THE RURAL ECONOMY OF INDIA

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THE RURAL ECONOMY OF INDIA

BY

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WITH PLAN

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CONTENTS

CHAPTER		PAGE
	PREFACE . . .	vii
I.	STUDY OF RURAL ECONOMICS . . .	1
II.	GEOGRAPHY OF AGRICULTURE . . .	8
III.	ECONOMY OF SMALL FARMING . . .	24
IV.	ORGANISATION OF AGRICULTURE . .	57
V.	AGRICULTURE AND POPULATION . .	83
VI.	ROBBERY OF THE SOIL	105
VII.	PERMANENT AGRICULTURE . . .	120
VIII.	CRIME AGAINST TREE AND WATER . .	141
IX.	USE AND ABUSE OF WATER . . .	163
X.	REGIONAL BALANCE OF OCCUPATIONS .	192
XI.	FAMINE	203
XII.	EQUILIBRIUM OF VILLAGE AND CITY .	215
XIII.	REVIVAL OF COTTAGE INDUSTRIES . .	230
XIV.	RURAL RECONSTRUCTION	238
	INDEX	251

ILLUSTRATIONS

PLAN OF A TYPICAL INDIAN VILLAGE . *Frontispiece*

CHART SHOWING SCATTERED PLOTS . *Facing page* 32

PREFACE

THIS book is the outcome of a course of Readership Lectures delivered in January last before the Patna University, which did me the honour of inviting me under the Banaili endowment. Economics as now taught in India does not easily fit into our rural environment. I have tried to present the agricultural and social data of India in a context which is apt to be missed in a mere application of industrial economics to the village. Rural economy appears here as an independent, worthy subject of investigation, and not as an adjunct of a set of doctrines derived from the city and industrial conditions. Thus the geographical and social factors which have governed the distribution and management of fields or the ancient adjustment of crops to conditions of soil and climate are analysed; and a connection established between rural organisation and contrasted types of farming. The study of rural institutions can claim kindred with science when we find a basis for the classification of types of village settlement and land-holding, and can mark out the epochs in agricultural history and transformations of rural economy, after a comparative study of farming methods and agricultural organisations in different regions. Thus the problems of agriculture are somewhat different in the West and in India, looking back to characteristic types of land settlement, which, again, are connected with political and social history; and their solution, accordingly, may have to be on different lines.

The questions of scattered and fragmented plots, low returns, wasted labour and deficient organisation have also been treated, and facts have been brought to light as a result of local investigation in different

provinces. Incidentally the size of the subsistence holding has been defined under different agricultural conditions and the dangers of the agricultural situation in the less fertile areas of some of the more densely populated regions indicated. The incredibly small scale on which farming is carried on in many parts of India will excite astonishment: the chief explanation of poverty and rural indebtedness lies here. Co-operative credit can offer little promise where the holding itself is uneconomic and agriculture becomes a losing concern from year to year. Evidences of the pressure of population, soil exhaustion and agricultural depression have been adduced from different localities. At the same time the assuring conclusion is forthcoming from other regions that a population more than four or five times as dense as in agricultural Europe can be maintained by superior farming and agricultural organisation on a standard of living higher than that of a large portion of the peasantry in Southern and Eastern Europe. The general level of tillage and culture in India has to be raised and the agricultural practices and methods of the more efficiently cultivated regions introduced to the less advanced tracts. The rehabilitation of peasant farming on the basis of an appropriate land settlement; intensive scientific cultivation, and utilisation of human waste; the consolidation of holdings and co-operative irrigation; agricultural co-operation; the improvement of fodder supply; forestry and river conservancy; land construction and agricultural engineering; the development of rural transport; the improvement of technical conditions of villages and the attainment of equilibrium between rural and urban interests, are matters of pressing importance which demand the attention of the expert and the villager alike that rural economy may be rationalised.

