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FOREWORD

IN THE SCHEME for the 'India—the Land and People' Series, every aspect of the country is proposed to be dealt with by various experts and authors. It is, however, felt that a book ought to be available which gives a general outline of the country taking into consideration all the various facts that go to make up its personality. This will be highly useful as an introduction to India as a whole.

The present book has been prepared with that objective by Dr. George Kuriyan, who is one of our eminent Geographers and Scholars and who was also the Director of Delhi University School of Economics.

The book gives a broad outline of the various aspects of India. It is not intended to deal with details but give a bird's eye view. It presents a broad sweep covering the whole country. It will help the reader in making his first acquaintance with India.

NEW DELHI
February 15, 1969

B. V. KESKAR
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CHAPTER I

GENERAL INTRODUCTION

SIZE

The Union of India is a vast country which extends for a distance of more than 3,200 km. from Kashmir in the north to Cape Comorin (Kanyakumari) in the south and for a distance of more than 3,000 km. from Gujarat in the West to Assam in the east. Approximately, the North to South and East to West distances then, are about 1/10th the circumference of the globe. India covers an area of 3,274,000 sq. km. and, therefore, is one of the larger political units of the world, there being only six nations—the Soviet Union, Brazil, Canada, U.S.A., Australia and China—which are larger in area than India.

POPULATION

The population of India is nearly 500 millions at present, approximately, a seventh of the world population. Few people realise that one out of every seven persons in the world is an Indian. And equally well, how many realise that the population of India is larger than the population of the U.S.S.R. and the U.S.A.: put together? India has a population more than forty times the population of Australia, and more than ten times the population of Great Britain. It is, therefore, true to conclude that its very size and population would justify it being called a sub-continent\(^1\).

FRONTIERS

The shape of India is that of an irregular quadrilateral, the south western and south eastern sides abut on the ocean and rest on

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\(^1\) It must also be remembered that till recently (August 15, 1947) the size of India was even much larger, as it included the territories of West and East Pakistan which together account for 940,000 sq. km., the western being much larger in area (800,000 sq. km.) but with a smaller population of 45 millions and the eastern with an area of 140,000 sq. km. and a population of 57 millions.
long smooth coast lines with few large inlets or good harbours. To the northwest, north and northeast, India has land frontiers, northwest with West Pakistan, north with Tibet and northeast with East Pakistan, Burma and China.

Among the land frontiers, geographically the northern frontiers alone are satisfactory; they are the high Himalayan mountains, the world’s most elevated region, forming a natural bulwark between Tibet and India, far above the levels of permanent human habitation. There are only a few passes in this mountain mass and consequently, till very recently, they formed a frontier of separation between India on the one hand, and Tibet and China on the other. But, however, in October 1962, the Chinese were able to send a large number of men and munitions across these frontiers and no longer can anyone look upon the Himalayan mountains as an invincible barrier, created by nature, which no enemy can surmount. India is, therefore, forced to expend large amounts of money in the defence of this frontier region.

As contrasted with this, one finds that, the frontiers between India and Pakistan are artificial and unsatisfactory except in the south western parts of the western sector where the boundary passes through the Thar desert, an uninhabited area, along a real line of separation between the peoples of India and West Pakistan. Elsewhere in the Punjab, the frontier runs along a smooth plain which on standards of political geography is unsatisfactory. In East Pakistan the boundary line criscrosses the vast delta of the Ganges-Brahmaputra rivers, indeed, very unsatisfactory as it does not tend to separate the people living on either side of the frontier. It is, therefore, clear that the present land frontiers of India are, far from being geographic, or natural; on the other hand, they are essentially man-made.

**Position**

India lies entirely in the northern hemisphere between 8 degrees and 38 degrees north latitude, and the northern tropic, the tropic of Cancer, at latitude 23.5 degrees north, passes through the centre of the region, being 15 degrees from either end. But the
shape of India is such that, the area to the north of this line, \textit{i.e.}, between 23.5 degrees to 38 degrees north, is nearly twice the area which lies to the south of it. In other words, the area of tropical India (the region within the tropics) is only half the area of temperate (beyond the tropics) India. Thus, on the basis of its shape and location, India is much more a temperate than a tropical country. But all the same, India has always been looked upon as a tropical country for two widely different reasons: \(i\) because the climate of the entire country is dominated by the tropical monsoon and \(ii\) because the culture of India is totally different from that of the temperate countries of western civilisation. Although Britain had political suzerainty over India for nearly 200 years and although it stamped India with many elements of its culture and civilisation, yet it is doubtful if it has significantly altered the culture core of India. It is true that India took to many British institutions like the English language, English Common Law, various customs and manners associated with western Europe, the costumes of the men particularly in urban areas being typically European. But, however, the Indian woman, because of her conservative traditions stuck to her multi-coloured sari and would not imitate her European sister’s skirt, indeed, a matter of great pride. The Indian home in spite of its close association with Britain, has remained securely Indian.

The Indian Ocean is the only ocean in the world which is named after a country. Obviously, this reflects the very great importance of India in the early days when these oceans got their names. India lies in the northernmost part of the Indian Ocean, and, therefore, the direct and shortest route from Europe to the Far East must necessarily skirt the shores of India. The lack of islands in the North Indian Ocean and the absence of any other country around its shores with a wealth and population comparable to that of India, makes India even today, by far the most dominant among the countries fringing the Indian Ocean.

\textbf{Routes into India}

The land routes into India are only from the north, northwest
and northeast. To the north of India are some of the highest mountain regions of the world, and the northern boundary of India lies almost wholly in regions far above the levels of any permanent human habitations. "Backed as they are by the huge and lofty plateau of Tibet, the Himalayas are beyond doubt the most formidable natural frontier in the world."1 and till A.D. 1962, this northern frontier with Tibet had been of very little importance in the foreign political relations of India.

"The mountain chains and elevate passes at the eastern entrance into Tibet from China, far exceed in natural strength and difficulty those which intervene between the plains of India and Lhasa. It must, therefore, be admitted that it is possible for an unopposed Chinese force to invade India by eastern Tibet, possibly even by the valley of Assam. Admittedly the natural difficulties for such an expedition are extremely grave, but it is a contingency for which adequate preparation must be made, however remote it may appear to be."2

To the northwest of India today, the frontier is with Pakistan, a creation of 1947, but the real and natural frontier, lies to the west of Pakistan in the mountain formations of Afghanistan and Baluchistan. It is only in the extreme northwest of the Indian subcontinent, about the hinterland of Kashmir and beyond, that any serious weakness could be found in the natural chain of defensive walls to the north of India. The great mountain chains here become both narrow and shallow; they are no more than 500 km. wide between the Indus Valley and the plains of Turkestan and a little to the west of its narrowest part are a few passes through which it is possible to round the western end of the Hindukush mountains without ever having to ascend an altitude more than 1600 metres. The base of all these northerly passes of Malakand,


2 See author's article on 'India, a Study in Space Relations' in *The Indian Geographical Journal*, Vol. XVII, No. 3, p. 209 (April 1942). This article was written when there was a threat of Japanese invasion in 1942 and it is really tragic that the country was not prepared for the defence of the frontier even 20 years later, in October 1962, when the Chinese actually carried out this threat and put it into action.
Khyber, Tochi, Gomal and Kohat, the so-called Kabul approaches, lies in Badakshah so that their chief characteristics as gates into the Indian sub-continent are common to all.

Afghanistan has always held the landward gates of India through which the great restless human tide has ever been on the move. Men, literally nations, have passed through them, the dynasties in India have been changed and her destinies relapsed time after time by the facilities of approach which they have afforded. The invader from Central Asia has throughout the centuries pushed his way towards the plains of India over these passes and it is in their deep and tortuous valleys that are found bodies of hardy and fanatical tribesmen, well armed and fearless, unable to extract more than the barest pittance from the stony ground where they live and quarrel, but having before their eyes the tempting prospect of booty from the passing caravan, or from a raid into the settled districts below them.\(^1\) They are one of the hardiest race of fighters in the world, Muslim by religion, highly skilled in the use of ground and for the most part, armed with rifles. Their trade, and indeed, their recreation from time immemorial has been raiding their richer and more peaceful neighbours. "Should they rise simultaneously, they could put half a million men into the field whose requirements are small, no great supply columns, no bases, nothing really vulnerable from the air".\(^2\) They are completely illiterate and always easily roused to religious frenzy against the infidels.

Further south, among the land routes, the highways of Herat and Seistan converging on Quetta form the only avenues for military approach that are neither barred by difficulties provided by nature not commanded by the sea. Owing to the peculiar geographical conformations of the Kirghar and Suleiman ranges, Quetta holds the key for the approaches from the west. Historically it seems strange that compared with the Kabul approaches, so little use has been made of this open highway, but probably the main reason for this was the barrier of the Thar desert, which

\(^2\) Sir Philip Chetwode. *Journal of the East India Association, 1936*, p. 161
however, can be easily crossed by rail today. Knowing the nature of the country which intervenes between Quetta and Herat to the northwest, or between Quetta and the Arabian sea coasts on the southwest, it is impossible to indicate any possible enemy lines of advance on Sind or the southern parts of West Punjab that would not be dominated by Quetta. Quetta lying at the head of the Bolan pass is easily one of the most important gateways into the sub-continent, a vulnerable outpost liable for an air or land attack, a real citadel for the frontier system of defence.

Thus it will be seen that the mountains to the northwest of India have a large number of shallow passes in them. They can be divided into two groups: (i) the Khyber, Malakand, Tochi, Gomal, etc., all of them in the north, leading from Afghanistan into the plains of the Punjab and (ii) the Bolan pass in the south leading into Quetta. The pages of history reveal how the facilities of approach offered by these northerly passes have determined the fate of various dynasties in India, literally nations have poured through them and the dynasties in India have changed.

On the other hand, on the northeast side the frontiers are in the jungle clad Arakan Yomas\(^1\), hardly 3,000 meters in elevation, but so completely forested as to make them an effective barrier, except where a river like the Brahmaputra cuts through them. The frontier of India with East Pakistan is one which, as has been pointed out, runs along the delta, an intensively cultivated agricultural region, in which there is not even a small mound or hill, which could be used for purposes of defence.

Thus, it is found, on a careful analysis, that the natural frontiers of India lie far beyond its political frontiers with Pakistan, both in the West and the East. The more facile land routes which lead into India from abroad, through the passes in the mountains, are all in what is now Pakistan territory, with the net result that should any enemy invade India, it may be necessary for India to defend herself not by trying to protect her own really indefensible frontiers, but by proceeding far beyond them. Because of the absence

\(^1\) Yoma means mountains in the Burmese language.
of any natural citadels in them, the nation will do well to attempt to defend herself at the natural frontiers, which lie beyond Pakistan.

The earliest immigrants of civilised man into India were probably the Dravidians, of whom we have no written records. It is believed that they migrated into India from the Tigris valley along the narrow Makran coast. This was followed by a series of others, the last, who came in by the Kabul approaches in the pre-historic days, were the Aryans; and later in historic times, others, *viz.*, Greeks, Parsees, Christians and Mohammedans have come into India, but all from the west. From India, there have been no return migrations westwards. But on the other hand, Indian influences have spread eastwards. Buddhism, a religion of Indian origin, conquered the whole of eastern Asia. The Colas had an empire in the East Indies and many other Hindu characteristic cultural traits (*e.g.*, the Bali dances) are found even today in the distant parts of the Far East. Why is it that Indian influence spread only eastwards, but did not spread westwards in spite of the fact that there has been an enormous amount of cultural contact between the west and India? Is it because one of the greatest tenets of Hindu philosophy (also Buddhist), the tenet of *Ahimsa*, ‘Thou shall not kill’ cannot thrive in the desert, while in the agricultural regions of the east, it can easily spread itself, to become the dominant trait? Or, is it because the constant winds of the southwest monsoon created a mental fear among the peoples of the west coast preventing them from venturing to the west, opposite to the direction of the monsoon, while it gave the necessary impetus to the people of the Coromandel coast to push eastwards. The northeast monsoon gave the Tamil sailor a guarantee for effecting the return voyage, *i.e.*, a possibility to go out eastwards on the southwest monsoon and return home on the northeast monsoon. Surprisingly it is the East Coast man, who alone was familiar with the northeast monsoon in the Bay of Bengal and he alone ventured to the East.
CHAPTER II

PHYSIOGRAPHY

India is a land of severe contrasts in more ways than one. Climatically, in the west is the dry desert of Rajasthan, extremely arid, with an average rainfall not much more than 10 to 13 cms., while in the east lies Chirrapunji, one of the world’s wettest spots, where it is in excess of 1,125 cm. Likewise, the winter temperatures are well below zero in parts of Kashmir while Ganganagar in Rajasthan may have a temperature approximately 50 degrees C. in July; and in Cochin in the south, throughout the year, the temperature is in the vicinity of 30 degrees C. There are few parts of the world where the climatic contrasts are more significant.

The physiographic features are perhaps equally unique, and so are the rocks, their age, structure and formation, being as widely divergent as they can be. On the one hand occur the vast swampy region of the Sunderbans, an area of tidal waters, while on the other are the most elevated parts of the world in the Himalayas with peaks like Everest, Kinchinjunga, etc.

On considerations of relief, structure and rock formations, it is possible to divide India into three units:

(i) Peninsular India, a very ancient land mass;
(ii) The extra peninsular mountains of India i.e. the mountains of the Himalayas and associated ranges, a very young folded group of mountains, and
(iii) The Indo-Gangetic lowland, the great plains of India between these, an extremely young land-mass dominated by its low-lying, horizontal topography.

(i) The Peninsular region—has an average elevation ranging from 300 to 2,000 metres, generally sloping from west to east. It is a very ancient table-land, called Gondwanaland1 which from

1 A name derived from Gonds, the most primitive peoples living in Andhra Pradesh.
The demarcation of the Gujarat West Pakistan Boundary in accordance with the Indo-Pakistan Western Boundary Case Tribunal Award is in progress (1968)
the earliest times (Cambrian) has been above the level of the sea, and therefore, has been subjected to sub-aerial denudation. Its mountains generally are the relic type of mountains, *i.e.*, mountains composed of harder rocks which have withstood the forces of denudation more effectively than the surrounding regions. Because of their great age, all the rivers have been able to aggrade themselves and have built up broad, shallow valleys.

But in some parts as in the northwest Deccan, there have been volcanic eruptions; large areas extending from the Arabian Sea coast in the west, as far east as Nagpur and from Gujarat in the north, to Belgaum in the south, have been covered over with a thick mantle of volcanic magma. The Peninsular block as a whole has remained stable, resistant to folding, but occasionally yielding to faults.

(ii) *The extra-Peninsular Mountains*—These are composed of a group of very young folded mountains extending all over the north of India as the Himalayas and their associated ranges. This area was once covered by a sea, the so-called midland sea of Tethys, lying between the two ancient land masses of Angaraland\(^1\) in the north and Gondwanaland in the south.

About 70 million years ago, the sediments which were brought as deposits into this sea, were subjected to powerful compression, either because the land mass of the north (Angaraland) moved southwards and westwards, or the ancient table-land of the south (Gondwanaland in which Deccan is centrally situated) moved northwards and eastwards. In any case, whether Angaraland moved southwards or Gondwanaland moved northwards, or both moved towards each other, the physical consequence would be the same; the intermediate area between them would be crumpled up. The sea of Tethys, in between, was as a result squeezed and crushed, and a series of folds were formed in the region, exactly in the manner in which a taut sheet of paper would be folded and crumpled if its ends are made to approach each other. This analogy can be elaborated still further and instead of a single sheet,

\(^1\) Constituting the ancient plateaus of northeast Asia, extending as far as Finland in the west.
the case of a ream of paper can be considered with a large number of sheets, each one representing a sedimentary deposit and kept in a taut position by the ends of the sheet remaining as far apart as possible. If either end is then made to approach the other, or both ends move towards each other by the application of pressure, then the sheets of paper will start getting squeezed, crushed and crumpled, the top sheets bending more than those at the bottom. Eventually, with continued application of pressure, a series of folds will be formed, one behind the other. Something like this has happened in the formation of the Himalayas and there is reason to believe that these movements are still in progress, though feeble. It is not surprising, therefore, that this is a scene of frequent seismic disturbances and tragic catastrophes. Because the region is young and has been up-lifted from the sea only in very recent times, the rivers are all youthful, actively eroding their beds and carving out steep valleys for themselves. The Himalayas, running as three parallel ranges, extend from Kashmir in the west to Assam in the east, for a distance of nearly 2,400 km. with a width ranging between 160 to 500 km. They are:

(a) the Siwalik foot-hills or the outer Himalayas;
(b) the lesser Himalayas or the Middle Himalayas; and
(c) the greater Himalayas or the Inner Himalayas.

It is only in the Inner Himalayas that one finds the high snow clad peaks, like Everest, Kinchinjunga, K2, Godwin Austin, Nanda Devi, Kedarnath, Kamat, and others; their average elevation being more than 6,000 metres. To the south of them lie the middle Himalayas, with a mean elevation of about 5,000 metres. And it is in them that one finds the famous hill stations of Simla, Nainital, Mussoorie, Darjeeling, etc. The outer Himalayas or the Siwalik hills with an average elevation of 1,000 metres are not a continuous range like the other two. These seem to be the foot hills created by the very sediments brought down by the great rivers from the Himalayas.

(iii) The Great Indo-Gangetic Lowland was probably a de-
pression which has subsequently been filled up by sediments brought by the rivers, both form the Himalayas and from the Deccan plateau. These extensive deposits have produced a monotonous plain, almost horizontal, through which the great rivers, the Indus, the Ganges and their tributaries meander sluggishly to the coast. The alluvium, generally hundreds of metres thick, effectively conceals the solid geology of its floor.

Thus, one can distinguish three units in the physiographic framework of India, the peninsular table-land, the extra peninsular mountains of the Himalayas and their associated ranges and the Indo-Gangetic plains between them. Rajasthan appears to be a transitional zone with the characteristics of both, the peninsular and extra peninsular regions.

A brief description of each of these regions follows:

**THE MOUNTAINS OF THE PENINSULA**

The Peninsular region of the Deccan table-land has a few mountains in them like the Aravallis, the Western and Eastern Ghats, etc., each of which deserves some mention.

*The Aravallis:* They are the oldest of all the mountains in India and probably one of the oldest in the world, extending for a distance of 700 km. from Gujarat to Delhi. They are typically folded mountains which are believed to have been formed at the close of the Archaen era—from almost the beginning of times—that is, they have remained as a mountain system throughout much of the greater part of the earth's history. Obviously, their dimensions were much greater when they were formed, probably even more gigantic than those of the Himalayas of to-day. Their highest peak now attains a height of nearly 1,300 metres, which must have been far higher in ancient times. They form the major water-shed of north India, separating the drainage of the Bay of Bengal from that of the Arabian Sea.

*Western Ghats:* They are the conspicuous group of mountains running parallel to the coast from the Tapti valley to Cape Comorin (Kanyakumari) enclosing a narrow track of coastal land. The Western Ghats from the Arabian Sea coast appear to be an
imposing mountain, but when seen from the plateau, they do not appear to be mountains at all. In other words, the slopes are very steep to the Arabian Sea in the West, while the land slopes very gently to the table-land of the East. From the coast into the interior, the routes across the Ghats are difficult, except where there are well-defined passes; and there are three of them, the Thal Ghat, Bhor Ghat and Palghat, through which the railways run, connecting the west coast with the interior of the country.

The Western Ghats which lie within a stone-throw of the Arabian Sea form the water-shed of the Peninsula, from which rise the major rivers, the Godavari, Krishna, Cauveri, etc., and flow across the entire Peninsula, south-eastwards to the Bay of Bengal. Furthermore, on a careful study, it is found that in the region of the Western Ghats alone in the Peninsula are rivers cutting deep valleys and deepening their beds; in other words, actively eroding their beds to become powerful agents of erosion. Obviously, then, these regions must have had a recent uplift, so that the drainage has not had time to adjust itself to the altered conditions.

*The Eastern Ghats* are not a continuous chain of mountains like the Western Ghats but are a group of isolated hills which have neither a structural unity nor physiographic continuity. The name Eastern Ghats, is, therefore, a misnomer and the various mountains and hill groups must be treated as independent units. The rivers which drain the interior of the Peninsula enter the Bay of Bengal, cutting through the discontinuous structure of the Eastern Ghats to form the great deltas along the east coast.

In addition to this significant difference between the two Ghats, that is, the Western continuous and the Eastern discontinuous, there is one more very important point to remember, namely the Western Ghats lie in a direction perpendicular to that of the south-west monsoon while the Eastern Ghats are almost parallel to it; this results in producing a tremendous difference in the deposition of rainfall during this monsoon season; the west coast receives a copious amount while the east coast is practically dry.

The two Ghats join together in the Nilgiris plateau forming the apex of the Peninsula, where they attain their highest elevation
at Doddabetta (2,633 metres). South of the Nilgiris, but separated from them by the well-defined Palghat Gap, the line of the Western Ghats is continued through the Cardamom Hills of Kerala to the southern most limits of the continent in Cape Comorin (Kanyakumari), with the highest peak of the Peninsula at Anaimudi (2,695 metres).

The Vindhya Mountains: The Vindhya Mountains run from the western shores to the river Jumna. To the north of them there are no steep falls, no well marked spurs or steep valleys. Southwards, however, they slope abruptly to the bed of the Narmada presenting the characteristics of a mountain range as seen from the river. They appear to be a line of prominent escarpments with an altitude between 800 to 1,400 metres, but taken as a whole, the system offers no formidable frontier, since the crests are not much more than 150 metres above the general level of the surrounding land. The Vindhyas are continued eastwards by a similar scarp known as the Kaimur range, an area of broad flat elevations where the rivers occasionally run deep. South of the Vindhyas and roughly parallel with them are the Satpura\(^1\) Mountains extending from Rajpipla in Maharashtra to Rewa in Bihar. Unlike the Vindhyas, some parts of the Satpuras show proof of folding and uplift. The Satpuras form the major water shed of the Peninsula. The Narmada and the Son rise on their northern slopes while the Tapti, Wardha, Wainganga, Brahmani and others drain their southern slopes.

The Vindhyas and Satpuras together constituted a main dividing line between North and South India. They present steep south facing cliffs, the result of linear faults and the valleys so formed have now been usurped by the Narmada and Tapti.

Till recently, it was believed that the mountains of South India were entirely of the relic type but doubts have now been raised about the validity of this and it looks as though several of them are typical horsts. For example, there is a sheer drop cliff of about 2,000 metres altitude in the Nilgiri massif above the peneplain

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\(^1\) Sat in Sanskrit means seven and pura, mountains, Satpura = seven mountains.
of Coimbatore. Another example is the cliff of the Palnis, at Kodaikanal overlooking Madurai. Similar systems of fractures intercept the terrain of South India; some of them form sunken basins, as in the case of the Godavari, Mahanadi and Damodar Valleys, indeed, a matter of special economic benefit to India because of the coal measures which were deposited and preserved in them. The Malabar coast is a perfect straight line for a large part of its course, probably a line of fracture, identical in origin\(^1\) to the Makran Coast in Baluchistan. Parallel to the Makran Coast are the two rifts of the Narmada and Tapti rivers and, surprisingly, they are the only two large rivers flowing westwards, across the Peninsula. It is not impossible that the general easterly drainage of the Peninsula is due to some tilt given to the rigid block of the Deccan at the time the fault on the west coast was being formed and the same may have resulted also in producing the water falls in the Cauveri at Sivasamudram, the Paikara river at Paikara, the Jog falls on the Sharavati, all of which have now been harnessed by man for the production of electrical energy. Thus, one finds that the Peninsular region is not totally free from earth movements although it has been and is still, a rigid block. Perhaps it is because of its multiple basin faulting that it has attained equilibrium, as a result of which it enjoys reasonable freedom from seismic disturbances although its fringes may still be liable. This block mountain and fault basin structure is also important for the economic exploitation of the minerals of the region. For example, the mica sheets of Bihar and Nellore are free from buckling; the coal seams in the valleys of the Damodar, Godavari and Mahanadi rivers are uncrumpled and undisturbed underground occurrences; the rich aluminious deposits are found as caps on hills of laterite throughout the southern parts of the Peninsula and besides these are also the world famous ores of manganese and iron, occurring in close proximity to each other, at or near the surface, in and around the Chotanagpur plateau.

\(^1\) And hence its liability to be occasionally subject to seismic disturbances, as in the recent earthquake of December, 1967 which seriously affected Koyna.
RIVERS AND VALLEYS

It has already been mentioned that the main drainage of the Peninsula is towards the east and southeast. But on a careful analysis, one finds that there are at least four main directions of flow:

(i) Mahanadi, Godavari, Krishna, Cauveri, and several smaller rivers draining southeast into the Bay of Bengal.
(ii) The Narmada and the Tapti flowing west into the Arabian Sea.
(iii) The rivers like the Son, Chambal, Betwa, Damodar, etc., flowing northeast towards the Ganges.
(iv) The numerous small streams that drain directly westwards from the Western Ghats into the Arabian Sea.

The bulk of the drainage of South India is to the Bay of Bengal, effected through the main rivers of the Mahanadi, Godavari, Krishna and Cauveri. All these rivers are in the adult stage, with low gradients and their channels are almost reaching base levels. At their mouths, the larger rivers have all built up deltas. Because of their low gradient, the velocity of the streams, except in times of flood, is very little and consequently the capacity of the streams to carry their loads is low; and they themselves become agents of deposition. Occasionally, one does find in their upper courses some water falls like those of the Cauveri at Sivasamudram, the Paikara in the Nilgiris, etc. Various explanations have been offered to account for this, but it is certain that this is due to recent earth movements, so recent that the rivers have not had the time to erode and flow in grade in the southwestern parts of the Peninsula.

The Peninsula admittedly is an ancient land-mass having remained above the level of the sea from time immemorial. This would normally lead one to expect that the water shed would lie in its central part like a spine, across the entire length from south to north, with the rivers flowing out equally on both sides of this central ridge. Surprisingly however, one finds that the rivers draining this
region have their origin, not in the centre of the Peninsula but at the western extremity. Indeed, this is in itself an anomalous situation, even more so, since the rivers that drain into the Arabian Sea are not only more heavily charged with water but also have greater velocities because of their steeper gradients. They should, therefore, have been able to deepen their valleys and eat up their heads more effectively than the rivers which flow eastwards, in such a way that the water-shed separating the drainage of the Bay of Bengal from that of the Arabian Sea should be located farther east of the centre of the land-mass rather than west of it. One hypothesis that has been put forward is, that adjoining the western parts of the Peninsula there was a similar land mass, with the Western Ghats running somewhere near the centre. This western portion, either sank into what is now the Arabian Sea, or a fracture was formed along the Western Ghats which resulted in the two parts drifting apart. It is difficult to say precisely as to which of these two views is correct, but increasing evidence lends support to the latter.

Likewise, it has been found that the Narmada and Tapti are not flowing through valleys which they themselves have created but through fault valleys which were probably formed by the Himalayan uplift. This movement might have been followed by the Peninsular block tilting eastwards slightly, thereby resulting in the drainage towards the east and southeast. It is believed that the Narmada and Tapti, till recently, had a joint exit, the Narmada flowing southwards through Khandesh to join the Tapti.

Godavari: The Godavari rising in the Nasik Hills in Maharashtra state and flowing approximately for a distance of 1,500 km. in a south easterly direction, receives a series of tributaries like the Wardha, Weinganga, and Penganga. In the most inaccessible and untrodden region of the Peninsula, through which another of its tributary, the Indravathi flows, lies the home of the Gond race, one of the aboriginal Dravidians, whose origin is still a matter of dispute and who even today use stone implements and erect stone monuments, occupying a very low rung in the ladder of
PLATE I. Backwaters of Kerala
PLATE II.  View of Mount Everest, Himalayas

PLATE III.  Furrowing the Field
Physiography

civilization and from whom the name Gondwanaland has been assigned to the ancient table-land of the Deccan. In most of the streams that flow into the Godavari, gold washing is, or has been an active industry. About 100 km. from its mouth, the Godavari flows through a narrow gorge, hardly 200 metres wide, near Bhadrachalam, where an anicut approximately 4 km. long has been constructed to regulate the flow of water into the delta to make it the greatest rice granary (about 250,000 hectares) of the south.

The Krishna rising near Mahabaleshwar at a distance of 65 km. from the west coast flows in a southeasterly direction under conditions similar to those of the Godavari. It receives as its main tributary the Bhima from the north and the Tungabhadra from the south. At Vijayawada (Bezwada), the river spreads out into the delta and an anicut to regulate the flow of water has been constructed here to create a rice granary in the delta, second only in size to that of the Godavari further north. The Tungabhadra dam recently constructed in its upper reaches near Hospet, will, when fully developed irrigate about 800,000 hectares, especially in the poverty stricken areas of Raichur, Bellary and Anantapur, besides generating 72,000 kw. of hydro-electrical energy. And a still larger dam, the Nagarjuna Sagar (near Vijayawada) is under construction and when completed will give additional irrigation for 809,000 hectares and generate 220,000 kw. of electrical energy.

The Cauveri is known as Dakshina Ganga or the Ganges of the South. Traditionally its source lies in Lake Manasarovar in the Himalayas in conjunction with those of the Indus, Ganges and Brahmaputra and in sanctity, it is second only to the Ganges. Actually it rises in the hills of Coorg and flows southeasterwards. It is the one river which has been harnessed for irrigation from ancient times and it is estimated that nearly 95% of its surface-flow is put to use before it is allowed to waste itself into the Bay of Bengal. The Grand anicut, over 300 metres in length, 15 to 20 metres in breadth and 5 to 6 metres in height, stretching across the whole width of the river was probably constructed as early as the second century A.D. and it commanded an area of about 25,000 hectares for irrigation. A modern anicut about 750 metres
in length has been constructed in its main distributary channel of the Coleroon. Up the river, in the State of Mysore, as many as twelve dams have been constructed to intercept its flow and about 35 years ago, the Mettur dam was constructed at Mettur, in the Salem District of Madras State, for the dual purpose of irrigation and power generation, the first of its kind in India. In its passage, the river encloses three sacred islands, (i) Seringapatam, (ii) Sivasamudram and (iii) Srirangam. It was at Sivasamudram that the first hydro-electric power station in Asia was constructed in the beginning of this century.

In addition to these main rivers, there are a series of smaller rivers like the Pennar, Palar, Vaigai etc., all of which contribute to the alluvial wealth and rice cultivation of the east coast.

(ii) Among the west-flowing rivers, the Narmada and Tapti are the longest and the most important. In the order of sanctity, the Narmada ranks as the third, inferior only to Ganga and Dakshina Ganga. It was considered a matter of supreme merit for a pilgrim to walk from the extreme west of the Vindhyas to the source of the river on Mount Amarkantek and back to the Cambay Gulf, on the one bank eastwards and on the other westwards, and no wonder, both its banks are studded with innumerable shrines. In its upper reaches where it is confined between the scarps of the Vindhyas and Satpuras, the Narmada is a magnificent stream of clear water, occasionally breaking into cascades and leaping into water falls, the one at Marble Rocks near Jubbulpore being the most picturesque. Once it leaves its mountain path, it widens itself and below Broach it forms an estuary approximately 13 miles in width. The approach to the port is entirely at the mercy of the tides. For country boats, the river is navigable for a distance of about 100 km.

(iii) Along the northern border of the Peninsula, there are several rivers which have their origin in the Vindhyas and Satpuras; the most important of them are the Chambal, the Betwa and the Son, all of which are characterized by seasonal flows, large and powerful in the monsoon season but becoming puny and insignificant in the dry season.
(iv) The numerous small streams that drain westwards into the Arabian Sea are in a youthful stage, all of them active eroding torrential streams. Many of them abound in rapids and waterfalls, e.g. the Jog falls on the Sharavati (nearly 280 metres in height, one of the tallest in the world) which has been harnessed for the generation of electricity, the Yenna falls of Mahabaleshwar (nearly 200 metres high) etc. These westerly flowing rivers have a high head erosion, effectively eating back their heads eastwards, continually pushing the watershed also eastwards, a process that will continue till the watershed has receded from its present asymmetric westerly position to the middle of the Peninsula, to make the gradient along the channels on either side, approximately equal. Does this not provide some evidence that the asymmetrical lie of the Western Ghats is of recent origin, and that it occupied a central position formerly, when there was a large area of land contiguous to it on the west, which disappeared recently, either as a result of sinking or drifting apart?

Coast Line: The coast line of the Peninsula is uniform and regular and, therefore, endowed with very few natural harbours. For the greater part of its length, it is sandy and the sea shallow. The western sea board has a larger expanse of lagoons and backwaters. Both the west and east coasts have low submarine platforms scarcely 100 fathoms deep. Raised beaches at an altitude of 30 to 50 metres are found fringing these coasts suggesting a recent uplift of land.

The low lying plains bordering the sea, linking the entire length of western India from Kathiawar to Cape Comorin (Kanyakumari), represented in medieval ages, most of the strength and wealth of India. Even today, they are noted for their specialised crops of spices—Pepper, Ginger and Cardamom. Ancient ports and factories—Arab, Portuguese and Dutch—are to be found scattered along the coast line; and among the palm groves of Kerala are the many relics of the days going back to those of King Solomon, when the entire commerce of the east was centred here. The backwaters and lagoons in the south have now been linked together to permit continuous navigation for country-craft, and a journey
in such a boat along these backwaters with the cocoanut palm bending in all directions in quest of solar light, and the tiny, isolated huts of the fisher folks in the background thatched with cocoanut leaves, lend an enchanting air to make this a tropical paradise.

Between the southern hills and the eastern coast is an expanse of low land, with an average width of 150 km. forming the richest regions of Tamil Nad (Madras) and Andhra Pradesh. Rain fall here is much less than in the west coast, but with the highly developed system of irrigation with which it is effectively coupled, it is sufficient to ensure remarkable productivity. The east coast is studded with lands of palm and rice cultivation, with magnificent temples and decorative Hindu monuments of pristine purity, and with scores of ancient centres of culture and industry.

The deltas of the Godavari and Krishna in Andhra Pradesh and of the Cauveri in Tamil Nad, together form the granary of the five \(^1\) southern States of India. To the north lies the Mahanadi with another system of delta irrigation contributing to the wealth of Orissa. At less frequent intervals, in these eastern coast lands are found lagoons, similar to those of the west coast. Wherever the delta occurs, wide banks and shallows push themselves out into the sea, to render the approach to the ports impossible, even to ships of moderate size. Where no such silt formation exists, the open roadstead affords fair and close anchorage.

**The Extra Peninsular Mountains**

The mountain ranges of the extra peninsular region owe their origin to a series of earth movements which proceeded from outside India. They are due to the powerful thrusts developed by the drift of the Peninsula to the north which has resulted in the production of folds, one after the other, in the crust of the earth. The shape of the Himalayas in the form of an arc may be probably due to the maximum push offered at the two ends, in the northwest by the Aravallis and in the northeast by the Assam ranges, both acting as two extended arms pushing out the extremities, while the central area sagged in a crescentic form. It is thus

\(^1\) Andhra Pradesh, Madras (Tamil Nad), Mysore, Kerala and Pondicherry.
postulated that Gondwanaland moved northwards and Angaraland remained stationary. As a consequence of this movement, the area in between was crushed and crumpled, and fold after fold was developed resulting in an uplift of the region and creating the great mountain ranges of the Himalayan group.

The Himalayas are not a single continuous chain but a series of parallel ranges intersected by deep valleys and broad plateaus. Their width is between 160 to 400 km. and the great Himalayas, the central range, is approximately 2,400 km. long. Surprisingly, the individual ranges present a steep gradient towards India and a much gentler one to Tibet, indeed, a fact of great political and strategic importance from the point of view of defence. Because of the great difference in the steepness of gradients it is much more difficult for the Indian soldier to climb up to the top of any of these individual ranges than it is for his Chinese counterpart. Furthermore, there is a difference in vegetation. The southern slopes being too precipitous do not have anything but a sparse jungle while the northern slopes are clothed with thick dense forests, again making the conditions for the Indian climber more difficult than for the Tibetan. The eastern Himalayas of Nepal and Sikkim rise abruptly from the plains of Bengal and suddenly attain great elevations; and within a very short distance from the foot of the

1 The earlier geologists had postulated that Gondwanaland was stationary and that Angaraland was the mobile land-mass, moving southwards and westwards. They had explained the crescentic shape of the Himalayas as the product of frictional resistance, the assumption being that the ends of any moving mass, because they were subjected to greater frictional resistance, would move less than the central parts of the mass, as in the case of a medial moraine. The centre having moved more to the south than the ends, produced, therefore, the arc of the Himalayas. But then it must be remembered that similar crescent shapes are found in the mountains of Japan and the east coast of China and South East Asia, all of them practically belonging to the same age as the Himalayas. If the Himalayas are due to the southwestward movement of Angaraland, then at the same time, Angaraland has also moved eastwards and southwards to produce the mountains of Japan, East China and South East Asia. This should have resulted in the cracking up of Angaraland, for which there is no evidence at present and hence the conclusion that Angaraland has remained stationary while Gondwanaland moved northwards and eastwards.
mountains are the remarkable peaks of Everest and Kinchinjunga, while the western Himalayas of the Punjab and Kumaon rise gradually from the plains through a series of lesser ranges, their peaks of perpetual snow being 150 to 200 km. in the interior.

