WHEAT STUDIES

OF THE

FOOD RESEARCH INSTITUTE

VOL. III, NO. 8 JULY 1927

INDIA AS A PRODUCER AND EXPORTER OF WHEAT

WHEAT is produced in India under peculiar climatic conditions, by small-scale, simple methods. Some 10 per cent of the crop land is sown to wheat. The area is usually 30 to 31 million acres, but is heavily reduced when summer rainfall is deficient. Over a third of the wheat acreage is irrigated. Yield per acre varies chiefly with the winter rainfall; the average seldom falls below 10 bushels, and is usually 11 to 12. Good crops range from 360 to 380 million bushels, mediocre crops from 310 to 330, poor crops below 280.

Domestic requirements now absorb about 320 million bushels a year—the great bulk of the crop even in good years; in years of crop failure India becomes a net importer of wheat. Wheat is not a universal staple of the diet even in the producing provinces. Per capita consumption has tended upward for many years, but today only about a bushel per capita is retained for food, seed, and waste. The volume of exports in any year is determined chiefly by the size of the crop, but is influenced by inward carryover, export prices, and prospects for new sowings. Exports move chiefly from Karachi, the nearest port to the great surplus-producing area, the Punjab, and are usually heaviest in the post-harvest months of June–August.

India's importance as a wheat exporter was greatest in 1881–94 and in 1903–14. In the record year 1904–5, exports exceeded 80 million bushels; the average net export for the 11 pre-war years was 45 million. Since the war, exports have exceeded 40 million bushels only in 1924–25, and the average net export has been only 13 million. The prospect is that consumption will keep pace with increases in production, and that India will remain a minor and erratic contributor to the world wheat trade.

STANFORD UNIVERSITY, CALIFORNIA

July 1927

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The central feature of the series is a periodic analysis of the world wheat situation, with special reference to the outlook for supplies, requirements, trade, and prices. Each volume includes a comprehensive review of the preceding crop year, and three surveys of current developments at intervals of about four months. These issues contain a careful selection of relevant statistical material, presented in detail in appendix tables for reference purposes, and in summary form in text tables and charts.

Each volume also includes six special studies bearing on the interpretation of the wheat situation and outlook or upon important problems of national policy. Typical subjects are listed on the fourth cover page of this issue.

The series is designed to serve the needs of all serious students of the wheat market, in business, government, and academic circles, by summarizing and interpreting basic facts and presenting current developments in due perspective.

The ten issues of Volume III will be published monthly from November 1926 to September 1927, except in April 1927. Ordinarily each issue will reach subscribers in North America early in the month designated. The subscription price for the volume, including a temporary binder, is $10.00. Individual issues may also be purchased separately. Address: Food Research Institute, Stanford University P.O., California. European subscriptions, at £2 2*s*., will be accepted by the Northern Publishing Co., Ltd., 16, Fenwick Street, Liverpool, England.

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INDIA AS A PRODUCER AND EXPORTER OF WHEAT

INTRODUCTION

India holds a distinctive position among the great wheat-growing lands of the world, as a country of large production and consumption of wheat, and of a small and highly elastic exportation. The average wheat crop of India since the war has been exceeded by that of three countries only, the United States, Soviet Russia, and Canada; and in wheat area harvested, India holds third place, with usually over 30 million acres. (See Table 1 and Charts 1 and 4, pp. 318–19, for further details of these and other important comparisons.) India frequently produces good crops of 360 to 380 million bushels, and frequently mediocre crops of 310 to 330 millions; occasionally, as in 1908 and 1921, there occurs a serious failure. The last six crops (1922–27), which have included no really poor ones, have averaged a little under 350 million bushels.

Although per capita consumption of wheat is exceedingly small in India, except in the Punjab and among certain limited classes of the population, the great bulk of the crop is used at home. (See Chart 2, p. 318.) Even in good years some nine-tenths of the crop is retained for food and seed. In the year of maximum exports (1904–5), the net exportation was only 23 per cent of the crop; mediocre crops yield very small exports, and in years of poor crops a net importation sometimes occurs. In this respect India is more closely similar to Soviet Russia, where wheat exports are yet very small in proportion to the total crop, and even to the United States, which retains about three-fourths of its crop, than to Canada, Argentina, or Australia, which produce predominantly for export and send abroad some two-thirds of their crops.

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Although never a great exporter, India played a larger part in the world's wheat trade before the war than she has in recent years. (See Chart 3, p. 319.) She first became a factor in the world wheat trade in the 'seventies, after the opening of the Suez Canal. In the 'eighties, with the extensive use of the iron steamship, the development of railway transportation in India, and radical reductions in costs of transportation, her importance as a wheat exporter increased both absolutely and relatively. The average annual exports from British India by sea, in the twelve years ending in March 1893, were 34 million bushels. After the early 'nineties India's exports declined in consequence of the world-wide depression of wheat prices and the occurrence of serious crop failures in India in 1896, 1897, and 1900. With better prices, the extension of irrigation, and only one very serious crop failure (1908), India's net exports averaged 45 million bushels a year in the eleven years before the war. In 1904–5 the record total of 83 million bushels was reached. In this year and in 1912–13 Indian wheat furnished the largest contribution to the British market from any single source of supply. In the last five pre-war years, as a result of an unusual succession of good harvests, India's net exports attained their highest level, with an average of some 52 million bushels a year. Even this quantity, however, constituted only a small fraction of the world's export movement and was exceeded by the exports of half a dozen other countries.

The war gave no such stimulus to India's wheat production as it did in Canada and the United States, and caused no such decline in wheat growing as it did in many

other countries. Acreage, indeed, expanded, reaching 35 million acres for the crop of 1918, but average yields were moderate and consumption increased. Exports, hindered by ocean shipping conditions and at times restricted by governmental action, were on a lower level than before the war, except under the stimulus of high prices in 1917–18. Since the war, except in two years of good crops and attractive world prices, India's wheat exports have been less than 10 million bushels a year, and in two years imports have exceeded exports. In the eight years since the war India's net exports have averaged only 13 million bushels a year, a very small contribution in comparison with those of the great exporters—Canada, the United States, Argentina, and Australia. (See Chart 4.)

India's past and present importance in the world wheat market is due less to the volume of her exports than to certain other

TABLE 1.—COMPARISON OF PRINCIPAL WHEAT-PRODUCING AND EXPORTING COUNTRIES, PRE-WAR AND POST-WAR*

	Wheat area harvested (million acres)		Yield per acre (bushels)		Wheat crop (million bushels)		Percentage of world crop		Net exports (million bushels)		Percentage of net exports to crop	
	1909–13 average	1920–25 average	1909–13 average	1920–25 average	1909–13 average	1920–25 average	1909–13 average	1920–25 average	1909–14 average	1920–26 average	1909–14 average	1920–26 average
United States	47.1	58.6	14.7	13.8	690	809	23.0	25.4	103.2	207.6	15.0	25.7
Russia	74.2	38.8[a]	10.2	9.3	759	359[a]	25.2	11.3	164.5	.....	20.0[b]	....
India	29.2	29.6	12.0	11.6	352	343	11.7	10.8	51.6	14.8[c]	14.7	4.3
Canada	9.9	21.8	19.8	16.2	197	352	6.6	11.1	95.6	248.7	48.5	70.7
Argentina	14.9	16.6[d]	9.9	11.8[d]	147	195	4.9	6.1	83.6	119.9	56.8	61.4
Australia	7.6	9.8	11.9	13.3	90	131	3.0	4.1	54.6	90.4	60.3	68.9

* Official data. For Argentina and Australia the crops are those harvested around the end of the calendar year indicated. Net exports are for the crop years ending March 31 for India, June 30 for the United States, July 31 for Russia and Canada, and December 31 for Argentina and Australia. Russian figures, except for pre-war exports, are for post-war boundaries.

[a] Average 1921–25, not comprehensive for all years.

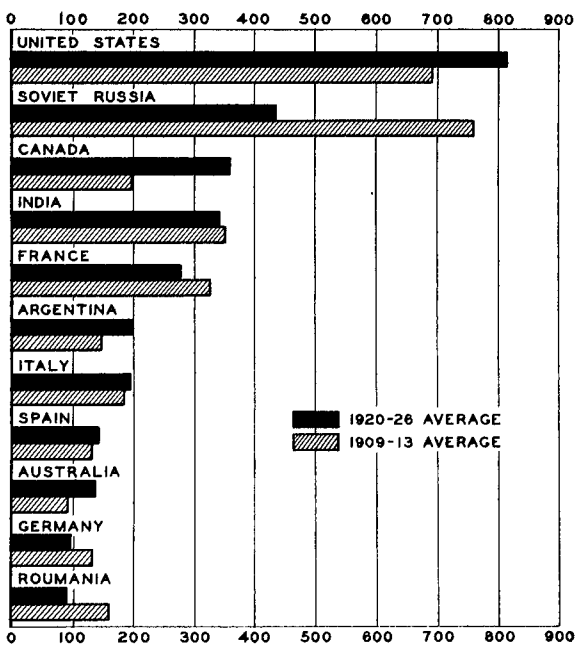
[b] Percentage of net exports to average crop of pre-war Russia, 815 million bushels.

[c] Includes gross export figures for the years 1923–24 to 1925–26.

[d] For area sown, not area harvested.

CHART 1.—WHEAT CROPS OF PRINCIPAL PRODUCING COUNTRIES, PRE-WAR AND POST-WAR AVERAGES*

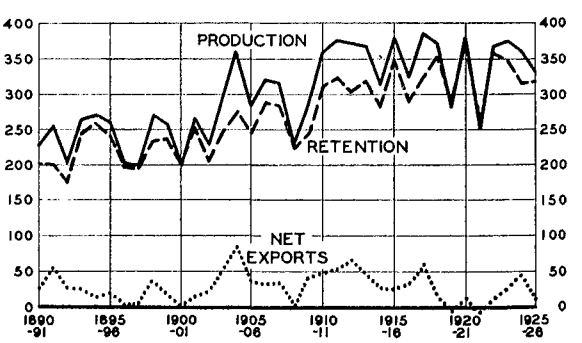
(Million bushels)



* Chiefly official data as summarized by U.S. Department of Agriculture. Where boundaries have been altered, pre-war figures are Department estimates for present territory.

CHART 2.—INDIA'S WHEAT PRODUCTION, NET EXPORTS, AND DOMESTIC RETENTION, ANNUALLY, 1890–91 TO 1925–26*

(Million bushels)

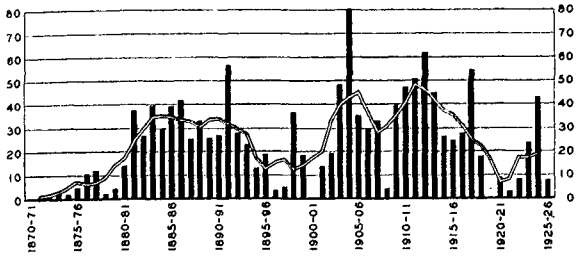


* See Appendix Table V. Crop figures for 1893 and following years; net exports and retention are for years April–March. The rising trend of production and retention in pre-war years is probably due in part to increasing comprehensiveness of the data.

facts. Her crop is harvested in March–May. Hence the bulk of her exportable surplus, when one exists, becomes available to importers in the summer months, at a time when other exporters have usually depleted their stocks and new wheat is not yet available from these sources (except, at times,

CHART 3.—WHEAT EXPORTS FROM BRITISH INDIA BY SEA, ANNUALLY, 1870–71 TO 1925–26, WITH 5-YEAR MOVING AVERAGE CENTERED*

(Thousand bushels)



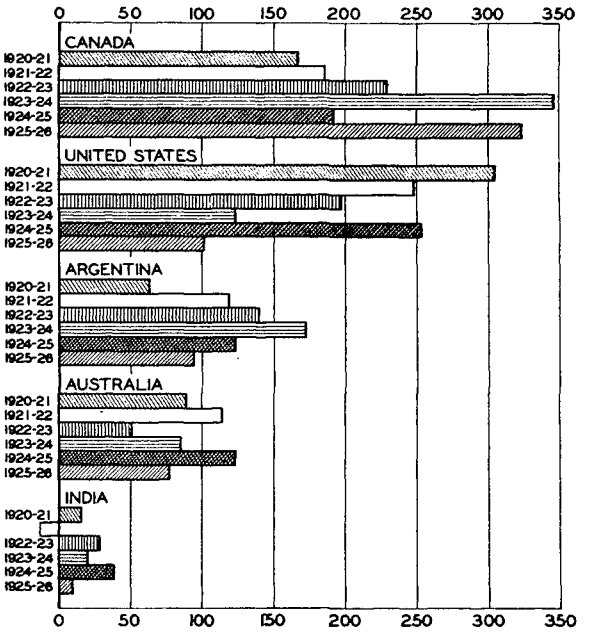
* Gross figures, exclusive of flour, for Indian crop years April–March. See Appendix Tables XIIA, XIIB.

the United States) or from European crops. In years of poor crops, Indian wheat falls out of the market for twelve months or more. But when the crop is good, the Indian wheat market is peculiarly sensitive to world price movements, holding grain closely when the price is low, and releasing it in large quantities when the price goes high, thereby checking the advance. In certain years exports of no more than 40 million bushels have considerable significance in the world market. Indian wheat also enjoys a special demand in import markets, notably Great Britain, because its milling characteristics make it suitable for blending with Russian wheats, and because its extreme dryness renders it particularly desirable for blending with wheat of high moisture content, especially with new British wheats, which are usually damp.

India's wheat is sown in October and November, makes its main growth during the coolest months of the year, and is harvested in March, April, and May, on the approach of summer heats. For moisture it depends largely on the accumulation in the soil from the rainy season between June and September, supplemented by a scanty but essential rainfall during the growing season and by irrigation from canals and wells. The summer rainfall varies greatly from one year to another, causing considerable variation in the acreage of all crops, including wheat. (See Chart 5, p. 320.) Because of the extensive use of irrigation, the variations in average yields per acre are very moderate (see Chart 6)—much smaller than in Canada, Argentina, and Australia; even the crop failures are never as extreme as in Australia. In India as in no other country, the variations in wheat production from year to year are due about as much to variations in acreage as to variations in yield per acre. The cultivators' implements are exceedingly primitive, though intelligently employed, and in spite of intensive methods of cultivation the average yield is consequently low—averaging 11 to 12 bushels to the acre; but there are now some

CHART 4.—NET EXPORTS OF WHEAT AND FLOUR BY FIVE LEADING EXPORT COUNTRIES, ANNUALLY, 1920–21 TO 1925–26*

(Million bushels)



* Official data for years August–July.

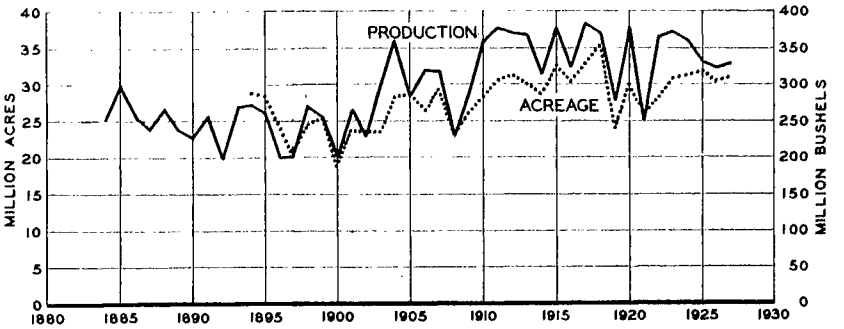
prospects for better yields through improvements in implements and agricultural practices.

India gives no promise of ever becoming a highly important factor in the world wheat market, except in occasional years. Nevertheless, a gradual improvement in

methods of cultivation and a further extension of irrigation are likely to cause a slow increase of wheat production for a number of years to come, until the crop becomes considerably larger than it has been in recent years. But the individual consumption of wheat has already shown a significant increase in some parts of India, and with the further growth of population and the spread of industrialism, the total wheat consumption must be expected to increase. On the whole, we are disposed to conclude that India is unlikely in the future to contribute as heavily to the world wheat trade as in the ten or a dozen years before the war.

In the present study we undertake first to set forth the conditions underlying the production of wheat in India—the characteristics of the country and its people, the development of irrigation enterprises, and the process of wheat growing. We next present a discussion of India's domestic and international trade in wheat, with some consideration of consumption and prices. Finally we review the historical development of India's wheat production and export, and consider, necessarily in some-what tentative fashion, the outlook for her future as a producer and exporter of wheat.

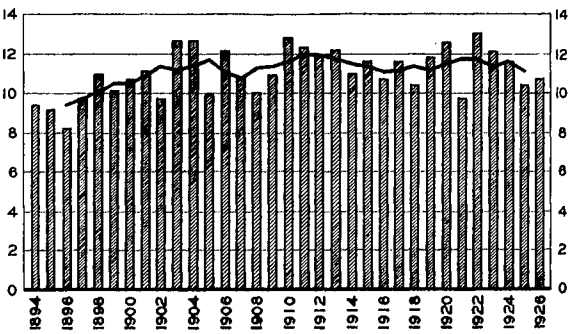
CHART 5.—INDIA'S WHEAT ACREAGE AND PRODUCTION, CROPS OF 1884 TO 1927*



*Production data for 1884–92 as given in U.S. Department of Agriculture, *Report of the Statistician*, September and October, 1892, pp. 355–59. Later data as in Appendix Tables I and II. Figures for Native States are presumably incomplete, especially before 1909.

CHART 6.—AVERAGE YIELD PER ACRE OF WHEAT IN INDIA, ANNUALLY, 1894–1926, WITH 5-YEAR MOVING AVERAGE CENTERED*

(Bushels)



* See Appendix Table III.

I. THE LAND AND THE CLIMATE

India, lying in the center of southern Asia, extends in latitude from about 8° N. to about 37° N., and comprises an area of some 1,800,000 square miles, of which more than half lies to the north of the Tropic of Cancer (23° 27′ N.). Measured against the North American continent, India would span from Panama to southern Kansas; and almost the whole of the Indian wheat district lies farther south than the wheat fields of Oklahoma and Texas. Of the continent of Europe, only the southern extremities of Spain, Sicily, and Greece overlap the latitude of the northern limits of India. In area and population, India is slightly smaller than post-war Europe exclusive of Soviet Russia.

For many years India has been a part of the British Empire, under a British viceroy. A distinction must be made at this point

between British India, which is divided into provinces and other divisions under British governors and British administration, and the Native States, which are ruled by native potentates under British suzerainty.[1] Both provinces and Native States vary greatly from one another in size and importance; many of their boundaries are most artificial and irregular, and correspond only very roughly with the physiographic features that influence the agriculture of the country. The principal significance of the political divisions for this study lies in their administrative and statistical relations to wheat growing.

Relief, Rivers, and Soils

The Empire of India comprises four great physical divisions: a region of high mountains to the north; a broad alluvial plain within the curve of the mountains; a southern peninsula of more broken relief; and a distinct eastern section comprising chiefly Assam and Upper and Lower Burma, which is of no concern for the present study. The mountains give little scope for settlement and agriculture, but in many ways they are potent to affect the life of India. In sharp contrast to the desolation of the mountains, the level plain-lands below maintain the densest population and the most intensive agriculture of India. To the south again, in the peninsula, the land and climate are less favorable, jungle and forest are more abundant, agriculture is less well developed, and in general the population is less congested.

From end to end the landward frontier of India is determined by the course of the mountain ranges; and chief among these ranges are the Himalayas, the highest wall in the world, separating India on its northeastern frontier from the rest of Asia for more than a thousand miles. But the mountain region is by no means an impenetrable barrier to intercourse with the rest of the continent; and passes, particularly in the north and northwest, for centuries have given a way to commerce and invasion. For the agriculture of India also the mountains possess immense importance; the wall of the Himalayas is a prime cause of the summer rainfall upon the plains below, and the snow-fields and hillsides provide a gathering-ground for many large rivers which water the plains.

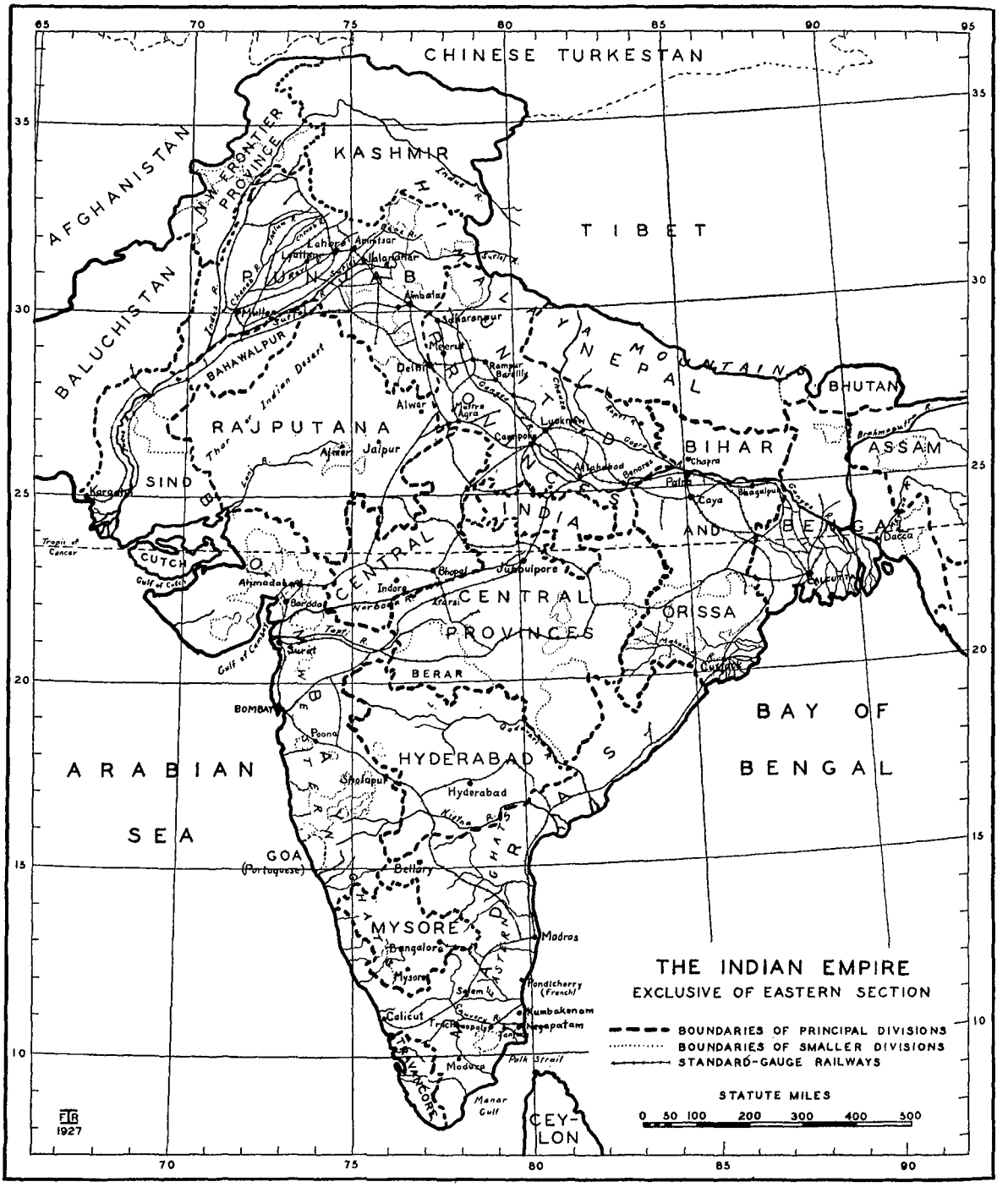
The great alluvial plain to the south of the mountains is of special importance to this study as the region which contains most of the principal wheat-growing districts of India. In a winding course, the plain is about 2,000 miles in length from sea to sea, and in width it varies from 200 to 250 miles or more. The drainage basins of two great rivers, the Indus and the Ganges, divide it into eastern and western portions of roughly equal extent. From these two rivers, the alluvial plain is often termed the Indo-Gangetic Plain. The Indus and its five great tributaries, the Jhelum, Chenab, Ravi, Beas, and Sutlej, all rise in the northwestern end of the Himalayan chain; after emerging from the mountains, they all flow in a southwesterly direction across the province of the Punjab (*punj-ab* —five waters) and unite in the single channel of the Indus to flow on through the arid province of Sind to a delta in the Arabian Sea. The Ganges and its great tributary, the Jumna, rise in the central Himalayas and flow southward and eastward through the United Provinces, and Bihar and Orissa, and then southward again through the province of Bengal, to a delta shared with the Brahmaputra (Jamuna) at the head of the Bay of Bengal. In its eastward progress the Ganges receives not only the drainage of many large tributaries from the eastern Himalayas, but also, un-

[1] The nine major provinces of British India have a total area of 1,018,624 square miles and a population, as of 1921, of 243,156,922, distributed as follows:

Province	Area	Population
Punjab	99,846	20,685,021
United Provinces of Agra and Oudh	106,295	45,375,787
Bihar and Orissa	83,161	34,002,189
Bengal	76,843	46,695,536
Assam	53,015	7,606,230
Burma	233,707	13,212,192
Central Provinces and Berar	99,876	13,912,760
Bombay	123,621	19,348,219
Madras	142,260	42,318,985

The six minor administrations of British India have a total area of 75,676 square miles and a population, as of 1921, of 3,846,371. There are 675 Native States, ranging in size from Kashmir and Hyderabad with some 84,000 square miles each, to others with an area of less than 20. The total area of the Native States is 711,032 square miles, with a population at the 1921 census of 71,939,187. The kingdoms of Nepal and Bhutan are not an integral part of the Indian Empire.

like the Indus, the drainage of rivers which rise in the alluvial plain itself and in the northern hills of the peninsula. Between the Sutlej and the Jumna there lies a broad flat watershed, on which several minor rivers flow and disappear. Though the highest part of the plains, this watershed is nowhere much more than 900 feet above the level of the sea.



This map, based on standard maps in various atlases, has been prepared at the Food Research Institute by D. L. King.

The surface of the plains possesses a

minor relief of considerable importance for agriculture. At one time the site of the plains was a depression, of undetermined depth, between the mountain system to the north and the old rocks of the southern plateau. In the course of time this depression has been filled up by the alluvial deposits of rivers, principally from the northern mountains. The rivers of the present day have begun to erode this older alluvium, and have cut for themselves wide level flood-plains, upon the floors of which they have deposited a newer alluvium. Throughout the Ganges basin, except in the vicinity of the delta, there is to be found a clear distinction between the older alluvium, the *bhangar* or high land, and the newer alluvium, the *khaddar* or low land, often with a sharp demarcation by cliffs or bluffs, and a difference of level which may amount to 200 feet or so. According to the size of the stream, the low land may vary in width from a few yards to several miles. In the Punjab the same river flood-plains are to be found, also bordered in places by low cliffs, but throughout the Indus basin the relief is much slighter, the river courses are more fluctuating, and the separation of old and new alluvium is indistinct.

The soils of the plains vary greatly, from heavy clays to porous sands; but the absence of stones and gravel is a characteristic common to all. The soils of the Punjab have been deposited by rivers newly emerged from the mountains, and are therefore in general much coarser than those of Sind or the provinces of the Ganges basin, which lie at greater distances from the gathering-grounds of the rivers and which have in consequence received only the finer deposits; this distinction between the sands and coarse silts of the Punjab and the fine silts and clays of Sind and the United Provinces is of great importance in determining the native practices of irrigation. In many places large areas of upland clay have become impregnated with sodium salts, so that they are now of little or no use to agriculture without expensive reclamation. Another type of chemical reaction in the soil has resulted in the formation of calcareous layers, termed *khankar*, below the surface of the soil. *Khankar* appears to be of the same nature as the *tosca* of the Argentine pampas; in this and in other respects, the two great alluvial plains bear a striking resemblance.

The peninsular area—the "Dekkan" or southland—is a triangular plateau of irregular relief, with hills and ranges of hills and broad well-cut river valleys. Close along the west coast runs the mountain chain of the Western Ghats, with an average height of about 3,000 feet; and an irregular succession of highlands on the eastern side of the peninsula, with an average height of about 1,500 feet, is sometimes called the Eastern Ghats. The northeastern angle of the triangle has been covered in past times by extensive lava flows, but elsewhere the original structure of ancient crystalline rocks is still exposed. Parallel to and near the northern edge of the plateau, two great rivers, the Narbada and the Tapti, flow westward in deep valleys across the volcanic rocks to the Arabian Sea. South of these valleys the Dekkan is drained by the river systems of the Godaveri and the Kistna, which flow eastward across the country, practically from coast to coast, into the Bay of Bengal. Two smaller systems, the Mahanadi to the north and the Cauvery to the south, complete the eastward drainage of the Dekkan.

On the uplands of the volcanic tract the soils are thin, light-colored, and gravelly or sandy; on the slopes they are darker and finer, and in the lowlands they are deep, black, and very heavy. These soils are closely, but not entirely, associated with the volcanic area, and may have been formed from wind-borne dust. The best of them are the well-known black cotton soils of India, which are wonderfully fertile and extremely retentive of water. Much of the wheat of Central India and the Central Provinces is grown on these black soils. Elsewhere in the Dekkan the soils are mainly laterite loams and clays, on which little or no wheat is grown.

Climate

India is chiefly distinguished from all the other great wheat-producing countries of the world by her singular climatic cycle: two mid-year seasons of tropical heat and tropical rain forbid the growing of wheat;

and the third season of more temperate character, during the winter of more northerly lands, usually supplies sufficient warmth and sunshine to bring the wheat crop to maturity before the return of summer heats. In the adjustment of agricultural practice to this climatic cycle the greatest problems are presented by the factor of rainfall, which is largely concentrated within the four-month period, June to September, and which tends to vary greatly from one year to another. In response to these problems the experience of many generations of cultivators has evolved a complex adaptation of crops and cultural methods. This adaptation, however, is far from perfect and complete, and the people of India run continual risk of food shortage or famine through vagaries of the rain.

The most remarkable features of all the varied climates and the uniform climatic cycle of India find their explanation in the singular position of India. It lies at the foot of the mighty Himalayan wall and projects toothwise from the continent of Asia, the largest land-mass in the world, into the Indian Ocean, a huge bay between three continents and the warmest of the great oceans. The great air currents which pass back and forth over India between the continent and the ocean determine the climatic rhythm of the whole realm of India, while the local variations of relief and latitude modify these major influences from place to place.

All over India the period from March to May is a season of steadily increasing heat and dryness, which gradually becomes oppressive in the extreme. During the month of June there comes a rapid and remarkable change. The trade winds, which south of the equator blow over the southern Indian Ocean in a northwesterly direction throughout the year, suddenly cross the line in June, changing their course from northwest to northeast as they cross. In this new direction they blow up the seas on either side of the Indian peninsula, and "break" inward over the land. These are the famous "wet monsoon" winds, that bring the rains on which the prosperity of India so largely depends. They break first on the south of India early in June, and usually reach the Punjab by the end of the month.

A western sector of the monsoon crosses the Arabian Sea, and blows from the southwest and west across the peninsula, supplying most of its summer rainfall; precipitation is particularly heavy on the seaward slopes of the Western Ghats. To the north of this range of highlands and the Gulf of Cambay this wind ceases, and only winds from the dry lands of Persia and Baluchistan blow up the Indus Valley and the lowlands to the east. The absence of rain-bearing winds from this part of India during the single opportune season of the year is the cause of the Thar, or Indian Desert, which extends over so large an area in Sind, Rajputana, and the southern Punjab.

An eastern sector of the monsoon blows up the Bay of Bengal, and splits up to left and right as it approaches the Himalayas, the left half blowing northwestward up the Ganges Valley, shedding rain on the plain as it goes. The precipitation from this air current diminishes from east to west, being about 60 inches in the Ganges delta and declining to 15 inches and less in the Punjab, far inland.[1]

The monsoon winds continue from June to September, and during this time the rains fall in occasional heavy storms, with longer spells of fair weather between. Before the coming of the rains the ground lies hard and dusty and dry, but after the first rainfalls there follows everywhere a sudden uprush of green vegetation. The heat becomes less oppressive, because day temperatures no longer rise to extreme heights; on the other hand, night temperatures do not fall so low. The humidity also increases and stands at more than 70 per cent of saturation over a large part of India during the monsoon months. The combination of warmth and humidity does great damage to property; in particular, it most strongly encourages the growth of moulds on all organic materials not preserved in the driest possible storage.

The greatest hazard of Indian agriculture lies in the uncertain amount and distribution of the monsoon rains, which may begin late, or end early, or cease for long intervals in midseason. Such irregulari-

[1] See Appendix Table VI.

ties of course work havoc with agricultural operations, and in the worst years may so greatly impede them as to bring famine. But in the normal course of events all India except the Thar and its borderlands receives sufficient rainfall to support some sort of cultivation during the monsoon season itself and the next six months or more of scantier rain.

Between September and the end of the year, the winds of the southwest monsoon gradually withdraw from India, ceasing first in the north and last in the south, and there follows a sudden change to cooler weather, clear skies, lower humidity, and a greater diurnal range of temperature. Everywhere the monsoon season comes and goes suddenly, with a great change of climatic conditions in very short transitional periods. At such times the cultivators must work at high pressure to make full use of the fleeting opportunities at their disposal.

From October onward the temperature falls until January and February, and then begins to rise once more. This period is known as the cold-weather season, by contrast with the rest of the year; the temperature seldom falls low enough to cause discomfort to Europeans or to check the growth of crops, but in northern India the cotton-clad natives, poorly housed and short of fuel, feel the cold severely. Frosts occur in the Indo-Gangetic Plain, but they are by no means a usual characteristic of the cold-weather season, and are seldom widespread or severe.

The rainfall of the cold-weather season, though scanty, plays an important part in the cultivation of wheat and other cold-weather crops. A little rain falls in October, after the withdrawal of the monsoon, and makes a useful contribution of moisture to the soil at sowing-time. November and December are not rainless, but the real period of winter rains begins only toward the end of December and persists during January and February. These winter rains are entirely restricted to the Indus and Ganges basins and the north and northeast of the peninsular plateau. They vary in amount from five inches or so within the mountains to an inch or half an inch to the south. Rather curiously, they are somewhat less in the transition belt of land between the Ganges plains and the plateau country than they are to the north or south.

After February the winter rains cease and the temperature rises. The risk of rain from sudden local storms continues into April and May, but the average precipitation of these months is small. Finally the heats of April and May return, and the Indian countryside again awaits the coming of the monsoon rains and the beginning of a new agricultural year.

River Floods

A factor of great importance for the agriculture of the alluvial plain is the yearly rise and fall of the rivers. Each river has its own peculiar rhythm of rise and fall, according to the nature and extent of its gathering-ground, but certain important characteristics imposed by the march of the seasons are common to all. The rivers are at their lowest in the cold-weather season; many are then merely narrow trickles of water. During the rainy season they become rapid, rushing torrents, filling the river beds from bank to bank and even overflowing the adjacent low-lying land.

The cause of the summer floods is to be found in the precipitation of the Himalayas. During the cold-weather season there occur the heaviest rainfalls and snowfalls in the mountains, which may cause a first rise of river levels in March or April. As the season advances, the mountain snows begin to melt and to send down further additions of water to the rivers of the plain. Finally, from the beginning of July, melting snows and monsoon rains combine to send immense volumes of water from the mountains and foothills to the plains below. With the end of the monsoon season and the fall of temperature which follows, the discharge from the mountains rapidly shrinks. The shorter the head of the river in the mountains, the briefer and quicker the rise and flood and fall. The Indus and the Jhelum, with lengthy mountain courses, rise evenly for several months and fall in like manner. Other rivers, such as the Sutlej, attain a higher maximum flood for a shorter time. The importance of these floods to the cultivator will be indicated when the topic of irrigation is discussed.

Seasons and Crops

The rainfall of the summer monsoon is the mainstay of Indian agriculture. During the period of the rains, warmth and humidity are high. It is therefore possible to plant crops of tropical character at the coming of the rains, since they will make their growth during the rainy season and ripen toward or shortly after its close. Other crops, which require a more temperate climate and cannot survive the heat and moisture of the rainy season, can be grown in the season of cooler, drier weather that follows the withdrawal of the monsoon. The moisture requirement of these cold-weather crops is supplied in some part by the winter rains which fall during the period of their growth, but in considerable part from stores of moisture accumulated in the soil, before sowing, by persistent working of the soil during the period of the rains. The only barren season of the Indian year is to be found in the fierce, dry heat of April, May, and June, whose withering influence few crops can withstand.

Crops grown during the monsoon rains are commonly called *kharif* (autumn) crops, because they are grown for the *fasl-i-kharif* (autumn harvest), which lasts from September to the end of the year. These crops require high warmth and abundant moisture for their growth, and cannot withstand exposure to cold. The principal examples are rice, maize, most of the millets, the cow-pea and a few other pulses, sesame (which may also be a cold-weather crop), cotton, jute, and indigo. Sugar-cane is not included in this list because, though it grows through the rainy season, it is planted at the beginning of the year and reaped toward the end.

Crops grown during the cold-weather season are commonly termed *rabi* (spring) crops, because they are grown for the *fasl-i-rabi* (spring harvest), in the months of February–April or even May. Several of the crops thus grown in the Indian cold-weather season are summer crops in more temperate lands; the principal crops of this kind are wheat, barley, and linseed. Other *rabi* crops, such as gram, other legumes, and various oil-seeds, are more narrowly confined to India.

Rotations of diverse kinds, both simple and elaborate, are practiced by Indian cultivators. Some of these resemble the rotations followed in temperate lands, while others are complicated by the employment of two growing seasons and the not infrequent practice of growing mixed crops.[1] Over a large part of India, land and climate permit a typical two-year rotation, of a *kharif* crop in one twelvemonth, followed by a fallow from six to nine months long, and a *rabi* crop in the next twelvemonth, followed by a fallow of three months or so before the next *kharif* crop is sown. But there are many circumstances to prevent this rotation from being followed as a matter of course. In Sind, for example, there is little or no rainfall, and most of the crops are *kharif* crops, grown under irrigation from the summer flood-waters of the Indus; in the Punjab, a small monsoon rainfall and good winter rains combine to favor *rabi* crops; in the United Provinces again, low-lying lands may be too wet for *kharif* crops during the rainy season, and high lands too dry for *rabi* crops during the cold-weather season. In one form or another, most of the land is *ek-fasli* (one-harvest) land, on which only one crop, *kharif* or *rabi*, is grown in the twelvemonth. There is comparatively little *do-fasli* (two-harvest) land, on which a *rabi* crop is sown as soon as the *kharif* crop has been harvested; and on such land, the *rabi* will usually be only a leguminous catch-crop. If any better *rabi* crop is attempted, its yield without the aid of manure will certainly be low. The importance of leguminous crops in maintaining the fertility of the soil is thoroughly understood, and the practice of growing these crops is general except on the irrigated lands of the Punjab, where the same need is perhaps supplied by a luxuriant natural growth of leguminous weeds.

The practice of growing mixed grains is common, and is often highly advantageous. In some cases, two food grains such as wheat and barley, or wheat and gram, are grown together because they will in the

[1] A detailed account in the *Proceedings of the Board of Agriculture of India, 1906* (Calcutta, 1906), is summarized in A. and G. L. C. Howard, *Wheat in India* (Calcutta, 1910), pp. 30–33.

end be eaten as a mixture. In other cases, the mixed crops are of different character, thriving under different conditions and ripening at different times, to insure a better chance of satisfactory return under possibly adverse conditions. But perhaps the most common practice is the addition of a leguminous crop to the major crop, of whatever kind, to enrich the soil with nitrogen and organic matter. Other possible types of mixing may also bring other advantages, such as, for example, the mixing of deep- and shallow-rooting plants, to draw their moisture from different levels of the soil.

Methods of Cultivation

"The present condition of Indian agriculture is the heritage of experience handed down from time immemorial by a people little affected by the many changes in the government of the country. The present agricultural practices of India," according to competent observers, "are worthy of respect, however strange and primitive they appear to western ideas."[1] The brief general description here given applies to areas which do not rely predominantly upon irrigation; of these, and of wheat growing in particular, more will be said below.

To a considerable degree, the methods of cultivation are dictated by climatic considerations. The first plowings for *kharif* crops may be made during the dry hot weather that precedes the rains. This work brings the ground into good condition to absorb the first rains that fall, and is therefore particularly valuable on heavy soils, but the extent to which it can be done is often limited by the hardness of the soil, the condition of the plow-bullocks during the hot weather, and the need for the labor of men and animals in completing the harvest of the cold-weather crops. Where the soil has not been worked beforehand, the first plowings are made as soon as the first rains have softened the ground, and sowings follow quickly after. The *kharif* harvests continue from September to December, according to the nature of the crop. After each crop has been cut its stubble serves for some time as grazing for the village cattle.

Much of the moisture which *rabi* crops require for their growth must be accumulated in the soil by repeated plowings during the monsoon rains. The first of these plowings may be given before the coming of the rains, or just after; but in general the cultivators' efforts at this time are fully directed to plowings and sowings for the *kharif* crops, so that as a rule they do not undertake the work of preparing the soil for *rabi* crops in earnest until the months of August and September. The usual type of Indian peasant's plow is a poor and ineffective implement which merely cuts a shallow groove and breaks up a little earth as it is drawn through the soil, so that a series of plowings and cross-plowings is required to prepare a proper seed-bed.[2] The number of plowings depends partly on the crop, a greater number being given to the more valuable crops, such as wheat. The first effect of the plowings is the prevention of capillary ascent of soil moisture to the surface and consequent heavy loss by evaporation. The aërification of the surface soil which results from plowing is also of value, not only for its ulterior benefits in assisting the growth of the crops, but also because it encourages the processes of bacterial nitrification, which proceed rapidly in the warm moist soil during the rainy season.

The work of plowing is performed during the spells of fine weather between the recurrent storms of rain; for good results in the soil, a regular alternation of fine and wet weather is essential. A long spell of dry weather, on the one hand, bakes the ground too hard for the plow and its bullocks, and leads to evaporation losses; while on the other hand, prolonged rains soften the ground so much that it cannot be properly crumbled by the plow. But if the sequence of weather is normally favorable, the results of working will be a finely divided upper layer of soil, well stored with moisture and nitrogen, and in good condition for the sowing of a *rabi* crop.

It is impracticable to sow *rabi* crops be-

[1] A. and G. L. C. Howard, *Wheat in India* (Calcutta, 1910), p. 7.

[2] See also below, pp. 341, 348–49. On account of the practice of cross-plowing, Indian fields, however small they may be, are usually square, or approach the square in shape; and field-systems of long, narrow strips are comparatively uncommon.

fore the end of the monsoon rains, because the soil is so warm and moist that the seed is likely to decay in the ground. It also runs the risk of attack by insect enemies. The end of the rains brings a sudden change of season and the soil rapidly dries and cools. Sowings must then be made quickly, because the heavy black soils of peninsular India dry and bake until they soon become too hard for seeding, and the light alluvial soils of the plains may lose a good deal of their moisture. The autumn or "sowing" rains help to replenish this stock and to keep the seed-bed sufficiently moist. Deficiency of these rains impedes sowings, and so also does excess, with the further drawback of reducing germination. The cooling of the soil may also turn to a disadvantage, as, for example, in Bihar, where the soil temperature may fall so rapidly that wheat must be sown within ten days or so of the end of the rains, under penalty of poor germination and a low yield for later sowings. Nevertheless, in spite of these unfavorable influences, which perhaps tell most severely against the more valuable crops, the cultivators continue *rabi* sowings, with the help of occasional rains, through the months of October and November, and even up to the end of the year.

The progress of the *rabi* crops is largely influenced by the "winter rains" of December, January, and February, which usually provide a couple of inches of rainfall, more or less, to meet the transpiration requirements of the growing crops. These rains fall more abundantly on the Punjab and the northern United Provinces on the one hand, and the plateau country of the Central Provinces on the other, than on the southern districts of the Ganges Valley, which lie between. For this reason perhaps, agriculture and wheat growing are not so well developed in this intermediate belt of land as they are in the territories beyond the divide. The growth of the *rabi* crops is brought to an end by a gradual rise of air temperatures from February onward, and if the crop is not well advanced by this time it may be withered and killed without bearing fruit. The power of rapid growth from seed time to harvest is therefore a desirable and important quality in Indian *rabi* crops, even at the cost of low yields.

II. IRRIGATION

The limitations and vagaries of the rainfall are so serious that agriculture in almost every part of India can find some advantage in the command of water from some more dependable source of supply. West and northwest, in Sind, Rajputana, and the southern Punjab, the rainfall is normally so small that cultivation can be maintained only where some form of irrigation has been established. Elsewhere, over practically the whole of India, the rainfall is sufficient to maintain cultivation, but is largely concentrated into the single season of the summer monsoon and is liable to dangerous failure in occasional years. In all such regions, any practicable form of irrigation can render service, by supplying water during the dry seasons of the year and by making up deficiencies in years of drought, thereby increasing and stabilizing crop yields.

For centuries past, irrigation has been employed in India over large areas. At native hands its development has for the most part taken the form of a wide use of small-scale methods, within the scope of single cultivators or of villages and other small districts. During the last hundred years or so, there has been added a vast further extension and advance through the introduction of western engineering, organization, and leadership. Old works have been reconstructed and enlarged, old methods have been improved, and new works, ranking among the largest in the world, have brought under control immense resources which previously ran to waste. Following the completion of these engineering tasks, there have arisen the more intricate problems of securing an economical and effective use of the water supply on lands already under cultivation, and of promoting settlement and agriculture on lands that were previously uncultivated waste.

