very hot. Rainfall in the area is scanty (28 cm annual) and the annual rate of evaporation is about 150 centimetres.

The manufacture of salt in this area is in the hands of ‘kharwals’ who have been working in the trade for generations. Rectangular
pits 2.7 m to 3.7 m deep and 15 m to 30 m wide are dug in the basin to reach the brine. These pits are scattered over an area of about 5,000 sq kilometres. The whole of this depression is divided into three areas: Heeragarh, Sambra and Posali.

The production figures indicate that the output of pit decreases in due course of time. The salt finding its way into the pit decreases its depth and makes the bottom and sides impervious, which obstructs the flow of fresh brine.

This area has been producing salt under many disadvantages. Among these can be mentioned the scarcity of water, severe arid climatic conditions, insufficient and untrained labour, lack of proper loading and transport facilities and high railway freight in earlier years. Some of the disadvantages have been overcome but the scarcity of water still persists.

**Didwana Salt Area**

This salt producing area of about 10 sq km is located about 50 km northwest of the Sambhar lake. The depression is surrounded by sand hills on all sides except in the west where an isolated spur of the Aravallis forms its western boundary. Didwana town is located at the northeastern end. Within this depression, two dams have been constructed from one end to the other to minimise the inflow of surface water towards the centre of the depression where salt manufacturing is carried on.

The bed of the depression shows the presence of black clay. Similar in appearance to that of the Sambhar lake. The brine springs in this depression has a brine density of 20° Be. The climatic and physical conditions are well suited for manufacturing salt in this area. The May temperature is about 46°C, and average annual rainfall only 37 centimetres. The rainfall does not affect the salt production at this source. The sub-soil brine reserves in the depression are sufficient even in years of drought to afford an ample supply to the brine wells.

In this part salt manufacture is carried on by private agency locally known as 'dewals' who have licences from the Government. The salt extraction is carried on even at present by century old
methods. Brine wells (kuls) are sunk at depths varying from 2.4 m to 4.6 metres. In these wells the densities of sub-soil brines range between 10° to 26°Be. The pans are fed through shallow drains. During a dry period of nine months about six to seven crops are collected. The first crop is obtained after about a month’s evaporation, the second after 20 days and the period of collection decreases as the heat and velocity of strong west winds increase before the monsoons.

The Didwana salt producing area has great potentialities for salt manufacturing in the State. Here, the salt can be produced at a cheaper cost than in the other two areas. This source is not dependent on rainfall and thus the level of production can be maintained even in drought years.

The salt production in the State can be considerably increased by starting closed salt works at Bharatpur and Bikaner. Apart from salt production there is scope for developing an alkali industry to produce soda ash, caustic soda and bleaching powder. A soda ash factory can be located in the Sambhar lake area. The Sambhar salt does not contain calcium and magnesium salts and these two are considered as main impurities for the manufacture of soda ash. The water can be made available through pipe line from either the Kalak bund or the Chapparwada bund about 29 km away from Sambhar. Good quality limestone is available in Sojat and Gotan in Jodhpur district and electric power is locally available at Sambhar.

COTTAGE AND SMALL SCALE INDUSTRIES

Cottage and small scale industries have an important place in the development plans of the State. In such industries there is scope for large scale employment with less capital. Small scale industries require more labour and hence can be located and developed in small towns and villages. They can provide the transitory stage for the development of large scale industries.

The modern type of small scale industries are poorly developed in this State. Such industries contribute about 5 per cent of the total factory production, while the average for India is about 8.0
per cent. The cottage and village industries contribute about 9.8 per cent of the State income. This shows that Rajasthan is dominated by traditional types of industries. The State consisted of a large number of princely states where facilities like power, transport and technical skill were very limited. Among the cottage and village industries, oil *ghanis*, khadi and handloom industries have been the main industries. In different parts of the State due to patronage of the princes, printing of textile and brassware developed much. At present most of the small scale industries are located in centres where raw materials are available. Such industries are based on agricultural products, livestock, forest and mineral raw materials. They are located in those towns where in addition to regular supply of raw materials, other locational advantages of power, transport and housing are available. The industries based on metal and chemicals are located mostly in large towns.
CHAPTER IX

TRANSPORT AND TRADE

TRANSPORT

The system of transport and means of communication serve as an index to the economic development and prosperity of any area. An easy, economic and sure accessibility provided by the transport system is one of the important factors in the development of an area. India, compared with some of the developed countries in the west and Japan in the east, has poorly developed means of communication. The economy is characterised as of self-sufficiency, and this is one of the contributory factors in the poor development of the means of communication.

Railways and roads are the principal transport systems in Rajasthan (Map 21). The State is served by a network of 6,227.5 km of railways and 25,554 km of roads. About 214,000 persons are engaged in railways, roads and road transport. Nearly 1.06 per cent of the total population is employed in transport while the average for the country is 1.6 per cent.

The existing transport system of roads and railways has several tasks to perform. The movement of surplus agricultural products like, foodgrains, cotton, oilseeds etc. has to be performed by this system. All these products are moved from rural to urban centres as well as to other States like Madhya Pradesh, Gujarat, Uttar Pradesh and Delhi. On an average in good years about one-third of the farm product is exported to the adjoining states and about 600,000 tons of foodgrains are moved by the existing transport system from rural to urban areas. Some amount of charcoal, small timber and firewood is also distributed and moved within the State. About 200,000 bales of cotton are moved to ginning and pressing factories locally and nearly half of this is distributed to the textile industry within the State and outside.

Apart from this, 150,000 tons of oilseeds need movement to the pressing factories and oil mills. About 50,000 tons is moved
to other States. In addition to the large scale transportation provided by roads and railway network, quite a good amount of transportation and movement of various products is effected by bullock and camel-carts and lorries. About 600,000 tons of sugarcane is moved to sugar factories and gur manufacturers annually. The task of distributing all these products is not uniformly distributed throughout the whole State. More productive areas with surplus grains, oilseeds, sugarcane etc. require these facilities more than the western arid and sandy tracts in the State.

In addition to farm products, mineral producing areas and various developing and growing industries in the State also need and mostly depend on railways and roads for the transportation of raw material and finished goods. The movement of salt to the extent of about 400,000 tons to other States and also within the State depends on roads and railways. For salt movement Pachpadra, Didwana and Sambhar railway stations are the most important. Due to industrial development and the production of a large variety of minerals there is a growing pressure on the existing transport system. Among the minerals, gypsum, limestone, glass sand, soap and sandstone, manganese ore, marble, and masonry items are the principal items which require transportation. The movement of all these items creates the traffic pressures at various centres like Sojat, Gotan, Jamsar, Nagaur, Ramganj, Mandi, Chittor, Nimbahera, Jaipur-Katni-Jaggar, Kota-Karauli, Bharatpur, Dholpur, Zawar and Jhunjhunu. The cement industry also puts pressure on the transport system. This is due to the assembly of raw materials at cement producing centres and finally transporation of about 700,000 tons of cement within and outside the State. Rajasthan being poor in coal supplies, nearly 600,000 tons of coal and coke are brought into the State and supplied to industrial centres. The movement of coal involves transhipment at Bhatinda, Sarai-Rohilla, Agra East, and Ratlam. The coal is again transported to thermal stations, cement and textile factories, limestone works and various other industrial centres in the State.
RAILWAYS

Rajasthan with an area of 342,274 sq km is served by 6,227.5 km of railways. Out of this nearly 5,820.2 km are in metre gauge (93.5 per cent), 293 km in broad gauge and 114.3 km in narrow gauge. On the basis of railway zones, the State is served by the Northern, the Western and the Central Railways. The following table indicates the distribution of length in different districts.