The magnificent splendour of the Himalayas has received eloquent and glorious tributes for their beauty from time immemorial, not only from poets like Kalidasa, but equally well from kings and sages, all of whom looked upon them with reverential awe, for it was believed that in their peaks and hollows they harboured the sacred abodes of the Gods. Studded as they are with sanctified shrines of all sects and groups, they indicate in some measure how they have been the ultimate goal of all pilgrims from the four corners of the country.

On consideration of relief, the Himalayas can be classified into three parallel zones:

(a) the Siwaliks or the Outer Himalayas,

(b) the Middle or the Lesser Himalayas, and

(c) the Inner or Greater Himalayas.

(a) The Outer Himalayas or the Siwalik ranges form a system of low foot hills about 1,000 to 1,500 metres in height with a width ranging from 10 to 50 km. In the western part there are bare boulders alternating with thorn forests, with shallow streams liable to large fluctuations in volume, while in the east, in Nepal and Bengal, the foot-hills merge into piedmont slopes, the Terai and the Duars, both ill-drained, and till recently Malaria-ridden. They are formed of gravels brought down from the mountains behind; and are dissected into a series of escarpments and open valleys (Duns). In the upper parts, they are extensively clothed with a thick forest cover, a perfect paradise to the Shikari is quest of big game hunting.

(b) The Lesser Himalayas or the middle Himalayas are closely related to the Greater Himalayas behind, but of lower elevation, between 3,500 to 5,000 metres with an average width of about 80 km. It is here that the contrasts between the southern and northern slopes have become spectacular, the south bare and rugged, the north clothed with a thick vegetative cover. They embrace in them all the famous hill resorts, Simla, Nainital, Mussoorie, Darjeeling, etc.
(c) With an average elevation of about 6,000 to 7,000 metres, the Greater Himalayas form the innermost high ranges, rising far above the limits of perpetual snow. They have in them the great peaks of Kamat—7,755m. (26,447 ft.), Annapurna—7,650m. (25,504 ft.), Nanda Devi—7,816m. (26,643 ft.), Davalagiri—8,075m. (26,921 ft.), Everest—8,848m. (29,141 ft.), Kinchinjunga—8,586m. (28,116 ft.), etc.

The snow line oscillates between 4,500 to 6,000 metres on the southern face, and between 5,500 to 6,000 metres on the northern, with large glacier movements in the vicinity of Nangaparbat, Badrinath and Kinchinjunga.

Geographically, the Himalayas can be considered to terminate in the west at the great bend of the Indus where it cuts through the entire ranges and its eastern extremity can be defined by a similar bend in the Brahmaputra.

THE HIMALAYAN VALLEYS

The major valleys of the Himalayas have a transverse course, i.e., they run across the main direction of the mountains in deep gorges or canyons which the rivers have cut themselves through the laborious process of corrosion of their beds. The only exceptions are the head portions of the Indus, Brahmaputra and the Ganges and a few of their main tributaries which flow parallel to the direction of the mountains. This peculiarity of the Himalayan system of the valleys is due to the fact that the water-shed lies to the north of the main axis.

The physical configuration of the valleys in the east and in the west are fundamentally different; in the Kashmir Himalayas the upper course of these streams show a series of abrupt alternations of deep precipitous gorges, either U shaped or I shaped valleys, while in the eastern Himalayas the valley courses are uniformly broad, with gently sloping sides, without any abrupt changes. This difference between the valleys of the east and the west is clearly due to the difference in rainfall. In the east, the rainfall is much greater and the valley sides have, therefore, been eroded simultaneously with the downward cutting of the bed. In the western Himalayas, on the
other hand, the rainfall is very low and the rivers concentrate solely in cutting deep into the hard rocks below, while the sides of the valley remain in taot.

The Himalayan valleys are all in an immature stage of development and they show remarkable examples of rejuvenation, as evidenced by the large number of water-falls, rapids and cascades in their courses. The most conspicuous of these is a sheer drop of 1,600 metres through which almost all the rivers fall as they leave the central Himalayan zone, a resource which can certainly be harnessed for power generation. These very same rivers, as they enter the end part of their mountain track—the Siwalik zone—cut through the very deposits they themselves laid down at an earlier period of their history; the rivers are older than the hills through which they traverse!

These valleys in their mountain section have a pleasant and magnificent scenery, almost unparallelled in other parts of the world. Amongst them the most famous is the valley of Kashmir, drained by the Jhelum. The temperate climate with its typical vegetation, the glaciers of the mountain almost coming down to the low altitude of 1,700 metres at which the valley lies, the enchanting beauty of the people, and the prospect of living in the lap of luxury in a house-boat, all these have conspired together to make the Kashmir Valley a paradise among the world's famous tourist resorts, as yet unspoiled through mechanisation. Less publicised, but equally pretty are the valleys of rivers like those of the Kishtwar, the Chamba, the Kangra and several others.

Occasionally, these Himalayan valleys are liable to be choked up by accidental circumstances such as landslips, glaciers, etc., which temporarily arrest the flow of these rivers and when these break open with startling suddenness, they produce inundation of a severe nature in the plains below. Some of the historic floods have been those of the Indus in 1859, of the Ganges in 1893, of the Sutlej in 1819, and of the Jumna in 1956. These Himalayan rivers have enormous potentialities for the generation of hydro-electric power and expansion of irrigation. Legendarily, it is to Bhagirath, one of the ancient Kings of Hindustan that we owe the gift of the Ganges, who through
his ceaseless penance and prayers brought down the celestial river to the plains below. After all, the present rulers of India are dogging the footsteps of this ancient and worthy master by attempting to control and harness the waters of giants like the Sutlej and Kosi for the permanent benefit of her people.

**The Indo-Gangetic Low-Land**

North of the Peninsula and south of the Himalayas lies the great alluvial low-land of the Indus, Ganges (Ganga) and Brahmaputra rivers, which together cover an area of approximately 750,000 square kilometres, extending for a total length of nearly 3,200 kilometres from the Indus mouth to the mouths of the Ganges, of which the Indian sector alone is not much less than 2,400 km. in length with a varying width ranging from 150 km. in the east to about 300 km. in the west. The surface deposits of this tract belong to the last chapter of the earth’s history and conceal beneath them the older Peninsular and other formations.

The most characteristic feature of this region is its extreme horizontality; it is a monotonous plain comprising mostly of sands and clays, with the clay element dominating towards the mouths of the rivers, while the sands are more preponderant in the upper reaches. Over the whole of the area, the soil is uniformly fine grained. Several borings have been put to determine the depth of the alluvium, and it looks as though the maximum thickness is somewhere between 2,000 to 3,000 metres. But in some places, the alluvium may be shallow, as for example, between the Rajmahal and the Garo hills. The Bihar earthquake of 1934 has shown that there are some zones of disturbance underneath the alluvium which are nearly parallel to the trend of the Himalayas. Even on a superficial basis, it is possible to divide it into two units: (i) an upland plain—the Bhangar lands comprising of the old alluvium, occurring as slightly elevated terraces, generally above the flood level, the rivers having cut through it; and (ii) a low-land plain—the Khaddar lands, or the new alluvium, which are cut out of the Bhangar by the rivers and which are liable to inundation in times of flood. The sub-soil consists of sand and clay, indeed, ideally suited for irrigation from wells.
The Indo-Gangetic low-land consists of two drainage basins, the Indus and the Ganges, separated by a low narrow ridge passing through Delhi and Ambala, a continuation of the Aravalli ranges. The lowest part of this water shed is not more than 300 metres above sea level and the plain appears to be continuous between the two drainage basins.

The drainage of the low-land is effected by the Indus, the Ganges, Brahmaputra and their tributaries. These three great rivers have the same essential conditions of permanent glacier, seasonal precipitation and great heat and intense evaporation and they have all the three stages of the mountain, the plain and the delta. The larger Himalayan rivers are all glacier-fed. Hence, they are perennial and they have actually more water in them during late spring and early summer, with the melt of the snows. Quite distinct from them are their counter-parts in the Peninsula, where there is not even one river with a glacier at its source, so that even the largest of the rivers like the Godavari and Krishna, become much smaller streams in the hot dry season, preceding the monsoon.

The Indus, (the Sanskrit equivalent is Sindhu which means the ocean, obviously an allusion to its large size in times of flood) is one of the mightiest rivers of the world. Its source, lies far beyond in Tibet, in lake Manasarovar in Mount Kailas. Like the Nile, it receives no tributaries for a large part of its course through the desert. Cultivation is only possible with the aid of irrigation, the farming operations being restricted to a narrow strip on either side of the river. The main tributaries are Kabul and Zhob on the west, Jhelum, Chenab, Ravi, Beas and Sutlej on the east, of which the Jhelum and the Sutlej are the most important, as both of them are trans-Himalayan. As a result of the partition of India in 1947, the greater part of the Indus basin, excepting the inner most mountain reaches of these rivers has been ceded to Pakistan, the Sutlej alone for some part of its plain course flowing through India, with the upper reaches of the Ravi forming the frontier between the two nations.

Among the three Himalayan rivers, Indus, Ganges and Brahmaputra, the Ganges is probably the least remarkable. Like the Indus
or Brahmaputra, it is not a trans-Himalayan river, but is sub-
Himalayan, rising on the southern slopes of the Himalayas. Many
tributaries of this river drain the area between Banderpunch and
Nanda Devi, some of them originating in the core of the great
Himalayan range. But within 300 km. of its source, the Ganges
escapes from the Siwalik gorge at Haridwar (Hari=Vishnu, Dwār=
Door. Vishnu’s door). The sources of this river are all studded
with temples, each one a sanctified place of pilgrimage, particu-
larly sacred to every Hindu, irrespective of the sect to which he
belongs. The plain stage of the river is over a very low level land;
its pace just enough to carry most of its silt, but however, above
Allahabad, for most of the year, it is irregular and broken, mainly
because much of its waters is being diverted to the irrigation channels.
Its most important tributary is the Jamuna.

With its tributaries of the Tons and the Giri, the Jamuna rises on
the southern flanks of the Himalayas at an altitude about 150 metres
above that of the Ganges and it is approximately 150 km. long.
Its mountain stage is only half that of the Ganges and it escapes from
the Siwalik gorge within about 150 km. of its source. But for the
remaining 1,200 km., it falls only 300 metres, meandering even more
so than the Ganges, which it joins at Prayag (Allahabad). Further
down, lies the most sacred of all cities, Varanasi (Banaras) dating
back to B.C. 2,500, indeed, the world’s oldest city, still continuing
at its original site.

Both these rivers appear to be turbulent when they emerge from
the Himalayan gorges, but on reaching the plains, they develop
broader valleys and collect several tributaries from the Himalayas.
the Gomati, Ghaghara, Gandak, Kosi, etc. The Son and the Damodar
from the Peninsular region, flow into the Ganges while the Chambal
and Betwa, also draining the Peninsula are the only large rivers that
flow into the Jumna. In the Patna-Bhagalpur section, the Ganges
flows due east but below Bhagalpur, it changes direction towards
the south to develop the vast deltaic region of Bengal, through a
series of distributaries, of which the Bhagirathi is the main in the
western and older section of the delta. The Ganges empties its
silt laden waters into the Bay of Bengal, building in its way the
alluvial flats of the Sunderbans. The new delta that the river is engaged in building, lies in East Pakistan with all the typical characteristics of an actively growing delta.

Physiographically, the Brahmaputra valley is almost identical to that of the Indus and its origin is also trans-Himalayan. The river breaks through the Himalayan ranges by means of a transverse gorge and receives from the east, three important tributaries, the Sesiri, Dibang and Luhit. Further down-stream, its course is marked by several bifurcations, reunions and formations of riverain islands. Below Dhubri, it flows towards the south and earning the local name Jumna in what is now East Pakistan territory, it joins the delta drainage of the Ganges. It has changed its course in the delta track, time and again. For some part of its course, the Indo-Pakistan boundary lies along the course of the river and it is not unlikely that its fleeting habit may create complicated international problems of territorial jurisdiction between India and Pakistan.

It is estimated that the Ganges carries about 300 million tonnes of silt per annum, that is, approximately, 900,000 tonnes a day. The Indus discharges more than a million tonnes of silt per day and the load of the Brahmaputra is even greater. Thus, on a very conservative estimate, the Himalayas are being denuded by more than three million tonnes a day!

The delta of the Indus, truly triangular in shape, is very small compared to the twin delta of the Brahmaputra and the Ganges mainly because of the difference in climate of the regions through which they pass—Sind arid, as contrasted with the humid Bihar and Bengal. The delta of the Ganges is barely above sea level and is covered in many parts with a vast impenetrable jungle; elsewhere mostly mangroves are found. This area known as the Sunderbans, a tiger-infested jungle, can only become inhabitable when the addition of silt has raised the surface of the soil well above high tide.
CHAPTER III

CLIMATE

The sub-continent of India is a meteorological unit in itself. Separated as it is by the high Himalayan barrier from the rest of Asia, it does not receive any Central Asiatic wind from the north, nor does it permit the winds of the Indian ocean to escape northwards, as a result of which there is some peculiar uniformity in the climate of the entire region to the south of the Himalayas. But at the same time it must be remembered that the size of India is so large that there are bound to be significant climatic contrasts between the different parts and no generalization should be attempted, except with caution. For example, there is Rajputana in the west with a rainfall approximately 10 to 15 cm. per annum, while on the east lies Chirrapunji with more than 1,100 cm. But, in the nature of its distribution, the rainfall in both cases is highly seasonal and typically monsoonal, which again tends to make it homogeneous.

There are stations in Kashmir where the annual temperature in the winter may be as low as —45°C, as in Leh, and there are stations in Rajasthan like Ganganagar which have registered a temperature of 51°C. On considerations of actual temperature, it will be found that there is a progressive march of warmth as the sun proceeds northwards, the southern parts being distinctly warmer in March and April, while by the end of June, north India has much higher temperatures. Characteristically looked at, there is a steady increase in temperature from January to May, and a fall from June to December. July is generally not as hot as June.¹

The annual range of temperature is low in Cochin, about 12°C, it is twice as great at Bombay and 6 to 8 times as great in the interior stations of the Panjab.

¹ Notice the contrast between India in this respect and most other northern hemisphere countries in similar latitudes, in all of which July is distinctly warmer than June and this is because of the monsoonal clouds and rains dominant practically throughout the country in the month of July.
Next to its sunny skies and somewhat oppressive heat, probably no feature of the Indian climate is more characteristic than the prevailing lightness of wind. The air is still just before the sun rises; at certain times of the year, it is absolutely calm and in around the large cities where it is in this stagnant condition, it becomes charged with mephitic gases and vapours. One begins to wonder whether the Indian habit of taking exercise before sun-rise, going out for long brisk walks, breathing such polluted air is really beneficial to health. Apparently it does more harm than good! But of course, once the sun is up, the movement of the air is stimulated and all the poisonous gases that had got accumulated in the lower strata, are lifted up and replaced by pure air from above. It would be for further investigation to determine whether the so-called healthiness of summer in north India is not a consequence of this factor.

There are at least two main seasons with characteristic winds (i) the Dry Winter, and (ii) the Wet Summer, with two transitional seasons between them.

(i) The winter season of the northeast monsoon, lasting approximately from the 15th December to the 15th March, is generally dry, except in the northwest of India. The distribution of pressure during this season is of paramount importance. This is the period when there is a vast high pressure located over the continent of Asia with its maximum intensity over Central Asia extending from Manchuria to Tibet and a similar high pressure, but of much smaller intensity over the Deccan peninsula, with a tongue of low pressure over the Indo-Gangetic low-land separating these two high pressure systems. Occasionally cyclones originating in the Mediterranean drift eastwards into this area of low pressure, giving about 15 cm. of rainfall in the North-west Frontier Province of West Pakistan and about 5 to 6 cm. rainfall in Delhi and around, but diminishing steadily eastwards, so that, they are generally not felt beyond Bihar. Except for this, it is a season characterized by pleasant weather and absence of rain in almost every other part of the country.

This generally dry winter season is followed by the pre-monsoon
transition period of a hot summer extending from the 15th of March through April and May to about the beginning of June. In March, the highest temperatures are approximately 40°C. in south Deccan; in April the seat of highest temperature moves northwards to the northern parts of Madhya Pradesh, with maximum figures of 45°C.; in May it moves still further north to Rajasthan where the temperature may be as high as 50°C., while in June the zone of maximum temperature is in south Panjab. Along with the movement of the sun and in sympathy with it, the low pressure consequent on the vertical sun moves, so that the low pressure is most intense in March in south Deccan, in April in Madhya Pradesh and in May in Rajasthan. The difference in pressure between the land and sea occasionally becomes so significant that in March and early April, there is a possibility of sea air invading the land, resulting in local thunderstorm showers, called Mango showers, in Madras and Andhra, and spring storm showers in Bengal and Assam. By the end of May and the beginning of June, just before the onset of the southwest monsoon, there is a vast tongue of low pressure located over the whole of the subcontinent extending from Sind in Pakistan, right across the Peninsula to the Chotanagpur plateau.

(ii) The season of the southwest monsoon, from about the 5th of June till the 15th of September, is the period when this low pressure system which runs right across India remains dominant; and to fill up this area of low pressure, air is sucked in, both from the Arabian Sea and the Bay of Bengal. But this being found inadequate, there is a tendency for the air in the South Indian Ocean (south of the equator) also to be brought into this circulation. Towards the end of May, the atmosphere is calm and remains absolutely still for about a week. Then with startling suddenness, the surface air from the South Indian Ocean is sucked into the circulation of the northern hemisphere and this is called the burst of the monsoon, which normally starts about the 5th of June in the south Kerala region and steadily progresses northwards, reaching Bombay by the third week of June and Uttar Pradesh and Panjab by the last week of June, or the first week of July.

The monsoon has really two branches; one the Arabian Sea
branch and the other, the Bay of Bengal branch, both trying to fill up the area of low pressure which runs as a wedge right across the Peninsula from Kutch to Orissa, the Arabian Sea branch from the south and west and the Bay of Bengal from the north and east. It must be pointed out that the Bay of Bengal branch of the monsoon, truly speaking, is generated not by the area of low pressure in India, but by the similar area of low pressure located over Thailand, where during this same season exist conditions of temperature and pressure identical to that of India. The bulk of this current of air, on meeting the Burma coast and the mountains of Malaya get deflected to the left, surprisingly against Ferrel’s Law, mainly as a result of the trends of the coast line and the mountains and proceeds up the Gangetic delta to fill up the Indian low pressure, but as it moves into India, it has, because of the earth’s rotation, a tendency to be deflected towards the right, so that a part of the air is sucked into the low pressure, while the other part impinges on the foot of the Himalayan mountains giving copious rains in the eastern sector, the quantity diminishing towards the west. The Arabian Sea branch of the monsoon is much more powerful for the following reasons: (i) The Arabian Sea is a larger sea than the Bay of Bengal; (ii) the entire Arabian Sea current is attracted to India, while only a part of the Bay of Bengal current enters India, the remainder proceeding to Burma, Malaya and Thailand. The Arabian Sea current impinges on the west coast of India and gives an extremely heavy rainfall all over the coast, especially where the angle of impinge is perpendicular to the direction of the Western Ghats, as for example, at Mangalore, Vayithiri in Malabar, etc.

The currents from the Arabian Sea and the Bay of Bengal tend to form a cyclonic whirl around the barometric minimum located over southwest Panjab and the absence of mountains, to some extent, accounts for the poverty of rainfall here. The physiographic features of India are of great importance in modifying the flow of the monsoon currents and therefore, of monsoon rainfall. The Arabian Sea current on ascending the western slopes of the Western Ghats, gives copious rains to the coastal region, but then it begins to descend on the eastern slopes so that on the immediate leeward side of the
PLATE IV. Silver Fir Forests in Western Himalayas
PLATE V. Jog Falls of the river Sharavati, Mysore State
CLIMATE

mountains, there is a narrow belt of marked aridity; but once this is passed, the sea air starts rising again, to give increasing quantities of rainfall further east.

The monsoon current is thus no more than a draught of air sucked in to fill the trough of low pressure extending from Sind to Chotanagpur; but this trough itself is not stationary in position, but moves north and south. All places which happen to fall vertically below it receive heavy rainfall during the period when it is directly above, the rains ceasing with the migration of the low pressure; and it is this that makes the monsoon rains discontinuous. The monsoon, therefore, is not a season of continuous rainfall; but it is actually characterized by bursts of incessant rain alternating with breaks, partially or generally as the case may be. To add to this, one finds that there are tropical cyclones which frequent both the Arabian Sea and the Bay of Bengal, but more dominantly in the latter, having a tendency to move into the land during this season. Almost all of them are sucked inward through the deltas of the great rivers, Ganges, Mahanadi, Godavari, Krishna, Cauveri, etc., giving excessive rainfall (as much as 64 cm. [25"] on a rainy day) and creating enormous floods and destruction in the densely populated deltas.

It must also be pointed out that the southwest monsoon is created by the continued existence of a low pressure, dominating over the region of Sind, Kutch and western Rajasthan, but surprisingly, this is the region which receives the least amount of rainfall. Actually, the highest rainfall is received at places farthest away from the low pressure centre, as in Bengal and Kerala, indeed, a paradox. Perhaps this may in part be due to the absence of a mountain barrier in Kutch and Sind, the Aravallis system being generally parallel to the direction of the wind and, therefore, offering no resistance to force air to ascend up its slopes, but at the same time, it must be admitted that the meteorology of this phenomenon is still a mystery and has not been completely unravelled.

It is during the southwest monsoon that approximately 80 to 85% of the total rainfall of India occurs, and nearly 4/5 of the country receives its rainfall during this season; thus the southwest monsoon accounts for 80% of the rainfall of India both seasonally
and regionally. Unfortunately, this monsoon is fickle and capable of remarkable variations from the normal.

Generally speaking, by about the 15th of September, the south-west monsoon dies as the barometric pressure begins to rise gently over the land mass and the low pressure centred over the Indian subcontinent moves southwards, in response to the southward migration of the sun. By the end of September, the winds start blowing out from the land. The Arabian Sea current retreats southwards and westwards through Rajputana and Gujarat and the Bay of Bengal current down the Gangetic plains. By about the beginning of October, a low pressure is centred over the northern parts of the Bay of Bengal and by the beginning of November, it moves further south. The land wind from India which responds to this gradient of pressure moves out into the Bay of Bengal getting continuously deflected to the right (in obedience of Ferrel's Law) and tries to fill in this area of low pressure and in so doing, impinges on the Coromandel coast, giving copious rains to the north of Madras in October and to the south of Madras in November. By December, the low pressure has moved further south into Ceylon and the winds are no longer felt. A similar phenomenon in the retreat of the monsoon is found in the Arabian Sea, but as it does not recurve on to the coast, it does not affect the climate of India. It is this phenomenon of the retreating monsoon which causes rainfall in the coastal tracts to the south of the Krishna mouth in Andhra Pradesh and in the Madras State, both on the coast and in the interior of the southern-districts. It must be pointed out that this is not the northeast monsoon at all, as many seem to believe, for after all, the northeast monsoon does not set in till the 15th December, by when these rains have totally stopped. This rainfall then, is purely the result of the retreat of the monsoon and should be called the retreating monsoon rainfall and not the northeast monsoon rainfall.

The quantity of rainfall received by any region is governed by the lie of the mountains. If the mountains are removed, there will be no rain and the pattern of distribution would be completely altered. It has been shown that more than 80% of the area of India receives
its rain during the period June to September, but there is a small quantity of rain even in the other seasons; the rainfall in the cool weather season from December to March in northwestern India may appear to be little, but is very important from the agricultural point of view, especially for the wheat crop; and this is followed during the hot weather months of March to May by the monsoon showers of the south and the spring storm showers of Bengal and Assam, and in September, October and November the retreating monsoons of the Coromandel coast follow in the wake of the southwest monsoon. Thus there is no month of the year in which rain does not fall in some part or other in India!

It has been estimated that the average rainfall for India, as a whole, is around 100 cm., which appears to be quite satisfactory, but there are remarkable variations from year to year, as much as 30 cm. plus or minus. First, the onset of the monsoon may be delayed considerably; second, there may be prolonged breaks lasting over the greater part of the months of July or August; third, the rains may cease prematurely resulting in extremely serious and disastrous consequences in regions of marginal sufficiency; and lastly the rains may persist more than usual in one part of the country consistently shunning another, a very common abnormality resulting in floods in one part and drought in another. Any one of these abnormalities will result in a famine, but, obviously, the regions receiving marginal amounts of rainfall are likely to be more seriously affected by such variations than the regions receiving either very much, or very little. Another peculiarity of the Indian rainfall is that the variations from the normal are greatest where the rainfall is least. Rajputana and Gujarat have shown the highest variations while Kerala and Bengal have shown the least. Droughts frequently occur in the interior districts of Cudappah, Kurnool, Anantapur, etc. in Andhra Pradesh and at the same time, the adjoining part of the country in Madras State may be suffering from deluges and floods.

The Indian rainfall is characteristically of a heavy, down-pouring type. The heaviest down-pours occur in association with cyclones that advance inland from the Bay of Bengal, or the Arabian Sea.
A rainfall of 50 cm. in a day is not uncommon, the highest record is round about 86 cm. in a period of 24 hours at Purnea in Bihar. But even places considered ordinarily as dry like Nellore, have registered nearly 57 cm. in 24 hours, more than 50% of its annual fall! The average rainfall per rainy day is 2.5 cm. both in Assam and the West Coast, 1.5 cm. in Bengal and Uttar Pradesh, 1 cm. in Mysore and parts of the Deccan peninsula, and more than \( \frac{1}{3} \) cm. in the dry desert of Rajputana. Chirrapunji gets its usual rain of 1,120 cm. in 180 rainy days, Ganganagar in the Rajasthan desert, its rain of 12 cm. in 10 to 12 rainy days. And hence the statement, "it pours, it never rains in India" is true, whether it be Chirrapunji or Ganganagar!! Even the driest tracts of the country have heavy down-pours when compared with the temperate countries, where the average rainfall is less than 0.25 cm. in 24 hours.

The Bay of Bengal occasionally causes great havoc through high winds, torrential rains and in some exceptional cases "storm waves" that invade and inundate the land up to as much as 6.5 metres height, causing tremendous destruction to life and property, for example, the Bakarganj cyclone in 1870 killing some 100,000 persons, the Orissa cyclone of 1942 killing an estimated 3,000 persons etc.

On the basis of rainfall, it is possible to divide India into a series of rainfall regions:

1. The regions of Kerala, Konkan and Western Ghats with a rainfall of more than 200 cm.;
2. Mysore, Andhra Deccan Plateau, Khandesh and Berar on the lee side of the Ghats with a rainfall between 50 to 75 cm., the rainfall increasing eastwards;
3. The Coromandel coast of Madras and Andhra States extending from Cape Comorin along the coast as far north as the Krishna delta with an average rainfall between 50 to 120 cm. with a freedom from rain during the season of the southwest monsoon but with its rainfall concentrated in the months of September, October and November, the Tinnevelly coast in the south being the driest part of this region;
4. Further north in Northern Circars, north of the Krishna mouth, and in Orissa, the rainfall occurs during the southwest monsoon.
season, mainly because of the change in the trend of the coastline, the amount varying from 75 cm. in the south to 150 cm. in the Gangetic delta;

(5) The southern parts of Madhya Pradesh, the country between Berar in the west and Panch Mahals in the east having a rainfall of about 125 cm., of which the bulk is received during the summer monsoon only;

(6) Chotanagpur and West Bengal with increasing rainfall from west to east and lying well within the area of summer rains, receiving about 150 cm.;

(7) Lower Bengal: The delta of the Ganges-Brahmaputra with a rainfall of more than 200 cm.;

(8) Eastern Bengal, Cachar and Assam with a heavier rainfall and a longer rainy season with the rains starting in May;

(9) The Gangetic plains of Bihar and Uttar Pradesh receiving their rains in July and August from the Arabian Sea, and in September from the Bay of Bengal, with a steady decrease of rainfall from east to west up the valley, and a more rapid fall from north to south, i.e. from the foot of the Himalayas to the Ganges, the area of minimum rainfall coinciding with the Ganges, Jumna doab, (perhaps because it has the lowest elevation of the ground, and the greatest distance from the Himalayan foot hills);

(10) South Bihar, western parts of Madhya Pradesh and eastern parts of Rajputana, where the rainfall is mostly from the western branch of the monsoon; with the rainfall being much higher in the south-east but diminishing rapidly northwest and northeast;

(11) The Panjab plains. With an average rainfall of about 50 cm. brought in by both the branches of the monsoon, the rainfall diminishing to the northwest in a line parallel to and at right angles to the Himalayas, as the distance from the mountains increase;

(12) Gujarat: Gujarat receiving its rains entirely from the western branch which in quantity is intermediate between the high rainfall of the Konkan and the very dry desert of Rajasthan, with a rapid decrease of rainfall from southeast to northwest; and

(13) Western Rajasthan and a part of the Thar desert with a very uncertain rainfall of 10 to 12 cm. a year.
CHAPTER IV

SOILS

The Soils of India can be divided into two main types:

(a) Soils of peninsular India and
(b) Soils of the Indo-Gangetic lowlands.

The soils of Peninsular India are the soils which have been formed by the decomposition of the rocks, in situ and these soils through the action of rivers and winds have been transported and redeposited only to a limited extent. On the other hand, the soils of the Indo-Gangetic lowland are entirely transported soils, brought down mostly from the Himalayas by the great rivers that drain them and deposited as sedimentary alluvium. A much smaller part is due to the rivers that drain north from the Peninsula.

The Soils of Peninsular India

There are at least four different types of soils in Peninsular India. (i) Regur (from the Telugu word Regada). This soil, otherwise known as the black cotton soil, first because cotton is the most important cultivated crop on this soil and secondly because it is black in colour due to its high content of humus and iron oxide, is a highly retentive, fine grained, black, clayey soil. It swells greatly and becomes sticky when wet, so that in the rainy season, it is almost entirely unworkable, as the ploughs get stuck in the mud. However, it does not become compact because it is underlain by a sub-stratum of lime (locally called murum) which absorbs some of the water and promotes drainage. Its great merit lies in its capacity to retain water for long periods of time. It is the most retentive of Indian soils. In dry weather, it is seamed with broad and deep cracks, often 10 to 15 cm. in width and up to a metre in depth, promoting oxygenation to such depths. Consequently it is a soil of extra-ordinary fertility and in many cases, is known to have supported agriculture for centuries without either manuring, or even following with little or no evidence of exhaustion. Practi-
cally the entire tracts of this soil are cultivated and are of remarkable fertility, while the isolated uncultivated bits, here and there are under grass.

The origin of this soil, till recently was ascribed to the decomposition of the basic rocks (the traps) over which they are found to occur extensively, but when it was realised that large tracts of regur extend far beyond the traps, the explanation was found to be unsatisfactory. In the river valleys like those of the Godavari, it could be interpreted as due to river transportation, but in distant places like the districts of Coimbatore, Ramanathapuram (Ramnad) etc., in the extreme south of India, it could not be ascribed to the decomposition of the trap, or to river transportation. Geographically looked at, it is found to lie in regions of high temperature with a rainfall less than 75 cm.; with a much higher rainfall of 200 cm., the same type of parent rock seems to get altered to laterite. It is, therefore, a soil of the dry hot regions of the Peninsula.

(ii) Red Soil: Very large parts of the Peninsula particularly in the States of Madras, Andhra Pradesh, Mysore and Orissa are occupied by granites and gneisses, which on weathering have given rise to the so-called red soil. The colour is obviously due to its very high iron content. A thin sandy soft soil of loose texture, it is non-retentive, and for successful cultivation, in general, the rainfall has to be supplemented by irrigation. Contrast these with the conditions in the regur soil, where no irrigation is necessary, partly because of its high retentivity, and partly also because it becomes unusually sticky and heavy when it is moistened, with the result that it will be extremely difficult even for large and heavy bulls to pull the plough through the muddy soil. At present, the red soil is considered a half way house in its stage of decomposition, between regur and laterite. The soil is ferruginous and deficient in lime, but with the application of fertilisers in proper proportion, it is an exceptionally productive soil from the agricultural point of view and responds well to agricultural efforts.

(iii) Laterite: The third type of soil is laterite, which occupies large tracts all over the crest of slopes of the mountains of the Peninsula, in the Vindhyas, Satpuras and their associated ranges,
in the Eastern Ghats and the southern portion of the Western Ghats extending from Mysore to Cape Comorin. It is probably an end-product of decomposition, found in regions of heavy rainfall, more than 200 cm., the rocks having been completely leached out, leaving a high proportion of iron and aluminium as residue. Laterite, thus, is a ferruginous aluminious rock and in some cases as at Belgaum, Katni and Jubbulpore, is rich enough to be classified as high grade bauxite for the extraction of aluminium. Occasionally, the bauxite is also rich in titanium. It can, therefore, be used for the manufacture of the metal and its compounds. It is soft on cut, but hardens when exposed, and it has been used as a cheap building stone for centuries, throughout the West Coast.

Laterite is a very poor soil from the agricultural point of view, but there are some plants like the cashew, which can thrive on lateritic soils. A significant method of improving the land-use of this laterite region located over South India would be the introductions of cashew plantations all over the area, which would be economically useful, both from the point of view of the nuts they give, an excellent foreign exchange earner, and from the point of view of supplying the much needed fuel, throughout the region. Root crops like tapioca also do reasonably well on lateritic soils, indeed, a desideratum in itself, as it helps to meet the deficiency of food.

(iv) Soils of the Coastal Regions: The coastal formations both on the east and west coasts are in general a mixture of sand and loam, former predominant except in the deltas where the clay dominates.

The Soils of the Indo-Gangetic Lowland

The soils of the Indo-Gangetic lowland are young and are all composed of river deposits; there are two types (i) the coarse gravel or the older alluvium known as bhangar found on the higher reaches about 30 metres above the flood level and (ii) the finer and newer alluvium, comprising of fine sand and clay, called khaddar in the valley bottoms through which the rivers now meander. The clay locally known as Mota is of great hydrologic significance, existing as it does, as islands in a sea of sand. The presence or absence of this clay
The demarcation of the Gujarat West Pakistan Boundary in accordance with the Indo-Pakistan Western Boundary Case Tribunal Award is in Progress (1968)
in the sub-soil and the depth at which it occurs determines the capacity of this soil to store-up water. The clay element in the soil is dominant towards the delta while in the upper parts, the sand constituent is much greater. The soil is prevalingly yellow in colour, excellently suited for irrigation and agriculture, lying as it does on a level surface, with low run off. The large parallel rivers which flow down from the glaciers in the Himalayas provide an assured source of water supply, to make this the most important agricultural unit in the country.
CHAPTER V

NATURAL VEGETATION

Since India presents a greater variety of physiographic and climatic conditions, more varied than any other area of similar size in the world, it has an equally varied vegetation, contrasting as they do on the one hand the tropical monsoon forests with the alpine meadows of the Himalayas, and on the other, the xerophytic desert vegetation in the marshy Sunderbans. When the geographical size of India and the latitudinal range it embraces—both tropical and temperate—is borne in mind, and when this is coupled with the great range in altitude from sea level to heights well above the limits of vegetation, the wealth and variety of its flora should not occasion any serious surprise. But at the same time, it is, indeed, astonishing that not one of the families of the flowering plants is peculiar to India and we have the remarkable result that its flora is no more than a mere aggregation of several floral types. Likewise, although the Tibetan and Siberian types reach India in the Alpine regions of the Himalayas, yet it is the Chinese and Japanese varieties that are typical of the temperate regions and although the lime, the Beech and the chestnut extend from Europe to the Far East, yet they seem to avoid even the temperate belt of the Himalayas, for reasons unknown.

There are only four types that characterise the landscape over wide areas, the Rhododendron belt in the Himalayas, the Pines of the Northwest, the Bamboos of South India and the Xerophytic types in the Rajasthan desert. But in much smaller isolated stands are found the Palms, especially in the South, the Acacias fairly widespread, the Strobilanthes in the Nilgiris, the Dipterocarpus in eastern Assam and Sal at the base of the Eastern Himalayas. These are at best conspicuous features of the landscape, but they cannot by any means be considered dominant. Even today, the struggle for supremacy is plainly seen, for e.g. the waterpest of the Bengal delta.

It may be noted that the palms in India are less diverse than those
further east or in the New World, the most important being the Talipot palms, the palmyrah, the coconuts and the arecanuts, the last two being more cultivated than natural. In the humid evergreen forests are found the rattans and the esturial palms, so characteristic of the Sunderbans.

The bamboos are ubiquitous and are important from sea level up to an altitude of nearly 3,000 metres—wherever moisture conditions are suitable—either growing as clumps, or to form an impenetrable jungle in association with other plants.

The conifers are entirely confined to the Himalayas, and amongst them are found Junipers extending eastwards from Europe.

The forest vegetation of India may be divided into five types: (i) the Evergreen Forests, (ii) the Deciduous Forests, (iii) the Dry Forests, (iv) the Mountain Forests and (v) the Tidal Forests.