Native Methods of Irrigation

Indian irrigation by native methods is mainly a multitude of small enterprises,

exploiting only what resources can be developed by crude and often toilsome ways and means, to the neglect of other valuable resources, the use of which would require a large and intensive employment of capital and engineering skill. Of all resources, the most amenable to native use are the immense stores of underground water in the alluvium of the Indo-Gangetic Plain and in the fissured rocks of the peninsula, and the heavy rainfall and surface run-off of the summer monsoon. The comparatively small flow of rivers during the drier seasons of the year is a much less accessible supply, mastery of which constitutes the most notable advance in irrigation that British engineers have accomplished.

The stores of underground water are drawn upon by native irrigation wells of three types—fissure wells in rock, and spring wells and percolation wells in alluvium. The fissure well is sunk deep into rock in the hope of striking a water-bearing fissure; it is the characteristic type of the peninsula, but is of little importance in the wheat-growing regions. Percolation wells and spring wells, on the other hand, are the characteristic types of the Indo-Gangetic alluvium, where they are to be found in large numbers, and principally in the great wheat-growing regions of the United Provinces and the Punjab. The percolation well is simply an open shaft sunk down to a layer of water-bearing sand, through which the water penetrates into the well-bottom. In the spring well an open shaft is excavated until an impenetrable layer of clay or *khankar* is reached, through which a narrow bore-hole is sunk to reach a water-bearing sand. The first uprush of water carries sand with it, until a cavity has formed in the sand below the hole. Into this cavity the water percolates, and thence it rises into the bottom of the well, as if from a spring. The terms "spring" (*mota*) and "cavity" are therefore indifferently applied to this type of well. The spring well possesses important advantages over the percolation well, because it yields a larger flow of water, and its foundations are not so easily destroyed by over-rapid working. In Sind and the United Provinces, where the firmer alluvium has been deposited, impermeable layers of clay are frequently to be found, and the spring well is much the more usual type. In the Punjab, where the alluvial deposits are of much coarser texture, clay is seldom to be met with, and the cultivators are restricted to the use of percolation wells.

Wells in the alluvium are further classed as *pakka* (permanent) or *kachcha* (temporary). Permanent wells are built with a strong lining of brick, to last for a number of years, and are usually sunk by professional well-makers. Temporary wells are merely shallow holes in the ground, perhaps with a rough lining of brushwork, whose sides will collapse after a year or two. *Pakka* wells predominate in the Punjab, where a well must be sunk to a considerable depth to reach water-bearing strata and the coarse strata through which it passes compel the use of support for the sides. In the United Provinces, where the surface deposits are finer and firmer and water-bearing strata lie nearer the surface, *kachcha* wells are more common. Large numbers of such temporary wells are rapidly dug by the cultivators themselves in times of severe drought, when rains have failed and rivers, canals, and other supplies are running low. Both permanent and temporary wells draw water from a more reliable source of supply than any other mode of irrigation, but even they may fail if they are overworked in times of drought and the level of underground water falls too low.

The heavy rainfall and river floods of the summer monsoon are employed for irrigation in several ways. In the peninsula the relief of the land gives many opportunities to throw dams across streams and valleys in order to impound the run-off of the rainy season in reservoirs or "tanks." On the level Indo-Gangetic Plain, there are no opportunities for storage, except in the United Provinces, where there exist numerous small depressions, called *jhils*, the remnants of old stream-beds. Water is collected in these *jhils* during the rainy season, to be used later on the *rabi* crops. In another, less common, method of irrigation, the rainfall is impounded on the uppermost of a series of fields and is drawn off at will to irrigate fields at lower levels.

The largest works of native construction are the "inundation" canals, which draw off river flood-waters in the summer season. Such canals are simple cuts, usually with beds above the low-water level of the river from which they draw; they gradually fill with water as the river rises in summer flood, and empty again as it falls. In general they are not of great length and irrigate only the lower lands of the river valleys, thus differing from the newer and larger "perennial" canals constructed by British engineers. Many inundation canals irrigate tracts of considerable size and have been taken over for improvements and administration by a governmental authority. Inundation canals are principally to be found in Sind and the Punjab, because the winter rains and melting snows of the northwestern Himalayas cause floods particularly high and prolonged in the Indus and some of its tributaries. The province of Sind receives so little rain that its agriculture is utterly dependent on its inundation supplies of water. Most of its crops are therefore grown during the flood-season, but some of the water is run onto land which will later be sown to wheat and other cold-weather crops.

Many simple but effective devices are used to raise water, where necessary, to the level of the fields. For short lifts, from either wells or surface water-courses, a man may work a bucket which hangs from the longer arm of a pivoted counterweighted pole, but for lifts of more than 15 feet or so, bullocks are usually employed. The most common device, which is to be found all over India except in some parts of the Punjab, is the *mot,* a large leather bag, holding from 30 to 40 gallons of water and raised by a pair of bullocks walking down a ramp away from the well. The sandy bottoms of the percolation wells of the Punjab are not so well able to withstand the sudden flows of water caused by the large drafts of the *mot;* hence such wells are usually worked by the Persian wheel, whose draft is small and continuous. This consists of an endless chain of pots which passes over a wheel at the top of the well and is driven through rough wooden gearing by bullock power. When bullocks are used, the lift of water may be as much as 60 feet, but for the most part lifts of 40 feet, either by *mot* or Persian wheel, are seldom exceeded.

Public Irrigation Works

More than a century of British rule in India has given British engineers opportunities to use their skill for the benefit of Indian agriculture in the construction of immense irrigation works. By far the most important result of their efforts, as a whole and in relation to wheat growing, has been the construction of a number of great canal-systems, which comprise some of the largest artificial water-courses and irrigated tracts in the world. The mere magnitude of the distributive components of these undertakings commands respect; yet perhaps there is more to be admired in the great head-works which control the most powerful rivers of India and make possible the diversion of their waters for irrigation, not in the flood-season only, but through the whole course of the year. The immense increase in the returns of agriculture from the use of these new resources of water is the economic reward for the conquest of these great rivers by engineering skill.

From the fact that these modern canals are constructed and employed to deliver water to the cultivators during both crop-seasons of the year, they are called "perennial" canals, as distinguished from the "inundation" canals, whose supplies of water to cultivators are restricted to the summer season of river floods. The general character of the construction of all the perennial canal-systems is very much the same. A movable weir is constructed across the river just below the intake of the canal; the intake itself is protected with sluice-gates; and the union of weir and intake into a single structure constitutes the head-works of the canal. The canal flows away from the river at an angle for a considerable distance on the easiest possible grade, until at length it has left the river valley and is flowing on high ground. When it has thus gained command of a territory, and not before, it throws off branches, which in turn throw off the distributaries from which the village water-courses are fed. Throughout this distributive system, regu-

lative sluices and escapes are constructed to control and direct the flow of water as required. In thus irrigating uplands, the perennial canal further differs from the inundation canal, which usually confines its irrigation to low valley-lands near the point of intake.

The mode of operation of the perennial canal varies according to the season of the year. During the summer season, the river rises high in flood and attains a flow far greater than the capacity of the irrigation canal which draws from it. The weir is then lowered or removed to permit free passage of the flood, and the sluices of the intake are brought into use to regulate the flow of water into the canal and to prevent the intrusion of silt. At this time of the year, the canal attains its fullest flow at a level which will carry water to all parts of the system at the same time. During the cold-weather season, the case is entirely altered; the river then falls to a low natural level and a tiny flow, and the flow of water in the canal falls, through necessity or design, to one-half of its summer maximum or less. To maintain the level of water required for distribution to all parts of the system, it is necessary to raise the weir, impound the water above the head-works, and restrict the number of open branches in the distributive system, so that outgoings shall not too greatly exceed incomings. A system of rotations is therefore followed at this time, by which each branch canal is alternately opened and closed for brief periods whose length depends on the flow of water at that time in the main canal.

Within the last ten years or so, several of the largest canal-systems of the Punjab have been linked together in a way that makes them now, as it were, parts of a larger whole. The works that accomplished this integration are known as the Triple Canals System, an engineering triumph of the first magnitude, both in itself and for its consequences. The underlying principle of their construction is the diversion of the comparatively large winter flow of the River Jhelum as an aid to the scantier winter flows of the Chenab, the Ravi, and the Sutlej, to its east. High up the Jhelum, a canal takes off from the left bank and flows along many miles of hill slopes and across the Jhech Doab,[1] on which it irrigates about 345,000 acres of land; but this is merely incidental, for the bulk of its flow, which reaches a maximum of about 8,500 cusecs,[2] is discharged into the Chenab on the right bank, and withdrawn a few miles farther down on the left bank, to supply the Lower Chenab System, an older system of over two million acres. This transfer from the Jhelum for the benefit of the Lower Chenab System permits the withdrawal of an equivalent amount of water at a point farther up the Chenab, to irrigate the Rechna and Bari Doabs. The canal which takes in this water is the largest perennial irrigation canal in the world, with a full flow of 11,700 cusecs. It irrigates the Upper Chenab System, an area of 600,000 acres in the Rechna Doab, and, by an immense level crossing of the Ravi, it sends on nearly 7,000 cusecs at full flow to irrigate a million acres in the Lower Bari Doab, the third component of the Triple Canals System. The original plan for the irrigation of this *doab* contemplated a diversion of water from the Sutlej on its right bank, in such large quantities that all opportunity for the development of irrigation on the left bank of the Sutlej would have been permanently destroyed. The Triple Canals project, by drawing in effect on the Jhelum for the irrigation of the Bari Doab, left the waters of the Sutlej to be used for a large-scale development of irrigation on its left bank. This prospective development is now in course of realization, through the construction of a series of large perennial canal systems of new and interesting design.

Financial Aspects of Irrigation

The government irrigation works are officially classified as productive, protective, and minor works. Productive works are those which have been constructed with the

[1] Do-ab—land lying between two (*do*) waters (*ab*). The names of the *doabs* of the Punjab are compounded of the names of the bounding rivers. The Jhelum-Chenab Doab thus becomes the Jhech Doab, and the Chenab-Ravi, the Rechna Doab. At one time the Beas, which is now tributary to the Sutlej, held its own course between the Ravi and the Sutlej almost to their confluence. From the recollection of this, the *doab* on the left bank of the Ravi retains the name of the Bari Doab.

[2] A flow of water of one cubic foot a second is termed a *cusec*.

expectation that they will fully pay their way. By and large, the productive works have financially justified their construction. Up to 1921 it was calculated that they had yielded, above operating expenses, an annual average return of 9½ per cent on the investment. Fifteen of these, however, had failed to be remunerative, yielding less than 2 per cent on the investment of 1,026 lakhs of rupees, while the profitable works were said to yield about 11 per cent on a capital outlay of 4,864 lakhs.[1] The protective works, on the other hand, have been constructed without expectation of being directly remunerative, but primarily to protect especially precarious areas against famine. Some 1,173 lakhs had been expended on these works up to 1921; they yield less than 1 per cent on the cost, and are financed largely from current revenues, usually from the annual appropriation for famine relief and insurance. The minor works consist chiefly of native works of several varieties which the government has taken over, improved, and maintained. Altogether these serve nearly a third of the area irrigated by government works. These yield from 4 to 6 per cent on their cost.[2] Taken as a whole, the government irrigation works of all three classes yield a satisfactory return of 7 to 8 per cent on the investment (which includes works not yet in operation), in addition to increasing crop yields, extending the agricultural area, increasing land values, and protecting large areas from scarcity or famine.

In most provinces except Madras, Sind, and parts of Bombay, the distribution of the water and the assessment of the revenue are handled by engineers of the Public Works Department, with satisfactory results. The terms on which irrigation water are supplied are well described in the following excerpts from the *Triennial Review of Irrigation in India, 1918–1921:*

> The charges for water are levied in different ways in the various provinces. In some, notably in Sind, the ordinary land revenue assessment includes also the charge for water. . . . . In others, as in parts of Madras and Bombay, different rates of land revenue are assessed according to whether the land is irrigated or not, and the assessment upon irrigated land includes also the charge for water. . . . . Over the greater part of India water is paid for separately, the area actually irrigated is measured, and a rate is charged per acre according to the crop grown.
>
> . . . . . .
>
> The rates charged vary considerably with the crop grown, and are different in each province and often upon the several canals in a single province. . . . . Practically speaking, Government guarantees sufficient water for the crop and gives it as available. If the crop fails to mature, or if its yield is much below normal, either the whole or part of the irrigation assessment is remitted.
>
> Various other methods of assessment have been tried, such as by renting outlets for an annual sum, or by charging according to the volume of the water used, but these have never been successful. The cultivator . . . . has no confidence in a system under which his liability for water rate is independent of the area and quality of his crop.
>
> A somewhat different system, the long lease system, is in force in parts of Bengal and the Central Provinces, under which the cultivators pay a small rate for a term of years whether they take water or not. In these provinces, where the normal rainfall is fairly high, it is always a question whether irrigation will be necessary at all, and if the cultivators have to pay the full rate, they are apt to hold off until water becomes absolutely essential, and the sudden and universal demand then usually exceeds the supply. By paying a reduced rate every year for a term of years they become entitled to water when required; consequently there is no temptation to wait till the last possible moment, and the demand is much more evenly distributed throughout the season.
>
> Taken as a whole, irrigation is offered on extremely easy terms, and the water rates represent only a very small proportion of the extra profit which the cultivator secures owing to the water he receives.

Extent and Distribution of Irrigated Area

According to the official statistics, the irrigated area in British India and the Native States is now usually some 56 or 57 million acres.[3] This represents about 20 per cent of the net area sown to crops as shown by professional survey.[4] In the past thirty years, as shown by Chart 7, the irrigated area has increased by about 26 million acres, the most notable increase occurring in 1906–9. The data are presumably somewhat incomplete, especially for areas

[1] A lakh = 100,000 rupees. This is the equivalent, at pre-war parity (1*s.* 4*d.* to the rupee), of $32,443.33, and at the present parity (1*s.* 6*d.*), of $36,498.75.

[2] Inclusive of navigation canals, or 8 to 9 per cent for irrigation canals alone.

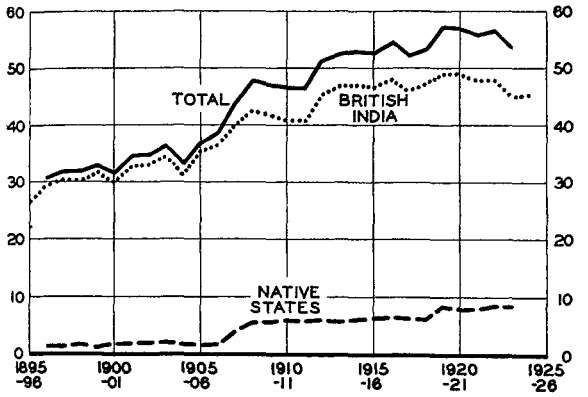
[3] See Appendix Table VII.

[4] See Table 3, p. 345.

irrigated by native methods, and the increase shown by these figures may be due in part to increased comprehensiveness of the data. Variations from year to year are caused not only by the gradual extension of irrigation facilities, but also by the fact that these are made use of in varying degrees in different years according to the season.

CHART 7.—AREA IRRIGATED IN INDIA, 1895–96 TO 1925–26*

(Million acres)



* See Appendix Table VII.

The distribution of the irrigated area according to the type of irrigation, for British India as a whole and for several of the leading provinces, is shown in Appendix Table VIII for three recent years. Taking the average for the three years, the percentages of the total area irrigated from each source were as follows:

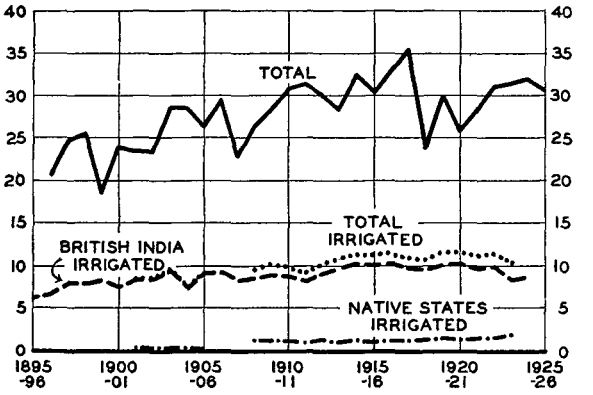
Source	British India	Native States	Total
Government canals	43.5	29.9	41.4
Private canals	6.4	10.5	7.0
Tanks	14.2	15.2	14.3
Wells	24.4	24.0	24.4
Other sources	11.5	20.4	12.9

In the Punjab, where the largest use is made of irrigation, and in Bombay, government canals strongly predominate, but wells are also extensively used in the Punjab. In the United Provinces the relative importance of these two sources is reversed. Tanks are relatively important in the Central Provinces and Berar, Bihar and Orissa, Bengal, and Madras. Miscellaneous sources are of considerable importance in the United Provinces, Bihar and Orissa, and Bengal. Broadly speaking, about half the irrigated acreage is supplied from government and private canal systems, and the other half from tanks, wells, and other sources of simpler construction.

As a rule, about one-fifth of the irrigated area is devoted to wheat. As shown by Chart 8, the wheat area irrigated now

CHART 8.—WHEAT ACREAGE AND WHEAT AREA IRRIGATED IN INDIA, 1895–96 TO 1925–26*

(Million acres)



* See Appendix Tables I and VII.

usually exceeds 10 million acres, and constitutes in most years over a third of the total wheat acreage. In no other country is so large a proportion of the wheat crop produced with the aid of irrigation.

The data in Table 2 (p. 334) show in a general way the present importance of irrigation in the agriculture of the various wheat areas, and in wheat growing in particular. In the Punjab, it will appear, about half the net area sown to crops, and well over half the wheat acreage, is irrigated. Indeed, about half of the wheat area irrigated is in the Punjab alone. In Sind the proportions are higher still. In the United Provinces, where a much smaller fraction of the cultivated area is irrigated, nearly half of the wheat is grown on irrigated land. Irrigation is important, though relatively less important, for wheat growing in the North-West Frontier Province, Bihar and Orissa, and the Rajputana States, but is of comparatively minor importance in the other wheat regions. The annual statistics since 1901–2, given for six of the wheat-growing

regions in Appendix Table IX, are of interest in showing how the expansion of wheat

TABLE 2.—EXTENT OF IRRIGATION IN PRINCIPAL WHEAT-GROWING REGIONS, ANNUAL AVERAGE, 1921–22 TO 1923–24*

(Thousand acres)

Region	Net area sown	Area irrigated	Wheat area sown	Wheat area irrigated
North-West Frontier Province	2,385	935	1,039	350
Punjab	26,400	13,291	9,360	4,986
United Provinces	35,692	9,245	7,059	3,141
Bihar and Orissa	25,232	5,421	1,209	303
Bengal	23,383	1,653	123	20
Central Provinces and Berar	24,069	1,098	2,911	55
Central Indian States	3,975	88	1,043	42
Rajputana States	6,532	846	727	224
Bombay (including Sind)	30,834	4,019	1,841	498

* Data from *Agricultural Statistics of India, 1923–24*. For more detailed data, see Appendix Table IX.

acreage, especially in the Punjab, has paralleled the extension of irrigation.

METHODS OF IRRIGATING

Irrigation plays its part in agriculture as an addition to rainfall, and also, in times and places, as a substitute. In the Punjab, it has turned wide stretches of waste land into the most prosperous agricultural regions of India. In years when rainfall fails, it protects against the clutch of famine. On lands already under cultivation, where indeed it has been most widely applied, it brings about higher yields and the growing of more valuable crops.

All over India, the mode of applying irrigation water to the soil is very much the same. The fields are divided by low banks into *kiaris* (compartments), and these are flooded in turn. The only difference of practice is to be found in the smaller size of *kiaris* constructed where the source of irrigation is a well, or some other such arduous supply.

When the water is supplied from perennial canals, the fields intended for wheat and other *rabi* crops are watered by a series of short floodings. The first flooding is given to the bare ground and is followed promptly by plowing and sowing; two, three, or more brief floodings are given at intervals, even up to a late stage in the growth of the crop.

Irrigation from wells is given more sparingly, because a well makes heavy demands on human labor and bullock power, and can irrigate only a few acres at best. In the United Provinces, where well irrigation is most largely practiced, the summer rains usually provide a sufficient store of water in the seed-bed to carry the *rabi* crops through the earlier stages of their growth, and the water from wells is drawn upon at need to supplement the relatively scanty rainfall of the cold-weather season.

On inundation systems, supplies of canal water are available for only a comparatively short time, and an entirely different practice must be followed. The fields intended for *rabi* crops receive a single prolonged flooding, in which the water stays on the ground for several weeks and thoroughly saturates the soil; after the water has subsided, the fields are plowed and sown. Inundation canal systems are mainly to be found in Sind and the southern Punjab, where there is little or no rainfall, winter or summer. Near the rivers and canal-beds, where the ground-water level is sufficiently near the surface, the *rabi* crops during their later growth are irrigated from wells; but where wells are impracticable, they are left to do the best they can with the water accumulated in the soil before sowing.

IRRIGATION PROBLEMS

To secure a proper economy and efficiency in the use of irrigation water is a matter that raises many serious and far-reaching problems. Concerning the economy of water obtained by native methods, but little information is available. The cultivators themselves, either singly or in groups, possess entire control and act in the light of their own traditional knowledge. Only to the practices of well-irrigation does any scientific attention appear to have been paid. It has been noted for this mode of irrigation that, though the limited supplies from individual wells would appear to favor a most careful economy and extensive distribution of water, the cultivators themselves prefer to

make heavy irrigations on restricted areas. As a possible scientific explanation of this preference it has been conjectured that, since well water is usually somewhat saline, the cultivators run much more water than the crops alone require in order that the excess may drain away to the subsoil; this would retain the saline water in solution and thus prevent the formation of a harmful saline deposit near the surface of the soil.[1] On corresponding preferences under other native methods of irrigation, the observations, if made, do not appear to have been recorded.

Much more serious consideration has been given to the use of irrigation water from the big perennial canal-systems, which are owned and operated by the government, in trust as it were for the cultivators. The illiteracy of the cultivators and the unreliability of the minor native officials have made it impossible to charge for water by volume, and, as we have seen, one or another system of assessments is employed instead. The cultivators therefore have no inducement to save water, and all major economies must be achieved by the canal administration itself, through its control of the canal rotations.

Over a period of years, the problems of economy assume a more complex form. River water is less saline than well water; yet an over-economy in its use involves the same risk that a saline deposit will form in the upper layers of the soil and prevent successful cropping.[2] On the other hand, if the water is used too lavishly, the soil becomes water-logged, and stagnant surface water permits the spread of malaria. Furthermore, chemical reactions between soil gases and soil moisture may cause the formation of alkali in the upper layers of the soil. "The terrible spectre of alkali," says Sir John Russell, the eminent agricultural authority, "looms ahead of every irrigation project; it may be kept under control for a longer or shorter time or it may completely wreck the scheme."[3] Alkali and salinity, though due to opposite causes, are equally destructive of fertility, and land which suffers from either trouble may be reclaimable only at heavy cost. Engineers are now fighting the direct evils of water-logging by the introduction of drainage systems. Time alone will show whether they can also achieve success in the struggle to preserve their territories from the disastrous invasions of alkali.

III. THE AGRICULTURAL POPULATION

Before turning our attention specifically to wheat production, we must give some consideration to the Indian people, and the agricultural classes in particular.

India is a predominantly agricultural country with an exceedingly dense population. With an area 60 per cent of that of the United States and a much larger proportion of the people engaged in agriculture, the population is nearly three times as large. On an area less than half that of Canada, the population is 36 times as large. The density of population is approximately the same as in Europe exclusive of Russia. For the whole of India, the population in 1921 averaged 177 per square mile; and in some of the principal agricultural regions the density, even of the rural population, attains a considerably higher figure. No other important country except China supports so large and so dense a population chiefly by its own agriculture. Hence it is not surprising that the standard of living, in a physical sense, is exceedingly low, that the pressure of population on the means of subsistence is persistently acute, and that agricultural methods are such as to use a maximum of labor and a minimum of capital. The process of natural selection and the pressure of necessity, however, have promoted the development of a notable skill in carrying on agricultural operations

[1] B. H. Wilsdon, "Studies in Soil Moisture, Part I," *Memoirs of the Department of Agriculture in India (Chemical Series)*, Vol. VI, No. 3 (Calcutta, 1920).

[2] The risk of this evil appears to constitute a strong objection to a scanty use of irrigation water. The suggestion that wheat can be raised on the water supplied by a single irrigation before sowing is put forward by A. and G. L. C. Howard in "The Saving of Irrigation Water in Wheat Growing," *Agricultural Research Institute, Pusa, Bulletin 118* (Calcutta, 1921), and is criticized on this ground by B. H. Wilsdon, in "Studies in Soil Moisture, Part I," cited above.

[3] Presidential Address to Section M (Agriculture) of the British Association for the Advancement of Science, Toronto, 1924.

with limited resources at a low margin of cultivation, and a store of practical wisdom in husbanding food supplies and managing the diet.

Population Growth and Distribution

At the last census in 1921, India had a total population of 319 million. The population is increasing at a moderate rate, as shown by the following decennial figures:[1]

Census of	Population	Census of	Population
1871–72	238,830,958	1901	294,361,056
1881	253,896,330	1911	315,156,396
1891	287,314,671	1921	318,942,480

But the statistics are imperfect, especially for the first two censuses and presumably later also, and the growth in census population may be due in some measure to more complete reports in later years. The moderate increase in the 'nineties was due to the famines and other unfavorable conditions prevailing during much of that decade. The very slight net gain between 1911 and 1921 was due to the extremely heavy toll of lives taken by the influenza epidemic of 1918–19. Under ordinary conditions a decennial increase of 15 million or more is apparently to be expected. Though satisfactory evidence is lacking, apparently improvements in productive methods have kept pace with the population growth, so that the standard of living has not declined, and has probably risen, during the past fifty years.

About 70 per cent of the population, 229 million in 1921, depends upon agriculture (including a small proportion in forestry and pastoral occupations) for its livelihood. The proportion engaged in agriculture has apparently been increasing, instead of declining as in most countries. In the decade 1911–21, indeed, the net increase of population was less than the increase in the agricultural classes, doubtless because the epidemic was most severe in the great centers of population. The caste system restricts mobility from one occupation to another; this, together with the usual conditions unfavorable to natural growth of city populations, especially strong in India, tends to increase the preponderance of the agricultural classes.

Of the 90 millions not engaged in agriculture in 1921, some 33.7 were engaged in mining and manufacture, 18.1 in trade, 4.3 in transport, 4.8 in the public service, and 5.0 in professional service and liberal arts, while 4.6 million were engaged in domestic service. Changes in the census classifications in 1911, and the effects of the influenza epidemic before the census of 1921, prevent one from drawing reliable conclusions as to the trend of occupational distribution. There is clear evidence, however, that between 1901 and 1911 there was a marked expansion in the numbers engaged in the textile industry, and if the normal growth in population had occurred in 1911–21 the numbers engaged in industry would probably have shown a further increase. On the other hand, the proportion engaged in the public service has apparently been declining.

India is therefore predominantly a land of small peasant cultivators, living in village communities. The number of towns and villages[2] and the distribution of population between urban and rural districts, in the principal wheat-growing areas, is shown below according to the census of 1921:

Area	Number of		Million Inhabitants	
	Towns	Villages	Urban	Rural
Punjab	146	34,119	2.2	18.5
United Provinces	435	104,347	4.8	40.6
Bihar and Orissa	75	84,814	1.4	32.6
Central Provinces	113	39,024	1.4	12.5
Central Indian States	51	21,790	.6	5.4
Bombay	206	26,528	4.4	14.9

The average population per village is around 400. The proportion of urban to rural population is only about 1 to 9. Some 55 per cent of the population consists of peasant cultivators, and another 12 per cent are agricultural laborers. These two

[1] Data from British documents. The first general census was taken in 1871–72, but local censuses, taken slightly earlier, were accepted for certain provinces. Excluding Rajputana, Central India, Hyderabad, and Burma, the figure was 206,162,360.

[2] No rigid distinction is made between *town* and *village* in the Indian census. In general a community of less than 5,000 is classed as a village and one of more than 5,000 as a town; but exceptional communities which have overstepped the 5,000 mark without urban characteristics are adjudged to be villages, and *vice versa*.

classes together comprise two-thirds of the Indian population, and many other classes are dependent on them and on the soil in varying degree.

Landholdings and Land Tenure

Such a social condition is accompanied by a minute division of the cultivated land into tiny, piecemeal holdings. The reasons are not far to seek. The laws of inheritance in India, both Mussulman and Hindu, provide for an equal division of a father's land among his sons after his death. The ceaseless repetition of this practice in an increasing population has brought about a minute division of fields and properties, so that the landholdings of a cultivator almost always consist of a number of tiny parcels, irregularly distributed, and often widely separated, among the village fields. The family in India, which comprises many degrees of relationship, is a strong and definite economic unit, and landholdings often seem to lie in the hands of families rather than of individuals. Probably for these reasons, no comprehensive tabulations appear to have been made to show the frequency distribution of landholdings of various sizes, or even a modal or median size.

Some indication of the size of holdings can be obtained indirectly from statistics of the net cultivated area (including current fallows) and the latest census enumerations of plows and bullocks, on the assumption that the number of separate holdings is roughly the same as the number of plows or pairs of bullocks employed in their cultivation. For the principal wheat-growing provinces the results, as of 1919–20, are as follows:

Province	Thousand acres cultivated	Thousand plows	Thousand pairs of bullocks	Acres per plow	Acres per pair of bullocks
Punjab	29,561	2,244	1,974	13	15
United Provinces..	38,781	4,872	4,937	8	8
Bihar and Orissa	30,808	3,054	3,128	10	10
Central Provinces and Berar	28,414	1,431	1,832	20	16
Central Indian States	5,788	331	424	17	14
Bombay	42,682	1,358	1,554	31	27

The computed figures strongly suggest an extremely small average landholding in the provinces of the Ganges Valley, where an abundant and well-assured rainfall gives ample opportunities for the congestion of population and agriculture. In the Punjab, where the rainfall is smaller and less certain, the holdings are apparently larger. The figures for Bombay appear anomalous, but no explanation is apparent.

For the Punjab and Bombay, however, better figures of recent date are now available. The data from the Punjab were obtained in the course of an economic survey which covered 2,397 villages and some 2 million acres of cultivated land.[1] Of the total number of landowners in these villages, 58 per cent were small owners with less than 5 acres apiece. About 26 per cent of the holdings were between 5 and 15 acres. Only 15 per cent of the whole number of owners held properties of 15 acres or more, but the total extent of their holdings was about 60 per cent of the surveyed area. Less than 4 per cent of these owners had holdings of 50 acres or more. The smallest holdings were principally found in the districts where the rainfall is comparatively heavy and fairly sure.

The existence of numerous tenancies causes many complications, which are ignored in the simple figures given above. Half the land in the Punjab was found to be cultivated by rent-paying tenants, and most of these tenants were themselves the owners of small holdings of less than 8 acres. The larger the proportion of land in the possession of small owners, the smaller the proportion of rented land; in congested districts this latter proportion fell as low as 35 per cent.

The data for the Bombay Presidency, which are a compilation of land-revenue records for 1921–22,[2] tell a similar story. They possess the advantage of covering the whole area of a province, but they lack the

[1] H. Calvert, "The Size and Distribution of Agricultural Holdings in the Punjab," *Agricultural Journal of India*, 1925, XX, 495. (A review of the Board of Economic Inquiry, Punjab, *Rural Section Publication No. 4.*)

[2] *Report of Land Revenues Administration, Bombay Presidency, 1921–22* (as quoted in U.S. Department of Commerce, *Trade Information Bulletin 397*, April 1926).

economic detail of the Punjab survey. The figures are shown below:

Size in acres	Thousand owners	Thousand acres	Percentage of total	
			Owners	Land owned
0–5	872	2,029	47.2	8.6
5–15	530	4,932	28.7	21.0
15–25	221	4,337	12.0	18.5
25–100	206	8,854	11.1	37.7
100–500	18	2,777	1.0	11.8
500 and over	0.5	557	.0	2.4
Total	1,848	23,487	100.0	100.0

Here the average size of holding was 12.7 acres, somewhat larger than in the Punjab. The proportion of owners of less than 5 acres is here only 47 per cent, the proportion of owners of more than 15 acres is 24 per cent, and the extent of their holdings no less than 70 per cent of the whole.

In legal theory all land in India is owned by the sovereign power, so that all possession of land has the form of a tenancy and involves the payment of revenue to the state. Tenure of lands is usually one of two main kinds—*ryotwari* or *zamindari*. In the former, the cultivator (*ryot*) holds his land directly from the government, and makes direct payment of revenue. In the latter, he holds from some overlord (*zamindar*), to whom his payment of revenue is made and by whom it is transmitted to the government. The *zamindar* may be an individual, usually of a superior social class, with hereditary standing, or the village or tribal community itself, but the legal character of the tenure is the same. Except in Bengal, where it was fixed once and for all, the revenue to be paid yearly on each piece of land is assessed at regular intervals of thirty years by a "settlement," which surveys the land to estimate its economic rent and imposes a revenue-charge of about one-half the estimated rent.

Private tenancies are a common form of landholding; their existence is in no way restricted by the formality of tenure from the sovereign power. An individual *zamindar* will receive private rents from a number of tenants in a village or group of villages. Elsewhere, the members of one caste, the descendants of former invading conquerors, will be the landlords, and members of other castes their tenants and the actual cultivators of the soil. Furthermore, even the smallest fields are let by the cultivators to one another. Private rents and land values have come into existence in India for the most part during the last century, through the establishment of orderly government and the disappearance of arbitrary exactions.[1] Their appearance has attracted the money-lender, who has taken advantage of the peasants' improvidence and misfortune to gain control of much land, first as a mortgagee and then, by a simple step, as the landlord. Consequent abuses of landlordism have impelled remedial legislation in most of the provinces, to protect the cultivators from the loss of hereditary holdings by foreclosure and to prevent the exaction of exorbitant rents.

The Canal Colonies of the Punjab

The extension of irrigation during the last forty years or so to the arid uncultivated wastes of the lower Punjab has given the opportunity to establish there a new and prosperous peasantry, in communities founded on novel but well-planned lines. The fruits of this colonizing enterprise have been not only a social experiment of great benefit to the people of the Punjab, but also the creation of a new expanse of agricultural land, whose *rabi* acreage is largely devoted to wheat growing. In these canal districts the landholdings are large and the population is, as yet, comparatively sparse. Production of wheat greatly exceeds local demands, and the large surplus consequently places these districts among the principal wheat-exporting regions of India.

The first schemes of colonization, on a small scale, were undertaken between 1886 and 1889, for the development of two minor systems of inundation canals. While they were still in course of completion a more ambitious project was elaborated for the settlement of the much larger areas to be commanded by the Lower Chenab Canal. Colonization of this district was begun in

[1] It is possible that the land-revenue system of India under British rule may still give opportunities for excess, both in assessing the revenue and enforcing its payment.

1892. For the first two or three years the pioneer settlers experienced serious adversities, but by 1895 the tide had turned and thenceforth the district enjoyed a rapid advance of prosperity. Organized settlement of this kind has since been undertaken with equal success on the more recent Lower Jhelum and Lower Bari Doab systems, where other large tracts of waste land were rendered cultivable for the first time, and also on several similar areas of smaller size available upon other systems.

The first step to colonization has always been a careful survey, which marked off the land into squares of 25 acres or so, to constitute the units of landholding. The distributaries for irrigation water and the drainage channels were then laid out and constructed. At the same time, the village areas were marked out, usually of about 50 squares in size; to save construction of bridges, their boundaries were drawn to follow water-courses as closely as possible. Similar intensive planning was carried out within each village area, and for the larger needs of the district as a whole. Upon all the later schemes, all the works thus planned have been executed, even down to the construction of field water-courses, before the arrival of the settlers, so that they have been left only the pioneer tasks of breaking the soil and building houses.

In general the colonists have been sought in districts where the standards of agriculture were good but the inhabitants were suffering from congestion of population. Rough-and-ready methods of selection were employed to pick promising men, and a group of selected men from each village was sent off to make its home in one of the new village areas, accompanied as a rule by a group of servants from the parent village. Such close acquaintance already in existence made strongly for mutual support in the earlier and more difficult days of the venture.

The allotments of land have varied from a half-square to three squares, with one square (25 acres) as the usual size. Additional grants were made to village headmen and larger grants for other purposes. The terms of grant are extremely varied and complex, but their general tendency has been to give the settler full title to his land, after a period of occupying cultivation, on terms below the current market rate.

Economic Influences of Religion

There is probably no country in the world in which religious considerations control the economic life of the masses as strongly as in India. The all-embracing and multifarious Hindu faith can scarcely be described, indeed, as other than the way of life of the great majority of the Indian people, and their way of life as the Hindu faith. It imposes much of men's social standing upon them according to the fortune of their birth, it dictates to them many of the most important values of their lives, and it enforces its authority upon them through a pervading social compulsion. Such is the silent power of Hinduism that its great rival faith, Mohammedanism, which is elsewhere so masterful and uncompromising, has in India assimilated in varying degree some of the most characteristic practices of the Hindu way of life.

The two phases of Hinduism which most strongly dominate economic life, and agricultural life in particular, are the institution of caste and the cult of the cow. With no intention of passing judgment on religious beliefs, one must give closer consideration to the immense economic consequences of these two canons of the faith.

The institution of caste divides the people of India into an immense number of isolated hereditary classes, whose social standings are determined by a complex scale of religious valuations. As a ceremonial institution, caste imposes countless obligations and aversions in matters of marriage, eating and drinking, and the like. As an occupational institution, it binds men to follow the hereditary occupations of their fathers and ancestors. For many individuals and groups, however, the traditional calling decreed by caste has been abandoned for some other, higher or lower, as opportunity or necessity has dictated, and only the ceremonial obligations of caste have still been preserved in respect.

The caste system exerts a very powerful influence upon the division of labor within the Indian village. In such a village some landlord or landholding group will hold a

position of ascendancy and beneath there will lie tenant-cultivators of various degrees,[1] and the tradesmen, artisans, and menials of the village. The occupations pursued within a village are numerous and run upward from sweeper, leather-worker, watchman, potter, washerman, barber, carpenter, blacksmith, goldsmith, to storekeeper, money-lender, astrologer, priest, in roughly ascending order of standing. Every one of these occupations, except for the lowest tasks performed by outcastes, is associated with its appropriate caste by ritual protections, which effectively deter the members of other castes from venturing to perform such work themselves. The cultivators, for example, will not defile themselves by doing such low-caste work as the handling of leather or hides; neither will they make or mend their simple agricultural implements, but leave such tasks to the blacksmith and carpenter castes. Further, many landowners of the higher and sacerdotal castes will not demean themselves by menial work in agriculture, and must hire laborers to till their land.

The cult of the cow makes the slaughter of cattle a sacrilege and the eating of beef a sin. (Indeed the majority of Hindus refrain, for reasons of religion and poverty, from the eating of meat of any kind.) Since there is no reduction by slaughter, the numbers of cattle in India stand far beyond the desirable economic limit, and further increase is prevented only by the severity of pressure upon the available food supply. The male cattle alone are of use, as a rule, to the cultivator, and then only as work animals. The flesh of cattle is worthless in India (except among the Mohammedan population), and the hides fall as a perquisite to the low-caste leather-worker of the village. Many cows yield not more than enough milk to nourish their own calves and are economically valuable only for the breeding of the male work stock; large numbers of the female stock are wasteful encumbrances to their owners and their villages and are preserved solely for their value as objects of devotion.[2] But certain breeds are good milkers, and at least in the Punjab a good deal of milk is consumed. For milk for his own use, the cultivator relies in part on the buffalo-cow, which gives adequate supplies, rich in butterfat and well suited to the making of *ghi* (clarified butter). The male buffalo is an inefficient work animal and is used only by the poorer cultivators or in regions of rice cultivation. The buffalo is not protected by sanctity, so that always there is some rejection of useless males by slaughter and starvation.

Hinduism encourages an overbreeding both of men and animals and so compels a conflict for the use of land and supply of food. Piety and necessity alike restrict the Indian population to a predominantly vegetable diet; and crops for human needs are so much in demand that forage crops have had little part in the traditional systems of Indian agriculture and are grown only to a limited extent, though in the Punjab they have a regular place in crop rotations. To some extent fodder-millet is grown, but in many regions cultivated lands are too precious to be given up to crops that will feed animals only. Working animals receive better care than others; they are fed on residues of the crops raised for human consumption, among the commonest of such residues being straw and *bhusa* (the mixture of chaff and broken straw and grain from threshing floors). For the rest, the cattle are turned loose to range for themselves on the village grazing grounds, the fallow fields of the village, by roadsides, and elsewhere.

With the growth of human population and the expansion of cultivation, the extent of village common grazings has been greatly reduced and the pressure of the livestock upon their food supplies has become increasingly severe. Their privation is at its worst in the hot-weather season before the rains, when all the grass has dried and bleached in the sun, and all fresh growth has ceased. As the grazings are eaten down, the cattle weaken and starve in their search for food, and if the rains

[1] But the tenants may be of higher caste than the landowners.

[2] The Hindu religion encourages the maintenance of homes for aged cows. Exporters of Indian grain pay small customary dues on their shipments for the upkeep of such homes. S. K. Thorpe, *Grain Trade Documents* (London, 1924).

come late or fail, they die of starvation by thousands. At this time of the year, the working cattle may be left to suffer with the rest, so that they are sometimes in terribly poor condition when they are set to work again at the beginning of the rains. Indeed at all times of the year, their efficiency is reduced for want of proper nourishment in adequate amount.

Possessions and Implements

Peasant possessions are few and simple. The houses are built of mud and consist merely of a few rooms and a courtyard for cattle. Of furniture there is little beyond a few beds and rugs. Cooking utensils and other simple domestic appliances make up the household property.

The cultivators' implements are also few and of primitive form. The plow is the principal and often the only implement used for preparatory tillage. It consists of a stake shod with a wedge-shaped block of hard wood that is tipped, as a rule, with iron; attached to a draught-pole, a yoke of bullocks draws this rudimentary plowshare, the cultivator holding it down and guiding it through the soil by means of the stake. The plows are generally small, but vary greatly in size and weight. The smallest weighs only a few pounds, and can easily be carried to the field on the cultivator's shoulders. The heaviest, employed principally in the black-earth regions of the peninsula, may require from four to six pairs of bullocks. Another implement in general use is the plank-drag, which is used after the plow to break up the clods and level the soil. It consists of a squared log, drawn by bullocks; their driver, standing on the log, adds much to the weight and efficiency of the drag. The common crops may be sown broadcast and then plowed into the soil, or may be drilled in, either by a simple type of seed drill or by an ordinary plow with an attachment. During the earlier period of their growth, the ground may be kept clean by a hand-weeding implement. In peninsular India, where a troublesome deep-rooted weed, *kans* grass, greatly interferes with cultivation, a scarifier (*bakhari*) may be used in place of the plow and drag. This is a short beam to which a horizontal blade is attached by a couple of brackets; the blade runs through the soil, eradicating the weeds, and the beam breaks up clods on the surface.

Many attempts have been made to devise more effective implements and encourage their use, and even to secure some employment of agricultural machinery. The problem of constructing plows for native use which shall be built of stronger materials and do better work in the soil, at the same time suiting the cultivators' purse and other requirements, has been the subject of constant study at several government experimental farms.[1] A sufficient degree of technical success appears to have been achieved, but the yearly recorded sales of improved plows still remain a painfully small fraction of the total number of plows in use in India. The hindrances to a more rapid adoption appear to be economic rather than technical. On the one hand there stands the problem of manufacturing in a country of low industrial development, and on the other hand the immense problem of publicity and sales. Merely to attract the attention of millions of illiterate cultivators in countless villages to the existence of improved designs of plows would be a business of no mean size. The actual sale of plows, in the face of native poverty and conservatism, is evidently a matter of much greater difficulty still. The demand for better plows is apparently being left to grow largely of itself, with but little encouragement from the manufacturers. Though it has so far been small, there are signs of a larger and more rapid growth in the future, with a gradual spread of confidence in the merits of the new plows. The plow is so much the most important implement of native cultivation that by far the greatest benefits are likely to be gained from its improvement. For this reason, little attention appears to have been paid to the improvement of other types of native implements, or to the invention and introduction of new kinds suited to native use.

The introduction of agricultural machinery has also met with very limited success. Tractors have been found to give

[1] See also below, p. 343.

good service in plowing hard ground and the lands infected by *kans* grass in the peninsula, but they can be profitably used only on large fields and are obviously quite impossible on the tiny plots of land of peasant cultivators. A similar difficulty applies to the use of reapers, which are scarcely practicable outside the larger landholdings of the canal colonies of the Punjab. For a variety of reasons, threshing-machines have proved impracticable under Indian conditions. The difficulties that attend the use of agricultural machinery in India lie not only in matters of design but also in the problems of securing skilled men to handle them and of procuring spare parts for repairs. Yet in spite of these handicaps the internal combustion oil engine is entering into fairly common use in India for such semi-rural employments as the pumping of well water and the grinding of grain in local mills.