A very large amount of research and experimental work has been conducted in the field of agricultural

science, and in its different branches, but economists and agricultural experts have met but seldom to take counsel together. I have sought to acquaint the student of Indian Economics with some of the investigations of the scientific agricultural and other services in India, which have a direct bearing on the increase of field productivity and full utilisation of our forest and water resources. In India the economist is lacking in appreciation of the scientific as contrasted with the commercial side of forestry, and the indirect advantages of the former to the country; while the all-important subject of wells, canals and waterways has been the monopoly of the engineer. Yet the co-operation of the scientific forester, the agricultural and the irrigation engineer and the economist is essential in order that the conservation of forests and of water-supply in different parts of the river basin, with which agricultural conditions are so intimately bound up, can be assured by a complete and systematic policy. Indeed, the alternate visitation of droughts and floods, shrinkage and overflow of rivers, and salt-encrustation and water-logging in irrigated and flooded areas, with their legacy of soil exhaustion and of diseases such as *kala-azar*, malaria and hookworm which directly or indirectly react upon agricultural life, alike call the rural economist to enlarge his narrowed field of vision. Similarly, such characteristic problems as those of famine, fodder and food supply, small-holding and cattle improvement have to be looked at from both purely agricultural and economic points of view. It thus will appear that an all-round development of rural life is possible only when improvement schemes are considered and inaugurated, not separately but as parts of a systematic programme of regional reconstruction. A forward policy of rural and agricultural improvement has been envisaged which I believe will offer a corrective to the present disorganisation of village life and production. There cannot be any

doubt that for the prosperity of the Indian masses we have to look, for a considerable time to come, not towards Bombay and Cawnpore, but to the never-ending fields of the country.

The physical and social backgrounds of rural life in India are so various that one cannot do justice to the subject in a small space, especially when so little has been written on it that a good deal of elementary information has to be imparted. Agriculture in India ranges from burning or brand cultivation to the elaborate system of rotation of crops and garden cultivation with the aid of well-irrigation. The monographic surveys of Mann, Kanitkar, and Bhalla, and of the students of different Universities, have proved of great value as giving accurate pictures of individual villages. Keatinge's publications, though dealing exclusively with the Deccan, are important for their suggestions towards a general agricultural policy for India. Similarly, Calvert and Darling marshal the agricultural data of an interesting province, but the facts and arguments relating to that province bear also on the agricultural problems of the whole country. The special questions of land tenures and land policy have been reserved for another volume, *Land Problems of India.*

In conclusion, may I be permitted to plead as my principal excuse for offering the present course that I have spared no pains to gain a practical, first-hand knowledge of the subject, having visited as a sociological tramp, by bullock-cart and on foot, a large number of villages in the various parts of India? One has to include in such an investigation types of village organisation as diverse as the compact villages of the Indo-Gangetic plain or the scattered hamlets of the Central Provinces, the canal colonies of the Punjab or the island villages in the Bengal delta, the terraced settlements of the mountain regions or the nomadic villages of the forest tribes.

Wherever I have gone during the past fifteen years I have experienced the greatest kindness from the peasantry, and my labours will be amply rewarded if this treatise should contribute to a deeper and more enlightened interest among the educated classes in some of the important questions which concern their daily hopes and fears.

One pleasant duty remains, and that is to acknowledge my indebtedness to Mr. E. A. H. Blunt, C.I.E., I.C.S., Financial Secretary, Government of the United Provinces, who kindly read this work in manuscript and made valuable suggestions.

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THE RURAL ECONOMY OF INDIA

CHAPTER I

STUDY OF RURAL ECONOMICS

Neglect of Rural Economics.—Rural life has been studied in Europe mainly from the point of view of the ethnologist and the constitutional historian. Remarkable treatises have been written which trace the race elements in the different agricultural systems of Europe. The history of farming and village organisation, however, has been neglected, since characteristic types of land settlement have been studied chiefly with reference to the migration and conquest of the peoples of Europe. For the economic historian, the type of evolution has been furnished by the social history of Western Europe, chiefly the phase known as industrialism, regarded apparently as far more interesting and important than the agricultural history. Yet, agriculture and the village have their own laws of evolution. Thus a study of economics which neglects the history of agriculture and the transformation of rural economy cannot but be partial and incomplete: it treats primitive and less advanced peoples as beneath its consideration and tends to view humanity exclusively from the standpoint of the nineteenth century. Again, even in the most industrialised country, there is the land problem, which is a fundamental political and social problem, though not recognised as such excepting in times of crises, or social upheavals. Even socialistic

economics agrees with classical economics in interpreting economic life in the light of urban interests alone, and pins its faith to the urban character of present-day industrial civilisation, and to the strivings and achievements of the urban workers.