(i) The Evergreen Forests: (a) Those growing in the regions of the southwest monsoon rains, in the West Coast of the Peninsula, in the northeast in Assam and Bengal and in the lower slopes of the Himalayas, having many trees of great economic value like Teak, Rosewood and Ironwood; and (b) those growing in the regions of the Caranatic, receiving the much lower quantity of rains of the retreating monsoon, with trees of much smaller stature but harder in texture e.g. the Ebony, the Neem, and the Tamarind.

(ii) The Deciduous Forests, found mostly in the Peninsula, economically the most valuable, with the major sources of Teak, Sal (from the Sub-Himalayan tract), the Sandalwood of Mysore, and occasionally Redwood and Anjan (Hardwickia) the heaviest of Indian wood.

(iii) The Dry Forests found in the more moist tracts of Rajasthan degenerating into the desert type in the southwest, the chief tree being the Jhand with some Tamarix.

(iv) The Mountain Forests found along the Himalayas from Assam to Kashmir, where flourish the Deodars, the Pines, the Firs, the Oaks, together with others such as the Walnuts, Chestnuts, Maples, Elms, Ash, Birch, Poplar and Rhododendron.

(v) The Tidal or Littoral Forests found on the deltas of the Ganges and the great rivers of the Peninsula. The chief timber tree is the
Sundri but perhaps even more important economically is the palm Nipa, the leaves of which are used for roofing.

Geographically there are six vegetation regions: (i) the Eastern Himalayas, (ii) the Western Himalayas, (iii) the Sutlej Basin extending into Rajasthan and the Aravallis, (iv) the Gangetic Plains, (v) the Malabar Coast, and (vi) the Deccan.

(i) The Eastern Himalayas, the most humid tract, with more than 4,000 species of flowering plants belonging to 160 families, besides 250 ferns. Its flora is of three altitudinal zones—tropical, temperate and alpine—each gradually merging into the other. In the tropical zone beginning with the foot-hills, are the forests of sal, with a rich undergrowth of shrubs, coarse grasses and herbs like orchids and balsams with a variety of climbers. In the temperate zone, extending from 2,000 metres to 3,500 metres, the composition of the flora changes rapidly; of the trees, the Magnolias are the most noticeable, but it is also characterised by oaks, laurels, maples, Birches and conifers like the Silver fir and the Spruce and by the remarkably beautiful Rhododendron. In the alpine zone, the orchids are totally absent and the sedges and grasses rather poorly developed and but for a few birches, trees are rare. Some shrubs like the rhododendrons and junipers do occur.

(ii) The Western Himalayas has also three similar altitudinal zones as in the East. In the tropical zones, the orchids, the palms and the bamboos become less important than in the East; the graminæ and leguminæ are dominant together with bulbous plants, and the pomegranate and oleander are also present. The temperate zone has more conifers and has all the eastern types except the larch, and there are large forests of pines, junipers, balsams and the oaks including the holm oak which is not found in the East. Shrubs peculiar to the region are the Indian bladder-nut, several kinds of roses, the lilac, mountain, ash and the hawthorn, with a remarkable diminution of the rhododendron, palms and bamboos. The alpine zone abounds in astragali together with grasses and legumes.

(iii) The Sutlej Basin extends into Rajasthan and the Aravallis and into Gujarat and Kutch. Except towards the lower Himalayas
and the slopes of the Aravallis, or where irrigation waters allow of their development, the forests are all stunted and tend to become scrub, obviously reflecting the semi-desert conditions. Shrubs generally replace the trees and the herbs that are found are all capable of withstanding prolonged periods of drought.

(iv) *The Gangetic Plains*, owing to human interference has lost much of its primeval appearance. There are several traditional legendary accounts—as in the *Ramayana*—of the region being under forests in which roamed elephants and deers, but today forests are few and far between. Due to the difference in rainfall, three subregions can be recognised, (*a*) the West consisting of Uttar Pradesh with dry forests similar to the Sutlej Basin and Savannah grasses, (*b*) the middle and east Gangetic plain to include Bihar, non-deltaic parts of West Bengal and Assam—one of the most intensely cultivated tracts of India with an ocean of rice fields, with village groves of mangoes, jack fruits, betelnuts, figs and palms, and with large tanks filled with lotuses, (*c*) the Sunderbans flora, in saline soils with heavy southwest monsoon rains, the typical mangrove forests, a dense evergreen forest of trees and shrubs, most of which have a multitude of aerial roots, making penetration extremely complicated. It is interesting to note that no species of bamboo has been able to accommodate itself to the wet saline conditions.

(v) *Malabar* because of its very humid climate, has a luxuriant vegetation, resembling the eastern part of the Gangetic plains and the deltas, with loftier trees and more palms, the shores skirted with coconuts, and the homesteads surrounded with betelnuts, arecanut palms, jack fruit trees, pepper vines, etc. The mass of the flora is Malayan and identical with that of Ceylon and many species are common to those of the Eastern Himalayas. The Malabar flora is closely akin to those of Khasi, Manipur and Naga hills, while the intermediate regions surprisingly show no such affinity. Teak is abundant but sandalwood occurs in the east in the drier pockets of the Ghats. The ravines and shaded slopes are occupied by thickets of small trees and shrubs resembling those of Ceylon and the Khasis of Assam. The Western Ghats rise precipi-
tiously from the West to extensive grassy downs and table-lands seamed with densely eroded gorges, the so-called ‘sholas’ filled with evergreen forests. Of the shrubs, the strobilanthes dominates—it is their blue flower which has given the name of Blue Mountains—Nilgiris—to this region.

(vi) The Deccan: Over the plateau, the deciduous forests are the most common feature with some evergreens found on the coasts and slopes with an eastern aspect. The sal is found as far south as the Godavari, but the teak occurs at intervals throughout the region. The Satinwood, Indian Redwood, and Toon are all important, but the best known is Sandalwood, the sweet scented tree, abounding mostly in the forests of Mysore. Among the herbs, orchids are generally absent, but most of the others found in the Gangetic plains are also found here.

The total area under forests in India is 695,000 hectares, about 22% of the area of the country, a proportion which is rather low and not entirely satisfactory. Man, during the last two centuries, has been responsible for a considerable encroachment into the forest areas. The expansion of the area under plantation crops like tea, and to a more limited extent of crops like rubber and cardamom, has resulted in a process of deforestation and a tremendous increase in soil erosion. It is time that these are halted and a more serious effort made to conserve the forests.
CHAPTER VI
IRRIGATION

It has already been shown that the Indian rainfall is (a) variable from year to year; (b) is very highly seasonal; (c) is such that it comes down as a heavy downpour, with a liability to produce floods and with little or no opportunity for the rain-water to penetrate into the subsoil and get stored-up there to be utilised by the roots of the plant; and (d) is such that it results in soil erosion. It is under these circumstances that the agriculturist in India has to fight for his existence. The effect of these conditions in producing famine would vary from one part of the country to another, and that naturally so, because much would depend on the total rainfall, the nature of the soil, whether it is retentive or otherwise, the nature of the crops cultivated, the cultural standards of the people and a host of others. Between the extremes of the desert in the west and the heavily rainfall regions of Assam in the east, lies a large tract of country, about 50 to 60% of its total area, where the annual rainfall varies between 25 cm. to 125 cm., no part of which could be termed secure against the scourge of famine. Although it is difficult to precisely determine what variation in rainfall would result in producing famine, yet, experience suggests that where the variation is 25% of the normal, it is considered to be very injurious to the crops and if it is more than 40%, it is absolutely fatal. Where the rainfall is less than 125 cm., a variation of even 12.5% is liable to result in serious famine. The famine tracts of India are parts of Gujarat, Malwa, parts of Madhya Pradesh, western Maharashtra, northern Mysore, Bihar and the ceded districts of Andhra Pradesh, where irrigation has been neglected to some extent, because of the bare adequacy of rainfall in normal years and because of the high cost of such projects. In much the larger part of the Gangetic lowland, natural moisture is sufficient to ensure a harvest, but such is the degree of uncertainty that in the absence of irrigation, agriculture is reduced to a mere gamble. If the mon-
soon is normal then the crop is generally satisfactory. Rarely, the monsoon is exceptionally heavy in some isolated parts resulting in a famine from floods, but more frequently, the monsoon is weak, then there is drought followed by poverty and famine. This has been the fate of India for quite a long time, till efforts were made by men, in a few favoured spots, to supply water artificially to cultivated crops by means of irrigation, as a result of which the intensity of these famines has been considerably minimised.

Historically looked at, the arts of irrigation were well-known and practised in the country from very early times. For, after all, of the oldest dams in the world is the Grand Anicut\(^1\), constructed over the river Cauveri, some time in the second century A.D., a weir approximately 300 metres long, 12 to 18 metres in width and 5 to 6 metres in height, irrigating as much as 25,000 hectares. Similarly, there are a series of canals constructed by the Moghal Emperors, for example, the Western Jumuna canal constructed by Firoze Shah in the 14th century, renovated by Akbar in 1568 and remodelled by Ali Mardan Khan, the celebrated engineer of Shah Jahan, in 1628. The Tungabhadra canals were constructed by Krishnadevaraya in 1529. Obviously, then, there have been many large irrigation works in India from very ancient times and the credit of initiating irrigation must go to the early Kings and Emperors of India, and not to the British as many people seem to believe. But at the same time, one cannot belittle the efforts of the British in expanding irrigation. The British were responsible for constructing the famous delta irrigation schemes of the Godavari and Krishna in 1850, the upper anicut in the Cauveri in 1836, and in the construction of the dual purpose irrigation scheme of Mettur on the Cauveri in 1934, the first of its kind in Asia and for several other magnificent schemes like the famous triple canal project of the Panjab, the Sukkur barrage in Sind, etc., both of which today lie in the territory ceded to Pakistan. Subsequently, independent India has also continued along the same lines on such schemes of irrigation like the Bhakra Nangal in the Panjab, Haryana and Rajasthan, the Kosi in Bihar, Damodar Valley in Bihar and West

\(^1\)This is a Tamil word for the weir or the barrage.
Bengal, the Mayurakshi in West Bengal, Nagarjunasagar in Andhra Pradesh and a host of others, large and small.

The available river water resources of the country have been estimated at about 1360 million acre-feet but owing to physiological conditions only about 450 million acre-feet can be used for irrigation. Upto 1951, only about 76 million acre-feet or 17% of the usable annual flow were utilized. By 1966, 150 million acre-feet or 33% of the usable flow was utilized. Today the irrigation works of India altogether utilize about 35% of the surface flow available for irrigation; the remaining 65% still runs to waste into the sea. It is possible to improve the utilization of the surface waters, but it is certain that more than 50% of it will continue to flow without being harnessed mainly because of (i) the natural conditions like the topography which prevent water being transported by gravity canals over long distances, (ii) the seasonal distribution of rainfall which compels the artificial reservoirs to be immensely large as they have to store up the waters from one year to the next, (iii) the nature of the soil, and (vi) the general absence of lakes and glaciers (except in the Himalayas) which can act as natural reservoirs.

There are three different sources of irrigation; (a) Canals, (b) Wells, and (c) Tanks.

Canals

Canal irrigation is of two types. (i) Inundation canal, which is a simple flood water drainage system, where irrigation is restricted to the land lying on a level lower than the river valleys into which the flood waters overflow1. (ii) The perennial canal, where a dam is constructed to arrest the flow of the river and the water so stored up is diverted through canals to the agricultural fields, both far and near, from the river. This type of perennial canal has become

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1 The inundation system is still found, although to a very limited extent in West Pakistan, where the rivers of the Panjab converge to form the lower Indus and where **khadar** widens at the expense of **bhangar**. For inundation canals to be successful, the floods must rise to the proper level at the proper time, failing which famine conditions may prevail. To ensure proper overflow, the canals have to be cleaned of the previous years’ silt deposits. It is, therefore, a precarious type of irrigation.
much more important than the former inundation type which is almost completely extinct.

In the case of perennial canals, a weir is generally constructed below the intake of the canals, the intake itself being protected by sluice gates. The canal flows away at the easiest possible grade until it has left the river valley and is flowing on high ground. Then it throw off branches and distributaries, irrigating not merely the lowland, but also the upland. Perennial canals are of two types, (a) the delta canals of South India and (b) the canals of the Peninsula and the Gangetic lowland.

(a) The Delta Canals. These are found in the deltas of the great rivers, the Godavari, Krishna, Cauveri and Mahanadi, all regions of rich soil with a uniform and gentle slope to the sea. The distributaries of the river itself are used as canals, and since these are on the ridges, they have an easy command of the entire country below and every part of the delta can be successfully irrigated by throwing a weir across the head of the delta. But there is a real danger from floods and the crops may be heavily inundated unless marginal embankments for protection are constructed. Rice is the most important of the delta crops and since it benefits by a change of water, drainage works are essential. The area to be irrigated is constant and cannot be increased and the production can only be enhanced through more efficient methods.

(b) The Canals of the Peninsular Region (e.g. Mettur, Tungabhadra etc.) and the Gangetic Lowland. In the lowland of the North the topography is so flat that the construction of canals is easy but there is some difficulty for the construction of the reservoirs. In the Peninsular region on the other hand, such reservoirs are more easily constructed because of the unevenness of the topography, e.g. Mettur reservoir, Krishnarajasagar etc., but the canal construction is more expensive. During the summer floods, all parts of the system receive the water, but during the winter, water has to be apportioned along the several tributaries and irrigation is either limited to a portion of the area, or the available water is distributed all over the area to keep the maximum number of ryots above the starvation level.
About 40% of the irrigated land in India is irrigated by these perennial canals. Out of 26 million hectares which were irrigated in 1964, nearly 11 millions were through canal irrigation.

**WELL IRRIGATION**

A well is a device by means of which water is obtained from the sub-soil. Obviously, then there is a significant difference between irrigation by wells and irrigation by canals. In the case of canal irrigation, the water is available at the surface but in the case of wells, the water is available only at a depth below the surface and consequently, it has to be lifted up.

*Methods of Lifting Water:* Manifold are the methods adopted in India for lifting water—the swing shovel, the Persian wheel, the Piccottah, the bullock Mhote—these are all found in different parts of the country. In India, the depth of water to be lifted alters with the season and therefore, the mechanism of the lifts must be able to adjust itself to this varying depth. Suggestions are frequently made that it would be advantageous to use mechanical and electrical pumps throughout the country, but as against this, it must be remembered that any mechanical device will become economical only if it works for at least 4 to 5 hours a day, requiring normally a source capable of yielding 300 cubic metres (about 10,000 ft.) per day and this will irrigate between 4 to 6 hectares, depending on the particular crop in question. The small size of the average Indian holding, about .5 hectares, and the dispersed nature of the holdings make it such that a mechanical lift is no more efficient than any of the indigenous ones like the bullock mhote or piccottah. But if the holding is enlarged through cooperation or by any other means, these mechanical pumps would be a desideratum. The best and most practicable method of popularising mechanical pumps would thus be for the agricultural ryots of the village cooperating together to lift the water from a common well jointly and then proportionately distribute it, similar to the manner in which it is done in the case of the tube-wells of Uttar Pradesh.

Different types of lifts are found in different parts of the country. Simplest is the single bullock mhote where the bullock moves down
a slope with a gradient of 1 in 5. As it moves down, it carries up a bucket of water from the well, which on reaching the surface is either tilted manually or automatically through some simple device. The bullock then backs up the slope. The double bullock mhote has a steeper gradient of 1 in 3 or $1 \times 2\frac{1}{2}$ and this requires that the bulls have to be unyoked at the bottom of the ramp before they walk backwards and they have to be yoked again demanding additional labour, but nevertheless, the double bullock mhote, is far more efficient than the single bullock type, the quantity of water lifted being much greater for the same size or weight of bullocks. The piccottah is nothing more than a lever weighted at one end and mounted asymmetrically so that it would remain in horizontal equilibrium when the bucket is full of water. A man walks up and down on the lever, tilting it in one direction to force the bucket down the well and then in the opposite direction to lift it up. Its efficiency is, indeed, very high since the man does not have to exert any force, his weight acting as the force that tilts the lever, but occasionally it results in a farm assistant slipping accidentally into the well, especially because these labourers prefer to start this work long before sunrise and continue it long after sunset, taking a prolonged time for rest between about 10 A.M. and 5 P.M. to avoid working in the hot sun.

There are different types of wells (a) Permanent wells, which are constructed with strong foundations as in Panjab and in South India, and (b) temporary wells constructed in Uttar Pradesh mostly for getting a small quantity of water just for a few days to tide over an emergency. In recent years, a new type of construction has come into existence, in what is known as the tube-well, started some time in the early 1930s. It has now spread all over Uttar Pradesh, Panjab, Bihar, Madras and Andhra Pradesh. Now there are over 200,000 tube-wells in the country each of which is capable of irrigating 400 hectares and affording protection for another 400 hectares. It must also be pointed out that there is an abundance of subsoil water supply in the Gangetic valley at or near the surface, so that irrigation by wells in these soils, is neither difficult nor expensive. On the other hand, the rock is much harder in the
peninsular region, sub-soil water occurs at a great depth and the 
construction of wells is expensive and it is only a rich ryot who 
can afford to have a permanent well. Thus we find greater con-
centration of wells in the lowlands of North India, much more than 
in the South. Of course, they are totally absent over the regur 
tracts. Nearly a fourth of the total irrigated area in India is by 
wells and this can certainly be augmented very considerably 
without heavy capital expenditure.

**Tank Irrigation**

A tank is a natural hollow on the surface, into which running 
water, or surface drainage is collected, stored up and utilized for 
irrigation purposes. Sometimes, a series of dams are placed across 
a river valley, so as to give chain of tanks, one below the other. 
The relief of the peninsular region with natural hollows is suitable 
for construction of tanks. Most of the larger tanks are owned by 
the Government, while a few of the smaller tanks are owned by the 
villagers. It has been considered that tank irrigation is uneconomic 
for the following reasons:

(i) the tank itself occupies approximately a quarter of the 
irrigated area;

(ii) as a result of drainage, the tank gets filled up very soon, 
unless it is frequently desilted;

(iii) tank water is silt-free water and hence it has no manuring 
properties;

(iv) the tank fails when the rain fails; and

(v) frequently, the use of the tank water and tank bunds have 
also given rise to quarrels and litigation among the villagers 
which has resulted in impoverishment of the whole 
village community.

Whatever argument might be urged against them, it must be 
remembered that: (a) they use the water which would otherwise run 
to waste, and (b) they also raise the level of the sub-soil water which 
aids in the construction of wells.

Tank irrigation is a peculiar characteristic of the states of Madras 
and Andhra; it is significant in the districts of Chingleput, North
Arcot and South Arcot of Madras, Nellore and Warangal in Andhra Pradesh and parts of West Bengal and Bihar. The area commanded by tanks is approximately a fifth of the total irrigated area, and there is further scope for expansion.

India has enormously increased her irrigation potential during the last 20 years after achieving political independence. In 1947, the area irrigated in undivided India was slightly less than 30 million hectares (72 million acres) of which the share of the Indian Union was nearly 20 million hectares (48 million acres). As a result of the completion of such schemes like the Bhakra on the Sutlej in the Panjab, Damodar Valley on the Damodar in Bihar and West Bengal, Hirakud on the Mahanadi in Orissa, Tungabhadra in Mysore and Andhra, the Kosi in Bihar, the Lower Bhavani in Madras, Paniyar in Kerala and a host of others, the area under irrigation has shot up to 36 million hectares (figure up to the end of 1964-65 was 27 million hectares) nearly double of what it was in 1947. Besides these, there are several large projects like the Nagarjunasagar in Andhra, Gandak in Bihar and U.P., the Rajasthan Canals in Rajasthan and scores of others, on all of which considerable progress has been made. At the beginning of the first Five Year Plan, the gross irrigated area was 22.4 million hectares (56 million acres), which increased to 29.6 million hectares in 1966. In other words, by 1966, the irrigated area in India, when compared to what it was in 1947, was practically twice as large, and by 1970 it is not impossible that it would have increased to two and a half times, indeed, no mean achievement!

Prolonged and continuous irrigation results in certain changes in the soil, especially when the water, as in the case of well water, is charged with salts. In tropical soils, where the salt infested sub-soil water comes to the surface as a result of capillary action and gets evaporated, an accumulation of salt occurs on or near the surface, and to this is added the salts that are left as residue by the evaporation of the surface irrigation waters. The concentration of these salts creates conditions of alkalinity and provides a higher osmotic pressure in the soil, with the result that the sap solution in the roots of plants is drawn out of the cells of the plant roots, instead of the
converse process, thereby killing the plants. Frequent dressings of silt and the use of bulky organic manures are useful methods of preventing alkalinity, but the real remedy to eliminate it would be over-flooding, water being applied in sufficient quantities so that the salts are dissolved and carried down to a depth well below the level of the roots, a remedy that is as dangerous as a double edged sword, because if the quantity of water applied is inadequate, it will make the disease even worse than before!
CHAPTER VII

AGRICULTURE & ANIMAL HUSBANDRY

One of the basic problems of India is the shortage of agricultural land per head of population, and the per capita acreage has been diminishing mainly as a result of increase in population; from approximately 0.4 hectare in 1901, today it is less than 0.3 hectare. The total cultivated area in India in 1960-1961 was 320 million acres, approximately 130 million hectares. If this is divided on an equal basis for the entire population of the country, 439 millions in 1961, then the per capita holding is 130/439 which is approximately 0.27 of a hectare. This appears very unsatisfactory in comparison with the approximate world average of 4.5 hectares per head of population.

It must be realised that about 30% of the land is uncultivated because of topography and relief and between 20 to 30% because of poverty of rainfall. Since land is required for a host of other purposes such as road, railways, construction of buildings etc., the area available for cultivation is approximately 40% which is in conformity with world standards in general. Since multiple cropping may be practised in a few favoured parts where the winter is not too severe and where water is available for a second crop, approximately 45% of the total area, 144 million hectares in all, could be considered to be cultivable. But even with this addition, the per capita holding for a population in excess of 450 million at the present day, of whom 80% or more depend upon agriculture as their main source of livelihood, would be extremely low. This is the basic problem of the country, the cause of its poverty, and this cannot be easily altered unless the number of people who demand agricultural land is diminished. It is highly improbable that there would be a significant expansion of the area under cultivation, but that does not mean that there can be no increase in the cultivated acreage. Here and there, it may be possible to expand the area under crops, to a substantial degree, but the picture is certainly not rosy. The total
The demarcation of the Gujarat West Pakistan Boundary in accordance with the Indo-Pakistan Western Boundary Case Tribunal Award is in progress (1968).
The demarcation of the Gujarat West Pakistan Boundary in accordance with the Indo-Pakistan Western Boundary Case Tribunal Award is in progress (1968).
method for more augmenting agricultural production hence lies in increasing the yield per unit area, rather than in expanding the area.

In the case of most crops, the average Indian yields today are deplorably low, but at the same time, it must be mentioned that the best yields in the country for crops like rice, wheat, cotton, etc., are as high as the best in the world. Is it realised by many people that if the average yield of rice in India is improved to equal that in the state of Madras, then there will be no scarcity of rice in the country, at least for the immediate future? There are vast tracts of country which are marginal and produce low yields, resulting in appreciably lowering the average for the country as a whole.

In India, rain becomes the blood of life, and agriculture is closely wedded to the monsoon. There are two seasons in the year, one the *kharif*, or the summer season, and the other the *rabi*, or the winter season. The plants which require large quantities of water like rice, tobacco, etc., are invariably cultivated in the wetter parts during the *kharif* season while those which require less water are cultivated in the drier tracts during the *rabi* season. Thus, throughout India is found an agricultural rhythm in which the crops and the activities of the *ryot* are determined by the incidence of rainfall, both regional and seasonal. India is, therefore, to be divided into two parts (i) the south and east where the rainfall is more than 100 to 120 cm. per annum, where the wet crops like rice, sugar cane, etc., dominate and (ii) the north and west where the rainfall is less than 100 cm. with dry crops like wheat, millets, cotton etc.,

During the *kharif* season, there is a great activity on the part of the agriculturists; ploughing starts a few days after the first shower, followed by sowing, transplantation, etc. After that, there is a period of rest and leisure, as the major operations are over and the only work that remains, is weeding and irrigation. During the *rabi* season, on the other hand, irrigation is much more important, especially so, for an expensive crop like wheat, while this is much less in the case of crops like millets, cotton, etc.

*Rice*: Among the crops cultivated, rice is by far the most important and occupies the largest area; approximately 28 million
hectares are under rice, producing about 30 million tonnes. Rice requires a high temperature, and it is seldom successful where the mean temperature in the growing season is less than 22 deg. C. An average temperature of 35 deg. C. to 45 deg. C. is a maximum, but if the water supply is adequate, it can stand even higher temperatures. Rice is a crop which thrives in standing water and the rice fields, therefore, have to be flooded at frequent intervals. In India, from the time of sowing till maturity, on an average, it requires about 100 to 120 cms. of water. If the crop depends entirely on rainfall, it must receive throughout the growing season, about 2 to 3 cm. in as many days, the rains being well distributed, the dry spells of weather being no longer than 10 days at a stretch, with the additional condition that the period of heavy rains should not synchronise with either that of sowing or harvesting. Since rice grows in standing water, the water is regulated in most cases by the cultivator, and irrigation becomes the technique of rice culture.

Scarcity of root hairs makes it such that rice can thrive best in soft clayey soils. The soil must be such that it must be able to retain the water without seepage; an ideal one, therefore, would be a loam over-lying heavy clay as in the deltas. Since lowland irrigation is permanent, the main question is not whether the soil will produce an excellent crop, but whether it will produce a long succession of tolerably good crops, the permanency of the crop being much more important than yield. Since water is to stand in the field, it can only be cultivated over level land and the small bunds one finds in paddy fields are absolutely essential as without them the water will not stand but will flow down the gradient. The space required for the bunds, is, therefore, not a waste and the individual plots have got to be small. Apparently then, at least in the case of rice cultivation, the problem of small holdings in India is not as serious as it has been made out to be. The deltas are the most important rice regions followed by the Gangetic lowland, mostly the eastern districts where the rainfall is more than 100 cms. It is the most dominant crop in the States of Madras, Andhra, Bihar, Orissa, West Bengal, Madhya Pradesh, Assam and Kerala. It is important in Uttar Pradesh but is second to wheat; in Maharashtra
and in Gujarat it is inferior to cotton and millets, both of which occupy larger areas. It is cultivated in the hill districts of the Panjab, on the lower slopes of the Himalayas, and in the Jhelum Valley of Kashmir.

One of the special characteristics of rice is that it is a crop which requires transplantation i.e. the seeds are sown in well-manured, specially prepared nurseries or seed beds. As soon as the seedlings have attained a height of a few inches, they are removed from the nursery and transplanted by hand into the fields. Though this is a labour consuming process, it gives excellent yields, much better than the two other methods of broad-cast sowing and drilling; the why of this is still unknown. And transplanted rice is only 50% of the total crop, while it is entirely so in both Japan and China. The problem has been insufficiency of labour; indeed, a paradox in a country teeming with unemployed. This is because the period of transplantation is restricted to a few weeks and not spread over a much longer period, so that the labour requirements are from an enormously vast region, just for a few days, creating scarcity conditions.

In India, the average yield is rather poor, not more than about 1,000 kg. per hectare (807 lbs. per acre) which is approximately a fifth of what it is in Japan, and a quarter of what it is in China. Partly this is due to the prevalent cultural practices like broad-cast sowing and partly also to the uncertainty of the weather and water supply, and probably also because of the types of seeds used in the country. Efforts are now being made to increase the yields effectively by improving the variety of seeds and by augmenting the water supply through expansion of irrigation facilities. More attention should be devoted to changing the cultural practices also, and it would be a matter for consideration whether school children should not be given an opportunity for rendering national service for a week or two, by working as transplantation labour, particularly those from the rural parts and others who make demands on free midday meals, etc.

Wheat: The art of cultivating wheat has been practised in India from time immemorial and grains unearthed from the ruins
of Mohenjo Daro are identified as a variety of *Triticum Compactum*, a type which is even now cultivated in south West Panjab. Although the extent of wheat production in India is much less than that of rice, yet wheat ranks second to rice in importance as a food grain. It must be noted that even in the Panjab where it is a major crop, it is not produced by any large scale methods, quite contrary to the conditions that exist in the temperate grasslands of the world, like the Canadian and United States Prairies, the Argentine Pampas, etc. Wheat farming throughout India, like rice farming, is done with little or no machines, no mechanical tractors, harvestors or thrashers.

Its cultivation, however, is carried on in regions where the climate and other conditions are very different from that of rice. Wheat is a grass first and then a grain and it requires moisture in its early period of growth and warmth when the grain is ripening. The quantity of grain on each stalk would depend upon the previous development of the grass, a cool wet growing season is ideal for the plant to produce a large number of stalks, and, therefore, a large quantity of grain. This is as important as a dry and sunny season for ripening the grain before harvest. But if the temperatures are very high towards the ripening season, the plant generally suffers from fungous diseases, especially so when the air is humid. As a consequence, wheat has to be harvested before the summer sets in, that is, long before the monsoon. It is only in the winter season that the weather is sufficiently cold in India, when the bulk of the grain is cultivated. The extent of cultivation and the distribution of the crop depends entirely on the length of the cool season since they have to be harvested before the onset of summer. Indian wheats must be and are fast growing varieties which mature in 3 to 4 months, but because they mature under dry heat in the months of April and May, the grain is a white, hard variety and has been in great demand in western Europe for mixing with the soft wheats of Europe.

As far as the rainfall conditions are concerned, it grows in regions of relatively dry climate. Even where the conditions of evaporation are as high as in India, wheat seldom thrives where the rainfall is over 100 cm. (40"). The character of the grain is much influenced by the amount and seasonal distribution of rainfall, the
grain of humid regions is soft and starchy with a weak flour, while that of drier land is harder with a richer protein content. If the rainfall is more than 100 cm, it is generally found that the plant suffers from fungoid diseases; secondly, the vegetative growth of the plant is promoted at the expense of fruiting; and thirdly, wheat has to compete with rice, and invariably rice is preferred because of its much greater yield per unit area.

It is, therefore, found that wheat cannot be cultivated in India during the period of the tropical monsoon, July to September, nor during the period of intensive tropical heat which precedes the monsoon from May to July. In other words, wheat is a *rabi* crop: its cultivation is restricted to the months from October to April, which means that it is generally cultivated on the basis of the water stored up by the sub-soil during the previous monsoon rainfall, unless irrigation facilities are available. Even a small quantity of winter rainfall in the months of January and February would be exceptionally useful for the plant and it is possible to see a close relationship between the regions of winter rains of the northwest India and those of wheat cultivation.

The areas climatically most suitable are Panjab, Western Uttar Pradesh, the eastern parts of Rajasthan and northern parts of Madhya Pradesh, in all of which irrigation is essential, but in the *regur* ridden tracts in the southeastern parts of Gujarat, the eastern parts of Maharashtra and the northwestern parts of Andhra Pradesh, it is an unirrigated crop. In eastern Uttar Pradesh, where the rainfall is heavier, wheat gradually gives place to rice.

Different varieties are grown in India and several improved strains have been discovered in the country at the Agricultural Research Institute, Delhi, some of which have found their way, even to Canada, *e.g.* the *Durum* variety.

The total area under cultivation has been increasing steadily since 1947, from about 10 million hectares in 1947 to more than 12 millions in 1965. But the average yield per unit area is still not very good, approximately about 52 quintals per hectare, only a third of the yield in Europe, and a fourth of what it is in Britain. In recent years, because of the improved varieties, the yield has been
slightly increasing to approximately 17.5 quintals per hectare. But even this, it must be remembered, is not very satisfactory. This is partly because the strains have to be fast growing ones ready for harvest before the onset of the high temperature in summer. The general rule that the yield of any crop is dependent upon the period of its growth, that is, it is greater if it has been in the ground for a longer period of time and vice versa is applicable in this case also.

In India, besides rice and wheat, a large quantity of millets are also cultivated, amongst which, the most important varieties are (i) Jowar (Andropogea Sorghum) (pearl millet), (ii) Bajra (Bullrush millet) with seeds similar to Jowar), (iii) Ragi (finger millet) (buck wheat) and (iv) small quantities of Maize (American Corn).

**Jowar:** Jowar is an important staple foodcrop in Deccan Plateau, and is cultivated over the whole of India wherever rice cannot be grown because of lack of water (less than 100 cm. of rainfall), even in the mountains where the climate and soil conditions are suitable. It is generally grown as a kharif crop, with wheat as the rabi crop, and is sown as soon as the monsoon rains have softened the ground sufficiently, to permit agricultural operations. Jowar is absent in the eastern and northeastern parts of the country where the rainfall is adequate for rice.

In addition to being a highly important food grain, its stalk is used as feed for cattle. Approximately 17 million hectares are under Jowar with a total production of 7 million tonnes, the average yield being 4.5 quintals per hectare. The application of modern methods of farming and the use of improved seeds in recent years have gone a long way towards increasing the production, but it is possible to augment it even more so.

**Bajra:** It is a millet similar to jowar but smaller in size, jowar being the giant variety. It is also a summer crop (kharif crop) but is found in those parts of the country where the rainfall is more dependable. It is more drought-resisting than Jowar and, therefore, occupies a large area in the dry parts of the Panjab, Central Rajasthan and the Peninsula. It takes less time to mature than Jowar and in some areas, therefore, it is cultivated when the monsoon rains are unusually delayed. On an average, about 11 million
hectares are under bajra, producing about three million tonnes, with an average yield approximately two third of what it is for Jowar. It is also a crop used by both man and beast, the grain by man and the stalks by cattle.

*Ragi*: Ragi (buck wheat) is sometimes called finger millet, because its fine seeds are carried on a cluster of five stalks like the fingers of a human palm. The grain has an extraordinarily high nutritional value. Its cultivation is almost exclusively confined to the Mysore plateau. It is also a dry crop like Jowar and better than that of Jowar or Bajra. Its yield per acre is nearly double that of Jowar and three times that of Bajra, but the total area is small, which has remained at about 2 to 2.5 million hectares, producing about 1.9 million tonnes. It takes only four months to mature and it is a supplementary food crop of the rice regions of the Mysore Plateau.

A very large number of other cereal crops are grown in summer, throughout the country. Together they occupy upto about 5 to 6 million hectares.

*Milo* (American Corn or Maize) is another food grain of minor importance and it is cultivated under a variety of conditions throughout northern and central India, Uttar Pradesh and Bihar. Since it cannot stand inundation, but requires at the same time, good deal of moisture, it is cultivated more on the Himalayan foothills. Its acreage and production have been more or less stationary, approximately 4 million hectares with an average yield twice that of jowar and a total production of nearly three million tonnes. Compared to yields in the United States, the Indian yield is usually less than one-third, and in some years, it may be as low as one fifth.

*Barley* is a winter crop occupying less than 5% of the area under food grains with a production also of 5% of the total food grains. It is only grown in north India, mostly in Uttar Pradesh, where the land is so poor that neither wheat nor rice can be cultivated with confidence. Because it requires less water than wheat, it can be planted later and harvested earlier, especially in those areas where the monsoon is very late in its commencement. But more than that, Barley has another very important and useful property in that it can stand alkaline soils. It is unfortunate that there is a prejudice
against it and by local traditions, it is only consumed, if no other cereal is available. Otherwise, it would be quite easy to expand its cultivation very significantly, particularly in the poor alkaline soils of Uttar Pradesh.

Grams, Pulses, etc. Most of the protein requirements of the human body are supplied in the Indian diet by grams and pulses, mainly because of the prevailing cult of vegetarianism. Gram (Bengal gram or Chick pea) is the most important pulse crop, the annual production being approximately of the order of 5 million tonnes. It is grown as a winter crop in the wheat producing areas, with considerable concentration in Uttar Pradesh, south west Panjab and northern Madhya Pradesh. It is a leguminous crop with fine, bluish green leaves which are usually ploughed into the soil, thereby injecting into it, a good dose of nitrogen. The total area under Grams is about 10 million hectares, with an average yield of nearly 5 quintals per hectare.

The most important pulse second only to gram in area is arhar, (or Tur, i.e. Cajanus Indicus or pigeon pea). It is a plant with a stem and branches, with dark green leaves, and yellow flowers. Most of the arhar grown in India is found to the east and south of the principal wheat growing areas. The total area under arhar is about 2.5 million hectares; the average yield being 6.5 quintals per hectare; the total production is about 1.7 million tonnes.

There are, besides these, various other pulses grown in India; black gram, green gram, horse gram, etc. India is a remarkable example of the adaptation of a leguminous crop to a wide range of conditions of climate, soil and water supply. Almost on every type of soil, one finds a leguminous crop all the way from the Himalayas to Cape Comorin (Kanyakumari). The ryot is fully cognizant of the value of such a crop as a fertilizer.

Oil Seeds: Ground nuts (peanuts) almost occupy about 6 million hectares, practically half the total area devoted to oil seeds in India. It is extensively grown on the red soils of south India and the black soils in the north western parts of peninsular India in Maharashtra and Gujarat, where rice cannot be cultivated. Most of the oil is used in the manufacture of vanaspati, a local brand of
Plate VI. Kota Barrage on River Chambal
PLATE VII. Girls at work in Tea Plantation
vegetable oil for cooking.