The conditions mentioned above explain why Indian agriculture has been largely unable to profit by the notable developments in the manufacture of agricultural implements and machinery in the United States and certain European countries. All told, India's imports of these products have recently averaged less than a million dollars a year.[1]

The Advancement of Agriculture

The productivity of agricultural land and labor in India is most undesirably low. The principal causes have already been made clear. In part they are fundamental and ineradicable, resting upon the pressure of population and the low margin to which cultivation must be carried. In part they rest upon deep-seated influences of religion, custom, illiteracy, and poverty. Nevertheless, many causes of inefficiency or ineffectiveness are susceptible of removal or modification. To this end the government of India and the provincial governments have undertaken on a considerable scale the tasks of agricultural research and education.

[1] Charles D. Martin, "Modern Farm Equipment in India," U.S. Department of Commerce, *Trade Information Bulletin No. 397*, April 1926.

[2] The motto of the Royal Agricultural Society of England.

The possibilities of the work are very great, but the field of operations is immense, the forces of the departments are scanty and limited, and there is little collaboration by private enterprise. For a long time it appeared that all the efforts and expenditure might prove unavailing to overcome the traditional customs and apathy of the native cultivators, but the achievements of the last few years can now be held to justify a much more hopeful outlook. Certain crops and districts have already received benefits which are clearly recognized by the cultivators, and the advice and assistance of government agencies now receive a much more favorable reception than ever before. The activities of the governmental services are still restricted, but with the prospects of success there is likely to be a considerable expansion. The result to be attained is a great advance in the productivity and prosperity of the Indian agricultural population.

There is no need to dwell upon the early record of official attempts at the improvement of agriculture. They achieved certain successes in their time, but perhaps the greater service which they rendered was to supply the background of experience for subsequent endeavors. The true beginnings of "science with practice"[2] in Indian agriculture are to be found in the appointment of an Inspector-General of Agriculture in 1901, the foundation of the Agricultural Research Institute at Pusa in 1904, and the creation during the next two or three years of small staffs of agricultural scientists for the Imperial Department of India and the provincial departments. In this new organization there emerged, perhaps for the first time, a point of view which regarded as a whole the elaborate interplay of scientific and economic forces that determines the complex processes of Indian agriculture.

It was recognized in the beginning that one of the chief causes of loss to the cultivators lay in the poor quality of their seed, which too often contained a hopeless mixture of varieties—good, bad, and indifferent. Hence one of the first endeavors of the new departments became the discovery of new and improved crops and varieties, suitable for the cultivators' use. Work of

this kind had already been attempted in a more or less haphazard manner; it was now undertaken with a scientific knowledge of plant selection and plant breeding, and with due regard for the economic interests of the peasants who would grow the crops. This work has already enjoyed considerable success, and is still vigorously proceeding. The results in the case of wheat, and the objectives still to be obtained, are described in a subsequent section (pp. 376–78). Other important crops stand in much the same case as wheat.

In the ordinary course of events, new crops and varieties undergo prolonged tests on experimental farms to determine their cultural possibilities. If found suitable, they are passed on to provincial seed farms for multiplication and are then sold by government seed depots to the cultivators. These depots also handle as seed the crops of cultivators who have raised the new varieties. The quantity of seed annually sold by these depots is still small in comparison with the total quantity of seed employed throughout India, but the effect of such distribution is already clearly discernible in the improvement of crops in the vicinity of the depots. In the case of the improved varieties of wheat, Pusa 12 and Pusa 4, cultivation has already expanded so far that their seed is now largely handled through the ordinary channels of trade. A similar result has also been, or soon will be, attained with other crops.

In the improvement of agricultural implements, not nearly so much work has been done, partly because good work had already been done before 1900, and also because the supply of better equipment depended largely upon the development of machinery manufacture in India, and upon improvements in the efficiency of the working cattle. The principal endeavors of the new agricultural organization have been to extend the use of improved implements and to demonstrate their advantages. With an iron mould-board (inverting) plow, it is possible to break up the stubble before the beginning of the rains and thus to insure good absorption of the first rain that falls; with harrows, it is also possible to work the ground during the rains, when it may be either too hard or too soft for the native plow, and thus to check evaporation or run-off from the surface crust which so easily forms. Teams of trained men travel in the provinces to demonstrate upon the cultivators' own fields the benefits which these implements confer, and also the advantages to be derived from better cultural practices, such as sowing crops in rows instead of broadcasting. Their efforts are being rewarded by a demand for the new implements, which, though extremely small, is nevertheless increasing. In the absence of ordinary trade services, the agricultural departments are about the only source of supply for implements and spare parts, and they are using their seed depots as channels of distribution.

The use of improved implements depends largely on the possession of strong draft bullocks. Great efforts are therefore being made to improve the quality of Indian cattle, with regard both to breed and to vigor. The working power of Indian cattle varies greatly from one time of the year to another, in accordance with their food supply. It is hoped to discover crops and methods of cultivation which will yield a generous supply of feed for the cattle throughout the year without reducing the production of foodstuffs for human consumption. This is a matter in which a considerable degree of success may perhaps be quickly attained. The further task of improving the breeds of Indian cattle with the definite purpose of combining good working and milking qualities in the same stock is of course a much more lengthy business and must proceed over a long period before any important results are achieved.

Another activity of some importance is the construction of wells. This work appears to be undertaken in places either where native methods of well-sinking would be ineffective or where they would not produce a sufficiently large yield. It is done on a small scale, only a few hundred wells being sunk in any one year, but it is work with cumulative results.

Agricultural researches of other kinds, with distinctly practical purposes, are also in progress, but of these, and of good results already produced, it is needless to speak here. Only brief mention can also be made

of the co-operative movement, which is at the present time largely an organization for co-operative credit. In the prospects which it offers of reducing the peasants' load of debt it is likely to exert most powerful influences upon the prosperity of the country. The principle of co-operation is applicable, not only to credit, but also to many other purposes, such as the purchase of seed, the joint use of implements, and the redistribution of land, in order to eliminate the evil of fragmentation which at present retards so many improvements and reforms.

IV. WHEAT GROWING

Having considered the human and physical conditions affecting Indian agriculture, we may now turn more directly to the main subject of the study. First we must deal with the place of wheat growing in Indian agriculture and the characteristics of the principal wheat regions. Then we shall be prepared to discuss the cultivation and harvesting of wheat.

The Position of Wheat Growing

Tropical exposure makes India a land of many crops, over the whole country and in single areas. Wheat is but one of these crops, and nowhere in India does it attain the predominance that it holds in the great wheat-growing regions of temperate lands. Even in the Punjab, where it is the major crop, it is not produced by large-scale methods, except on a small number of large estates. Perhaps for these reasons, the economic aspects of wheat production in their relation to Indian agriculture as a whole have not received serious attention, and the statistical data are not sufficient to furnish a reliable basis for many clearly warranted conclusions.

Wheat is one of the great cash crops of India; probably for this reason, it is usually grown on the better soils and the manured soils near the village sites. Yet as a cash crop it is one among others, and the cultivator has some opportunity to choose among wheat, cotton, flax, rice, sugar-cane, and other staples; the producing areas of these crops overlap to a surprising degree.[1]

The principal available measure of the importance of wheat in Indian agriculture is afforded by statistics of land disposition, with special reference to the land in crops. These statistics are not sufficiently complete to enable one to make positive statements regarding the use of the total area, or to trace the acreage of various crops over a period of years. Data are available only for the area covered by professional survey, which is constantly being extended both in British India and in the Native States. The net area thus surveyed has increased in British India from 528 million acres in 1891–92 to 668 million in 1923–24, and in the Native States from 28 million acres in 1896–97 to 135 million in 1923–24. As this is increased the areas under different crops show increases which represent in part increasing comprehensiveness of the data rather than actual expansion of cultivation. For this reason one cannot safely employ statistics of either area or production as if they were to be taken at their face value. It may be, however, that most of the cultivated area is now covered, and that further extensions of the surveys will add mainly to the uncultivated area.

Table 3 summarizes the disposition of the surveyed area as shown by the official statistics for the years 1921–22 to 1923–24, using an average of these three years. The area covered by professional survey amounted to some 802 million acres, or about 70 per cent of the total area of India; the unsurveyed area lies almost entirely in the Native States. Of this surveyed area 103 million acres is forest, 176 million more is not available for cultivation, and 169 is cultivable waste. Thus only about 350 million acres is devoted to crops, of which usually over 60 million and sometimes considerably more is in fallow. The degree to which two crops are sown on the same land in a single year is suggested by the difference between the gross and net area sown. The total crop area, the area devoted to particular crops, and the proportion in each, all vary from year to year. The years covered by Table 3

[1] Compare the various maps mentioned below, p. 345, footnote.

included one year of drought and less than the usual area in wheat.

TABLE 3.—LAND DISPOSITION IN INDIA, 1921–22 TO 1923–24 AVERAGE*

(Million acres)

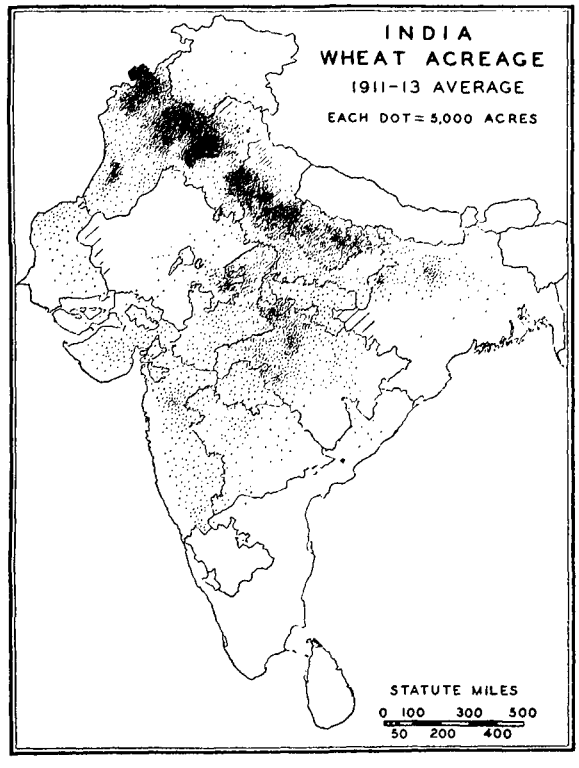
	British India	Native States	Total
Net area by professional survey	667.2	134.4	801.6
Uncultivated land: total	440.5	70.1	510.6
Forest	85.7	17.4	103.1
Not available for cultivation	152.3	23.5	175.8
Cultivable waste	153.4	15.9	169.3
Fallow land	49.1	13.3	62.4
Net area sown to crops	223.5	63.6	287.1
Gross area sown to crops	256.0	66.5	322.5
Sown to:			
Rice	79.2	3.6	82.8
Millets	41.5	24.7	66.2
Wheat	23.7	5.5	29.2
Gram	15.4	4.6	20.0
Barley	7.3	1.1	8.4
Maize	6.0	2.2	8.2
Other food grains	29.2	5.8	35.0
Cotton	13.5	6.0	19.5
Jute	1.8	....	1.8
Other crops	38.4	13.0	51.4

* Official data from *Agricultural Statistics of India, 1923–24*, I and II. Practically the whole of British India is covered, but less than 30 per cent of the area (460 million acres) of the Native States.

The great bulk of the acreage in crops is sown to cereals, and all of these, including what are feed grains in less congested countries, are raised for human food. Rice is by all odds the principal crop, with some 83 million acres. Millets rank second in importance, the three principal types (*jowar* or sorghum, *bajra* or bulrush millet, and *ragi*) covering some 66 million acres. Wheat ranks third, with over 29 million acres, and gram (or chick-pea, a legume) fourth, with about 20. Barley, maize, and other food grains cover over 50 million acres. Wheat ordinarily employs 9 to 10 per cent of the gross area sown to crops, whereas rice covers nearly 26 per cent, and the millets over 20.[1]

THE WHEAT REGIONS

The distribution of wheat acreage in India is best shown by the accompanying dot map, showing the position shortly before the war. The main change since then is an increase in the Punjab. Table 4 (p. 346) supplements this map by showing the acreage, production, and yield per acre by provinces, using the average of the four crops of



Reproduced, with the eastern portion deleted, from V. C. Finch and O. E. Baker, *Geography of the World's Agriculture* (Washington, 1917), p. 25.

1923–26. More detailed statistics by years are given in Appendix Tables. Table VI in the Appendix, showing the average rainfall by calendar years from 1907 to 1923 for the more important wheat-growing areas, indi-

[1] The geographical distribution of many of the most important crops is admirably shown by a series of dot maps in the atlas that accompanies Dr. Th. H. Engelbrecht's discussion of the influences of climate on the distribution of crops in India, in *Die Feldfrüchte Indiens in ihrer geographischen Verbreitung* (Abhandlungen des Hamburgischen Kolonialinstituts, Band XIX, Hamburg, 1914). Similar maps for a smaller number of crops and without the relevant climatic data are presented in V. C. Finch and O. E. Baker, *Geography of the World's Agriculture* (United States Department of Agriculture, Washington, D.C., 1917). Both these atlases show the distribution of crops before the war. The post-war distribution is less satisfactorily shown by a series of colored maps in the *Crop Atlas of India* (Commercial Intelligence Department, Calcutta, 1925), and by world dot maps in *Putnam's Economic Atlas* (London and New York, 1925).

cates the tendency for rainfall to be light in the northwest and to be increasingly heavy as one proceeds from west to east. The principal wheat belt, some 200 to 300 miles wide, extends from the North-West Frontier Province southeastward into Bengal at the eastern angle of the triangle of India; and another belt extends southwestward from the United Provinces into Bombay on the west coast of the peninsula. Wheat is grown in other parts of India and under other conditions, but the production is negligible in comparison to the production of these two great zones.

tance as wheat producers in the 20 years before the war, but probably much of this increase represents merely increasing comprehensiveness of the statistics; in recent years their wheat area has about equaled that of the Central Provinces and Berar. Bombay, with Baroda and Sind, on the western coast, ranks fifth with a wheat area usually exceeding 2 million acres. Bihar and Orissa, to the east of the United and Central Provinces, rank sixth in area, with usually 1.2 to 1.3 million acres, or with Bengal, farther east, a little more; because of high yields, however, this area usually out-

TABLE 4.—INDIAN WHEAT ACREAGE, PRODUCTION, AND YIELD, BY PRINCIPAL REGIONS, 4-YEAR AVERAGE, 1923–26*

Region	Acreage		Production		Average yield per acre	
	Thousand acres	Per cent of total	Thousand bushels	Per cent of total	Bushels	Per cent of average
North-West Frontier Province	1,076	3.5	8,838	2.5	8.2	73.2
Punjab (including Delhi)	10,930	35.2	133,261	38.3	12.2	108.9
United Provinces	7,208	23.2	93,370	26.9	13.0	116.1
Bihar and Orissa	1,208	3.9	17,584	5.1	14.6	130.4
Bengal	125	.4	980	.3	7.8	69.6
Central Provinces and Berar	3,381	10.9	36,353	10.5	10.8	96.4
Central Indian States	3,250	10.5	28,747	8.3	8.8	78.6
Rajputana States	974	3.1	8,886	2.6	9.1	81.2
Bombay, Baroda, Sind	2,138	6.9	16,678	4.8	7.8	69.6
Hyderabad	760	2.4	2,474	.7	3.2	28.6
Total India	31,087	100.0	347,237	100.0	11.2	100.0

* Official data from the *Indian Trade Journal*. See Appendix Tables I–III for footnotes bearing on the reliability of these data. For the location of these regions, see map on p. 322.

The chief wheat-producing area lies in the northwest, in the Punjab. Here the wheat area is usually between 10 and 12 million acres, and constitutes about 35 per cent of the total. The area extends into the North-West Frontier Province, formerly part of the Punjab. Second in importance are the United Provinces of Agra and Oudh, which lie southeast of the Punjab. Here the wheat acreage is usually around 7 million acres, 20 to 25 per cent of the total. Third in importance are the Central Provinces and Berar, to the south of the United Provinces, with an area around 3½ million acres, sometimes reaching 4 million and in bad years falling below 3 million. The Central Indian States, lying north and west of the Central Provinces, appear to have increased greatly in relative importance as wheat producers in the 20 years before the war, but probably much of this increase represents merely increasing comprehensiveness of the statistics; in recent years their wheat area has about equaled that of the Central Provinces and Berar. Bombay, with Baroda and Sind, on the western coast, ranks fifth with a wheat area usually exceeding 2 million acres. Bihar and Orissa, to the east of the United and Central Provinces, rank sixth in area, with usually 1.2 to 1.3 million acres, or with Bengal, farther east, a little more; because of high yields, however, this area usually out-ranks the Bombay-Sind area in wheat production. The Rajputana States, south of the Punjab, and Hyderabad, south of the Central Provinces and Berar, contain the other principal wheat areas.

The average yield per acre is quite different in the different wheat regions. This is evident from Table 4, but is shown more clearly by annual data over a period of years given in Appendix Table III. In the United Provinces, and in Bihar and Orissa, it is much above the average for all of India, usually from 14 to 17 bushels to the acre. These are regions of substantial rainfall. In the Punjab the average yield, though somewhat lower, is usually a bushel or two per acre above the average for the whole country. Here the rainfall is considerably smaller, but irrigation is most ex-

tensively practiced. In the North-West Frontier Province and the Central Provinces and Berar, the yield is usually 1 to 3 bushels below the general average, and in the Central Indian and Rajputana States and Bombay it is lower still; while in Hyderabad extremely low yields, rarely approaching 4 bushels to the acre, are reported. In general, yields are appreciably higher on irrigated lands. In consequence of the large acreage and high yields in the Punjab and the United Provinces, about two-thirds of the total crop is raised in these two regions.

In the Punjab the rainfall is low—a disadvantage that weighs less with wheat than with other crops—and irrigation has been more widely applied and is more consistently practiced than in any other part of India. Something like half of the cultivated area is irrigated. Large perennial canal-systems under government ownership and control are the principal means of irrigation, and constitute a most important influence in the growing of wheat. In comparatively recent years, the expansion of these canal-systems has brought hundreds of thousands of acres of waste land into cultivation for the first time, and has been largely responsible for the contemporaneous advance of wheat growing. In much of the Punjab over 40 per cent of the net area cropped is in wheat, and in some districts over 50 per cent.

The wheat-growing region of the United Provinces, lying in the Ganges basin, is practically continuous with that of the Punjab, in the Indus basin, though wheat cultivation is less dense upon the broad low watershed between these two river basins. In many respects the conditions of wheat production are much the same on either side of this intermediate zone. The United Provinces, however, possess a better rainfall than the Punjab, and the cultivator has a wider choice of crops. Hence wheat cultivation is less dense: over most of the area 20 to 40 per cent of the net crop acreage is in wheat; a larger proportion holds only in a small area in the northwest, and in the southern portions the proportion is smaller. These provinces have been more closely settled for a much longer period, so that a span of twenty years reveals no great changes in agriculture. Irrigation by native methods has been long and widely practiced in the United Provinces, and has been followed during the last century by the introduction of irrigation from government perennial canals. Since the normal rainfall is sufficient for agriculture, irrigation of either kind has been largely applied to lands already under cultivation, in order to confer the benefits of higher yields, more profitable crops, and assurance against failures and famine.

The greater part of the wheat production of the United Provinces is to be found in the drier northern and western districts, to the north and west of the city of Cawnpore. To the east and southeast wheat cultivation continues down the Ganges Valley, through Bihar and Orissa, and even a little into Bengal, but the density of its cultivation steadily decreases all the way. A line drawn north and south, slightly east of Cawnpore, denotes where wheat gives place to rice as the predominant crop.

To the south of the Jumna, the alluvial plain gradually gives way to the northernmost hills and highlands of the peninsular plateau. Here the density of wheat cultivation declines, and wheat tends to be replaced by barley or is grown in mixture with the chick-pea. This transition zone, for such it is, separates the wheat-growing districts of the United Provinces from the next wheat region.

The third great region of wheat production in India lies in the black soils of the upper Narbada Valley. The river itself marks the political boundary between the Central Provinces to the south and the Native States of Central India to the north. The agricultural statistics of these Native States are not of many years' continuance, and appear to be not wholly reliable, at least for the earlier years. Furthermore, the two political divisions extend far beyond the limits of the Narbada, and comprise large areas whose thinly distributed cultivation of wheat makes a considerable addition to the total production of the Narbada Valley region. For these reasons, broad statistical comparisons, either with past times or with other places, do not lend themselves to any very definite interpretation. The heavier rainfall of this region does

not tell against wheat growing as it does in the lower Ganges Valley, because the black earth becomes too wet and heavy during the summer rains to be worked and sown to rice or other *kharif* crops. Outside of the black-earth districts, the laterite soils are too poor to be profitably cropped with wheat. Little or no wheat is grown under irrigation; on the laterite soils irrigation would be difficult, and on the black soils the moisture-retaining qualities render it unnecessary. The famines and low prices of the 'nineties seriously disorganized the agriculture of the peninsular region, which had previously been a larger producer and exporter of wheat than it is at the present time. In the course of the recovery, wheat was largely displaced by cotton in the southwest of the Central Provinces, and in the Narbada Valley itself it has yielded some of its ground to other crops.

Some of the principal climatic influences determining the limits of wheat cultivation in India have been most lucidly demonstrated by a German geographer, Dr. Th. H. Engelbrecht.[1] In his opinion, the most notable boundary of wheat growing is the October isotherm of 26° C. (78°8 F.), which circles round the Thar or Indian Desert, and follows the southeastern margin of wheat cultivation of the Punjab, the southwestern margin of the United Provinces, and the northwestern, southwestern, and southeastern margins in the Central Indian region. Only where the average temperature falls below this point is wheat widely cultivated. For the rest, where this influence of temperature does not offer an adequate explanation, various phases of the rainfall can be shown to determine the cultivation of wheat. Thus, the comparatively small cultivation between the United Provinces and the peninsular regions can be attributed, in the first place, to a rather lower rainfall in the winter season, and also, in some degree, to a lower monsoon rainfall in September. Another diminution of the winter rainfall to the eastward largely determines the southeastern boundary of the predominance of wheat in the United Provinces and the northeastern boundary for the peninsular region. The gradual diminution of wheat cultivation as one proceeds down the Ganges Valley finds its explanation in other climatic influences. An earlier rise of temperature after the new year in the lower Ganges Valley means a shorter growing season for wheat; the risk of rust attack, a consequence of climatic mischances, increases to the southeast; last and perhaps the most important of all, the heavier monsoon rainfalls of the lower Ganges Valley give advantages to the cultivation of rice, a *kharif* crop which holds the land until the time for sowing wheat has passed.

[1] *Op. cit.*

[2] See above, pp. 323–28, 334.

Preparation of the Soil for Wheat

We have already discussed the climatic conditions which influence agricultural practices, the general character of methods of cultivation, and the mode of applying irrigation water.[2] Here a few words may be added, with special reference to wheat growing.

During the hot season before the coming of the rains, the ground is in stubble from a preceding *kharif* or *rabi* harvest, and lies open to grazing by the village cattle. In the Punjab, the soil is cultivated in the hot, dry summer months. Elsewhere, although a first plowing may be given before or shortly after the first rains, pressure of other work at this season usually postpones preparation of the wheat land until the later rains of August and September, and it is continued, between rains, for several weeks. The native plow, having no inverting share, merely cuts a narrow, shallow groove and breaks up a little earth. Because the furrows are so narrow and the bullocks move so slowly, a plow of this kind can usually cover only about an acre a day. After the first plowing, another, at right angles and slightly deeper, must follow, and so on repeatedly, until a fine tilth has been obtained to a depth of several inches. The number of plowings depends on the weather, the condition of the soil, the condition of the bullocks, and the time of the cultivator. The plank-drag, or occasionally a heavy wooden roller, may be used to perfect the seed-bed before sowing.

Other methods of preparing the soil are followed in some places. Over the greater

part of the peninsular region of wheat growing, the black earth is too heavy for plowing during the rainy season, and sufficiently absorbent to make plowing unnecessary. Here, then, the scarifier is normally used in place of the plow for the prime purpose of preparing a soft seed-bed in the soil before sowing. Another method of cultivation, peculiar to this region and covering nearly half a million acres, consists in enclosing the fields with embankments.[1] The monsoon water is impounded in these fields to a depth of 12 to 24 inches, and at the end of September the *bund* or check is cut to drain out the water. As soon as the surface begins to cake, sowing is done, with or without a preliminary scarifying. No other cultivation is given to the fields, even after harvest, and the decayed stubble of the previous year's crop is often plainly visible at sowing. No manure ever is given to these fields, as it is supposed to depress the yield.

The use of manure varies greatly from region to region.[2] In the Punjab a good deal is used, except in the canal colonies and on lands commanded by inundation canals, where fertility is maintained by natural means. Indigo refuse, where available, is a favorite fertilizer. Street sweepings are carted out from the cities to supplement rural supplies. Manure is also extensively used in the United Provinces and on the irrigated lands of the Bombay Presidency, but very little in Bengal and the Central Provinces. As a rule, manure is not applied to wheat land directly, but to the preceding crop, such as maize or sugar-cane. On lands irrigated from wells, however, a top dressing of pulverized manure may be given to the young wheat crop when it stands about 6 inches high.

Seed and Sowing

The length of the sowing period varies considerably from one wheat-growing district to another. In the eastern Ganges Valley and the peninsular region, it is very short, because of the rapidity of change in the condition of the soil and the shortness of the growing season. To the northwest, a later harvest-time gives opportunities for a somewhat longer seed-time. Over large areas, the best time of sowing appears to be the second half of October and the first half of November, a few weeks after the withdrawal of the monsoon rains, and close upon the moderate rainfall that follows the end of the monsoon—the "sowing" rains. If the autumn rains are either scanty or excessive, the ground is likely to be either too hard or too soft for the plow, and the sowing is correspondingly delayed; excess of moisture in the soil also reduces germination. In the Punjab and the North-West Frontier Province, the cultivators may wait even till January for rains that will allow the sowing of wheat, but elsewhere a much shorter delay than this will usually lead to the substitution of some other crop.

The cultivator is guided in his choice of sowing-time by the fall of the autumn rains and his knowledge of soil conditions, but he will probably select the auspicious day with the aid of an astrologer or a proverb. Even with such safeguards, great risks are run, because either too much or too little rainfall after sowing may reduce germination and lower the yield of the crop.

Various methods of sowing are used, the choice depending partly on the soil and its condition, partly on the custom of the region. Broadcasting is very common, even on lands irrigated from wells and on inundated lands when the soil is moist enough. In this case the seed is usually worked into the soil by two cross-plowings or by the plank-drag. On the canal colonies of the Punjab, the seed is commonly dropped into furrows cut by the plow, and the seed-bed consolidated by the plank-drag. Frequently the plow is used as a drill, the grain being run into the soil through a bamboo tube attached behind the plowshare. In some areas a native drill, with two, three, or more bamboo tubes fed from a wooden bowl above, is employed. Even when the seed is drilled, the plank-drag or a light scarifier may be used to consolidate the seed-bed.

The rate of seeding of wheat varies enormously under the great variety of Indian

[1] The description of this method has been sent to the Food Research Institute by an officer of the Central Provinces.

[2] The widespread use of cow-dung for fuel very greatly limits its use as manure.

conditions. In the black-earth region of the Central Provinces, for instance, the cultivators may sow up to 150 pounds an acre, and in other districts of the same provinces as little as 40 pounds. Typical figures suggest a common use of from 80 to 100 pounds an acre, with many cases of heavier or lighter sowings. Where soil and climate demand a finer tilth, smaller quantities of seed are used. In the Punjab, 50 pounds is said to be the more usual rate.

Prosperous cultivators are likely to save good grain of their own to be used as seed, but those who are in debt—the great majority—are usually bound to deliver their crop or share to the village *bania,* who is money-lender, grain-dealer, and storekeeper combined, and to buy their seed from him when they need it, at a high price even for the very poorest quality. In defense of the *bania,* however, it may be urged that the problem of seed supply is extremely difficult, since climatic vicissitudes at the beginning of a season may very greatly diminish the demand for one kind of seed and correspondingly increase the demand for another. In increasing degree, selected seed, grown on special seed farms, is purchased from government seed depots.[1]

The Growth of the Wheat Crop

Once the crop is sown, the greater part of the cultivator's care and toil is ended, and thenceforward the crop lies largely at the mercy of nature. If it is sown where irrigation is imperative or important, the labor that irrigation compels is a necessary and normal contribution to its progress. Elsewhere, the cultivator can do little other than mitigate the worst consequences of natural adversities, by special exertions at irrigation when the usual rainfall fails, and by giving protection to his crops from the injuries of weeds and animal enemies. In a few areas, where growth tends to be rank, the crop is grazed off in December.

Favorable conditions of winter temperature for the growth of wheat are found in all parts of India, outside the northern mountain regions. The distribution of the small but highly important rainfall of December, January, and February is the principal factor of winter climate that operates to determine the major regions of wheat production of India, and only where irrigation serves effectively as a substitute does the wheat crop overstep the boundaries imposed by this rainfall.

Departures from the normal régime of winter climate involve the risk of grave damage to the wheat crop. Of such climatic adversities, the worst is drought, which, if prolonged, may reduce the yield of all the *rabi* crops so seriously as to threaten destitution and famine. On occasion frost also has done widespread damage throughout the Indo-Gangetic Plain, but in general its attacks are only local and by no means frequent. Similar localized damage may also be done by high winds, hail, and unseasonable or excessive rain.[2] The last of these adversities further involves the risk of rust, a fungoid disease of wheat, whose worst attacks are supposedly encouraged by persistently wet and cloudy weather in January and February. Even under normal climatic conditions, rust is a regular cause of serious damage; but in the peculiarly adverse years it becomes a grave danger over large areas and may cause serious losses.[3]

Animal and bird pests may also damage the crop. Where jungle still exists near cultivated land, as in the Central Provinces, the deer, antelope, wild pig, and other jungle animals make raids on the crops by night. Away from the jungle, domestic animals in their foragings replace the wild animals as enemies of the crop. In some years rats also prove a serious danger, presumably through a temporary disappearance of some natural check. Birds are yet another and a regular cause of loss, but their attacks, like those of the wild pig, can be frustrated by growing bearded varieties of wheat. Insect pests are not dangerous, as a rule, though damage by white ants is occasionally reported. Locusts do not appear to be a dangerous pest. The severity of

[1] See above, p. 343.

[2] Many of the wheats, especially those grown in the United Provinces and Bihar, are characterized by weak straw, and are therefore most seriously liable to "lodge," should winds and rains occur during the ripening period.

[3] "Watt estimates the annual loss caused by wheat rusts at 10 per cent of the value of the crop, an estimate which is certainly not an excessive one. . . . ." A. and G. L. C. Howard, *Wheat in India* (Calcutta, 1910), p. 5.

incidence of all these pests is accentuated by the cultivators' aversion to the taking of life. Some killing is done by village hunters and others, but for the most part the enemies of the crops are merely scared away. During the growing season, therefore, the caste watchmen of the village and members of the cultivator's family are employed in this work of protection, by day and by night. The prejudice against such taking of life, however, does not hold among the Moslems, and it is today less characteristic of other classes than was formerly the case.

Weeds are not, on the whole, particularly troublesome in India, chiefly because of the systematic cultivation necessary to utilize rainfall to full advantage. The cultivators possess implements for hand weeding, but in general they pay comparatively little attention to the wheat fields,[1] evidently because cultivation at other times of the year is sufficient to keep the weeds down. In the Central Provinces, the *kans* grass, a deep-rooted pernicious weed, gained a footing during the famine of the later 'nineties and has thrown many hundreds of thousands of acres of black-earth land out of cultivation. In its earliest stages, *kans* grass is very easily controlled, but once the deep underground stems are established, the native plow is helpless and the weed spreads through the field. The only remedy for such a condition is a costly eradication by hand, with crowbars, or more recently, a cheaper, yet still expensive, deep plowing with tractors. In the canal colonies of the Punjab there is considerable infestation with weeds. Most of the winter weeds, however, are leguminous, and are regularly picked and fed to cattle. In addition, they regularly enrich the soil with nitrogen, and make possible an unbroken cultivation of wheat from year to year.

Harvesting and Threshing

The harvesting of the wheat crops of India is spread over a longer period than the sowing. The zone of harvesting of the *rabi* crops passes slowly across India from east to west in the early months of the year. On the black cotton soils of the peninsula, wheat ripens in February. Later in February, harvesting begins in Bengal and Bihar, and in March in the Central Provinces and the United Provinces. In the eastern districts of the Punjab, harvesting begins in early April. As the month advances, the harvest passes to the north and west, until the last of the Indian *rabi* harvests are reaped in the North-West Frontier Province toward the end of May, and in Baluchistan even as late as July.

The wheat is reaped by sickles, which cut the straw or partially uproot it, according to their edge. In this work, and in the binding and stooking, the cultivators usually employ some hired labor from village and town. On the larger holdings, in the canal colonies of the Punjab and in the Central Provinces, where it is frequently difficult to secure sufficient labor for the harvest operations, some reaping machinery is employed; elsewhere the old hand-harvesting methods still prevail. The wheat is usually bound by wetted straw bands into large bundles, which may be readily counted and which are stacked roughly for threshing.

The grain is separated from the ear on the cultivator's threshing floor by the trampling of the cultivator's bullocks. In some regions (notably in the Punjab), the bullocks are yoked to a threshing-frame (*phala*) that is made of a hurdle covered with brush, weighted with clods or brick, and fastened to a stake in the center of the earthen (or paved) floor. The trampling breaks up the straw, and thus makes *bhusa*, the mixture of chaff and broken straw that constitutes the main fodder of India. But this benefit of making *bhusa* is offset by the disadvantage that the bullocks are worked to exhaustion on the threshing floor at the time when they might otherwise be employed in raising water from the well or doing a valuable piece of plowing before the rains.

Winnowing may be done by the wind or by fanning or sifting. Winds in India are weak and variable, as a rule, but they usually suffice for winnowing at this season. The mixture of grain, chaff, and broken straw is thrown up into the air or poured from a height; the grain falls to the ground and the lighter *bhusa* is blown to one side in a heap. Fanning by a sheet of cloth is a

[1] A. and G. L. C. Howard, *Wheat in India* (Calcutta, 1910).

slower and more expensive practice, rarely employed, when suitable winds fail or where they seldom blow. Sifting in a basket by hand may be performed either as a first winnowing on the threshing floor, or as a second winnowing after the air has done its work. Winnowing is usually done by low-caste village servants, and but rarely by the cultivators themselves.

The work of harvesting, threshing, and winnowing proceeds so slowly that the grain may have to lie on the threshing floor for some weeks, and even after the threshing and winnowing are completed, the division of the crop among landlord, tenant, *bania,* priest, village servants, and others may be carried out on the threshing floor. The months of April and May are always dry and hot, but there does exist some risk of rain, which may start sprouting of the grain as it lies exposed on the threshing floor, with considerable damage and loss.

Factors Determining the Crop

The size of the Indian wheat crop is determined by acreage sown (since abandonment is slight) and the yield per acre. Variation in acreage is a much more important factor than in most countries, and, as in no other country, is almost as important as variation in yield in determining the outturn. If the area sown is 30 million acres or more, India can usually count upon at least enough wheat for domestic use, but the amount of the surplus will depend on yield per acre; while if the acreage is reduced considerably below 30 million the chances are against a surplus crop. Poor crops are almost invariably the result of simultaneous reductions in acreage and in yield per acre. (See Charts 5 and 6, p. 320.)

An increase or decrease of 3 million acres (10 per cent) is of quite common occurrence; an increase or decrease of 5 million acres is not unusual; and occasionally there occurs a decline of 7 million acres or more. The dominant factor in determining the acreage in any particular year is the amount of rainfall during the summer months. In years of ample rainfall, unirrigable lands near the margin of cultivation can be sown to wheat, occasional irrigation (especially by inundation) can be applied to lands which seldom have opportunities to receive this benefit, and regular irrigation of all kinds, particularly in the large perennial systems, can be carried on to greater advantage, with a wider and more economical distribution of water. Deficient rainfall is the common cause of reduced acreage, though in some wheat regions excessive rainfall, especially in the latter part of the summer, may interfere with preparation of the soil and, in rare instances, with sowing. In the case of the most extreme decline yet recorded, nearly 12 million acres in 1919, the influenza epidemic was an important contributing cause.[1] Especially in the peninsular region, an important after-effect of a famine is a reduction of the area subsequently sown to wheat, both because many cultivators cannot afford to make the outlays required by wheat sowing, and because all possible land is devoted to *kharif* crops, in order to secure a prompt reconstruction of food stocks.

The area sown to wheat each year is strongly influenced by the character of the summer rains. If the rains come late, *kharif* sowings will be smaller than usual and more land will be held back to be worked up for *rabi* crops. If the summer season goes badly for the *kharif* crops, with too much or too little rain, some of them will be spoiled and will be removed by the cultivators to make room for a *rabi* crop. Conversely, if favorable weather conditions have led to extensive sowings and reapings of *kharif* crops, less land will, in some cases, be worked up for *rabi* crops. Again, if the monsoon rains are scanty or ill-distributed, the ground may be too hard for plowing, and will absorb too little moisture. Yet if they are excessive or too frequent, the ground may become sodden, and plowing will be ineffective; the soil will become caked and compact, and the fine tilth desired for seeding will not be attained. In the districts (e.g., in the Punjab) where the chief reliance is upon irrigation water rather than upon rainfall, the wheat acreage is not subject to these influences and varies but little from year to year. Generally price prospects, not only for wheat but for

[1] An indeterminate part of this decline, however, may have been purely statistical, through a temporary failure of the administrative machinery for making and transmitting crop reports.

alternative crops (notably cotton, where it can be grown), exert an appreciable influence on the acreage sown to wheat. To some extent, also, the cultivators are influenced by the success or failure of previous wheat harvests.

Variations in yield from year to year are less considerable in India than in most other countries. The extreme range in the average for all of India during the past 30 years has been from 9.7 to 13.0 bushels per acre. (See Chart 6, p. 320.) Over a period of years the average yield has been something like 11.5 bushels to the acre. The amount and character of the rains during the cultivation and sowing periods affect the yield chiefly through their influence on the preparation of the soil, the progress of sowing, and the germination of the seed; but the winter rainfall is the most important factor. Thanks, however, to the irrigation facilities, rainfall deficiency in some regions is unimportant and in others can be partially offset by increased use of irrigation water. This fact explains why more severe declines in yield do not occur.

V. WHEAT CONSUMPTION

The great bulk of the Indian wheat crop is consumed in the producing provinces, either in the producing village itself, in neighboring villages, or in urban provincial centers. It is therefore pertinent to discuss the consumption of wheat before dealing with the marketing process, which has its principal importance in respect to the fraction of wheat that is shipped to the seaports for export or consumption there.

Agriculture and the Dietary[1]

With a population of omnivorous dietary habits the agriculture of a country tends to determine, in very large measure, the diet of the population. This is true of particular regions of India, for there is a strong tendency for the population of a region to subsist on the products of that region, rather than to specialize in production and develop a more or less uniform diet by means of internal trade. In some regions rice is the staple cereal; in others it is almost unknown. The same is true of wheat. For India as a whole, however, the dietary habits of the population determine the agriculture, or at least modify it profoundly. A large proportion of the people are vegetarians, by reason of religious scruples. While such do not bind the Mohammedan population (except as regards the eating of swine products), vegetarianism is the prevailing institution. Not only are slaughtered meats not consumed by the great majority of the population, but comparatively little use is made of fish, eggs, and dairy products. In certain rural districts, agriculturists use moderate amounts of fluid milk, and use is also made of curdled milk (*dahi*), condensed sweetened milk (*khir*), and clarified butter (*ghi*). But the cattle industry chiefly serves the purpose of production of work animals and, viewed as a unit process, is highly inefficient from the standpoint of agricultural potential. A population with the habits of the Chinese would make a more efficient use of the area of India than do the Indians.

The fat requirement of the Indian diet is supplied largely by vegetal oils of various kinds—cottonseed, rapeseed, sesame, peanut, coconut, and others. Sugar is valued both as a foodstuff and a flavoring, and condiments and spices of many kinds are in common use.

Where the consumption of animal products (and also of fish, whose use is said to be restricted by the salt tax) is so small, the protein requirements of the population are furnished by legumes and cereals. Fat-poor and fat-rich legumes, both rich in protein, are extensively used, and are thus of particular importance in the diet. Of the cereals the three most prominent are millet, rice, and wheat. In relation to food values, millet is generally the cheapest; of wheat and rice, one or the other may be the dearer according to the particular region in question. Wheat is the richest in protein, millet the richest in calories. The cereal diet varies from region to region, rice being consumed especially in the coastal areas, wheat in the interior (and in Bombay, Calcutta,

[1] This sub-section has been written by Dr. Alonzo E. Taylor.

and Karachi), millet more or less throughout the country.

In India, not only the quality but the quantity of the diet depend in large measure upon the purchasing power of the several classes and castes, and more or less subnutrition is continuously present in certain groups of the population. In a sense, therefore, India never has a genuine surplus of wheat. Nevertheless with what may be regarded as normal crops, India is usually an exporter of wheat as well as of rice,[1] barley, and gram. Although at times the export of wheat has been restricted by the government, in general the country's interests are apparently believed to be better advanced by obtaining imports by means of export of wheat than by devoting this wheat to improving the state of the undernourished classes.

The food supplies of the Indian masses are so small that the exportation of wheat arouses many protests, and the proposal is often made that the Indian Government should prevent this drain of valuable food by imposing an export tax on wheat. But to such proposals the reply is made that the export of wheat encourages a more extensive cultivation, that the surplus production constitutes a reserve which can be diverted from exportation at any time to succor any region that may be in famine, and that the production of a surplus in normal years affords some insurance against extreme deprivation in a year of crop failure.

Per Capita Consumption

In the extremely modest Indian dietary wheat holds no such primary position as it holds in the world at large. Neither bread, nor wheat in any form, is the staff of life for the agricultural and industrial population, except in certain areas and for limited classes. In the United States, after a decline extending over many years, wheat consumption averages between 4 and 4½ bushels per capita. In most other countries which produce large quantities of wheat, whether they are net exporters or net importers, the per capita consumption is higher, and the relative importance of wheat in the diet is much greater. This is true also of many countries which produce little wheat. In Asiatic countries generally, and in India in particular, on the other hand, the rate of consumption is very much smaller.

The amount of wheat retained in India averages only about a bushel per capita, but the human consumption is considerably less than this very low figure. Some 30 to 40 million bushels are probably used for seed, and the loss from spoilage and insect damage, notably from the weevils that multiply in much of the stored grain, is very heavy. No reliable estimates of the disposition of successive wheat crops can be made. Probably the human consumption of wheat does not, on the average, exceed four-fifths of a bushel.

Averages, however, do not tell the whole story. In the first place, the consumption of wheat is largely restricted to the principal regions of production and, outside of these, to Calcutta and Bombay. As we have seen, in many provinces and districts, wheat plays little or no regular part in the diet. The present rates of consumption of wheat in various parts of India are indeterminable, among other reasons because of the discontinuance of certain statistics of internal trade. The following data, covering the crop years 1911–12 to 1914–15, show the approximate position in the principal wheat-growing areas in a 4-year period of high production and consumption before the war:[2]

Province	Crop *(million bushels)*	"Exports" *(million bushels)*	Retention *(million bushels)*	1911 population *(millions)*	Per capita retention *(bushels)*
Punjab..	127.8	36.8	91.0	20.7	4.4
United Prov...	103.7	16.1	87.6	45.4	1.9
Central Prov...	33.8	6.2	27.6	13.9	2.0
Bihar and Orissa.	20.7	1.2	19.5	34.0	0.6

The per capita figures, it will be observed, are for retention; if account could be taken of seed requirements and waste, they would be considerably smaller. Moreover, the

[1] India's exports of rice come almost entirely from Burma. The rest of India, as a whole, is in general a rice-importing region.

[2] From G. F. Shirras, *Statistical Tables Relating to Indian Wheat* (Calcutta, 1916). The term "exports" here signifies the movement of grain from a province, either abroad or to some other part of India.

average population in this period was certainly higher than at the census of 1911; hence the use of the 1911 census figures leads to an overstatement of per capita wheat retention.

The Punjab is the one province of India in which wheat forms a general staple of consumption. Even there, the per capita consumption is considerably less than in the United States or in Europe; but in a population which eats little meat it is clearly of much greater relative importance in the diet. Indeed, an Indian economist criticizes the smaller cultivators of the Punjab for raising too little wheat for sale and too much for subsistence, to the partial neglect of other subsistence crops.[1] The rate of consumption in the United Provinces and the Central Provinces is much lower than in the Punjab. These provinces contain large districts in which wheat is displaced by rice as the principal cereal, and even in the wheat-growing districts many poor cultivators live largely on barley or millets, and raise small quantities of wheat, mainly for sale. In Bihar and Orissa the submergence of wheat goes much farther, and it is practically unknown in other provinces of British India.

Changes in Wheat Consumption

Because of the limited place of wheat in the diet, there is considerable possibility for variation in consumption from year to year, depending on the size of the crop and carryover, the abundance or scarcity of other foodstuffs, the relative prices of different foods, and the degree of prosperity. It is impossible to measure the extent of this variation, because statistics of stocks do not exist. During the war the government made special efforts to secure accurate estimates of stocks, and in December 1918 made a serious attempt to take a formal census, with results officially stated to be "of very little value." The practice of storage is such, however, that these variations are much less extreme than would be directly inferred from annual statistics of domestic retention (crop less net exports).