<table>
<thead>
<tr>
<th>Zone</th>
<th>Length in km</th>
<th>Gauge</th>
<th>Districts served</th>
</tr>
</thead>
<tbody>
<tr>
<td>Northern</td>
<td>328.5</td>
<td>metre</td>
<td>Bikaner, Jodhpur, Ganganagar, Churu, and Hanumangarh districts.</td>
</tr>
<tr>
<td>Western</td>
<td>2,523.5</td>
<td>metre</td>
<td>Alwar, Jaipur, Sawai Madhopur, Kota, Ajmer, Udaipur.</td>
</tr>
<tr>
<td></td>
<td>272.0</td>
<td>broad</td>
<td></td>
</tr>
<tr>
<td>Central</td>
<td>133.6</td>
<td>broad and narrow</td>
<td>Dholpur and Gangapur (Bharatpur).</td>
</tr>
</tbody>
</table>

Rajasthan has an average of 44.8 km of railways per 2,600 sq km of territory while the average for India is 45.2 km for the same territory. As the population in the State is sparse, the average railway kilometrage in respect of population is better than the average in India. In Rajasthan a population of 10,000 is served by 3.09 km of railway while average for India is only 1.43 kilometres. These averages whether in Rajasthan or in India, do not give a clear account of the nature of the railways unless compared with other countries. When the averages are compared with other developed and industrialised countries, it is realised that along with India, this State is also poorly served by a network of railways.

In Rajasthan the difference in the railway gauge poses the problem of transhipments at Bharatpur, Dholpur, and Sawai Madhopur (Map 21). There are other centres outside the State like Ratlam, Agra-East Bank, Sarai-Rohilla, and Bhatinda which have special significance for inter-State traffic by railways. These are transit centres for bringing coal, coke and a large variety of commodities
Based upon Survey of India map with the permission of the Surveyor General of India. © Government of India Copyright, 1962.
in the State. This incoming traffic exceeds the outgoing traffic. Along with the industrial development of Rajasthan, this trend will also continue in the future.

During the last decade the traffic has increased considerably inside the State and this has created bottlenecks at several centres like Sawai Madhopur, Phulera, Hanumangarh, Ratangarh, Sadulpur and Ganganagar. The main causes of such traffic congestion are limited line capacity, wagon detentions at marshalling yards and transshipment points and inadequate handling facilities at terminal stations.

The railways are not uniformly distributed in Rajasthan. The railway map shows that the three districts of Jaisalmer, Banswara and Dungarpur have no railways. These districts cover about 14 per cent of the total area of Rajasthan. The districts of Tonk, Jhalawar and Jalore with 7 per cent of the total area have very little railway mileage. Thus nearly 20 per cent of the area of the State has almost no railways. The main reason is that Jaisalmer lying in the most arid and sandy part of Rajasthan has very little population. The area is somewhat a negative area for agricultural activity, with no economic future and thus the construction of railways in this part was not considered an economic necessity. The districts of Banswara and Dungarpur are located in the Aravalli range region. Due to the hilly terrain and its undeveloped nature, there are no railways in this area also.

The general characteristic of the railway map shows that west of the Aravallis, the routes are straight, over long distances. The absence of hills enables the railway lines to run for miles without changing the course, while in the Aravalli region, the routes follow winding courses. At several places depending upon the nature of the terrain, the line has to make long detours in order to avoid physical obstruction.

ROADS

Rajasthan has a network of painted, metalled, gravelled, fair weather and dressed up tracks, all together about 27,562 km long.
All these roads provide the indigenous means of communication (Map 21). In comparison to railways, roads are more economical and take less time in construction. The construction of unmetalled fair weather and dressed up tracks present no great difficulty. Although the cost is less when compared with railways, roads have certain drawbacks. The unmetalled roads are not very effective and serviceable as the railways. During rainy season especially in the east and southeast of the Aravalli, such roads become unserviceable, while in the western sandy and arid plains the summer sand storms cover large part of such roads. In both cases the effectiveness of the roads as a means of communication is hampered.

The road system in this State is not very well developed. It has 137.3 km of roads per 1,000,000 population or only 0.8 km of road per sq km of area. This is much less than the average for India, i.e. 0.13 per sq kilometre. Out of 27,562 km of roads, there are 30.7 per cent painted roads, 21.8 per cent metalled roads, 19.2 per cent gravelled roads and 28.2 per cent fair weather and dressed up tracks. It has about 40 km of cement concrete roads, in Alwar and Kota districts, nearly 30 km of which are found in urban centres.

The road map shows that the area east of the Aravalli has more roads than the area lying west of the Aravalli range and hilly region. The relief and the agricultural and industrial activities are the major factors in the regional distribution of roads in this State. The Aravalli region in Udaipur and the western sandy plains have poor systems of roads. The districts east of the Aravalli cover about 37 per cent of the total area and constitute above 60 per cent road kilometreage.

The following figures show the percentage of different types of roads in various districts.

The above figures indicate that nearly half of the State’s painted roads are in six districts. While one-third of metalled roads are in five districts only, more than half of the State’s gravelled roads, are in the districts of Barmer, Jodhpur, Nagaur and Udaipur. Nearly 45.2 per cent of the fair weather roads are in the seven dis-
districts located in the Aravalli range and the southeastern plateau area.

<table>
<thead>
<tr>
<th>Type of Roads</th>
<th>Percentage</th>
<th>Districts</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Painted roads</td>
<td>50.0</td>
<td>Ajmer, Alwar, Bharatpur, Jaipur, Jodhpur, Udaipur.</td>
</tr>
<tr>
<td>3. Gravelled road</td>
<td>55.6</td>
<td>Barmer, Jodhpur, Nagaur and Udaipur.</td>
</tr>
<tr>
<td>4. Fair weather and dressed up tracks</td>
<td>45.2</td>
<td>Banswara, Bhilwara, Bundi, Dungarpur, Jalor, Kota, Udaipur.</td>
</tr>
</tbody>
</table>

The arid and sandy plains of the west, in the districts of Bikaner, Jaisalmer, Barmer, western part of Jodhpur and part of Jalor, have a poor system of roads.

TRADE

The economic prosperity of any region is measured by the amount and nature of its trade with other regions. All regions do not produce all the items they need. Various factors are responsible for the production of various materials, whether it be farm, industrial or mineral product or any other item of economic value.

A large part of Rajasthan, mainly west of the Aravalli ranges consists of sandy and arid tracts. The agricultural activity in such a region has many limitations. Bajra and pulses are the main farm products and wherever irrigation is possible as in Ganganagar, cotton, gram and wheat are also grown.

The State is rich in a variety of minerals but at present the production is confined to only few selected areas. The coal resources are poor.

The State is mainly agricultural and thus the internal and external trade is characterised by the movement of bulky commodities. Rajasthan’s main imports consist of coal and coke, iron ore,
kerosene, sugar, khandsari, gur, jaggery, wheat, rice, cotton, glass, bajra, groundnut, vegetable oil and large numbers of other items. The following table gives some of the main items of imports and the States from where they are mostly obtained.