**Rape and Mustard:** They both look alike in the field and for all practical purposes can be treated together. Both are winter crops found mainly in the chief wheat zones of North India and to a lesser extent in northeast India in West Bengal and Assam. They are generally cultivated together with wheat and harvested earlier than wheat. The area again is approximately half that of groundnuts, producing less than a quarter, the average yield being less than half that of ground nuts.

Besides rape and mustard, *Sesame* is an important oil seed grown in the southwestern parts of the wheat zone and central and southern India. The total area under *sesame* is about 2 million hectares, but the average yield is extremely low, about 2 quintals per hectare.

Other oil seeds are Castor concentrated on less fertile land with more uncertain rainfall and found in parts of Andhra Pradesh, Maharashtra and Rajasthan.

**Cocoanut Oil:** Cocoanut oil is a by-product of the *coconut* industry. India has about 0.6 million hectares under cocoanuts, mostly located in the West Coast. India ranks as the third producer of the world, after Indonesia and Japan, both in acreage and production of cocoanuts and it is mostly a crop dominant in Kerala, the Konkan coast and in the deltas of the Cauveri, Godavari, Krishna, and Mahanadi. Over half the cocoanut crop is being consumed as nuts and the rest is dried up and converted into *copra* from which the oil is extracted. The annual production of cocoanut oil in India is about 170,000 tonnes, but imports mainly from Ceylon generally to the extent of 25,000 tonnes has been a characteristic trait during the last few years.

**Sugar Cane:** India has now been self-sufficient in sugar with a little surplus for export during the last few years. Although sugar cane is a tropical plant, its cultivation in India is more widespread in the temperate region, mainly because it requires an assured supply of water. Sugar cane demands soils of a heavy texture, deep loams rich in humus being the best. The temperature requirements are a mean annual temperature of 20° C. (68° F.) with a period
of summer lasting for about 6 to 9 months, when the temperature is at least 5 deg. to 6 deg. C. warmer. The minimum rainfall requirements, without irrigation, are between 125 cm. to 200 cm., falling during the active period of growth of six months with a dry season following it for harvest. Seventy per cent of the sugar cane is grown on irrigated land. It is planted in March and frequently irrigated during the dry summer months. The perennial canal systems of the Gangetic lowland in the north alone are able to do this more effectively than the peninsular region of the south, where such assured water supply is only available in the deltas, but here, it meets with effective competition from rice. It is not surprising, therefore, that in India, sugar cane cultivation is dominant in Uttar Pradesh, Bihar, Panjab, and in all parts of the country where irrigation is dependable. Till recently, a large proportion of the sugar cane cultivated was converted into Gur (brown sugar or jaggery) but since 1931, after tariff protection was given to the industry, manufacture of white sugar was started on a very extensive scale. The gross area under the crop is round about two million hectares, with a total yield of about 2 million tonnes of white sugar and 2.5 million tons of gur. The average cane yield is low in the north, while in the south it is much higher. Remarkable progress in the improvements of varieties of cane has been achieved in the Sugar Cane Research Institute at Coimbatore, some new strains have been discovered which today are found as far away as Jamaica and Java, but their cultivation has not been so widespread over India. Even today a sizeable portion of the canes cultivated in India is of the indigenous varieties, which are by no means good yielders. This is another example in which the problem of Indian agriculture is not lack of knowledge, but the inability to apply the existing knowledge more widely in the field. There are at least 20 million sugar cane cultivators in the country and it is the third largest industry.

*Fibre Crops:* Cotton is the most important non-food crop in India which occupies the largest area, nearly 7 to 8% of the total cultivated land. Climatically, it requires a temperature of 20 deg. C. to 25 deg. C. during the growing season with no sudden change
of temperature. The soil should be neither too wet nor too dry, and the best soil is one which is a deep medium loam, well drained and retentive of moisture. Too dry a soil makes the plant dwarfed, too wet a soil causes it to run to leaf at the expense of fruiting. It is true to say, that for cotton, the mechanical texture of the soil is even more important than the chemical composition. Heavy rainfall or high winds at the flowering or the fruiting season will damage the bolls. However, the Indian cotton is similar to the Indian Jowar in that it can withstand and survive the most adverse conditions of climate. Generally speaking, good cotton takes about 7 to 8 months to mature, but the indigenous cottons are all fast-growing varieties taking 3½ to 5 months. In the cultivation of this crop, there are no large-scale operations as in the plantations of the U.S.A.; it is done on a small farm on the usual subsistence standards.

Cotton is a dry crop found in those areas where the rainfall is between 50 to 100 cm. Most varieties of Indian cotton were till recently short stapled, the length of the staple being less than 2.5 cm. For the manufacture of fine counts of yarn, the staple length should be more than 2.5 cm. (1"), and therefore, India had to import good quality long staple cotton from abroad for the manufacture of superior yarns. Efforts are now being made to improve the cultivation of long staple cotton in India and it is not unlikely that within a few years, the country would be totally independent of imports. The Indian Cotton Committee has done a considerable amount of research work in evolving excellent varieties of cotton and the main difficulty seems to be in the application of this knowledge by the farmer.

Cotton is generally grown in the rainy summer months and picking is done during the dry autumn season and the early winter months. It takes about 5 to 7 months for the plant from sowing to harvest, although there are some indigenous varieties which take as little as 3½ months. Average cotton yield in India is extremely poor, approximately 1.2 quintals per hectare (95 lbs. per acre) which is less than a third of the average yield of the United States. Most of the cotton is grown without irrigation in regions where the rainfall is about 75 cm. but it is generally found that cotton cultivated under
irrigation has a better yield, nearly double the average figures. The area under cotton cultivation has been steadily increasing, more so after partition, since the major sources of supply of good quality cotton formerly was from Sind and West Panjab, that is from Pakistan and these, on partition, became external and foreign sources. Short staple varieties less than 1.7 cm. (11/16") long (nearly 23% of the total) are obtained from Madhya Pradesh, Berar, Khandesh, Rajasthan, and Uttar Pradesh and the long staple varieties more than 2.2 cm. (7/8") long are obtained from Gujarat, Kathiawar, Madras and Mysore (17%), while the medium varieties are widely distributed (1.7 to 2.2 cm. long—50%).

**Jute:** The major world production of Jute is concentrated in the Gangetic delta. As a result of partition, a large part of this delta, more than three quarters of the area under Jute, has been ceded to Pakistan and the area which India has inherited is less than a quarter. Further more, the Gangetic drainage is more active in the eastern parts of the delta and consequently, the crop in this well drained soil is cleaner and whiter than that of West Bengal. In other words, the Indian Jute compared to Pakistani Jute is not only poor in quantity but equally poor in quality also.

Climatically, it requires a high temperature and a heavy rainfall starting early in the summer. There are two varieties, high grown and low grown. Sowing starts earlier in the case of the low grown variety, even as early as February, and harvesting is in July when the flood waters are high; but for the high grown variety sowing commences in April and May and reaping is in August/September. The fibre of Jute is weaker and less durable than that of flax or hemp, and is somewhat easily rotten by water.

The successful production of Jute depends upon the following:

(i) an annual flood of silt-laden water. In well-drained soil the quality of the fibre is superior;

(ii) there should be very little change of temperature during the growing period of four months, April—July;

(iii) clean water for wetting purposes, that is, the rivers have to be active in removing the silt; the Ganges is not so good as some of the northern rivers; and
(iv) 25 cms. (ten inches) of rain, or more in the month of May is perhaps the most important factor in determining the quality.

The above four conditions are generally prevalent in East Pakistan and it is no wonder then, that the best quality of jute comes from East Pakistan where the yield is better. On a careful assessment, therefore, it may appear that only 10% of the area devoted to jute is ideally suited to the crop, but its cultivation has expanded throughout the delta, mainly because it is the only cash crop of the region and it is true that the rural economy of the Gangetic delta (West Bengal and East Pakistan) is pre-eminently dependent on jute.

Many people, therefore, seem to think that jute is the most important crop of the Gangetic delta. This is far from being true. Jute occupies only 10% of the cultivated area of the delta in West Bengal and East Pakistan put together, while rice occupies nearly 75% of the area. In other words, jute occupies less than a seventh of the acreage under rice, but because it is a cash crop and brings money from outside, it is of great significance to the agriculturists who constitute more than 80% of the population of the delta.

On an assessment of the comparative costs and profits of rice and jute cultivation, it must be confessed that jute is much more remunerative than rice, nearly twice. Probably sugar cane and tobacco are the only other crops which are more remunerative. Throughout the delta, jute is grown in small plots by individual agriculturists who are mostly men of small means and resources and therefore, it contrasts effectively with the plantation crops like tea and rubber. There is no organisation among the agriculturists either with regard to production or marketing, with the result that there is an army of middle men who swindle the ryot. Cooperative farming and marketing can certainly be introduced with advantage.

In spite of all the efforts for effectively increasing the area under jute, it has been found that its cultivation outside the Gangetic delta is unsuccessful. Efforts are now being made to improve the average yield rather than expand the area and there has been some success, the estimated figures for 1966 being 1.52 tonnes per hectare (1200 lbs. per acre). The total acreage is about three quarter million
hectares, the average production being four million bales each of
180 kg. (400 lbs.)

*Tobacco:* India is the third largest producer of tobacco in the
world, preceded only by U.S.A. and China. The total area under
tobacco is about 360,000 hectares (930,000 acres); production is not
increasing mainly because of Government restrictions. The major
tobacco area is in the Guntur district of Andhra Pradesh, where
the flue-cured tobacco is grown. In Madras, in the districts
of Tiruchirappally (Trichinopoly) and in the Dindigul Taluk of
Madurai district, tobacco is grown for making *cheroots,* cigars, etc.
For *beedis*¹ tobacco is being grown widely, in Maharashtra and
Madhya Pradesh and for *hookahs*² in West Bengal and the western
parts of Uttar Pradesh. The total production in India is ap-
proximately 250 million kg. with an average yield of 700 kg. per
hectare (640 lb. per acre).

There are many other crops which are cultivated in India, *e.g.*
potatoes in about 300,000 hectares, producing about 2 million
toennes grown in the winter months, sweet potatoes in about 150,000
hectares providing about a million tonnes, and tapioca, extensively
grown in Kerala, in about 250,000 hectares producing about 1.5
million tonnes. In a country like India, where there is so much of
shortage of cereal foods, the cultivation of root crops like potatoes
and tapioca should be expanded.

India cultivates a variety of spices, pepper, chillies of many types
(orange and red varieties) in about 600,000 hectares (1.5 million
acres) producing about 350,000 tonnes. Narcotics like opium, the
production of which is under very strict government control, is
cultivated in about 20,000 hectares on the slopes of the northern
mountains. The production of indigo is almost completely extinct,
since the introduction of synthetic dyes.

*Plantation Crops:* A plantation in India means a block of land,
exclusively, or predominantly devoted to the commercial cultivation
of a perennial crop like tea, coffee, rubber, etc. Some plantations
are small, about five hectares and some may be very vast, running

¹The indigenous type of cigarette.
²Where the smoke is inhaled through water.
upto 2,000 hectares and it is, therefore, not the size of the area but the specialization on a single crop that is its characteristic. The plantation industry is the only large scale commercial agricultural enterprise in India but it occupies less than 1% of the total cultivated land in India giving employment to less than 1% of the agricultural population. But it is responsible for earning as much as 25 to 30 percent of the foreign exchange for India. Tea, rubber, coffee and cinchona come almost exclusively from plantations. There are others like cocoanuts, cardamom, pepper, cashewnuts and ginger which sometimes are grown under plantation conditions, but more frequently as part of the farming operations in the home gardens. Plantations in India started about 1830, notably by the British for tea and coffee. Even today, British interests in the plantations are large, especially for the tea gardens of the north in Assam and Bengal, while 75% of the plantations in the south are practically owned by Indians. Most of the plantations have been developed by clearing of forests on new lands in hill areas. The large tea plantations are in North Bengal on the slopes of the Brahmaputra River Valley bordering Assam and in the Cachar hills of Assam, with a few others, very much smaller in size in the hills of Bihar, Panjab and Himachal Pradesh. In the south, the major production comes from the Nilgiris and the adjoining high-lands in the Western Ghats, the high ranges of Kerala, the Anamalais the Palnis and Mahendragiri hills.

**Tea:** India ranks first amongst the tea growing countries of the world and in recent years, it has been producing about 300 million kg., more than half the world’s production, excluding that of China. (China may be a larger producer than India, but there are no reliable statistical figures of production). About 60% to 70% of the tea grown in India is exported, nearly 200 million kg. valued at 300 million dollars, three-fourths of it to U.K., the second largest consumer being U.S.A. Indian home consumption of tea has increased very considerably in recent years and it is now estimated to be approximately a third of the total crop.

The tea plant is probably a native of Assam and northern Burma. As a plant, it grows to a height of 10 metres, but since the leaves of
the plant have to be plucked and collected, the tree is deliberately cut and pruned to a height of about 1.5 metres. Tea requires a warm climate with abundant rainfall and high humidity. The temperature throughout the year should be in the vicinity of 22°C to 25°C and if the temperature goes up to more than 35°C, the plant may be damaged. It requires a minimum of 150 cm. of rainfall, evenly distributed, but can stand much higher rains, provided the drainage is good. Thus, wherever the rainfall is much higher, the plantations are developed on the slopes to promote drainage, as otherwise the roots of the plant may get rotted. It can stand a variety of soils, but they must be deep and well drained.

Tea is cultivated in India at very different elevations depending upon the temperature conditions. In the south, most tea plantations are in the highlands, 800 metres or above, because otherwise the temperatures are too high. In the north, especially in the Duars and Assam, tea is cultivated at an altitude less than 600 metres. Assam accounts for more than half the tea production and the neighbouring areas for a quarter. The tea growing districts are Kamrup, Darrang, Lakhimpur and Sadiya to the north of the Brahmaputra river and Sibsagar and Nowgong south of it. It is also grown extensively in the Cachar hills in the Surma valley, adjoining which are the tea plantations of East Pakistan. It is grown in Darjeeling hills and in the Duars of North Bengal. In the south, tea is cultivated in the Kerala hills and in the Nilgiri hills of Madras, each producing respectively 9% and 8% of the Indian crop. Outside these areas, a small quantity of tea (less than 2% of the Indian production) is cultivated in Coorg in Mysore and all along the foothills of the Himalayas from Panjab to Bihar. Generally speaking, the higher the tea is grown, the better its quality, one of the finest being the broken orange pekoe cultivated at altitudes above 2,000 metres.

Coffee: Indian coffee is of a high quality and is in great demand in the world's markets. The production is very small—about 30 million kg., 1% of the world's production. Domestic consumption practically consumes 7/8 of the entire crop. Coffee has been grown in India since the 16th Century, when it was introduced first
The demarcation of the Gujarat West Pakistan Boundary in accordance with the Indo-Pakistan Western Boundary Case Tribunal Award is in progress (1968).
into the country by the Haj pilgrims on return from Mecca. It is not impossible that both Indonesia and Brazil received their first coffee plant either from India or by way of India. In 1830, large plantations were established by the British in Mysore and Coorg and by 1850 Indian planters also entered the field and the area increased very considerably towards the end of the century, to more than 120,000 hectares; nearly 1\(\frac{1}{2}\) times the present area under the crop. The majority of the estates, however, are relatively small, most of them between 20 and 40 hectares and about 35,000 plantations are reported to be less than 2 hectares each, while very few may go up to 400 hectares or more, in size. Indian yields are far lower than those of Brazil, Columbia and British East Africa. Till recently, Arabica coffee alone was grown, but robusta coffee, a native of Central Africa has now been introduced since the beginning of the century. This Congo coffee is a hardier plant and its yield is much poorer.

The ideal temperature for the coffee plant is between 15° to 25° C. with the average at 20° C. Lower or higher temperatures retard its growth. It does not tolerate frost. Optimum yields are found where the rainfall between is 150 to 225 cm., well distributed throughout the year, except for the period following harvest, when the berries have got to be dried. It thrives best in rich, well-drained soils. Arabica is best grown at elevations of 800 to 2,000 metres while Congo coffee is found even in the low-lying lands. Seventy percent of the coffee in India is grown in the Coorg and Chickmagalur districts of Mysore, and twenty percent in Madras-Kerala States in the adjoining districts of Nilgiris and North Malabar (Wynaad).

Coffee plantations in India have suffered a host of disasters, sometimes climatic through drought or excessive rainfall, or sometimes as a result of diseases like the fungus leaf disease, but even more serious was the pest of the stem boring beetle, which in some cases led to the complete abandonment of this crop, both in India and Ceylon. The Indian Coffee Board which was established in 1940, has controlled the industry since its origin; it now purchases the entire crop of all plantations of more than 2 hectares size, and fixes wholesale and retail prices and conducts campaigns for the
spread of coffee consumption.

Rubber: The commercial cultivation of Para rubber (Hevea brasiliensis) commenced in the beginning of the century in the high ranges of South Kerala. Although, its cultivation has now moved out beyond the original tract, yet it is almost exclusively found in the Kerala region. There are still a few large plantations each 200 hectares in size, originally founded by the Britishers, accounting for less than two third of the total acreage, but today more than a third of the area is in Indian hands and the expansion in recent years has been of tiny holdings of two hectares each, generally a one family operation.

In Kerala, rubber is cultivated at an altitude between 300 to 700 metres; the climatic requirements of the plant are heavy rains (300 cm.) well distributed throughout the year, constant humidity and a temperature in excess of 20° C. The crop does well in a variety of soils, even on the poor laterites, provided adequate fertilizer is applied. More than 80% of the Indian crop is from Kerala and the remaining comes from the adjoining areas of Nilgiris and Madurai (Madras State) and Coorg (in Mysore). The average yield of rubber is not very high, approximately half of what it is in Malaya, about 300 kg. per hectare (270 lb. per acre) while that in Malaya is between 400 to 500 lb. per acre. The entire produce is practically used up internally for the manufacture of tyres, tubes etc., Rubber prices are controlled by the Government of India and fixed by the Indian Rubber Board.

Cinchona: The Cinchona tree from whose bark quinine, the remedy for malarial fever is extracted, is grown on Government plantations, totalling approx. 5,000 hectares, in area, two-third of which is in Nilgiris in Madras and the remaining in North Bengal, Kerala, Assam, etc. Although the demand for cinchona has been reduced through synthetic drugs, still the bulk of the bark produced in the country is locally consumed for the manufacture of the drug. The tree requires an average rainfall of 250 to 400 cm. well distributed throughout the year and a temperature between 18 to 25° C., and is generally found at altitudes of 1,000 metres.

Cashewnuts: Today India is the largest manufacturer of cashew
nuts, an industry which has developed during the last 25 years. Exports were as little as 3 tonnes to 15 tonnes in 1925, but today it is more than 25,000 tonnes. At the same time it must be remembered that the industry imports raw cashewnuts from East Africa in substantial quantities, the processing is done all along the West Coast, Quilon and Mangalore being the most important centres. The nuts are fried and roasted and then the shells are broken and removed by careful hammering—all processes in which the female element of labour is preponderant. They require a certain dexterity of fingers which today is practically the monopoly of these West Coast women. But at any moment it is not unlikely that the African women would also unravel the mysteries of this art and process the nuts in Africa for direct export abroad.

Cashew plantations were introduced by the Portuguese from Brazil, sometime in the 16th century. The trees are grown mostly in home gardens all along the slopes of the Western Ghats, Mangalore being the principal centre. It will stand the most adverse conditions of soil and climate. It is found in different areas under different conditions, in laterite soils on the West Coast with a rainfall between 300 cm. to 400 cm. and on sandy soils on the East Coast, with even lower rainfall, about 100 cm. The nut ripens during the months of February to June. It would be desirable to expand the cultivation of this tree crop, as it gives not only an excellent yield in the form of this nut, but it would form an equally excellent source of fuel for which there is almost an insatiable demand in the country.

Cardamom: Cardamom, the aromatic spice, is cultivated in regions of constant warmth, high humidity and heavy rainfall 150 to 375 cm., well distributed throughout the year. In India, its cultivation is found in the high ranges of Kerala where tea is cultivated, between the elevations of 800 to 1,600 metres. These southern hills of Kerala, have been named Cardamom hills, obviously because of its importance.

Pepper: From the earliest times, India has been a rich producer of pepper and wave after wave of Westerners came to India in search of this spice. Today, India supplies about half the world market, the remainder coming mostly from Indonesia, the crop having been
introduced from Malabar into the region by the Dutch. Its cultivation is done essentially as a rural undertaking in small units, every home has its pepper vines, and, therefore, it is difficult to determine precisely the area under cultivation. It is estimated that the total area would be about 80 to 90 thousand hectares, found mainly on the West Coast extending from Konkan to Cape Comorin and to a very limited extent in Andhra and Orissa coasts. In Kerala, it is widely distributed and is cultivated in every home garden; till recently the prosperity of Kerala was pickled in pepper. It requires a high temperature, a high humidity and abundant rainfall. As a vine, it requires support trees for climbing and it can only thrive in shade, protected from high wind. It is, therefore, interspersed with shrubs and trees. Pepper is cultivated from sea level right up to an altitude of 1,200 metres. It grows to a height of about 20 ft. and continues to bear in about 4 years time for about 30 years.

**Ginger:** Ginger has been cultivated for thousands of years, the bulk of it is consumed internally and very little enters international trade. Actually, it is grown widely in India, the total area is about 20,000 hectares. Kerala is its main home. It requires only moderate moisture and can stand varieties of soil.

**Fruits:** Many fruit trees grown in India are found in home gardens and it is, therefore, impossible even to estimate precisely the area under fruits, but one thing appears to be certain, that the area under fruits is extremely small in relation to the total area under cultivation. It must also be remembered that fruits in India are only sold during the seasons in which they ripen, there is hardly any preservation of fruits. Most widely grown fruits are Mangoes, Bananas, Plantains, Oranges, etc. Citrus fruits are of various types, the greatest centres of which are around Nagpur and Poona. Smaller centres are found in the Panjab, Madhya Pradesh and Coorg where the varieties are sweet, as contrasted with the Guntur District of Andhra Pradesh where they are sour. Mango is the most important fruit in India, cultivated for thousands of years and in almost every part of India, this is cultivated in the home gardens, in the villages. Several varieties are grown, from the large Alfonso variety (named after the Portuguese Viceroy Alfonso de Alburquerque to whom
this was a great delicacy) and the extremely sweet Banganappally variety found in Andhra Pradesh, to the small indigenous ones. The mango tree requires a high temperature with a heavy rainfall in the period just before flowering and a dry season for the ripening of the fruit.

Plantains or Bananas are found widely throughout the country, again in home gardens; about 150,000 hectares are probably devoted to this crop.

The consumption of fruits in India is extremely low and more attention should be devoted to expanding the area under fruit culture, especially from the nutritional point of view.

*Animal Husbandry:* India has the largest bovine population in the world, approximately 150 million cattle, 43 million buffaloes, 40 million sheep, 47 million goats, 1.5 million horses, etc. There is little or no demand for beef owing to religious inhibitions. As a matter of fact, bovine cattle are protected from indiscriminate slaughter by State legislation and cattle protection is one of the directive principles of the Constitution of India. The annual yield of milk of a cow varies very considerably from 30 kg. (65 lb.) in Madhya Pradesh to 660 kg. (1,445 lb.) in East Punjab;¹ the yield of a buffalo varies from 120 kg. (315 lbs.) in Assam to 1,100 kg. (2,500 lb.) in Saurashtra. India with more than 15 times the number of cattle in Canada, has an yield of milk, only twice as great!! From early times, a large proportion of the milk has been utilised for making ghee (clarified butter) and therefore, greater attention has been devoted to richness rather than yield.

It cannot be denied that there exists a tremendous surplus of useless and inefficient cattle which press upon the inadequate supplies of fodder. The probable cause why cattle deteriorate in stature, stamina and in productive capacity is mal-nutrition and it may be induced, at least partly by the poor food value of the paddy

¹The average consumption of milk per head per day in India is one of the lowest on record, about 0.18 kg. (6 oz.), but it varies from 0.6 kg. (19 oz.), in Saurashtra to 0.03 kg. (1.2 oz.) in Assam, to that of Canada 1.5 kg. (57 oz.), Australia 1.2 kg. (44 oz.) United Kingdom 1.1 kg. (40 oz.) and U.S.A. 1 kg. (36 oz.).
straw which forms either their exclusive diet, or a very large part of it. A significantly large proportion of milch cattle get little or no succulent fodder except for the natural grazing during the monsoon months. The various reserves for grazing are not properly managed to yield the fullest benefit. Silage is unknown and the annual production of concentrates other than rice, gram and gowra is about 2.5 million tonnes, giving a per capita quota of 25 lb. per annum!

With approximately a fifth of the world's cattle, India is not in a position to afford the luxury of maintaining separate types for milch and draught. On the other hand, it must maintain a dual purpose animal, the male for transport and agricultural operations, and the female for milk. By constructing Gosalas (homes for the cows), the First Five-Year Plan proposed segregating the old and inferior cattle, but the achievement till recently showed that only a small percentage—3% of the money set apart for this—had been spent, showing thereby that it has not received the popular support that was expected. Several key village centres and artificial insemination centres have been established, but only in South India and Bihar are the latter popular. Very much more work will have to be done in the field to popularise these methods and to segregate the old and infirm cattle.

Fishing: For a diet which is mostly comprising of cereals like rice and vegetables as in India, fish would form an excellent supplementary, providing the necessary proteins,¹ and its consumption has consequently both a qualitative and quantitative value. The potentialities for the development of the fishing industry, are, indeed very great. Not even a minute fraction of the wealth which lies off the 2,900 miles of the coastline of India is being exploited, mainly because of the limited range of the fishing vessels and the inadequate freezing facilities for storage and distribution. Off the coast of Kerala, deep sea fishing is being experimentally conducted by the Mother-Craft method under the guidance of Norwegian experts. Besides

¹The annual per capita consumption of fish in 1950 in India was estimated to be as low as 1.5 kg. (3 lb.) and this figure stands as a remarkable contrast to the neighbouring countries like Ceylon and Burma where it is 7 kg. and 32 kg. (16 and 70 lb.) respectively.
these, eleven insulated vans have been received and they are being operated by the Government through co-operative societies in Bombay, Madras and Kerala. Furthermore, cold storage plants have also been established at Mangalore, Calicut, and Satpati (Bombay). The industry is getting modernised and its prospects are rosy.
CHAPTER VIII
POWER RESOURCES AND DEVELOPMENT

India is still in the agricultural age, the amount of industrial development that has taken place being small. The latest census suggests that the population engaged in organised industries is not more than 2.4 millions.

India, therefore, has not yet entered the machine age and for any country to remain non-industrial is to subject itself to poverty and inefficiency. The nations which have increased their wealth look principally to come from industry, trade and transport. The rapid industrialisation of the country providing for diversified employment is an absolute must for progress. Most countries, as they advance in civilization and prosperity, reduce the percentage of population dependent on agriculture. About 130 years ago, in the U.S.A., 70% of the population was dependent on agriculture, but today, less than 10% is devoted to agricultural pursuits; in the meantime, the agricultural production in the country has increased, at least, three-fold. India, which at one time was greatly skilled in industries and produced such high quality manufactured goods that the European traders came in search of them from far and distant lands, is today condemned to a perpetual holiday.

The industrial development of any country is dependent on the organised development of its power resources. Every form of energy that we have on the surface of the earth is finally traceable to the sun, which accounts for the vast stores of solid, liquid and gaseous fuel that feed our furnaces. Under the most optimum conditions of insolation, every hectare would receive about seventeen thousand horse power in the form of radiant energy from the sun; if even a fraction of this could be directly harnessed, the problem of scarcity of power would have been solved, once and for ever. And the people of the tropics would be better off than those of the temperate lands of the world, obviously because the latter do not receive such dependable quantity of sunshine!!
Plate VIII. Bokharo Power Station
PLATE IX. Palana Coal Mines Bikaner

PLATE X. A view of Sindri Fertilizer Factory
Sources of energy are of two classes: *i.e.* (i) the replenishable and (ii) the non-replenishable and the distinction between these two is very important and vital:

(i) The replenishable resources are those generated continuously by the action of the sun as fast as they are being utilized; for example, (a) the energy of tides, winds, water power, solar heat, etc., and (b) the energy which could be derived by the utilization of forest trees and vegetables like potatoes, sugar cane, etc., (ii) the non-replenishable resources are the accumulated forms of energy; for example, coal, oil, natural gas, atomic minerals, etc., which are formed under the action of the sun, light and heat and which have been stored up, through the ages, in the bowels of the earth.

Today, the world depends much more upon these non-replenishable and exhaustible resources like coal, oil, atomic energy, etc., and it is certain that the rate at which these resources are being utilized at the present day is far greater than the rate at which they have accumulated in the past, and consequently the world will eventually get exhausted of these resources. In other words, as far as the power resources are concerned the world is following a policy of bankrupt economy, spending much more than what it earns.

On the other hand, the replenishable resources like solar heat, tides, winds, water power, etc., do not by their utilization leave the world any poorer. Amongst these, winds and tides have been and are being carefully studied for the generation of energy; but their application, however, has not become sufficiently widespread and this is equally true of directly harnessing solar energy. It is said that there is a blast furnace operating for about 250 days in a year, in the Pyrenees, directly converting solar heat to produce pig iron from iron ore, but still, its application has not become widespread. Enormous progress has, however, been made with hydro-power generation that today, all the world over, it is an important source of energy. In India coal, petroleum, natural gas and atomic energy, besides hydro-power, are all important sources of energy.

**Coal**

India has received a step-motherly treatment as far as her coal
resources are concerned both in quantity and in quality. The workable coal seams occur in two groups (i) the older deposits in the valleys of the Damodar, Mahanadi, Godavari and their tributaries, approximately constituting 98% of the total resources and (ii) the meagre, young deposits found as coal in Assam, Rajasthan and Kashmir and as lignite in Madras and Kerala, with low carbon and high sulphur content. Thus it is found that the most important coal measures of India are in the river valley fields in the northeast of India, lying east to west along the Damodar and Sone valleys and from northwest to southeast along the Mahanadi and Godavari valleys and their tributaries. Coal in these belts occur in two strata; (a) the Raniganj coal measures and (b) the Barakar coal measures. Seams of both measures vary in thickness from 0.3 to 30 metres, those occurring in Jharia and Bokaro being the thickest and of very high grade quality with low sulphur content, less than 1%, but the ash content is rather high, between 10 to 20 per cent. The Barakar coal is generally more valuable because of its lower moisture content and higher carbon content of 65% to 75%, while Raniganj has 54 to 60 percent. Barakar coal makes excellent coke and is, therefore, suitable for the blast furnace and is exclusively found in the coal fields of Jharia and Bokaro and in smaller amounts, in the coal fields of Jainthi and Giridih. Raniganj and Karanpara coals, however, when mixed with Jharia coal, make good coke.

The Damodar Valley in Bihar and West Bengal is easily the largest with the best reserves and is the most important coal producing region. The one field of primary importance is Jharia in Bihar, followed by Raniganj, which is located between the two states of Bihar and West Bengal; each of these produces approximately a third of the total production of the country. Other fields adjoining them produce about 16%. The Mahanadi field contributes 5% and the Godavari field about 10%. This indicates the poor distribution of coal from the national point of view, more than 80% of the coal is found in the Damodar Valley. The poverty of coal is very significant in Uttar Pradesh, Panjab, Maharashtra and South India, and some of the coal which Bombay and the South demand for their industries and railways has to be sent by coastal steamers from Calcutta—
the coal port of India, to save a railway haulage exceeding 1500 km.

The total resources appear to be large, about 65,000 to 154,000 million tonnes, but unfortunately, the efforts that have been made in recent years to determine the exploitable wealth in coal have not shown very encouraging results; and if our estimate is restricted to seams not less than 1½ metres (4 ft.) in thickness, with not more than 25% ash on a moisture free basis and at a depth not more than 1,200 metres (4,000 ft.) the resources which originally were estimated as much as 65,000 to 154,000 million tonnes dwindle down to 25,000 million tonnes and if the assessment is restricted to the resources in good quality coal, that is, with not more than 16% ash, in seams more than 1½ metres thick, occurring up to a depth of 600 metres, the reserves come down to 5,000 million tonnes, indeed, a very steep fall! And all the good quality coal is exclusively found in the fields of Raniganj, Jharia, Bokaro, Giridih and Karanpura. The non-cokable coals here are abundant and at the present rate of consumption probably should last for three or four centuries, but the real shortage is in good quality coking coal. It is estimated that the minable quantity of good quality coking coal is not much more than 2,000 million tonnes, indeed, a very unsatisfactory situation, when it is remembered that this may last at the present increased rate of consumption for not more than 25 years, and they will be completely exhausted in about 50 years! Obviously, therefore, every effort must be made to conserve the good quality coal and utilize it only for the manufacture of coke.

There is a good export market for Indian coal to Pakistan, Ceylon and most parts of South East Asia. Even Japan and perhaps Australia depend upon coal from abroad and India can supply some of them with low quality coal. Her competitors would be South Africa and perhaps China. On an average, India exports about 3 to 4 million tonnes of coal.

The production of coal has been increasing very significantly in the near past, in 1960, 15 million tonnes of coking coal and 37 million tonnes of non-coking coal; for 1966 the target was 97 million tonnes of which 31 millions was to be cokable, but the achievement has been only 70 million tonnes of coal. Altogether, India manufactures any-
where between 3.5 to 4 million tonnes of coke, about a third of which is soft coke, while the rest is hard coke manufactured chiefly by the iron and steel companies. The plants of these are located in the vicinity of the Damodar coal fields and at the smelting centres of Jamshedpur and Hirapur. In recent years, coal gas has been produced and distributed by two small firms in Bombay and Calcutta, approximately 0.03 million cubic metres (1.1 million c. ft.) each.

Petroleum

A belt of rocks in which oil and gas occur extend along the eastern banks of the Brahmaputra and Surma valleys from the extreme northeast of Assam through East Bengal to the islands off the Arakan-coast for a distance of 1,250 to 1,600 km. (800 to 1,000 miles). This belt is parallel to the Burma Oil belt and is of Tertiary Age. In these, the only areas where commercial exploitation is taking place are in Digboi and Naharkatiya in the Brahmaputra valley and Badarpur in the Surma valley. The two most important fields are Digboi and Naharkatiya, the former producing approximately 5,500 barrels per day. It is a small field just about 5 km. in length. Naharkatiya, west of Digboi was discovered in 1953 and it produces more than 2,500 barrels daily and this is becoming more and more important in the region.

During the last five years, oil has been discovered in Ankaleshwar in Gujarat and this field is apparently a continuation of the Persian Gulf fields. A new refinery has been erected at Koyli, near Baroda and it looks as though the production from Koyli is likely to be greater than that from Assam. The search for new sources of petroleum continues and trial borings are being made in the delta of the Cauveri and in the Gulf of Cambay.

Standard Vacuum refineries started production since 1954, the Burmah Shell since 1955 both at Bombay, and Caltex since 1957 at Vishakhapatnam, each producing over a million tonnes. The Government of India through the Indian Oil Corporation supplies large quantities of oil, for not merely her own refineries at Koyli, near Baroda, but equally well for the refineries of the Burmah Shell, Standard Vacuum and Caltex. New refineries are being construc-
ted, one at Nunmati near Guahati (2.75 million barrels capacity), another at Barauni in Bihar (2 million barrels capacity), while the third at Ankleshwar has recently gone on stream capable of producing 2 million barrels. The total crude produced in the three public sector undertakings of Nunmati, Barauni and Ankleshwar, in 1965 was 15.6 million barrels. A still more recent construction is the refinery, with a petro-chemical complex, at Madras.

The consumption of petroleum has been increasing very considerably and the bulk of the production, it is hoped, will soon be made by the Indian Oil Company and from its subsidiaries in the Gujarat region.

Power Alcohol can be produced from molasses, the byproduct of the sugar industry and could be mixed with petroleum in the ratio of not more than 1:4 to produce a fuel suitable for motor vehicles, although not so good as pure gasolene. About 420,000 tonnes of molasses are available from which more than 100 million litres (25 million gallons) of alcohol can be distilled. The production is only 45 million litres (ten million gallons) owing to the high cost of distillation.

**Rare Earths**

The beach sands of southern Kerala and Madras are extremely rich in ilmenite (the primary source for titanium) and rutile (a secondary source). Monazite (the source of thorium), garnet, zircon, etc. are concentrated in large sand patches, southwards from Chavara near Quilon to beyond the tip of Cape Comorin (Kanyakumari). The ilmenite has a 60% titanium content and the monazite a 10% thorium content, making this area probably the world's richest tract in these rare earths. Likewise, the thorium reserves—the base for the production of atomic energy—are also one of the largest in the world.

There are three stages in the production of electrical energy from these rare earths: (i) to utilise the natural uranium as fuel to produce power and the fissile element plutonium, (ii) to use plutonium as fuel and thorium as fertile material, producing power and converting a part of the thorium into U 233, and (iii) to use U 233
with thorium in breeder reactors, so that while electricity is generated, more U 233 is produced than what is burnt up. It is estimated that one tonne of uranium is equivalent to 10,000 tonnes of coal, so that, if atomic energy becomes a major source of energy, then obviously all our problems of transport costs of fuel become negligible.