[1] H. Calvert, *The Wealth and Welfare of the Punjab* (Lahore, 1922).

[2] Based on data in Appendix Tables V, XI, XII, with minor estimates for certain missing trade data in the earliest period.

(See Chart 2, p. 318.) We are more concerned, however, with the trends of wheat consumption over a period of years. On this point also it is difficult to reach wholly satisfactory conclusions, for lack of annual estimates of population and because of imperfections in statistics of crops and their domestic disposition.

In the four years of good crops before the war, per capita consumption appears to have reached a higher level than ever before in a period of equal length. Thus the average domestic retention for the four years 1910–11 to 1913–14 was 314.2 million bushels (or nearly a bushel per capita) out of an average crop of 368.5 million. This was clearly exceptional. The post-war average retention has been only a little higher, although the population has increased. Perhaps the fairest indication of trend in per capita retention can be secured by taking 6-year averages, of crops less net exports, centering in the census years. The results of this computation are as follows:[2]

6-year period ending	Crop (million bushels)	Net exp. (million bushels)	Retention (million bushels)	Census population (millions)	Per capita retention (bushels)
1893–94.	244.3	29.8	214.5	287.3	.75
1903–04.	267.5	31.3	236.2	294.4	.80
1913–14.	345.2	47.8	297.4	315.2	.94
1923–24.	334.8	13.8	321.0	318.9	1.01

These figures clearly suggest a rising trend in per capita consumption. True, one cannot accept them wholly at their face value. The crop statistics of the first and second periods, at least, are probably incomplete, and the per capita retention figures may be too low in consequence. The third period included four years of good crops, and the per capita retention figures are probably higher than was "normal" for that period. For the fourth period, the population figures of 1921 may understate the average population during the six years, thus tending slightly to overstate the per capita retention. These qualifications render doubtful such precise inferences as that per capita consumption is now 25 per cent greater than it was early in the present century, or any attempt to calculate a line of trend that can be projected into the future; yet they do not seriously call into question the fact of a rise in trend.

Another point deserves passing mention.

The age distribution of the population changed considerably between 1911 and 1921, the proportion of adults of both sexes between the ages of 20 and 35 being conspicuously smaller in 1921 than in 1911. The loss of lives in the war and the great influenza epidemic were largely responsible for this change, but another important cause appears to have been the famine years of the later 'nineties, which contributed a much smaller number of children to India than the more prosperous period between 1902 and 1914. For the recent period, with a larger proportion of children and elderly adults and a smaller proportion of younger adults, who are the heaviest workers and largest food-consumers of the population, one would expect, other things being equal, a reduced per capita consumption. Since the figures point to an increase, one may reasonably infer that for persons of a given age and class the increase has been greater than that suggested by the above figures.

The fact of an increase in per capita consumption of wheat in India is affirmed by all observers, including officials who have special facilities for ascertaining the facts.[1] The Punjab is always specially mentioned as the place of greatest increase, but there is no evidence of decreased per capita consumption elsewhere. The pre-war increase was doubtless associated with the advance in wheat growing under irrigation and the more prosperous conditions as compared with the 'nineties. The more recent increase has occurred not in the rural areas but chiefly in the towns and to a small extent in the larger villages.[2] The principal reason given for the more recent increase is the higher earnings of urban workers. Formerly they consumed chiefly the cheaper and coarser food grains. During and after the war, with increased industrial activity and prosperity, their wages rose, and did not fall appreciably in subsequent years when prices of wheat and other food grains declined. With a larger purchasing power in terms of food, they have preferred to increase their consumption of wheat and to reduce their consumption of cheaper and inferior grains. Thus the increased consumption reflects a rise in the standard of living in these classes of the population. The Punjab is one of the principal recruiting grounds for the Indian army, and large numbers of its men saw service during the war. It is stated that these men returned to civil life with a broader outlook on life, and with many new tastes, among which the desire for a liberally wheaten diet is by no means the least important.

[1] According to letters from the Director of Industries, Punjab, December 22, 1926, and the Director of Industries, United Provinces, January 6, 1927.

[2] An inquiry made by the staff of the Director of Industries, United Provinces, indicated a 10 per cent increase in the towns, 2 per cent increase in the large villages, and very little in rural parts.

[3] Radhakamal Mukerjee, *The Foundations of Indian Economics* (London, 1916), pp. 103–5; *Northwestern Miller*, February 6, 1924, p. 589; *Accounts and Papers*, ... , 1924; *India in 1925–26*, p. 316.

How Wheat Is Eaten

Some brief account must be made of the various ways in which wheat is prepared and consumed in India. For centuries past, all wheat was ground by hand between stones, the work being done by women as a household duty, or else for payment in the employment of a *chakkiwallah* (grinderman). The laboring classes still grind wheat in their homes in *chakkis*. But the *chakkiwallahs*, in recent years, have been practically driven out of business in urban areas through the competition of flour mills, and even in rural areas they are being gradually displaced by small flour mills driven by oil engines; where the oil engine has not penetrated, *zamindars* (overlords) have taken to grinding wheat in bullock-driven *chakkis*.

The principal products sought for in grinding, either by machinery or by hand, are *suji*, *atta*, and *maida*. *Suji* is the product of the first coarse grinding. It is ground again more finely, and then sifted to separate *atta*, a product like semolina, from *maida*, the finer flour. *Atta* is the food of the masses, and *maida* the food of the well-to-do. *Atta* is not commonly made into bread by fermentation, but is baked into coarse pancakes (*chapattis*), which are eaten promptly after cooking, along with the vegetables and condiments that make up the rest of the meal.

In recent years there has been a development of flour milling, with modern machinery, on a larger scale.[3] In 1906 there

were reported 42 such mills, employing some 3,000 persons. Half of these mills were in the Punjab. In 1921 the number had increased to 63, with 5,638 employees. The number of joint-stock companies registered in British India and actively engaged in flour milling rose from 28 in 1911–12, with a paid-up capital of 6.8 million rupees, to 37 in 1920–21,[1] with a paid-up capital of 9.3 million rupees. The industry is still of relatively minor importance, in 1923 ranking only twenty-seventh; but it is increasing at a fairly rapid pace. As yet, however, it grinds only a small fraction of the wheat domestically consumed. "In towns," according to Mukerjee (1916), "bread and biscuits prepared from flour are greatly in use. Several biscuit factories have been started in the country and show great promise." It is of some interest and significance that caste scruples in diet have not been extended to biscuits and soda water.

VI. WHEAT MARKETING

To a certain extent the wheat is consumed in the villages in which it is produced, but to a large extent it figures as a cash crop that comes upon local markets to be purchased there for local consumption or for shipment to other parts of India or to seaports for export. The internal trade is far larger than the export trade, but deserves less emphasis in the present study. Here we shall deal with the domestic phases of the Indian wheat trade, whether for domestic consumption or for export, and in the following section with the export movement proper.

WHEAT STORAGE

The cultivators tend to sell their crops soon after harvest. The principal reason is to be found in their heavy standing indebtedness, and to their water dues and rent or land taxes, which are payable shortly after harvest; but the desire to reduce risks of loss in storage must also be reckoned a powerful motive, particularly among those who are not sufficiently prosperous to possess effective means of protecting their grain. In the consequent low level of prices after harvest exporters find their most favorable opportunity to make large purchases of wheat; then desiring, like the cultivators, to avoid loss by storage under Indian conditions, they endeavor to ship to Europe as quickly as possible.

The safe-keeping of wheat in India is greatly hindered by the summer rainfall and by the ravages of insect pests. During the fierce heat of the harvesting and threshing season the grain becomes very dry, and thus most acceptable to the European purchaser. Nevertheless, so long as it lies on the threshing floor it incurs a risk of damage by rain that would become a certainty if the grain were left exposed till the time of the monsoon rains. When it is removed from the threshing floors to the granaries commonly employed in India, it is still liable to serious damage, most notably from the several insect pests that make their home in the granaries. The smaller and more primitive the form of storage, and the more defective the granary, the greater is the risk of loss from various causes.

The cultivators have only the crudest facilities for storage. As a rule the grain that is not sold from the threshing floor is stored in the houses—in earthen jars for household use, in a corner of the house separated off by wicker-work, in a pit dug under a room or outside, or in earthen bins of sun-dried clay. Only the well-to-do have granaries of mud or brick. Special pains are taken to preserve seed grain from moisture and insects.

The facilities for storing wheat after it has left the cultivators' hands are also, for the most part, quite unsatisfactory.[2] The large exporters, indeed, have some granaries of substantial construction and with good roofs, though usually built on the ground level with only an earthen floor; but these are usually intended and employed for grain awaiting shipment rather than for storage. The Army Supply Department uses silos of masonry, some twelve feet high, lined with cement, filled from

[1] The 1920–21 figure is equivalent to about 3 million dollars.

[2] See especially F. Noël-Paton, *Indian Wheat and Grain Elevators* (Calcutta, 1913), pp. 2–3, 23, 69–72, 104–8.

above, sealed over, and charged through a tube with a volatile insecticide (carbon bisulphide); but even these afford imperfect protection and are not in private use. The common types of granaries maintained by the native warehousemen, especially in the Punjab, are of masonry or brick (*kothas*); most of these, however, are defective, easily penetrated by moisture and infested by weevils of many kinds. The wheat may be stored in bags, or in bulk with a layer of straw or chaff below and above. Such grain runs the risk not only of depredations by rats and human thieves, but of serious injury by insects. Rapid multiplication of weevils is encouraged by the high air temperatures of the summer months, if the grain is at all damp, and by the humidity of the air during the monsoon rains. The same factors probably conduce to further deterioration of the grain in other ways. It is difficult for exporters to avoid lots of weeviled grain or to destroy the insects when they are present.

Such granaries are inadequate to take care of the crop, especially in years of good harvests, even with the development of transport facilities making possible more rapid movement of the crop. Large quantities of wheat, especially from large crops, are stored in pits (*khattis*), which are the principal means of storage available to the growers; and in the United Provinces, where *kothas* are not common, such pits are extensively used by the native warehousemen. These pits "are lined with straw and chaff and sometimes, it is said, with a plaster compounded of mud and cowdung," the bulk wheat being covered with straw, earth, and a thatch. Probably because of the generation of carbonic acid gas, pit-stored wheat is less subject to damage by weevils, but it tends, after prolonged storage, to become mouldy, dark, and malodorous. In some places also it is liable to damage from sub-soil water resulting from the presence of irrigation canals.

The Purchase of Wheat

The first movement of wheat is made from the village in which it was grown to a local market nearby. If the cultivator who raised it is well-to-do or independent he takes the grain to market himself, but if he works on a small scale and is poverty-stricken and in debt he delivers his grain to the village *bania,* who is store-keeper, grain-dealer, and money-lender all in one, and the *bania* will send it to market as his own grain. The owners of large estates in the Punjab are usually in direct touch with exporting firms, and in recent years the small growers have become less dependent on the *bania* and have tended to deal more directly with the exporters' agents.[1] The actual carriage of the grain will be by bullock-cart, or on donkey-back—the village potter being bound by caste obligations to employ himself and his donkey for this service.

The village market, termed a *mandi,* is simply an open space in a village, surrounded by small warehouses owned by the various dealers. Here are to be found the larger merchants and warehousemen and representatives of exporting firms, competing with one another for the purchase of the village deliveries of grain, which they then put together into larger parcels for storage or rail-shipment.

Methods of purchasing wheat by exporters are somewhat complex. Broadly speaking, each exporting firm has a head office at Karachi with warehouses for handling and shipping grain. Some firms have no branches. Others have branches at a few of the more important country points. Others, of which there are now only three,[2] have an extensive organization comprising a number of branches, a score or more, at various *mandis* in the wheat-growing territories. Each of these branches is managed by a native salaried agent who, with the aid of a small staff, controls the buying, handling, inspection, storage, and shipping of wheat. To each branch there is also attached a *dalal,* or sub-broker, who is employed, not by the exporting firm itself, but by a *dalial,* or larger broker, who has contracted with the exporting firm to undertake the broking for a large district. By virtue of this agreement, the salaried agent makes no purchases himself, but only in-

[1] See footnote below.

[2] According to testimony given before the Royal Commission on Food Prices (see their *Report,* London, 1925) by G. Eumorfopoulos, of Messrs. Ralli Brothers, London—one of these three firms.

structs the *dalal,* who then goes out into the *mandi* to purchase on the firm's account.

Price limits for purchase are sent out daily by wire from the head office at Karachi to the various branches. On the basis of these limits the agents calculate the prices which can be offered for delivery in the *mandi* and instruct their *dalals* accordingly. Apparently a similar mode of organization is maintained by the native merchants who buy wheat in the *mandis* for shipment to other parts of the country, and by the warehousemen, who buy grain at times when the price is low and store it for sale on an advance in prices.

Cash purchases of wheat by exporters may be made in any one of three ways—by ready purchase, by Karachi pass, or by agency pass. In "ready purchase," the grain actually offered for sale in the *mandi* is bought by the broker and shipped by the agent. This form of transaction places a good deal of responsibility upon the judgment of the agent and is not so satisfactory as the Karachi pass, which is, in fact, the principal mode of purchase. In "Karachi pass," the agent contracts through his broker with a native merchant for the delivery of grain at Karachi within a specified brief time. The merchant organizes the shipment in his own way, and hands over the railway bills of lading to the exporter's agent, receiving an advance of 90 per cent of the purchase price. When the grain arrives at Karachi, it is weighed and inspected by the exporting firm, whose decisions on these points are final and must be accepted by the merchant. The payment of the balance due, on the basis of the exporter's decision on weights, quality, and cleanliness, then completes the transaction. In "agency pass," a somewhat similar procedure is followed, except that the local purchasing agency weighs and inspects the merchant's consignment. This method places an undesirable responsibility upon the agency, and hence is the least used. The actual financing of the transactions is carried out by native bankers, termed *shroffs,* who act as agents for the exporters and draw bills on them for subsequent payment. If this practice is not followed, it may be necessary for the exporting firm to send large shipments of coin up-country from time to time. The head offices may also purchase cash wheat from native merchants in Karachi—wheat in their own warehouses or in transit.

In addition to these various forms of dealing in cash wheat, there is also a considerable trade in contracts for future delivery (*sattas*). This trade is apparently not a European innovation, but a long-established native practice, by which the natives satisfy a gambling propensity and the merchant classes of India contrive to adjust prices far ahead to the needs and prospects of the future. Exporting firms often buy wheat for future delivery from merchants in Karachi; they also sell wheat to them for future delivery in Karachi as hedges against up-country purchases.

A considerable part of the grain delivered on *sattas* is doubtless obtained by subsequent purchases of peasants' grain in the *mandis,* but much of it is brought out from organized storage. Mention has already been made of the presence of warehousemen in the *mandis,* who buy up grain during the period of low prices that follows the harvest and thus compete most strongly with the exporters, who make their largest purchases at about the same time. When the grain is sealed up in the store, its owner makes out an invoice (*bijck*) stating the quantity of grain and the place of storage. The *bijck* is a negotiable document, whose accuracy is never questioned. After it has passed perhaps through many hands, some purchaser will present it to the warehouseman and call for delivery of the grain. When the store is opened, an upper layer of dust and weevils is scooped away and the grain is brought out to be sacked. Grain delivered from *kothas* usually comes out in good condition except for weevil damage, but the grain from *khattis* (pits) is liable to be moist, dark, and unpleasantly odorous.

Grain may be purchased in considerable quantities for storage at times of low price and held firmly for long periods as a speculation in the hope of a remunerative advance. Though the warehouseman competes with the exporter at the time of purchasing in the *mandi,* he also serves him well by holding grain in store during the busy trading season after harvest and thus somewhat prolonging and easing the season of shipments. To the people of

India, also, he renders service by carrying over large stocks of grain after years of good harvest and adjusting the food supplies between plentiful and lean years. No figures are available for the quantities of such stocks and carryovers, but they must often be sufficiently large in the aggregate to exert an important influence upon domestic prices.

Internal Movement of Wheat

The great bulk of the wheat crop of India is retained in the wheat-growing regions themselves, and a relatively small proportion passes over the boundaries of the producing province. According to the figures quoted above (p. 354), shipments out of the four major wheat-growing provinces averaged only 60 million bushels a year, or 21 per cent of the average crop, in the four years ending March 1915. On the whole, these were years of fairly heavy movement. Other statistics covering a longer period, but not wholly comparable with them, suggest that in most years the shipments out of the producing provinces are smaller than this.

Nearly all of the wheat shipped out of the surplus-producing provinces goes to the three seaports of Calcutta, Bombay, and Karachi—to Karachi chiefly for export, to the other great cities chiefly for consumption in their metropolitan areas. In the four years 1911–12 to 1914–15 the wheat receipts at these three cities averaged 60 million bushels, and India's wheat exports, largely through these ports, averaged 46 million. Hence the export movement was three-fourths of the total. Since the war the proportions have been different, for exports have been smaller and urban consumption probably larger. Little wheat is shipped to interior towns outside the wheat-growing regions, but the great cities of the producing provinces are of considerable importance as interior consuming markets. All told, it is doubtful whether the inter-provincial trade for domestic consumption often reaches 20 million bushels in a year.

Shipments are made almost entirely by rail, though a little wheat is shipped by river, and a little also by sea. The Punjab ships mostly to Karachi, the Central Provinces mainly to Bombay, Bihar and Orissa chiefly to Calcutta. The United Provinces are more nearly equidistant from all three great ports of India. As a rule the greatest share of their "exports" goes to Calcutta for local consumption and overseas shipment, but in years of large harvest, big deliveries are made to Karachi and Bombay.[1]

The movement has a pronounced seasonal character, which is broadly indicated by Table 5. Shipments begin soon after harvest and increase rapidly through the dry season before the monsoon rains begin. Especially in years of large harvests, there is a severe strain on the railway facilities at this period. Arrivals at Calcutta and Bombay, which are supplied by regions of earlier harvest, rise in April, usually reach their peak about the middle of May, fall off considerably in June, and are at a low level throughout the rest of the year. As a rule the arrivals of April, May, and June constitute 40 per cent of the total receipts of the year. From the Punjab, where the harvest is several weeks later, the movement is similar in course but somewhat later. Arrivals at Karachi are at a minimum in March and very low also in April, but rise sharply in May to a peak in mid-

Table 5.—Wheat Arrivals at Calcutta, Bombay, and Karachi, by Rail, River, and Sea, Monthly, 1911–12 to 1914–15*

(Million bushels)

Month	1911–12	1912–13	1913–14	1914–15
Apr.	3.2	4.1	5.7	1.5
May	10.0	10.2	13.7	7.2
June	12.3	16.5	14.7	9.0
July	7.4	11.7	8.7	3.3
Aug.	3.7	6.2	3.6	3.4
Sept.	3.8	8.0	2.6	4.9
Oct.	4.5	7.5	2.1	2.5
Nov.	3.0	3.4	2.2	2.9
Dec.	3.2	2.8	1.6	1.8
Jan.	3.6	3.5	1.4	1.1
Feb.	3.9	1.7	1.3	1.0
Mar.	3.2	2.7	1.5	1.4
Total	61.8	78.3	59.1	40.0

* Data from G. F. Shirras, *Statistical Tables Relating to Indian Wheat* (Calcutta, 1916).

[1] See Appendix Table IV for sources of wheat receipts at Karachi, Bombay, and Calcutta in the years 1912–13 to 1914–15.

June, and in July, though declining, average about as high as in May. Over half the year's receipts are usually concentrated in the months of May, June, and July, but the movement in the following three months is a little larger than in all the rest of the year.[1] The seasonal movement is illustrated by the following index of monthly arrivals of Indian wheat at Karachi, based on the five years ending March 31, 1915, each figure representing the percentage of arrivals during a given month to the average monthly receipts during the whole period:[2]

Apr. 41	Aug. 89	Dec. 47
May 176	Sept. 107	Jan. 47
June 294	Oct. 89	Feb. 41
July 179	Nov. 51	Mar. 37

The Question of Bulk Handling

The wheat is shipped almost entirely in bags. There has been repeated agitation for the development of a system of handling Indian grain in bulk, both for the domestic and the export trade. The need for a system of suitable country elevators has been especially urged.[3] The first proposals for an elevator system were made in 1890, but to the present time next to nothing has been accomplished. In 1913 an elevator of 140,000 bushels capacity was erected as an experiment at Lyallpur, the focal city of the Chenab Colony in the Punjab; this was opened for commercial service, but apparently not before 1920. It has found some use in grain storage and has rendered service in cleaning grain and raising its value, but though a few small shipments already made from it have earned a premium in the British market, the disorganized state of the export trade in recent years has thus far prevented adequate demonstration of its capabilities. It still remains, apparently, the only building of its kind in India, and Indian ports and railways still maintain the old-established practice of handling grain in sacks, without any discernible prospect of change.

The first obstacle to the introduction of bulk handling is to be found in the indifference of the firms engaged at the present time in the business of exporting wheat from Karachi. They all profess to be satisfied with existing methods, which supply an abundance both of cheap accommodation in the storage yards and of cheap labor for working the grain. In criticism of this attitude it has been suggested that these firms really object to the introduction of bulk handling on rail and in elevators on the ground that it might bring new competitors into the field against them. It might involve them in serious loss of capital investments in personnel, organization, and equipment and cause unpredictable and disconcerting changes in the conduct of their business.

A further obstacle to the introduction of elevator handling and storage is the attitude of the Karachi Port Trust, which has opposed the construction of elevators in advance of demands from established traders and the management of the North-Western Railway. That this is not a merely negative attitude is shown by the fact that the port of Karachi is undergoing considerable enlargement at the present time, in order to increase its loading capacity, and that by this means accumulations of grain at the port during the summer months may be minimized or avoided. In face of the uncertainty of large wheat exports from India in future years, the Port Trust is probably pursuing a prudent policy in sinking capital in quays which can handle all kinds of cargo rather than in elevators and loading galleries which can be used for grain alone.

Yet again, the introduction of the new system would require the maintenance of an inspection service for the grading or certifying of grain—a most difficult problem in India—and would involve the provision of suitable rolling-stock by the railways. The existence of obstacles such as all these make it appear improbable that bulk handling of grain will be introduced into India within the near future, if at all.

Ports and Port Handling

The long coast-line of India is peculiarly devoid of natural harbors, and the overseas trade is practically restricted to five major ports. Karachi is the only port north of the Tropic of Cancer; it lies near the mouth of

[1] These statements are based on official data for weekly arrivals at Calcutta, Bombay, and Karachi, in the years 1911–12 to 1915–16.

[2] From the same source as Table 5.

[3] See especially F. Noël-Paton, *op. cit.*

the Indus, in Sind, not far from the border of Baluchistan. It is far and away the principal wheat port; before and during the war it handled, on the average, around 80 per cent of the wheat shipments, and since the war it has handled all but about 4 per cent. Bombay, on the west coast of the peninsula, was the leading wheat port in the 'eighties, but has long since been a poor second to Karachi in this respect. Calcutta, near the mouth of the Ganges in Bengal, was the principal wheat port in the earliest days of the trade, was an important wheat port until the 'nineties, and in some years before the war it shipped more wheat than Bombay; but during and since the war its wheat exports have been very small.[1] Madras, on the southeast coast of the peninsula, and Rangoon, in Burma, chiefly important for rice shipments, handle no wheat.

Several natural advantages have combined to concentrate India's export wheat trade in Karachi. In the first place it is the nearest port to the Punjab, which is best suited of all the provinces of British India to the growing of wheat and produces a large exportable surplus. At the present time, also, the hinterland of Karachi produces no other commodity which competes with grain for shipping space at Karachi, whereas Calcutta exports rice and jute in large quantities, and Bombay cotton and manganese ore. It is not easy to predict how long Karachi will continue to enjoy this advantage, because the development of cotton growing in Sind, dependent on the progress of an immense irrigation system now under construction, may provide a considerable export traffic in cotton in future years. Furthermore, Karachi lies outside the region of monsoon rains and can therefore accumulate large stocks of the harvest shipments of wheat in the open air, to be shipped out gradually as tonnage becomes available. Bombay and Calcutta, on the other hand, experience heavy rainfalls during the summer monsoon and must pay the price of storing grain under cover. Nevertheless, in partial compensation for this handicap, the wheat harvests of the United Provinces and the Central Provinces occur about a month before the wheat harvests of the Punjab, and in past years, when shipments of wheat from Bombay and Calcutta were important, the peak of the movement through these ports took place some weeks before the peak of the much larger movement of the Punjab crop through Karachi in the second half of June or in July.

The port handling need be described with reference only to Karachi. The sacked wheat is unloaded into the exporters' *godowns* (warehouses), and there sampled and weighed. It is then emptied from the bags onto a heap in the *godown,* and thus mixed in with other lots to secure a good average quality of wheat for shipment. Lots containing a large proportion of impurities may be mixed in small quantities with cleaner lots of wheat or may be cleaned before mixing. From the large mixed heaps in the *godowns,* the wheat is then resacked for ocean shipment in even weights of two hundredweight (224 pounds). The sacks are carried to the ship's side by rail, and are loaded by cranes. As much as 2,000 tons of grain can thus be placed on board a ship in a day.

In the earlier years of the Indian wheat trade, the carrying capacity of the North-Western Railway, from the Punjab to Karachi, was regarded as the factor which limited Karachi's exportation of wheat. In the course of time, improvements to the railway, including double-tracking, have relieved this constriction, and at present the limit to Karachi shipments is imposed by the number of loading berths in the port. During periods of heavy deliveries by the railways, grain thus tends to accumulate in large quantities in the exporters' hands, and must go into storage. In most modern grain ports, storage space is provided by grain elevators; but in Karachi, once the exporters' covered *godowns* have been filled, the surplus is stacked in the open air. Because of the extremely low rainfall of Sind and the absence of industries, land in the neighborhood of Karachi has comparatively little value in use, and large areas between the city and the port have been systematically reserved to provide space for stacking grain sacks in the open during the summer months when the risks of damage by rain are negligible.

[1] See Appendix Table XI, for statistics of wheat exported from the different ports annually since 1872–73.

VII. WHEAT EXPORTS, IMPORTS, AND PRICES

In this section we deal with various aspects of India's export and import trade in wheat and flour, and with certain characteristic relations between wheat exports and wheat prices. The historical development of the export trade is largely reserved for subsequent consideration.

Volume and Importance of Exports

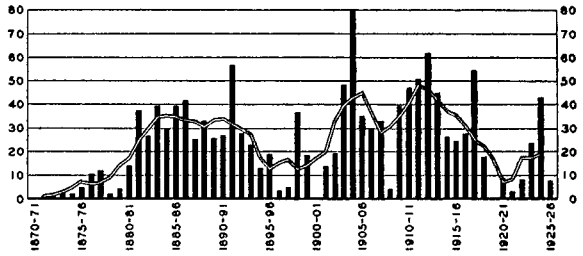
In the export trade of India, wheat and flour rank as valuable products but far below the top of the list.[1] Since 1890–91 the only year in which they have gained first place was in 1891–92, when they constituted 14.2 per cent (by value) of the total seaborne exports of British India. Even in 1904–5, which was the year of their maximum export by volume, wheat and flour contributed only 12 per cent of the total value, and were exceeded by the exports of rice. In every other year since 1890–91, rice and raw cotton, and in most years raw jute and tea also, have been more important; while since 1913–14 jute gunny cloth and usually also jute gunny bags have been more important. In the period of maximum exports from 1903–4 to 1913–14, wheat and flour exports averaged only 6.4 per cent of the total exports from British India by sea; in the first six post-war years the average was only 2.5 per cent, and in the post-war year of maximum exports, 1924–25, the proportion was under 5 per cent.

A broad view of the course of India's exports of wheat is afforded by Chart 9, which shows the gross exports of wheat grain (by sea) annually since 1870–71. The Indian fiscal year ending March 31 is well suited to this purpose, for the bulk of the exports from a crop are made in May and subsequent months. The vertical bars on the chart represent annual figures, and reflect the marked variations from year to year; the curved line, representing a centered 5-year moving average, gives a better view of trends and levels. As always in a country which consumes the great bulk of its crop, the annual variations in exports are relatively large—a small crop permitting very little export, a large crop permitting exports to reach high figures.

The chart shows clearly the beginnings of India's export trade in the 'seventies; the rise to real importance in the 'eighties; the marked decline in the 'nineties; the recovery early in the twentieth century to a new high level, with a year of record exports in 1904–5; the subsequent decline caused chiefly by the crop failure of 1908; the rise to a record level in the five years before the war; the decline during and after the war; and the recent moderate recovery.[2]

Chart 9.—Wheat Exports from British India by Sea, Annually, 1870–71 to 1925–26, with 5-Year Moving Average Centered*

(Thousand bushels)



* Gross figures, exclusive of flour, for Indian crop years April–March. See Appendix Tables XII A, XII B.

Flour exports from India are usually small by comparison with her wheat exports, though in occasional years of very low wheat exports, as in 1900–1, 1919–20, and 1921–22, the flour exports are the larger. In the middle 'nineties, when the statistics first became available, the flour exports were the equivalent of slightly over 1,500,000 bushels a year. They reached their peak in 1913–14, at the equivalent of 4,235,000 bushels. They remained heavy during the war years; latterly they have averaged around 3 million bushels a year.

Imports

India usually imports small quantities of wheat and of flour, but very rarely is a net importer of either.[3] Flour imports into India are almost negligible. The maximum, equivalent to 355,000 bushels of wheat, was

[1] See Appendix Table XIII, for values of the principal exports annually from 1890–91.

[2] See further below, pp. 380–82, 385–90.

[3] Annual figures, so far as available, are given in Appendix Tables XII A, XII B.

reached in 1908–9, but they have exceeded 200,000 bushels in only three years, and usually run much lower. In 1900–1, after a very short crop, wheat exports were only 345,000 bushels and wheat imports were 1,310,000, but flour exports, though small, so much exceeded flour imports that there was a net export of wheat and flour equivalent to 332,000 bushels of wheat. Until after the war, however, wheat imports never much exceeded a million bushels, and attained this height only in 1896–97, 1900–1, and 1908–9. In 1918–19 wheat imports for the first time surpassed 2 million bushels, but these were exceeded by wheat exports and there was a net export of wheat and flour of over 17 million bushels. Most of these imports were made in March 1919 in anticipation of the poor harvest, and really belong with the next crop year. In two crop years (April–March) since the war, however, India has been a net importer, as shown by the figures below, in thousand bushels:

	Exports	Imports	Balance
1919–20			
Wheat	323	5,537	5,214 net import
Flour as wheat.	2,571	14	2,557 net export
Total.....	2,894	5,551	2,657 net import
1921–22			
Wheat	3,017	16,426	13,409 net import
Flour as wheat.	3,436	104	3,332 net export
Total.....	6,453	16,530	10,004 net import

Australia is the natural source of India's wheat imports, when they are not purely incidental in character. This is true partly because of Australia's relative proximity, and partly because its wheat is available (and seasonally lowest in price) toward the end of India's crop year, when prices in India tend to be highest and the largest importations are usually made. In 1921–22, however, large imports were made in the closing months of 1921, and these came chiefly from the Pacific Coast of the United States.

Factors Determining Yearly Exports

The volume of exports in a particular year is affected not merely by the size of the current crop, but by preceding and succeeding crops, reflecting a considerable but indeterminate adjustment of stocks. The largest exports are usually made from a large crop following one or more large crops, when the new crop also promises well, as in 1904–5, 1912–13, and 1924–25. As we have seen, India's high average of exports during the period immediately preceding the war was due to the unusual good fortune of four good crops in succession, ranging from 360 to 380 million bushels. After two or more large crops, exports may continue in a year or two of mediocre crops, as in 1925–26 and 1926–27, because of good carryovers. Exports are small from a good crop after a poor crop, as in 1922–23, because of the necessity for reconstituting depleted stocks; and they are the smaller when, as in 1920–21, the new crop following starts under unfavorable conditions.

The price of wheat and the prosperity of the Indian workers are also important factors in determining the volume of exports in a season. There is a considerable elasticity in domestic consumption. When domestic wheat prices are low in relation to prices of other foodstuffs, or in relation to earnings, consumption in the towns and cities increases at the expense of other foods or in addition to them. High export prices draw out considerably greater quantities than would be exported at low prices. It is the combination of these various influences that largely determines the volume of exports in a particular crop year.

The early estimates of the Indian crop are usually fairly close to the final figure. Hence in April or May one can usually make a reasoned estimate of the probable volume of exports during the Indian crop year, April–March. Such an estimate cannot, however, be made with precision, in part because the amount of stocks varies a good deal and no statistics of stocks are gathered; in part because consumption and waste vary considerably; and still more because exports in the latter half of the crop year depend heavily upon the developing prospects for the new crop, as estimated from the summer and winter rainfall. Occasionally, also, radical price changes are important. Thus exports in the spring and summer of 1924, when world prices

were low, were very moderate in view of the size of the crop, but the sharp advance in the international market called forth unusually heavy exports from October to February, inclusive.

The forecast of India's contribution to the international wheat market during what may be termed the international crop year, August–July, is far more difficult, primarily because, apart from the factors named above, the bulk of the exports from the preceding crop will have been shipped before August 1, and as a rule the major portion of the exports, August–July, will be made from the subsequent crop, which is not planted until the autumn. Such forecasts, if made in August or September, can be little more than crude guesses. The best that one can do is to estimate the remaining exports from the old crop and the April–July exports from the new crop, assuming it to be of average size. When the summer rainfall, the acreage sown, and the early season conditions are known, something more than a guess may be hazarded; but since the difference between a mediocre yield and a good yield is usually determined during the winter, one must wait until the approximate size of harvest is known before gauging the prospects of exports for the year ending July 31. Since official estimates are seldom available before March or April and are seldom comprehensive until May, and since private estimates are often wide of the mark, the export position is not clear until spring.

Export Destinations

The great bulk of India's wheat exports goes by sea to northwestern Europe, the United Kingdom usually taking well over half of the total.[1] Exports to Mediterranean Europe are relatively much smaller, as a rule, despite the greater nearness of these consuming regions. The small remainder goes chiefly to Egypt — whence some part at least is doubtless reconsigned to other countries — and to miscellaneous destinations nearer India, much of this to be consumed — like India's exports of flour — by Indians abroad. The overland movement is relatively insignificant.[2]

The United Kingdom has always been the greatest overseas consumer of Indian wheats. In 1904–5 and 1912–13 England took more wheat from India than from any other single source. In the period 1909–10 to 1913–14, Great Britain purchased a yearly average of 37 million bushels of Indian wheat, or three-fourths of India's average total export of some 49 million bushels. This figure, obtained from Indian export returns, checks very closely with the figure of 36 million bushels calculated from British trade statistics to be the average yearly importation of wheat from India, and clearly represents the actual yearly consumption of Indian wheat at that time by Great Britain. Such confusion as is found in the statistical record of wheat movements from Canada to Great Britain is entirely absent from these figures of the Indian trade. Since the war, the exportation of Indian wheat has been much smaller, and the British proportion has been around 70 per cent.

Belgium stands next to Great Britain, though far behind her in the list of purchasers, taking as a rule anything up to 4 or 5 million bushels a year of Indian wheat. The bulk of this wheat commonly goes to the Antwerp market for distribution to Belgium, Holland, and Rhenish Germany. France has been on the whole nearly as good a customer for Indian wheat as Belgium and indeed, allowing for Belgian reexportation, probably a larger consumer. The bulk of the Indian wheat supplied to France is shipped from Bombay to Marseilles; a part of it is probably semi-hard wheat grown in the Central Provinces and Central India, which is used for making alimentary pastes. To Italy, Indian wheat exports have almost always been smaller than those to Belgium or France, having seldom risen beyond 2 million bushels a year; Bombay has been the principal shipping port and Naples the principal receiving port. Probably an even larger fraction than in the consignments to France consists of hard wheat for the manufacture of macaroni and other pastes, though ranking below the durum wheats of Russia, North Africa, and the United States.

[1] See Appendix Table XV for annual exports by destinations since 1880–81.

[2] See Appendix Table XII B.

Shipment from India

During the busy months of the year, in years of considerable shipments, a large part of the wheat shipped from Karachi is shipped in full cargoes by tramp steamers, while the cargo liners regularly engaged in the Indian trade also carry wheat in large consignments which may constitute a great part of their freight. In years and months of small shipment, the tramps may largely withdraw from the trade, and practically all the wheat be carried by the liners, often in parcels of a few hundred tons. Wheat from Bombay and Calcutta is carried almost exclusively by liners, chiefly because of the extent of liner services to these ports and the limited quantities of wheat available there for shipment.

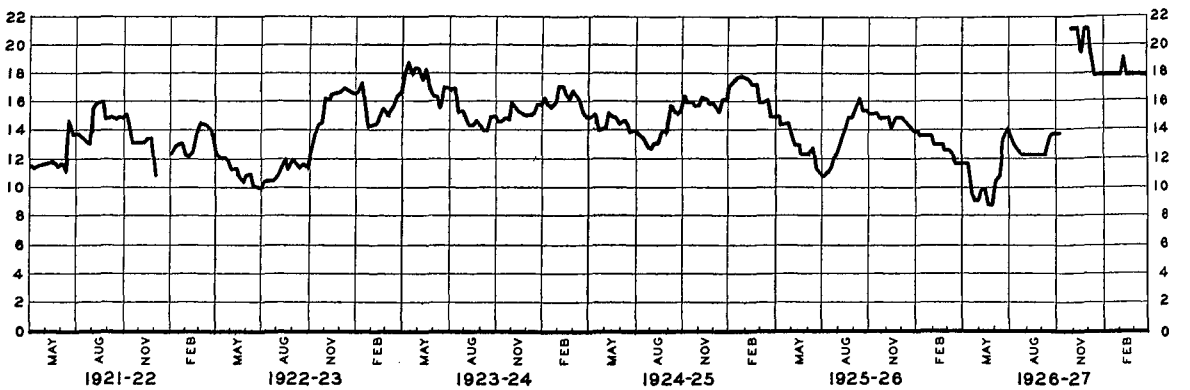
The shipments by tramp steamers are sent to various destinations in western Europe. Shipments to Great Britain, however, move chiefly by three routes—Karachi to Hull, Bombay to Liverpool, and Calcutta to London. These may be explained in part by the preferences of these different English markets, in former days, for the kinds of wheat that were characteristically shipped from the respective Indian ports; and in part by the existence of strong liner connections, which are probably to be regarded as a response to strong demands for traffic between the two ports of each pair. Although wheat is not a highly profitable freight for liners, its shipment may have been one of the influences which have led to the growth of these connections, especially in the case of Karachi–Hull; but other commodities have had greater influence in the cases of Calcutta and Bombay.

Only the freight rates for charters of tramp steamers appear to be published in the British grain-trade press. The liner companies either do not quote definitive rates to all shippers or prefer to keep knowledge of such rates as much as possible to themselves. The absence of this information is matter for regret, because the predominance of liner shipments in the Indian wheat trade makes it probable that liner berth rates are more important than tramp charters in determining price spreads between England and India. In periods of heavy movement, exporters tend to draw upon available shipping from the Mediterranean and the Black Sea, and the charter rate may thus at times reflect the cost of a voyage in ballast through the Suez Canal to Karachi.

The weekly course of reported rates on wheat from Karachi to Great Britain, for the past six crop years, is shown in Chart 10. Throughout this period ocean tonnage has been abundant in relation to the demand, except during 1926–27, when the British coal strike caused a notable advance.[1] During most of the period the rates, on what may be considered a depressed

Chart 10.—Ocean Freight Rates on Wheat from Karachi, India, to United Kingdom, Weekly, 1921–22 to 1926–27*

(U.S. cents per bushel)



* Data from *International Crop Report and Agricultural Statistics*, here converted to United States currency from shillings and pence per quarter. The tabular data may be obtained from the Food Research Institute on request. Gaps indicate absence of quotations.

[1] On this advance, see Wheat Studies, January 1927, III, 152–56, 173, and May 1927, III, 271–72, 295.

level, ranged usually between 11 and 17 cents a bushel, and averaged about 14 cents. Only once has the rate fallen below 10 cents a bushel, and this in the spring of 1926, when shipments were light. The seasonal variations in rates are not clearly defined, but there is a tendency for rates to be at a minimum in the spring and at a maximum in the autumn. The volume of India's wheat exports exerts some influence on the rates, at times decisively; but they are determined much more largely, as a rule, by broader influences affecting tonnage supply and demand.

Seasonal Character of Export Movement

India's wheat export movement shows a pronounced seasonal character. This is clearly revealed by Chart 11, which shows by vertical bars the monthly exports of wheat from British India by sea (constituting the great bulk of the total) from April 1902, together with a curve representing a centered 3-month moving average which smooths the monthly figures slightly. As a rule over half of the exports moves out in the months of May–August; July is almost invariably the peak month, though occasionally June, which is usually a good second, has outranked July. The export movement is generally very light in the months of December to April.

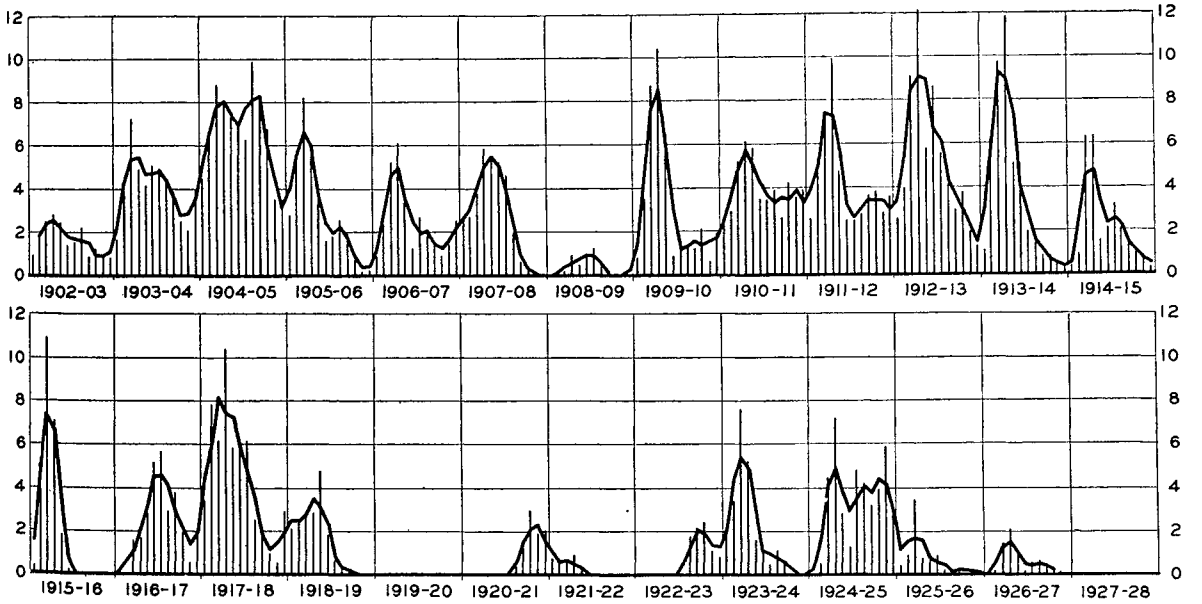
The average or characteristic seasonal variation in pre-war years, as derived from monthly data over the 12-year period 1902–3 to 1913–14, is indicated by the following index figures:[1]

Apr.	52	Aug.	135	Dec.	65
May	108	Sept.	103	Jan.	64
June	181	Oct.	101	Feb.	36
July	210	Nov.	92	Mar.	53

In general, years of heaviest shipments show a more nearly uniform distribution over the year. Radical departures from these averages occasionally occurred, for special reasons, before the war. During the war, shipping conditions and other factors materially disturbed the course of shipments, and since the war there have been

Chart 11.—Wheat Exports from British India by Sea, Monthly, 1902–3 to 1925–26, with 3-Month Moving Average Centered*

(Thousand bushels)



* Gross figures, exclusive of flour. See Appendix Table XIV.

[1] Computed by the Persons' link-relative method. F. Noël-Paton, *Indian Wheat and Grain Elevators* (Calcutta, 1913), p. 4, gives the following simple average percentages for the ten years ending 1911–12: 58, 107, 176, 188, 136, 90, 94, 97, 76, 69, 46, 64.

some instances of more extreme departure from these averages. Thus in 1920–21 and 1922–23, after poor crops, exports were restricted in the early months of the crop year, until favorable prospects for the next crop were assured; and in 1924–25, the great advance in prices in world markets called forth a much larger volume of exports than would otherwise have been made during the autumn and winter. Something like the pre-war seasonal variation, however, is likely to obtain in the future, but as long as the volume of shipments remains small the movement is likely to be more irregular; and with the Punjab now almost the sole source of exports, the characteristic movement will probably be somewhat later because of the later harvest.

The characteristic seasonal variation is attributable to several influences. In the first place, the producers are under strong pressure to sell their grain promptly after harvest. Such pressure is to be found in all producing regions of the world, but it is peculiarly severe in India, where the growers are, as a rule, heavily in debt, and wheat, their chief cash crop, is a commodity liable to deterioration. To minimize risk of damage in storage and the cost of protection against damage, middlemen and exporters have good reason to move their purchases quickly.