**Main Items of Imports in Rajasthan 1961-2**

<table>
<thead>
<tr>
<th>Items</th>
<th>Total imports (in quintals)</th>
<th>Main states from where imported</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coal and Coke</td>
<td>15,722,921</td>
<td>Bihar, West Bengal, and Madhya Pradesh.</td>
</tr>
<tr>
<td>Iron</td>
<td>1,382,461</td>
<td>West Bengal, Bihar, Bombay and Uttar Pradesh</td>
</tr>
<tr>
<td>Kerosene</td>
<td>521,900</td>
<td>Bombay</td>
</tr>
<tr>
<td>Cement</td>
<td>556,830</td>
<td>Bombay, Madhya Pradesh and Punjab.</td>
</tr>
<tr>
<td>Cotton (raw)</td>
<td>60,395</td>
<td>Punjab and Bombay.</td>
</tr>
<tr>
<td>Glass</td>
<td>34,486</td>
<td>Uttar Pradesh and West Bengal.</td>
</tr>
<tr>
<td>Wheat</td>
<td>1,876,169</td>
<td>Bombay, Punjab and Madhya Pradesh.</td>
</tr>
<tr>
<td>Wheat flour</td>
<td>75,980</td>
<td>Bombay and Madhya Pradesh.</td>
</tr>
<tr>
<td>Bajra</td>
<td>88,473</td>
<td>Punjab.</td>
</tr>
<tr>
<td>Rice (not in husk)</td>
<td>288,333</td>
<td>Bombay and Madhya Pradesh.</td>
</tr>
<tr>
<td>Vegetable Oil—Groundnut</td>
<td>111,668</td>
<td>Bombay.</td>
</tr>
<tr>
<td>Sugar (excluding Khand-</td>
<td>449,049</td>
<td>Uttar Pradesh.</td>
</tr>
<tr>
<td>sari)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Khandsari</td>
<td>181,832</td>
<td>Uttar Pradesh.</td>
</tr>
<tr>
<td>Gur Jaggery</td>
<td>651,253</td>
<td>Uttar Pradesh.</td>
</tr>
<tr>
<td>Salt</td>
<td>152,003</td>
<td>Bombay.</td>
</tr>
<tr>
<td>Timber</td>
<td>632,034</td>
<td>Uttar Pradesh, Madhya Pradesh, Bihar and Bombay.</td>
</tr>
</tbody>
</table>

## Main Items of Exports From Rajasthan

<table>
<thead>
<tr>
<th>Items</th>
<th>Total exports (in quintals)</th>
<th>Main states to whom exported</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sheep and goats (Nos.)</td>
<td>399,763</td>
<td>Bombay and Madhya Pradesh</td>
</tr>
<tr>
<td>Bones</td>
<td>140,648</td>
<td>Bombay, Kerala and Madhya Pradesh</td>
</tr>
<tr>
<td>Cement</td>
<td>7,646,952</td>
<td>Bombay, Uttar Pradesh, Punjab Madhya Pradesh.</td>
</tr>
<tr>
<td>Cotton (raw)</td>
<td>146,094</td>
<td>Punjab and Bombay.</td>
</tr>
<tr>
<td>Vegetable Oil-Groundnut</td>
<td>13,476</td>
<td>West Bengal and Bombay.</td>
</tr>
<tr>
<td>Rape and mustard</td>
<td>576,921</td>
<td>West Bengal, Bihar and Bombay.</td>
</tr>
<tr>
<td>Maize</td>
<td>252,778</td>
<td>Bombay, Uttar Pradesh and Bihar</td>
</tr>
<tr>
<td>Jowar</td>
<td>246,459</td>
<td>Bombay.</td>
</tr>
<tr>
<td>Bajra</td>
<td>134,465</td>
<td>Bombay.</td>
</tr>
<tr>
<td>Wheat</td>
<td>686,257</td>
<td>Uttar Pradesh and Bombay.</td>
</tr>
<tr>
<td>Gram and gram products</td>
<td>1,533,874</td>
<td>Bombay, Madras, Andhra Pradesh, Mysore, Punjab and Uttar Pradesh.</td>
</tr>
<tr>
<td>Iron</td>
<td>229,293</td>
<td>Bombay, Punjab and Uttar Pradesh.</td>
</tr>
<tr>
<td>Manganese ore</td>
<td>3,716</td>
<td>Bombay.</td>
</tr>
<tr>
<td>Salt</td>
<td>1,818,967</td>
<td>Bihar, Punjab, Uttar Pradesh and Union Territories.</td>
</tr>
<tr>
<td>Wool</td>
<td>54,346</td>
<td>Bombay and Uttar Pradesh.</td>
</tr>
</tbody>
</table>

1 Ibid., pp. 81-4.
CHAPTER X

POPULATION

RAJASTHAN has a population of about 20.16 million (1961) persons spread out in an area of 342,274 sq kilometres. This State covers 11.2 per cent of the country’s total area and supports only 4.6 per cent of the total population. The size of the population and the area over which it is distributed, are important factors in demographic study since they affect the living standard of the people.

The population is not evenly distributed throughout the whole State. The average density of population is 59 persons per sq kilometre. It is the lowest density except in Jammu and Kashmir where it is only 25 persons per sq kilometre. This low density of population is due to the fact that most of the western and northwestern parts are arid and semi-arid, covered with stable and shifting sand-dunes. Nearly 83.7 per cent of the population live in villages of different sizes and the remaining 16.3 per cent live in urban centres. The rural and urban density is 50.2 and 59.8 persons per sq kilometre respectively. Compared to other states in India, the population of Rajasthan indicates a sharp contrast with regard to the density, total population and regional distribution.

A detailed population distribution map of Rajasthan would reveal that the distribution is controlled by a large number of factors, although broad patterns can be explained with reference to geology, relief, climate, natural vegetation and agricultural potentialities in different areas. The Aravallis running northeast to southwest across the State for a length of about 550 km serve as a population divide. In a general way, the population density decreases towards the west and northwest of the Aravallis and increases towards the east and northeast.

GENERAL DENSITY

The general density map indicates (Map 22) that east of the
Aravallis the density of population ranges between 50 to 150 persons per sq kilometre. The density is heaviest in the districts of Jhunjhunu, Sikar, Jaipur, Bharatpur and Alwar in the north-east of the State in the Trans-Yamuna tract and also in the Dungarpur district. In these districts it ranges between 100 to 150 persons per sq kilometre. The lowest density of less than 25 persons per sq kilometre has been recorded in the districts of Bikaner, Barmer and Jaisalmer, while the last district shows the lowest density of 4 persons per sq kilometre. The reasons for this unequal distribution of population as revealed in the density map are not far to seek. The population being mainly rural and agricultural the density is higher in areas, more suited for agriculture, where water supply is assured and the surface topography is more level.

A population density is the result of several factors. Among these are physical, social, agricultural, and historical—in fact the whole of physical, economic and cultural environment affects it. Of all these, the physical factor is the most important. It is a common feature that the population centres round fertile tracts. This is applicable not only to villages but to larger areas as well. If there are no special causes to prevent it, the best lands of a village are found next to the village site. It is also for this reason that, generally, the most fertile parts of this region are thickly populated. The population in Rajasthan decreases from east to west.

FACTORS AFFECTING DENSITY OF POPULATION

**Topography:** The relief features play an important part in determining the density and distribution of population in this State. The larger aggregations of population are found in the level tracts with better water supply either by rain or by irrigation. In such areas along with adequate water supply, fertility of the soil and food production are the main factors. There is a grater concentration of population in the river valleys in the eastern plain area and to some extent in the Luni basin and the sub-montane zone in the west. The high density of population in these plains in general and Trans-Yamuna in particular indicates that this area is a better food producing region. The soils are renewed by the detrital matter
brought down by the rivers from the hills and this action enriches the low lying tracts.

In the southeastern part of the State, there are a few areas of dense population. Such areas are well watered, low lying tracts where rainfall is heavier and more regular. The soil in this part is more fertile. There are extensive areas of black soil which produce good crops of wheat and barley.