Two new plants for the processing of monazite sands were opened during the first Five Year Plan, the first, the Indian rare earths at Alwaye, near Cochin, in 1952 with French collaboration, capable of handling 1500 tonnes a year, and a second plant on Trombay island (Bombay City) in 1955 under the direct supervision of the Indian Atomic Energy Commission, to utilize the thorium residue from the Alwaye Plant.

**Hydro-Electric Power Generation**

The geographic and economic factors associated with hydro-power development are fundamental. The physiographic factors of relief, or configuration must be such that (i) it is possible to have a short diversion from the head waters above to the turbines below and (ii) the rainfall must be such that there is a minimum amount of water available throughout the year. In case the rainfall is unevenly distributed, this would necessitate the construction of storage reservoirs and dams. The occurrence of glaciers and lakes in the courses of rivers will certainly regulate the flow of the rivers much better than anything which an engineer can construct, but it is only in the Himalayan rivers that such natural reservoirs are found.

It must be remembered that the rainfall of India is highly seasonal, with the total quantity fluctuating considerably from year to year. Assam, Eastern Bengal and the southern portion of the Western Ghats have a longer rainy season than anywhere else in India, with the dry season being not longer than 5 months in duration. Bombay has its rainfall from June to September, 3—4 months in the year, the remaining eight being dry. Obviously, this means that the power schemes pure and simple are difficult in India, because the power needs to be continuous, while the rainfall is seasonal and the rivers are non-perennial and, therefore, it is necessary to have artificial reservoirs and dams to regulate the monsoon flow. Another
problem of Indian rainfall is that occasionally it pours so heavily that any artificial dam that is constructed may burst due to the enormously high floods which come down with startling suddenness! The dams have got to be extra strong and this again increases the cost per unit of energy generated.

The main economic considerations are: (i) the cost of the scheme should be such that the interest on the capital outlay must be less than the cost of the competing fuel, (ii) while the thermal power station can always be installed at the market, hydro-power station are invariably located far away and this means long distance transmission lines have to be constructed for carrying the power from the generating stations in the mountainous regions to the consuming markets in the plains below; and (iii) it generally demands a large investment of capital expenditure. But at the present day, it is possible to link hydro-power generation with irrigation, another productive enterprise and the cost of the hydraulic works could be shared by both irrigation and power generation, so that the interests charged on the capital need not be borne by power generation, or irrigation, alone. This would certainly make hydro-power generation more competitive with coal and oil, and incidentally, it may be able to get some irrigation projects started which were shelved, as they were considered unproductive.

It must be remembered that the running cost of hydro-electric generation at any station is almost a fixed amount and the total cost does not depend upon the load, so that with increasing load, the hydro-electrical plant becomes more economical, while in the case of fuel consuming generators, every extra unit generated involves the consumption of an added amount of fuel with a definite cost; and therefore the total cost increases with increasing load, and at the same time the cost per unit will fall, but this however will not be directly proportionate to the number of units generated. Thus, the economic practicability of a hydro-electric scheme depends on the cost of the competing fuel in the market where the power is required.

There is a popular fallacy that water power costs nothing, but it must be remembered that the saving is only in the cost of the fuel. The criterion for economic competition than would be whether the
capital charges for interest and depreciation on the excess cost of the
water power plant would be substantially less than the cost of the
fuel used by the other. Thus, if the capital costs can be reduced by
linking power generation with another productive enterprise like
irrigation, then it becomes much more competitive.

Today it is generally true to say that it is cheaper to transmit power
(up to a distance of about 400 to 500 km.) than to transport the
bulky raw materials for any industry. Electricity is power in a
mobile form and it has the great merit of decentralising industry;
it is no longer necessary for the worker to leave his village home and
migrate to an industrial urban centre; power can reach him in his
own home. Electrical energy has none of the ugly features of the
steam-coal civilization. And, is this not a desideratum in itself?

Since hydro-power transmission lines pass through vast areas,
it has a tendency to generate a market, not merely for domestic
lighting but also for industrial purposes, thereby uplifting the
economic progress of the country-side. This is what actually
happened in Mysore; as power from Sivasamudram was despatched
to Kolar for the operation of the gold mines, it passed through
various towns like Mandhva, Bangalore, etc., in which manufactur-
ing industries started sprouting up. Another similar case would
be that of Coimbatore, the distributing centre for Paikara power in
Madras, which in the span of a few years became the largest cotton
manufacturer of the south.

Remembering the distribution of coal and oil in India and the fact
that large areas of the country do not possess these two valuable
resources, the need for hydro-power development becomes obvious.
The developed hydro-power energy in India is mostly from the
Western Ghats and to a smaller extent from the Himalayas. The
three Bombay schemes developed by Tatas produce altogether
280,000 kW. and this has been linked to the Koyna project with a
potential of 240,000 kW. Mysore State developed the earliest
hydro-power in the whole of Asia at the Sivasamudram station, for
42,000 kW. in 1902. This has been subsequently augmented by
(i) the construction of an additional power house slightly lower
down at Shimsha generating another 17,000 kW., (ii) the Gandhi
The demarcation of the Gujarat West Pakistan Boundary, in accordance with the Indio-Pakistan Western Boundary Case Tribunal Award is in Progress (1968)
Power House at Jog falls generating 72,000 kW, but the largest single power station in Mysore State today is located on the Shrawati with a potential of 178,200 kW. The energy is distributed as far as Mysore, Bangalore and Kolar. A third unit is associated with the Tungabhadra dam and the left bank (Mysore State) of this dam generates about 18,000 kW. For hydel-power, Mysore State is one of the most developed parts of the country.

In Madras State, power generation started in 1932 in Paikara which today generates about 68,000 kW. This has subsequently been linked with (i) the power-house at Mettur on the Cauveri for 48,000 kW, (ii) Papanasam in the extreme south from the Tambravarni river for generating 24,000 kW, and (iii) the Periyar, 105,000 kW, (iv) the Kunda 145,000 kW. (v) the Moyar 36,000 kW. and other schemes.

In Kerala generation was first developed at Pallivasal in 1940 which now generates 36,500 kW. Subsequently, this has been augmented by the constructions at Sengulam for 48,000 kW. and Peringalkuthu on the Chalakudi river for 24,600 kW. and projects are in hand at Pambai (Sabirigiri) 300,000 kW, Iddiki 390,000 kW, Kuttiaadi 45,000 kW, etc. Thus the three southern States of Madras, Mysore and Kerala, have developed their resources much more than Andhra Pradesh where the only major projects that have been completed are: the Tungabhadra (right bank) with a total generating capacity of 36,000 kW. of which only a part up till now has been developed; Nizam Sagar in Hyderabad is smaller, a multipurpose project generating 15,000 kW.; the Nagarjuna Sagar project on the Krishna near Vijayawada when completed will have 100,000 kW., Srisailam, 330,000 kW., and Upper Sileru 120,000 k.W., Machkund project is a joint undertaking of Andhra and Orissa Governments with a capacity to generate 130,000 k.W. In Orissa, the Hirakud has been the largest developed one with an estimated capacity of 123,000 kW. more than half of which has been commissioned. In Bihar and West Bengal are the Damodar Valley schemes which were opened in 1953 with the power houses at Tilaya, Maithon, Panchet Hill, Konar, etc., with a total generation

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1 Since completed.
of 150,000 kW. and this is to be linked to the thermal stations at Bokaro and Durgapur which will generate 250,000 kW. In Uttar Pradesh, the Ganges canal project was opened in 1930's with an ultimate capacity of 241,000 kW., These have been augmented by Pathri (20,400) kW. and Sarda 41,400 kW. and by a thermal station at Kanpur 45,000 kW. Work is nearing completion on the hydro-stations of Rihand 250,000 kW. Mathatila 30,000 kW., Yamuna 320,000 kW., Ramganga 127,000 kW., etc., and the thermal stations at Singrauli 250,000 kW. The Chambal project a joint undertaking of Madhya Pradesh and Rajasthan has a capacity to generate about 200,000 kW. Umtroo project in Assam is generating about 7,500 kW. But the largest scheme is that of the Bhakra Nangal on the Sutlej river which has 12 hydro-electric generating units with an eventual capacity of 1,000,000 kW., the first two units are now in operation. In Himachal Pradesh is Jogindernagar, with a capacity of 52,000 kW., opened in 1935.

A very large number of hydro-electric projects are under construction and it is estimated that the total production of hydro-energy in India will be augmented to 12.6 million kW. by the end of 1966, a 125% increase over the 1961 figures and a 600% increase over 1947. The per capita increase would be from 18 kWh. in 1951 to 28 kWh. in 1956, 45 kWh. in 1961 and 95 kWh. in 1966. Do not these figures speak for themselves?

Thermal electric power installation are mostly found in the large industrial cities like Calcutta. The Calcutta Electric Supply Corporation generates approximately 600,000 kW. In the heart of the Indian Coal fields in the Damodar valley, Jamshedpur area with 30 power stations in operation, produces 550,000 kW. and to this may be added the Bokaro thermal station with an ultimate capacity of 250,000 kW.

In Maharashtra at Kalyan, close to Bombay city, there is a power station generating 105,000 kW. which is linked to the hydro-power. Madras also has a large thermal station generating approximately 60,000 kW. in the city and another at Neyveli (lignite) generating 150,000 kW.
CHAPTER IX

INDUSTRIES

THE INDUSTRIAL SCENE

During the last 20 years, and particularly since the middle 1950's, the industrial scene in India has radically changed. On the eve of independence the industrial structure was simple and totally unbalanced. The overall contribution of industry to national income was very low. The relative backwardness of industrial development may be judged from the fact that this contribution was a bare 5 to 6 percent and the total labour force engaged in this sector was about 2.4 million or less than 2 percent of the total working population in the country. The more serious dimension of backwardness was that except for the production of simple consumer goods like textiles, sugar, glass and paper and some consumer durables like bicycles, fans and sewing machines, very few key and heavy industries had made their appearance.

Before the First World War the only major industries which had developed substantially were cotton and jute textiles. The inter-war period saw some brisk industrial development in the country in response to the favourable fiscal policy adopted by the Government. During these years, the production of cotton textiles increased 2\frac{1}{2} times, the production of steel ingots over 8 times, that of paper 2\frac{1}{2} times and in the case of sugar the country was self-sufficient by the middle of the 1930's. Some of the other industries which came to be established during this period were cement, glass, vanaspati and several engineering industries.

The outbreak of the Second World War meant almost complete stoppage of imports and this gave a tremendous fillip to the local industries. Due to the difficult availability of raw materials as well as financial resources, it was not possible to set up large factories. But modest beginnings were made in many new directions while the units in the old industries were expanded. Among the former may be mentioned ferro-alloys, non-ferrous metals
like aluminium, diesel engines, pumps, bicycles and sewing machines, chemicals like soda ash, caustic soda, chlorine and super phosphate and certain types of machine tools and simple machinery. There was a real boom in medium and small industries like light engineering, pharmaceuticals, medicines and drugs etc. After the end of the war a number of new industries were started such as rayon, automobiles, ball and roller bearings, carding engines, ring frames and locomotives. There was a substantial expansion in the capacity of established industries like fertilizers, cement, glass and chemicals. Thus, on the eve of the era of economic planning, the industrial development in the country was such as to ensure an adequate level of consumer industries like cotton textiles, sugar, soap, matches and salt. There was also some expansion in the output of consumer durables like bicycles, sewing machines and fans. But on the whole, the capacities established were not adequate. In the case of capital goods and intermediate products, the situation was very unsatisfactory. The indigenous output of iron and steel hardly met half the total demand. Similar was the case with other metals and minerals. In regard to industrial machinery, a beginning was made in the production of textile machinery but almost all such machinery had to be imported from abroad. Manufacture of synthetic drugs and antibiotics as well as of dyestuffs and organic chemicals had also just begun on a modest scale.

Since the beginning of the first plan in 1951, the industrial structure has advanced not only in terms of higher levels of production, but also in newer direction. It may be that industrial production as a whole, has not increased at an even and steadily growing pace but in perspective the growth is quite substantial. In the first place, now we are manufacturing and are self-sufficient in a wide range of consumer goods and consumer durables. Not only this but we are in a position to export many of the articles. Then there has been considerable expansion in such industries as chemicals, fertilizers and drugs and pharmaceuticals. Progress is particularly impressive in key sectors like industrial machinery, metals and minerals.

Iron and steel are the mother of machine-making industries. The production of steel ingots in 1950-51 was a mere 1.5 million tonnes
but in 1966-67 it was 6.6 million tonnes. The country was producing no special steels till recent years but now we have an output of 50,000 tonnes with further capacity to come into existence. The output of aluminium ingots has registered a marked increase from 4,000 tonnes to over 80,000 tonnes since 1950.

During the years 1960-65 the growth in key industries was particularly accelerated. For example, it was 71 percent in electrical machinery, 82 percent in non-electrical machinery, 57 percent in metal products, 59 percent in transport equipment, 49 percent in basic metals, 48 percent in petroleum products and 38 percent in chemicals and chemical products. The increase in output of additional consumer industries like sugar and textile on the other hand was only of the order of 13 and 20 percent respectively.

The production of industrial machinery, particularly in the public sector, was very impressive. The heavy electrical plant at Bhopal achieved a stable production of about Rs. 10 crores per year. The heavy electrical plant at Ramachandrapuram and the Boiler Plant at Tiruchirapalli have gone into production. The heavy engineering plant at Ranchi and the Mining and Allied Machinery Corporation at Durgapur are under construction and production has started in some departments. Production has also begun at the Heavy Machine Tools Plant at Ranchi. Apart from the two units of the Hindustan Machine Tools at Bangalore which had gone into production earlier, three new units were put up during the Third Plan.

Thus the great highlight of the development during the last 10 years in the industrial sector is in regard to the considerable degree of self-sufficiency in industrial machinery. Considering development in depth, it is not enough that we produce steel and other basic intermediate product. We must produce machines to produce steel. When the Ranchi complex goes into full production, we shall have enough capacity to put up new steel plants from year to year to meet our growing needs of steel. The country now makes the bulk of sugar plant machinery, cement machinery, textile machinery, the normal range of machine tools, diesel locomotives, wagons and coaches, electrical pumps and so on. Even more important than greater production is the breaking of new ground in the manufacture
of more basic and complex equipment. For example, capacity is being increased for the manufacture of electrical equipment like turbines, boilers, transformers, switch gears etc. We are putting up large capacity for fertilizer production and, in respect of design and engineering capacity in this field, the two public sector projects, namely, the Fertilizers Corporation of India and the Fertilizers and Chemicals (Travancore) Ltd., are now in a position to undertake between them the planning, designing and construction of 3 to 4 fertilizers factories per annum.

Yet one more great achievement of the last decade is the emergence of a viable petroleum industry. At the commencement of the First Plan, the country almost entirely depended on imports for its requirements of petroleum products. The Assam Oil Company’s refinery at Digboi, the only one in the country, could hardly meet about 5 percent of the demand. Three new refineries based on imported oil were provided in the First Plan. The Standard Vacuum Oil Company’s refinery at Bombay was set up in 1954 and that of Burmah-Shell, also at Bombay, was set up the next year. The Caltex Company put up its refinery at Vishakhapatnam in 1957. These three had a combined capacity of 3.9 million tonnes.

Until 1958 there was no prospect of getting any oil in the Indian sub-continent. But soon afterwards oil was discovered and quite remarkable results have been achieved since then. As a result three more refineries, all in the public sector were established in the Third Plan period at Nunmati (Assam), Barauni (Bihar) and Koyali (Gujarat). Work on Government refinery at Madras is in progress. A private concern refinery at Cochin has just gone on stream. There will be yet one more public sector refinery at Haldia in the next 3-4 years. A capacity of 17-18 million tonnes of petroleum refining has been so far established. The present (1967-68) output of petroleum products is 13.5 million tonnes. Today we produce roughly one-third of our requirements of crude oil and further explorations which hold out great promise will take the country to a further stage in self-reliance. A viable petro-chemical complex has already come up in Bombay and another at Koyali in Gujarat will soon follow. This industry will supply a wide range of modern products
like plastics, synthetic fibres and rubber, detergents, drugs and pharmaceuticals, insecticides and so on.

It would be seen in perspective that all these developments have meant a basic transformation of the industrial scene in India. The entire machinery required during the First Plan had to be imported. The value of machinery made by Indian industry in 1950-51 was about Rs. 30 crores. This increased to Rs: 500 crores by 1965-66. This is a measure of the great stride the country has taken in diversifying its industrial structure as well as in self-reliance.

The most serious gap in the machine building capacity is in respect of fertilizer and chemical equipment. A beginning has yet to be made in the manufacture of some of the sophisticated equipment. A heavy plate and vessels project which was included in the Third Plan could not be implemented. The programme of development of alloy and special steels has also been lagging very much behind our requirements. The main feature of industrial development in the coming years, therefore, will have to be filling in these gaps as well as accelerating the pace of implementation of the schemes and projects which are already under way.

**IRON AND STEEL INDUSTRY**

*History:* The date of origin of the Indian Iron and Steel industry is still unknown and shrouded in mystery. The rusted implements which have been obtained from the pre-historic tombs of Mohenjo Daro and Harappa may date back to 2,000 B.C. The Indians used steel implements as much as the Greeks did at the time of Alexander's invasion in B.C. 326. Near Kutab Minar in Delhi, there is a solid shaft of wrought iron weighing about six tonnes, more than 40 cms. (16 inches) in diameter, and slightly more than 7 metres (24 ft.) in height. Historians have dated it at approximately A.D. 415. Even today, that is, after exposure for more than fifteen centuries, it has not been rusted and the inscription on it is as clear and sharp as when the pillar was erected.

There is a reason to believe that the manufacture of wootz which anticipated the principle of the cementation process was of Indian origin and steel was made in South India by the carbonisation of
wrought iron in the beginning of the Christian Era, a process which Europe discovered only several centuries later. Probably these steels were worked into the famous Damascus swords of medieval times. Temples and tombs especially those in the South, have in them forged iron bars, several centuries old, but preferably well preserved. The indigenous industry which was widespread throughout the entire length and breadth of the Deccan Peninsula was a prosperous cottage industry, until recently. Even today, remnants of the industry are found in isolated parts like the villages inhabited by Agarias, in Madhya Pradesh, who forge their own metal, using ferruginous sandstone and charcoal as the only raw materials and manufacture implements like spades, axes, hammers, etc. Thus we find that it is only in comparatively recent times that the Indian iron and steel industry had succumbed to the competition with imported metal.

Early attempts to revive the indigenous industry on modern European methods, however, proved dismal failures. The first iron and steel manufacturer was the Indian Steel and Iron Chrome Co., established in 1830 at Porto Novo, using Salem ores. Later, this company was amalgamated with the Indian Iron Co. and additional furnaces were erected at Thiruvannamalai (N. Arcot), Beypore (Malabar) in 1833, and at Pallampatti (Salem) in 1853. Due to a variety of causes, mostly financial, these were all closed in 1867. Similar was the history of the early enterprises by Furquhar and Mott (1778-75), Jessop and Co. (1839), Mackay and Co. (1855-75) and the Kumaon Works (1857 to 1862); all these furnaces used charcoal as fuel.

For the first time in 1874, coke made from Indian coal was used for smelting and two furnaces were erected, at Kulti near Barakar, on the Raniganj coal field, capable of producing 20 tonnes a day, but it failed four years later mainly for want of capital. In 1882, the plant was taken over by the Government of India and one furnace was started which worked until 1889 when it was sold to the Bengal Iron Co. The plant was subsequently re-modelled and the Company was rehabilitated on modern lines when it was amalgamated with the Indian Iron and Steel Co.
PLATE XI. Chittaranjan Locomotive Works
PLATE XII. Aircraft Factory, Bangalore
Later developments are the formation of the Tata Iron and Steel Co. which was opened in 1911 at Jamshedpur, the inauguration of the Indian Iron and Steel furnaces at Burnpur, near Asansol, in 1918, and the Mysore Government foundry with a furnace at Bhadravati in 1923. Since the attainment of political independence in 1947, besides giving assistance for the expansion of these three existing furnaces, Government of India have started in the public sector three new steel plants while the fourth is under construction. The new steel plants are at Bhilai in Madhya Pradesh in collaboration with the Soviet Union, at Rourkela in Orissa in collaboration with the West German manufacturing firm of Krupps Demag, and at Durgapur in West Bengal in collaboration with a British Consortium of steel interests. A fourth plant is being erected at Bokaro in collaboration with the Soviet Union.

**IRON ORE RESOURCES OF INDIA**

India is one of the especially rich countries of the world as far as iron resources are concerned. Most important among the regions of wealth are centred around the Singhbhum district of Bihar and the adjoining areas of Bonai, Keonjhar and Mayurbhanj in Orissa. This is one of the world’s largest iron ore fields, in which occur enormous resources of ore of high quality. At a minimum estimate, the wealth in high quality iron ore with an iron content of more than 60%, exceeds 10,000 million tonnes. Nearly 60% of the resources in ore are found in the hill tract between Bihar and Orissa and large deposits are found scattered in north eastern Orissa, central and southern Madhya Pradesh, Andhra Pradesh, Mysore, Madras and Goa. Smaller fields exist in Maharashtra, West Bengal and Kashmir. Goa, Bailadilla in Madhya Pradesh, Singhbhum in Bihar, Mayurbhanj in Orissa are the main producing regions. Bababudan Hills of Mysore and Ratnagiri in Maharashtra are other producing areas. Of the total output of 26.5 million tonnes in 1966, 6.7 million tonnes came from Mayurbhanj, 6.5 million tonnes from Goa, 4.0 million tonnes from Bailadilla. Mysore’s contribution was a little over 3 million tonnes.

In India, generally speaking, iron occurs at or near the top of the
hills and consequently no deep shaft mining is necessary. The principal type of iron ore is the Haemetite in the Bihar-Orissa ranges, where characteristically the hill tops are capped by rich massive ores, approximately 30 metres (100 ft.) in thickness and with an iron content in excess of 60%. Below this is laminated ore the iron content of which is slightly less, 55% to 60% and still below shaly ores are found. Mining today is almost exclusively confined to the hill tops of the massive ores. The ore is carried by broad gauge railway to the main junction at Maniharpur and via Chaibasa to the loading points at Noamundi, Goa and Jamda where aerial ropeways, narrow gauge tramways and trucks feed into the wagons. The two manufacturers, the Tata Iron and Steel Co., and the Indian Iron and Steel Co., have been exploiting these regions, Noamundi by Tatas and those near Maniharpur and Goa by the Indian Iron.

Mining in Mayurbhanj in Orissa is limited to three areas viz., Badampur, Sulaipet and Gorumahisini; all these are owned and operated by Tatas and they are located within 65 km. of the Tata foundries at Jamshedpur. The iron content is extremely high, between 63 to 68%. Here the workings are all surface operations, the majority of which are in close proximity to broad gauge railway lines, although they have their own metre gauge and narrow gauge railways or ropeways to facilitate loading.

Other than the two steel plants, there are large number of mine owners who are producing ore for export from this area. The Kiriburu mine of the National Mineral Development Corporation is one of the biggest public sector mine which is completely mechanised and is meant for export of ore to Japan at the rate of 2 million tonnes every year till 1971 and after that for meeting the needs of Bokaro Steel Plant. Another Government company, the Hindustan Steel Ltd., is engaged in the exploitation of the ores in the Dalli-Rayhara hills in Madhya Pradesh.

Iron ore occurs widely in the South, particularly in the hills of Mysore where it has been exploited to some extent in the Kemman-gudi mines of the Bababudan hills, the total wealth of which is probably in excess of 300 million tonnes. There are rich iron ore deposits in the Goa-Ratnagiri region and their proximity to the coast
makes them ideal for export purposes. During the last few years, there has been considerable export of ore from these areas to Japan, mostly haematite of 60% iron content.

Manufacturing Industries: Generally, the modern manufacture of iron and steel is carried out in blast furnaces where coke is used as the fuel. All coals are not coking. The main raw materials required, apart from coal, are iron ore, limestone, dolomite etc. It would, therefore, be more economical to locate this industry near the coal fields, than near the iron ore regions, particularly so in India, for two reasons:—(i) it would be more economical to convert the coal to coke at the blast furnace (rather than at the pit-head) where the by-products can be better utilised, and (ii) obviously it is more expensive to transport 3.5 tonnes of coal to the site of the works than 1.5 to 2 tonnes of ore, partly because of the difference in weight and partly also because the ore is much denser demanding less wagon space. The iron and steel industry of the world uses coke almost exclusively as the blast furnace fuel for the conversion of ore to pig iron and to a large extent in the second process of conversion from pig iron to steel, but in recent years, there have been attempts to use electricity, or oil and gas for the latter.

India is particularly poor in coking coals, only the Jharia coals and those of Giridih are coking, while the Raniganj coals have to be mixed with Jharia coals before they can be converted into coke. It is, therefore, essential to remember the overwhelming importance of coke, proximity to which would be extremely significant in the determination of costs.

The Tata Iron and Steel Co. was founded on the banks of the perennial Subarnarekha at the village of Sakchi now called Jamshedpur or Tatanagar (named after the founder of the factory, Jamshedjee Tata); 250 km. (154 miles) west of the market and port of Calcutta, 240 km. (150 miles) south of the coking coals of Jharia and 75 km. to 100 km. (45 miles) north of the iron ore mines of Singhbhum and Keonjhar, with dolomite (the flux) being located 180 km. (110 miles) southwest at Gangpur. In other words, the industry is located at a most advantageous site with the market and all the raw materials available at close vicinity to each other.
The other dependent industries are the Indian Cable Co. producing electrical cables, the Indian Tin Plate Co., rolling tin plates and sheets, etc. During the last decade, the steel plant has been enlarged and its size increased considerably. The annual production at present is about two million tonnes of steel ingots.

The Indian Iron and Steel Co., till recently operated three separate plants, all near Asansol, the first at Hirapur 6½ km. (4 miles) south of Asansol, the second at Kulti 16 km. (10 miles) west of Hirapur and the third at Burnpur 5 km. (3 miles) southwest of Asansol. These are today integrated into a single unit. The type of production is almost identical to that of Tatas. Kulti produces pig iron only while Hirapur and Burnpur manufacture both pigs and finished steel. It enjoys the same locational advantages as Tatas; the raw materials for this industry are also from the same areas as Tatas. Coal comes from Jharia 60 km. away and from Raniganj hardly 8 km. away, limestone and dolomite from Gangpur about 300 km. away and iron ore from Singhbhum about 260 km. away. The Hirapur coke plant is a modern one distilling various by-products. The water resources are obtained from the Damodar river for Kulti. A number of ancillary industries are located here, the Eastern Light Castings at Kulti, the Indian Standard Wagons at Burnpur, the Chittaranjan Locomotives at Chittaranjan and scores of electrical and mechanical industries. The Indian Iron and Steel Co. produces about 1.0 million tonnes of steel ingot per annum, which is being expanded to 1.3 million tonnes per annum.

The Mysore Iron and Steel Co. is the only integrated iron works in South India built by the Government of Mysore in 1932 for the production of pig iron and later a steel plant and rolling mills were added. Coal is not available anywhere in South India and hence the Mysore works depend upon charcoal obtained from the forests, for which the Government has set apart a reserve forest of approximately 1,700 sq. km. (700 sq. miles). It employs as many as 5,000 persons daily for cutting the wood! Adequate tree growth in the region coupled with careful deforestation on a rotation basis, assures a continuous supply of charcoal.

Iron ore is from the Kemmangudi mines (Bababudan Hills)
about 40 km. (25 miles) from the works, mostly haematite with 55% iron content; limestone is found within 20 km. and dolomite within 40 km. Manganese is available within 50 km. and all these are transported by the company’s narrow gauge railway. Chromite and other refractory materials are available in close vicinity. Adequate quantities of perennial water is available from the Bhadravati river and like Jamshedpur, Bhadravati township was established essentially by the Mysore Iron and Steel Works. The plant commenced operation in 1923 to produce 0.1 million tonnes of steel. It is now being converted to produce 77,000 tonnes of alloy and special steels.

The Government of India started three public sector undertakings during the Second Plan period (1956-61) at Bilai, Rourkela and Durgapur under the management of Hindustan Steel Ltd. The Bilai steel plant has been constructed in collaboration with the Government of the Soviet Union at Bilai in Madhya Pradesh, 720 km. (450 miles) west of Calcutta, with an original capacity of one million tonnes of steel ingots and 750,000 tonnes of rolled and finished steel products, but this has subsequently been increased to 2.5 million tonnes of steel ingots. It has been in operation since 1961. The Russian Government financed a loan of about 200 million roubles at 2½% interest, to be returned in rupees over a 12-year period. The Soviet Government has supplied the plant, equipment and technical personnel and has been training Indian technicians to operate the plant. Ore comes from the Darr District, 130 km. (80 miles) away, for which a new railway line has been constructed, but coking coal has to come from Jharia 720 km. (450 miles) away. Limestone is available about 25 km. away. A 10 sq. km. (4 sq. miles) reservoir will be filled with Mahanadi water and a canal passing close to the township will serve as a cooling reservoir for the steel mill. Between the steel works and the Bilai township is the new 1.6 km. (1 mile) wide artificially created forest to arrest the flow of hot air from the factory to the fast growing township. The production was 1.85 million tonnes ingots in 1966-67.

The Rourkela Steel Works also was started with an original
capacity of one million tonnes of steel ingots but its steel ingots capacity has now been increased to 1.8 million tonnes. This undertaking was set up in collaboration with the West German manufacturing firm of Krupps Demag. Indian technicians and engineers were trained in West Germany. Coking coal comes from Jharia about 320 km. (200 miles) away. Most of the electrical energy required is being supplied from the Hirakud Hydro-Electrical Project, less than 150 km. away. Iron ore and manganese are being obtained from the Bihar-Orissa range within 50 km. while limestone and dolomite occur in the vicinity. The water requirements are met by the Mahanadi, and a new reservoir has been constructed. This is the only plant in India using the LD process of steel making.

Durgapur plant is the third undertaking of the Government of India. Its original capacity of 1.0 million tonnes of steel ingots has since been enhanced to 1.6 million tonnes of steel ingots. All the raw materials are obtained from the same areas as those of the Indian Iron and Steel. The coal is from Jharia, 70 km. west and from Raniganj locally, iron ore comes from the Bihar-Orissa regions, 250 km. to the southwest of Durgapur. Durgapur, therefore, has all the advantages of location, like that of Jamshedpur.

The fourth steel plant is under construction at Bokaro, on the Bokaro coal field itself, with Soviet assistance. The initial capacity of 1.7 million tonnes of steel ingots is to be expanded to 4.0 million tonnes later. It is expected to start production by the end of 1971. This is based on 200 million roubles credit from the U.S.S.R.

It was hoped that there would be a significant spurt in output by 1965-66, but unfortunately much of this hope has not been fulfilled. The production target for 1965-66 was 9.2 million tonnes of steel ingots and 1.5 million tonnes of pig iron for sale but the production has fallen short of this. The actual figures have been 6.5 million tonnes of steel ingots and 1.2 million tonnes of pig iron for sale in 1965-66. The shortfall in production was mainly on account of the delay in the completion of the steel expansion programme.
ALUMINIUM

India has enormous resources of the ore of aluminium *viz.* bauxite. Indian resources of bauxite ores are placed at about 275 million tonnes, of which about 75 million tonnes are of high grade. These deposits are found in west Bihar and northeast Madhya Pradesh, central Madras area, western Orissa, western Maharashtra and southwest Kashmir. Today mining is taking place in Ranchi (Bihar), Jubbalpore in Madhya Pradesh, Gujarat, Maharashtra and Madras. The Kashmir deposits are not easily accessible. 7,54,000 tonnes of bauxite was mined in India in 1966-67. The output in 1950-51 was only 65,000 tonnes. Bauxite is being used in the production of aluminium and for the chemical refractory and cement industries and also being exported.

The present aluminium production in the country is about 100,000 tonnes and this is being produced by five smelters at Asansol, Hirakud, Renikut, Alwaye and Salem. The Indian Aluminium Company (1943) in collaboration with Canadian interests is the oldest producer whose smelters are located at Hirakud and Alwaye.

The second manufacturer is the Aluminium Co. of India with its smelting and reduction plant and rolling mill, an integrated process, located at Jaykay Nagar, near Asansol on the Raniganj coal fields; its operation started in 1944. Bauxite is brought by road and rail from the Lohardaga mines of western Bihar, 320 km. away and also from the Jubbalpore district of Madhya Pradesh. The company has its own thermal power plant and a new hydro-station is being linked to it.

As far as the aluminium industry is concerned, the most important factor determining the cost of production is the availability of large quantities of electricity at very cheap prices. This is even much more important than the proximity of the raw materials. Aluminium industry demands large scale operations and it has been possible to set up two new plants with the generation of hydro-electric power at Rihand and Salem. The public sector (Bharat Aluminium Co.) proposes to set up two smelters one at Korba in Madhya Pradesh and the other at Koyna in Maharashtra. The Indian Aluminium Co. is erecting a smelter at Belgaum in Mysore State which will go into production in the middle of 1969.
COPPER
Copper is mined in the Singhbhum mines whose resources are not very large. Copper ore is not known to exist widely throughout the rest of India. A new copper project at Khetri in Rajasthan is now under implementation by Hindustan Copper Ltd. The project with a capacity of 31,000 tonnes of copper is expected to go into production by 1971.

LEAD
Lead and zinc occur in Rajasthan, the most famous of the sources being the Zawar mine in Udaipur, with a total estimated resource of about 10 million tonnes of combined lead and zinc ores, with zinc being the dominant element. Lead is smelted at Tundoo in Bihar. The Hindustan Zinc Ltd. has put up a smelter at Debari near Udaipur with a capacity of 18,000 tonnes of zinc and 60 tonnes of cadmium per year. In the private sector a smelter at Alwayne is being constructed based on imported concentrates with a capacity of 20,000 tonnes.

RARE EARTHS
The mineral sands found in the southwestern tip of India, on the coasts of Kerala and Madras are extremely rich in a number of relatively rare minerals like ilmenite, the chief source of titanium, and monazite—the chief source of thorium, uranium, garnet, etc. These are believed to be among world’s largest deposits for both ilmenite and monazite. The ilmenite occurs in patches from Quilon to Cape Comorin for a distance of nearly 150 km., the estimated reserves being 300 million tonnes. Two new plants have been put up by the Government, the first the Indian Rare Earths Ltd., a joint undertaking of the Government of Kerala and Government of India, to process 1,500 tonnes of monazite and to utilize the residue of thorium from this plant, and the second one, established under the supervision of the Atomic Energy Commission at Trombay (Bombay) to manufacture thorium nitrate and to process other uranium and thorium ores. Ilmenite and rutile is a by-product in the monazite extraction.
The demarcation of the Gujarat West Pakistan Boundary in accordance with the Indo-Pakistan Western Boundary Case Tribunal Award is in progress (1963)
The demarcation of the Gujarat West Pakistan Boundary in accordance with the Indo-Pakistan Western Boundary Case Tribunal Award is in progress (1968).
MICA

India is the world’s largest source for mica and for more than 60 years, 75% of the mica production of the world came from India. Mica has been mined in India from very early times, *circa* 2,000 B.C. Mining is carried on primarily in Bihar, much the largest, a second one in Rajasthan and a third in Gudur (Nellore) in Andhra. There are smaller deposits in Orissa, Mysore etc., which have been worked only very occasionally. The Bihar mica belt in Gaya, Hazaribagh and Monghyr districts is about 150 km. long and 30 km. wide, a large part of which is in operation. Three-fourth of the production comes from Hazaribagh district. Rajasthan ranks second in production. The Nellore region in Andhra Pradesh is a belt 10 to 16 km. wide and 100 km. long. This affords employment for a large number of people, at least for 250,000, half of which are in Bihar. The export of mica in 1966 was round about 30,000 tonnes (including scrap), the production being 22,000 tonnes.

CEMENT INDUSTRY

India has been more or less self-sufficient in her demands for cement, although this demand of late has been increasing very considerably. There are two major groups of cement manufacturers, *viz.* (i) the Associated Cement Company owning 15 factories, and (ii) the Sahu-Jain-Dalmia group, owning 7 factories, besides 12 factories belonging to other parties. In addition, there are five government-owned factories, in Mysore, Orissa, U.P., Kashmir and Assam. The Third Five Year Plan had a production target of 13 million tonnes *viz.* 1965-66, almost all of which has nearly been achieved by 1967.

The essential raw materials for the production of cement are *(a)* limestone of good quality, *(b)* suitable good clay, *(c)* fuel and *(d)* gypsum. Good deposits of limestone occur only at a few places and the easily accessible supplies have mostly been consumed with the result that factories today have to transport limestone over long distances. The older factories have their locations on the limestone regions, as in Rajasthan, Madhya Pradesh, Saurashtra and southeast Madras. But all these centres are far away from
coal resources, which necessitate long distance transport of coal. Another essential raw material is gypsum and till partition, gypsum was obtained from areas now ceded to Pakistan, so that all of a sudden it became a raw material of foreign origin. Since 1947, it is being obtained from the Bikaner and Jodhpur areas of Rajasthan.