The usual character of the world's demand at this season provides additional inducement to early exportation, because Indian wheat will then arrive in European markets at its most advantageous time of the year, when the rush of shipments from the Southern Hemisphere is spent, the earliest crops of the Northern Hemisphere have scarcely been cut, and the only serious competition to be encountered is the spring movement of wheat from western Canada, following quickly upon the opening of navigation of the Great Lakes, and the early shipments of new winter wheats of the United States. Midsummer arrivals of wheat from India are as a rule especially welcome in Great Britain, because the great dryness of Indian wheat makes it particularly suitable for blending with the damp wheats of the British crop. Moreover, the earlier shipments are most likely to be free of weevils and otherwise in good condition; for later shipments the risk of poorer quality tends to depress their price.

Exports and Prices

The relation between prices of wheat in India and in the world markets cannot be traced with precision, partly because of limitations of data on prices and quality. A few broad statements, however, can be made with some confidence, and an interesting seasonal relationship merits discussion.

The volume of India's wheat exports is materially influenced by the level of wheat prices.[1] Repeatedly in the history of the trade, radical advances in prices in foreign markets have called forth exceptional exports from India. The first notable instance was in 1881–82, on a speculative movement in the United States. Others occurred in 1891–92, a year of famine in southern Russia; in 1898–99, the year of the Leiter corner; and in 1904–5, 1909–10, 1917–18, and 1924–25. On the other hand, when the level of wheat prices declines or is at a low level, exports are restricted even if crops are good. The most notable instances of this were in 1884–85 and in 1923–24. This implies that the Indian market demand, for consumption and storage, is elastic with respect to price.

Normally wheat prices in active export markets, such as Karachi, tend to run a course roughly parallel with prices in Liverpool. Substantial changes in the level of world wheat prices tend to be reflected in the Indian markets chiefly through influencing the volume of wheat withdrawn from the Indian market for export. Even in years when India is a substantial exporter, however, changes in costs of shipment cause special divergences between prices in India and those in importing markets. The parallelism is also disturbed by reason of changing differences in prices of different wheats in Liverpool, for to a considerable extent Canadian, American, Australian, Argentine, Russian, and Indian wheats are so different that substitution of one for another is accomplished with friction and only under a price stimulus. In general, Indian wheats are among the

[1] Compare Chart 9, p. 363, Chart 11, p. 367, and Chart 14, p. 386.

lower-priced wheats in British markets, but their position in the range of Liverpool prices varies from year to year.

At times, as shown by Chart 11 (p. 367), India exports no wheat, either because of government restriction, as in 1919–20 and 1921–22, or because export shipments are unprofitable. At such times wheat prices in India fluctuate out of line with world market prices. (See Chart 14, p. 386.) In such periods prices in India may rise so high that imports are attracted. This has been true in several years since the war,[1] including the season just past. The range of variation in prices is normally wider in a country which is now on an export basis and now on an import basis, than in one which is consistently an exporter or an importer, especially when it is (like India) distant from other producing and consuming regions or maintains (as India does not) high import or export duties. Since India is today less continuously an exporter than in pre-war years, the margins between Liverpool prices and Indian prices are, and may be expected to continue, more variable than before the war.

Within India, export prices exert an influence on prices of wheat for domestic use, but variations in crops in the different regions, the limited degree of internal trade, and transportation costs combine to prevent prices in different markets from reaching a common level or from maintaining any constant relationship. This is made abundantly clear by series of monthly wholesale prices at seven Indian markets, for the period January 1905 to April 1916, which are given in Appendix Table XVII. But analysis of these relationships would carry us too far afield.

Seasonal Variations in Prices

There is a fairly characteristic seasonal variation in wheat prices in India; it is significantly associated with the seasonal variation in exports discussed above, and with the seasonal course of wheat prices in England. The late F. Noël-Paton, for a number of years Director of Commercial Intelligence in India, published some valuable material and analyses on this subject in his work on *Indian Wheat and Grain Elevators* (Calcutta, 1913), in which he argued the advantage of introducing into India a modern system of country elevators. Unfortunately it is not easy to summarize his material, his statistical procedures leave much to be desired, and he did not publish the price data from which a fresh analysis can be made.

For analysis of seasonal variation in Indian wheat prices, Noël-Paton utilized price data for the ten years ending March 1912 for six markets in the Punjab—Delhi, Lyallpur (the center of the irrigated area), Lahore, Amritsar, Ferozepore, and Multan; taking for each market "the recorded monthly wholesale prices, in each case the average of two half-monthly returns," probably for the middle and end of the month. For the first two markets separately and the other four combined, he computed indexes of prices for each year in terms of the average of April, May, and June prices as 100. For each month the ten index figures were averaged to get indexes of seasonal variation as follows:

Month	Delhi	Lyallpur	Four markets	Six markets
Apr.	103.1	104.7	104.9	104.6
May	99.0	98.7	99.1	99.0
June	97.9	96.6	96.0	96.4
July	101.6	99.6	98.3	99.1
Aug.	102.5	104.1	102.5	102.8
Sept.	100.7	103.0	104.3	103.5
Oct.	103.3	106.7	105.1	105.1
Nov.	107.1	109.0	109.1	108.7
Dec.	107.6	111.0	110.9	110.4
Jan.	111.2	113.4	113.8	113.3
Feb.	112.9	111.7	113.7	113.2
Mar.	108.8	109.3	111.2	110.5

Using the Persons' method of calculating an index of seasonal variation, we have made a computation from Noël-Paton's material, employing a lengthy and not altogether certain process of reconstructing monthly price series from the index form

[1] See above, p. 364, and Appendix Table XII B. During the war, for a multitude of reasons, the margins between Liverpool and Karachi prices varied to an extraordinary degree.

in which he gave them. The results are as follows:[1]

Apr. ... 99.5	Aug. ...101.2	Dec. ...102.0
May ... 95.2	Sept. ...100.0	Jan. ...103.9
June ... 94.2	Oct. 99.0	Feb. ...104.5
July ... 97.4	Nov. ...100.6	Mar. ...102.4

In so far as these results and Noël-Paton's differ from the index we present below, the differences may be explained largely by the facts that the markets used are different, the periods covered are not the same, and the basic price data refer to different dates in the month.

We have prepared an index of seasonal variation of monthly prices of Karachi White at Karachi, from data relating to the *first week* of each month, by the same method as was used in computing the seasonal index of exports, but (for lack of data for 1902–3 to 1904–5) covering the eleven years 1905–6 to 1915–16. The results are as follows:[2]

Apr. ... 99.9	Aug. ... 97.1	Dec. ...101.4
May ... 99.9	Sept. ... 99.6	Jan. ...102.1
June ... 96.2	Oct. 100.1	Feb. ...104.5
July ... 96.3	Nov. ...100.5	Mar. ...102.5

So great are the fluctuations in prices from one year to another, under the influence of world markets and India's peculiar conditions, that Indian prices rarely show so orderly a seasonal development; but this index may be accepted as a rough measure of the seasonal element in price variations in many years. Indexes based on prices for other Indian markets would be somewhat different, but probably not radically so; though in interior regions of earlier harvest, and probably also in Calcutta and Bombay, minimum and maximum prices would be reached somewhat earlier.

The range of this seasonal index is from 96.2 early in June (and about the same early in July) to 104.5 early in February, almost 9 per cent higher. A weekly index would probably show a slightly greater variation. Probably the minimum is reached around the middle of June, and the maximum late in January. The tendency is naturally for the lowest prices to prevail shortly after harvest, when the cultivators and dealers endeavor to sell the unstored new grain before the monsoon rains begin, and when the movement into Karachi is at its height.[3] Prices tend to advance considerably in July and August, because the unshipped grain has gone into storage and tends to be firmly held until the end of the monsoon on the reasonable certainty of a moderate advance in price and the chance of a radical increase if the monsoon should fail. Ordinarily, when the rains are sufficient, the price advances more slowly in September–November; but when the rains fail, no such relaxation occurs, and the price may jump up by 5 or 10 per cent a month. In November–December prices tend to advance somewhat more rapidly, as storage charges accumulate. In January a sharp advance tends to occur, perhaps because of the closer holding by dealers at this time, when the growing crop is especially subject to risks of drought, excessive rain, rust, and frost. In the next two months, before new wheat becomes available, prices tend to decline from the peak early in February to about average in April and early May. This decline is presumably attributable to the release of stocks by dealers as the harvest becomes assured; in occasional years when yields are poor, prices may advance at this period instead of declining.

It has been argued, doubtless with truth, that the seasonal variation in Indian wheat prices is excessive—that it is due not only to inevitable costs of handling, interest, and insurance, but in considerable measure to loss and damage in storage. Doubtless these losses could be reduced (though by no means eliminated) by the erection of improved storage facilities, but it remains an open question whether the savings would overbalance the capital charges involved.

Undoubtedly the seasonal variation in Indian wheat prices, and especially the depression immediately after harvest, would be still more pronounced if it were not for the export outlet, through which large quantities are drawn off the domestic mar-

[1] In showing a seasonal decline from August to October, it differs from Noël-Paton's indexes and from the index number of Karachi prices that we have computed. If this decline has significance, it is probably to be explained by a temporary diminution in the demand for wheat resulting from the ripening of the *kharif* crops—whose grains, because of their higher moisture content, are usually consumed soon after harvest.

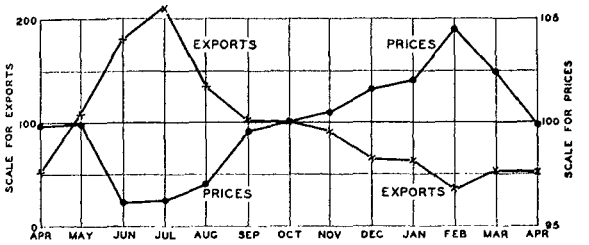
[2] Based on Appendix Table XVII.

[3] See above, pp. 360–61.

ket at a time when they tend especially to depress prices. In this fact, and in the fact that price variations from year to year tend to be lessened by exports of variable quantities, lies part of the justification for maintaining the export trade in Indian wheats.

The significant relation between Karachi prices and Indian exports is indicated by Chart 12, in which the two indexes of seasonal variation are plotted, on considerably different scales. The marked tendency for exports and prices to vary inversely is clearly indicated; indeed, the inverse correlation is almost perfect. There is naturally some lag between purchases and exports, but since the price index is based on prices in the first week of the month, and the export index on exports of the month, this lag is at least partially allowed for in the chart.

CHART 12.—INDEXES OF SEASONAL VARIATION OF WHEAT EXPORTS FROM BRITISH INDIA BY SEA, 1902–3 TO 1913–14, AND OF WHEAT PRICES IN KARACHI, 1905–6 TO 1915–16*



* Computed by Persons' link-relative method from data in Appendix Tables XIV and XVII.

In Liverpool the seasonal element in the movement of prices of imported wheat is very slight.[1] This is largely the result of having a large number of export regions, with different harvest and shipping periods, on which to draw, and of the skill of the British grain trade in buying wheat in each source of supply when it is cheapest. When, therefore, wheat prices in India are especially low, notably in the period of several weeks centering in July, British purchasing is stimulated by price differentials; while during the winter months, when Indian wheat prices are seasonally high, British purchases in India are light, and Australian and Argentine wheats are sought instead. Prices of home-grown British wheats have a fairly pronounced seasonal variation, usually reaching their peak in August and their low point in October. Indian wheat therefore reaches the British market in largest volume at or shortly before the time when new British wheats are low in price, and the blending of the two is favored by this fact as well as by considerations of milling quality. On the whole, Indian wheats in Liverpool tend to stand at a discount in the British market except during September–December, when they are in special demand for blending with British and Russian wheats which are then seasonally cheap.

VIII. INDIAN WHEATS AND THEIR IMPROVEMENT

The commercial classes of Indian wheat known in the export trade constitute a selection from the large number of botanical varieties of wheat which are cultivated in different parts of India. By a singular turn of events it happened that the classes of wheat first approved by the British markets were soft, white wheats, well suited to the stone milling of the time. In consequence, considerable encouragement was given to the cultivation of such wheats, and they became the standard types for exportation. Meanwhile milling and baking practices underwent great changes and wheat buyers transferred their preference to harder wheats yielding stronger flour. For certain good and peculiar qualities of their own, Indian soft wheats still continued in fair esteem and for a long time it passed almost unobserved that India could produce also hard wheats, yielding strong flour. This potentiality was first effectively discovered in 1906. Since then great efforts have been made, with splendid success, to

[1] A seasonal index of prices of Karachi White wheat in Liverpool, computed by the Persons' method from a monthly series of prices obtained from Broomhall's *Corn Trade News* and *Corn Trade Year Book* for the ten years ending March 1912, using the mean of daily prices for about the 5th, 15th, and 25th of each month, gave the following results:

Apr. 99.1	Aug. 99.2	Dec. 100.5
May 100.9	Sept. 99.3	Jan. 101.2
June 98.8	Oct. 100.1	Feb. 100.7
July 99.2	Nov. 100.1	Mar. 100.4

select the best native types of hard wheat for India, and to distribute the most highly approved varieties for general cultivation.

Early Analyses

The first steps toward an improvement of Indian wheats and the expansion of the export trade were made in 1877, when the government of India called for samples of wheat and reports on the practices of cultivation from all wheat-growing districts of India. The large collection of samples was submitted to Dr. Forbes Watson, the expert in economic products employed at the India Office in London. He reported in 1879 that a large number of the samples submitted to him were greatly superior to the ordinary types of Indian wheat then offered for sale on the British market. He attributed this inferiority of the commercial grades to a limited production of the superior varieties and a strong demand for them in India, which made it more profitable to export principally the poorer kinds, and he advised a policy of distributing the seed and encouraging the cultivation of the better types. He also recommended a series of careful milling and baking tests to determine more precisely the commercial qualities of the principal kinds of Indian wheat.

These tests were made in 1882 by Messrs. McDougall Brothers, a leading London firm of millers. Four kinds of wheat—hard red, hard white, soft red, and soft white—were submitted for testing, and they were milled by both stone and roller grinding. The McDougall report praised the great dryness, thin bran-coat, and high flour-yield, but stated also that on account of bad flavor and other defects Indian wheats would not come into demand for manufacture into flour without a liberal admixture of other wheats.

Both Watson and McDougall Brothers selected the soft white varieties as the most suitable kind for Indian cultivation and exportation, being guided in this recommendation by the milling practices and market preferences of the time. Stone milling, which was then still in vogue in Great Britain, gave preference to wheat with a soft, friable kernel and a white bran-coat which would not discolor the flour. The process of gradual reduction between rollers gave preference, on the other hand, to a hard wheat with a vitreous kernel and a tough bran-coat, a type of wheat that has subsequently been described as "free-milling." Wheats of this latter kind have further proved in general to yield flour considerably stronger and more valuable to the commercial baker. In 1882, at the time of the McDougall report, stone milling was rapidly giving place to roller milling, but apparently it still predominated sufficiently to hold the price of soft white wheats well above the prices of other kinds. With only minor and ineffective mention of roller milling and hard wheats, both reports concurred in recommending the cultivation of soft white wheats as most profitable to the producer and most satisfactory to the purchaser. Unfortunately, the hard Indian wheats submitted to McDougall Brothers have since been shown to have been macaroni wheats, which were by no means suitable for bread making; and the preference they expressed for the soft wheat may have been due in large part to this mischance.

Efforts toward Improvement

At the time of these reports, the prevalent wheats of the Indus basin were soft and red, and in the Ganges basin soft and white, and indeed so they remain to this day. In spite of the cultivation of excellent wheats in many parts of India, the bulk of the production was apparently poor, on account of the increased cultivation and selection required to raise superior varieties. After the presentation of the reports, the government of India determined on a policy of improvement, and through the provincial departments of agriculture encouraged the cultivation of better wheats by a widespread distribution of seed. Apparently in framing this policy, it thought only of encouraging the growth of the soft white wheats then preferred by Great Britain and paid little or no attention to the possible advantages of other kinds of wheat more suitable to other countries or to the domestic trade.

The work of improvement was actively undertaken. In the Narbada Valley of the Central Provinces, the cultivation of an

indigenous variety of soft white wheat, termed *pissi* or *desi pissi*, was encouraged. Another soft white wheat of excellent quality, found in Muzzaffarnagar, a district lying between the Jumna and the Ganges, was widely distributed through the Punjab and the western districts of the United Provinces. A third type, found in the vicinity of Buxar, at the other end of the United Provinces, was distributed in what is now the province of Bihar and Orissa and in the eastern portions of the United Provinces. Many attempts were made at the same time and in subsequent years to introduce new varieties of wheat from other countries, but all met with ultimate and complete failure. In general, wheat must grow in India in so short a time and under such severe conditions that only the long-selected wheats of the Indian cultivators can survive to bear fruit; imported varieties demand excessive care and watering, ripen too slowly, give poor returns, or succumb to attacks of rust.

It is worth recalling that in 1888, at a time when trials of imported wheats were at the height, a number of samples of Indian wheat were sent to Canada, in the hope that their rapid growth might make them suitable for cultivation in the West, where the early autumn frosts so greatly threaten the crop. They failed in Canada because of too low yield, but one of them became a parent of the famous Marquis wheat, which has done so much to insure and extend profitable wheat growing in the Prairie Provinces. The prosperity of Western Canada may thus be said to depend in considerable part upon the patient efforts of generations of Indian peasants to select a quickly ripening wheat. Perhaps some new Canadian discovery may one day repay the debt.

Before the days of the export trade, these soft white varieties had usually commanded a lower price in the domestic market than the harder and more vitreous kinds, but with the growth of an export demand, they became the more valuable. Their cultivation expanded rapidly and they soon became, in pure or mixed form, the staple types of Indian wheat in foreign markets. Such hard wheats as India exported were to be found merely as undesirable impurities in the soft wheat, or else in consignments of the straight run of country wheat.

So long as Indian hard wheats continued to be exported under such unfavorable circumstances, it was natural that the good qualities of individual botanical varieties should be overlooked by the British miller and that no separate demand for them should arise. From 1890 to 1905, the principal quest of cerealists in India was a remedy for rust or the production of a rust-resistant wheat, and the problems of milling and baking quality were disregarded. In 1899, Farrer, the distinguished Australian wheat-breeder, reported to the government of India that certain varieties of Indian wheat yielded flour of high strength, and recommended their extensive propagation. Apparently no notice was taken of his advice, and the cultivation of soft wheats for export continued unchecked.

Commercial Varieties of Export Wheats

Before consideration is given to the new developments in wheat culture which began in 1905, it is desirable to survey the qualities of the standard exportable Indian wheats which determine their milling values in competition with wheats from other parts of the world. Mischance determined that the demand for Indian wheat should prefer inferior kinds, a mischance which is now being set right by scientific research. In the meantime, the old types and standards continue. They play a special part in the miller's reckoning—when he can get hold of them—and to appreciate the character and tendencies of the Indian trade it is necessary to understand the peculiarities of milling demand.

More than a dozen distinct commercial varieties of Indian wheat can be found in the quotations of the British trade press and elsewhere. Some of them probably enjoyed considerable importance at one time, but the majority have now disappeared from sight. Even during the years of heavy trade before the war, staple varieties numbered only some four or five, and since the war, with the virtual disappearance of the Bombay and Calcutta trade, there has been a further reduction to only two or three.

The names of the principal commercial

varieties on the British market before the war were as follows: *Choice White Delhi, Choice White Karachi, Red Karachi, Choice White Bombay, No. 2 Club Calcutta.* Since the war, the only two varieties that have been shipped in any appreciable quantities from India are *Choice White Karachi* and *Red Karachi,* the former greatly predominating.

There are no legal or commercial definitions of these varieties and they are regularly sold on the basis of "fair average quality of the month's shipments," with an analysis to determine the admixture or "refraction" (dockage) of other grains, seeds, and dirt. Similar wheat might be shipped by different exporters under different names or grades. The only real standards of type and quality are the opinions of the British grain trade, ultimately enforced by the East India Committee of the London Corn Trade Association through its determination of standard samples.

The bases of the various export grades are the selected soft white wheats which were distributed for cultivation in the 'eighties and later. The Calcutta blends are classed and graded largely according to quality and proportion of Buxar wheat that they contain, and the Bombay blends likewise according to the *pissi* wheat of the Narbada Valley. Karachi types depend on the Muzzaffarnagar variety.

In view of their greater importance, the Karachi types deserve special consideration. The highest quality of Karachi shipments is *Choice White Delhi,* which is principally composed of well-filled soft white grains of the Muzzaffarnagar variety. Next comes *Choice White Karachi,* which contains from 75 to 80 per cent of white wheat and from 20 to 25 per cent of red. Both the white and the red grains may vary considerably in shape and color, and may be either hard or soft. Probably a large proportion of the white wheat in the mixture is of the Muzzaffarnagar variety, depreciated by the admixture of other and inferior kinds of wheat which give dissatisfaction in the bakehouse and the mill. *Red Karachi* appears to be merely a mixture of the better kinds of common soft red wheat of the Punjab, with or without admixture of white.

Milling and Baking Qualities

A curious medley of good and bad qualities is to be found in the milling and baking qualities of Indian export wheats. They are extremely dry, indeed among the driest wheats of the world. In the early years of the Indian trade British millers soon discovered this quality and took advantage of it by blending Indian wheats with the damp wheats of their home crop, or any other kind of wheat that might be damp or out of condition. The flintiness sometimes found in berries of Indian wheat apparently results from this dryness and tends to disappear on the addition of moisture. Another characteristic of Indian wheats, described in the McDougall report and there alone, may be the remarkable thinness of the bran-coat and the consequent high flour-yield of the grain.

One of the basic problems of gradual reduction milling between rollers is to secure a clean and easy separation between the flour and the offals. Wheat that is too hard calls for the use of considerable power on the rolls, and may seem horny and non-friable. On the other hand, wheat that is too soft may not granulate properly, the broken particles will cling together with a woolly appearance, and a long, slow sequence of grindings may be required to produce satisfactory flour. Between these two extremes lie the desirable wheats for milling, which break up easily on the rolls and clean up well in the separators. The term "free-milling" has been invented by Mr. A. E. Humphries as a general description of such wheats. As delivered to the miller, wheats of different kinds differ greatly from one another in respect of this milling quality and it is an important part of the miller's craft to moderate or "temper" these natural differences before grinding by treatment — "conditioning" — with water, possibly with steam and heat. The bran-coat is rendered tough and tensile by this treatment and desirable changes are wrought in the condition of the endosperm.

Indian wheats as a class are notable for the difficulties they present in milling. In general they possess the fictitious hardness due to extreme dryness and if put straight into the rollers without conditioning they

appear brittle and flinty. The term "harsh" is often applied to the flour from such wheats and is probably intended to describe the feeling of grittiness which it gives. The great advances made in the art of conditioning were applied with especial advantage to these ordinary Indian wheats and did much to make them behave as "mellow" or "free-milling." In contrast to the ordinary white wheats, the soft, white Muzzaffarnagar wheats tend always to be pasty, even after the most careful conditioning. When both kinds of wheat are present in the same mixture, as is usually the case with *Choice White Karachi*, proper conditioning and milling are difficult and flour of only lower quality can be produced. If any durum-like wheats chance to be present, the problems of milling become still more serious. As an insurance against the prospects of such difficulties, the miller carefully protects himself by limiting the price that he will pay for Indian wheats.

In the bakeshop, the behavior of flours made from Indian wheat is somewhat peculiar. During the process of conditioning the miller can take some advantage of the dryness of the wheat to increase its moisture content—and thus his output of flour—but he is restricted in this by his need to put the wheat into the best possible condition for grinding. The flour, as he sells it, may have a low water-content, and the commercial baker is able to add water liberally to it, and to secure a large yield of loaves from his flour. In so far as water absorption is a form of strength, the baker considers that flour made from Indian wheat is satisfactorily strong; on the other hand, in its ability to produce large, well-piled loaves, he finds it much less effective. Both the gluten and the carbohydrates of the flour contribute to this deficiency. Doughs made from Indian wheat flour do not become sticky or runny, but remain inelastic and viscous—"gluten-bound"—even on liberal admixture of water. In the early stages of kneading they feel sandy, and change into a uniform dough only after the lapse of time, as if the hydration of the flour were a matter of some difficulty.

Apparently the glutens in different Indian wheats do not behave uniformly. This has been attributed to deficiency of proteolytic enzymes. In the present state of our knowledge of gluten, however, such a suggestion has little meaning; and the term "gluten-bound," though widely used, conveys to the physical chemist no clear idea of attributes. It has also been suggested that, on account of high sugar-content and deficient diastatic enzyme, yeasts act feebly in fermentation. Here, again, we find explanations that exceed our technical knowledge. About all that can be said is that many Indian wheats, like some American wheats, have gluten that is not of the best quality and form doughs that do not rise well during proofing and baking.

Various remedies can be employed to reduce these baking defects of Indian wheat flours. Skilful conditioning before grinding brings the flour into better condition for baking. The baker also can secure a similar result by the addition of malt extract to his dough. Both means of improvement, however, achieve only partial success. The flavor of bread made from Indian wheats is poor or unattractive, the color is yellow or gray,[1] and even after proper conditioning and the use of malt extract, the texture of the crumb may be coarse, and the crust colorless and poor. In the practice of British millers, the only effective and satisfactory way of using Indian wheats is in mixtures, to which their cheapness, their dryness, and their stability contribute good value, and in which their deficiencies are compensated or concealed. They are, for example, particularly useful in mixtures which contain Russian wheats. The quality of blends of Russian and Indian wheats is probably due to the quantity and quality of gluten in the Russian wheat, whereby Russian wheat may be stretched with Indian wheat without loss of baking properties.

Nevertheless there are limits to the commercial bakers' use of flours which contain only a moderate proportion of Indian wheat in the blend. In Scotland, for example, commercial bread making is common and the method of baking requires the use of very strong flours. Imported Cana-

[1] Indian wheat has done a great deal to educate the British miller. Its heavy content of dirt compelled the use of elaborate cleaning machinery, its poor baking qualities much advanced the art of conditioning, and its unattractive color greatly encouraged the practice of flour bleaching.

dian flours are in principal demand, and little or no Indian wheat is consumed. In Yorkshire, on the other hand, household baking is almost universal, and the standards of flour quality are much less exacting, because the housewife can give close attention to each loaf in all the stages of preparation and is not troubled, like the commercial baker, about questions of appearance and yield. The cheapness of Indian wheats renders them particularly desirable in flours for household baking, and for this reason they tend to be shipped in considerable quantities to Hull, the great port of Yorkshire. For the same reason of cheapness, and because of the chalky whiteness of its flour, *pissi* wheat of the Central Provinces goes to Ireland and to some parts of England, especially the northeast. In other parts of England local preferences are less distinct; the use of Indian wheat in flours for commercial bread making is likely to be somewhat restricted, and it probably plays a part of fluctuating importance in the flours prepared for general household use.

In the United Kingdom a large amount of flour goes into biscuits, both for the home market and for the export trade. Biscuits, like pastries of all kinds, are better made with weak than with strong flours, and the soft wheats, if otherwise good, yield the flours preferred by manufacturers of biscuits. Flours from white Indian wheats find a wide use by biscuit bakers, though they are inferior to the flours secured from soft white Australian wheat or from the soft wheat of the American Pacific Coast.

White bran carries a premium in feeding circles in the United Kingdom; and this circumstance gives an advantage to white Indian and Australian wheats. It is difficult to trace the origin of this preference. Other things being equal, the lower the extraction of flour, the whiter will be the fraction of grain offal, and the higher the percentage of nutrients as distinguished from indigestible material. It may be that, a long time ago, feeders came to regard light-colored offal as reflecting a low milling extraction, and that later it came to be assumed that all light-colored wheat offals were thus secured.

The New Quest for Better Wheats

One of the great landmarks of agricultural development in India was the foundation in 1904 of the Agricultural Research Institute at Pusa, in Bihar, with a staff of agricultural scientists to initiate and coordinate agricultural research and instruction throughout the Empire. (The equipment of the Institute was largely provided by the gift of £30,000 for the advancement of agriculture, by Mr. Henry Phipps of Chicago.) Among the positions attached to the Institute was that of Imperial Economic Botanist, to undertake the improvement of the staple Indian crops. In 1905, Mr. Albert Howard was appointed to the post, and he entered upon its duties in collaboration with his wife, herself a well-known plant physiologist (Miss Gabrielle Matthaei).

Mr. and Mrs. Howard began their work on the improvement of Indian wheats by a survey of the botanical varieties of wheat from all parts of the Empire and proceeded to raise many of them in pure culture. In 1907 they made inquiries of cultivators about the kinds of wheat which they preferred for their own consumption, and discovered that they invariably preferred a translucent sample and particularly liked wheats which were dark in tint. The Howards were impressed by the resemblance of these wheats to the strong and valuable wheats of Russia and North America. Nitrogen determinations strengthened the resemblance by showing that Indian wheats of this kind were also rich in protein. Accordingly a small number of samples of various kinds of wheat was sent to England for milling and baking tests by Mr. A. E. Humphries, a leading English miller of the highest scientific repute. This was the beginning of a series of agricultural selections and experiments in India and of milling and baking tests in England which continued for the next five years.

The purposes of the Howards were threefold: (1) to determine the value of the wheats then cultivated for export, (2) to obtain improved varieties, which would satisfy both the home and the foreign demand for strong wheats, and (3) to determine the influence of the place and methods of cultivation on the quality of

these superior wheats. The series of reports by Mr. Humphries presented complete answers to all the problems which the Howards had raised. Almost from the beginning, he recorded the examination of Indian wheats greatly superior to the ordinary Indian wheats of commerce, and abundantly confirmed the Howards' anticipation that India could raise wheats which would compare well in quality with the strong wheats of Russia and North America.

Some of the wheats sent to England were selections made from the botanical varieties of the Punjab, and others were picked out of cultivators' crops, but the wheats which rose to prominence during the tests were some selections made by the Howards at Pusa, from unspecified sources. During the whole period of Mr. Humphries' tests the Howards maintained experiments in India on the agricultural characteristics of the various wheats, and their behavior in different surroundings. The conclusion of the matter, which was reached in 1913 or thereabouts, can best be stated in their own words.

> No matter how high the grain quality and no matter the premium obtained for the seed, any new variety brought to the notice of the cultivator *must yield well under his conditions* and must be easily grown. Further, if grades of improved produce are to be established in India, the country crop over large areas must be replaced by one variety, so that the type can be kept reasonably pure and admixture rendered difficult. For this purpose, the new wheat must stand out in the field from the country varieties so that the extent of replacement can be readily observed and the degree of admixture of the crop easily detected. The working conditions, therefore, of this aspect of the question were the provision of varieties with good grain qualities which would yield well when grown by the people and which would stand out clearly from the country crop. Two wheats, Pusa 12 and Pusa 4, fulfilled these conditions and emerged from the preliminary trials as being the most useful types of the first set of Pusa wheats. The yield of both wheats was satisfactory when grown by the people. Pusa 12 is tall and beardless with shining red chaff, bright strong straw, and large white seed. Pusa 4 is a strong-strawed, beardless variety with bluish-green foliage, white felted chaff, and large translucent white grain. Like Pusa 12 it differs sharply from the country wheats and is easily distinguished in the field.[1]

One other conclusion of great importance was also reached through these tests: "Strong wheats with good milling qualities have been found to retain strength and milling qualities both under canal irrigation on the alluvium and also on the black soils of Peninsular India."[2] In this respect India appears to present an exception to the results of irrigation in other parts of the world, for reasons that do not appear to have been made clear.

From this time on, the work of distributing the seed of these two varieties was undertaken in earnest, and at the present day they are so widely cultivated in the United Provinces and the Punjab that separate determination of their acreage is now no longer possible. They are appreciated by the cultivators because they give high yields and respond well to good cultivation. The quality of their grain is appreciated in turn by the Indian consumer, and creates a premium in the domestic market which has so far made it impossible for exporters to purchase them. The work of the Howards at Pusa has been paralleled in the various provinces by the provincial botanists, and other suitable varieties have been provided to meet more local needs. In the Punjab, Punjab 8A, in the United Provinces, Cawnpore 13, and in the Narbada Valley, selections from the *pissi* wheat, have all shown themselves to yield better than the cultivators' ordinary seed, and have also passed into common use in their most suitable districts.

The task of producing new wheats by cross-fertilization was undertaken by the Howards at Pusa, and has been practiced elsewhere, in the hope of combining the qualities already obtained with the further advantages of a stronger straw, greater immunity from rust, and a bearded head which will resist the attacks of bees and wild animals. Considerable success has been attained in these experiments, but for the present the hybrid strains are not being

[1] B. C. Burt, A. Howard, and G. L. C. Howard, "Pusa 12 and Pusa 4 in the Central Circle of the United Provinces," *Bulletin 122, Agricultural Research Institute, Pusa* (Calcutta, 1921); also A. Howard, *Crop Production in India* (Oxford, 1924).

[2] A. Howard, H. M. Leake, and G. L. C. Howard, "The Influence of the Environment on the Milling and Baking Qualities of Wheat in India (The Experiments of 1909–10 and 1910–11)," *Memoirs of the Department of Agriculture in India (Botanical Series)*, Vol. V, No. 2 (Calcutta, 1913).

widely distributed. Until much superior wheats are obtained, no attempt will be made to replace Pusa 12, Pusa 4, and the other improved varieties already in use.

In these later experiments, the importance of milling and baking tests appears to have been overlooked, in the search for high yields and good agricultural qualities. So long as the new wheats gain the liking of the Indian consumer and are freely bought by him, the lack of such tests is perhaps of minor importance. It was found in the case of the early Pusa wheats that the qualities appreciated by the Indian consumer were the same as those expressed in the export markets. This may be also the case with the newer wheats, but apparently the point is not yet proved. The new wheats must be reckoned as an important factor in increasing India's yield of wheat during many years to come. In this event, production may once more outstrip consumption, and India may again possess in ordinary years an exportable surplus of wheat. Should this happen it is clearly of no small importance that the surplus wheat should be of the best possible quality, and experience in other countries has shown that there is no satisfactory means of estimating the commercial quality of wheat other than the industrial tests of milling and baking. The interests of the Indian people come first, and their food requirements should receive paramount consideration, but it is much to their interests that the export fraction should be representative of the crop. It has already been clearly established that India can raise wheats of the most desirable quality for export, and it will be very unfortunate if this great potentiality should be neglected through a mistaken restriction of the necessary research.

IX. HISTORICAL REVIEW OF THE WHEAT EXPORT TRADE

In our previous discussion of India's wheat production and trade we have referred only incidentally to its historical development. A résumé of this progress, with its major fluctuations, is now essential as a background for a consideration of the outlook for the future. We must first consider, however, the growth of the Indian railway system, and subsequently treat, at some length, certain other important factors affecting India's wheat production and exportation.

Development of the Railway System

The construction of railways was a condition precedent to the development of the Indian wheat trade. The natural disadvantages of Indian rivers and the preference of British engineers have made railways the principal mode of long distance transportation in India. The construction of Indian railways was first undertaken in earnest in the 'fifties, when Lord Dalhousie, then Governor-General, decreed the routes of a system of trunk lines and established a system of guaranteed returns to the private companies undertaking construction and operation. The major elements in his plan were (1) a line from Calcutta to the Punjab up the level, densely populated Ganges Valley, (2) a line from the Punjab to Karachi, down the Indus Valley, (3) a line from Bombay to the middle reaches of the Ganges, running northeastward through the cotton districts of the Tapti Valley and the wheat districts of the upper Narbada Valley, and (4) a line from Bombay running southeastward across the peninsula to Madras. In place of the third line Lord Dalhousie himself would have preferred a more northerly line from Bombay to the upper Ganges Valley, but he was overborne by the merchants of Bombay, who wanted a connection with the cotton-growing districts to the northeast.

By 1866 the main line of the East Indian Railway was practically completed from Calcutta to Delhi, a distance of more than a thousand miles, and four years later the completion of a main line from Delhi to Lahore connected Calcutta with the Punjab. In 1870 also, the northeastward route of the Great India Peninsula Railway made connection at Jubbulpore with a long branch of the East Indian Railway running southwest from Allahabad, and thus opened railway communication between Calcutta and Bombay. For some years the only transport service between the Punjab and the

port of Karachi was provided by a limited steamboat flotilla on the Indus, until, in 1878, the opening of the Indus Valley Railway gave a rail connection, and provided a practicable outlet for the trade of the Punjab.

The completion of these three main lines was sufficient to establish natural connections between the three principal wheat-growing regions of India and their ports, the Punjab with Karachi, the Central Provinces with Bombay, and the United Provinces with Calcutta. But a glance at the map (see p. 322) shows that the wheat-growing districts of the United Provinces lie nearly equidistant from all three ports, so that an important part of the subsequent railway development of India is the story of attempts to establish competitive connections that would break the hold of Calcutta.

In 1881, the northward line from Bombay was constructed to Agra and Delhi in the United Provinces, reducing the rail distance from Delhi to Bombay from 1234 to 888 miles, and to less than the 954 miles from Delhi to Calcutta. The capacity and value of this route were impaired by the fact that it was largely of narrow gauge. Nevertheless it offered effective competition, with the consequences of competitive freight reductions and a considerable increase of movement to Bombay. This was the first conflict of rates in India, the previous reductions of 1869 and 1876 having been imposed by the government as public policy, to secure a large volume of traffic at easy rates. In 1887, this narrow-gauge line threw off a branch from Rewari to Lahore, thus entering the Punjab. This branch might have caused some diversion of Punjab traffic from Karachi to Bombay, even in spite of a greater length of route; but it was unable to do so because the narrow-gauge main line south of Lahore was already filled to capacity with traffic from the United Provinces.

Another connection with Bombay was made in 1889, when the Indian Midland Railway was opened between Itarsi on the Great India Peninsula Railway, and Agra and Cawnpore. This new line saved the long detour of 170 miles by way of Allahabad and Jubbulpore and for the first time brought Bombay into competition for the traffic of the United Provinces. In the next two years, the wheat exports of Bombay increased at the expense of Calcutta, although for other reasons Karachi gained the lead over both.[1] Competitive reductions of railway rates and the completion of the Kidderpore docks in the port of Calcutta appear to have been effective in restoring the trade thereafter to its former channels; but the subsequent succession of famines greatly disorganized the course of trade for the next seven or eight years and obscured normal commercial tendencies. Cheaper coal supplies on the East Indian Railway permit of lower railway rates to Calcutta than to Bombay; this advantage has done much to offset the shortening of the route and repeated reductions of the rate to Bombay, and even Bombay's natural advantage of closer proximity to Europe. Even the restoration of more normal trading conditions after 1900 did not lead to any regular large movement of wheat from the United Provinces to Bombay, although in 1904–5, considerable shipments were made to Bombay. In 1909 the last link of a broad-gauge line between Bombay and the United Provinces was completed, much in accordance with Lord Dalhousie's original plan. There appears no indication that its construction caused any significant diversion of the wheat traffic.

In 1900, a narrow-gauge line was opened across the Indian Desert between Karachi and the United Provinces, and in spite of its limitation it has made possible extensive shipments of their wheat through Karachi, notably in 1903–5 and 1910–14. The construction and operation of a broad-gauge railway across desert country would seem to present many difficulties, but the present rapid development of the port of Karachi may make it desirable that these difficulties should be overcome, in order to give Karachi a direct broad-gauge connection with the United Provinces. In ordinary years, however, Calcutta will presumably continue to get the bulk of the wheat of these provinces; in years of large crops Karachi, and to a lesser extent Bombay as well, will handle a share of their export wheat traffic.

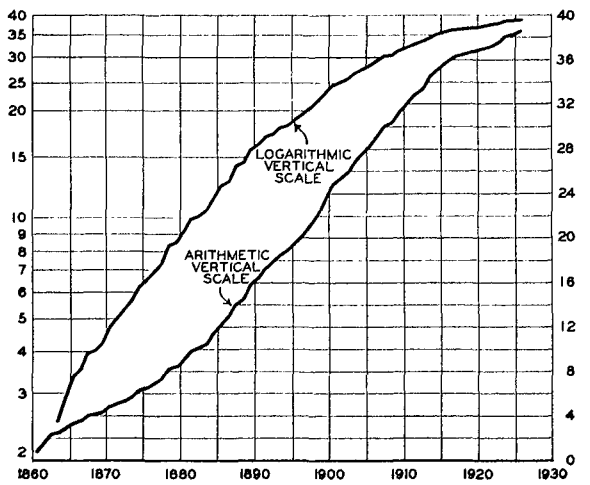
Construction of subsidiary and branch lines naturally followed the completion of

[1] See Appendix Table XI.

the great main lines. An indication of the course of effective construction is presented in Chart 13, which shows in two ways the railway mileage, of all gauges, open for traffic in India, annually from 1860 to 1926. The lower curve, drawn on an arithmetic scale, shows the growth in absolute figures. The upper curve, drawn on a logarithmic or ratio scale, reflects the changing rate of growth: equal vertical distances in periods

CHART 13.—RAILWAY MILEAGE OPEN FOR TRAFFIC IN INDIA, 1860–1926*

(Thousand miles)



* Data in Appendix Table X; as of December 31, 1860–1912, and March 31, 1914–26.

of equal length represent the same percentage increases, and the gradual flattening of the curve reflects the slackening rate of gain. Both curves reveal the retardation in certain periods, such as the early 'nineties and the years 1917–21. The greatest absolute increase in any 10-year period, 8,893 miles, occurred in the years 1898–1907. By contrast the increase between 1916 and 1926 was only 2,731 miles—less than in any 10-year period since the early days of railway construction. The map on page 322 shows the standard-gauge railway lines, which constitute about half of the total mileage.

THE RISE OF THE EXPORT TRADE

Before the opening of the Suez Canal in 1869, only small quantities of Indian wheat reached England, in the holds of East Indiamen sailing around the Cape of Good Hope. The Canal provided a much shorter and more reliable route, and consequently a cheaper one, but for steamships only, because sailing ships cannot navigate the Red Sea. There followed an extensive construction of iron steamships of new and improved type, especially built for the requirements of the trade through the Canal.

Until its repeal in January 1873, an export duty impeded India's wheat exports. This duty, not of long standing, stood at the time of its repeal at 3 annas per maund—the equivalent at current exchange of 1*s.* 10*d.* to the rupee, of 2*s.* 0¾*d.* a quarter, or in United States currency at par, of about 6 cents a bushel. In the three years before its repeal, exports averaged only 0.8 million bushels a year; in the three years following, they averaged 3.3 million bushels, a more than fourfold increase. In 1876–77, India's exports first exceeded 10 million bushels, and in 1877–78, the peak year of the decade, they reached 12 million bushels. In the next two years exports again fell off, because of drought, crop failure, and severe famine in India.

India's export trade in wheat was not a spontaneous growth, originated and organized in India. It appears rather to have been developed by set policy of the British and Indian governments with the approval and support of the financial and commercial interests of Great Britain and India, on the grounds of a belief that the interests of both countries would best be served by an exchange of Indian raw materials with manufactured products from Great Britain. The policy of encouraging the creation of an export surplus of food received further special justification on the ground that such a surplus could always be diverted to famine relief when and wherever required, provided adequate means of transport were available. The development of the Indian railway system thus received additional justification. Nevertheless in practice, the system appears to have been planned rather for the benefit of the export trade and for political and military advantage than for the necessities of internal trade.

The ten or fifteen years which followed the opening of the Suez Canal constituted a period of immense change and activity in the grain trade of the world. Inland trans-

portation in many countries was much improved and cheapened by a wide-spreading extension of railways, and ocean navigation by the coming of the iron steamship. As one consequence of these world-wide transformations, and of others with more local importance, there followed fundamental changes in the sources of European wheat supplies. Movements among the countries of Western Europe and their nearer neighbors declined in importance, while shipments from more distant countries greatly increased. Most notable was the rapid and immense advance in exportation from the United States. Smaller in magnitude, but yet of much consequence, was the rise of the Indian export trade, following quickly upon the construction of direct, reliable, and ever cheaper communications between the wheat-growing provinces of India and the ports and markets of European countries. Though the exports of the 'seventies were small, especially in comparison with the great increase in exports from the United States, they were sufficient to gain a recognized place for Indian wheat in British markets.

The period was one of great excitement and uncertainty in the British grain trade. The immense productive capacity of North America was known and appreciated, but by no means with enthusiasm. The situation was further complicated by the development of the process of gradual reduction milling, first by stones and later by rollers. English millers failed to employ the new process and in consequence were severely harassed at this time by the competition of high-grade patent flour from Hungary and the United States. British traders feared that their markets would lie too much at the mercy of price manipulations in the United States, and both traders and millers feared that imports of the raw material, wheat, might give way to the manufactured product, flour. Seeking an escape from such prospects, they set their faces toward India, where they envisaged a land of vast productive capacity, entirely under British control, able to deliver immense quantities of wheat—and yet no flour—at an incredibly low price. Definite knowledge of India was lacking, but hopes ran high, and the most optimistic spirits dared to believe that Indian competition would compel the United States before long to desist from exporting.

The truth of the matter was more clearly revealed in the course of a few years. Investigations and reports on Indian wheat gave assurance that India produced large quantities of wheat and that this wheat could attain a high standard of quality. But 1878 and 1879 were years of widespread and serious famine in India, which greatly reduced the volume of exports and taught a first lesson in the vagaries of the Indian trade. Other lessons quickly followed in the next few years.