West of the Aravallis, except the districts of Sirohi, Pali, Sikar and Jhunjhunu, the whole of this area lies in the Western Sandy Plains which includes the arid and semi-arid areas. In a large part of this area, extreme arid conditions prevail, temperature is very high during the greater part of the year, irrigation facilities are almost absent (except the area served by Rajasthan Canal) and the land is covered by vast stretches of sands which has resulted in a very low density of population. The river Luni is the only stream in the west and even that is non-perennial. The Luni basin drained by this river and some smaller tributaries occasionally floods this basin. This results in the deposition of alluvial material which produces some wheat. This area supports a larger population than that lying further west.

Rainfall: There is a relationship between the density of population and the rainfall. It is generally stated that rainfall along with the fertility of the soil and the surface terrain combine to control the density of population. This is however, a wide generalisation which has numerous exceptions and is not always applicable. In Rajasthan, the density increases from west to east and southwest to northeast. Jaisalmer, the driest part of the State with less than 10 cm of annual rainfall, has the lowest density while Alwar and Bharatpur in the northeast have a density of about 142 persons per sq kilometre, the highest in the State. But some of the districts in the southeast like Jhalawar with greater rainfall than the northeast region, have a lower density of 80 persons per sq kilometre. Dungarpur located on the eastern edge of the Aravallis in the south receives about 90 cm of rainfall. Although this area is more hilly and rugged in the west than Udaipur district, it has a density of 133 persons per sq kilometre, much higher than in Udaipur.
where the density is only 89 persons per sq kilometre. This is due to the smaller area of Dungarpur and better and fertile land available for cultivation. The population here consists of tribals like ‘bhils’ and ‘menas’ who have a lower standard of living.

Settlements: Western Rajasthan includes the whole of the arid plain of Marwar and part of Jaisalmer, Barmer and Bikaner. The lower density of less than 25 persons per sq kilometre is in the districts of Bikaner, Barmer and Jaisalmer, the lowest being in Jaisalmer where it is only 4 persons per sq kilometre. The whole of this region is deficient in rainfall, climatic conditions are inhospitable, the surface topography is marked by wind blown sand ridges and the drainage is characteristically internal. In spite of these, man has succeeded in settling down even in these remoter parts of the State. Many settlements like Nokh, Bap, Bikampur, Girasar, Sihar and many others have grown up in this region. Water supply is made available from wells which are sometimes about 50 metres or even more deep in the northwest of Phalodi where the annual rainfall is less than 25 centimetres. In this part, chains of crescentric sand dunes cover up the ground with an average elevation of over 30 metres. Further northwest in Ganganagar, part of the land has been reclaimed in areas where irrigation is available. The extreme western parts of Jaisalmer, Bikaner and northwest Barmer receive rainfall ranging between 10 cm to 25 cm which is completely inadequate for any agricultural operations. The road from Gadra Road to Phalsund is the dividing line between the northern Jaisalmer desert and the southern Barmer desert. The northern desert has sief or longitudinal type of dunes and the southern part has sand dunes of the barchan type or the transverse dunes. In the south the dunes are much higher averaging between 50 to 100 metres above the ground level. They are more stable as they cannot be shifted by winds. These fixed dunes have resulted in a higher density of population, i.e. an average of 17 persons per sq kilometre as compared to 4 persons per sq kilometre in Jaisalmer area. The railway line that runs from Barmer to Bhimarlai traverses through the country interspersed with shallow basins (blowouts) which are occupied by rural settlements. Barmer with a population of 27,600
(1961) is the largest commercial town in this area. It is located on the eastern edge of a degradational piedmont surface carved out of Jurassic sandstone hills, and dotted with residual hills. The formation of these steep sided, isolated and residual hills is characteristic of hot dry lands in the western part of the State. The nature of settlements are determined to a great extent by the size and the location of sand dunes which rise to a height of about 100 metres. East of the river Luni the sand dunes are of fixed type. The density of population is 24 persons per sq kilometre, which is the highest in this region.

The Jaisalmer desert is more desolate and covered mostly by the shifting sand locally known as 'dhrians'. 'West of Shahgarh the dhrians' run in chains and are of very complex type. It is, however, only in the blowouts of this desert that man could get some foothold. The number of such settlements of precarious existence does not exceed 100. The largest number is to be found in the Jaisalmer pediplain, which is also carved out of Jurassic sandstones. A number of short, intermittent and discontinued streams traverse the Jaisalmer pediplain, the dry beds and banks of which could more easily be tapped for groundwater; and wherever the water supply is more or less assured settlements could spring up. To the north of Jaisalmer a number of playa lakes, designated as ranns, occur in basins more or less rimmed by low scarps. These lakes, though fed by centripetal drainage, remain dry for the greater part of the year, but their importance is mainly due to the fact that they yield salts. A number of settlements, including Sri Mohangarh, the largest village with a population of about 1,424 (1961) owe their existence to the salt deposit in these ranns. Near the Aravallis, the rainfall increases to 50 cm in the north and to 65 cm in the south and there are a large number of streams coming down the hills. This has resulted in the concentration of population in the foothill zone especially in the triangular area bounded in the north by the river Luni and in the southeast by the Jawai-

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2 Ibid., Plate 112.
Plate 20—A Typical Rajput Rural House Type in Charkhera Village, Bikaner. (See page 160)

Plate 21—A Typical House Type in the Desert Tract of Barmer and Bikaner. (See page 160)
Plate 22—BARMER TOWN—TYPICAL OF DESERT TOWNS. (See page 170)

Plate 23—JODHPUR FORT OVERLOOKING THE TOWN. (See page 171)
Sukri rivers respectively. There are several towns in this fertile tract including Pali town. Settlements have also sprung up around salt lakes and marble quarries. Didwana in the northeast and Pachpadra in the southwest are the typical salt towns. Makrana is the well known centre of marble quarries. Jodhpur, the largest town in this region, is located on a rocky surface around a large ancient fort. South of Luni is characterised by isolated rocky hills, bare and unpopulated whereas at the base of the Aravallis are a large number of villages which receive their water supply from hill streams during the monsoon season.

The Aravalli range, stretching for a distance of about 550 kilometres from Khetri to Khed Brahma from northeast to southwest across the state provides another inhospitable environment for human settlements. The hills consisting of hard quartzite rocks rise abruptly from the adjoining plains. 'In the Aravalli range the villages are few and far between and in many cases settlements consist of a few homesteads, erected either in forest clearings or in depressions between rugged quartzite ridges. Some concentration of population is, however, found where an extensive flat surface intervenes between rugged ridges, as in Bhorat Plateau between Kumbhalgarh and Gogunda.'

There are many gap towns north of Beaver, and the largest town being Ajmer. The Sambhar lake occupies one such gap in the north, around which a number of settlements have grown up. In the south is located the artificial lake Dhebar (Jai Samand) and the lake city of Udaipur. The northern part of the Aravallis is much more dissected and contains few settlements though Alwar is located on the eastern edge of the hill.

The eastern Rajasthan though slightly bigger in area than the western part contains more than four times the population of the western part. The Mewar Plain covers the eastern and southern part of eastern Rajasthan. This area is drained by the river Banas and its two tributaries Kothari and Khari. Here the rainfall is higher, the soils are fertile and better irrigation facilities from wells and tanks are possible. Hence such areas have larger dispersal of

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population. The rural population is concentrated along the river courses and around irrigation tanks. The famous Nathdwara temple town is located in this area. The Jaipur Plain occupies the northern part of eastern Rajasthan and the soil consists of alluvium and sand drift. Jaipur the capital of this State is located on an outlier of the Aravallis at the northern edge of the alluvial plain. In eastern Rajasthan, the plateau and wooded ridges are sparsely populated. These plateau and ridges are formed of sandstone rocks of the Vindhyan age. Bundi town is located on a sandstone ridge and Kota town at the edge of the flat land drained by the river Chambal, Kali Sindh and Parbati.