Rural Economics and Peace.—Further, the study of rural economics investigates into the most primitive and fundamental of human arts and exhibits man in different stages of social development winning his livelihood from the soil by adapting himself to physical conditions as best he can. Thus it widens man's sympathies. It also imports a new obligation into the relations between the manufacturing and the agricultural peoples. Man hitherto has made a heedless and extravagant use of the resources of the tropics, and a new science of world economics, which will show the way to a wise husbandry and control of the world's soil resources, region by region, is indispensable for assuring international peace. Between competing nations, too, a radical change in agricultural practice is often seen to bear the seeds of war or peace, and foresight in this respect as well can come only from a larger interest in rural life than is found to-day.

Agriculture, the Beginning of Civilisation.—The geography of agriculture shows that the growing of certain cultivated plants and the rearing of certain domesticated animals, which are selected from among the native stock of a region, influence man's interests and habits and his social organisation in the early stages. The region weaves around it a complex web of life in which plants, animals and human groups are inextricably linked by chains of actions and interactions which man is slow to recognise. But in these chains of circumstances which reach up and down and all around we have the essential factors which mould his civilisation.

Agriculture implies a fixed abode; with agriculture therefore become increasingly manifest the effects of

fixation and isolation on man's social life. Rural economy being the simplest and oldest form of man's adaptation to environment thus reveals in the sequence of stages certain fundamental types which all go back to the cumulative effects of environment and biological succession. The basic economic adjustments are co-extensive with civilisation. Hence Rural Economics is an adjunct of the comparative study of civilisation.

Interrelations of Agriculture and Civilisation.—The study of the framework of rural life serves as the best prelude to investigations in comparative social economics. There is an intimate relation between man's economic and social life, and the nature and succession of vegetation and animal life in the region. It is thus that the variety of staple crops and of domesticated animals which are selected from among the native stock of a region, and the manifold uses to which these may be put by man's growing intelligence and experience, govern materially the arts of production and civilisation of the communities concerned. Very often it is forgotten that agriculture dominates the life of nearly five-sixths of the human race, for whom therefore the region is the selective agency for social habits and activities. In South-Eastern Asia the population is so dense as to require for its maintenance such economic measures as intensive agriculture, an essentially vegetable diet and the omission of animal-raising. Such crops as can be produced economically, or products which are capable of yielding large quantities of food per unit of land, such as rice, potatoes and beans, are more generally consumed than wheat and beef, which require great areas of land. If highly intensive agriculture of this nature, with its careful husbandry of organic manure and rotation of leguminous crops, which are characteristic of China and India and which support more than half the world's population, could be adopted in Western Europe, she would have no difficulty in feeding two to

four times her present population. As contrasted with the Eastern type of cultivation, the Western type is, indeed, far more wasteful of the resources of the soil. Such climatic and geographical factors as lie behind the two standards of land utilisation in the world—the South-East Asiatic standard of rice cultivation, hand labour and largely non-flesh diet and the Western standard based on wheat cultivation, animal raising and agricultural machinery—dominate contrasted social types and relations. The former is the mainstay not merely of the endurance and home-spun produce of Asia's teeming millions, but also of the peaceful settled habits of her abiding communalistic civilisation. The latter is associated with the tendency to expand on more land rather than to stay where population is dense, with commerce and colonisation.

Rice and Wheat Culture as affecting Landed Property.—Along with farming methods and practices which are, so to speak, a feature of the "natural region" we have characteristic adaptation of landed property to the practice of agriculture. There are significant social and economic contrasts between rice and wheat cultivation; for instance, both small ownership and the growth of village communities are connected with the practice of rice agriculture, which necessitates the breaking up of land into small plots surrounded by dykes and channels and the collective management of irrigation. Wheat cultivation, on the other hand, lends itself to being conducted on a large scale. It favours the creation of large estates, while both the employment of agricultural machinery and stock-breeding encourage a disparity of economic classes. Private property in land is quite a different thing in China and India, where rice is the chief food of the population, from what it is in the wheat-regions of the New World. Secondly, where the rotation of crops is an established practice, as in South-Western Asia, the fields will lie not in contiguous blocks but in

scattered strips so as to profit from different soil and climatic conditions. Thus the contrast between the large enclosed farm and the open and scattered field system becomes evident. Again, the crop rotation restores not only the fertility of the soil but also the balance of a preponderant starch diet of the race. Similarly, there are characteristic methods of orientating rural life which represent a significant relation to the economic needs of dense or sparse population inhabiting a region. The adjustment of rights in land between the different classes of the village community would be far different in the densely populated valleys of China, India, Mesopotamia and Egypt, from what it would be in the forest areas of Northern Europe, the Mediterranean region and the tropic jungles of Central Africa and East Indies. The spirit of Eastern law and custom and the spirit of Eastern rural economy, which have responded to the agricultural practices and social instincts of the peoples, favour a great subdivision of land, a communal control of pastures, tanks, and irrigation channels and cultivation by peasant proprietors.