Activity in the 'Eighties

In the 'eighties, India's wheat exports gained an important place in world trade, actively competing with exports from the United States. In 1881 a poor harvest in the United States was followed by a speculative movement which sought to achieve a considerable advance in price. The attempted corner failed, partly because India exported 37 million bushels of wheat in 1881–82, nearly three times as much as in any previous year. The higher level of India's wheat exports was maintained, and Indian wheat thenceforward held an established place in the British market. During the twelve years from 1881–82 to 1892–93, India's wheat exports by sea averaged 34 million bushels a year. They never fell below 25 million bushels, and once, in 1891–92, on the occurrence of famine in southern Russia, they attained a volume of 56 million bushels.

The discovery of another peculiarity of India as a wheat exporter was made in 1884. Large shipments, resulting from general good harvests, were flowing into Europe from several countries, and a record exportation was anticipated from India. Instead of this, as the price of wheat fell, Indian exports greatly declined, and it was found that Indian producers and dealers were refusing to deliver grain at the prices offered to them, and were placing it in storage in their barns and pits. Thus was discovered the tendency, since frequently illustrated, for Indian wheat exports to fall off greatly in years of low price when the

rest of the world is making abundant shipments.

The expansion of India's exports was favored by several circumstances. In the first place, the period from 1880 to 1896 was unbroken by serious crop failure. No other period of equal length in the history of India's wheat export trade has been equally favored. In the second place, the extension of the railway net had given the Punjab harvest an outlet through Karachi, and the development of railway facilities caused a substantial decline in railway rates to all the seaports. In the third place, costs of ocean shipment declined. The striking extent of these last two factors is suggested by the following data, in cents per bushel, on the cost of railway carriage of Indian wheat from Jubbulpore in the Central Provinces to Bombay and by sea from Bombay to Great Britain, annually from 1873 to 1886:[1]

Year	Rail to Bombay	Bombay to U.K.	Total
1873	29	40	69
1874	29	36	65
1875	21	34	55
1876	20	32	52
1877	20	28	48
1878	19	15	34
1879	19	19	38
1880	19	25	44
1881	19	28	47
1882	19	21	40
1883	17	19	36
1884	17	13	30
1885	16	15	31
1886	15	12	27

In the fourth place, the British grain trade developed its Indian business with increasing efficiency. Finally, the extension of large-scale irrigation works made possible the expansion of wheat acreage and the improvement of wheat yields.

Two influences bearing on India's wheat exports in the first two periods may well be discussed before proceeding with the later periods. These are the decline of the rupee in terms of sterling and the problem of impurities in Indian export wheats.

The Decline of the Rupee

The currency of India was established on the standard of a silver rupee by the East India Company in 1835, the quantity of silver in the rupee being such that it would have an exchange value of one-tenth of a gold sovereign (2 shillings-worth of gold) in international trade. For a period of nearly forty years, during which the world experienced little or no change of currency standards, this equivalence of the rupee was maintained. But a large increase in the world's production of silver, from the 'sixties onward, brought about a depreciation of silver and stimulated a change to a gold standard by several important countries in the early 'seventies. From this there followed a long decline in the gold equivalence of the rupee, which wrought serious changes in the Indian economy. The worst sufferer from the descent of the rupee was the government of India itself, whose revenues were collected in India on a silver standard, and which was required to make heavy payments on a gold standard in Great Britain each year on account of interest, troops, supplies, salaries, and pensions. Every year that the equivalence of the rupee fell, a larger contribution was required from the Indian budget for the purchase of sterling currency, with a consequent strain on Indian revenues and a continual harassing need for new or increased taxation.

It was widely supposed that this decline of the rupee tended to increase the volume of India's exports and to diminish the volume of imports, and that the great advance in Indian wheat exports after 1873 was due to this circumstance. The reason for this supposition is simply that an importer in a gold-standard country finds himself able to make larger purchases of silver-standard currency with a given sum of his gold-standard money, and so to offer a higher price in silver-standard currency for a desired quantity of wheat.

Strong opposition arose against this point of view, partly on the ground that it was wrong in theory, since exports and imports must pay for one another, and partly on the ground that the theory did not cover all the facts of the case. It was argued that the advance of the Indian export trade, in wheat and other commodities, was primarily attributable to the improvements of communications in India and on the sea, to reductions of rail and ocean freights, and to

[1] Converted to U.S. currency at par from shillings and pence per quarter from table in the *Report of the Royal Commission on Gold and Silver*, II, 252. See *Journal of Political Economy*, September 1894, II, 578.

the beneficial effects of good harvests. Exchange rates had fallen steadily, it was true, but their fall was offset by a much greater fall in commodity prices in importing countries as a result of their adoption of gold standards and a general appreciation of gold. The effects of sudden declines in the equivalence of the rupee, it was conceded, might give a temporary stimulus to exportations, but only for brief periods and insignificant quantities, while on the other hand, the disadvantages of uncertainty in the exchange ratio of gold and silver currencies would act continually as a check to the development of any large and steady trade.

The decline in the gold equivalence of the rupee continued for a period of more than twenty years. By 1892, it had fallen to less than 1*s.* 4*d.*, a drop of between 30 and 40 per cent, with no indication of having attained any stable level, and the government of India was compelled to propose abolition of the free coinage of silver in its mints. Their proposal was reviewed in London by a committee appointed by the Secretary of State. With the recommendations of the committee, this study has no concern beyond recording the fact that it laid the foundations of the gold exchange standard of Indian currency, which in the course of the next three or four years brought back the rupee to an artificial parity of one-fifteenth of the pound (1*s.* 4*d.*) and maintained it at that level till 1914.[1] The section of the committee's report most important at this point is its verdict upon the relations between the fall of the rupee and the growth of India's foreign trade. After observing that there appeared to be no coincidence of the more rapid breaks of exchange with the more rapid advances of exportation, the committee gave the weight of its opinion to the conclusion that the effect of a falling exchange on the country at large, in influencing either exports or imports, had not been very considerable over a series of years. An identical verdict based on both practical and theoretical grounds had previously been expressed by the Royal Commission on Gold and Silver, which reported in 1886–88.[2]

Dockage and Refraction

Among the factors affecting the growth of the Indian wheat trade was the realization of the peculiar qualities of the wheat which India exported, and of its characteristic advantages and disadvantages. One aspect of this subject, the characteristic properties of the wheat itself, has already been discussed, so far as it concerns the British market.[3] The other, its depreciation as a commercial commodity through the presence of large quantities of other grains and undesirable dirt, will now be considered, with a similar limitation. Unfortunately, for lack of information, it is impossible to give consideration to the trade in Indian hard wheat for alimentary pastes, smaller in magnitude but yet of some importance, that sprang up with certain countries of Continental Europe.

From the beginnings of the trade, a considerable proportion of impurities (or, in American phraseology, "dockage") was found in shipments of Indian wheat. At first, this evil was taken more or less for granted, on the assumption that such impurities were merely the natural consequence of treading out grain on threshing floors. Gradually it was revealed, however, that the wheat as it left the threshing floors was always reasonably clean and that the presence of the impurities was the consequence of adulteration by native dealers. One stage further in the investigation indicated that the terms of purchase by exporters in India and importers in Great Britain must be regarded as the prime source of the evil. In Calcutta, exporters made their purchases on the basis of a minimum of 5 per cent of impurities, with a right of rejection if the impurities

[1] The war, which so seriously disorganized most of the world's currencies, affected also the Indian exchange, and broke up the 15 to 1 ratio of the rupee to the pound sterling. A Royal Commission appointed in 1919 recommended stabilization at 10 to 1 (2*s.* per rupee), but after spending some 250 million dollars the Indian Government abandoned the attempt. In 1925–26 another Royal Commission reconsidered the whole matter, and eventually recommended stabilization at the rate of 1*s.* 6*d.* to the rupee (virtually the going rate), and the establishment of a gold standard on this basis but without a gold currency. These recommendations are now being carried into effect.

[2] *Final Report of the Royal Commission Appointed to Inquire into the Recent Changes in the Relative Values of the More Precious Metals* (London, 1888).

[3] See above, pp. 372–76.

should exceed 7 per cent. Such a fixed allowance for impurities was termed "refraction." In the case of the British grain trade, the East Indian contract form of the London Corn Trade Association, which was used as the basis for all trading in Indian wheat, stipulated a minimum refraction of 4 per cent on shipments from Bombay, and 5 per cent on shipments from Calcutta.

Dissatisfaction with this state of affairs gradually assumed an organized form, first in India and then in Great Britain. The Bombay Chamber of Commerce seems to have taken the lead by pressing, in 1886, for a general reduction of refraction to a total of 2 per cent for dirt and other grains. Their action in circularizing the British Corn Trade Associations was followed in 1888 by a detailed investigation of the problem from the miller's point of view, conducted on behalf of the India Office by a leading British miller, Mr. John McDougall. Answers by a large number of British millers to Mr. McDougall's formal inquiry showed that the consumption of Indian wheat by British millers would be likely to increase considerably if it could be delivered in cleaner condition. To give full consideration to the matter, a conference of all interested parties was held in 1889 at the India Office, London. No conclusions were reached at this conference, because while all other parties pressed for an improvement of standards, the London Corn Trade Association singly defended the existing terms of contract and contended that its standards of refraction merely defined the normal standards of impurity of the Indian cultivators' produce.

For various reasons, the London Corn Trade Association occupies a position of especial authority in the British grain trade, and in face of its opposition no reform could be achieved. The reasons advanced for its opposition do not appear to have carried conviction to the other parties to the dispute, and subsequently provoked much unfavorable comment. It was said that the presence of dirt in Indian wheat was encouraged by certain large millers who possessed elaborate cleaning machinery, and who thereby gained the advantage over their competitors in that they were able to handle wheat which the latter could not touch, and thus secured the sale of Indian wheat to themselves at unduly depreciated prices. The East India Committee, which had represented the London Corn Trade Association at the conference, incurred still more severe criticism. In a private capacity, its members acted as arbitrators upon the quality of individual shipments, receiving arbitration fees for their services. It was charged against them that the extent to which these services were required was enhanced by the presence of impurities in the wheat submitted to them for appraisal. In other words, the cleaner the wheat, the fewer the arbitrations. The justice of these charges is now indeterminable, but they appear to have been made sincerely and on good authority.

After the conference, the standard monthly samples of Indian shipments from the crop of 1888 were submitted to analysis. These were composite samples made up monthly to obtain the "fair average quality" of the month's shipments, but in practice with an exclusion of particularly dirty samples. The analysis led to the somewhat surprising discovery that the refraction of these samples was less than the stipulation of the contracts, and that the adulteration of Indian wheat had perhaps not been carried far enough! In the face of this revelation, the London Corn Trade Association could hardly maintain its existing refraction, and there followed a revision by which each type of wheat received a separate standard. The assumed proportion of total impurity now varied from 3 to 5 per cent for ante-monsoon shipments and $3\frac{1}{2}$ to 7 per cent for post-monsoon. The proportion of dirt was also specified, being restricted to $1\frac{1}{2}$ per cent for ante-monsoon and 2 per cent for post-monsoon shipments. The Bombay Chamber of Commerce promptly made protest against these standards as excessive on the ground that the analyses had shown in general a higher degree of purity, but their appeal was fruitless. For some reason or other, the Liverpool Corn Trade Association had given consent to the new terms, and conceded to London the final negative decision.

As an equilibrium between opposing forces, the agreement thus reached in 1889 appears to have been tolerably satisfactory

to all the interests concerned, and it continued to serve as the basis for trading until 1906, when a second and more thoroughgoing revision of the terms of refraction was achieved.[1] But the more immediate benefits of the agreement of 1889 cannot be definitely determined and appraised because the volume of wheat exports from India was greatly reduced after 1891–92, first by the severe decline in wheat prices and later by serious famines in India.

The Period of Restricted Exports

In the years following 1890 the course of world wheat prices exerted a powerful influence on India's wheat exports. As a background for the discussion, Chart 14 (p. 386) presents certain monthly price data for Liverpool, Winnipeg, and Karachi. The Liverpool series begins in 1881, the Winnipeg series in 1890, and the Karachi series in 1905.

Liverpool prices of imported wheat tended downward in 1882–84, and remained on a low level slightly above a dollar a bushel throughout most of the years 1885–90, except for a bulge of several months' duration in 1888–89. In 1891 again, prices rose substantially, because of short world crops, and, as we have seen, a record volume of exports was obtained from India. From a peak late in 1891, at over $1.25 a bushel, Liverpool prices declined fairly steadily to an extremely low point of 60 cents late in 1894. Under this depressing influence,[2] India's wheat exports declined from the high level of 56 million bushels in 1891–92 to some 12½ million bushels in 1894–95, the lowest figure since 1879–80.

Late in 1894 Liverpool prices began a recovery which brought them to a level around 80 cents during most of the Indian crop year 1895–96, and India's exports rose to nearly 19 million bushels. In 1896–97 and 1897–98 prices rose still more, culminating in a peak in April 1898 of nearly $1.60 a bushel. But India, like other wheat exporting countries, suffered severe crop failure in 1896 and 1897, and in the face of severe famine exported only 8 million bushels of wheat from the two crops. Her shortage was therefore partly responsible for the great advance in world prices. The Indian crop of 1898, however, was an excellent one for its day, and under the extraordinary price stimulus, India's exports rose above 36 million bushels, contributing in no small degree to the notable price decline of 1898–99. Though the Indian crop of 1899 was nearly as large as that of 1898 and initial stocks of grain were presumably larger, the removal of the price stimulus, together with dismal prospects for the crop of 1900, led to a restriction of India's exports to 18 million bushels. The crop of 1900 proved a serious failure, and with Liverpool prices around 90 cents a bushel, India's wheat exports were negligible in quantity—smaller, indeed, than in any year since 1870–71. The crop of 1901 was good, but since stocks were depleted and foreign prices were not attractive, exports were less than 14 million bushels. Though the next crop was not as good, foreign prices were somewhat better, and prospects for the new harvest were excellent; hence exports showed some increase, but only to 19 million bushels.

On the whole the decade from 1893–94 to 1902–3 was a period of small and irregular exports from India. After the first year, except in 1898–99, when a large crop coincided with exceptionally high prices, the annual export did not reach 20 million bushels; and the average export was only 15 million. The factors responsible for the decline in India's importance as an exporter in this period were primarily the occurrence of several poor crops and the low level of world wheat prices occasioned (apart from influences affecting the general level of prices) by the rise of exports from Argentina, Russia, Roumania, and other sources of supply.

The Pre-War Period

In the eleven years before the war, India's wheat exports rose to higher levels than in the twelve years preceding the period of restricted exports. This was a period in which world wheat prices were tending upward somewhat more rapidly than prices in general, but only in 1909 was there such

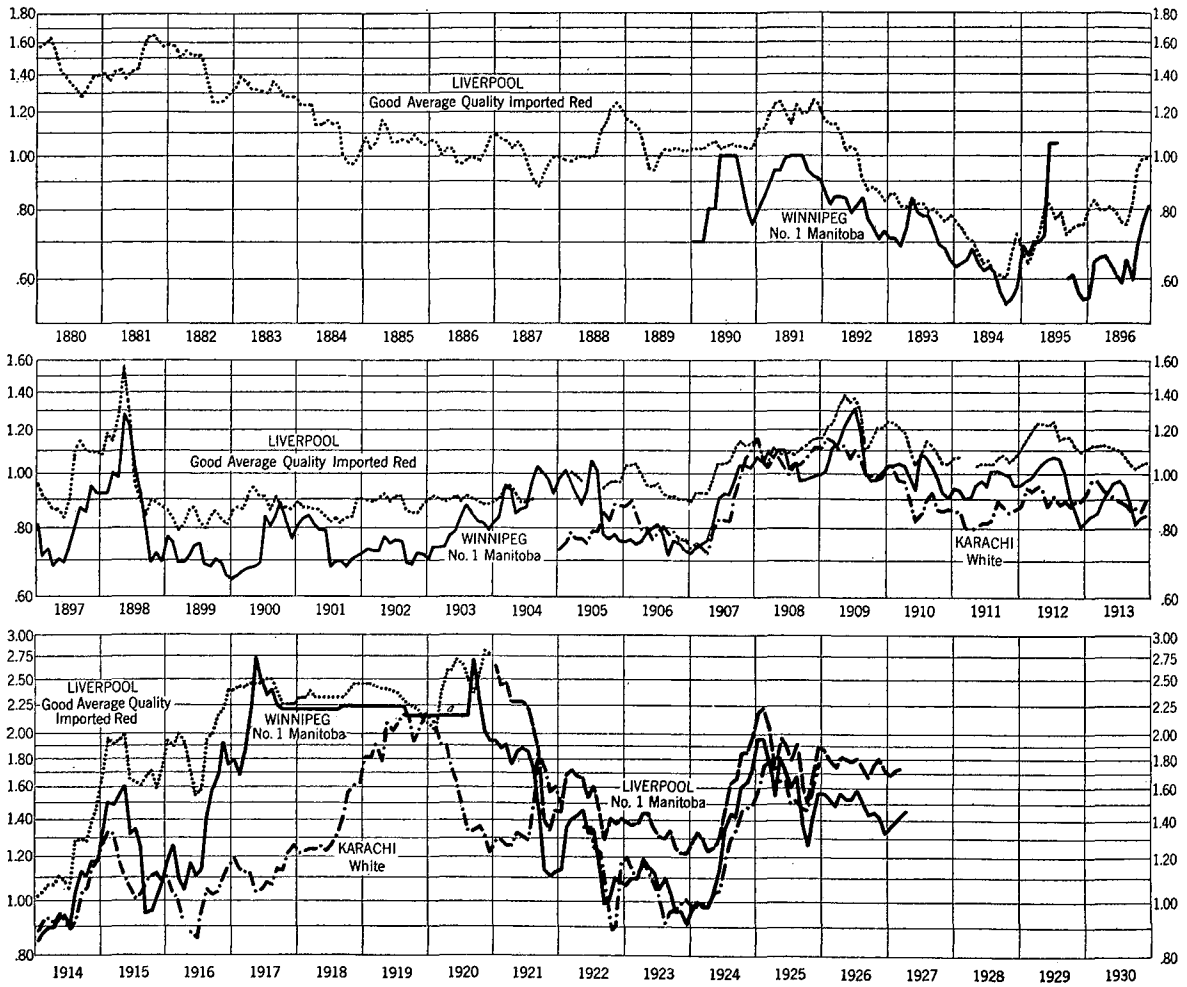
[1] See below, p. 387.

[2] As shown by Appendix Table II, good crops were secured in 1893, 1894, and 1895.

an advance in price as greatly to stimulate exports from India. The stabilization of the rupee, in 1898, the revision of the refraction clause, in 1906, and further improvements in transportation were favorable to this growth of exports. The decline in export competition from the United States was no mean factor. But the principal factors were the expansion of production and the prevalence of good yields. With the extension of irrigation works, wheat acreage and production rose to higher levels, and though consumption increased, the export fraction rose also. This period was broken by only one crop failure, in 1908, and except in 1908–9 the annual export never fell below

CHART 14.—WHEAT PRICES IN LIVERPOOL, WINNIPEG, AND KARACHI, INDIA, 1880–1927*

(Dollars per bushel; logarithmic vertical scale)



* Liverpool prices from U.S. Department of Agriculture *Yearbook, 1923*, p. 630, continued in later *Agriculture Yearbooks;* Winnipeg prices from Canadian Department of Labour, *Wholesale Prices, 1890–1910*, p. 65, Winnipeg Grain Exchange, *Annual Report, 1924*, pp. 35–49, and *Grain Trade News*, Winnipeg; Karachi prices as given in Appendix Tables XVI, XVII.

This chart was originally prepared for our earlier study of *Canada as a Producer and Exporter of Wheat* (WHEAT STUDIES, July 1925, I, 242–5). Hence for the period of disturbed exchanges Liverpool prices were converted into Canadian dollars at current exchange rates. For the years 1920 and 1921, therefore, when the Canadian dollar was appreciably below parity with the United States dollar, Karachi prices, which are expressed in United States dollars, are not precisely comparable with the others. During the war years, also, there is some distortion, for the Canadian dollar was below par and the rupee above, but rupee prices were converted to United States dollars at parity of 32.44 cents to the rupee. The resulting lack of comparability is not serious for a general view.

[a] Guaranteed price, $2.15; 48 cents additional was subsequently paid to holders of participation certificates.

30 million bushels. In 1904–5, after an exceptionally good crop and with some price stimulus from Liverpool, the volume of wheat exports, 80 million bushels, set a record that has not since been approached. In that year, and again in 1912–13, the British market secured more wheat from India than from any other single country. The average for the five pre-war years, nearly 50 million bushels, was unprecedentedly high. Over the 11-year period the average gross export of wheat by sea was 43 million bushels, and the net export of wheat and flour about 45 million. On the whole, however, despite its larger size, India's contribution to the world market during this period was relatively less important than in the 'eighties; for, though America's exports were tending downward, Australia and Canada had entered the ranks of the great exporters, and exports from Argentina, Russia, and Roumania were expanding.

An important event of this period was a second revision of the refraction clause of the East Indian contract in October 1906, which was effected without overt controversy. The revised terms of sale, which have been maintained to the present day, run as follows:[1]

> That the wheat be assumed to contain 2 per cent Barley and/or Pulse and/or other feeding stuffs and to be free from dirt, oil-seeds and other extraneous matter. All Barley, Pulse or other feeding stuffs beyond the 2 per cent to be deemed one-half the value of Wheat.
>
> That all dirt, seeds, etc., up to 2¼ per cent, be paid for by the Seller at Contract Price of the Wheat and at double that price beyond 2¼ per cent.

These terms, which prevent shippers from obtaining any return on the dirt content of their deliveries, are said to have given entire satisfaction to the British trade. But from India complaints have even since been made that the terms of purchase by exporters continue to stipulate a needless and excessive content of dirt.[2]

[1] Cf. London Corn Trade Association, *Forms of Contracts in Force* (second edition, London, 1922).

[2] H. K. Trevaskis, "Some Aspects of Agricultural Marketing as Illustrated by the Lyallpur Co-operative Commission Sale Shops," *Agricultural Journal of India*, 1923, XVIII, 115–31; J. H. Barnes and A. J. Grove, "The Insects Attacking Stored Wheat in the Punjab, and the Methods of Combating Them," *Memoirs of the Department of Agriculture in India (Chemical Series)*, 1915, IV, No. 6 (Calcutta).

The War and Post-War Period, 1914–22

The latest completed period deserves somewhat fuller discussion, partly because it is marked by the exercise of government control, but for several other reasons as well. Chart 9 (p. 363), Chart 11 (p. 367), and Chart 14 (p. 386) are all illuminating for this period.

The outbreak of war in August 1914 brought to an end the period of large exports. The Indian wheat crop of 1914 was mediocre and in April–July, before war was declared, India had exported some 14 million bushels. The Canadian crop was short, the Australian crop of 1914–15 promised badly and proved a failure, and the Argentine crop movement was delayed by bad weather. Without the consequences of war, these conditions would have been sufficient to raise the price of wheat, in India and elsewhere. As it was, the closing of the Dardanelles, the reduction of European harvests, and the increased demand from neutral and belligerent countries provided further impulse to a serious price advance, which threatened to cause excessive exports and consequent embarrassment to Indian consumers.

The first measure of control was ordered in December 1914, when the government of India decreed a restriction of exports, between that time and March 30, 1915, to 100,000 tons. Prices continued to rise, however, until the middle of February. At this time, the government of India decided to take over the marketing of the surplus from the large crop of 1915. Purchasing policy in India was directed by an official, the Wheat Commissioner, and selling policy in Great Britain by an official committee, the Indian Wheat Committee, and the actual work of buying and selling was performed at a fixed commission by nine of the principal firms previously engaged in the Indian wheat trade. In India wheat was purchased at a continually decreasing maximum price, and it was sold again in Great Britain at prices fixed by the Indian Firms Committee, comprising representatives of the agent firms.

By reason of the gradual reduction of the maximum price offer, and also because prices in Europe and more notably in other

exporting countries declined heavily as excellent crops became assured for the following season, wheat exports from India ran high in May, June, and July, 1915, and ceased in September. Thus the producer gained a good price for his exportable surplus, while, for the rest of the Indian crop year, wheat remained in India on a domestic basis and the consumer was able to purchase at reasonable prices.

The crop of 1916, like that of 1914, was of moderate size and did not promise any large exportable surplus sufficient to justify the maintenance of such elaborate marketing machinery. Moreover, the great advance in costs of ocean shipment effectually reduced the stimulus that might have come from high prices in Europe. Accordingly, from May 1, 1916, the system was abandoned and private trading was resumed under license from the Chief Customs Officer, the Wheat Commissioner deciding the quantity of wheat to be exported in each seasonal period of export by each firm. Exports at first ran low, but the summer monsoon proved favorable and large stocks carried over from the ample harvest of 1915 were released for export. The price of wheat in India meanwhile continued low, until in the second half of 1916 a sharp advance in prices followed the very unfavorable harvest results in the Northern Hemisphere.

In October 1916 the British government undertook, through the Royal Commission on Wheat Supplies, the control of all wheat purchases for Great Britain and subsequently for the allied countries. At first it bought Indian wheat in London from importing firms; in November 1916, it undertook purchasing in India on its own account; and finally, from February 1917, it bought through the agency of the Wheat Commissioner — an arrangement which lasted beyond the end of the war.

The crop of 1917 was 382 million bushels, the largest on record for India. The shortage of export wheat in other sources in the Northern Hemisphere was so great that 54 million bushels of India's wheat were exported—a total only thrice surpassed. A record area of 35 million acres was sown for the crop of 1918; unfortunately the average yield was low, but 370 million bushels were harvested. A large export program was provisionally arranged. For a time exports were well sustained, but currency difficulties necessitated a reduction in June, and in July the government temporarily suspended purchases. The serious failure of the monsoon augured ill for the next crop, and early in October purchases, except for Mesopotamia, were stopped altogether. Happily, the end of the war made available the Argentine and Australian stocks, and Indian shipments were light in the later months of the crop year.

The following annual average figures, in million acres, bushels per acre, and million bushels, furnish an illuminating comparison of the 5-year period including the war years, with the 5-year period preceding and the 4-year period following:[1]

Crops of	Acreage	Yield	Crop	Net exp.	Retention
1909–13	29.2	12.0	351.8	51.6	300.2
1914–18	31.9	11.1	353.0	32.7	320.2
1919–22	26.9	11.8	318.9	3.0	315.9

Thanks to higher acreage and in spite of lower average yields, the crops of 1914–18 were slightly better than those of the preceding 5-year period, though not as large as the average for the four years 1910–13; domestic retention was about 20 million bushels larger, probably somewhat more than in proportion to the population increase; and net exports were 19 million bushels less. In the following 4-year period, for reasons that will shortly appear, acreage was greatly reduced and the average crop was much lower; domestic retention was slightly reduced, though probably not in proportion to the reduced population; and net exports shrank to negligible proportions.

The monsoon of 1918 was one of the worst on record, equaled only by that of 1899 and outdone only by that of 1877. Partial or complete failure affected every province. *Kharif* sowings were greatly reduced, and the percentage of crop failure was abnormally high. *Rabi* sowings were delayed and limited. Furthermore, the terrible influenza epidemic of the autumn of 1918 cost India several million lives and greatly restricted the harvesting of the *kharif* crops and the sowing and harvesting

[1] Summarized from Appendix Tables I, III, V.

of the *rabi* crops of 1919, including wheat. The wheat acreage declined from a high level of 35 to less than 24 million acres (according to probably incomplete reports); and, in spite of fair yields per acre, the reported crop was only 280 million bushels, considerably below the usual domestic consumption. Crops of rice, millets, and gram were even further below normal. To make up some part of the deficiency, it was necessary for the Royal Commission on Wheat Supplies to divert some 7½ million bushels of Australian wheat to India, where it was distributed through the organization maintained by the Foodstuffs Commissioner with considerable difficulty and loss but with beneficial effects on the domestic price of wheat.

The crop of 1920 was 378 million bushels, again a splendid total, and was expected to yield a large export surplus. In view of the reduction of stocks and by way of special precaution, however, the government of India checked exportation until the end of the summer monsoon. This proved unfavorable, and accordingly the government in September limited the exportation of wheat during the next six months to 400,000 tons, provided that it could be purchased below a stated price. As it happened, the price of wheat in India never fell below this level, and the actual purchase was considerably less than the allowance. By February 1921, it could be seen that the coming wheat crop in India would be short. Meanwhile European prices were falling. Government trading in wheat for export was abandoned, and up to the end of the crop year, March 31, 1921, the agent firms were allowed to trade for themselves, subject to the regulations laid down in the previous September.

The crop of 1921, only 250 million bushels, was extremely low in consequence of the failure of the monsoon, and Indian wheat prices rose high. Between July and October, when world prices were sharply declining, Karachi prices rose from $1.29 to $1.86. An embargo on exports was maintained, and the high prices attracted imports to a total of 16½ million bushels from Australia and the Pacific Coast of the United States. With a favorable monsoon, Indian prices fell sharply after September, but for several months prices were higher in Karachi than in Liverpool. In spite of a good crop in 1922, which was followed by further sharp declines in prices, even more pronounced in India than in Liverpool, the embargo on exports was maintained as a precautionary measure until September 1922, when a good monsoon had given assurance of good harvests in 1923. The removal of the embargo was followed by six months of fair exports. Indian prices had fallen below their normal relation to Liverpool prices, and advanced considerably in November–December as export sales were made.

The removal of the embargo marked the end of government control of Indian wheat supplies, and of the war period which began in 1914. So far as can be seen, this control was well managed, and it was reasonably successful in restraining the advance of prices in India, averting serious food shortage, and supplying wheat in good quantities when most desired by the allied countries of Europe.

The Present Period

A new period opened with the crop of 1923, and is still in progress. The wheat acreage, which had been greatly reduced by the joint influence of the influenza epidemic and two failures of the summer rains, rose for the 1923 crop to nearly 31 million acres and has since varied moderately between 30 and 32 million acres. There have been no crop failures. Three good crops (1922 to 1924), averaging 367 million bushels, have been followed by three mediocre crops averaging about 329. Consumption, which was seriously restricted as a result of the poor harvests of 1919 and 1921, is apparently again on the higher level of the war period, if not higher. The average domestic retention from the four crops of 1923 to 1926 has been about 325 million bushels. There have been some imports, but each year has shown a balance of exports.

From the good crop of 1922, as we have seen, exports were small because stocks had been heavily depleted in the preceding year and because wheat prices, in India and Europe, were abnormally low. The latter influence operated for a time to re-

strict exports from the crop of 1924, the third good crop in succession. In the last half of the crop year, however, exports were exceptionally stimulated by the radical advance in world prices, so that the net export of wheat and flour in 1924–25 was about 45 million bushels. Since then exports have been small, but the larger because of the higher level of world prices. The average net export from the crops of 1923 to 1926 has been about 22 million bushels—considerably higher than in the immediate post-war period, but yet a low figure.

X. THE OUTLOOK FOR THE FUTURE

On the basis of our analysis of the factors determining India's production, marketing, consumption, and exports of wheat, and our historical review of her wheat export trade, we are now in a position to attempt an appraisal of the prospects for the future. Beyond reasonable doubt, production and consumption will tend to increase, but at what rate? Will consumption tend to overtake production, leaving India little or no balance for export, or will production increase the more rapidly? Will India regain the export position she held for a period of years before the war, or attain an even higher rank? Or will she remain a distinctly minor exporter, or even become predominantly a wheat importer? To such questions as these we now seek some considered answer.

The Future of Wheat Production

In the past fifteen or twenty years there has been no clearly marked or sustained trend in India's wheat production. (See Chart 5, p. 320.) The good crops throughout the period have been closely similar in size; so also have the mediocre crops. Because of the fortune of four good crops in 1910–13, and the occurrence of two poor crops in 1919 and 1921, a statistical calculation of a trend for the crops of 1910–27 would show a downward inclination, but this would be as misleading as the upward line that would result from taking in years before 1910.

Nevertheless, there are good reasons for expecting an upward trend in the wheat production of India, both by an advance of yield through the spread of improved agricultural practices, and by an extension of acreage through the further development of irrigation. Each of these tendencies is largely independent of the other.

The investigation and instruction by the Imperial and provincial departments of agriculture during the past twenty years are beginning to bear fruit among the cultivators themselves, principally in the adoption of superior crop varieties and of more effective implements. The selection of superior types of wheat, of better quality and higher yield, is now being followed by their spread among the cultivators as staple varieties for general production. When grown on experimental farms these new varieties have in some cases proved more prolific, by four or five bushels an acre, than the ordinary wheats of the district. Nevertheless, an equal advance is not to be expected when these wheats are widely grown by the cultivators themselves. In Western Canada, Marquis wheat showed itself superior to Red Fife by about 4 bushels an acre when grown on experimental plots, but in spite of its universal adoption by the farmers, it has done little or nothing to advance average yields of wheat, though it may well have prevented the decline that might otherwise have occurred. The new varieties in India should therefore be considered to do well if they give half the advantage in general cultivation that they do when grown under scientific control. The chief gain from the introduction of newer implements will probably be the improvement of the seed-bed through the employment of the iron mould-board plow, which is now finding its way into use. As this takes place, earlier and deeper plowing will become possible at smaller expenditure of labor. The soil will be more thoroughly broken up; it will hold moisture better and will permit the formation of better root-systems by the growing crops.

There appear to be good prospects for a widespread adoption of these improved practices. At the present time a Royal Commission is investigating agricultural con-

ditions, and, though the terms of reference are not as wide as perhaps they should be, they should yield valuable recommendations for the advancement of agriculture in India. Furthermore, in advance of a report from the Commission, the government of India has already determined on heavier expenditures for agricultural research and education. Hitherto the Indian steel industry, of almost Lilliputian dimensions for so large a country, had been more liberally supported by public moneys than agriculture, the occupation of more than two-thirds of the population. The policy of developing Indian industry is doubtless sound and under the circumstances must involve considerable governmental assistance and support. Nevertheless industrial development can scarcely benefit directly more than a small proportion of the population, though it may well increase the urban demand for wheat; the prosperity of the Indian masses must largely depend on the efficiency of their agriculture. The new Viceroy of India, Lord Irwin, is an agricultural expert and enthusiast; under his rule and guidance it is likely that the government of India will make wholehearted endeavors to improve agricultural practices.

It is easy to anticipate too large a return from these improvements, either in total or for single crops. Even at the present time, India's average wheat yield of 11 to 12 bushels an acre need not be considered extremely low, except by comparison with European countries employing intensive cultivation. The average yield of wheat in the United States is only 2 or 3 bushels an acre more, and the pre-war yield of Russia was 1 or 2 bushels an acre less. Average yields in Argentina and Australia are not much higher. No large advance in yield seems likely to be attained, and the increase will probably not be attained over the whole of the wheat-growing area. Intensive efforts to increase wheat yields would scarcely be made outside the Punjab, the United Provinces, Bihar and Orissa, and the Central Provinces, and would probably not affect an area of more than 20 million acres. Already, in the first three of these areas, yields are above the average for India. An increase of 2 or 3 bushels an acre would raise them to the level attained by the peasant cultivators of the Balkan countries in the years before the war, and if one arbitrary maximum must be selected rather than another, this one seems as good as any that can be obtained. The maximum advance of output to be anticipated as the result of improvements in agricultural practice is therefore of the magnitude of 50 million bushels a year. Such an advance will by no means be attained in the course of the next few years. At a guess, one or two generations—say, twenty-five or fifty years—will be required for the general adoption of the new and improved practices, and throughout this period continual progress should be made toward the realization of the goal.

The further development of irrigation by large public works constitutes the other principal means by which an extension of wheat growing and an increase of output will be obtained. Several such projects are now in the course of construction. The total areas thus to be brought under irrigation, in both the *kharif* and the *rabi* seasons, are estimated beforehand, of course, as closely as possible. Published reports of the estimates are easily to be found, but unfortunately they give no precise indication of the areas that will be devoted to the cultivation of separate crops. It is therefore necessary to guess as well as may be the additions likely to be made to the areas devoted to wheat.

In the Punjab and adjacent Native States an area of about 2 million acres of *rabi* crops is to be brought under cultivation by the Sutlej Valley project, and in Sind about 3 million acres by the immense Sukkur Barrage project. A large part of the Punjab acreage will be devoted to wheat growing —say three-fourths, or 1½ million acres. The prospects for Sind are more dubious, because the Sind cultivator is not accustomed or inclined to *rabi* cultivation; probably at most not more than half the *rabi* acreage, or 1½ million acres, will be sown to wheat. In any case, the development of agriculture in both territories can only be very gradual, as colonization and the natural increase of population supply labor for the newly available lands; the projectors themselves appear to consider thirty years or so as the time required to bring the settlement of

the districts to completion. If these two projects ultimately succeed, and yield wheat at the rate of 16 bushels an acre, they should contribute a fresh 50 million bushels or so to India's wheat supply.[1]

In the United Provinces, the Sarda project, now under construction, is planned to bring 1¾ million acres under irrigation, of which perhaps one-third may be devoted to wheat. This project is likely to be completed and fully developed within a comparatively short time, but since most of the land which it is to serve is already under cultivation, the resulting additional production of wheat is likely to be comparatively small, and perhaps no more than 5 million bushels.

In course of time, another large project may be undertaken in the Punjab on the Sind Sanghar Doab, the left bank of the Indus, but while funds and labor are still so largely employed on the Sukkur and Sutlej projects, and the success of these ventures is still so much open to doubt, it is unlikely that any further large works will be begun. At some indefinite time in the future, the realization of the Sind Sanghar project may add another half-million or million acres to the wheat acreage of the Punjab, but this prospect is so uncertain that its production should not yet be reckoned as a possible addition to the Indian wheat supply. When this project is completed, the application of large-scale irrigation to the Punjab *doabs* by prevailing practices will be complete, and any further large extensions must come through the introduction of other types not yet employed there.

The present wheat production of India averages roughly 350 million bushels a year, barring years of serious crop failure. To this there may gradually be added 50 million bushels a year through the improvement of methods of agriculture, and 50 million through the extension of irrigation.[2] The wheat production of India may thus attain a maximum level of 450 million bushels a year. Larger crops may in time be harvested in particular years, and in general, better methods of cultivation may help to insure more uniform crops from year to year; but such a level is not likely to be exceeded. The time required for the attainment of this level is probably between twenty-five and fifty years, though it may well take longer. Progress will probably be slow at first, more rapid in the middle years, and later slow again.

[1] The success of the Sukkur Barrage project has been seriously questioned by some engineers of experience and high standing. They fear that the barrage may disturb the course of the Indus upstream in a way that would cause disaster to the established irrigation and agriculture of Sind.

[2] Assuming that it is not offset by alkali damage to irrigated soils now in use.

The Future of Wheat Consumption

If it is necessary to speak in guarded terms of the expansion of wheat production in India, it is still more difficult to speak with assurance of the future course of wheat consumption or domestic retention. As we have seen, there is evidence, though not highly detailed or specific evidence, of a rising trend in per capita consumption of wheat in India, before, during, and since the war. For this advance the greater earning power of the urban classes appears to have been chiefly responsible. There is every prospect of further increase in consumption, but at what rate and to what level one cannot predict within a wide margin of error. It is desirable, however, to consider the influence of the principal factors, namely, the rate of population growth, the age and occupational distribution of the population, the earning power of the urban classes in or within reach of the wheat-growing regions, and the price of wheat.

India's growth in population has been quite irregular, chiefly because of general and local famines and epidemics. There is no prospect that India will ever reach a stage in which the food supply is as abundant as in Western nations, in relation to population, and serious local deficiencies calling for organized relief are likely to remain a chronic condition. Nevertheless, with an ever wider use of irrigation, better transport and distribution facilities, and accumulated experience, it seems improbable that famines will be as frequent or as severe as they were before the present century. Barring serious famines and epidemics, and assuming ordinarily prosperous conditions, the growth of population

may well be 4 or 5 per cent a decade, and probably more than this among the wheat-consuming population. Increase of at least a million a year would seem a conservative forecast; in fairly healthy, prosperous periods, with lower death-rates, a considerably larger growth is likely to occur.

The age distribution of the population, which has been subject to influences that have reduced the proportion of younger adults who tend to be relatively heavier consumers of wheat,[1] is being readjusted; and from this change one may anticipate a higher consumption per capita.

Despite the figures for the decade 1911–21, which showed (doubtless because of the toll of lives taken by influenza) a lower rate of increase of population in urban than in rural areas, the indications are that the trend is toward increasing industrialization and a more rapid increase in the urban classes, though not necessarily in the largest cities. Here the growth in per capita wheat consumption has apparently been most marked, but there seems to be considerable room for further expansion. Changes in dietary habits are gradual, and it is highly probable that this change will proceed with cumulative effects.

During the past twenty-five years the earnings of urban workers have risen to higher levels. It would be hazardous to predict an indefinite further increase, or even the maintenance of the present level. But the tendency has been almost world-wide, and is apparently associated with increased productivity of labor in capitalistic industry, in the reward for which, labor as well as capital has shared. These causes are still at work to prolong the tendency. A period of more intense competition in world markets may be in store, and India may have to go through a period of industrial depression; but the very youth and limited extent of her industries, and the breadth of her home market, may in some degree protect her from serious recessions. Years of bad trade will doubtless come, but the trend of real wages in Indian industry seems more likely to be upward than downward for some years to come.

Another important factor bearing on per capita consumption is the price of wheat, not so much in money terms as in relation to money wages and the general level of prices. It seems improbable that wheat prices will fall, for any considerable period, to the low relative position which they held for nearly two years in 1922–24. On the other hand, in view of increasing production in Europe, Russia, Canada, Argentina, and Australia, it seems improbable that world wheat prices will rise for many years, save in exceptional seasons, to a higher level in relation to wages, and perhaps to prices in general, than prevailed in the years immediately preceding the war. Probably this will be true also in India, but if India should more or less permanently shift from an export basis to an import basis, the consequent advance in Indian wheat prices might effectively check the increase in Indian consumption.

All things considered, the probabilities are that wheat consumption in India will increase as rapidly as wheat production, perhaps more rapidly in the next few years; and there is yet no evidence that any large part of the increased consumption will be furnished by substantial reductions in the heavy toll taken by weevils, rats, and spoilage.

The Future of Exports

In the earliest days of India's export trade in wheat, as we have seen, high hopes were held that she would prove perhaps the greatest wheat exporter in the world and the only source required to satisfy Great Britain's immense demand. Such hopes were soon destroyed, never to revive. In the 'eighties and early 'nineties, indeed, and again during the period of her heaviest trade, from 1903–4 to 1913–14, India's exports were a substantial factor in the world wheat trade, but in the latter period her exports were usually surpassed by those of half a dozen other wheat-exporting countries. In 1904–5 and 1912–13 Indian deliveries made the largest single contribution from any country to British markets, but even then provided only about one-fifth of all Great Britain's supplies. In the period since the war, India has been distinctly a minor exporter.

[1] See above, p. 356.

If our reasoning is correct, there is no prospect that India will ever attain to a leading position in the wheat export trade such as Canada, the United States, Argentina, and Australia usually hold, and as Russia and Roumania may again attain. In an occasional year, indeed, given a fortunate conjuncture of fine crops, high world prices, and a promising outlook for the new season, India may figure as a really large exporter. Conceivably she may again, for a series of years, make as heavy exports as in the years before the war. But in considering the prospects for India's exports, we have to deal with magnitudes expressed, not in one or more hundred millions, as in the case of Canada and Russia, but in scores of millions of bushels.

Furthermore, in our judgment, India shows no promise of becoming, in the near future at least, a continuously substantial contributor to world wheat markets, even to the extent that was true in the dozen years before the war. Canada, Russia, Argentina, and Australia all have far greater possibilities for expansion in production and export surpluses. The rate of increase in any one of these countries will be greatly influenced by the exports of others, with Russian exports the most highly problematical; but the present outlook is that expansion of production will be restrained by moderate prices of wheat, rather than that high prices of wheat will be brought about by inability to increase production to keep pace with rising consumption.

If the world comes to depend more largely on Russia's wheat exports, Indian wheat may come into new demand because of its peculiar suitability for blending with Russian wheat. However, new varieties of wheat which yield considerably stronger flour are making their way into cultivation in India. These wheats may not be particularly suitable for blending with Russian wheats, and in this case the joint demand will lapse. It will probably be replaced, however, by a demand for Indian wheat in virtue of its independent strength. Already the United States frequently experiences a deficiency of hard wheats and strong flours, primarily due to the artificial scarcity induced by a duty of 42 cents a bushel on imported wheat. For the rest of the world, the prospects of a deficiency are not so serious, both because, as a result of increased Canadian production, supplies of hard wheat are larger and because the demand for strong flour is more elastic. In the face of pronounced premiums for hard wheats, European bakers generally will modify their flour standards and make shift to use softer available wheats. Nevertheless, except for some radical change in the technique of baking, any country that has good supplies of hard wheat will usually find a fair market for its surplus.

Certain historic characteristics of India as a wheat exporter will presumably persist. Acreage and crops will vary with the summer and winter rains. India will export fair quantities from a succession of good crops but little in years of mediocre crops, and will be a net importer in years of crop failure. High prices of wheat in European markets will stimulate exports, low prices will restrict them. India's exports will normally be shipped most largely in June, July, and August, arriving at a time before European harvests are generally available and when arrivals from Canada, Russia, and the Southern Hemisphere tend to be light, and when United States winter wheats are the chief competitors in European markets. In so far as American exports decline, the seasonal demand for Indian wheats may well be intensified. But except in occasional years, and at certain seasons in many years, Indian wheat is likely to play a distinctly minor rôle in world markets.