RURAL AND URBAN POPULATION

According to the 1961 Census more than four-fifths of the total population—83.7 per cent live in rural areas (Map 23) with about 16.3 per cent in urban centres. Rajasthan is thus basically agricultural and rural. The growth of industrial activities in the State is of recent development and it has not been so significant as to change appreciably the percentage of population living in rural and urban centres.

The following table shows the distribution of rural population and the number of different sizes of villages.

<table>
<thead>
<tr>
<th>Size of villages</th>
<th>Total rural population in million</th>
<th>Total number of village</th>
<th>Per cent of population</th>
<th>Per cent of villages</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Less than 200</td>
<td>1.116</td>
<td>10,321</td>
<td>6.6</td>
<td>32.0</td>
</tr>
<tr>
<td>2. 200–499</td>
<td>3.726</td>
<td>11,291</td>
<td>22.2</td>
<td>35.0</td>
</tr>
<tr>
<td>3. 500–999</td>
<td>4.607</td>
<td>6,597</td>
<td>27.0</td>
<td>20.4</td>
</tr>
<tr>
<td>4. 1,000–1,999</td>
<td>3.979</td>
<td>2,936</td>
<td>23.8</td>
<td>9.1</td>
</tr>
<tr>
<td>5. 2,000–4,999</td>
<td>2.850</td>
<td>1,003</td>
<td>16.8</td>
<td>3.1</td>
</tr>
<tr>
<td>6. above 5,000</td>
<td>0.600</td>
<td>94</td>
<td>3.5</td>
<td>0.4</td>
</tr>
<tr>
<td>TOTAL</td>
<td>16.874</td>
<td>32,241</td>
<td>100.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>

RAJASTHAN

DISTRIBUTION OF POPULATION

EACH DOT REPRESENTS 2,000 PERSONS

1961

Based upon Survey of India map with the permission of the Surveyor General of India. © Government of India Copyright, 1962.
The rural population inhabits about 32,241 villages. Nearly two-thirds of the total villages are small villages with less than 500 persons which account for 28.8 per cent of the rural population. Nearly 20 per cent of the villages are with a population of 500 to 999 persons, where 27.0 per cent of the population is living. Thus about 85.0 per cent of the villages have population of less than 1,000 persons in each village. In these villages about 55.0 per cent of the population is living. These figures indicate that Rajasthan has small sized agricultural villages. The regional distribution of these villages indicates that they are mostly located in a scattered form in the Western Sandy Plain area and the Aravalli Hill region. The aridity and relief conditions in these regions have restricted the growth of large sized villages. Generally, the cultivators prefer to settle in small hamlets adjacent to their holdings. Nearly 3.5 per cent of the rural population live in large villages of over 500 persons.

The growth of rural population is associated with urbanisation in the State. There has been a constant drift of rural population to urban centres in several regions. This trend has adversely affected the growth of rural population. Along with the industrial development in this State, higher rate of growth in urban population is quite natural.

There has been a gradual decline in the rural population since 1921. It was 86.7 per cent in 1921, 86.3 per cent in 1931 and 85.7 per cent in 1941. In 1951 the rural population was recorded as 81.5 per cent. The famines and epidemics have been responsible for the fall in the birth rate. This resulted in the reduced growth rate in the rural population also. The 1961 Census shows a slight increase in rural population. In this State nearly 84 towns were declassified as rural in 1961 Census which were classified as towns in 1951. The total population of these rural centres was 450 thousands in 1961. These persons would have been counted as urban population in 1961, but for the declassification, which resulted in their inclusion in rural population. Thus the percentage of rural population increased from 81.5 per cent in 1951 to 83.7 per cent in 1961. Along with this, there has been expansion in cultivated area
as well as agricultural production which resulted in rural employment.

The urban population in this State has remained stationary up to 1941. The variation during 1901 to 1941 has been only between 13.0 to 14.0 per cent. The 1951 urban population rose to 17.3 per cent while it came down to 16.3 per cent in 1961. In this State the growth of urban population has not always been the result of industrial development. Some of the towns like Bikaner and Udaipur, have been deliberately founded. In most cases, a narrow defile and hence a highly defensible site was often the criterion for founding a town. Examples of these are Jodhpur, Chittorgarh and Lachmangarh which initially developed around the forts.

The growth in urban population has also been possible partly due to the disintegration of self sufficient economy of the villages and partly due to the growth of villages into market towns and the development of communications, commerce and industry in the State. The following table\(^1\) shows the classwise growth of towns in Rajasthan from 1901 to 1961.

<table>
<thead>
<tr>
<th>Class of towns</th>
<th>1901</th>
<th>1911</th>
<th>1921</th>
<th>1931</th>
<th>1941</th>
<th>1951</th>
<th>1961</th>
<th>Per cent of population to total urban population in 1961</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>4</td>
<td>6</td>
<td>38.0</td>
</tr>
<tr>
<td>II</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>7.4</td>
</tr>
<tr>
<td>III</td>
<td>8</td>
<td>8</td>
<td>7</td>
<td>9</td>
<td>13</td>
<td>21</td>
<td>23</td>
<td>18.7</td>
</tr>
<tr>
<td>IV</td>
<td>26</td>
<td>25</td>
<td>20</td>
<td>26</td>
<td>28</td>
<td>37</td>
<td>52</td>
<td>22.6</td>
</tr>
<tr>
<td>V</td>
<td>64</td>
<td>60</td>
<td>58</td>
<td>64</td>
<td>74</td>
<td>96</td>
<td>51</td>
<td>12.1</td>
</tr>
<tr>
<td>VI</td>
<td>32</td>
<td>41</td>
<td>58</td>
<td>47</td>
<td>36</td>
<td>67</td>
<td>9</td>
<td>1.1</td>
</tr>
</tbody>
</table>

There is great reduction in the classes V and VI towns which is due to the fact that most of these towns which in 1951 were included as towns have been dropped from the category of towns in 1961.

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\(^1\) Ibid., pp. 232-4. Percentage population of each class has been calculated on the basis of population according to 1961 Census.
Census. In the 1961 Census, 34 class V towns and 50 class VI towns with an aggregate population of 450 thousands have been classified as rural. This has decreased the urban population in this State from 17.3 per cent in 1951 to 16.3 per cent in 1961.

In this State bigger cities are growing in population from middle sized towns. Class I cities like Jaipur, Ganganagar and Kota have recorded a marked increase since 1941. The growth of Jaipur city can be attributed to its becoming the capital of this State and also for increased industrial development in recent years. The city of Ganganagar expanded due to agricultural development. In this district a large number of displaced persons have also been colonised. The population in Kota city increased at a faster rate than any other town in Rajasthan, mainly due to the increased industrial development in this district.

The trend in Rajasthan is towards greater urban development. In most of the cities, better housing facilities, electric supply, recreational and educational facilities, medical, transportation and communication facilities and security have provided incentives for the people to move into urban centres.
CHAPTER XI

GEOGRAPHICAL REGIONS

Before 1948 the present State of Rajasthan consisted of a large number of princely states and chiefships, each having its own boundary and territorial extensions, determined during the course of history. Ajmer–Mêrêwara, located in the middle of these princely states, was directly under the British rule. These princely states extended over one or several geographical regions. The State of Rajasthan with its present boundaries came into existence nearly a decade back after the promulgation of the States Reorganization Act of 1956. The western and northern boundary of this State are marked by the eastern boundary of W. Pakistan. This boundary does not follow any natural feature and it runs across the Great Indian Desert. In the north and northeast the boundary is formed by the States of Punjab and Uttar Pradesh, in the southeast by Madhya Pradesh and in the southwest by Gujarat. A small part of the boundary in the east between this State and Madhya Pradesh is formed by the river Chambal while the rest of the boundary does not conform to any natural or geographical boundaries. The Rajasthan territory, as such, does not extend over only one geographical region. The State boundary cuts across several regional boundaries since it is largely an artificial contrivance and in character mainly political. Such a boundary is not expected to conform with the geographical regions of India. The State, because of its size, covers more than one geographical region whether natural or man-made and constitutes one political unit. For administrative purposes this State is divided into districts and further sub-divided into Tehsils, and revenue circles. Even these sub-divisions may and may not coincide with geographical regions.