Indian Village and Peasantry in Decline.—In India democracy rests on the land, and it rests not on the landlord's estate but on the village community. The development of the compact village community, though obscured by the relation between the landlord and the tenant, has been inconsistent with subordination to an overlord or his agents in a feudal order. Thus we find the economic and the political touching each other: in any scheme of political reform, the revival of village organisations must be the bedrock on which alone a true and stable democratic edifice can rest in India. Agriculturally speaking, the decline of the village community and the rise of rent-receivers of superior and inferior grade have meant also loss of security and independence to the small-holder. It is only in South Indian village communities that local

organisations which meet communal needs are found in a thriving state. Agricultural partnerships and brotherhoods, the communal management of manures, pasture-lands, tanks, irrigation-channels, etc., which were the mainstay of the small-holder, are disappearing everywhere. With their collapse the peasant, isolated and helpless, is caught between the rent-receiver on the one hand and the money-lender on the other. Thus he loses morale. Caprices of the seasons which make agriculture a gamble instead of an occupation destroy his thrift and generate an ardent belief in an inexorable fate. Here man's character becomes like climate and the soil, one of the unalterable factors in the agricultural situation. In some regions, as certain fertile areas in the Indo-Gangetic plain, fragmentation of holdings and decline in plough-cattle due to population crowding the land constitute a threat to intensive farming. But elsewhere a dense population co-exists with a spirit of adventure and prosperity. Multiple cropping and domestic industries develop, debt is reduced by co-operation, holdings are consolidated, and inconvenient customs and prejudices given up. The prosperity of the peasant in the canal colonies of the Punjab, in the alluvial plains of Eastern Bengal and in the coast strips in the South show what the Indian cultivator can do. Similarly, in Bombay and Berar we find the cultivator keenly alive to price fluctuations of his produce in the distant markets of the West. Having abjured long ago the old-fashioned practices nurtured in the age-long isolation of the village, he avails himself of modern business organisations and methods. But throughout most of the continent the peasant still is faithful to the ancient routine. For him, more efficient implements, purer seeds and more lucrative crops are out of reach, simply because his tiny plot of land and his small credit cannot afford these.

Further, it is not seldom that the obvious method

of increasing yield by importing practices which have been found useful elsewhere proves unsatisfactory in India. On experimenting with varieties of seeds from other areas, it is found that the local variety gives the best results. Expensive ploughs or artificial manures of approved value in Europe and America are ineffective in India, either yielding no good results at all, or at too great a cost. Such experience makes it the more imperative that rigorously scientific methods should be followed, and this with reference to local agricultural conditions, such as the size and distribution of holdings and the economic position of farmers in particular regions.

Urbanism in Economics and its Correction.—Modern science and social policy have touched only the fringe of our rural life. The Co-operative and Agricultural Departments have reached but a microscopic minority of our millions. In the meantime the industrial and social revolution in the cities has brought the villages into decay, whilst the organisation of agriculture and village handicrafts has been neglected in the general advance. What is worse is that village unsettlement and agricultural depression are regarded by a careless, industrial economics as the travails of "Progress." The study of rural economics will show the essential connection between the framework of social polity and the adjustment of population to resources and regional conditions. In its constructive aspects, it will rescue rural organisations from the impact of industrialism, preserve and expand the social and traditional values associated with agriculture as an important factor in social progress. Thus the application of science to the arts of life will promote a wide diffusion of population and social initiative and correct the present tendency to look upon culture as a purely urban product. Economics being shorn in this manner of its urban predilections, social development will proceed on more harmonious lines.