This conclusion is strengthened by consideration of political developments in India. We have not the temerity to predict the outcome of the ferment and unrest that have characterized the post-war years, the concessions made by British policy, or the influence of developments in China. But whatever the future, it seems probable that Indian policies will be determined largely by Indian interests, and that the improvement of the Indian diet and the conservation of India's food supplies will be regarded as weightier considerations than the promotion of wheat exports to British markets.

APPENDIX

BIBLIOGRAPHICAL NOTES

A considerable literature on India and its economics and agriculture is in existence, but only a small part of it deals specifically with the production and export of wheat. Much of the information utilized in this study has thus of necessity been gleaned from articles and publications written on multifarious topics and with widely differing purposes. The following notes indicate the principal sources from which material has been drawn for the present study. They do not include all the titles which have been consulted; still less do they constitute a comprehensive bibliography on the subject. The sources of statistical data are indicated in footnotes to the tables. In the sources mentioned below, an asterisk (*) marking a title indicates an official publication of India or Great Britain.

Special acknowledgment must be made to the weekly *Journal of the Royal Society of Arts* (London), for reports of lectures by eminent authorities on a wide range of Indian topics. This *Journal* has frequently been consulted for information of many kinds, and seldom without reward. Lack of space prevents many specific acknowledgments to reports of high value that it contains. It is necessary to state with regret that several of the official serial publications of the government of India, such as the annual *Statement Exhibiting the Moral and Material Progress of the People of India,** seldom give information of economic value.

1. Geographical Factors in India's Wheat Production

The following three books present scientific descriptions of the geography of India: Sir Thomas Holdich, *India* (London, 1904); *Imperial Gazetteer of the Indian Empire,** Vol. I (new edition, Oxford, 1909), chapters by various authorities; and *Oxford Survey of the British Empire,* Vol. III, *Asia* (Oxford, 1914), chapters by various authorities. The climate of India is further described in the following works: H. F. Blanford, *Climates and Weather of India* (London, 1889); J. Hann, *Handbuch der Klimatologie,* Band II (Stuttgart, 1910); and W. G. Kendrew, *The Climates of the Continents* (Oxford, 1922). *A Climatological Atlas of India** (Edinburgh, 1906) gives many valuable maps. Maps of India showing the areas under cultivation of different crops are given in the *Crop Atlas of India** (Calcutta, 1925), published by the Commercial Intelligence Department, India; and dot maps for certain crops in the period shortly before the war, in V. C. Finch and O. E. Baker, *Geography of the World's Agriculture* (Washington, 1917).

A most valuable description of the relations between climate and wheat production is presented by Th. H. Engelbrecht, *Die Feldfrüchte Indiens in ihrer geographischen Verbreitung* (Abhandlungen des Hamburgischen Kolonialinstituts, Band XIX, Hamburg, 1914). This book is accompanied by a most valuable atlas of maps which have been specially drawn to show the distribution of the various crops, and the principal climatic factors that influence distribution.

2. Agricultural Practices in Indian Wheat Growing

The most complete account of the cultivation of wheat in India is to be found in A. and G. L. C. Howard, *Wheat in India** (Calcutta, 1910); additional information of value is contained in the *Imperial Gazetteer of the Indian Empire,** Vol. III (new edition, Oxford, 1909), and in Sir George Watt, *A Dictionary of the Economic Products of India** (Calcutta, 1889–96), and *The Commercial Products of India* (London, 1908), articles on *"Triticum v."* and other crops. W. H. Moreland, in *The Agriculture of the United Provinces** (second edition, Allahabad, 1909), a masterpiece of agricultural literature, describes the problems which agricultural production presents to the cultivator. N. G. Mukerji's *Handbook of Indian Agriculture* is a lengthy and detailed book which deals primarily with Bengal. Numerous articles in the *Agricultural Journal of India** (Calcutta), the *Memoirs of the Department of Agriculture in India,** and the *Bulletins of the Agricultural Research Institute, Pusa,** describe various aspects of Indian agriculture, but only a few of them bear directly on the production of wheat.

Two clear pictures of village life and organization are presented by E. D. Lucas, *The Economic Life of a Punjab Village* (Lahore, 1920), and by R. Mukerjee, *Principles of Comparative Economics,* Vol. II (London, 1922).

Economic aspects of land tenure in India in its relations to the state are discussed in Frank Noyce, "Land Revenue Administration and Tenure in British India," *Bulletin of Economic and Social Intelligence* (Rome), 1914, V, Part 11, p. 125, and Part 12, p. 85; and in two articles by Sir James Douie, "Partition and Consolidation of Holdings, and Relaying of Field Boundaries in the Punjab," *ibid.,* 1915, V, Part 10, p. 87, and "Land Tenures in the Punjab in their Original Form and as Affected by British Rule," *ibid.,* 1917, VIII, Part 7, p. 51.

The course of efforts for the improvement of Indian agriculture is to be traced in the yearly *Report of the Imperial Department of Agriculture in India,** now entitled the *Review of Agricultural Operations in India,** the yearly *Report of the Agricultural Research Institute, Pusa,** and the yearly reports of the provincial departments of agriculture.

3. Irrigation as a Factor in Wheat Culture

The problems of Indian irrigation as they appeared at the beginning of the twentieth century are stated in the *Report of the Indian Irrigation Commission** (London and Calcutta, 1903), and the answers, so far as government canals are concerned, in the *Triennial Review of Irrigation in India,** of which the volume covering 1918–21 (Calcutta, 1921) is especially valuable. A good summary description of all forms of irrigation in India is to be found in the chapter on "Irrigation" in the *Imperial Gazetteer of the Indian Empire,** Vol. III (new edition, Oxford, 1909). A. V. Williamson, "Irrigation in the Indo-Gangetic Plain," *Geographical Journal* (London), 1925, LXV, 141, presents some points of interest.

E. A. Molony, *Manual of Irrigation Wells** (Allahabad, 1909) offers the best of several good descriptions of native wells. The agricultural aspects of irrigation are described in various articles in the *Agricultural Journal of India;* perhaps the best is by W. Roberts and O. T. Faulkner, "Some Factors Affecting the Efficiency in the Use of Canal Water,"* *Agricultural Journal of India** (Calcutta), 1918, XIII (Indian Science Congress Number), p. 81. Such articles devote their attention to irrigation from canals, and though they recognize the importance of well irrigation and express concern for the digging and use of wells, they say little about effective utilization of water, either from wells or other native forms of irrigation. Henry Marsh, "Indirect Benefits of Irrigation," *Asiatic Review* (London), 1914, New Series, VI, 403, presents interesting conclusions.

Settlement on canal colonies is described by L. Robertson, "Irrigation Colonies in the Punjab," *Journal of the Royal Society of Arts* (London), 1907, LV, 774; by Sir James Douie, "Canal Colonies in the Punjab," *Bulletin of Economic and Social Intelligence* (Rome), 1915, VI, 102; and by D. N. Bannerjea, "Indian Irrigation and the Punjab Canal Colonies," *International Review of Agricultural Economics* (Rome), 1925, New Series, II, 212.

Engineering aspects of irrigation are presented in the following works: R. B. Buckley, *The Irrigation Works of India* (London, 1905); N. F. Mackenzie, *Notes on Irrigation Works* (London, 1910); E. S. Bellasis, *Irrigation Works* (London, 1913); W. L. Strange, *Notes on Irrigation, Roads and Buildings* (London, 1920); and in various articles in *The Engineer* (London, weekly). A study of one work by its constructor is presented by Sir John Benton, "The Punjab Triple Canal Project," *Proceedings of the Institute of Civil Engineers* (London), 1915–16, CCI, 24.

4. The Present Status of the Indian Wheat Trade

A detailed description of wheat trading in India is given in a lecture by H. J. Casey on "The Indian Grain Trade," reported in the *London Corn Circular,* Supplement, January 5, 1925. A much briefer description is given in the statement of G. Eumorfopoulos quoted in the *Report of the Royal Commission on Food Prices . . . . with Minutes of Evidence and Appendices** (London, 1925). C. W. E. Cotton, *Handbook of Commercial Information for India** (Calcutta, 1924, second edition), surveys many aspects of the present situation. Stanley H. Titford, *The Work of the London Corn Trade Association* (Liverpool, 1926), describes some details of the London trade in East Indian wheat. S. K. Thorpe, *Grain Trade Documents* (Liverpool, 1924), supplies some points of interest.

H. K. Trevaskis, "Some Aspects of Agricultural Marketing as Illustrated by the Lyallpur Co-operative Commission Sale Shops," *Agricultural Journal of India** (Calcutta), 1923, XVIII, 115, describes an interesting new development in the Punjab. Valuable information on native methods of storage and exporters' practices is given by J. H. Barnes and A. J. Grove, "The Insects Attacking Stored Wheat in the Punjab," *Memoirs of the Department of Agriculture in India (Chemical Series)** (Calcutta), 1915, IV, No. 6; and T. B. Fletcher and C. C. Ghose, "Stored Grain Pests," *Agricultural Research Institute, Pusa, Bulletin 111** (Calcutta, 1921); and Noël-Paton's work mentioned below, in which other scientific papers by Hooper, Maxwell-Lefroy, and Cole are reprinted.

Descriptions of native foods and ways of preparation are contained in Sir George Watt, *A Dictionary of the Economic Products of India** (Calcutta, 1889–96) and *The Commercial Products of India* (London, 1908), under various headings. The problem of India's exportable "surplus" is discussed by B. Narain, *Indian Economic Problems* (Lahore, 1922), who presents an Indian opinion, and by H. Calvert, *The Wealth and Welfare of the Punjab* (Lahore, 1922), who puts forward the British and official point of view. Both works are able and valuable.

Frederick Noël-Paton, *Indian Wheat and Grain Elevators** (Calcutta, 1913) gives a full discussion of the seasonal movement of Indian wheat for export, in relation to prices and transportation facilities, in support of arguments for the construction of a country elevator system.

5. Commercial Qualities of Indian Wheats

The first investigations of Indian wheats were described by Dr. J. Forbes Watson in his *Report on Indian Wheat** (London, 1879), and the tests on their milling and baking qualities were recorded in Messrs. McDougall, Brothers, *Report on Indian Wheats** (London, 1883).

The commercial characteristics of the usual types of export wheat are described in W. and W. C. Jago, *The Technology of Bread-Making* (London, 1911), E. Bradfield, *Wheat and the Flour Mill* (Liverpool, 1920), P. A. Kozmin, *Flour Milling* (London, 1921), D. W. Kent-Jones, *Modern Cereal Chemistry* (Liverpool, 1924), P. A. Amos, *Processes of Flour Manufacture* (second revised edition, London, 1925), and in some of the reports and bulletins mentioned below.

The milling and baking qualities of the new wheats selected by Mr. and Mrs. Howard are described in the following *Memoirs of the Department of Agriculture in India (Botanical Series)*:* A. and G. L. C. Howard, "The Varietal Characters of Indian Wheats" (1909, II, No. 7), and three publications by A. Howard, H. M. Leake, and G. L. C. Howard, "The Influence of the Environment on the Milling and Baking Qualities of Wheat in India" (1910, III, No. 4; 1913, V, No. 2; 1914, VI, No. 8); in the following *Bulletins of the Agricultural Research Institute, Pusa*:* three papers by A. and G. L. C. Howard, "The Milling and Baking Qualities of Indian Wheats" (*No. 14,* 1908; *No. 17,* 1910; *No. 22,* 1911), Sir James Wilson, "Memorandum on Indian Wheat for the British Market" (*No. 20,* 1911), and B. C. Burt, A. and G. L. C. Howard, "Pusa 12 and Pusa 4 in the Central Circle of the United Provinces" (*No. 122,* 1921); and also in A. and G. L. C. Howard, *Wheat in India* (Calcutta, 1910). All these reports except *Bulletin 20* contain reports by Mr. A. E. Humphries of his milling and baking tests on the various wheats. Further information about the course of the experiments is to be found in the annual official reports cited at the end of Section 2 of these bibliographical notes. (All the foregoing memoirs, bulletins, and reports were published in Calcutta.)

6. Progress of India's Wheat Export Trade

The course of export trade in Indian wheat can be followed in the annual *Review of the Trade of India** (London and Calcutta) a publication of fifty years' standing. Events of the early years are well described in *The Miller* (London, weekly), which began publication in 1875. The development of the railway system is recorded in the annual *Administration Report on the Railways in India** (London and Calcutta), and S. C. Ghose, *A Monograph on Indian Railway Rates** (Calcutta, 1918).

The most authoritative opinions upon the decline of value of the rupee and its effects on foreign trade are to be found in the evidence and the three reports of the *Royal Commission on Gold and Silver** (London, 1887–88), and the evidence and report of the *Indian Currency Committee** (London, 1893).

Information upon the first controversy over refraction is given in *Reports and Papers on Impurities in Indian Wheat** (London, 1889), *Report of the Conference on Indian Wheat Impurities, at the India Office, 8th May, 1889** (London, 1889) and *Papers Regarding the Impurity of Indian Wheat . . . . 1885–1890** (London, 1894). Unofficial opinions were freely expressed at a lecture on Indian Wheats by Mr. John McDougall before the Royal Society of Arts (*Journal of the Royal Society of Arts,* London, 1889, XXXVII, 637). The second reform of 1906 is described in resolution of the government of India, reported in the *Board of Trade Journal** (London), 1907, LVI, 175, and in occasional notes in the current issues of Broomhall's daily *Corn Trade News* (Liverpool).

The early administration of Indian wheat supplies during the war is described in the *Report of the Indian Wheat Committee for 1915 and 1916** (London, 1918), and the administration of the later years in the *First Report of the Royal Commission on Wheat Supplies** (London, 1921) and the *Report on the Operations of the Indian Foodstuffs Commissioner** (Delhi, 1919). The annual *Review of the Trade of India** continues to supply excellent information on this period.

TABLE I.—WHEAT ACREAGE IN PRINCIPAL PRODUCING REGIONS OF INDIA, ANNUALLY FROM 1890–91*

(Thousand acres)

Harvest year	Total	North-West Frontier Province[a]	Punjab, Delhi[b]	United Provinces	Bihar, Orissa, Bengal[c]	Central Provinces and Berar[d]	Central Indian States	Rajputana States	Bombay, Baroda, Sind[e]	Hyderabad[f]
1891.....	26,576	.....	7,074	5,207	1,504	5,111	.....[g]	1,507	2,865	.....[g]
1892.....	24,088	.....	6,224	4,695	1,190	4,638	.....[g]	1,471	2,620	.....[g]
1893.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1894.....	28,717	.....	8,265	6,675	1,461	4,914	1,537	1,646	3,056	1,163
1895.....	28,422	.....	8,052	6,334	1,413	4,283	2,043	1,529	3,352	1,413
1896.....	24,071	.....	6,893	5,177	1,427	3,461	1,741	1,307	2,604	1,454
1897.....	20,580	.....	6,584	4,932	1,342	2,351	1,366	1,374	1,854	773
1898.....	24,538	.....	8,014	5,985	1,570	2,562	1,501	1,302	2,596	1,003
1899.....	25,370	.....	7,729	6,349	1,583	2,941	1,614	1,196	2,841	1,113
1900.....	18,688	.....	6,367	6,203	1,550	1,651	693	361	1,522	339
1901.....	23,864	.....	8,766	6,790	1,499	2,300	1,244	713	1,913	636
1902.....	23,446	797	7,227	6,462	1,408	2,900	1,459	542	2,044	603
1903.....	23,395	823	6,995	6,910	1,417	2,502	1,182	818	2,129	614
1904.....	28,414	994	7,766	7,789	1,508	3,374	1,956	1,125	2,761	1,135
1905.....	28,470	882	7,712	7,706	1,506	3,497	2,227	1,024	2,784	1,127
1906.....	26,357	1,025	8,572	6,479	1,408	3,444	1,852	666	1,975	934
1907.....	29,213	1,146	9,100	7,044	1,539	3,714	2,448	842	2,335	1,040
1908.....	22,912	978	8,272	4,406	1,096	2,802	1,694	604	2,125	933
1909.....	26,236	1,019	9,002	5,695	1,332	2,860	2,046	888	2,294	1,098
1910.....	28,106	1,008	9,142	6,491	1,500	3,176	2,313	1,085	2,291	1,097
1911.....	30,565	1,033	9,981	7,342	1,455	3,585	2,460	1,187	2,415	1,104
1912.....	31,141	1,203	11,018	7,578	1,428	3,739	2,563	963	1,675	970
1913.....	30,073	879	9,346	7,382	1,416	3,743	3,216	1,014	2,222	851
1914.....	28,495	992	9,608	6,406	1,486	3,384	2,695	622	2,592	702
1915.....	32,475	1,183	11,368	7,301	1,352	3,393	3,096	902	2,959	898
1916.....	30,320	868	10,274	6,599	1,464	3,616	2,949	649	2,840	1,045
1917.....	32,941	1,050	10,774	6,764	1,437	3,996	3,517	1,147	2,879	1,344
1918.....	35,487	1,143	11,313	7,248	1,319	4,007	4,382	1,407	3,379	1,262
1919.....	23,798	872	8,559	5,444	1,080	2,881	2,301	603	1,425	623
1920.....	29,949	1,025	9,984	7,037	1,261	3,350	2,993	976	2,524	770
1921.....	25,784	722	8,809	6,589	1,211	2,660	2,798	810	1,853	310
1922.....	28,207	938	10,022	6,906	1,257	2,525	2,549	850	2,492	644
1923.....	30,852	1,138	10,948	7,085	1,391	3,104	2,960	989	2,515	700
1924.....	31,181	1,055	11,064	7,283	1,346	3,377	3,452	969	1,922	698
1925.....	31,774	1,013	10,984	7,472	1,301	3,410	3,347	1,101	2,323	800
1926.....	30,470	1,096	10,733	6,991	1,293	3,634	3,240	836	1,793	844
1927.....	30,891	993	10,510	6,834	1,315	3,819	3,255	995	2,786	959

* Official data: for 1891 and 1892 from U.S. Department of Agriculture, *Report of the Statistician*, September and October, 1892; for 1894 to 1896 from A. and G. L. C. Howard, *Wheat in India* (Calcutta, 1910), Appendix B; for later years chiefly from annual reports of the Commercial Intelligence Department of India on *Acreage, Production, and Yield of Principal Crops in India*, supplemented for latest years from the *Indian Trade Journal*. Comparable data for earlier years and for 1893 have not been found. Totals include very small areas in Mysore, and in Ajmer-Merwara from 1914. Figures for 1927 are those of the fourth wheat forecast.

For the Native States, the agricultural statistics are still incomplete and imperfect, but most of the wheat-growing areas are probably covered. Acreage figures are for area sown except when abandoned acreage has been sown to other crops. The statistics of wheat acreage rest in part upon official inspection of almost every field. This is true in the Punjab and some other provinces, and generally where irrigation charges are levied according to the kind of crop. In other regions, the acreage statistics are mainly compiled from rough estimates by district officers, and may be wide of the mark. In the past twenty-five years the statistics are said to have become considerably more trustworthy, as well as more comprehensive for the Native States.

[a] Constituted in 1901 out of the Punjab; from 1910 including the Tochi and Kurram agencies.

[b] Excluding Delhi in 1891 and 1892, including the area of the North-West Frontier Province to 1901 inclusive, and including Native States from 1908.

[c] Bihar and Orissa were created in 1910 out of Bengal; from 1922 certain feudatory states producing little wheat are excluded.

[d] Including the states of Khairagarh and Nandgaon from 1908, and other Native States from 1920.

[e] Exclusive of Baroda in 1891 and 1892; Bombay and Sind (from 1924 part of Bombay) figures include Native States; from 1913 official estimates for non-reporting tracts in Bombay are included.

[f] Figures slightly more inclusive from 1903.

[g] "Other territories," comprising chiefly Central Indian States and Hyderabad, reported in 1891 acreage of 3,308 and production of 19,040, and in 1892 acreage of 3,250 and production of 18,592.

TABLE II.—WHEAT PRODUCTION IN PRINCIPAL PRODUCING REGIONS OF INDIA, FROM 1890–91*

(Thousand bushels)

Harvest year	Total	North-West Frontier Province[a]	Punjab, Delhi[b]	United Provinces	Bihar, Orissa, Bengal[c]	Central Provinces and Berar[d]	Central Indian States	Rajputana States	Bombay, Baroda, Sind[e]	Hyderabad[f]
1891.....	256,704	.....	77,317	65,147	14,933	37,520	.....[g]	14,747	28,000	.....[g]
1892.....	203,168	.....	51,968	58,949	9,333	30,502	.....[g]	13,515	20,310	.....[g]
1893.....	268,538	.....	.....	.....	.....	.....	.....	.....	.....	.....
1894.....	271,375	.....	95,586	69,242	17,136	27,847	8,505	14,523	34,459	4,078
1895.....	261,293	.....	89,426	54,880	25,622	24,361	14,805	13,745	35,852	2,591
1896.....	200,866	.....	65,474	59,408	12,902	17,588	10,854	11,781	19,658	3,186
1897.....	200,234	.....	69,888	69,104	14,448	13,291	6,720	10,976	15,083	709
1898.....	269,109	.....	88,069	84,000	22,139	21,840	10,416	11,461	30,053	1,120
1899.....	255,230	.....	73,845	85,008	24,491	19,040	10,752	10,304	30,539	1,232
1900.....	200,005	.....	68,059	89,973	21,392	7,541	3,733	2,949	6,272	75
1901.....	264,849	.....	109,797	89,040	17,659	17,584	8,213	6,384	15,717	448
1902.....	227,372	5,936	68,917	89,675	14,635	22,587	9,520	3,883	10,752	1,456
1903.....	297,604	8,736	86,427	110,955	18,144	26,171	15,269	7,131	22,736	2,016
1904.....	359,917	11,275	114,800	120,587	19,712	30,651	19,563	11,088	28,448	3,771
1905.....	283,076	10,005	106,587	70,821	18,480	31,061	17,659	7,056	18,032	3,360
1906.....	319,951	10,453	131,040	90,683	16,651	31,136	15,717	5,115	17,584	1,568
1907.....	317,023	11,387	121,968	80,789	15,717	33,749	22,960	6,795	19,563	4,069
1908.....	228,651	7,952	92,923	62,533	11,947	18,928	10,117	4,965	16,763	2,501
1909.....	285,197	7,952	114,315	79,296	12,469	26,917	14,859	7,392	19,302	2,688
1910.....	359,648	8,773	128,203	111,067	21,131	37,035	19,189	9,931	21,765	2,539
1911.....	375,629	9,931	138,469	108,976	22,699	36,325	21,728	9,893	23,968	3,621
1912.....	370,500	10,453	142,203	113,195	22,550	33,749	25,611	7,616	13,514	1,605
1913.....	368,217	7,280	111,962	109,685	21,653	39,648	39,163	9,109	27,888	1,792
1914.....	312,367	9,669	119,392	82,917	23,669	25,685	18,517	4,555	26,246	1,605
1915.....	376,993	12,357	139,478	113,568	14,150	29,045	23,968	8,101	34,198	1,904
1916.....	323,045	9,184	93,072	100,800	23,183	36,325	24,080	4,331	29,158	2,800
1917.....	382,140	10,341	110,133	114,277	23,816	43,605	33,525	9,856	31,435	4,704
1918.....	370,420	11,349	128,315	107,856	19,712	29,381	24,304	10,229	34,160	4,704
1919.....	280,261	8,400	108,416	86,016	14,261	26,171	18,331	5,040	11,983	1,531
1920.....	377,889	10,453	145,151	111,851	19,637	32,741	24,603	6,907	24,043	1,979
1921.....	250,356	5,488	86,352	88,629	18,144	13,627	19,003	5,749	12,879	224
1922.....	366,988	9,781	156,912	100,763	21,355	26,059	22,027	7,056	20,758	2,016
1923.....	372,368	10,901	143,098	96,581	20,422	39,536	29,120	8,400	22,101	2,315
1924.....	360,640	7,168	150,715	99,157	18,256	31,323	29,680	9,147	12,992	2,091
1925.....	330,997	7,280	112,224	91,355	18,592	40,693	28,747	10,827	18,368	2,725
1926.....	324,949	10,005	127,008	86,389	16,986	33,861	27,440	7,168	13,253	2,763
1927.....	330,399	8,251	127,418	93,931	19,003	29,755	23,968	8,101	17,286	2,389

* For sources and qualifying notes, see Table I. The production data rest upon estimates of acreage and yield, and are subject to errors in both estimates. Though apparently improved considerably in the past twenty-five years, they are still to be regarded as approximations, the less exact because it is impossible to check them, as in the United States and Canada, by statistics of disposition of the crop.

TABLE III.—WHEAT YIELD PER ACRE IN PRINCIPAL PRODUCING REGIONS OF INDIA, FROM 1890–91*

(Bushels per acre)

Harvest year	Total	North-West Frontier Province	Punjab, Delhi	United Provinces	Bihar, Orissa, Bengal	Central Provinces and Berar	Central Indian States	Rajputana States	Bombay, Baroda, Sind	Hyderabad
1891.....	9.7	....	10.9	12.5	9.9	7.3	....	9.8	9.8	....
1892.....	8.4	....	8.3	12.6	7.8	6.6	....	9.2	7.8	....
1893.....	....	....	....	....	....	....	....	....	....	....
1894.....	9.4	....	11.6	10.4	11.7	5.7	5.5	8.8	11.3	3.5
1895.....	9.2	....	11.1	8.7	18.1	5.7	7.2	9.0	10.7	1.8
1896.....	8.3	....	9.5	11.5	9.0	5.1	6.2	9.0	7.5	2.2
1897.....	9.7	....	10.6	14.0	10.8	5.7	4.9	8.0	8.1	0.9
1898.....	11.0	....	11.0	14.0	14.1	8.5	6.9	8.8	11.6	1.1
1899.....	10.1	....	9.6	13.4	15.5	6.5	6.7	8.6	10.7	1.1
1900.....	10.7	....	10.7	14.5	13.8	4.6	5.4	8.2	4.1	0.2
1901.....	11.1	....	12.5	13.1	11.8	7.6	6.6	9.0	8.2	0.7
1902.....	9.7	7.4	9.5	13.9	10.4	7.8	6.5	7.2	5.3	2.4
1903.....	12.7	10.6	12.4	16.1	12.8	10.5	12.9	8.7	10.7	3.3
1904.....	12.7	11.3	14.8	15.5	13.1	9.1	10.0	9.9	10.3	3.3
1905.....	9.9	11.3	13.8	9.2	12.3	8.9	7.9	6.9	6.5	3.0
1906.....	12.1	10.2	15.3	14.0	11.8	9.0	8.5	7.7	8.9	1.7
1907.....	10.9	9.9	13.4	11.5	10.2	9.1	9.4	8.1	8.4	3.9
1908.....	10.0	8.1	11.2	14.2	10.9	6.8	6.0	8.2	7.9	2.7
1909.....	10.9	7.8	12.7	13.9	9.4	9.4	7.3	8.3	8.4	2.4
1910.....	12.8	8.7	14.0	17.1	14.1	11.7	8.3	9.2	9.5	2.3
1911.....	12.3	9.6	13.9	14.8	15.6	10.1	8.8	8.3	9.9	3.3
1912.....	11.9	8.7	12.9	14.9	15.8	9.0	10.0	7.9	8.1	1.7
1913.....	12.2	8.3	12.0	14.9	15.3	10.6	12.2	9.0	12.6	2.1
1914.....	11.0	9.7	12.4	12.9	15.9	7.6	6.9	7.3	10.1	2.3
1915.....	11.6	10.4	12.3	15.6	10.5	8.6	7.7	9.0	11.6	2.1
1916.....	10.7	10.6	9.1	15.3	15.8	10.0	8.2	6.7	10.3	2.7
1917.....	11.6	9.8	10.2	16.9	16.6	10.9	9.5	8.6	10.9	3.5
1918.....	10.4	9.9	11.3	14.9	14.9	7.3	5.5	7.3	10.1	3.7
1919.....	11.8	9.6	12.7	15.8	13.2	9.1	8.0	8.4	8.4	2.5
1920.....	12.6	10.2	14.6	15.9	15.6	9.8	8.2	7.1	9.5	2.6
1921.....	9.7	7.6	9.8	13.5	15.0	5.1	6.8	7.1	7.0	0.7
1922.....	13.0	10.4	15.7	14.6	17.0	10.3	8.6	8.3	8.3	3.1
1923.....	12.1	9.6	13.1	13.6	14.7	12.7	9.8	8.5	8.8	3.3
1924.....	11.6	6.8	13.6	13.6	13.6	9.3	8.6	9.4	6.8	3.0
1925.....	10.4	7.3	10.2	12.2	14.3	11.9	8.6	9.8	7.9	3.4
1926.....	10.7	9.1	11.8	12.4	13.1	9.3	8.5	8.6	7.4	3.3
1927.....	10.7	8.3	12.1	13.7	14.5	7.8	7.4	8.1	7.9	2.5

* Computed from acreage and production figures in Tables I and II, and subject to the same qualifying notes.

Though data on average yields are not usually published, the estimates of production are derived from estimates of acreage and yield. The estimates of yield are subject to considerable margin of error; ". . . . in India," according to Sir James Wilson (*Memorandum on Wheat for the British Market*, Calcutta, 1910, p. 4), "owing to the ignorance of the great mass of cultivators, and the great differences in the outturn of different fields, it is more difficult than in Western countries to make a fair approximation to the truth." Sir James believed the actual variations from year to year are larger than reported.

TABLE IV.—WHEAT RECEIPTS AT PRINCIPAL INDIAN PORTS FROM PRODUCING REGIONS, 1912–13 TO 1913–14*

(Thousand bushels)

	1912–13			1913–14			1914–15		
	Karachi	Bombay	Calcutta	Karachi	Bombay	Calcutta	Karachi	Bombay	Calcutta
Grand total	53,335	12,512	12,409	35,618	13,109	10,356	28,843	5,187	5,923
By rail and river, from									
Punjab	39,105	397	9	28,101	188	900	26,778	1,471	1,435
United Provinces	14,013	3,464	9,918	5,793	797	5,895	387	218	2,463
Bihar and Orissa	.....	.....	1,778	.....	.....	362	.....	.....	1,070
Bengal	.....	.....	174	.....	.....	69	.....	.....	86
Central Provinces and Berar	.....	4,973	465	3	4,933	2,450	.....	415	845
Rajputana and Central India	26	3,258	64	19	5,716	270	1	824	8
Bombay	.....	230	.....	.....	481	.....	.....	591	11
Sind and British Baluchistan	181	.....	.....	1,660	.....	1	1,627	1	.....
Other places	5	16	1	.....	.....	1	.....	33	5
Total	53,330	12,338	12,409	35,576	12,115	9,948	28,793	3,553	5,923
By sea, from									
Sind and British Baluchistan	.....	25	.....	.....	125	407	.....	973	.....
Other British India	1	4	.....	.....	16	1	2	3	.....
Non-British ports in India	1	54	.....	42	853	.....	33	619	.....
Foreign countries	3	91	.....	.....	.....	.....	15	39	.....
Total	5	174	.....	42	994	408	50	1,634	.....

* Official data from G. F. Shirras, *Statistical Tables Relating to Indian Wheat* (Calcutta, 1916).

TABLE V.—INDIAN WHEAT PRODUCTION, NET EXPORTS, AND DOMESTIC RETENTION, ANNUALLY FROM 1893–94*

(Million bushels)

Crop of	Production	Net exports	Retention	Crop of	Production	Net exports	Retention
1893	268.5	24.1	244.4	1910	359.6	49.3	310.3
1894	271.4	13.9	257.5	1911	375.6	53.4	322.2
				1912	370.5	65.5	305.0
1895	261.3	19.9	241.4	1913	368.2	48.9	319.3
1896	200.9	3.7	197.2	1914	312.4	29.0	283.4
1897	200.2	5.4	194.8				
1898	269.1	37.9	231.2	1915	377.0	27.5	349.5
1899	255.2	18.7	236.5	1916	323.0	31.7	291.3
				1917	382.1	58.1	324.0
1900	200.0	.3	199.7	1918	370.4	17.4	353.0
1901	264.8	14.3	250.5	1919	280.3	(2.6)[a]	282.9
1902	227.4	21.2	206.2				
1903	297.6	50.4	247.2	1920	377.9	14.0	363.9
1904	359.9	82.9	277.0	1921	250.4	(9.7)[a]	260.1
				1922	367.0	10.2[b]	356.8
1905	283.1	36.2	246.9	1923	372.4	26.0[c]	346.4
1906	320.0	31.5	288.5	1924	360.6	44.8[c]	315.8
1907	317.0	34.1	282.9				
1908	228.7	4.0	224.7	1925	331.0	11.3[c]	319.7
1909	285.2	40.8	244.4	1926	324.9	9.0[d]	315.9

* Production and net exports from Appendix Tables II, XIIB, except as noted. Net exports are for years April–March following harvest. Net exports are calculated exclusive of flour trade by land, for which no data are available; the omission is probably unimportant.

[a] Net import.

[b] Does not include land trade figures.

[c] Sum of monthly figures, excluding land trade, as reported by International Institute of Agriculture.

[d] Provisional, exclusive of land trade.

TABLE VI.—AVERAGE ANNUAL RAINFALL IN CHIEF WHEAT-PRODUCING PROVINCES OF INDIA, 1907–23*

(Inches)

Calendar year	Punjab		United Provinces		Central Provinces and Berar		
	South-west	East, North	West	East	East	West	Berar
Normal	9.9	23.2	37.4	39.2	53.5	46.8	32.3
1907	9.6	21.4	25.8	25.7	48.4	38.7	30.3
1908	17.9	32.4	37.4	29.9	59.9	46.6	35.1
1909	11.5	31.9	42.2	42.0	50.4	39.9	31.2
1910	9.3	26.4	42.6	41.5	56.5	47.6	40.6
1911	9.2	21.6	33.1	42.0	55.0	40.8	23.8
1912	8.5	22.2	34.9	33.5	54.8	40.7	25.9
1913	12.5	22.6	23.3	30.4	47.7	40.0	33.9
1914	18.7	31.9	39.9	38.0	54.5	44.1	40.7
1915	4.9	18.4	37.2	53.5	55.5	51.3	38.0
1916	12.3	26.8	47.7	47.2	54.1	57.5	47.2
1917	21.5	41.8	50.9	46.3	64.5	60.1	41.7
1918	6.8	13.2	19.2	23.3	53.3	33.6	19.2
1919	10.2	24.9	39.6	40.9	72.7	61.9	31.3
1920	6.8	15.6	29.6	31.7	37.4	32.9	16.0
1921	12.3	18.3	46.0	41.9	49.9	39.6	32.0
1922	7.9	22.3	46.3	51.6	49.8	44.9	34.9
1923	12.2	26.5	39.9	42.2	50.9	52.4	29.2

* Data from *Accounts and Papers of the United Kingdom* and annual reports of the Commercial Intelligence Department of India on *Estimates of Area and Yield of Principal Crops in India.*

TABLE VII.—AREA IRRIGATED AND WHEAT AREA IRRIGATED IN INDIA, ANNUALLY FROM 1889–90*

(Thousand acres)

Crop year	Total area irrigated			Wheat area irrigated		
	British India	Native States	Total	British India	Native States	Total
1889–90	27,722	....	....	6,595	....	....
1890–91	28,309	....	....	6,738	....	....
1891–92	27,233	....	....	6,577	....	....
1892–93	26,838	....	....	6,380	....	....
1893–94	26,702	....	....	6,379	....	....
1894–95	23,826	....	....	5,361	....	....
1895–96	26,737	....	....	6,281	....	....
1896–97	29,366	1,415	30,781	6,603	....	....
1897–98	30,418	1,426	31,844	7,831	....	....
1898–99	30,370	1,603	31,973	7,828	....	....
'99–1900	31,508	1,357	32,865	8,120	....	....
1900–01	30,018	1,740	31,758	7,493	....	....
1901–02	32,582	1,947	34,529	8,330	229	8,559
1902–03	32,912	1,975	34,887	8,491	230	8,721
1903–04	34,244	2,125	36,369	9,441	288	9,729
1904–05	31,027	2,049	33,076	7,420	287	7,707
1905–06	35,346	1,667	37,013	9,133	157	9,290
1906–07	36,654	1,983	38,637	9,208	....	....
1907–08	39,914	4,045	43,959	8,305	....	....
1908–09	42,487	5,418	47,905	8,592	1,062	9,654
1909–10	41,581	5,539	47,120	8,908	1,160	10,068
1910–11	40,895	5,902	46,797	8,792	1,112	9,904
1911–12	40,679	5,858	46,537	8,140	974	9,114
1912–13	45,539	5,933	51,472	9,084	1,099	10,183
1913–14	46,836	5,736	52,572	9,706	974	10,680
1914–15	47,194	6,049	53,243	10,119	1,075	11,194
1915–16	46,898	6,218	53,116	10,056	989	11,045
1916–17	48,004	6,565	54,569	10,310	1,144	11,454
1917–18	45,867	6,487	52,354	9,792	1,069	10,861
1918–19	47,222	6,200	53,422	9,562	1,030	10,592
1919–20	48,963	8,309	57,272	10,106	1,417	11,523
1920–21	48,957	8,048	57,005	10,248	1,252	11,500
1921–22	47,790	8,286	56,076	9,755	1,382	11,137
1922–23	47,875	8,640	56,515	9,853	1,475	11,328
1923–24	44,925	8,537	53,462	8,552	1,894	10,446
1924–25	45,299	....	....	8,790	....	....
1925–26	47,566	....	....	9,673	....	....

* Data from *Accounts and Papers of the United Kingdom* and *Agricultural Statistics of India*, with latest figures (provisional) from the *Indian Trade Journal*. Dots (. . . .) indicate absence of data.

TABLE VIII.—AREA IRRIGATED, BY SOURCES OF IRRIGATION, IN INDIA AND ITS PRINCIPAL PROVINCES, 1921–22 TO 1923–24*

(Thousand acres)

Crop Year	Total	Government canals	Private canals	Tanks	Wells	Other sources
	TOTAL INDIA					
1921–22	56,076	23,164	3,499	8,207	14,084	7,122
1922–23	56,515	23,661	3,650	8,330	13,549	7,325
1923–24	53,462	21,954	4,517	7,240	12,791	6,960
	NATIVE STATES					
1921–22	8,286	2,687	820	1,208	1,957	1,614
1922–23	8,640	2,605	918	1,337	2,110	1,670
1923–24	8,537	2,329	939	1,324	2,033	1,912
	BRITISH INDIA					
1921–22	47,790	20,477	2,679	6,999	12,127	5,508
1922–23	47,875	21,056	2,732	6,993	11,439	5,655
1923–24	44,925	19,625	3,578	5,916	10,758	5,048
	NORTH-WEST FRONTIER PROVINCE					
1921–22	959	356	423	....	68	112
1922–23	963	381	403	....	132	47
1923–24	882	359	400	....	82	41
	PUNJAB					
1921–22	13,293	8,997	547	15	3,587	147
1922–23	13,511	9,622	543	14	3,216	116
1923–24	13,070	9,294	439	12	3,214	111
	UNITED PROVINCES					
1921–22	9,869	2,240	16	61	5,262	2,290
1922–23	9,884	2,260	38	65	4,889	2,632
1923–24	7,982	1,613	23	63	4,252	2,031
	CENTRAL PROVINCES AND BERAR					
1921–22	1,133	331	2	610	148	42
1922–23	1,059	337	2	572	106	42
1923–24	1,102	...[a]	...[a]	934[a]	125	43
	BIHAR AND ORISSA					
1921–22	5,528	992	875	1,712	643	1,306
1922–23	5,300	907	879	1,703	639	1,172
1923–24	5,436	970	954	1,705	639	1,168
	BENGAL					
1921–22	1,764	180	96	827	10	651
1922–23	1,770	188	114	755	11	702
1923–24	1,426	155	111	599	25	536
	BOMBAY (INCLUDING SIND)					
1921–22	3,964	3,022	56	107	588	191
1922–23	4,085	3,205	57	96	568	159
1923–24	4,008	3,116	63	88	587	154
	MADRAS					
1921–22	9,562	3,747	203	3,477	1,700	435
1922–23	9,509	3,537	235	3,564	1,777	396
1923–24	9,000	3,474	178	3,189	1,732	427

* Data from *Agricultural Statistics of India, 1923–24.*

[a] Including under "tanks" areas irrigated by canals.

TABLE IX.—EXTENT OF IRRIGATION IN PRINCIPAL WHEAT-GROWING REGIONS, ANNUALLY, 1901–2 TO 1923–24*

(Thousand acres)

Crop year	Net area sown	Total area irrigated	Wheat area sown	Wheat area irrigated	Net area sown	Total area irrigated	Wheat area sown	Wheat area irrigated	Net area sown	Total area irrigated	Wheat area sown	Wheat area irrigated
	NORTH-WEST FRONTIER PROVINCE				PUNJAB				UNITED PROVINCES			
1901–02	1,582	670	511	226	21,509	8,851	5,657	3,764	34,949	10,291	6,488	3,711
1902–03	2,025	737	699	248	22,705	9,353	6,414	3,737	35,398	10,564	6,935	4,020
1903–04	2,328	753	903	277	24,912	9,679	7,818	4,073	35,711	11,065	7,814	4,367
1904–05	2,018	711	822	235	23,218	9,519	7,682	3,956	35,905	7,937	7,731	2,533
1905–06	2,197	721	917	240	24,112	9,977	8,505	4,497	34,995	11,211	6,503	3,720
1906–07	2,441	768	1,129	256	25,960	10,499	9,657	4,451	36,666	10,832	7,105	3,774
1907–08	2,196	753	956	228	21,801	10,530	7,393	4,374	33,104	11,617	4,469	3,086
1908–09	2,439	849	1,030	262	25,821	10,174	8,397	4,054	35,889	10,070	5,759	3,222
1909–10	2,397	841	1,028	259	25,593	9,943	8,676	4,128	36,594	10,093	6,578	3,445
1910–11	2,412	844	1,026	278	24,808	10,094	8,885	4,359	36,250	8,723	7,406	3,126
1911–12	2,285	847	1,199	280	22,257	10,955	9,725	4,551	35,591	7,936	7,636	2,426
1912–13	2,140	874	927	272	24,159	11,302	8,767	4,695	36,062	9,646	7,442	3,196
1913–14	2,390	893	1,031	277	24,258	11,470	8,473	4,506	33,184	11,563	6,441	4,010
1914–15	2,623	898	1,183	286	26,653	11,495	9,916	4,576	36,167	11,108	7,359	4,037
1915–16	1,924	931	868	294	22,349	11,677	8,992	4,774	36,249	11,195	6,663	3,766
1916–17	2,463	966	1,050	312	26,939	12,196	9,467	4,935	36,754	11,054	6,827	3,856
1917–18	2,531	975	1,143	332	27,163	11,314	9,926	4,658	36,412	10,884	7,313	3,745
1918–19	1,905	939	872	305	19,007	11,874	7,684	4,740	31,523	11,207	5,508	3,701
1919–20	2,312	971	1,025	319	25,677	12,929	8,813	4,877	35,563	10,856	7,101	3,932
1920–21	1,692	889	722	310	21,788	12,954	7,751	4,993	34,301	11,195	6,557	4,061
1921–22	2,419	959	938	333	25,962	13,293	8,789	4,905	35,811	9,869	6,873	3,613
1922–23	2,340	963	1,123	379	26,961	13,511	9,620	5,049	35,615	9,884	7,057	3,464
1923–24	2,397	882	1,055	339	26,576	13,070	9,672	5,005	35,649	7,982	7,246	2,347
	SIND				BOMBAY				BIHAR AND ORISSA			
1901–02	3,380	2,937	499	415	22,791	773	1,100	138	.....	.....	.....	...
1902–03	3,201	2,672	313	293	23,738	710	1,241	143	.....	.....	.....	...
1903–04	3,797	3,264	549	486	23,506	704	1,555	164	.....	.....	.....	...
1904–05	3,357	3,034	491	453	23,190	789	1,749	182	.....	.....	.....	...
1905–06	3,867	3,450	585	510	21,977	644	963	117	.....	.....	.....	...
1906–07	4,279	3,610	632	497	23,944	671	1,276	144	.....	.....	.....	...
1907–08	3,607	2,894	422	313	24,452	870	1,312	186	.....	.....	.....	...
1908–09	4,319	3,459	516	385	24,849	894	1,307	177	23,475	4,171	1,193	371
1909–10	3,815	3,058	447	373	25,353	883	1,383	182	27,132	4,097	1,352	407
1910–11	4,113	3,259	531	429	25,351	880	1,420	191	27,511	4,043	1,312	313
1911–12	2,941	2,885	368	349	22,906	1,005	984	196	27,556	3,845	1,285	274
1912–13	3,991	3,274	457	403	25,180	1,004	1,262	201	27,122	4,805	1,177	254
1913–14	4,321	3,444	456	409	25,385	896	1,454	149	25,948	4,031	1,342	272
1914–15	4,500	3,688	666	568	25,711	948	1,570	187	26,027	4,602	1,254	374
1915–16	3,254	3,206	564	544	27,058	980	1,709	210	25,948	4,498	1,330	358
1916–17	4,622	3,786	607	532	27,470	914	1,664	193	25,890	4,560	1,308	368
1917–18	4,468	3,257	675	485	27,300	973	2,026	200	25,803	4,429	1,199	253
1918–19	2,707	2,533	334	284	22,590	1,081	774	193	23,182	5,490	980	251
1919–20	4,069	3,218	565	392	26,847	1,033	1,417	187	25,616	5,808	1,145	300
1920–21	3,564	2,857	346	249	24,576	1,106	1,106	175	24,782	6,013	1,097	348
1921–22	4,036	2,982	432	309	26,862	981	1,501	176	25,383	5,528	1,134	300
1922–23	.....[a]	.....[a]	...[a]	...[a]	30,679[a]	4,085[a]	2,028[a]	557[a]	25,639	5,300	1,266	299
1923–24	.....[a]	.....[a]	...[a]	...[a]	30,924[a]	4,008[a]	1,563[a]	452[a]	24,674	5,436	1,226	310

* Data from *Agricultural Statistics of India*. About 85 per cent of the irrigated wheat acreage, as reported, lies in these provinces. The wheat acreage figures here given differ from those in Table I, chiefly because these figures exclude native states. No figures are given here for the Central Provinces and Berar, where irrigation is of little importance for wheat growing; for the Central Indian States, where the available statistics, probably incomplete, would seem to show that irrigation is little used; or for the Rajputana States, where the wheat acreage is somewhat smaller.