The division of Rajasthan into geographical regions, however, does not imply isolationism. The regions are not to be considered as an isolated and completely self-sufficient unit, but they are to be treated as a cell within a larger organism. To a varying degree it
depends on exchange with neighbouring regions and ultimately with the super region which is the whole country itself. A region is thus a basic unit, facilitating by its quality the existence of larger units functioning well.

CRITERIA OF REGIONAL DIVISION

The criteria for the delimitation of regional boundaries is determined by the purpose and the objective for which the regional reconstruction is needed. In such cases regional demarcation would be based mainly on factors which may help in demarcating these regions. In fact there are several objectives which form the basis for such demarcation. Among these objective criteria can be included, firstly, geographic factors such as climate, river valleys, topography, soils and vegetation, secondly, cultural cohesion—in terms of a common language, history, religion or ideology or similarity of political institutions, and thirdly, distinctive economic features—like stage of industrial development, nature of agriculture, sources of minerals and lastly, various technical and welfare considerations like air transport, incidence of diseases, pest control, or illiteracy. The practical aspect of such criteria to regional reconstruction demonstrates that none of them is fully adequate for such construction. Secondly geographic, cultural or economic unity seldom coincides with the state boundaries.

While dividing Rajasthan into geographical regions, different factors have been taken into consideration. Among these factors can be mentioned as those pertaining to physiography, climate, vegetation, soil, agriculture, minerals and industries, population, social and traditional factors. From the regional division that follows, it would be observed that there is great disparity in the area covered under different regions (Map 24). The quality of man–land relation that has been established within the region, the nature of economic development which has been achieved and potentialities of the region are some of the characteristics which transform geographical areas into living regions. Hall has pointed out that, 'The limit of a region is after all not of the critical factor, it is the qualities of the area within it which are of major geographic
significance.¹

In the present day society with too much emphasis on planning, it has been felt that in many cases the district boundaries are no longer suited nor do they coincide with regional units, but due to traditional demarcations they are continuing. In this State there is great disparity among districts in respect of their sizes. The smallest is Dungarpur (3,781 sq km) while the largest is Jaisalmer (38,454 sq km) almost more than ten times the size of the former. The geographic personality of each district equally varies. Rajasthan is one of those states in the country which shows great contrast from one area to another. This disparity is prominent in respect of relief, climate, soil, vegetation, agricultural practices and mineral resources. To add to these, man-made factors like irrigation facilities, industrial development, and means of communication also show great disparity from one region to another. Thus the geographical environment, in the physical and economic sense, are so varied that not even a small area can be claimed to be identical with another. All the environmental conditions, mentioned above, not only distinguish between different areas and regions, but their measure of influence on social life differs from place to place.

Rajasthan may be divided into the following seven geographical regions (Map 24).
1. Western Arid Region
2. Semi-Arid Region
3. Canal Region
4. Aravalli Region
5. Eastern Agro-Industrial Region
6. Southeastern Agricultural Region
7. Chambal Ravine Region

Each of these regions have distinct characteristics in respect of physiography, climate, soil, vegetation, agriculture, minerals, population and means of communication. The factors which have made them separate regions are natural and man-made. The

Based upon Survey of India map with the permission of the Surveyor General of India. © Government of India Copyright, 1962.
Western Arid Region is the case of the former while Rajasthan Canal Region is made by man. Though in the map each region has been demarcated by lines, these regions cannot be demarcated into such rigid compartments. There are many variable factors involved which in due course of time may affect the boundary of each of these regions. Some regions may enlarge in size, some may shrink while others may disappear altogether. The regional boundaries should be taken as guide lines to demarcate regions with distinctive characteristics, indicating a certain amount of unity within the region.

1. Western Arid Region: This region covers the whole of Jaisalmer district, northwestern part of Barmer and Jodhpur, southeastern Bikaner, southwestern Churu and western part of Nagaur. It is characterised by typical desert conditions. The 25 cm rainfall line marks the eastern boundary while the western boundary is marked by the international boundary with W. Pakistan. In size this is the largest region in this State. The physiography is marked by vast stretches of sand dunes of different types and at some places the rocks are exposed at the surface. The rainfall in the eastern side is 25 cm and goes on decreasing to less than 10 cm towards the west. The temperatures are very high during the summer and range between 32° C to 48° C. Among the crops bajra is the most prominent, almost throughout this region, while some pulses are also grown in Bikaner. Nearly 30 to 40 per cent persons are cultivators living in scattered small rural settlements. The spacings between these settlements increase as one proceeds towards the western boundary. Apart from cultivation, livestock rearing is another important occupation of the people, which provides subsidiary occupation to the desert inhabitants mainly nomadic tribes. In this region the Tharparkar and the Rathli breed of cattle are most predominant. The area is rich in gypsum and important gypsum producing areas are Jamsar village and Lunkaransar in Bikaner, (having the largest deposit in the State), Mohangarh, Hamirwali, Dhani and Lakha in Jaisalmer and Kawas, Kurla, Sheokar and Uttarlai in Barmer district. The region is very poorly served by railways. Jaisalmer in the west has no railway and the whole area
has few roads connecting important places. This part of Rajasthan is the most arid and least developed. The main reason for its paucity of development is the extreme aridity due to lack of rainfall and very high temperatures. Lack of good transport system is another drawback, perhaps consequential. In Jaisalmer nearly two-fifths of the area is classified as barren where no agriculture is practised. The natural and economic potentialities of the area have not attracted a large number of inhabitants. In the extreme western part of the region the average density is only four persons per sq km, being the lowest in India.

Bikaner town with a population of 150,634 (1961) is located beyond the extensive deposits of sand dunes in the western part of the Thar Desert and serves as a regional centre. The present city was founded by Rao Bikaji in 1488 after founding the former Bikaner State in 1465. The fort dominates the city which has many buildings in red and yellow sandstones. Barmer with 27,600 (1961) inhabitants is the largest commercial centre in this region. The town is located on the eastern edge of the pediplain, carved out of sandstone hills and dotted with residual hills. Jaisalmer town (population 8,362) is located in the western part and it is the typical example of a desert town. The fort, temples and palaces are all built of yellow stone amid the arid vista of yellow sands. This town is 113 km by road from Pokran, the terminus of the Jodhpur-Pokran line of the Northern Railways and 158 km from Barmer on the same line. The city founded by Raval Jaisal in 1156, stands at the southern end of a low range of hills. As in other fort towns, this town is also enclosed by a stone wall about 5 km in circumference with bastions and towers. Other important centres in this region are Phalodi, Pokran, Bap and Sheo.

2. Semi-Arid Region: This region lies west of the Aravallis and runs from northeast to southwest. The western boundary is marked by 25 cm rainfall line, part of the eastern boundary in the south is marked by the western edge of the Aravalli hills and the northern boundary by the 50 cm rainfall line. The region stretches in the districts of Jalore, Pali, southeastern Jodhpur and Nagaur, Sikar, Jhunjhunu and northeastern part of Churu.
The southern part is drained by the Luni river and its small tributaries, while the northern parts of this region are characteristically an area of interior drainage. Most of the drainage is concentrated on the Sambhar lake, famous for salt production. Temperatures are high and rainfall varies from 25 cm in the west to 50 cm in the east.