CHAPTER II

GEOGRAPHY OF AGRICULTURE

Economic Map of Asia.—The continent of Asia exhibits all the different characteristic natural unities or regions of the earth with which are associated the different types of economic and social organisation. An observer surveying with far-reaching vision the continent from the high table-land of Tibet, would see stretching around him strangely unlike regions: to the south-west and east, the countries watered by the rainy monsoon of summer; to the north, on the contrary, desert depressions, beyond which, forming a transition between these deserts and the great forest or Siberian *taiga*, is a succession of great grassy plains forming an almost continuous strip of vegetation from Manchuria to the steppes of Southern Russia, and over plains of the same type in Roumania and Hungary.[1] These, again, present marked contrasts with the economic conditions of the desert of Arabia and the tropical forest of Borneo. Thus the great continent of Asia can be partitioned into a series of regions, distinguished alike by climate, vegetation and modes of economic life. To the north we have the cold tundra region passing southward into the forest region. To the south of the Asiatic forest stretches a zone of steppes passing into desert and even into tundra in the elevated regions of Central Asia. On the northern plains of Asia, in the high and low steppes, the conditions have been unfavourable to the growth or agglomeration of population and to economic progress. A population dependent on intensive agriculture is substantially rooted to the soil as it expands in numbers. It is the

[1] Brunhes: *Human Geography*.

nomadic or semi-nomadic grazing society that is restless and menacing to the settled lands beyond; and such a society is nothing if not widely dispersed. Indeed, by far the greater part of Asia is occupied by wandering pastoral nomads, among whom economic life has not advanced beyond the rudimentary stage.

Pastoral Nomads and their Seasonal Movements.—Most of the vast tract including Siberia and Western Asia is too dry or too cold for large, stable communities, the exception being the grain-land strip across Central Siberia and occasional small and scattered areas elsewhere. Pastoral nomadism, accompanied by some form of primitive agriculture, here represents the economic type. For the success of the pastoral type what is practically a continuous pasturage is needed, so that the animals can subsist without the necessity of too rapid transit from one feeding-ground to another. Such regions are to be found on mountain plateaux like those of West and Central Asia, on the higher lands of the mountain valleys, or of the river valleys at the edge of the plateaux where altitude makes the land unsuitable for agriculture, or on the steppes of the temperate, and the tundras of the colder, latitudes. In these areas the strictly seasonal character of the vegetation is responsible for the nomadic life of the inhabitants. In the tropics the advance of the season burns off the grass with the increasing heat, necessitating movement either north or south, according to the situation in relation to the equator, or to relatively higher ground where springs and grass are to be found in rifts in the hills. In mountainous regions the melting of the snows with the advancing season opens up the higher valleys with their rich grass, and the cattle and sheep follow the snow-line as it recedes. Owing to the seasonal character of the vegetation and the absence of water without more elaborate irrigation than is available, these lands are not suited to agriculture, at any

rate on any but the primitive scale.[1] Thus the movements of the nomadic people are controlled by the arrangement of the vegetation in belts and the differences in climate from place to place. Just as there is a movement from mountain to basin floor in each separate basin with the approach of winter, so there is a general movement of the nomads from the grassy belt of Southern Siberia southward to warmer winter pastures on the borders of the desert. The wanderings of the people are a response to geographic conditions that here are seen to be a more powerful influence than in almost any other primitive society of the Old World. In Turkestan the shepherds still follow the rainfall when it occurs at different seasons in the steppes. In Mongolia the Mongols herd together in winter with their flocks of goats and camels in protected valleys, but disperse in summer throughout the country when the flocks utilise every possible water-hole or grass patch. Thus the tundras and plateaux of Northern and Central Asia are in motion at regular seasons of the year and the mass movements of enormous caravans serve the same purpose to-day as they did seven centuries ago. Villages are shifted to the hills and mountains for the summer's grazing. In the autumn the people go back again to the plain and the desert to escape the snow. Their houses or tents are completely erected and shifted in a half-hour. The Mongol has his *yurt*. First the lattice framework is opened out, and the circular top held up, while stick after stick is inserted to form the cone-shaped roof; then the door is put in place and layers of felt are tied on roof and sides. When occasion demands it can be dismantled and moved with ease. It is thus that the desert-dwellers, accompanied by their camels, ponies and sheep, have formed a pageant for centuries, tracing the great trade routes long before the travels of Marco

[1] E. N. Fallaize: Article on "Pastoral Peoples" in *Encyclopedia of Religion and Ethics*.

Polo. Mongolia is still a land of mystery, of painted deserts dancing in mirage, of limitless grass plains, and of untracked forests. But even here the Chinese farmers are coming with their ploughs and harrows, and as they arrive the pastoral Mongols retreat farther into the grass-lands. The Bedouins of Arabia pasture their flocks in the desert in the rainy season, and migrate to Mesopotamia in the drought.