[a] Sind included with Bombay from 1922–23.

TABLE X.—RAILWAY MILEAGE OPEN FOR TRAFFIC IN INDIA, ANNUALLY FROM 1855*

Date	Miles	Date	Miles	Date	Miles
Dec. 31		Dec. 31		Dec. 31	
1855	169	1880	9,162	1905	28,295
1856	272	1881	9,890	1906	29,097
1857	287	1882	10,149	1907	30,010
1858	427	1883	10,458	1908	30,576
1859	625	1884	11,631	1909	31,490
1860	838	1885	12,283	1910	32,099
1861	1,587	1886	12,892	1911	32,839
1862	2,333	1887	14,103	1912	33,484
1863	2,507	1888	14,576	Mar. 31	
1864	2,958	1889	15,887	1914	34,656
1865	3,363	1890	16,401	1915	35,285
1866	3,563	1891	17,308	1916	35,833
1867	3,929	1892	17,815	1917	36,286
1868	4,008	1893	18,504	1918	36,334
1869	4,255	1894	18,900	1919	36,616
1870	4,771	1895	19,539	1920	36,735
1871	5,074	1896	20,246	1921	37,029
1872	5,369	1897	21,117	1922	37,266
1873	5,697	1898	22,032	1923	37,684
1874	6,226	1899	23,512	1924	38,039
1875	6,541	1900	24,752	1925	38,252
1876	6,860	1901	25,365	1926	38,564
1877	7,320	1902	25,930		
1878	8,219	1903	26,956		
1879	8,494	1904	27,565		

* Data from Administration Reports on the Railways in India, as given in *Accounts and Papers of the United Kingdom*, and for latest years, in the *Indian Trade Journal*.

TABLE XI.—WHEAT EXPORTS FROM BRITISH INDIA BY SEA, BY PRINCIPAL PORTS, ANNUALLY FROM 1872–73*

(Thousand bushels)

Apr.-Mar.	Total[a]	Karachi	Bombay	Calcutta
1872–73	735	314	140	271
1873–74	3,278	1,489	811	959
1874–75	1,995	267	1,183	524
1875–76	4,663	571	1,564	2,484
1876–77	10,422	850	2,304	7,257
1877–78	11,835	1,134	2,164	8,486
1878–79	1,951	42	243	1,661
1879–80	4,099	513	620	2,961

TABLE XI.—*Continued*

Apr.-Mar.	Total[a]	Karachi	Bombay	Calcutta
1880–81	13,895	316	6,188	7,388
1881–82	37,079	3,458	21,147	12,447
1882–83	26,402	5,100	12,988	8,287
1883–84	39,118	8,163	16,745	14,208
1884–85	29,551	7,974	16,787	4,785
1885–86	39,314	11,650	19,803	7,821
1886–87	41,558	4,879	23,531	13,138
1887–88	25,271	1,233	15,944	8,092
1888–89	32,872	7,474	19,888	5,508
1889–90	25,758	13,254	9,608	2,895
1890–91	26,731	12,632	11,596	2,315
1891–92	56,565	20,767	26,937	8,861
1892–93	27,950	6,483	15,259	6,207
1893–94	22,693	11,981	8,774	1,938
1894–95	12,858	10,455	1,952	449
1895–96	18,672	11,560	5,223	1,889
1896–97	3,567	1,262	2,165	138
1897–98	4,467	3,619	705	141
1898–99	36,437	17,878	12,104	6,456
1899–1900	18,114	9,350	4,313	4,451
1900–01	93	3	45	45
1901–02	13,668	13,390	155	122
1902–03	19,212	16,517	729	1,966
1903–04	48,367	32,452	6,889	9,021
1904–05	80,269	52,977	11,135	16,140
1905–06	35,000	24,186	6,450	4,289
1906–07	29,921	28,810	858	243
1907–08	32,870	31,600	1,033	236
1908–09	4,097	3,965	105	28
1909–10	39,221	30,166	4,195	4,849
1910–11	47,270	36,048	4,815	6,406
1911–12	50,816	38,848	5,543	6,426
1912–13	61,981	49,331	7,424	5,225
1913–14	44,882	33,351	8,797	2,732
1914–15	26,372	25,881	431	60
1915–16	24,375	19,643	2,935	1,796
1916–17	27,959	25,357	2,308	295
1917–18	54,297	40,477	9,063	4,719
1918–19	17,774	15,311	1,479	947
1919–20	323	206	92	25
1920–21	8,873	8,771	76	25
1921–22	3,017	2,903	57	57
1922–23	8,221	8,155	32	33
1923–23	23,819	22,594	832	402
1924–25	42,953	39,060	2,178	265

* Data to 1883–84 from annual *Review of the Trade of India*, and for later years from *Annual Statement of the Sea-Borne Trade of British India*. These sources give provinces of export (Sind, Bombay, Bengal), but may be assumed to refer to the ports named.

[a] Including small quantities from Burma (Rangoon) and Madras.

TABLE XII A.—WHEAT EXPORTS AND IMPORTS OF BRITISH INDIA BY SEA, 1870–71 TO 1889–90*

(Thousand bushels)

Apr.–Mar.	Exports	Imports	Apr.–Mar.	Exports	Imports	Apr.–Mar.	Exports	Imports	Apr.–Mar.	Exports	Imports
1870–71	465	...	1875–76	4,663	37	1880–81	13,895	...	1885–86	39,314	71
1871–72	1,189	...	1876–77	10,422	112	1881–82	37,079	386	1886–87	41,558	54
1872–73	735	...	1877–78	11,835	806	1882–83	26,402	370	1887–88	25,271	2
1873–74	3,278	...	1878–79	1,951	767	1883–84	39,118	351	1888–89	32,872	200
1874–75	1,995	...	1879–80	4,099	22	1884–85	29,551	34	1889–90	25,758	192

* Data from *Accounts and Papers of the United Kingdom*. Dots (....) indicate that data are unavailable.

TABLE XII B.—INDIAN EXPORTS AND IMPORTS OF WHEAT AND FLOUR, ANNUALLY FROM 1890–91*

(Thousand bushels)

Year Apr.–Mar.	Wheat					Flour as wheat[a]			Wheat and flour: net exports[a]
	Exports by sea	Exports by land	Imports by sea	Imports by land	Net exports	Exports by sea	Imports by sea	Net exports[a]	
1890–91	26,731	91	231	105	26,486	1,120	...	....	.....
1891–92	56,565	97	646	278	55,738	1,453	...	....	.....
1892–93	27,950	123	192	138	27,743	1,380	...	....	.....
1893–94	22,693	84	99	189	22,489	1,630	35	1,595	24,084
1894–95	12,858	95	433	146	12,374	1,568	29	1,539	13,913
1895–96	18,672	77	271	291	18,187	1,765	29	1,736	19,923
1896–97	3,567	77	1,122	362	2,160	1,600	32	1,568	3,728
1897–98	4,467	45	86	322	4,104	1,347	77	1,270	5,374
1898–99	36,437	67	00	414	36,090	1,821	21	1,800	37,890
1899–00	18,114	123	575	439	17,223	1,488	45	1,443	18,666
1900–01	93	261	1,043	267	(956)[b]	1,325	37	1,288	332
1901–02	13,668	106	394	411	12,969	1,411	75	1,336	14,305
1902–03	19,212	330	2	151	19,389	1,915	64	1,851	21,240
1903–04	48,367	233	35	233	48,332	2,160	51	2,109	50,441
1904–05	80,269	202	00	343	80,128	2,749	21	2,728	82,856
1905–06	35,000	170	849	461	33,860	2,397	35	2,362	36,222
1906–07	29,921	174	392	336	29,367	2,181	13	2,168	31,535
1907–08	32,870	112	478	245	32,259	1,984	131	1,853	34,112
1908–09	4,097	78	1,081	297	2,797	1,605	355	1,250	4,047
1909–10	39,221	77	15	192	39,091	1,869	125	1,744	40,835
1910–11	47,270	168	2	162	47,274	2,147	155	1,992	49,266
1911–12	50,816	364	65	217	50,898	2,749	208	2,541	53,439
1912–13	61,981	325	95	189	62,022	3,653	157	3,496	65,518
1913–14	44,882	179	00	157	44,904	4,235	229	4,006	48,910
1914–15	26,372	140	54	166	26,292	2,880	149	2,731	29,023
1915–16	24,375	211	00	110	24,476	3,125	75	3,050	27,526
1916–17	27,959	172	00	149	27,982	3,742	4	3,738	31,720
1917–18	54,297	213	66	203	54,241	3,817	6	3,811	58,052
1918–19	17,774	259	2,062	194	15,777	1,650	22	1,628	17,405
1919–20	323	142	5,536	123	(5,194)[b]	2,571	14	2,557	(2,637)[b]
1920–21	8,873	2,029	00	142	10,760	3,241	4	3,237	13,997
1921–22	3,017	625	16,426	209	(12,993)[b]	3,436	104	3,332	(9,661)[b]
1922–23	8,221	...	707	...	.....	2,667	...	....	.....
1923–24	23,819	...	410	...	.....	....	...	....	.....
1924–25	42,953	162	161	310	42,644	....	...	....	.....
1925–26	7,728	1,359	714	519	7,854	....	...	....	.....

* Official data here compiled principally from *Accounts and Papers of the United Kingdom*, supplemented by recent data from various sources. Dots (....) indicate that data are not available.

[a] Data for exports and imports of flour over land boundaries are not available; this trade is negligible, however.

[b] Net import.

TABLE XIII.—VALUES OF PRINCIPAL PRODUCTS EXPORTED FROM BRITISH INDIA, ANNUALLY FROM 1890–91*

(Million rupees)

Year Apr.–Mar.	Grand total	By land: total	By sea: total	By sea								Percentage wheat and flour[a]
				Raw cotton	Rice	Tea	Raw jute	Jute gunny cloth	Jute gunny bags	Wheat	Wheat flour	
1890–91	989.3	30.3	959.0	165.3	128.8	55.0	76.0	2.8	21.8	60.4	2.7	6.58
1891–92	1,074.7	39.2	1,035.5	107.6	133.9	62.8	68.5	3.1	22.0	143.8	3.6	14.23
1892–93	1,053.3	33.8	1,019.5	127.4	124.1	66.2	79.4	3.8	28.5	74.4	3.4	7.63
1893–94	1,054.4	34.2	1,020.2	133.0	103.8	65.9	85.2	5.6	28.7	51.9	4.1	5.49
1894–95	1,073.8	36.2	1,037.6	87.0	138.1	75.6	105.8	9.9	32.0	25.7	3.7	2.83
1895–96	1,131.6	36.1	1,095.5	140.9	135.4	76.6	99.9	11.2	35.4	39.1	4.2	3.95
1896–97	1,040.6	41.8	998.8	129.7	119.5	81.2	105.5	16.3	35.2	8.4	4.3	1.27
1897–98	978.3	40.4	937.9	88.7	117.1	80.6	101.3	21.4	37.2	13.4	4.2	1.88
1898–99	1,139.3	45.8	1,093.5	111.9	158.2	81.9	69.4	23.6	33.9	97.2	5.0	9.35
1899–00	1,098.9	42.0	1,056.9	99.3	131.0	90.9	80.7	27.2	35.2	39.2	3.9	4.08
1900–01	1,085.8	44.2	1,041.6	101.2	132.2	95.1	108.6	33.6	44.4	.3	3.6	.37
1901–02	1,259.6	47.6	1,212.0	144.3	139.2	81.4	117.9	39.0	47.2	32.6	3.8	3.00
1902–03	1,301.1	42.3	1,258.8	147.6	189.0	73.6	111.3	43.2	46.4	45.2	4.6	3.96
1903–04	1,537.8	41.4	1,496.4	243.8	190.8	85.5	117.2	48.4	45.6	110.8	5.2	7.75
1904–05	1,590.6	49.2	1,541.4	174.3	196.2	84.6	119.7	51.2	47.6	179.1	6.9	12.07
1905–06	1,634.4	52.5	1,581.9	213.4	186.3	88.5	171.3	63.0	60.8	85.4	6.4	5.80
1906–07	1,787.5	53.2	1,734.3	219.8	185.2	98.6	268.4	82.6	73.5	72.6	5.8	4.52
1907–08	1,797.0	61.0	1,736.0	257.1	203.4	103.0	179.7	96.9	84.8	85.8	5.6	5.26
1908–09	1,560.7	62.1	1,498.6	197.7	158.8	104.0	198.3	78.9	77.7	13.4	5.2	1.24
1909–10	1,905.2	60.2	1,845.0	314.4	182.4	117.0	150.9	84.3	86.1	127.0	6.0	7.21
1910–11	2,121.2	65.0	2,056.2	360.6	232.4	124.2	155.0	83.6	85.6	129.6	6.3	6.61
1911–12	2,297.3	79.1	2,218.2	295.3	290.5	129.5	225.6	83.5	75.8	133.5	8.0	6.38
1912–13	2,508.5	95.0	2,413.5	283.4	325.6	132.9	270.5	130.6	96.7	176.9	10.8	7.78
1913–14	2,525.9	83.9	2,442.0	410.4	266.1	149.8	308.3	155.9	125.3	131.3	12.5	5.89
1914–15	1,860.0	85.2	1,774.8	334.9	171.6	155.3	129.1	131.1	125.9	83.2	9.2	5.21
1915–16	2,012.2	86.6	1,925.6	249.3	154.6	199.8	156.4	176.7	201.5	84.4	11.2	4.96
1916–17	2,466.9	95.9	2,371.0	361.0	188.2	167.7	162.9	201.0	213.4	91.5	13.0	4.41
1917–18	2,457.6	123.2	2,334.4	426.6	208.1	176.7	64.5	230.7	194.7	190.0	15.1	8.79
1918–19	2,530.2	136.9	2,393.3	309.8	231.7	177.8	127.2	296.9	223.3	67.5	8.1	3.16
1919–20	3,275.5	152.7	3,122.8	586.5	102.0	205.6	247.0	311.5	185.8	2.0	14.8	.54
1920–21	2,558.2	158.1	2,400.1	416.3	182.0	121.5	163.6	285.4	239.1	41.0	17.2	2.42
1921–22	2,445.1	131.3	2,313.8	539.7	249.2	182.2	140.5	159.3	139.2	14.7	18.7	1.44
1922–23	3,143.6	152.0	2,991.6	709.7	350.4	220.4	225.3	243.2	159.6	34.4	13.0	1.58
1923–24	3,651.2	162.8	3,488.4	984.7	349.0	316.5	200.0	237.5	181.7	91.2	11.4	2.94
1924–25	4,034.0	187.4	3,846.6	912.3	372.3	333.9	290.9	282.8	232.1	172.0	16.9	4.91

* Data from *Accounts and Papers of the United Kingdom* and *Review of the Trade of India.*

[a] To total exports by sea.

TABLE XIV.—WHEAT EXPORTS FROM BRITISH INDIA BY SEA, MONTHLY FROM 1902–3*

(Thousand bushels)

Year Apr.–Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Total
1902–03.....	915	1,927	2,452	2,773	2,384	1,345	1,466	2,223	886	1,255	803	783	19,212
1903–04.....	1,648	3,854	7,237	4,870	4,106	5,020	4,952	4,347	3,876	2,438	2,039	3,982	48,369
1904–05.....	4,439	6,665	8,767	7,892	7,399	6,932	6,305	9,883	8,305	6,730	3,518	3,430	80,265
1905–06.....	2,710	5,729	8,211	5,729	3,892	1,570	1,674	2,520	1,834	739	121	272	35,001
1906–07.....	866	2,329	5,261	6,097	3,333	1,274	2,643	1,858	1,528	894	1,355	2,482	29,920
1907–08.....	2,624	2,665	3,719	5,819	5,416	5,243	4,593	1,966	623	113	18	72	32,870
1908–09.....	2	10	153	913	451	838	1,263	352	21	34	22	37	4,096
1909–10.....	749	3,502	8,687	10,356	6,500	822	1,392	1,343	1,192	2,080	637	1,960	39,220
1910–11.....	2,280	2,857	5,226	6,092	5,782	3,496	3,441	3,880	2,611	4,224	3,512	3,866	47,267
1911–12.....	2,537	5,065	7,077	9,937	4,672	2,455	2,453	2,765	3,632	3,803	2,806	3,612	50,814
1912–13.....	2,572	3,995	9,091	12,244	5,719	8,642	5,543	4,267	2,972	3,702	1,922	1,311	61,980
1913–14.....	1,020	6,210	9,720	11,889	5,029	5,031	1,968	1,743	811	772	362	326	44,881
1914–15.....	339	915	6,311	6,326	1,586	2,096	3,295	2,053	1,381	934	807	327	26,370
1915–16.....	398	3,918	10,897	7,002	1,784	215	14	9	11	17	71	34	24,370
1916–17.....	119	78	1,565	1,644	2,797	5,179	5,633	2,949	3,710	1,948	542	1,794	27,958
1917–18.....	3,473	7,793	6,132	10,381	5,745	5,711	6,109	2,557	2,059	943	553	2,967	54,423
1918–19.....	2,080	2,384	2,856	2,857	4,706	1,763	620	294	120	51	20	23	17,774
1919–20.....	8	44	23	25	31	29	29	14	33	28	30	28	326
1920–21.....	20	46	34	25	22	29	30	335	1,313	2,935	1,930	2,014	8,733
1921–22.....	684	456	552	881	220	12	20	18	7	25	10	15	2,900
1922–23.....	12	12	7	3	12	7	33	1,693	2,135	2,345	1,070	760	8,089
1923–24.....	2,095	3,352	7,602	5,218	1,647	1,343	436	1,078	572	52	20	38	23,453
1924–25.....	19	558	4,426	7,150	2,782	1,316	4,715	4,207	3,202	3,984	5,811	2,700	40,870
1925–26.....	340	833	3,438	688	665	862	219	187	162	285	61	36	7,776
1926–27.....	25	139	1,447	2,048	949	154	515	617	235	262	51	26	6,468
Average:													
1909–14.....	1,831	4,326	7,960	10,104	5,540	4,089	2,959	2,800	2,244	2,916	1,848	2,215	48,832
1920–26.....	528	876	2,676	2,328	891	595	909	1,253	1,232	1,604	1,484	927	15,304

* Official data: for 1902–3 to 1907–8, converted to bushels of 60 pounds from data in F. Noël-Paton, *Indian Wheat and Grain Elevators* (Calcutta, 1913), p. 81; for later years from yearbooks and bulletins of the International Institute of Agriculture. The final digits are not wholly accurate. Because of this and minor revisions, the totals of monthly figures do not agree precisely with annual data given in Appendix Table XII B.

TABLE XV.—WHEAT EXPORTS FROM BRITISH INDIA BY SEA, BY DESTINATIONS, ANNUALLY FROM 1880–81*

(Thousand hundredweight of 112 pounds)

Year	Total	United Kingdom	Belgium	Holland	Scandinavia	Germany	Spain	France	Italy	Other Europe	Egypt	Asiatic Turkey[a]	Arabia	Persia	Other
1880–81	7,444	4,802	226	365	...	...	...	1,347	137	65	...	109	106	78	209
1881–82	19,864	9,379	2,625	712	...	38	...	5,308	359	206	919	...	97	...	221
1882–83	14,144	6,575	1,459	578	...	...	2	3,568	176	690	800	...	17	...	279
1883–84	20,956	10,508	2,594	193	...	25	18	3,398	446	267	3,306	...	10	...	191
1884–85	15,832	7,445	1,739	134	...	...	...	3,312	701	193	2,150	1	58	2	97
1885–86	21,061	12,071	2,662	86	...	...	78	2,145	1,218	113	2,296	...	154	10	228
1886–87	22,263	9,668	2,404	207	...	...	52	2,804	5,212	190	1,318	16	153	3	236
1887–88	13,538	6,040	596	61	...	...	53	2,559	3,074	154	660	22	128	28	163
1888–89	17,610	9,038	2,478	...	...	...	...	3,132	1,125	43	1,658	1	60	2	73
1889–90	13,799	7,686	2,330	251	...	7	...	1,250	403	23	1,654	...	75	1	119
1890–91	14,320	8,209	1,920	8	...	23	...	1,518	440	82	2,000	...	56	...	64
1891–92	30,303	12,345	4,655	523	...	664	...	6,024	1,062	87	4,859	...	26	...	58
1892–93	14,973	7,413	1,226	386	...	903	164	1,724	690	273	2,045	...	59	26	64
1893–94	12,157	6,093	1,452	356	...	38	32	1,913	409	43	1,687	...	68	20	46
1894–95	6,888	4,768	594	242	...	216	...	525	3	7	440	...	24	2	67
1895–96	10,004	6,035	826	360	...	393	...	575	123	71	1,514	...	20	1	86
1896–97	1,911	1,503	53	4	...	...	...	240	54	6	1	...	11	1	38
1897–98	2,393	1,684	126	...	...	2	...	342	121	...	...	10	42	35	31
1898–99	19,520	9,337	2,057	190	...	251	...	3,229	1,119	...	3,139	6	107	40	45
1899–1900	9,704	5,298	2,123	70	...	13	88	877	248	...	934	...	12	3	38
1900–01	50	8	...	...	...	...	...	...	...	...	...	...	5	...	37
1901–02	7,322	3,951	1,224	115	...	40	...	99	24	...	1,690	23	48	62	46
1902–03	10,292	6,683	878	...	...	...	...	23	...	...	2,346	18	170	93	81
1903–04	25,911	21,232	2,803	145	...	72	...	992	76	...	186	...	45	8	352
1904–05	43,001	28,929	7,589	371	231	1,196	532	3,428	23	...	262	4	163	13	260
1905–06	18,750	14,183	1,131	181	173	36	826	1,855	62	59	54	...	40	1	149
1906–07	16,029	14,610	791	...	195	51	47	194	...	...	20	3	43	2	73
1907–08	17,609	15,431	1,409	...	80	14	...	318	5	...	...	10	13	2	327
1908–09	2,195	2,071	...	...	...	...	...	8	1	...	1	37	21	12	44
1909–10	21,011	17,639	2,421	46	...	170	...	344	183	...	...	72	34	25	77
1910–11	25,323	20,840	1,187	...	172	117	...	2,805	75	...	5	13	54	6	49
1911–12	27,223	20,655	3,714	61	253	380	...	1,455	325	...	290	2	34	...	54
1912–13	33,204	23,705	3,680	63	346	458	...	2,707	2,042	...	59	1	68	5	70
1913–14	24,044	15,675	2,785	19	459	502	197	3,250	775	6	33	114	78	15	136
1914–15	14,128	12,053	555	...	100	47	28	1,006	...	105	76	62	21	2	73
1915–16	13,058	12,103	...	113	...	...	...	255	20	313	...	15	31	1	207
1916–17	14,978	8,241	...	...	...	...	...	3,196	2,590	166	232	157	88	34	274
1917–18	29,087	1,469	...	...	...	...	...	3,558	3,096	724	18,417	367	255	252	949
1918–19	9,522	133	...	...	...	...	...	420	528	99	8,165	66	25	41	45
1919–20	173	...	...	...	...	...	...	...	...	...	...	53	24	25	71
1920–21	4,753	1,901	443	299	...	554	...	396	262	...	727	63	34	19	55
1921–22	1,616	591	123	144	109	263	...	...	219	...	...	18	58	35	56
1922–23	4,404	3,827	232	10	...	3	...	85	91	5	...	...	32	5	114
1923–24	12,765	9,846	769	33	...	1	...	1,271	563	...	7	...	73	3	199
1924–25	22,234	15,079	2,463	341	1	284	...	1,031	800	216	1,197	...	80	17	725

* Data from *Accounts and Papers of the United Kingdom* and *Annual Statement of Sea-Borne Trade of British India*. These data are not absolutely reliable, because of shipments for orders, changes in destination after leaving India, reshipment from ports of destination, and changes in the detail in which the statistics are available. For the purposes of this table, it has not seemed essential to convert the reported figures to bushels of 60 pounds.

[a] Figures prior to 1911–12 relate to the whole of Asiatic Turkey; in 1911–12 to Levant and Black Sea; from 1912–13 to Red Sea and Persian Gulf.

TABLE XVI.—MONTHLY PRICES OF WHITE WHEAT AT KARACHI, INDIA, 1912-26*

(U.S. dollars per bushel of 60 pounds)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1912	.90	.94	.94	.96	.93	.89	.88	.89	.88	.89	.89	.91
1913	.92	.97	.97	.93	.92	.90	.90	.87	.87	.86	.88	.88
1914	.91	.93	.91	.92	.94	.91	.90	.96	1.08	1.09	1.22	1.23
1915	1.27	1.43	1.22	1.21	1.07	1.02	1.02	1.06	1.12	1.10	1.09	1.07
1916	1.09	1.03	.97	.89	.88	.86	.95	1.05	1.03	1.04	1.10	1.15
1917	1.19	1.14	1.13	1.12	1.04	1.05	1.08	1.07	1.14	1.13	1.22	1.26
1918	1.22	1.23	1.24	1.24	1.25	1.23	1.26	1.31	1.41	1.57	1.61	1.63
1919	1.82	1.82	1.91	1.78	2.07	2.01	2.06	2.16	2.14	1.93	2.04	2.16
1920	2.12	2.09	1.91	1.90	1.74	1.62	1.49[a]	1.35[a]	1.34	1.36	1.32	1.22
1921	1.28	1.29	1.26	1.26	1.33	1.31	1.29	1.52	1.86	1.73	1.57	1.60
1922	1.50	....[b]	....[b]	....[b]	1.36	1.36	1.25	1.22	1.11	.89	.91	1.17
1923	1.20	1.12	1.12	1.17	1.13	1.07	1.03	.91	.96	.97	.99	1.01
1924	.98	.98	.99	.99	1.04	1.05	1.19	1.30	1.35	1.46	1.47	1.49
1925	1.57	1.76	1.80	1.62	1.65	1.64	1.49	1.52	1.47	1.46	1.62	1.77
1926	1.67	1.65	1.63	1.57	1.51	1.47	1.44	1.45	1.38	1.42	1.39	1.35

* *Agriculture Yearbook, 1925,* Table 35, p. 769, supplemented by later figures furnished by the U.S. Department of Agriculture. Data compiled by the Division of Statistical and Historical Research from *Indian Trade Journal;* converted at par of $0.3244 per rupee to 1919, and at current exchange rates as given by *Federal Reserve Bulletins* 1919-26.

[a] First week of month, from *Review of the Trade of India.* [b] Not quoted.

TABLE XVII.—MONTHLY WHOLESALE PRICES OF WHEAT AT CERTAIN PLACES IN INDIA, FROM JANUARY 1905 TO APRIL 1916*

(Rupees, annas, and pies per maund of 82 2/7 pounds)

Month		Calcutta Club No. 2	Bombay Delhi No. 1 White Pessy	Karachi White	Jubbulpore (Central Provinces)	Meerut (United Provinces)	Cawnpore (United Provinces)	Lahore (Punjab)
1905	Jan.	2 12 3	3 1 3	3 1 5	2 8 0	2 6 9	2 5 7	2 5 1
	Feb.	2 13 3	3 2 9	3 2 11	3 1 2	2 10 9	2 14 7	2 5 7
	Mar.	3 4 0	3 7 3	3 4 8	2 15 4	2 13 7	3 3 2	2 8 0
	Apr.	3 1 0	3 4 6	3 3 8	2 13 7	2 9 3	3 1 3	2 6 9
	May	3 5 0	3 5 3	3 3 8	2 13 7	2 9 3	2 15 4	2 5 7
	June	3 3 0	3 6 9	3 2 8	2 15 4	2 9 7	3 0 4	2 6 7
	July	3 4 3	3 7 6	3 5 2	2 15 4	2 12 2	3 1 3	2 8 0
	Aug.	3 4 0	3 8 6	3 5 2	2 15 4	2 13 0	3 1 3	2 11 1
	Sept.	3 8 6	3 9 3	3 9 8	3 1 2	3 10 3	3 2 1	2 13 9
	Oct.	3 7 0	3 8 6	3 7 8	3 1 2	2 15 6	3 4 4	2 13 9
	Nov.	3 10 0	3 12 3	3 11 8	3 3 2	3 1 11	3 5 4	3 1 3
	Dec.	3 11 6	3 11 6	3 11 5	3 5 2	3 4 6	3 10 1	3 1 3
1906	Jan.	4 4 6	3 13 3	3 11 2	3 9 11	3 8 2	3 12 10	3 7 6
	Feb.	4 8 0	3 14 6	3 12 6	3 9 11	3 9 11	3 12 10	3 7 0
	Mar.	3 15 0	3 12 0	3 9 11	3 7 6	3 3 3	3 7 8	2 14 4
	Apr.	3 11 6	3 9 9	3 5 11	2 14 5	2 13 5	3 3 3	2 15 4
	May	3 8 0	3 7 3	3 6 2	2 13 7	2 12 0	3 1 4	2 7 6
	June	3 6 0	3 7 3	3 3 10	2 12 0	2 10 5	3 2 1	2 7 4
	July	3 7 0	3 7 3	3 4 10	2 14 5	2 13 3	3 2 1	2 9 3
	Aug.	3 9 3	3 7 9	3 6 2	2 14 5	2 12 0	3 2 1	2 8 6
	Sept.	3 7 6	3 5 0	3 4 8	2 14 5	2 10 7	3 0 4	2 8 0
	Oct.	3 6 0	3 4 6	3 5 2	2 12 2	2 11 8	3 1 3	2 6 9
	Nov.	3 6 6	3 6 0	3 3 8	2 13 7	2 13 9	3 1 3	2 6 9
	Dec.	3 8 6	3 6 9	3 3 8	2 13 7	3 1 4	3 5 4	2 7 4
1907	Jan.	3 10 0	3 3 6	3 1 10	2 15 4	2 13 9	3 4 2	2 6 3
	Feb.	3 4 6	3 2 0	3 2 8	2 15 4	2 13 9	3 2 1	2 6 9
	Mar.	3 5 6	3 4 3	3 2 8	2 15 4	2 11 6	2 15 4	2 3 4
	Apr.	3 5 6	3 4 3	3 0 8	2 9 1	2 10 7	3 3 2	2 3 4
	May	3 7 0	3 11 6	3 5 8	2 10 7	2 15 6	3 1 3	2 3 4
	June	3 13 0	3 11 9	3 8 2	2 15 4	3 8 8	3 3 2	2 8 0
	July	3 11 6	3 12 6	3 8 2	3 1 1	3 5 4	3 6 5	2 8 0
	Aug.	3 14 0	3 12 6	3 7 11	3 3 3	3 5 4	3 9 0	2 15 4
	Sept.	4 5 6	3 15 3	3 13 11	3 5 2	3 10 3	4 1 7	3 4 4
	Oct.	4 3 0	.....	4 2 0	4 7 2	4 5 4	4 9 1	3 12 11
	Nov.	5 0 6	.....	4 8 0	4 7 2	4 9 4	4 13 7	4 3 4
	Dec.	5 3 0	5 0 9	4 10 6	4 13 7	4 11 2	5 0 0	4 11 2

* Data from G. F. Shirras, *Statistical Tables Relating to Indian Wheat* (Calcutta, 1916). See note on next page.

TABLE XVII.—MONTHLY WHOLESALE PRICES OF WHEAT AT CERTAIN PLACES IN INDIA, FROM JANUARY 1905 TO APRIL 1916—*Continued*

(Rupees, annas, and pies per maund of 82 2/7 pounds)

	Month	Calcutta Club No. 2	Bombay Delhi No. 1 White Pessy	Karachi White	Jubbulpore (Central Provinces)	Meerut (United Provinces)	Cawnpore (United Provinces)	Lahore (Punjab)
1908	Jan.	6 0 0	4 9 0	4 14 9	5 8 0	5 5 4	5 0 0	5 2 7
	Feb.	5 3 0	4 6 6	4 7 9	5 2 7	5 2 5	5 0 0	4 3 4
	Mar.	5 3 0	4 5 0	4 5 6	4 9 0	4 10 9	4 11 2	4 0 0
	Apr.	5 1 6	4 9 0	4 8 6	4 7 0	4 10 9	4 13 7	4 0 0
	May	5 0 0	4 9 6	4 8 9	4 9 0	4 7 0	4 5 1	4 0 0
	June	4 13 6	4 10 6	4 5 8	4 11 3	4 1 5	4 9 1	3 10 1
	July	4 13 0	4 10 6	4 3 6	5 0 0	4 1 5	4 9 1	3 7 6
	Aug.	4 12 0	4 9 0	4 5 8	4 13 7	4 1 3	4 7 0	3 7 6
	Sept.	4 11 6	4 9 9	4 6 6	4 13 7	4 3 2	4 3 4	3 11 6
	Oct.	4 15 0	3 14 3	4 8 0	5 5 5	4 11 2	4 9 1	3 14 5
	Nov.	5 0 0	4 1 9	4 10 0	5 2 5	4 11 2	4 11 2	4 11 2
	Dec.	5 2 0	3 15 6	4 11 6	4 13 7	4 11 2	4 11 2	4 11 2
1909	Jan.	5 1 6	4 1 0	4 11 3	4 13 7	4 13 5	5 0 0	4 11 2
	Feb.	5 3 0	4 3 0	4 14 3	4 9 1	5 5 4	5 1 3	4 13 7
	Mar.	5 0 6	4 4 0	4 13 3	4 9 1	4 11 2	4 9 1	4 9 1
	Apr.	4 8 0	4 7 6	4 10 9	4 0 0	4 1 5	4 1 11	4 8 2
	May	4 6 6	4 9 6	4 12 3	4 1 7	3 14 7	4 0 0	3 13 0
	June	4 6 6	4 7 0	4 7 9	3 12 10	3 14 7	4 3 4	3 15 2
	July	4 10 6	4 11 9	4 10 9	4 1 7	3 14 6	4 3 4	4 0 0
	Aug.	4 7 0	4 10 3	4 8 3	4 1 7	3 14 6	4 3 4	4 2 6
	Sept.	4 8 0	4 8 0	4 3 3	4 0 0	3 10 2	3 14 4	3 13 7
	Oct.	4 4 0	4 5 0	4 3 3	3 14 5	3 7 8	3 14 4	3 9 5
	Nov.	4 2 6	4 4 9	4 2 9	3 14 5	3 8 3	4 0 0	3 12 11
	Dec.	4 6 0	4 0 9	4 3 9	3 12 11	3 10 2	4 0 0	3 12 5
1910	Jan.	4 6 6	4 2 0	4 5 9	4 0 0	3 10 2	4 1 7	3 10 1
	Feb.	4 6 6	4 2 9	4 5 9	4 1 7	3 14 2	4 1 7	3 7 6
	Mar.	4 7 0	4 2 6	4 1 9	3 11 6	3 14 6	3 14 4	3 10 1
	Apr.	3 14 6	4 2 6	4 1 3	3 5 5	3 5 3	3 7 8	3 7 6
	May	3 9 0	3 14 0	3 12 9	3 3 2	3 2 2	3 5 3	2 13 9
	June	3 7 0	3 10 3	3 7 8	3 3 2	2 15 6	3 3 2	2 10 8
	July	3 10 0	3 12 3	3 8 2	3 3 2	3 2 2	3 5 3	2 12 1
	Aug.	3 11 0	4 2 0	3 12 9	3 5 5	3 7 8	3 7 8	3 1 3
	Sept.	3 11 0	3 15 9	3 14 6	3 5 5	3 2 2	3 3 2	2 13 9
	Oct.	3 6 0	3 9 3	3 10 8	3 1 1	3 0 3	3 3 2	2 15 4
	Nov.	3 4 6	3 8 6	3 10 2	3 1 1	2 13 9	3 1 3	2 15 4
	Dec.	3 8 0	3 10 9	3 10 8	3 1 1	2 12 9	3 2 1	2 15 4
1911	Jan.	3 8 0	3 9 3	3 10 5	3 1 1	2 13 9	3 1 3	2 15 4
	Feb.	3 5 0	3 13 3	3 9 8	3 1 1	2 13 9	2 15 4	2 15 4
	Mar.	3 5 0	3 10 0	3 6 8	2 15 4	2 12 9	2 13 7	2 10 8
	Apr.	3 5 0	3 5 6	3 5 8	2 12 1	2 12 0	2 15 4	2 10 8
	May	3 5 9	3 12 3	3 6 2	2 14 6	2 13 9	2 15 4	2 13 9
	June	3 3 6	3 6 3	3 7 2	2 15 4	2 11 2	2 14 6	2 10 8
	July	3 4 0	3 7 0	3 7 2	2 15 4	2 12 11	3 1 3	2 13 9
	Aug.	3 8 0	3 9 9	3 8 2	3 5 5	3 1 3	3 6 6	3 1 3
	Sept.	3 7 0	3 12 3	3 12 3	3 1 1	3 1 3	3 3 2	3 3 0
	Oct.	3 6 6	4 0 9	3 10 11	3 1 1	2 15 6	3 1 3	3 1 3
	Nov.	3 7 6	3 9 3	3 9 8	3 1 1	2 14 5	3 2 1	2 15 2
	Dec.	3 6 0	3 9 0	3 10 2	2 15 4	2 15 6	3 1 3	3 0 11

"These statistics are compiled from fortnightly returns furnished by local governments and administrations. They relate to the wholesale prices in the market, which prevailed on the last (or nearest mart) day of the first half of each month. The statistics of the ports are compiled from the Prices-Current and Market Reports published by local Chambers of Commerce and they relate to the prices that prevailed during the first week of each month." During the period the parity of the rupee was 1*s.* 4 *d.* or 32.44 cents. There are 16 annas to the rupee, and 12 pies to the anna.

TABLE XVII.—MONTHLY WHOLESALE PRICES OF WHEAT AT CERTAIN PLACES IN INDIA, FROM JANUARY 1905 TO APRIL 1916—*Concluded*

(Rupees, annas, and pies per maund of 82 2/7 pounds)

	Month	Calcutta Club No. 2	Bombay Delhi No. 1 White Pessy	Karachi White	Jubbulpore (Central Provinces)	Meerut (United Provinces)	Cawnpore (United Provinces)	Lahore (Punjab)
1912	Jan.	3 7 6	3 13 9	3 10 11	2 15 4	3 1 3	3 4 4	3 3 0
	Feb.	3 13 1	3 14 6	3 15 9	3 5 5	3 4 0	3 6 7	3 5 4
	Mar.	3 10 6	3 13 9	3 15 3	3 5 5	3 4 4	3 6 7	3 2 9
	Apr.	3 12 6	3 15 3	4 0 3	3 7 6	3 5 4	3 7 6	3 9 11
	May	4 0 6	3 15 6	3 15 3	3 7 6	3 1 3	3 2 1	3 5 4
	June	3 8 0	4 2 9	3 10 11	3 5 5	3 1 3	3 3 2	3 8 0
	July	3 9 6	4 1 6	3 13 3	3 10 3	3 2 7	3 5 4	3 4 4
	Aug.	3 8 6	4 0 9	3 11 8	3 10 3	3 1 3	3 4 4	3 6 3
	Sept.	3 10 0	4 0 0	3 12 3	3 7 6	3 2 3	3 4 4	3 4 0
	Oct.	3 8 9	4 0 3	3 11 2	3 10 3	3 3 2	3 4 4	3 4 0
	Nov.	3 11 6	4 1 3	3 12 3	3 13 0	3 1 3	3 4 4	3 8 0
	Dec.	3 8 0	3 15 9	3 12 3	3 10 3	3 2 3	3 4 4	3 8 11
1913	Jan.	3 9 6	4 0 3	3 14 2	3 10 3	3 3 2	3 5 11	3 9 11
	Feb.	3 12 6	4 2 9	4 1 9	3 10 3	3 9 0	3 12 0	4 1 5
	Mar.	3 15 6	4 1 9	4 1 9	4 0 0	3 10 3	3 12 0	3 13 0
	Apr.	3 15 0	4 2 0	3 15 3	3 7 6	3 9 0	3 8 0	3 11 2
	May	3 10 6	4 2 0	3 13 11	3 5 9	3 5 4	3 5 5	3 6 7
	June	3 9 6	4 1 9	3 13 3	3 3 3	3 5 4	3 8 0	3 5 11
	July	3 12 6	4 1 9	3 12 9	3 3 3	3 6 7	3 9 11	3 8 0
	Aug.	3 12 0	4 1 0	3 11 8	3 3 3	3 7 8	3 9 0	3 5 4
	Sept.	3 15 0	4 0 3	3 10 2	3 3 3	3 5 4	3 8 0	3 5 4
	Oct.	3 15 6	4 4 6	3 10 11	3 10 3	3 9 0	4 0 0	3 8 0
	Nov.	4 5 0	4 4 3	3 9 11	3 13 0	3 9 11	4 1 11	3 8 0
	Dec.	4 6 0	4 4 3	3 12 9	3 13 0	3 11 6	4 3 0	3 9 0
1914	Jan.	4 5 6	4 4 3	3 11 8	3 13 0	4 0 0	4 4 0	3 13 0
	Feb.	4 6 0	4 5 6	3 14 3	3 13 0	4 1 5	4 3 0	3 14 7
	Mar.	4 6 6	4 5 3	3 14 9	4 1 7	4 3 2	4 1 11	3 14 7
	Apr.	4 5 0	4 4 9	3 13 9	4 1 7	2 10 3	4 1 11	3 11 6
	May	4 3 6	4 5 6	3 15 11	4 1 7	3 9 0	3 1 11	3 7 6
	June	4 5 0	4 5 0	3 14 9	4 5 1	3 10 3	4 4 0	3 7 6
	July	4 4 6	4 3 9	3 12 6	4 5 1	.....	4 1 11	3 7 6
	Aug.	4 8 0	4 6 3	3 14 9	4 5 1	4 0 0	4 4 0	3 10 3
	Sept.	4 6 9	4 2 0	4 5 3	4 5 1	4 3 6	4 8 0	4 0 0
	Oct.	4 8 6	4 3 3	4 7 3	4 9 1	4 5 0	4 12 0	3 12 10
	Nov.	5 3 9	4 5 9	4 13 9	4 13 7	4 13 5	5 4 0	4 11 2
	Dec.	5 9 6	4 8 9	5 0 3	5 2 7	5 0 0	5 4 0	4 11 2
1915	Jan.	5 15 0	5 2 3	5 5 4	5 8 4	5 11 4	5 9 0	4 13 5
	Feb.	6 2 0	5 4 6	5 10 4	6 6 5	6 10 9	6 10 9	5 14 9
	Mar.	6 4 0	4 13 0	5 9 4	5 14 9	5 5 4	5 12 0	5 2 7
	Apr.	5 2 0	4 7 8	5 0 3	4 8 2	4 8 6	4 9 0	4 13 5
	May	4 5 0	4 13 2	4 11 3	4 3 6	3 14 7	4 4 0	3 7 6
	June	4 6 0	4 15 6	4 7 3	4 5 1	3 13 0	4 5 0	3 11 6
	July	4 8 3	4 13 4	4 4 9	4 8 2	4 3 6	4 9 0	4 0 0
	Aug.	4 14 0	5 2 10	4 5 9	4 3 5	4 13 6	4 13 6	4 11 3
	Sept.	5 2 0	5 4 6	4 8 9	4 8 2	4 5 0	4 13 6	4 9 3
	Oct.	5 2 0	4 15 2	4 11 3	4 11 4	4 7 0	4 14 0	4 7 0
	Nov.	5 5 0	5 1 0	4 11 9	5 2 7	4 11 3	4 14 0	4 7 0
	Dec.	5 4 0	4 15 4	4 9 9	5 0 0	4 11 0	5 0 0	4 7 0
1916	Jan.	5 5 0	5 0 1	4 11 0	4 14 10	4 9 0	5 0 0	4 7 0
	Feb.	4 12 0	4 13 8	4 5 9	4 7 1	4 11 0	4 14 0	4 3 3
	Mar.	4 14 0	4 11 1	4 3 9	4 7 1	4 0 0	4 0 0	4 0 0
	Apr.	4 2 0	4 6 9	3 13 9	3 10 2	3 9 0	3 13 0	3 9 0

This study is largely the work of Conrad P. Wright, late of the staff of the Food Research Institute, who investigated the literature and wrote most of the manuscript. The statistical material, for the most part, has been assembled and worked up by the statistical staff of the Institute, under the direction of Joseph S. Davis, who is responsible for these portions of the study and some other parts of the text, and who revised the manuscript for publication.

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