The percentage of net sown area in this region is more as compared to the area lying further west and on an average 40 to 60 per cent of the area is under cultivation. Nearly half of it is devoted to bajra cultivation. Other crops are jowar, pulses and oilseeds grown on better lands where irrigation facilities are available. Nearly all the irrigation in this region is practised by wells and tube wells. In Pali district irrigation is possible due to the construction of a large number of tanks.

This region is rich in livestock wealth and three types of cattle breeds are found, namely the Hariana breed in the north, the Nagauri breed in the middle and the Sanchore breed in the south.

It is also rich in non-metallic minerals and good quality gypsum is produced in the districts of Jodhpur, Pali, Barmer and Nagaur.

The northern and central part of the region has slightly better system of railways as compared to the western arid region. There are larger number of roads in the eastern part. The southern part in Barmer district is poorly served by railways. The scarcity of water is the main problem in this region. With the supply of water either through canals or by developing underground water resources, the area can be developed into a good agricultural belt in this state.

Jodhpur (pop. 224,760) is the largest town in this region and occupies the central position on a rocky surface around a large ancient fort. The old city surrounded at present by a partly broken wall, was founded in 1458 by Rao Jodha, the head of the Rathore clan of Rajputs. The fort is built on an isolated rock eminence and dominates the city. About 8 km north of Jodhpur is the city of Mandor, the ancient capital of Marwar. Mandor is famous for extensive gardens and the cenotaphs of the former rulers of Jodhpur. Pali town (pop. 33,303) is located on the fertile tract and is mainly
an agricultural town. Didwana (pop. 13,547) and Sambhar (pop. 14,139) in the north and Pachpadra in the south are typical examples of salt lake towns. Makrana (pop. 17,270) is a world famous centre for marble quarries. Other towns in this region are Jhunjhunu (pop. 24,962) and Sikar (pop. 50,636) in the northeast and Jalore (pop. 12,382) and Sirohi (pop. 14,451) in the southwest.

3. Canal Region: The region is located in the northwestern part of the State, and includes the whole of Ganganagar district and northwestern part of Bikaner district. This is the typical region where the influence of man is very well marked. The whole of this area, although broadly falls in the western arid region, the construction of the Rajasthan Canal has made it a distinct unit. The main drawback of this area, had been the scarcity of water. The Gang Canal in Ganganagar district has changed the whole economy of this region. Due to water supply the land under bajra crop has decreased and other crops like wheat, barley, gram, pulses, sugarcane and cotton are grown. In the whole of Rajasthan, this district alone produces nearly 10 per cent of wheat, 20 per cent of barley, 23 per cent gram, 15 per cent of sugarcane, and more than half of the cotton of the State. The district economy is based on agriculture and agriculture based industries like sugar and cotton. With the completion of the Rajasthan Canal the northwestern part of Bikaner will have enough water supply and it is expected that northern agricultural area will extend towards the south also and the whole of this region would become the granary of Rajasthan. Ganganagar district is served by railways while Jaisalmer part of this region does not have this facility except at Bikaner which is connected by rail with Suratgarh in the north, and Ratnagarh in the southeast.

Among the important towns of this region are Ganganagar (pop. 63,854), Hanumangarh (pop. 17,909), Suratgarh (pop. 8,330) and Raisinghnagar (pop. 9,943) in the north. In the southwestern part there are no large towns yet. Small settlements like Birsilpur, and Lunkaransar are of importance.

4. Aravalli Region: The region covers almost the whole of Udaipur, southeastern part of Pali and Sirohi and western part
of Dungarpur districts. It is the most distinctive region in Rajasthan, predominated largely by the Aravalli range and hilly region in the southwest. The western boundary is marked by the edge of the hills and the eastern by the Banas and the Chappan Plains. In the northern part of the region the hills are about 50 km wide and the ranges branch out towards the southwest and southeast. The southeastern part of Sirohi is occupied by the principal ranges of the Aravallis. Guru Shikhar (1,727 m) the highest peak in Rajasthan is located in this part. The highest part of this region lies between Kumbalgarh and Gogunda northwest of Udaipur. This area is known as the Bhorat Plateau with an average elevation of about 1,225 metres. Rainfall varies between 50 cm to 100 cm mostly occurring during the monsoon season. The region has red and yellow soil in the northwest and ferruginous red soil in the southeastern part.

The area being hilly, it is only a small part of the land where irrigation is possible. In Udaipur nearly two-thirds of the land is barren and not suitable for agricultural use. Nearly one-tenth of the land is under forests and about 27 per cent is classed as culturable waste, used for pasture and tree crops. In about 23 per cent of the area, crops are grown. Among them are wheat, jowar, maize, barley, gram and oilseeds. Maize occupies nearly one-fourth of the total acreage.

The region is rich in mineral wealth. It has large deposits of lead and zinc in Zawar mines about 40 km southeast of Udaipur, beryllium mines at Bari Sikarbari, Selaka Gudha and Champa-Gudha in the north and south of Amet, mica in northern Udaipur, emerald between Deogarh in the north to Kankroli and soapstone, talc and steatite in Udaipur district. Other minerals like feldspar and asbestos also occur in this area. This region and almost the whole State is poor in coal resources and iron ore deposits. But the availability of power from Gandhi Sagar Power House will certainly help to develop it into one of the major mining areas in Rajasthan.

The most picturesque lake city Udaipur (pop. 111,139) popularly known as the “City of Sunrise” is the largest town in this region.
It is located west of Udaipur and Eklingji.

Nathdwara, another centre of pilgrimage is 26 km from Eklingji and 40 km from Udaipur on the Ajmer-Udaipur highway. The famous temple of Dwarkadhish is in Kankroli which is situated on the banks of Rajsamand lake about 16 km from Nathdwara.

Mount Abu (pop. 8,076) located in the Aravalli in the southwestern part of the region at an elevation of 1,219 m is the only health resort in the State. The summit of the plateau opens out into a valley about 13 km long and 5 km wide. The valley is covered with granite rocks and a luxuriant deciduous vegetation. Mount Abu is approached by a 29 km motorable road from Abu Road railway station.

5. **Eastern Agro-Industrial Region:** This region covers the districts of Jaipur, Ajmer, Sawai Madhopur, Bhilwara, Bundi, Alwar, Bharatpur and north-western part of Kota. It lies east of the Aravalli range and the western boundary of the region is marked by 50 cm rainfall line. The northern boundary is marked by the state boundary of U. P. and Punjab and the eastern and southern boundary by the Chambal ravines and the southeastern agricultural region. It is mainly drained by the Banas river and its tributaries.

This region has a wide variety of soils ranging from alluvium, red and yellow soil in larger parts of Ajmer and mixed red and black soil in eastern Bhilwara, Bundi and southwestern Tonk. The northern part is largely covered with alluvium except in the southern parts of Alwar and in part of Bharatpur where detached Aravalli hills are more prominent. The rainfall ranges between 50 cm to 100 cm and the soil is fertile.

The main economic activities are agriculture and industry. The percentage of land under cultivation decreases from north to south and west. Nearly three-fourths of the land in Bharatpur and Alwar
is devoted to crop cultivation. Among the important crops grown here are bajra, wheat, jowar, maize, gram and pulses. Where irrigation facilities are available some cotton and sugarcane crops are also grown. The area of land under crops is larger in Jaipur, Sawai Madhopur and Tonk, i.e. about 42 to 48 per cent, while in the districts of Bhilwara, Ajmer and Bundi it is between 21 to 37 per cent. Bhilwara being hilly in the west has a still smaller area available for agriculture. In this region land under bajra crop decreases towards the south where irrigation facilities are better and the soil is fertile. Other crops grown are wheat, jowar, barley, maize, gram and oilseeds. Cotton is grown in the Ajmer and Bhilwara.