Economic Life of Asiatic Nomads.—Among the countless high peaks in Tibet, the nomads dwell in black tents of yak-hair close to the snow, because their yaks thrive best in a cold temperature, and go down the valleys when winter sets in, thus utilising the supply of grass to best advantage. Their food is parched barley-meal and buttermilk; while their garment consists of raw sheepskin made with the wool inside. There are also half-nomads who during the summer live in stone huts and cultivate barley, and the rest of the year roam a small distance away with the herds of sheep and the yaks. Sven Hedin observes that the nomad is naturally less dependent upon the weather than is the dweller in Southern or Eastern Tibet. However, the early spring rains delight the nomad because, after the rains, the grass springs up abundantly and the domestic animals and the wild yaks, wild sheep and wild asses become fat and well fed. The yak-cows and ewes supply better milk and butter and the nomad's family also wax fat. In times of drought the grass is scant and poor, pasturage must be sought afar, the animals grow thin and the milk and butter supplies are unsatisfactory. After heavy snowfalls in late winter it may happen that the sparse pasturage is completely covered, and then it becomes necessary to break camp earlier than usual and seek fields not hidden by snow. In the valleys that open to the south and cradle the tributaries of the Tsangho or Upper Brahmaputra, there are permanent habitations, clusters of villages of stone huts and houses and

many temples, of which some are very large. The characteristic industry of the arid plateaux throughout the region from Arabia to Tibet is the care of herds of horses, sheep, goats, and camels, and the people generally are nomadic. In the western steppe region the Kirghizes do not cultivate land, or only to a very slight extent, and practically do not eat bread, though flour and rice, obtained by barter, are employed by the richer. Milk and milk products with the flesh of the flocks form the basis of their diet, and a milk wine produced by the fermentation of milk is a characteristic drink. Since the middle of the nineteenth century, the Kirghiz steppe region has been settled by Russian agricultural colonists, who in large part have displaced the nomadic hordes. The manufacture of butter has become a great industry with the new colonist and, like agriculture, would have developed much further had it not been for a wholly inadequate transportation system and a generally primitive organisation of commercial facilities. Wheat, rye, oats and millet are the chief field crops. The pastorals of Tibet are nominally Buddhist, but all supplement the diet of milk, butter, barley meal and fruit imposed by their religion by the flesh of game, yak and mutton. They also are very fond of blood, and the children are fed on a diet of cheese, butter and blood. In the north of the continent, on the tundras of Siberia where grass gives way to reindeer moss, the pastorals depend on the reindeer. In South India the Toda villages are dotted here and there on the plateaux of the Nilgiris hills. Each community, usually one family, has several villages to which the cattle and those concerned with them migrate at different seasons of the year. It follows, therefore, that though all the villages are occupied in the course of the year, not all are inhabited at one time. Their diet consists of milk, buttermilk, *ghi*, grains, rice and sugar, but there is a tradition among them that at one time they lived on roots, herbs, fruits

and honey. The grain which forms a large part of their diet is obtained from the Badagaz whom they regard as a subject race.[1]

Intermediate Lands and Semi-Nomads.—South of the Asiatic steppes and deserts comes an interrupted band of warm temperate or tropical forest, luxuriant to the east where there are summer rains, scanty and scrub-like to the west, where Asia meets the Mediterranean. Immediately southward of the steppe region of the Kirghiz extends the territory of Russian Turkestan, which also includes a desert tract. The desert portion is marked by irrigated bands of country along the northward-flowing streams and by towns of both historic and recent importance—Merv, Khiva, Samarkand, etc.; the whole region is practically treeless save on certain of the mountain slopes, the vegetation being of shrubs with coarse pasture on the lowlands and mountain pasture at higher levels. Large numbers of the people depend for subsistence on their flocks and herds; all are clannish to a degree owing to the present and former nomadic habit. Wool, hides and skins are among the staples here; and, as in Persia, there is local carpet and rug manufacture (at Bokara) and leather-work. The region is hemmed in on the south and east by the mountains of Central Asia, broken in two places by the Zungarian "gates" through which have passed practically all the ravaging hordes of Turks and Mongols that have streamed into Western Asia and Eastern Europe. Towards the east extends Eastern Turkestan, which is an uneven plain and desert bordered by snow-covered peaks. It is in the oases which are widely scattered and separated by desert or mountain country that the population chiefly lives. Only 10 per cent. are nomadic shepherds (Kirghizes); and there is a small group of fisher folk (Lopliks) who live among the lakes and reed swamps of Lop Nor. This region has been the field of fierce