Today the largest centres of the industry are located in Andhra, Gujarat, Madhya Pradesh, Madras and Rajasthan regions. The demand for cement has been increasing at an extraordinarily fast rate, mainly for house construction, dam construction, road buildings, etc., but even then, it must be confessed that the *per capita* consumption of cement in India is amongst the lowest in the world, 12 kg. (27 pounds) as against 40 kg. (90 pounds) in Japan, 200-240 kg. (400 to 500 pounds) in the United Kingdom and 320 kg. (700 pounds) in Scandanavian countries.

**Chemical Industries Including Fertilizers**

India has rapidly progressed in the development of chemical industries since the Second World War. Her production capacity has multiplied several times in ammonium sulphate, super phosphate, caustic soda, sulphuric acid, soda ash etc. India has also attained self-sufficiency in a variety of other chemicals. Likewise, there has been equally rapid progress in the manufacture of paints, varnishes, soaps, paper and a host of others, like synthetic fibres, plastics, coal tar and its derivatives.

Sulphuric acid is the most important raw material for the chemical industries and its manufacture is widely distributed throughout the country, the major concentrations of output being in Maharashtra, Gujarat, West Bengal, Kerala and Bihar. The Alwaye plant with an annual capacity of 246,000 tonnes is the largest followed by the plant belonging to the Gujarat State Fertilizers Co. with 150,000-tonne capacity and the Dharmasi Morarjee Chemical Co. with 139,000-tonne capacity. The total output in 1967 was about 700,000 tonnes with a corresponding installed capacity of 1,650,000 tonnes.

The manufacture of soda ash and caustic soda requires high capital investment and till recently they were imported in large quantities.
It was only at the end of the Second World War that Tatas started manufacturing soda ash at Mithapur, followed by the Dharangadhra Chemical Works, both located in Kathiawar, utilizing the local supplies of salt and limestone. By the end of the Third Five Year Plan numerous plants were commissioned and the manufacture of soda ash was 3,31,000 tonnes, an approximate increase of nearly 2 times the production in 1961. Recently demand for caustic soda has increased considerably. There are now several 50-tonne-a-day plants and some are much bigger. Together they produced 2,33000 tonnes in 1966-67, nearly 2 times the production in 1961.

Fertilizer Industry: Rapid increase in agricultural production, particularly of foodgrains has been central to our planning process. The two successive droughts of 1965-66 and 1966-67 have more pointedly focussed the issue of agricultural development. The intensive agricultural development approach with emphasis on fertilizers, high yielding seeds and intensive irrigation has made an early break-through in agriculture possible. In the new development strategy, therefore, agricultural inputs, particularly fertilizers, hold the key to success in agricultural sector. The manufacture of fertilizers constitutes the largest sector in the Indian chemical industries. The application of artificial fertilizers, is essential for stepping up agricultural production, mainly because most agricultural lands in India are tired and exhausted as a result of continuous cultivation. To obtain increased yields, adequate quantities of nitrogen, phosphorous and potash have to be applied to the fields. Originally ammonium sulphate was produced only as a by-product in the coke ovens; but now there are several units amongst which the Ennore factory in Madras, the Alwaye factory sponsored by Madras and Kerala Governments and the Sindri factory at Sindri (Dhanbad) are the most important. The Sindri factory produces about 350,000 tonnes of ammonium sulphate per annum.

Ammonium sulphate, however, no more occupies the central place, it conventionally did in the past. New chemical fertilizers, which are much more rich in nitrogen, have come into the picture. Urea is a leading example of this group. The first three public sector fertilizer factories at Nangal, Neyveli and Rourkela, which
followed Sindri, constituted a watershed in the shift from ammonium sulphate to urea. Their main product was ammonium nitrate or sulphate-nitrate. The later factories at Trombay, Gorakhpur, Namrup (all in the public sector), and the Gujarat plant are oriented to urea production. The factories under construction at Durgapur, Cochin, Madras, Barauni (all in the public sector) and Kanpur (I.C.I.) will also have urea as their main product. The completed schemes have now increased the national capacity to 900,000 tonnes of nitrogen. When the units under construction and the firm proposals already sanctioned go through by 1971 the total capacity of 21,00,000 tonnes of nitrogen will have been reached. In the very recent past, Government has opened up opportunities for foreign investors to start fertilizer factories.

Technological changes in fertilizer industry are quick. For making fertilizers available at cheap prices, it is absolutely essential to plan new factories on the basis of latest technological advancement. The projects put up in recent years or now under construction are not only of considerably large capacity but also based on naphtha available from the refineries.

A significant stage has been reached towards self-reliance in designing and engineering of fertilizer projects. The Fertilizer Corporation and the Fertilizers and Chemicals (Travancore) have between them gained considerable expertise in putting up three to four factories every year. The public sector factories now under construction at Cochin, Namrup, Durgapur and Barauni have been designed and engineered by these agencies.

**Phosphate:** The primary raw materials for the manufacture of phosphatic fertilizers are phosphate and sulphur, both of which have to be imported. The Indian reserves of rock phosphate at Singhbhum and Trichinopoly are poor in quality. New sources have been discovered in Uttar Pradesh and Rajasthan. Major manufacturers of phosphatic fertilizers are to be found in Madras, Maharashtra and West Bengal. Total output in 1966-67 was 144,000 tonnes with an installed capacity of over 180,000 tonnes.

Potassic fertilizers are all imported at present as India has no output of potassium chloride and potassium nitrate deposits found in Bihar,
Uttar Pradesh, Panjab and Rajasthan are not significant.

Drugs and Pharmaceuticals: The progress in the manufacture of major chemicals in India has been phenomenal and, in many cases, output has shot up more than 10 times during the last ten years. In recent years chemicals, drugs and pharmaceutical products are also manufactured within the country. There are a few major plants, evenly distributed between Calcutta, and Bombay, then a set of second rate plants in Madras, Kerala, Mysore and the Panjab States and several thousands of other manufacturers widely distributed all over the country.

The Government Penicillin Plant in Poona was set up in the First Five Year Plan. This was followed by private units manufacturing drugs like Aureomycin, Acromycin, Chloromycetin, Sulpha drugs, etc. During the Third Plan period (1961-66) an antibiotics plant was put up at Rishikesh and a synthetic drugs factory in Hyderabad. These developments have made the country almost self-sufficient in antibiotics and other important drugs.

D.D.T. factories have been established under Government at Delhi and Alwaye and a private factory for the manufacture of Gammexene near Calcutta.

Fibre Industries

Cotton Industry: Cotton and jute manufacture are the most important fibre industries in the country, but in addition there are a host of smaller ones, like Silk, Wool, Coir, etc. Cotton and jute are the oldest and most important industries, both of which started as domestic cottage industries and between them cotton is more important; and it will not be an exaggeration to say that the cotton industry is by far the most important single industry in the country.

From about B.C. 1500 to A.D. 1500, for nearly thirty centuries, India held the world monopoly in the manufacture of cotton goods. The Rig Veda makes some reference to cotton although authorities differ about it. In the laws of Manu, the sacrificial threads of the Brahmin are mentioned as made of cotton. Herodotus in the fifth century A.D. speaks of Indian cotton in the highest terms. "The Indians possess likewise a kind of plant, which instead of fruit, pro-
duces wool of a fine and better quality than that of sheep. Of this the Indians make clothes”.

In the Middle Ages, there was a curious myth known as the “Vegetable lamb of Tartary” or “the Scythian lamb”, according to which it was believed that “the fruit of this tree when it fully bursts open, disclosed to view within it, a little lamb. From the fleece of these tree-lambs, which were of unsurpassing whiteness, the native wove materials for their garments and head dresses.” There were many ancient centres of importance along the East Coast, from Na gapatam to Dacca and in the West Coast were the historic and famous centres such as Broach, Surat, Cambay, etc. Muslin so fine and of such extraordinary delicacy, that a single ounce of cotton could be spun to a length up to a few miles was an art well-known and practised in Dacca! The Europeans landed at Calicut in quest of the Indian cotton goods and even today, the trade name for Indian cotton goods is ‘Calico’—the product of Calicut.

The world owes a deep debt of gratitude to India for the pioneer work it had done in the cultivation and manufacture of cotton which today has become widespread throughout the world. Masulipatam according to Marco Polo produced the finest and the most beautiful cottons. Other important centres were Arcot (in Madras), Ahmedabad, and Banaras where is most cases, cotton cloth was woven together with gold and silver threads in a filigree. India’s fabrics, the most beautiful that human art had anywhere produced, were sought by merchants at the expense of great toil and danger. It is estimated that at the beginning of the 18th century, the annual imports of cotton goods into Europe was worth more than a million dollars. Writers like Defoe complained that a wave of fashion in their favour had grown up, thereby killing the indigenous woollen and silk industries, but at the same time, he had to acknowledge that the quality of the goods was excellent.

Towards the end of the 18th century, the East India Company realised the value of the inventions in Lancashire, especially the possibilities of spinning and weaving of cotton by mechanical methods and decided to encourage the growth of cotton in India for power looms of Britain; and the power loom was later followed
by the steamer and the railway locomotive. The real cause, therefore, of turning the tables against Indian were these three great inventions, but at the same time, it would be idle not to admit that the pace of the defeat of the Indian competition had not been accelerated by the protective duties which were established in England against the goods of Indian manufacture. In the early stages of the machine industries, Indian goods could be sold at prices 50% to 60% less than these fabricated in England and therefore, it was necessary to protect the British industry behind the tariff wall of 70% to 80% ad valorem (by value) on goods imported from India. Surely, had not such prohibitive duties been levied, the mills of Paisley and Manchester may have been crippled at the outset and may not have been set in motion by the power of steam. By 1840, the trade of Dacca—once the most famous centre for the manufacture of muslin—had completely become extinct and the local population totally abandoned their family occupation of spinning and weaving, and drifted into agricultural operations, mostly as labourers.

The cultivation of raw cotton in India was the only alternative occupation, and as a result of this, export of raw cotton increased. By 1858, the exports of raw cotton to Britain reached the formidable figure worth more than £4,000,000 while the export of manufactured goods in that year formed only 20% of it. This was partly because of the British policy of promoting agriculture as a whole and partly because the raw material supplies of cotton to Britain from the United States had diminished, consequent on the American Civil War and the industrial development that came there in its wake. Britain at the same time exported to India, manufactured cotton goods in that year worth £5,060,000; in other words, by 1858, India became dependent on Britain for the supply of manufactured cotton goods.

The Indian Handloom Industry was the country’s largest industry which employed millions of artisans and craftsmen; they were forced to abandon their time-old occupation and take to agriculture. Cities such as Dacca, Surat and Murshidabad were ruined and India became a cultivator of the cotton crop.

After partition, India found herself particularly short in long
staple cotton and efforts were made for meeting the deficit by internal production of better quality cotton, but even today the production of medium staple (more than 11/16th" and less than 7/8") is about 50\% and that of short staple (less than 11/16") about 23\%, the long staple cotton only occupies about 20 to 25\% of the area, mostly found in Gujarat, Kathiawar and south Maharashtra, in the north Coimbatore, Madura, Tirunelveli, and Ramnad in Tamilnad (Madras State).

The Indian Central Cotton Committee has made concentrated efforts on improving the quality and it is not unlikely that within a few years, it might be possible to meet the home demand for the long stapled varieties. The general statement that the Indian yield of cotton is extremely poor and is less than a fourth or a fifth of that of Egypt and less than half that of U.S. is true only of unirrigated cotton. But where cotton is properly irrigated and cultivated, one finds the yield in India to be between 180 to 200 pounds of lint per acre, as against 60 to 90 pounds in unirrigated areas. But unfortunately, the area of unirrigated cotton far exceeds that under irrigation and hence the poverty of the average yield for the country as a whole.

The Cotton Mill Industry of India: The first cotton mill was established in 1818 near Calcutta, but the real development of the mill industry started only from 1851, when the first mill was established in Bombay by an Indian entrepreneur, Manubhai Devar and production commenced in 1856. About the same time, a cotton mill was established in Broach.

The foundation of the textile industry at Ahmedabad was laid in 1859. The Indian industry originally concentrated on supplying cotton yarn to China, but later, as more and more mills were established, there was significant growth in both spindles and looms. By 1866, there were 13 mills; by 1885, 55 mills; by 1900, 195 mills; by 1914, 239 mills; by 1919, 253 mills; by 1937, 370 mills; by 1940, 388 mills; by 1945, 417 mills; after partition in 1947, 408 mills; by 1955, 461 mills and by 1965, 562 mills (277 spinning and 285 composite). Today India has more than 17 million spindles and 207,000 looms and is thus one of the world’s most important cotton cloth
PLATE XIII. Ship Building Industry at Visakapatnam
Plate XIV. Iron and Steel Factory, Rourkela
manufacturers. The early mills declared such good dividends that more and more capital was drawn into the industry. The political movements like the Swadeshi movement gave a great impetus to the industry. The First World War of 1914, brought tremendous profits when no supplies came from Britain, although a small quantity came from Japan. The industry then had unprecedented prosperity, the average annual dividend being more than 30%. Even during the so-called period of depression, 1928-1933, the industry was not seriously affected, because of the Swadeshi movement and the effective propaganda carried on by the political parties for eschewing British and buying only Indian goods. During the Second World War conditions were even better than during the First, because imports were not available even from Japan.

On the eve of independence, in 1947, the industry was very large, with more than 400 mills. But partition did hit it hard, not because some of the mills went to Pakistan, but mainly because West Panjab and Sind were important suppliers of long staple cotton to the Indian mills and a sudden cessation of these supplies created problems of shortage of raw material, which could only be solved by importing from as far away as Egypt, Kenya and U.S.A.

There is a great scope, even today, for an increase in the per capita consumption of cloth, which in India is deplorably low. To some extent this is true. The per capita consumption has varied from 14.5 metres in 1914 to 8.5 metres in 1919, 14.5 metres in 1930, 16.45 metres in 1938, 10 metres in 1942 and 14.5 metres in 1954. It has steady at 14.5 metres in recent years. If the general standard of living remained more or less of the people is slightly increased, then the demand for cotton goods would be very considerably increased.

Location of the Mill Industry: The cotton mill industry had a tremendous concentration in Bombay in the early part of its history and 100 out of 144 mills in 1895 were in the then Bombay Presidency with 66 of them in the Bombay city alone. In 1904, more than 3/4 of the yarn and 80% of the woven goods were manufactured in Bombay Province and more than 50% of both yarn and goods came from the city of Bombay. In the same year, Ahmedabad had 8% of the yarn and 22% of the woven goods.
Bombay and Ahmedabad retained their undisputed supremacy till 1922; Bombay City then had 83 out of 232 mills in India, while Ahmedabad had 68 mills; but other centres also came into the picture and the mills were more or less widely scattered in Sholapur, Madras, Nagpur, and Kanpur, all of which together produced 38% of the yarn and 24% of the cloth. It is not true to say that the distribution of cotton mills in the early period was essentially in accordance with availability of raw cotton. It must be remembered that nearness to raw materials is not a compelling condition in the case of a manufacturing industry like cotton, which is not of a weight-losing type. Raw cotton, once it is ginned, becomes a pure material and enters fully into the weight of the finished product, i.e. 100% of the yarn gets woven into cloth, so that in the process of manufacturing the weight of the raw material is not lost. Contrast this condition with the iron and steel industry, where the weight of the finished product is far less than the weight of the raw materials which go to make it. The general rule, "that raw materials tend to attract industries to their place of production is in inverse proportion to the amount of raw material which enters into the finished product," is definitely true. It is because of this reason that the industry was attracted to the sources of power and finance as at Bombay. Furthermore, in the early period of its history, the industry was essentially concentrating on spinning and Bombay had excellent facilities to export the yarn to other parts, both by land and water, and abroad to China. By 1931, both Bombay and Ahmedabad had an equal number of mills and by 1932, Ahmedabad had more mills than Bombay and became the premier centre of the industry. Bombay has apparently continued the textile specialisation of Manchester with the commercial and shipping characteristic of Liverpool. Ahmedabad, from its early period of growth, concentrated on woven goods rather than on yarn. In recent years, electric power has been distributed through grids over a wide area in the country and this also has affected the location of the industry, by decentralising it, and it looks as though in future, the more important centres will be in the cotton growing areas and near sea ports from where the finished products could be easily distributed.
INDUSTRIES

There has been a wide dispersal of the industry in recent years to different parts of the country—Delhi, Nagpur, Kanpur, Madras and more recently around Calcutta. Apart from Calcutta, there is no other centre in West Bengal and none in Bihar, or Andhra Pradesh. There are only a few mills in the southwest in Kerala and Mysore, and so it is with Assam in the northeast. The most important centres today according to the number of spindles are: Ahmedabad, Bombay, Coimbatore, Kanpur, Calcutta, Madurai, Sholapur and Indore; and even today more than a fourth of the spindles and a third of the looms are in the city of Bombay, indeed, the result of its early start and the momentum it has gained.

The total production of Indian mills reached the peak at 4675 million metres of cloth in 1964-65. In recent years it has slightly fallen and the 1966-67 output was 4202 million metres. It is supplemented by the handloom and power loom industries which produce approximately two thirds of this (over 3,000 million metres). Indian mills produce very little of super-fine cloth, nearly 60% of the production is coarse, or medium cloth which meets 70% of the demand within the country.

The Handloom Industry: It has already been mentioned that India has been a producer of cotton cloth from time immemorial and it is generally admitted that India was the original home of the industry. It, however, collapsed in the 19th century, perhaps not entirely due to the competition of mill-made goods from Britain. In most of the noted centres, it flourished under Court patronage and when it declined, the industry also followed suit. Apart from this, there was a change of fashion for the men in the upper classes who gave up their customary dhori and started wearing pants thereby creating a lack of demand; but as against this the women of India stuck steadfast to the multicoloured and artistic sarees, which could not be manufactured economically by the mills and it was the women’s conservatism which kept this industry alive for nearly two centuries. A decline in handweaving brought into its wake a decline in hand-spinning and this resulted in larger imports of yarn from abroad. There was a total collapse of the handloom industry in the middle of the 19th century when no hand spun yarn was
available. During the latter part of the century, the handloom weavers started adjusting themselves to the yarn produced by the Indian mills. Between 1896-1900, the competition between the handlooms and the mills was not serious, their relationships being complementary; the mills spin the yarn which the handlooms wove. The Indian mills during the period are estimated to have used 85 million pounds of yarn annually for the manufacture of cloth, while the handlooms consumed not less than 200 million pounds. In other words, at the beginning of this century, the handloom industry was 2 times as large as the mill industry. From then on, many mills started weaving in addition to spinning; and in 1914, when the First World War commenced, both handlooms and mills were approximately of the same size, each consuming about 250 million pounds of yarn. But during the First World War (1914—1918), when imports of cloth from the United Kingdom were not forthcoming, the mills concentrated on the production of cloth, consuming the bulk of the yarn they manufactured and incidentally left little for the handlooms. By 1920, the handlooms consumed 127 million pounds of yarn, while the corresponding figure for the mills was 340 million pounds. In other words, as a result of the First World War, the handloom industry was hard hit, and its production diminished by more than 50% from 1,100 million yards of cloth to about 500 million yards. In attempting to promote the handloom industry, import duties were levied on cloth and yarn. The duty on cloth was of direct benefit to the mills but was of doubtful value to the handlooms since handlooms produced a different variety of cloth. But the import duty on yarn was of direct disadvantage to the handloom creating a heavy burden on it, as it was the handloom which consumed the bulk of the imported yarn.

It is difficult to estimate the total number of handlooms in India, but the figure that is generally given is two millions, of which approximately an eighth to a quarter is, perhaps, idle. The majority of these handlooms, about 75%, concentrate on the production of cotton, 5% on wool, 16% on silk and 1% on artificial silk. It is difficult to determine precisely the number of persons employed in the handloom industry. Probably there are as many as
3.5 millions, besides unpaid apprentices, who may be numbering another 2 millions. In other words, the number of persons who depend directly upon the handloom industry would be approximately 6 million workers and, assuming that there is only one dependent for every two workers, the number of people dependent upon the handloom industry is in the vicinity of 10 million. This number is far greater than the number of people dependent upon the mill industry, which today has approximately 750,000 employees. If a calculation is made on the basis of four dependent for each mill worker, the total population dependent upon the mills for their livelihood is about 3.75 millions, far less than half the population dependent upon the handloom industries! But not all of them are dependent only on this industry.

The total production of the handloom and powerloom industry was over 3,100 million metres in 1966-67 as against 800 million metres in 1950-51. Today it is no longer a part-time occupation that it once was except perhaps in Assam where the men ply the handlooms during the off-season period for two or three months in the year, November to January, while women work at them throughout the year. There are age old customs one of which is that every woman is expected to spin and weave in Assam. Furthermore, as a rule, even today, weaving is the occupation of a particular caste, and others are not taking up to it in very large numbers.

Next to agriculture, handloom weaving is the most important source of livelihood in India. More and more handloom weavers are getting organised into cooperative societies. There are more than 3,600 such societies in India. Cooperative societies in some cases have their own spinning mills and their own sales depots. The problem confronting this industry is mainly lack of demand.

**Powerlooms**

This is growing up in many centres, especially in Maharashtra, Mysore, Madhya Pradesh, Andhra Pradesh, etc., and at present it is estimated that there are about 25,000 powerlooms, more than a third of which is in Bombay City. They have been introduced in the centres of Maharashtra State where the handlooms originally were
plying and it is said that they are worked by the same weavers. The powerlooms have certain advantages over the mills. They do not have the irksome restrictions of the factory. The weaver can, if necessary, spend longer hours and produce multi-coloured fabrics without much loss of time. It can utilize cheap electrical power and avail itself of modern appliances in weaving. The cost of production is comparatively low owing to small overhead charges and economies of mechanical production. Sometimes one finds some local specialisation as at Sholapur and Poona which concentrate on the production of fine saris with mercerised cotton. With a cheap supply of electricity throughout the country, it should be possible for the handloom weaver, even living in his own village to utilize the electricity available locally and produce fabrics on the powerlooms, not much less than two to three times his output in the handlooms, which necessarily means that the cost of production would be considerably less, and the profit better.

JUTE INDUSTRY

Almost the entire supply of raw jute for the whole world comes from the Ganges-Brahmaputra delta in Bengal. Jute is grown all over the delta but mostly in East Pakistan and to a smaller extent in West Bengal. Small outliers are found in Orissa, Bihar and Assam. The total production of raw jute was 5.4 million bales in 1966-67 and was estimated at 6.4 million bales for 1967-68.

Jute is a bast fibre and the economically important product is contained in what is known as its bark. It is extracted by retting, or fermentation in water, when the soft tissues in the fibre are dissolved leaving the fibre as residue. It is this fibre which is separated from the pith, washed and dried and then is ready for the mill, or the market. It must be remembered that the fibre is weaker and less durable than flax or hemp and is somewhat easily rotten by water.

Jute has been a staple crop of the Bengal delta from ancient times. At the end of the 18th century, through the reports of Britishers like Hamilton, Buchanan, etc., jute seems to have caught the attention and interest of the East India Company's directors at home. At that period, the home-made jute cloth was the common wearing apparel
of the people of North Bengal. The manufacture of gunny bags developed in the early part of the 19th century and on the opening up of the prairies in the New World, the industry developed at a terrific pace and this gave a tremendous impetus to the cultivation of the crop.

The handloom industry in jute was in the most flourishing condition till about the middle of the last century; accounting for the entire amount of the export of jute fabrics from India. It was a cottage industry with an unparalleled importance and dominated the market till about 1850. This pre-eminent position was gradually lost to the growing competition with the mills, both at home and abroad. It was only in 1828, that the first commercial consignment of raw jute reached Europe, although from 1795 onwards, samples were forwarded to Dundee in Scotland for experimental purposes, where the first mill was established in 1835. By 1838 the new process of batching with oil was introduced and the Dundee spinners who till then had confined their attention to flax and hemp, turned to jute. The jute industry made steady progress in Dundee and due to the Crimean War, which shut off all Russian supplies of flax, it consolidated its position and the American Civil War gave it an additional fillip.

India’s first power driven jute spinning mill was established in 1855, at Rishra, near Serampore, Calcutta. It was essentially a spinning mill and weaving was done by hand. Powerlooms were installed in 1860. Very soon several mills were established in rapid succession. By 1890, the export of handloom jute articles had completely ceased and the handloom industry became totally extinct. By 1947, there were as many as 110 mills, 1.4 million spindles and 68,000 looms; of these 99 million were located in Calcutta, 5 in Assam and 3 each in Bihar and Uttar Pradesh. They processed as much as 75% of the raw jute cultivated in the Gangetic delta. The rest of the world had about 45,000 looms and amongst these, Scotland, France and Germany were the three important centres. The jute industry located in India, till very recently, was a foreign industry, with the result that all the profits went out of India and it was, therefore, very different from the cotton mill industry which was almost totally Indian.
Partition in 1947, affected this industry very vitally. Most of the jute growing area went to Pakistan, while all the mills were located in India. But during the last 20 years, India has made great progress in growing raw jute needed for our jute industry. For maximum capacity production the Indian mills require 7 million bales of raw jute. The home production has gone up from 3.5 million bales in 1950-57 to over 6 million bales in 1967-68 (estimated). Our imports have gone down 35% of total supplies in 1950-51 to 17 per cent in 1966-68. However its quality has to be improved. The output of jute manufactures too has gone up from 8,37,000 tonnes in 1950-51 to 12,00,000 tonnes in 1967-68.

Coir Industry

Coir, like jute, is a fibre which has to be retted. The fibre is extracted from the husks of coconuts. It is found that the husks have to be put into stagnant water for quite some time, about eight months before retting is completed and brackish water is slightly superior to fresh water as it gives the fibre more strength. Once it gets softened, the fibre is pulled out by hand, beaten, cleaned and then spun into yarn; and later, the yarn is woven into mats, rugs, carpets, etc. India is a major source of supply of both the yarn and woven products.

Coir industry is almost exclusively located along the Kerala coast, in the tract between Quilon and Cochin with Alleppey as the most important centre. The Konkan coast, south Madras and West Bengal are secondary regions. Probably half a million people are employed in this industry, of whom more than half would be female labourers.

Silk

Silk reeling and weaving have been known to India from time immemorial and both raw silk and hand woven silk were important items of export to Europe for several centuries. During the early days of the British East India Company, till about the middle of the 19th century, India used to supply large quantities of raw silk to British manufacturers, and with the growing competition from Italy and Japan, and later from the rayon industry, the processing
of raw silk deteriorated very considerably. Local production is in the vicinity of a million kg. of raw silk, which together with an import of nearly 30%, mainly from Japan, is converted into about 18 million metres of finished goods, one half by handlooms and the other, by powerlooms. Local production of silk is rather expensive because most Indian growers follow the traditional methods of silk worm culture and little effort is made to make silk of a better quality, nor is the food for the cocoon available in abundance. Furthermore, the methods of reeling are primitive. In 1949, the Central Silk Board was created by the Government of India to promote improvements in silk worm strains, methods of cocoon handling, etc. and to sponsor extensive mulberry plantations. A National Research Station for silk has been established at Berhampore (West Bengal) with a branch at Kalimpong and several states have their own local research stations.

There is a certain amount of wild worm cocoons especially in the forests of Assam, Madhya Pradesh and Bihar, producing a coarse silk. Domesticated mulberry fed cocoons are found mostly in Bengal, Mysore, Kashmir and Madras. Two types of yarn are spun, (i) the filature, i.e. factory spun which is near enough to international standards and (ii) the hand-spun charka which is of an inferior quality and can only be used by the handlooms. Even today the bulk of the production is charka, the filature being less than 20% of the total. Srinagar is the largest centre of factory silk production and it has also extensive cottage industries for spinning and weaving.

Rayon and Staple Fibre

Artificial silk had been introduced into India as early as 1930, but its actual manufacture started only by about 1950. Apart from the old producers in the field, viz. Travancore Rayons at Alwaye (Kerala), the National Rayons at Kalyan (near Bombay, Maharashtra), Sirsilk at Hyderabad (Andhra Pradesh), Gwalior Silk Garments at Gwalior (Madhya Pradesh) and the Century Spinning and Manufacturing Company (Maharashtra). Many more units have gone into production in recent years. Altogether they produced
45,000 tonnes of rayon filament and 38,000 tonnes of staple fibre in 1965-66.

**WOOLLEN INDUSTRY**

India being mostly a tropical country, the need for woollen clothes has not been very imperative, but at the same time, it must be mentioned that for at least two to three months of the year, the temperature is sufficiently low throughout the Gangetic lowland that the wearing of woollen garments would add to the comfort of the population, especially when they are outdoors. The nights are generally cool throughout North India with minimum temperature in the vicinity of 4°C to 5°C. Because of the conditions of poverty, more than anything else, the bulk of the local population does not have woollen garments, with the result that the total amount of woollen consumption in the country is exceedingly low, round about 70 to 80 million pounds—less than 3 ounces per head of population, and if the tropical parts of India are eliminated from this account, it would leave a *per capita* consumption of wool in the colder parts of India at approximately 1/2 pound (0.25 kg.).

Nearly three fourth of the production and manufacture of wool in India is from Kashmir, Rajasthan, the Himalayan foothills and Uttar Pradesh with a minor output from Hyderabad (Andhra Pradesh). India has about 82 large woollen mills (and many smaller ones) with over 200,000 spindles, 3,000 powerlooms and probably 1,000 handlooms in the organised sector. The mill industry is located at Kanpur in Uttar Pradesh, Dhariwal and Amritsar in the Panjab and in the cities of Bombay and Bangalore. Among the factors of location, Kanpur has been alleged to have the advantage of coal from Bengal and wool from Panjab, but is this not too far fetched? The growth of Kanpur as a manufacturer of wool is not due to any advantage of location but only because it was the principal depot for the British Indian Army! Dhariwal and Amritsar are in the heart of the sheep-rearing region, and, therefore, the raw material is close by. It must, however, be remembered that as in the case of cotton, proximity to the raw material is not a compelling necessity in the case of the woollen industry especially when it is a factory industry. Today the
greater pull can be attributed to the use and availability of hydro-electric power in that area. Bombay started manufacturing because it was the chief port for import and export of woollen goods, and it had already the tradition of spinning and weaving of cotton; and it started manufacturing a mixture of woollen and cotton goods and later specialised on wool. The Bangalore Cotton and Woollen Mills, a branch of the Madras Buckingham and Carnatic Mills, is easily the largest cotton weaver in the South.

Manufacture of Vegetable Oils

From the point of view of world production, India produces nearly half the groundnut oil, 40% of the castor oil, 30% of the til oil, 10% of the linseed oil, and 6% of the coconut oil. Much of the oil is still extracted by the indigenous crude mills which leave quite a large amount of the oil as unextracted in the residual cake and it is possible to increase the oil extraction very considerably by the use of modern methods. From out of the oilseeds, hydrogenated vegetable oils are manufactured amongst which Vanaspati is the most important.

Tea

India leads the world in the production of tea, about 375 million kg., and, as a source of foreign exchange, tea is second only to jute. Tea production in India is probably more than half the world production (excluding China), of which nearly 80% is exported to the United Kingdom. Assam is the principal tea growing State, followed by West Bengal, Madras and Kerala which have large tea plantations. Most of the larger tea estates have their own factories for processing the leaf. Domestic consumption of tea is estimated round about 70 million kg. (150 to 160 million pounds for the country) or 1/6 kg. \(i.e.\) about 1/3 of a pound \per capita\ per annum.

Coffee

Indian coffee production is small, about 60,000 tonnes, of which nearly 40% is exported. The quality of Indian coffee is considered to be very high.
Sugar

Sugar cultivation and the manufacture of sugar certainly originated in India, as is well evidenced by the fact that the Sanskrit word *Sharkara* is found in some form or other throughout the world, Sucrere in French, Zucher in German, Azucar in Spanish, etc. As early as the 4th century B.C. it was manufactured in India and Alexander the Great reported about the existence of sugar. The cottage industry handles quite a large amount of the Indian crop where the sugar cane is crushed between the bullock driven iron rollers; the juice so extracted is then boiled and evaporated in shallow open pans to produce *gur* (Jaggery). The method of extraction is rather poor, but it is cheap. Factory methods were started in the beginning of the century but it was only in 1930 when protection was afforded to the industry that the factory industry developed considerably. In three years, 1932-35, 100 large mills were installed. There are about 200 mills today which have a combined annual output of 3.5 million tonnes. As in the case of sugar cane cultivation, Uttar Pradesh and Bihar have the largest concentration of sugar mills. About a decade ago these two States produced over 80% of total sugar, but in recent years a large number of factories have been established in the South. The sugar content of cane grown in the South is higher than in the North. Of the new factories, quite a large number are in the cooperative sector particularly in Maharashtra. There are already some 50 cooperative sugar factories and it is Government’s policy to establish a new capacity in the cooperative sector.

Tobacco

India ranks next to the United States and China as a producer of tobacco, all together about 325,000 tonnes. Almost half the production is used in the manufacture of *beedies*, which are made by rolling cut tobacco in a tobacco leaf and tying it by a small string. It is bitter and strong. Leaf tobacco is used directly for a variety of purposes, dried and powdered to manufacture snuff for inhalation, for smoking in the *hooka* and for the manufacture of cheroots, cigars and cigarettes. *Beedi*-making is the most important manufacturing
process; it is very widely distributed throughout the country with some concentration in centres like Sagar in Madhya Pradesh and Hyderabad in Andhra Pradesh. Cigarettes consume nearly 10% of the crop and on an average 10 to 12 millions are manufactured in the country. Approximately, a fourth of the crop is exported, mainly to the United Kingdom which is the largest market.

PAPER

The production of paper in the country on modern methods is extremely recent and there are only a few mills. The raw material is in some cases from Sabai, a grass found in the foothills of the Bihar Himalayas. Paper of good quality is produced from bamboo pulp while the sabai pulp is used for the production of coarser grades. There are still a few centres manufacturing handmade paper, a survival of the cottage industry that came from China many centuries ago. The quality is good, but the prices are too high. Early mills were located at Calcutta. Mills in Bombay, Madras and Mysore have been carefully located with respect to the bamboo pulp and power supplies. In Mysore at Bhadravati, there is a Government concern utilizing power from the Jog falls. The National Newsprint and Paper Mills at Nepa Nagar in Madhya Pradesh is a joint Central and State Government enterprise to produce newsprint with a capacity of about 30,000 tonnes a year.

PLYWOOD

The most important use of plywood is for the manufacture of tea-chests. The first plywood mill was opened in Assam after the First World War, but it was not very successful as the quality of the wood locally manufactured could not compete with imports from abroad. As late as 1939, there were only three small plywood mills in operation, two in Assam and one in Calicut, producing less than 10% of the demand, which was as high as 5 million tea-chests. The Second World War gave this industry a tremendous fillip, since all imports were completely cut off. By 1944, nearly half the local demand was met by indigenous production but immediately on the cessation of hostilities, imports began to pour in from abroad and the industries
faced a virtual collapse. By 1950, however, Government aid was
given to the industry, since when it has developed very rapidly. By
1955, the country was almost self-sufficient in her requirements.
The important centres are in Assam, northern parts of West Bengal,
Calcutta, Bombay and the Kerala coast. Assam and West Bengal
together produce nearly half, while the Kerala coast produces 40% of
the total production. The mills, except those in Calcutta and
Bombay, are located near the tea plantation. Calcutta is now getting
some of its supply of raw materials from the Andaman Islands.

MATCHES

India’s matches are all locally produced from five mechanised
factories of the Western India Match Company Ltd., a Swedish
concern, at the cities of Bombay, Madras and Calcutta and at
Bareilly (Uttar Pradesh) and Dubri (Assam). There are also very
large cottage industries in match manufacture entirely done by hand,
located in Sivakasi in the Ramanathapuram (Ramanad) district of
Madras State.

LAC

India is one of the few countries of the world with resources in lac,
which is a resinous substance secreted by small insects ‘laccifer-lacca’
which feed on the sap of various tropical and subtropical trees,
especially the species of Ficus. The industry has been an ancient
one and traditionally it is believed that even in the days of the
Mahabharata, lac was so well known that one of the Kaurava Princes
had a palace built out of lac and there was a trade in lac with Africa,
through the Red Sea, in the first century A.D. But Europe received
lac for the first time only in the early 1600’s. Lac is a very important
ingredient in the manufacture of shellac; today an absolute necessity
in the engineering, gramophone and electrical industries. It is also
used to an increasing extent in the manufacture of varnishes, lacquer,
polishes, etc. The average export of about 22,000 tonnes is worth
nearly 30 million dollars. It is estimated that the collection of lac
forms a source of supplementary income to as many as 30 million
farm families in Bihar and Madhya Pradesh and lac processing gives
direct occupation for about 30,000 workers. Modern methods of
extraction are found only in two mechanised factories in Calcutta,
but the bulk of the processing is done in small cottage industries by
crude and primitive methods. The Lac Research Institute was
started by the Government of India in 1925 at Nankum in Bihar and
it has been responsible for improving both the quality of the
product and the efficiency of collection and processing. However,
it must be admitted that only a very small fraction of the total avail-
able quantity is now collected and tremendous improvements are
easily feasible.