Nearly 40 per cent of the people are cultivators and 70 to 90 per cent of the population live in rural areas. The general density of population increases from south to north ranging from 60 to 140 persons per sq kilometre. In Alwar and Bharatpur districts, the density of population is the highest, i.e. 142 persons per sq kilometre.

In addition to agricultural activity, this region has the largest number of industries located mainly at Jaipur, Ajmer, Kota, Bhilwara and Shahpura. The southern part of this region is poorly served by railways. Roads are the important means of communication.

The regional centre and the capital of this State, Jaipur with a population of 403,444 (1961) is located on the Delhi–Ahmedabad route of the Western Railways. Famous as the rose–pink capital of Rajasthan, it is one of the most picturesque cities in the world. The city has taken its name from Sawai Jai Singh, who founded it in 1727 and shifted the capital from Amber. It is located on an outlier of the Aravallis at the northern edge of the Aravalli Plain. The city is surrounded on all sides except the south by rugged hills. Most of the hill tops are crowned with forts and towers. In the northwest, Nahargarh Fort tops a precipitous hill. The national highway which runs from Alwar to Udaipur via Ajmer and a second highway from Bharatpur to Sikar, both pass through Jaipur. Ajmer town (pop. 231,240) occupies a central position in this
State. It is also developing as an industrial centre. It is located about 132 km southwest of Jaipur in a valley at the foot of the Taragarh hill which forms an imposing background. The crest of the hill rises to about 243 m from its base and is encircled by Taragarh fortress. It is a city of great historical, religious and architectural interest. The city derives its name from Ajayameru (the invincible hill). In the seventh century, Ajaipal Chouhan contributed much to the development and growth of the city and as such he came to be regarded as the founder of this city.

Bundi with a population of 26,478 (1961) is located 39 km west of Kota. The city is a gap town situated in a narrow and picturesque sandstone gorge. Kota (pop. 120,345) is located on the left bank of the Chambal river at the junction of an alluvial flat drained by the Chambal, Kali Sindh and Parbati rivers and flat sandstone plateau of Kota and Chittorgarh. Another important town in this region is Tonk (pop. 43,413) located on the right bank of the Banas river. Bhilwara (pop. 43,500) and Shahpura (pop. 12,165) are the other two small industrial centres. Alwar town is located midway between Delhi and Jaipur. It is about 161 km from Jaipur. The town is dominated by a fort built on a big conical hill and is also backed by a range of hills. Bharatpur has a population of about 49,766 (1961) and is famous for its historic fort. The town was founded by Maharaja Suraj Mal in the thirties of the eighteenth century. Dholpur (pop. 27,412) is another important town of this region famous for its glass industry, wild life sanctuary and historical associations.

6. **Southeastern Agricultural Region:** The area lying east of the Aravalli region and south of the Eastern Agro–Industrial Region is covered by the Southeastern Agricultural Region. It covers the districts of Banswara, Chittorgarh, Jhalawar and Kota.

The Vindhyan Plateau has an average elevation of 350 m to 580 m and it is formed of sandstones and shales. Part of this region in the Kota–Jhalawar area consists of stony uplands and also includes part of Kota–Bundi plateau. In this area mainly deep black soil is found. The Chambal river and its tributaries have formed an alluvial basin in Kota.
Plate 24—Umaid Bhawan Palace, Jodhpur. (See page 171)

Plate 25—Hawa Mahal (Palace of Winds), Jaipur. (See page 174)
Plate 26—Amber Palace near Jaipur. (See page 174)

Plate 27—Observatory (known as Yantra) at Jaipur. (See page 174)
Agriculture is the main activity in this region. In Kota and Jhalawar districts nearly 40 to 50 per cent of the land is under crop cultivation. Banswara and Chittorgarh being more hilly, the cultivated area in these districts ranges between 27 to 35 per cent of the land. Among the important crops grown are wheat, jowar, maize, gram and oilseeds. Cotton is grown on black soil areas in the districts of Jhalawar, Bhilwara and Chittorgarh, where irrigation facilities are available. With the completion of the Chambal Valley Project, the whole of this area would become an important crop producing region in the southeast.

It is poorly served by railways. Banswara and Jhalawar towns are not even connected by railway lines. Jhalawar and Kota have some good roads while the area between Chittorgarh and Banswara has not even these.

Jhalawar (pop. 14,643); Chittorgarh (pop. 16,888) and Banswara (pop. 19,566) are the important towns in this region. Banswara, a sixteenth century town is located on the extreme western edge of the Malwa Plateau.

7. **Chambal Ravine Region**: The region lies along the river Chambal where it forms the boundary between Rajasthan and Madhya Pradesh. Within Rajasthan the ravine lands run in a narrow belt ranging from 5 to 20 km in the Madhopur and Bharatpur districts. The ravines are not confined to Rajasthan side of the border, they extend in Madhya Pradesh and even in Uttar Pradesh up to the point where the Chambal river joins the river Yamuna.

The topography of the Chambal Valley in this State consists of hills and plateaus. The whole of this valley consists of the newer alluvial deposits. The general slope of the valley is towards the northeast.

Along the course of the Chambal river in Rajasthan, the uncontrolled water coming from the upstream has made large areas unfit for cultivation. In Kota and Bundi districts it has been estimated

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that 10 per cent of the area suffers from sheet erosion and 23 per
cent of the area is infested by ravines and gullies. In this area,
a large number of watersheds occur during the monsoon, resulting in
a heavy amount of run off which is accelerated by the heavy nature
of the soil. The area north of Bundi suffers from over flow during
the monsoon, which is due to the flow of water from Bundi hills.

This region is faced with the problem of soil erosion which
has affected the nature of vegetation. The water courses cross the
contours with their attendant gullies which increase in size and also
erode the good lands. Nearly one-fourth of the area is unpro-
ductive on account of good lands having been converted into
ravines. Erosion along the river is quite serious. Cultivated land
close to the ravines is constantly in danger of being washed away.
### APPENDIX

**STATEMENT OF COVENANTING STATES**

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Name of the Union Formed</th>
<th>Date of Formation</th>
<th>States forming the Union</th>
<th>Area (sq. miles)</th>
<th>Population Number</th>
<th>Revenue in Rupees</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Matsya</td>
<td>17.3.1948</td>
<td>1. Alwar</td>
<td>3,158</td>
<td>823,055</td>
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<td>2. Bharatpur</td>
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<td>4. Karauli</td>
<td>1,227</td>
<td>152,413</td>
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<tr>
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<td>Rajasthan (Former)</td>
<td>25.3.1948</td>
<td>1. Banswara</td>
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<td>9. Tonk</td>
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<td>356,495</td>
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<td>III</td>
<td>United State of Rajasthan (II and III)</td>
<td>18.4.1948</td>
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<td>1,926,698</td>
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<td>2. Jaipur</td>
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<td>3. Jaisalmer</td>
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<td>2,368,325</td>
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<td>V</td>
<td>United State of greater Rajasthan (I, II, III &amp; IV)</td>
<td>15.5.1949</td>
<td>1. Matsya</td>
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<td>VI</td>
<td>Rajasthan (I, II, III, IV &amp; V)</td>
<td>26.1.1950</td>
<td>1. Sirohi (excluding Abu Road Taluka)</td>
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<td>VII</td>
<td>Rajasthan (Reorganised)</td>
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<td>3. Sunel Tappa</td>
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