Leather

India is practically self sufficient in her demands for most of the
leather goods and it has a sizeable export trade in tanned leather and
manufactured goods. Till recently, the export was mostly of raw
skins and hides, but in 1951, the Government, to encourage local
processing, has prohibited the export of raw cattle and buffalo hides,
although the skins of goats and sheep are still exported. India, which
has the world’s largest cattle population, can certainly become one
of the world’s largest manufacturer of leather goods. The estimated
production of hides and skins is roundabout 60 million (cattle 16.12,
buffalo 55, goatskins 23.2, and sheepskins 15.1). There is a small
amount of production of skins of monkeys and donkeys. Madras
and Andhra Pradesh produce the largest amount of cattle, buffalo
and sheep skins while Bihar and Maharashtra run as close seconds
for cattle hides. The largest amount of goat skins comes from
Madhya Pradesh with Maharashtra, Madras and Andhra as secon-
dary sources.

Tanning in India is primarily a cottage industry and small
establishments are operated by leather merchants. Till recently,
tanners used wattle bark from South and East Africa as principal
tanning ingredient, but with the ban on trade from South Africa, they
have had to turn to indigenous sources and to quebracho imported
from South America. Wattle bark to a small extent now comes
from the new plantations in the Nilgiris of Madras. In north
India, especially in western Uttar Pradesh the chamars have their
own village tannery in which they use babul bark (Acacia arabica).

Animals in India are rarely slaughtered and most of them die of old age, with the net result that at least 75% to 80% of the raw hides and skins which reach the tannery are those of animals which have died of old age or from diseases. In other words, skins and hides which reach the tanneries are not of top quality. The hides and skins that are manufactured locally by chamars in Uttar Pradesh are generally poor in quality because they have been rather crudely handled, both in the skinning and curing processes. Modern types of tanneries are found in Agra, Bombay, Bangalore, Calcutta, Kanpur and Madras, approximately 26 in all, which produce leather for the manufacture of foot-wear, suit-cases, leather bags, harness, gloves, etc. Cottage industries and small shops are responsible for nearly 90% of the production; the remainder is from mechanised factories. Altogether they consume as many as 14 million hides and skins and produce about 85 million pairs of shoes. (The principal centres are at Agra, Bombay, Bangalore, Calcutta, Kanpur and Madras). Kanpur is an important centre for the production of chappals (Indian sandals) and Calcutta for the manufacture of shoes, the Kanpur factory being a British pioneer and that at Calcutta built by Batas of Czechoslovakia.

RUBBER

The Indian rubber industry now meets the local demand for rubber goods and the indigenous supply of 50,000 tonnes of raw rubber from Kerala plantations supplemented by synthetic and reclaimed rubber meets the bulk of the demand of the country. The plantations are centred in Kerala while the rubber industries are located in Bombay, Calcutta, Madras and Kerala. 2.3 million tyres and an equal number of tubes for motor vehicles, and 18 million each of cycle tyres and tubes are now manufactured in the country. Some of the other automobile requirements, such as insulated cables, hoses etc. are also increasingly met by indigenous production.
CHAPTER X

TRANSPORT

All types of modern transport—aeroplanes in the air, railways, automobiles (cars, buses, trucks, etc.), scooters, bicycles, both motor and pedal on land and steam or motor launches on water—are now frequently found all over the country, together with the bullock and camel carts and country crafts. Even today vehicles drawn by bullocks, horses and camels carry a very large part (estimated by some to be more than 50%) of the total passengers in India; the most popular being the bullock cart. Bicycles have, in recent years, become much more important in the towns and cities and have begun to compete with bullock carts.

By 1840, permission was granted to British Corporations to build separate systems of railways, one east and north from Bombay and the other north and west from Calcutta. The first line that was opened was from Bombay to Thana in 1853, a stretch of 30 km., followed a year later, by the line from Calcutta to Raniganj, a distance of nearly 180 km. and in 1856 from Madras to Arkonam, a distance of nearly 70 km. As early as 1853, the then Governor-General of India, Lord Dalhousie, began to lay plans for the construction of railway lines to link up all the major cities. By 1871, the three Presidency towns of Calcutta, Bombay and Madras were interlinked with a branch running up to Amritsar and another to Calicut. The East Indian Railway tapped the rich Gangetic Valley, the Great Indian Peninsular Railway (G.I.P.) the rich cotton lands of the Deccan and the two met at Allahabad. The Madras railway met the G.I.P. Railway at Raichur and had branch lines to Bangalore and Calicut. Bombay had another line running to Ahmedabad and Lahore was linked to Delhi via Amritsar. In the early years, guarantees were offered by the then British Government, 4.5% to 5% on capital investment, as incentives for attracting private capital from Britain. Although it gained the desired objective and secured the necessary capital, it, however, incurred a considerable
amount of wastage in the construction costs, which hit the Indian Government hard, resulting in a terrible financial drain. During the second period of development, 1872-1879, the Government of India directly took over the construction and management, but it happened to be a period of wars, poverty and famine, as a consequence of which the progress was not very rapid. During this seven year period, because of financial stringency, economy in cost of construction was called for and the apparent answer was to lay metre-gauge lines from Madras along the east coast to Tuticorin, from Ahmedabad to Agra and Delhi and a loop line between Banaras and Delhi via Lucknow. The original gauge was the 66" broad gauge, later the metre gauge, and still later, the narrow gauges of 30" and 24" were adopted, especially in the hill and barren regions and in suburban areas, all the belief that this was the most economical method of construction, both for the immediate and distant future. India thus has four gauges, the 66" broad gauge, the metre gauge 39.3", the narrow 30" and the narrower 24". By 1906, direct broad gauge lines were completed between Calcutta and Madras and Calcutta and Nagpur (to connect the line to Bombay) and the broad gauge lines in the Gangetic Valley, interlinking the more important towns, were completed. But the most significant development was mostly in the expansion of metre gauge lines; Ahmedabad was connected to Delhi, Agra, and Kanpur, the upper Brahmaputra valley was linked to the delta by the construction of the Bengal and Assam Railway; the Bengal and North Western Railway and Tirhut and Rohilkhand-Kumaon railway were completed in the Gangetic Valley, in addition to the Bangalore-Poona, and several other branch lines in the Peninsula. In 1880, India had 3300 km. (2,050 miles) of metre and 11,362 km. (7,060 miles) broad gauge. In 1906, the broad gauge doubled to more than 26,024 km. (15,548 miles) the metre gauge tract increased six times, the total being 20,288 km. (12,613 miles). There were also 2,253 km. (1,400 miles) of narrow gauge lines. Most of the railway system of the country was completed in 1906, the subsequent construction being mostly of short branch lines. Under the original terms of the lease, after a period of 99 years of private operation, there was a reversionary
right to the Government of India which it exercised in 1947 and thereby gained control and possession of the entire railway system in the country. Construction of railways in India has been no simple matter; the engineer was confronted with very broad rivers with frequent floods, making the construction of bridges extremely difficult and expensive, the abrupt ascent on the scarp of the Western Ghats demanding the construction of tunnels at Thalghat and Bhogvhat and a host of others, all demanding engineering skill and effort of a very high order. The mountain ranges of the Satpuras, Vindhyas, and many parts of the Eastern Ghats have retarded, and in some cases, even blocked railway construction.

Mountain railways are either metre, or narrow gauge lines. These were constructed by the British mostly to reach some of the hill stations in the Himalayas, for example, from Pathankot to Manali, from Kalka to Simla, from Siliguri to Darjeeling, from Mettupalayam to Ootacamund and the two foot tramway line in Matheran in Bombay.

On the eve of partition, the sub-continent of India had 66,208 km. (41,141 miles) of railways, of which, as a result of partition, India inherited 54,969 km. (34,157 miles) with seven out of the nine major railway systems, in tact. The other two, the Bengal-Assam and North-Western Railways and a part of the Jodhpur State Railway were divided between India and Pakistan. Rolling stock were allotted entirely on the basis of location. Immediately after partition, construction of lines had to be started to link up West Bengal with Assam, which was almost completely isolated, with no direct railway connection with the rest of the country. Most of the trade of East Panjab, Delhi, Rajasthan and western Uttar Pradesh, originally destined to Karachi had now to be redirected to Bombay. To relieve the congestion at Bombay, a new port was reestablished at Kandla in Kutch. The Assam rail link which runs from Manihari Ghat on the Ganges river to Fakiragram, a distance of about 425 km. (260 miles) was completed in the record time of two years, through that narrow tongue of land which is hardly 20 km. (12 miles) wide between East Pakistan and Nepal. By using sections on existing lines, the actual construction was limited to a distance of
230 km. (142 miles), and the metre-gauge system of Assam was also linked with those of Bihar and Uttar Pradesh. The ferry service across the Ganges from Manihari Ghat to Sakrigali Ghat connects the Assam metre-gauge rail system with the broad-gauge systems to Calcutta. A new railway bridge was constructed across the Ganges near Mokameh in Bihar providing direct link east of Varanasi (Banaras), between the metre-gauge and broad-gauge systems. To meet the growing industrial demands, the route from Raniganj to Calcutta has now four tracks and some of the heavily used lines in the Gangetic valley have been double tracked. Today the railway administration is conducted as a Central Government Department with eight major systems; Northern Railway, Western Railway, Central Railway, South Central Railway, Eastern Railway, South Eastern Railway, Southern Railway and the North Eastern Railway.

A very large area of India is still inadequately served by railways, but the most productive sections have been interlinked, although the differences in gauges and the lack of bridges certainly reduce the effectiveness of this net. The Gangetic plain is the best served part, but Assam is the poorest and so is the west coast from Bombay to Mangalore.

India today has 24,140 km. (15,000 miles) of broad-gauge lines, 18,500 km. (11,500 miles) of metre-gauge lines and 4,820 km. (3,000 miles) of narrow-gauge lines. In total railway mileage, India ranks fourth in the world, with the U.S.A., Canada and U.S.S.R. preceding her, but when the calculation is made on the basis of population, the Indian mileage is extremely poor. She has less than 18 km. of railway for every 1,000 sq. km. i.e. 28 miles for every 1,000 square miles of area but she has only 15.2 km. (9.5 miles) of track for every 100,000 persons, far below the world average of 50 km. (30 miles per 100,000). India has very little water transport and, therefore, the demand for railways is so much greater than in any other country. By far the most important type of traffic is the passenger traffic, approximately 1,500 million passengers are annually carried on Indian Railways.

During the pendency of the Second World War, there were no replacements of Indian locomotives, coaches and freight cars and
at the end of the war, the Railways were seriously depleted of these various items. Several manufacturing plants were started in India to make up these deficiencies.

Four plants, three in Calcutta and one at Burnpur produce freight cars totalling 20,000 per annum. Four plants were started recently for the manufacture of passenger coaches; the Indian Standard Wagon Company, subsidiary of the Indian Iron and Steel Company at Burnpur, the Hindustan Aircraft at Bangalore, the Tata Iron and Steel Company at Jamshedpur and the Integrated Coach Factory at Madras; all together manufacture about 1,000 coaches annually. Locomotives are manufactured by Tatas at Jamshedpur, and by the Government plant at Chittaranjan (Asansol). Tatas started manufacturing 50 locomotives and 50 boilers a year, with German technical assistance and this was doubled a few years ago. The Chittaranjan plant, a Government of India undertaking with technical assistance from the United Kingdom produced 120 broad-gauge locomotives and 50 boilers in 1950; the capacity of the plant has since been doubled. India is nearly reaching self sufficiency from the point of view of locomotives.

*Defects:* That the Indian railways has a multiplicity of gauges has already been emphasised and it is obvious that this would create considerable delays in the transhipment of freight across the country and increase its cost. Unfortunately, the short term policy that was taken by the British administration in the 1870’s to construct metre-gauge lines on considerations of economy has hit the country hard, and there appears no immediate remedy for this malady—the multiplicity of gauges must remain a fait accompli for several years to come.

It must also be pointed out that the various lines were constructed by the British to link up the major ports of Bombay, Calcutta, and Madras with the interior of the country, with no serious consideration for the economic development of the country, as a whole. And this is not surprising in the least, for after all, the British looked to these ports as their points of approach into the country, the gates of India having become sea-gates and the way to India, the way of the sea. As a result of this, the railways have not been
able to play the desired role in the economic development of the country.

ROADS AND ROAD TRANSPORT

The Indian road system is, indeed, an ancient one which is well evidenced by the existence of paved streets in the ruins of Mohenjodaro and Harappa, approximately 5,000 years ago. The earlier emperors of India were anxious to link up the uttermost parts of their territories to the capital and Chandra Gupta Mauriya, the famous ruler of India, (circa 300 B.C.) is reported to have constructed a road linking his capital Pataliputra (modern Patna) with the North West Frontier. It was well constructed, providing facilities for drainage, the surface itself being convex to allow rapid drainage of rain water. Ashoka the Great extended this route and improved the so-called Imperial high-ways. The Moghul Emperors were equally noteworthy as great road builders—the trunk road from Dacca in East Bengal through Varanasi (Banaras), Agra, Delhi, and Lahore, as far west as the river Indus, with branches from Agra to Jodhpur, from Agra to Indore and Lahore to Multan, all of them are credited to Emperor Sher Shah. Rest houses were constructed all along the roads and absolute security to the travelling public was guaranteed by an effective police system. The British later on, improved Sher Shah’s roads from Bengal to the Indus and called it the Grand Trunk Road in the late 1840’s. Still later, they constructed the Great Deccan road from Mirzapur near Varanasi (Banaras) to Jabalpur, Nagpur and Bombay and the Western Deccan road from Agra to Jhansi and then to Bombay. The British got themselves so encumbered with railways that after 1870, they were not genuinely interested in developing either roads or inland waterways. They felt that investment on roads would be uneconomical with practically little or no returns and perhaps they feared that the roads would be competitive with the railways in which they had financial interests. They were only interested in construction and maintaining roads and highways which had some strategic value and the construction of all these military roads was practically completed by 1900. From 1900 to 1947, i.e. till political power was handed over to Indian hands, there
was very little major road construction in India and indeed, this was the period when the automobile and the trucks invaded other parts of the world and revolutionised the modes of transport. Thus during this entire period, of very nearly half-a-century India was in the doldrums, almost at a standstill.

It has been estimated that India had a total length of 157,019 km. (98,137 miles) of surfaced highways and 242,923 km. (151,827 miles) of unsurfaced roads in 1951. But of these, only 22,399 km. (14,000 miles) were fit for fast motor traffic, paved with concrete or bitumen. Generally speaking, there is a tremendous shortage of motorable roads in the country. This is particularly true of the roads in the Gangetic lowlands—the most densely populated part of the country—where the constituents of the surface rocks are clay and sand, and hence very soft. The problem is further accentuated by the need for the construction of bridges. During the season of annual floods, serious and prolonged traffic interruptions are characteristic.

Furthermore, the roads that were constructed were again mostly those linking the big cities; the net result was that they ran parallel to the railways, creating conditions of competition, between the trucks and buses on the one hand and the freight and passenger trains on the other. Thousands of villages in India are still unconnected by roads capable of taking fast motor traffic.

In 1943, the ambitious Nagpur plan was drafted by a group of engineers, economists and industrial leaders, who proposed a minimum 645,000 km. (400,000 miles) for the pre-partitioned India, of which at least three quarters would be in the Union of India. Their idea was that in a highly developed agricultural areas no village should be more than 2 miles from a road, not more than 5 miles from a main road, the average distance from a main road being generally less than two miles; in non-agricultural and less developed areas, no village should be more than 5 miles from a road, the average distance from a main road being 6 or 7 miles in most cases. India would have to develop at least 245,000 km. (150,000 miles) of country roads to meet this target. However, the Nagpur plan was then shelved, because of the war emergency.

When the First Five Year Plan was drawn up in 1951-56 the
development of roads was given a high priority and nearly 6,500 km. (4,000 miles) of existing National Highways were improved and equipped with one line asphalt carriage ways; 600 miles of road links were newly constructed and 400 miles were macadamised for taking two-lane traffic. Pathankot was linked up with Jammu, a distance of 102 km. (65 miles) in a record period of four months. Later, a second road from Dalhousie Road to Udampur, was constructed, a distance of 160 km. (100 miles) in which there is a tunnel 1.5 mile long with duel tubes, at an altitude of 2,200 metres (7,250 feet) just below the snow line, to circumvent the famous Banhal Pass at 2,750 metres (9,000 ft.) altitude which may get snow-bound. The two roads today, give access from India into Kashmir, during all seasons of the year.

It is also important to remember that village road improvements have been effected by the cooperative efforts of the villagers, by voluntary contributions of labour, e.g. in Assam, a 157 km. (123 miles) road from Aijal in the north to Lungleh in the south, indeed, a monument of cooperative enterprise.

The Second Five Year Plan invested a huge amount of money on roads in comparison with the outlay during the First Five Year Plan. The main achievements were the construction of (i) 1,000 km. (625 miles) to link up the National Highways, (ii) 60 river bridges, (iii) widening 6,400 km. (4,000 miles) into double lane arteries and (iv) providing asphalt base in many other sections of main roads. It is estimated that the mileage of surfaced roads had increased from 157,000 km. (97,500 miles) in 1950-51 to 235,790 km. (147,000 miles) in 1960-61 and that of unsurfaced roads from 243,000 km. to 269,000 km. (151,000 to 168,000 miles) during the same period.

With the programmes undertaken during the First and Second Five Year Plans, the targets of the Nagpur Plan of 1943 have been exceeded in the case of both surfaced and unsurfaced roads. In spite of that, however, the road network remains definitely deficient in many respects, such as unbridged river crossings, narrow carriage ways, a substandard surface, etc.; and in about 60% of the total road mileage of the country, there are only earthen roads. Out of
The demarcation of the Gujarat West Pakistan Boundary in accordance with the Indo-Pakistan Western Boundary Case Tribunal Award is in Progress (1965)
The demarcation of the Gujarat West Pakistani Boundary in accordance with the Indo-Pakistan Western Boundary Case Tribunal Award is in progress (1968)
the 24,000 km. (15,000 miles) of National Highways, less than a
sixth alone has two-lane carriage ways.

The objective of the Third Five Year Plan was that no village in
a developed and agricultural area should remain more than 6.5
km. (4 miles) from a metalled road and more than 2.5 km. (1½
miles) from any road. It is expected that by 1981 there will be at
least 400,000 km. (250,000 miles) of surfaced roads and 650,000
km. (400,000 miles) of unsurfaced roads. The road programme
are to be undertaken both by the States and the Central Govern-
ments. Priority needs of the backward areas are to be kept in mind
and new roads are to be constructed in Assam, Kashmir, Madhya
Pradesh and Rajasthan.

The bulk of the freight traffic in the villages in India is still carried
by the bullock cart. It is estimated that there are now as many as
14 million bullock carts in the country as against 2.5 lakh trucks.
But the quantum of goods transported by 14 million carts is less
than that hauled by 2.5 lakh of trucks. Even the capacity, in
terms of ton-kilometres, of cart ‘population’ is far less than the
truck ‘population’. The carts, however, enjoy many advantages;
they can reach the areas which will be inaccessible to other vehicles;
they could even reach those parts where there are no roads; they
are very inexpensive to operate with the bullocks which are used
both for ploughing and for draught purposes, etc. But they have
inherent disadvantages also. Their range of travel is small and their
speed equally so; because of the iron tyres which are narrow, they
cut deep, even into the paved roads and damage them very much
more than what the heavier trucks do. Obviously, it would be
impossible to use pneumatic tyres for all the bullock carts; but the
question does arise whether it would not be possible to use rubber
cushioned tyres and wheels with ball bearings for the bullock carts
of the countryside. If this can be done, the distance travelled by
each bullock cart per day would be much greater, nearly double,
the strain on the bullocks would be much less and the carrying
capacity of each vehicle considerably enhanced. In course of time,
even pneumatic tyres can be thought of.

In India, men carry on their heads or backs, goods in all parts
of the country and it is not an uncommon sight even today to find men, women and children carrying food, fuel and other household goods along the village paths. Two wheeled hand-carts are even today used to carry heavy and bulky goods and as many as 4 to 5 persons are sometimes required to pull and push each cart. Rickshaws pulled by man are still found in the streets of some towns although cycle rickshaws are replacing them fast. During the last few years, the bicycle has successfully invaded the Indian roads and conditions today are such that the country has almost reached the bicycle-age! (cf. U.S.A. in the automobile age) and has attained self-sufficiency in bicycle requirements. The large bicycle manufacturers are Hercules at Madras and Sen-Raleigh at Calcutta, besides a host of small firms in the Panjab, all together producing nearly 3-4 millions per annum.

**Motor Vehicles**

These are essentially found in the larger cities with trucks and buses acting as feeders for railways. Bus services are not generally very satisfactory, time schedules are rarely kept up, and over crowding is the rule. Many if not all States have now taken over bus transport as Governmental undertakings, either wholly or partly, e.g. Kerala, Madras, Panjab, etc., but it cannot be said that this has improved the amenities to passengers. The conditions of transport in South India, however, are far better than what it is in North India.

There has been a constant battle between the State Governments and transport owners, mainly because the rates of taxation in India are amongst the highest in the world! On every vehicle that is imported or its spare parts, import duty has to be paid. The diesel oil that is used is again taxed both by the Central Government and by the States. Each vehicle is further taxed for using the roads according to its weight and the trucks plying from one State to another have to pay full taxes of both the States!! In addition, there are sometimes octroi duties, that is, charges on goods entering and leaving towns. As far as taxes on motor vehicles are concerned, India apparently is one of the most heavily taxed countries
in the world; perhaps a legacy of the British.

The assembling of motor vehicles started in India about forty years ago. It has not made much progress, partly because of the generally low standard of living of the people, but the high taxes, the high cost of fuel, the lack of good roads, these have all been equally important factors in creating these conditions of poverty. The industry started with assembling plants; the General Motors and Fords had assembling plants, the former at Bombay and the latter at Bombay and Calcutta and later at Madras. Till 1943, they were the most important manufacturers. For reasons unknown, both General Motors and Fords have closed their assembling plants. Various other assemblers came into the picture, Continental European Vehicles and a British one, which imported engines and transmission, to complete units, as well as chassis of trucks, the bodies, of trucks being made locally. Some parts were manufactured locally and most vehicles had Indian made tyres and tubes, rubber hoses, upholstery, pistons, bearings, ball-bearings, etc. Today, however, out of the assembling companies, there are only half a dozen which are in the market; Hindustan Motors at Calcutta with an annual capacity of 18,000 vehicles manufacturing a modified form of Morris cars; the Premier Automobiles at Bombay with 12,000 vehicles annual capacity, manufacturing Fiats; Standard Motors at Madras manufacturing 2,950 Standard Cars; the Ashok Motors at Madras, manufacturing 7,540 Leyland 5-ton diesel trucks; the Tata Engineering Locomotive works at Jamshedpur manufacturing 3-ton Daimler Benz trucks; Mahindra and Mahindra at Poona manufacturing Willy's Jeeps.

Three types of motor-cycles are now being manufactured with foreign collaboration, Enfields, Java and Rajdoot.

The manufacture of various automobiles parts has progressed very fast in India and several new concerns started during the last few years are manufacturing important ingredients like cylinder heads, gears, brakes, dynamos, crank-shafts, etc.

The Government of India had a small car project but so little progress has been made up till now, that one does not know what will be accomplished in the near future.
INLAND WATER TRANSPORT

In ancient days, inland waterways played a very important role in the transport of commercial traffic, but not even a minute fraction of this is found today. This decline has been most marked on the Ganges and its tributaries, but it has also occurred in other rivers like the Brahmaputra, Krishna, Godavari, Cauveri, etc. At one time, several hundred passengers were carried on all the main Gangetic rivers and they had, in addition, a tremendous amount of freight traffic. The Ganges and Jamuna were the most important rivers in the early days for goods traffic and many people seem to think that it was the competition with the railways which was entirely responsible for crippling the system; perhaps this is not the whole story. During the last 70 to 80 years, a tremendous amount of irrigation development has taken place so that the bulk of the water is carried from the rivers through the irrigation channels to the fields below, and consequently the rivers have become shallow and so do not permit the passage of large barges. It cannot also be denied that the British sponsored and backed up the railways both financially and by their trade interests. Furthermore, mechanised railway transport was faster and more dependable. River traffic, which in many cases was slow, created losses in cargo by deterioration, but to this must also be added the not infrequent doses of river piracy, with no protection from insurance.

Today it is estimated that there are at least 10,000 km. (6,000 miles) of river channels in India and Pakistan, of which at least 8,000 km. (5,000 miles) are in Bengal, Assam and Bihar, and another 6,500 km. (4,000 miles) of irrigational channels which could carry goods.

Partition, however, has created tremendous problems of river transport in the Ganges-Brahmaputra delta and the traffic between Calcutta and Assam; Calcutta and eastern Bengal; and Assam and Bihar by way of eastern Bengal has been completely arrested as a result of the creation of the Indo-Pakistan boundary running criss-cross across the delta. The deltas of the peninsular rivers also carry some amount of traffic. There are still navigable canals, for example: (i) the Orissa canal from Hooghly to the Mahanadi,
(ii) the Madras system including the Buckingham canal about 450 km. (260 miles) south of Madras, (iii), the Kurnool-Cuddapah canal, between Krishna and Pennar rivers, 145 km. (90 miles) long, and (iv) the thousands of metres of canals and interconnected back waters in Kerala, linking the capital of the state at Trivandrum in the south, with Beypore in the north.

Efforts are now being made to develop navigation in the Damodar and to link up the coal fields of the Damodar valley with Calcutta. ECAFE suggested sometime ago the revival of the Gangetic valley boat traffic and it was then estimated that a well-organised system of inland navigation could transport bulky commodities at nearly 1/4 of the present railway rates. Barges would be ideal for transport of ore, pig iron, fuel oil, timber, grain, limestone, large machinery, etc. This aspect needs special encouragement, especially when it is remembered that one of the big bottlenecks associated with the development of the great steel projects at Bhilai and Rourkela would be transport, demanding the assembling of at least 4 to 5 million tons of coal from Jharia and an equal amount of ore from nearby areas and the despatch of two to three million tons of finished steel from the furnaces to the markets, of which Calcutta will be the more dominant. It is hardly possible that, when all the steel furnaces are in full operation, the railways will be able to carry this load. One would like to go back to the early days of Sir Arthur Cotton in the fifties of the last century when he had plans to link up the Godavari, Krishna and other systems. If the Himalayan rivers could be linked up with those of the South, it would also bring the additional benefit of meeting the perennial water shortage that is so characteristic of the South, and geographically, there does not appear any insurmountable hurdle.

SHIPPING

Indian ships today carry about 15 percent of the overseas trade of India; much of the internal trade takes place on the coast between West coast and Calcutta using both small power boats and sailing ships, and coastal shipping has now been reserved for Indian operated vessels. Prior to independence, India’s international trade was
almost completely controlled by British shipping interests, and Indian ships carried almost no Indian goods abroad. The British Indian Steam Navigation Company and its subsidiaries like the Peninsular and Oriental Steam Navigation Company practically controlled both freight and passenger traffic and the British Government gave them the necessary assistance by insisting that all mails and Government trade and official passengers (the Britishers going home on, and returning from leave) should be carried by these vessels. On Independence, however, the Government of India purchased 110,000 tonnes of war surplus vessels from the U.S.A. and established a Government owned line, the Eastern Shipping Corporation for the foreign trade of India, and in 1956, Government nationalised the Scindia Steam Navigation Company. Ships are being built in Indian docks at Vishakhapatnam.

PORTS AND HARBOURS

There are only a few ports in India, 8 major ports, each with an export and import tonnage of 100,000 tonnes or more. The large ports of Calcutta and Bombay together account for 65% of the foreign trade while Madras, Cochin and Vishakhapatnam jointly account for about 20%. Few Indian ports have the modern facilities required by large ocean liners and freighters. The Government of India started opening a new port in Kandla in Kutch (i) to take over the trade of western Uttar Pradesh, Panjab and Rajasthan which before partition was destined through Karachi and (ii) to relieve the pressure at Bombay. Several improvements have been made in the ports of Bombay, Cochin, Vishakhapatnam in the near past and it is not unlikely that Marma Gao which till recently was under Portuguese control will also receive a tremendous impetus in the years to come. Mangalore is being developed, and on the east coast, development is taking place at Tuticorin.

Bombay owes its pre-eminence to its large deep water harbour, open throughout the year. In its early history, the island of Salesette gave the necessary protection to the ships at bay, especially during the southwest monsoon season. The excellent rail connections it has with its productive hinterland which extends as far as Delhi
have made it what is today, with eight kilometres (five miles) of modern docks!

Calcutta is the largest port of India, handling 30% to 40% of India's foreign trade. The port extends for a distance of nearly 8 km. (5 miles) on the Hooghly river, nearly 125 km. (80 miles) up from the Bay of Bengal... River silting makes constant dredging necessary. Large ships must dock at Diamonds harbour 65 km. (40 miles) down stream and efforts are now being made to construct an ancillary port at Haldia 90 km. (56 miles) down stream from Calcutta. Consequently a barrage has to be constructed at Farakka to store enough water from which a regulated supply can be given to flush the silt in the port to eliminate the tremendous efforts at dredging, now essential for the life of this port.

Madras is the third biggest of India's ports. Its small artificial harbour is being enlarged by the construction of new docks which should make it capable of handling 4 million tonnes annually. Vishakhapatnam by the end of 1968 should be able to handle an additional two million tons of iron ore. A series of minor ports like Kadwar, Honavar, Mangalore, Tuticorin are also to be developed.

India has only one ship building yard located at Vishakhapatnam started by the Scindia Steam Navigation Company.

AIR TRANSPORT

Commercial Civil Aviation has made rapid progress during the last few years. Mail and passenger traffic was first started in 1929 when the Imperial Airways operated between London and Karachi and subsequently extended to Delhi, flying direct services between London and Delhi. Later, however, several Indian companies were started, the Tata Airlines, which connected London with Bombay, Madras and extended subsequently to Colombo; this was followed by the Indian Airways and a host of smaller concerns. Actually, to the conditions created by the Second World War must be credited the growth of internal airways. The war brought into India an enormous amount of equipment, meteorological stations, radio and radar communication, engine over-haul and servicing depots and an equally large amount of flight information together with a nucleus
of technical personnel. At the end of the war, many surplus cargo aircrafts from the U.S. Army and Air Force were made available for conversion to civil air navigation in India. After partition it became imperative to develop three important airports in India—Palam at Delhi, Santa Cruz at Bombay and Dum Dum at Calcutta. In 1953, all Indian Airlines were nationalised with two corporations, the Indian Airlines Corporation for internal and the Air India International for international traffic. Today the major cities in India have all been linked together by air services, but all the same the traffic is less than 1% of the total passenger and freight traffic in the country, mainly because fares in India are almost the same as in most other countries of the world and is excessively high for a poor country like India which cannot afford to pay such high rates. Nevertheless, air services are becoming popular and the internal and international services are both profitable undertakings.

The Air India International today operates flights from Tokyo to New York via Calcutta, Delhi, Bombay and most other important European cities including Moscow, besides its flights to Nairobi. In competition, with various foreign lines, it must be acknowledged that Air India has been able to hold its own.
The demarcation of the Gujarat West Pakistan Boundary in accordance with the Indo-Pakistan Western Boundary Case Tribunal Award is in progress (1968)
CHAPTER XI

POPULATION

Among the countries of the world which in recent years have shown a remarkable spurt in the growth of population, perhaps the greatest are China and India, not because their birth rates, as generally believed, are much higher than those of other countries but mainly because they have started with an exceptionally large base. The population of India has grown from 235 millions in 1901 to 439 millions in 1961 but during the first two decades of this century, the population was fairly stable (1911, 252 millions; 1921, 251 millions) and since then it has been increasing steadily (1931, 279 millions; 1941, 318.5 millions, 1951, 361 millions).

India in 1961 had a total population of 439 millions and, as such, has the second largest population in the world, second only to her big neighbour China. The population of India is larger than the population of the U.S.A. and the U.S.S.R. put together. The average density of population in India at present is nearly 5 times the world average and to make matters worse and more difficult the population is increasing at a very fast rate, about 2.25 to 2.5% per annum. It is estimated that the population in 1968 is round about 500 millions, more than a seventh of the world's population. Few people realise that one out of seven human beings in the world is an Indian and when it is remembered that the total area of India is only 2% of the land surface of the earth, one begins to realise the enormous human agglomeration that is found in India.

Some parts of the country have shown a much greater growth than others and a careful study of the maps of population distribution during the last four decades shows that greater increases have taken place in regions of high density than in areas of low density. High densities and high rates of growth are both found in the better agricultural tracts. The poorer tracts have remained under populated throughout the last sixty years. This indicates that the problem of population in India is not a case of
maldistribution; higher densities are found in those parts of the country where there are better opportunities for eking a livelihood, which in most cases is agricultural activity. Obviously, then, the problem of population cannot be solved in India by redistribution.

India is still in the agricultural stage and from the point of view of economy it is underdeveloped, because more than 50% of its national income is contributed by the agricultural sector and about 70% of the population is directly dependent upon agriculture as the primary means of livelihood.

The increase of population in India, as perhaps in most of the underdeveloped countries of the world, is more the result of a reduction of death rates rather than an increase of birth rates. The birth rate in India is approximately 30 per thousand and it has been this for quite sometime, for at least 40 to 50 years, but the death rate in India which was about 28 per thousand in the early part of the century, has since 1921, gone down steadily and today it is estimated to be between 18 and 20 per thousand. In other words, during the last 30 to 40 years, there has been a constant widening of the gap between birth and death rates which has resulted in considerably augmenting the population. Many people seem to think that the birth rate in India is inordinately high. This is not correct. There are many countries in the world, of course much smaller than India, like Puerto Rico, Palestine, Mexico, etc., where the birth rate is even higher. Perhaps in China too, such is the case, although there are no definite statistics. Thus we find that the enormous increase in population has been the consequence of a diminishing death rate, rather than an increase in birth rate.

This reduction in death rate is the result of a host of factors like controlling famine through quick relief measures and better administration, effective maintenance of law and order, developments in the fields of medical sciences, the invention and wide application of low-cost medicine, etc. As a result of developments in the field of medicine, both preventive as well as curative, diseases like cholera, plague, small-pox, malaria, etc., which took a very heavy toll of human life have now been effectively controlled by preventive action.

It is estimated that the virtual elimination of a single disease
like malaria would lower the death rate in India by 11 per thousand. In 1951, it was estimated that there was as many as 200 million people living in the malarial tracts of India. In other words, a powerful anti-malaria campaign would result in diminishing the death rate approximately by 11 per thousand in India and indeed, such was the case in Ceylon. Likewise, the B.C.G. vaccination may reduce the death rate due to tuberculosis significantly. Improvement in sanitation and the supply of filtered water to every village will certainly reduce the death rate due to diseases like dysentery, cholera, etc., and the death rate would diminish by at least 10 per thousand during the next two decades.

Furthermore, recent discoveries of various drugs like the sulpha drugs, penicillin and its derivatives, etc., have all become so efficient that most of the fatal diseases are now no longer serious threats to life. At the same time, infantile mortality, invariably a consequence of the fevers and other diseases following child birth, has been almost totally eliminated. It is certain that in the years to come, more diseases will be controlled, and cured so that the chances are that the gap between births and deaths will continue to widen, so long as the birth rate remains as it is.

The actual death rate has declined from approximately 31 per thousand in 1951 to $25\frac{1}{2}$ per thousand by 1966. The expectancy of life at birth, which was about 32 in 1930, is likely to be 50 in 1970 and perhaps 60 in 1980. Surely, this alone would increase the total population, and furthermore there would be a significant change in the composition of the population, in that there will be a much larger proportion in the older age brackets, who like the children would be dependent upon the output of the working population.

There is absolutely no indication to show that the birth rates have declined substantially in recent years. It is true that the age of marriage would increase slowly, but perhaps not high enough to affect fertility and it is probable that the increase in the age of marriage would result in producing a larger surviving family since the children born are healthier and are not likely to meet with infantile mortality, as they used to, when their mothers were very young. If the widows in India had a fertility rate as high as those
of married women of the same age groups, it is not unlikely that the number of births in India would be higher by 10% than what it is now. The latest census figures suggest that India has 226 million men as against 212 million women so that with advancement in education, and a more liberal outlook on widowhood, more widows are likely to get remarried and when they constitute about 11% of the married women in the age group between 15 to 44 and 9% of the married women in the age group 25 to 34, then it is obvious that if they are allowed to marry, they will have 10% of the total children born. In making forecasts of population, therefore, one should be prepared for this factor also.

Geographically looked at, the most important aspect of population is its distribution. The simple questions are: which are the parts which are densely populated and which are those which are thinly populated, and why? If one were to look at the map of density of population, one finds that it is highly uneven in its distribution. The highest rural densities are found in those parts of the country with the greatest agricultural potential, the lowest densities are found where the agricultural potential is lowest. In other words there seems to exist a close co-relation between the agricultural potential and rural densities. When it is remembered that more than 80% of the population of India is rural, and nearly 80% of the population is depending either directly or indirectly upon agriculture as the main source of livelihood, the significance of these geographical factors becomes apparent. It has already been shown in an earlier chapter that agriculture in India is to a large extent delimited by monsoon rainfall. In other words, population densities and isohyets are easily correlatable but for some minor exceptions.

Another aspect of the problem which should also be borne in mind is the fact that as population went on increasing, more and more people were forced to drift into agricultural effort, since no avenues of employment were available in the industrial and commercial sectors. During the period of India’s dependence on Britain, one of Britain’s consistent policies was to keep India in the rural stage as a non-industrial nation thereby maintaining a market for
British manufactured goods, but this, in its wake, created the problem of far too many people drifting into agricultural occupations, with the result that the size of the agricultural farm steadily diminished, and productivity, both per man employed and per hectare cultivated, steadily fell down.

It is found that approximately more than a third of the population is concentrated on 1/16th the land surface, giving an average density of more than one person per acre, or more than 24 persons per hectare, indeed, one of the world’s highest densities. But it must also be remembered that in an agricultural country like India, the density of population should be calculated not on the total area but on the cultivated lands, since agriculture, as already pointed out, is the mainstay of the population. On this basis, few places in the world could beat the densities that are found in the Gangetic delta, on the Ketal, etc., anywhere between 4 to 5 persons per acre, i.e. 10 to 12 persons per hectare. Is it surprising then that the standard of living in India is low? These figures should be compared with the corresponding figures in other parts of the world, where the extent of cultivated land per head of population varies anywhere between 4 to 5 hectares, and in several of these cases, agriculture forms only one of the sectors in the economy of the people, industry, trade and transport together contributing a greater share.

Sixty years ago, at the beginning of the century, the extent of cultivated land per capita was approximately 0.6 hectares (1.5 acres), but today it is less than 0.3 hectares (0.75 acres) approximately, in other words, the per capita acreage has been halved, the total cultivated area having remained practically the same during this period. There has, therefore, been no upsurge in the production of food, consistent with the increasing population. Consequently, there has been a steady diminution in the amount of food available per capita during the last 60 years. It is estimated that it has fallen down from 600 pounds in 1901 to 400 pounds at the present day, even when adequate weightage has been given for industrial and commercial crops like cotton, tea, jute, etc. Similar conditions exist in the adjoining parts of South-East Asia. Thus South and South-East Asia with nearly half the population of the world is suffering
from hunger and poverty. In the shrinking world of the mid-20th century, when distances have been totally annihilated, is it likely that it can continue to remain in peace, when half its population in South and South-East Asia remains underfed, steeped in poverty, while the other half of the world is rolling in the lap of luxury? Unless there are planned efforts, it is certain that there is bound to be starvation, disease, premature deaths, and perhaps violence and revolution.

One of the primary needs for India is to increase its agricultural production. If we look at the statistics of the land devoted to crops during the last 50 or 60 years, the most staggering fact is that the area under cultivation has remained more or less static. There has been no increase in the extent of cultivated land going hand in hand with the increase in population. It is true that there has been some expansion of cultivated land, in some cases, on the hill slopes by deforestation, in others where large irrigation schemes have brought water to desert regions making them cultivable. But by and large, these are not very significant. The total cultivated area in what is now the Indian Union has increased only by 10% during the last 60 years and today, it is estimated to be round about 320 million acres, which coupled with the multiple cropped land of 40 million acres make an aggregate total of 360 million acres. For a population of 500 millions, the per capita holding is less than 3/4 of an acre (0.3 hectares). There is really the basic problem of poverty in the country. Can this be solved by a redistribution of land? Or by putting a ceiling on the size of the agricultural holdings? Surely not. Re-distribution of land can only produce wealth, provided there are large areas to be so distributed to a small number of people, so that each recipient would get a viable economic holding. The problem in India is not one of maldistribution, but it is one of abject poverty of land, the total area available for cultivation is far too little for the large numbers of people who demand it. Any expectation that the total cultivable area in India is going to increase significantly in the next few years is nothing other than a mirage; if at all, the increase is going to be very marginal. What then is the real remedy for improving the production of food
within the country? Actually, it has already been pointed out in
the chapter on 'Agriculture' that the average yields of crops in India
are deplorably low, some of them being less than 1/4 or 1/5 the
world's best yields. It is not as though there are no good yields
in India. There are tracts, isolated ones, which produce yields as
good as, or better even than some of the world's best, but there are
also tracts where the average production is less than a tenth of the
best, and it is these large areas of low productivity which bring
down the averages.

The low productivity of the soil cannot be easily increased without
improving the soil itself. Till recently, the farmer believed in leaving
the land as fallow. Approximately, the fifth of the cultivable land
in India is remaining as fallow. The merit of this method is that it
requires no investment on the part of the farmer, either capital or
recurring, which at a first glance appears to be attractive, but it
must be pointed out that this is a very wasteful proposition, because
a sizeable part of the land, namely 20% to 25%, remains unproductive
in each agricultural season. In other parts of the world, e.g.,
Japan, only 5% of the land is in fallow, and India will do well to
emulate Japan. This is possible if and only if, fertilizers are supplied
to the soil to retain its productivity.

Other improvements can be suggested like changing the character
of India's farming from sustenance farming that it now is, to commer-
cial farming, but this requires in the first instance that the holdings
must be much larger than what they now are. It is estimated that
the average Indian holding is less than 1/3 or perhaps even 1/4 of
an economic holding. To make matters worse, even the uneconomic
holdings frequently are fragmented and generally not contiguous,
but are dispersed in the villages. All these are due to various
characteristic features like the Hindu laws of inheritance, giving each
son an equal share in the ancestral property, but the most important
consideration now should be to discover a means to effect consoli-
dation and not to try and find an excuse for the present state of
affairs.

Other countries like China and Russia have, in fact, solved this by
eliminating individual ownership and the state assuming it, but it
does not appear as though under Indian conditions this may work, and one hopes that it does not.

The only practical way appears to be through cooperation, but this is not as easy as it looks. If the ryot is to give up his individual holding—the only thing that he can call his own in this world—satisfactory baits must be thrown at him. Up till now, cooperation has not been a success, because of the failure to attract the villagers willingly into the cooperative sector. The Government should guarantee every cooperating ryot that he would be assured of a crop as big as what he had in the previous years and that any excess due to improved methods of agriculture will be given to him after compensating for the additional expenditure on fertilizers, etc., and that he would be assured of employment opportunities. Consistent with this, efforts should be made to remove persons from agriculture into other occupations.

Agriculture in India is a profession to which persons who have been failures in other professions have finally drifted into. If, however, agriculture is to succeed, it should like any other profession attract the best in society. Perhaps it was the decline in the handicraft industries which forced people into agriculture during the latter half of the 19th century, which in its wake made the average holding smaller and smaller and larger numbers of them lost their tiny landed possessions, either through mortgages or sales, and today there is an army of landless labourers, who with their dependents are estimated to constitute approximately 20% of the total population. This is the group of people who become pawns in the hands of political propagandists. It is realised that today there are approximately 120 million more people depending on agriculture than what there were at the beginning of the century and is it surprising then that agricultural production has fallen down?

Many people have suggested that the introduction of mechanical methods of ploughing, harvesting etc., are likely to improve agricultural yields throughout the country. This is not entirely true. The introduction of mechanical methods only assures an increased yield per man employed, but not per hectare cultivated. There are many countries like China and to some extent Japan which use only
the manual methods and yet produce yields which are enviably high. But at the same time, it must also be remembered that the introduction of mechanical methods like the tractor-plough is bound to create unemployment problems. Unless adequate means of employment by the introduction of mechanised methods, one hesitates to recommend their introduction into India.

In countries like India and China where there is a plethora of labour, mechanisation of agriculture appears to be absolutely redundant. But this does not mean that there should be no effort towards industrialisation. Mechanisation of agriculture and industrialisation are not synonymous. Industrialisation must make rapid progress and industries must be such that large numbers of people are taken out of agriculture. Mechanisation of agriculture, if any, should be restricted exclusively to those parts of the country where the indigenous methods are not applicable because of difficult conditions, like the nature of terrain, presence of uneradicable weeds, etc. Is it realised that a small tractor can do at least the work of 5 labourers? With complete tractor ploughing in the country, it would be possible to remove from the agricultural operations at least 25 million, perhaps 35 million labourers, who are now working with the indigenous plough. In other words, they can be thrown out of employment and each one of these workers will have at least two or three dependents, so that the introduction of tractors alone would produce poverty due to unemployment in a sector of about 100 to 150 million people, approximately 1/4 to 1/3 of the total population. Can any society under these conditions remain stable without facing a revolution? Alternate sources of employment have to be found for the large numbers. Unfortunately many people in India believe that in the twinkle of an eye, they can be absorbed in industry. To create opportunities overnight for 20 to 25 million labourers in the industrial field is an absolute impossibility. Is it realised that the total number of industrial workers in the whole of western Europe, i.e., West Germany, France and the United Kingdom put together is only about 20 millions and that of the U.S.S.R. is also about the same? Can India within the next few years reach this stage of economic growth? The proper remedy appears to be that more
people should be employed in agriculture and household industries for more intensive production and at the same time, promote the growth and development of small scale industries, cottage industries, etc; in other words, labour intensive methods should be developed rather than capital intensive methods. At the same time, every muscle must be strained to establish large scale industries throughout the country offering new avenues of employment, enabling the agricultural worker to drift into industrial and commercial occupations.

Hand in hand with this, there should be a conscious effort to reduce the birth rate to prevent a significant growth of the population. Family planning has now been an accepted policy of the Government of India and of the component states and the question is often raised whether it would become practicable in a country like India where the literacy is so low and where nearly 4/5 of the population live in rural villages, into which effective propaganda and publicity are difficult to reach. Furthermore, to practice the modern methods of contraception and their application require a considerable amount of privacy which is generally absent in a poor Indian home, and these methods, therefore, have a tendency to become impracticable for a variety of reasons. In spite of all that the Government is doing, one finds it difficult to affirm that it is bound to be successful, and one should not be surprised if it is found that it will be difficult to break the cake of custom in the productive life of the villagers, in the twinkle of an eye. If we are able to, the question arises by when? There is good reason to believe that these words of wisdom will take at least half a century to penetrate into the minds and activities of every part of India, indeed, by then the bubble might have burst.

There are other serious dangers in the practice of contraceptives. Generally looked at, the better class people will accept it more readily than the poorer classes and if the time lag between them is large, then the composition of the population in the succeeding generation is likely to change, the children from the poorer homes with less facilities for educational and cultural development will be the dominant component of the succeeding generation. Has adequate provision been made for this? Or, is this a mere hoax?
In recent times the 'pill' has been recommended as the universal panacea, but we must realise that this is a double-edged sword. A malign administrator like Hitler would have been able to exterminate the Jews of Germany if he had been fortified with this pill; all that he would have had to do would have been to isolate the Jews in every city of Germany to some particular sector of the city and then adulterate either the water supply or the flour with these pills. And just a couple of his henchmen alone need over know at! The poor inhabitants of this ghetto will remain childless and would not even know why they are all sterile and barren, providing a rich crop of patients to the gynaecologists around. Has any thought been devoted to this aspect of the problem? Which is better, the disease or the treatment advocated?

Among other important measures, it is suggested that the modernisation of economy will result in improving the status of life that produce changes in the organisation of society, which in itself create motives for the voluntary control of birth. Is this as simple as all that?

It must be remembered that with industrialisation in Western Europe, there was an increase in population immediately following the prosperity of industrial production and the diminution in birth rate was found to commence only after a fairly long span of time, by when living conditions had become significantly better than what they were before.

The handicaps and difficulties of the under-developed and developing countries of today are entirely different from those of Europe in the early 17th century, because these under-developed countries of today have already a large and dense population which is growing fast and there is not a single hectare of virgin lands in the world, open to them for exploitation.

The industrialisation of Western Europe which was immediately followed in its wake by a tremendous growth of population was reflected in the migration of European people to the new continents of America, Australia, South Africa etc., in other words, by the opening up of the grasslands of the world. There are no such parts awaiting the plough for the over-growing populations of China and India, except perhaps Manchuria and the unoccupied parts of
North Australia. To Manchuria none other the Chinese can hope to go. It may not be too much of a prophecy to say that the yellow man is going to make a serious bid for the tropical lands of Australia, if not today, at least tomorrow, a possibility which cannot be discarded. In spite of the considerable financial and other incentives which Australia has offered to the European peoples, even today, they remain unoccupied. The question may be asked whether it would not be better for Australia to accept the brown Indian of the British Commonwealth and permit his immigration than be forced to accept the yellow man within her frontiers.

Many people seem to think that the problem of population of India would be solved, if migration is promoted, but few people realise the difficulties of this proposition. If the pressure of population at home is to be released, at least, 1/3rd of the total population of India must migrate in a short period of time, say, one or two years, i.e., 150 million people have to leave the shores of India in about 50 to 100 weeks and that would bring down the population to 300 millions, at which it should be kept constant for some time to come. This would, indeed, mean a task which all the shipping of the world put together will find it difficult to achieve. The entire shipping now plying in the Indian Ocean will find it difficult to achieve the migration of 200,000 persons per week, that is 10 million a year and a migration of 10 million will not provide any relief at home and should not be encouraged, because it would only add to the problem of Indians abroad; but looked at from the point of view of Australia, it would be better to have the northern coast line effectively occupied so that these shores could be defended in the event of any emergency. Surely the Indian could do this much better than any others in the neighbourhood and, therefore, Australia will do well to invite Indians in sufficient numbers to occupy its northern shores, but all the same, this will not be a remedy for India's growing population. She will have to stabilise her population and this can only be achieved by concerted efforts at rapid education of the vast masses of the country, making them conscious of the seriousness of this problem. There is perhaps no shortcut, however much we may wish to find it.
CHAPTER XII

ETHNIC AND LINGUISTIC COMPOSITION
OF INDIA

India has been a meeting place of various peoples from time immemorial and it has often been the highway through which there has been a restless human tide. The earliest inhabitants of the peninsula of India had perhaps Negrito affinities and some of them are still present in the Andaman Islands. These Andamanese are a short-statured race, living far off from the mainland in the small group of islands in the Bay of Bengal. Their skin colour is dark chocolate brown; the hair is woolly, often with vacant spaces intervening between tufts of hair; they are generally broad-headed (brachycephalic), round faced with a short, broad nose. In most cases, steatopygia is found among women and in stray instances it is found even in men.

Their kinship to the tribes in the Malay Peninsula and Indonesia is well-established but they have apparently left very few traces among the peoples of the mainland of India. There are, however, a few tribes like the Kadars and Uralis in the Anamalais and Perambiculam hills in Kerala, whose somatic characteristics are supposed by some anthropologists to be related to the Negrito. The Kadars, however, are not broad-headed but generally are narrow-headed (dolichocephalic) and occasionally are medium-headed (mesocephalic). They apparently resemble closely the Semangs of Malaya and the Melanesians. An interesting cultural feature that one notices, is the large number of designs in the combs that the Semangs possess, which are almost identical with those used by the Kadars of Kerala. Furthermore, there are tribes like the Angami Nagas in the northeast in Assam, the Badgis, in the Rajmahal Hills in Bihar, etc., some individuals among whom show physical traits reminiscent of the Negrito. The conclusion has, therefore, been drawn by some authors like Hutton or Guha that the Negrito once had a much wider distribution, even on the mainland of India.
Many anthropologists consider the Negrito as the oldest surviving type of man and it is possible that he even preceded Neanderthal man, by whom he was probably displaced and dispersed. From all evidence that is now available, it looks as though the Negrito was the earliest inhabitant of South and South-East Asia and traces of his stock are apparently discovered in the most inaccessible parts of India, in the hills and enclaves of the mountains of Kerala, Bihar and Assam.

If the Negrito was the earliest inhabitant of South Asia, he was displaced and supplanted by the Proto-Australoid fairly early. This Australoid type, with its characteristic somatic features like pronounced supra-orbital ridges with a sunken nasal root, are easily discernible among some of the aboriginal tribes of South and Central India, and similar traits were attributed to the skulls unearthed in the burial urns, as at Aditanallur\(^1\) and in other centres in South India. If a comparison is made of some of the tribes, notably the Veddas of Ceylon with the aborigines of Australia, a considerable amount of similarity is found in the shape of the head and the face, form and texture of the hair and the colour of the skin, although there is a difference in stature, the Australoids being much taller. The Veddas are closer to the Australoids than the Indians, so that it appears as though there is a gradation, the shortest and smallest being the Indian tribes, after whom come the Veddas and lastly the Australoids, suggesting that apparently all three belonged to the Indian tribes having most of the basic characteristics while the extra-Indian groups have developed more marked features.

The comparative study made by Colonel Sewell of the skulls of the Veddas of Ceylon with those of Mohenjo Daro, Kish, Al Ubaid and Aditanallur shows the transition series commencing with a long and narrow nose in Kish, passing through the slightly shorter and broader noses of Al Ubaid, and then through the Mohenjo Daro and Aditanallur skulls, where these changes are even more marked, to the maximum alteration in the Veddas of Ceylon. There is, therefore, a clear unity of somatic characteristics among the tribes of Central

\(^1\) Tirunelvelli District of Madras State.
and South India, although they pertain to different linguistic families. It is not unlikely that a similar unity will be found among the tribes of Western India and those in the Gangetic Valley. The Bhils, Kols, Badagas, Korwas, Kharwars, Mundas, Bhumijes, and Malpaharias of the highlands of Central India and the Chenchus, Kurumbas, Malayans, and Yeruvas of South India may all be treated as Proto-Australoids.

This distribution extending all the way from Kish to Australia suggests that their origin is somewhere in the West and the manner in which they show admixture with the Negritos seems to suggest conclusively that they came later than the Negritos, pushing and pressing them hard, a pressure which the primitive Negritos found it difficult to withstand, as a result of which they were forced to the more inaccessible and less hospitable areas, where they are found even today. In this process it is quite possible that the Proto-Australoids have absorbed some Negrito blood, perhaps more so in the South than in the North, simply because in the South there is no possibility of retreating any further. It is probably this face which accounts for the difference in the groups at the present day and the safest hypothesis appears to be that the Proto-Australoid type in India is derived from a very early migration from the West and its special features were finally determined and permanently characterised in India itself.

If the somatic characteristics of the people of the Gangetic Valley are examined, after eliminating the two previous aboriginal strains, then it will be found that the dominant racial trait is a medium-statured, dolichocephalic people, with a narrow vertical bulging forehead with faintly marked supra-orbital ridges, a short face with prominent cheek bones, pointed weak chin, full lips and large mouth with a tawny brown skin colour, black eyes and straight wavy hair. This is by far the most prominent characteristic of the peoples of South India and to a large extent of the peoples of North India. The rather difficult question has often been asked, whether this type originated in India or whether it came from abroad. It is probably best to consider them as having come from abroad, because of two reasons:
(a) they could not have evolved in the humid heat of the plains of India since the nose under those conditions should be broad and short and should not have the low medium index which these peoples now have, and

(b) Professor Sir Grafton Elliot Smith has found a close resemblance between the skulls at Aditanallur and those in the pre-dynastic graves of Egypt.

Does this not suggest that these people came from North Africa or perhaps from the Middle East, bringing with them their culture in Neolithic times? The work of De Terra has shown that there is a close affinity in time between the Megalithic remains of Europe (late Neolithic times) associated with the Cro-Magnon man and with those of North-West India. In South and Central India, the megalithic culture was associated with bronze and iron and consequently must have been recent. From the crania discovered at Aditanallur and other Deccan cairns, it appears as though a race similar to the one which inhabited pre-dynastic Egypt brought this culture to India from North Africa during Neolithic times. Thus, the basic type of Central and South India is this dolichocephalic type which must have come to India after the advent of the Proto-Australoids.

Two other dolichocephalic types are found in the Indus Valley during Chalcolithic times: (i) the types whose earliest relics are found in the open burials at Harappa and in the lower strata of Mohenjo Daro with well-developed supra-orbital ridges and an enormous growth of the post-auricular parts of the skull and (ii) a more delicately made, slender type with sharp well-cut features and a fine narrow nose, whose remains are also found in abundance in all the burial sites from Nal to Mohenjo Daro. This type appears to resemble the cairn builders of South India, but they are really distinguishable from the latter because of their more refined features, lower cranial vault, well-arched forehead and narrow high-pitched nose, therefore, a race closely allied to the so-called Mediterranean race of Europe.

The Mediterranean type appears to be the one that has contributed most to the physical composition of the peoples of India and perhaps
also to its culture. The centre from which it dispersed appears to have been the Eastern Mediterranean, but that it reached India at a very early date is to be inferred from the crania found at Nal in Baluchistan, at Sialkot and at Bayana, which link the inhabitants of Northern India to the dolichocephalic skulls of similar type found at Kish and at Anau. Without doubt, this early Mediterranean race has entered largely into the composition of the people of North India and perhaps also among the Brahmins and upper castes of the South.

On the racial framework so built, there entered from the North-West, (i) a non-Mongoloid brachycephalic race and (ii) the proto-Nordic Vedic Aryan.

(i) The earliest evidence of this brachycephalic race with a round and broad face and long prominent nose was found at Mohenjo Daro during the Indus period, and at a later date, it occurs more frequently at Harappa—and here for the first time is seen the flattened occiput of the Armenoid race. Similar traits are found at Aditanallur and in some crania in the cairns at Hyderabad. Today the brachycephalic non-Mongoloid races are dominant in Gujarat, Kanara, and Bengal. Mixed with the older basic dolichocephalic type and the Proto-Australoid races, it occurs largely in Maharashtra and Tamilnad. The characteristic traits are: short to medium stature, broad high head with somewhat receding forehead, flattened, vertically inclined occiput, a long nose often arched and convex, (especially among the Gujaratis). The face may be short (Gujarati), or long (Bengali) and the skin colour may vary from pale olive (Nagar Brahmans and Coorgis) through light brown (Bengali Kayastha) to dark brown (Tamil Chetty). The eyes are round and horizontal and the hair straight and profuse, both on the face and the body. This race is more closely related to the Dinaric race of Eastern Europe than with the Armenoid, and it may be considered to be Alpine.

It is likely that this race entered India from the western littoral in early Chalcolithic times and drifted into Kanarese and Tamil lands leaving Malabar and Andhra unaffected. "That the brachycephalic admixture extends to the Tamil Nad, but not to Andhra Desa is a
conclusion which is substantiated not only by the appearance of the people, but also by their character, the Tamil being far more pragmatical and more sensible of hard facts and values, whereas the Telugu has precisely that volatile, artistic and sensitive temperament that one is accustomed to associate with the Mediterranean stock." Apparently the thrust of the Alpines failed to penetrate the High Ranges and the heavy jungles of the Western Ghats and this isolated the Malabar Coast from this trachycephalic influence. An early easterly movement of this race seems to have penetrated into the Gangetic delta.

The Tamils, the Kanarese, the Gujaratis and the Sindhis show a combination of Armenoid and Mediterranean features. That intercommunication took place between the Mohenjo Daro civilisation and Mesopotamia (Iraq) has been demonstrated by the discovery of objects of common type in both areas and Sir John Marshall concluded that there was a lively intercourse between the Indus Valley and the Elamite and Mesopotamian (Iraqian) sites at the end of the fourth millennium B.C. Marshall assumes that it developed in India, but it seems a much safer hypothesis that the main features came from Iraq, to the early civilisations of which it obviously bears a close affinity—e.g. the fish cults of the South, East and Malabar Coast and in Iraq (Mesopotamia). It is probable that direct contacts existed between Southern India and Iraq by sea, but the presence of the Brahui in Baluchistan makes the existence of land contacts equally likely.

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1 In his very suggestive paper on the 'Origins and Ethnological Significance of the Indian Boat Designs',—Memoirs of the Asiatic Society of Bengal, Volume 7, pp. 139-246, Hornell has explained the brachycephalic character of the Parawar, Shannan and Parayan of the Tinnevally (Tirunelvelli) District as due to a Polynesian immigration into southern India, bringing the outrigger canoe and coconut with it, prior to, or soon after the arrival of the Dravidians. It is probably quite true that both the outrigger canoe and coconut were introduced from Polynesia, but it is not necessary to postulate a character of the Tamils, nor is brachycephaly confined as Hornell supposed to the coastal Tamils. It is dominant among all the upper castes and runs northwestwards through Kanarese country to Maharashtra and to Gujarat and, therefore, cannot be satisfactorily explained by a coastal drift of Polynesian blood.
“Everywhere in southern Baluchistan there are remains of enormous dams and bunds proving that at one time the land was elaborately irrigated and pointing perhaps to the period at which its natural waters began to fail on account of climatic changes involving the undertaking of conservancy on a larger scale”, and one would probably justify in picturing Baluchistan, a land of hills and valleys, now barren and windswept, as five thousand years ago, a good land of fountains and rivers, drinking waters of the rain of heaven.

“The presence in Baluchistan of the Brahui, speaking a Dravidian language, living among remnants of a lost civilisation, in a country rendered inhospitable by a change of climate, professing skin-deep allegiance to Islam, but in practice worshipping at pre-Islamic shrines and phallic stones, and using circles of stones to dance in, and exercising devils by the dancing of medicine-men like the people of the Malabar Coast, points very suggestively to speakers of Mohenjo Daro and perhaps the givers of culture to India, while the fact that they claim Aleppo as their place of origin and bury their dead to face westwards, indicates their connection with the Mediterranean.”

The Dravidian language is now found to have Iraquian (Mesopotamian) and Caucasion affinities and it is not unreasonable, therefore, to conclude that the civilisation of the Indus Valley was associated with speakers of Dravidian languages of Mediterranean race with an Armenoid admixture and a developed culture derived from the Near East.

(ii) The Proto-Nordic race of the Vedic Aryan who invaded the country in the second millennium B.C. produced the most profound changes in shaping the culture and history of India. Their characteristics were the comparative broadness of the skulls, with lower cranial vaults and a mean cubic capacity of 1,552 c.c., with highly pitched and narrow nose and a face well-built and long. This type is now found as the dominant element in the Northwest frontier among the various Pathan tribes, especially among the Kaffirs of the Hindukush and the tribes living in the upper Indus Valleys of the Swat, Panjkora, Kunar and Chitral. It is also marked in the Panjab and Rajasthan and it exists with some admix-
ture with the dolichocephalic, chalcolithic and the Indus types of North India.

The skin colour becomes lighter; it is "milk tinged with coffee" colour in Panjab, but becomes rosy white among the northern mountain tribes and the eye also changed to grey and blue grey, sometimes accompanied by chestnut or red hair; in rare cases, almost the true blonde of the Nordics. Some groups in northern India retain the Nordic characters of stature, head and nose without the fair tint of the skin, probably as a result of the environment.

The presence of light eyes among the Chitpavan Brahmins of Maharashtra and in a very small degree among those of Uttar Pradesh, Bihar and Bengal shows that the influence of this type extended far beyond the Northwest frontier.

The cults and customs of Asia Minor are still strong in India, as also the Dravidian tongue; but it is clear that the fusion between the earlier civilisation and the Rig Vedic Aryans did not take place in southern India to which the Aryan penetrated only in historic times. It did not apparently take place in the Indus Valley and it, therefore, must have occurred in the Ganges basin, where the Middle Kingdom has always been regarded as the true focus of Hindusthan, the standard for the rest of Sanskrit India, both in regard to language and religion.

In addition to this rosy-coloured element in the whole of the Northwest, there is another intruding element, often called the "Oriental" with fair skin, black eyes and hair, with markedly long and aquiline nose, e.g. Badakshis of North Afghanistan. Throughout the Pathan country from Dir to Khyber, it forms a strong layer. The short-statured, long-headed type, the characteristic one of the Himalayas extending from Chitral to western Nepal is probably a variant of the Oriental type. In the plains, the presence of the Oriental strain is not felt strongly except in the Panjab. Among the Muslims of upper India, the Oriental type survives as the relic probably of the Pathan invaders, who themselves probably had some Badakshi admixture in them.

The main movements of the Mongoloid races appears to have passed by India without affecting it very vitally, except in the foot-
hills of the Himalayas, Assam and Burma. Along the foot-hills in Bhutan, Nepal, etc., the type, though not so characteristic as elsewhere, shows much of the Mongoloid traits of round, broad head and face with high cheek bones, and long flat nose, with little or no hair on the face and body. The skin colour is light brown tinged with a reddish tint. In Nepal proper, the people exhibit gradual increase of Mongoloid blood as one proceeds east and north.

In Assam, they are dolichocephalic and so appears to be a mixture, but in Burma, they are, as elsewhere, brachycephalic although shorter. The Burmese are closely allied to the Malayans and it is likely that Burma got its wave from Malaya.

There is also evidence of a Mongoloid Melanesian intrusion from Oceania to Tamilnad and Malabar and probably that accounts for the occasional Mongoloid element noticed among them.

Thus, to recapitulate: The earliest occupants of India were perhaps of the Negrito race, but they have left little trace on the mainland of India and are today found only in the Andaman Islands. The Proto-Australoids who followed them and whose origin might be sought in Palestine, may claim to be the true aborigines, on the ground that their racial type was ultimately fixed in India. They were followed by an early branch, probably of the Mediterranean race, speaking an agglutinative tongue from which the present Austro-Asiatic languages are derived. They must have migrated down the Gangetic Valley, mingling no doubt with the Proto-Australoids and finally penetrating to the farthest southeast of the Asiatic continent. This early branch of the Mediterranean race may have carried with it the beginnings of culture with a rudimentary knowledge of agriculture. They may also have carried with them the practice of erecting rude stone monuments and perhaps of primitive navigation. This migration was followed by a later migration of civilized Mediterraneans from the Persian Gulf, but ultimately from eastern Europe who brought with them, the knowledge of metals, but not of iron. They were followed by later waves of immigrants and a generally advanced culture, which maintained a connection with the cities of Iraq (Mesopotamia) and evolved or developed with prehistoric civilization in the Indus Valley and in
all probability, a similar civilization in the Gangetic Valley. All of these immigrants were of the dolichocephalic type, but mixed with this last wave, coming in as later settlers, was a brachycephalic element coming ultimately from the Anatolian plateau in the form of the Armenoid of the Alpine race. The civilization which arose in India under the auspices of these races had developed by the end of the fourth millennium B.C. a high standard of comfort, art and sanitation in city life, and a religion which bears many resemblances to the earlier religions of the eastern Mediterranean. The language in use was perhaps allied to Dravidian and there was a pictographic script analogous to those in use in prehistoric Mesopotamia. This civilization was flooded in the West during the third millenium B.C. by an immigration from the, Iranian plateau and the Pamirs, of a brachycephalic race speaking perhaps an Indo-European language of the Pisacha or Dardic family; the main course of this migration went down the west of India, across the Mysore plateau to the south, missing the Malabar Coast, which has thus preserved some of the ancient civilization of Dravidian-speaking India. Another branch of these immigrants, probably fewer in number, penetrated the Gangetic Valley, but they were not strong enough to obliterate the Armenoid-Mediterranean civilization, though they may have modified it to some extent.

Meanwhile, other movements were going on in the extreme east of India, and there was movement of the southern Monogoloids into Assam and perhaps to Bengal. Finally about 1500 B.C. came the Indo-Aryan migration into the Panjab, which first occupied the area between the Indus and the Jumuna and later set colonies across the Jumuna into Hindustan. These imposed themselves upon the surviving civilization there, which so reacted to this powerful stimulant as to produce from the combined material, the philosophy, religion, art and letters, that were the glory of ancient India.

Language

Linguistically the people of India and Pakistan belong to five special groups of languages: they are Aryan, Dravidian, Munda, Tibeto-Chinese and Khasi. The Munda language may have been
the first of the five groups to reach India, perhaps coming from the east. It is now restricted to the hilly parts of Bengal, Bihar, Orissa Madhya Pradesh, etc. Its branches are in use among the so-called tribal groups who are at a low level of economic culture. The Dravidian group of languages constitutes the second most important group. They were there long before the Aryans came into India, and probably once extended over the whole country. Today they are found in the south of India, approximately south of 18° N. latitude. The states of India have been reorganized on the linguistic basis and there are four important languages, each with its well-developed literature. They are Tamil, covering the Madras State and the State of Pondicherry, Telugu in Andhra Pradesh, Kannada (Kanarese) in Mysore and Malayalam in Kerala.

The largest and most important language group in India today is the Aryan which is allied to most European languages. Sanskrit is the chief classical language of India. In ancient and medieval times, it was the tongue through which all communication took place amongst the intelligentsia throughout the country and all religious books have a Sanskrit base. The Moghul invasion created an impediment to the continuation of these traditions and Arabic, Persian and other languages of the Moghul conquerors began to replace Sanskrit from A.D. 1400 onwards. Then came the European conquest and with it the spread of the English language and education.

In north India many Aryan languages are found, the most widely used being Hindi, the language of Uttar Pradesh, which by the Constitution of India has now become the official language of India. It has several spoken varieties, Hindustani being the most popular; itself it has two forms, one of which is Hindi in a narrow sense and the other is Urdu, the difference between the two being that Hindi is written in the Devanagiri script and Urdu in the Persian script, the former using Sanskrit as its base and the latter, Persian. The next important language is Bengali found in the State of West Bengal of the Indian Union and in East Pakistan. Others are Marathi spoken east and southeast of Bombay, Gujarati spoken north of Bombay, Panjabi, Rajasthani, Behari, Oriya, Kashmiri, etc., each in its provincial zone.
There are 179 languages according to the linguistic survey of India, but of these the following: Hindi, Urdu, Bengali, Oriya, Marathi, Gujarati, Kashmiri, Panjabi, Nepali, Assamese, Telugu, Kannada, Tamil and Malayalam have received official recognition in the Constitution. The large number of languages in India had always been cited to be a hindrance to Indian unity. But it must be noted that the development of each of the regional languages has helped considerably in the spread of education, as well as in the replacement of local dialects by standard forms of the State languages. It has thus helped in bringing about more unity and solidarity within the States themselves.

This has however tended, on the other hand, to sharpen differences between State and State to some extent. But this, we hope, is only a passing phenomenon.

Current political and social problems rising in India centre around the question what the state language and the medium for higher education should be. Hindi has been accepted by the Constitution as the state language, but English continues to be used as an alternate and was given permissive sanction until 1966. There are obvious conflicts, Aryan with Dravidian, Hindi with Urdu, etc. When the British introduced English, they did so partly because that was the simplest thing for them to do and partly also because they did not have to choose between Hindi and Urdu or between Sanskrit and Persian. Under nationalistic ideals Indian languages received considerable promotion—Gandhiji’s establishment of Vidyapith (Hindi) at Ahmedabad and Tagore’s Santiniketan, now the Visva-Bharati University (Bengal), and the Osmania University (Urdu, later changed to English). Unfortunately in recent years before Independence, Hindi and Urdu became the rival symbols of Hindu-Muslim communalism. Nationalist elements urge the demotion of English, but Hindi is far from being universal and it remains to be seen if it would become so in the immediate future. Parliament has recently passed a law that English shall continue to remain an alternate language till such time as the non-Hindi-speaking states demand its continuance, perhaps the most practicable solution for the present.
CHAPTER XIII

CONCLUSION

IN CONCLUDING this account of India, perhaps it may be worth-while to make some specific mention of the achievements in the country since Independence two decades ago. In the field of education in 1951, there were twenty-three million children in schools between the ages of six and seventeen; the corresponding figure in 1966 was seventy-two millions. The enrolment of students in universities has gone up by more than 500% in the same period; and from thirty universities in 1951 there are now 72 universities. It is true that mere increase in numbers does not amount to much; it is perhaps more important to assess the quality of teaching and the specific standards attained, but unfortunately there is no simple yardstick to measure these. Nevertheless, it looks as though the country is on the road to an educational revolution. One of the major difficulties to achieve this has been alleged to be the shortage of teachers, but surely, this could easily be got over by insisting upon a compulsory period of two years of National Service as teachers, by all students in the universities before they are allowed to graduate. If the number of teachers made available by such compulsory National Service is found to be inadequate, it could certainly be extended to students completing their high school education. Would this not, indeed, be the proper thing to do, in the climate of India’s role as a lover of peace and as a peace-maker in the world? Unless the standard of literacy in the country improves to approximately 100% in the next few years, it will be found that none of the other advances made in the fields of public health, industry, agriculture, etc. will give the genuine returns they were expected to. Money expended on education is certainly a long term investment which must give appropriate dividends in the fullness of time.

Specific mention has been made in the previous chapters regarding the growth and development in the fields of agriculture,
power generation, industries and transport, together with the major problems like growth of population, economic poverty, defence and a host of others which confront the country. Economic growth and prosperity in India during the last two decades should not be compared with those of the economically advanced countries like the United States or West Germany or Japan, but it should be compared with all those countries like Indonesia, Burma, Malaya, Pakistan and Ceylon, which like India blossomed forth recently into political independence.

It will be found that despite all these problems of Himalayan magnitude, the achievements in the economic sectors have been significant, but even more significant perhaps is the simple fact that the country has maintained and is even today practicing democracy in the political arena, which is by no means characteristic of the neighbouring countries. Has this not in itself been an accomplishment worth striving for? It looks as though, given peace and goodwill, India will soon be able to round the corner and enter the take-off stage towards economic prosperity.
## APPENDIX

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¹Includes NEFA, which has an area of 81,424 sq. km. and a population of 3,56,558.

²In working out the density of population per sq. km. only the censused area (1,38,982 sq. km.) has been taken into account.

*Including Sikkim (7,107 sq. kms.)
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