[1] Rivers: *The Todas*, p. 580.

and continual struggles between the civilised and sedentary population of China and the nomadic barbarian hordes of inner Asia. It is still of interest to China, Russia and India as a thoroughfare for trans-Asiatic commerce and influence.[1] In the "islands of the land" (oases), the people, however, live isolated lives bound to their palm-trees, springs and reservoirs and carrying on a cultivation which is always artificial and precarious. Nearer the equator we find the steppes giving place to forests, merging first into savannah which itself merges into forest. This transformation is realised in the zones of the trade-winds. These regions, where westerly winds generally prevail and assure abundant rains and an equable climate, are most favourable for the development of a varied and successful agriculture and a large aggregation of population.

Lands of Intensive Culture.—Thus the great bulk of the population of Asia are agriculturists and are concentrated in the plains of India and China, which exhibit some super-excellent types of farming and agrarian organisation. The main foods here are cereals. The soil is so carefully cultivated in most of China proper and Japan that these regions are literally to be called gardens. Here have arisen among the mass of settled inhabitants some of the world's best specimens of vegetable gardening, with contemporary development of art and handicraft as well as the art of socialised living. In Japan the most characteristic feature of the land is its mountains. No less than three-quarters of the island territory constituting Japan is mountain land, to a great extent uncultivated because uncultivable. The remaining quarter is worked with a minuteness of care and an intensity of energy which are admirable indeed. The hard conditions of life engender habits of frugality, endurance

[1] See Bowman: "The Mohamedan World," *Geographical Review*, January, 1924.

and self-reliance, greatly to the raising of the peasant's status. Domestic occupations as well as crafts which require great labour, such as the production of tea, silk and rice, have developed into perfection among this thrifty and laborious people. Again, the climatic conditions of Japan, which offer more striking contrasts than any other country of similar area, and the extraordinary variety of form and structure which give to her mountain landscape a most romantic charm, make the people lively, impressionable and artistic. From the constant and imperative need of repairing damages wrought by violent winds, floods and earthquakes, they also have become stoical, persevering and, withal, somewhat fatalistic.[1]

Dense Populations of S.-E. Asia and Intensive Farming.—Over 839 million people live in India, Indo-China, China, Korea, Japan and the south-eastern islands, i.e., half the population of the world on one-tenth of its surface. So dense a population leads to the introduction of more intensive types of farming on the small plateaux or in even the tiniest of level valleys. There is a tendency also to carry agriculture farther by resorting to terracing as a means of extending permanent cultivation to the less level lands. In India, China, and Japan, this effort is carried to extremes, and terraced hillsides, whose natural slope is nearly or quite 45 degrees, are cultivated in narrow strips by hand labour. Many mountains in these countries, as well as in Ceylon, Java and the Philippine Islands, are terraced for rice far up their sides; perhaps in no place in the world is a more remarkable engineering feat to be seen than in the rice-terraces, with their artificial walls and elaborate system of irrigation, constructed by the Filipinos in Northern Duzon. Further, a most economical method of cultivation has been adopted, *viz.*, the introduction of rotations of

[1] Walter Weston: "The Geography of Japan," *National Geographic Magazine*, July, 1921.

leguminous and grass-crops which restore a great deal to the soil through the cover of vegetation and nodules, or decayed stems laden with bacteria. Every device that human ingenuity could contrive has been brought to the aid of agriculture; all the elaborate schemes of canalisation and irrigation, the selection of crops, the intensive systems of mud and soil fertilisation, are immemorial practices in China. All this makes up for the small amount of cultivable ground in China, where, of 1,000 million acres, only 125 millions are available for agriculture: the rest being locked up in the form of forest, pasture, royal preserves, pagodas or townships. For the same reason, although sheep and cattle, horses and various other animals are mentioned as early as 1100 B.C. in Chinese history (Chow period), and the use of animal manure for fertilisation was known, sheep and cattle are comparatively rare in China proper, excepting in districts adjoining the treaty ports, and always have been so.[1] The water-buffalo is kept because it draws the plough, and the horse here and there serves as a beast of burden; but, aside from these, swine are the only animals which are common because they will thrive in confinement—that is, will live without pasture.[2] The Chinese do not utilise the aid of domestic animals, but their own strength and manual dexterity excited to the utmost, and compensate for their want of animal manure by a plentiful use of nightsoil.[3] Similarly, there is probably no country

[1] Febvre: *A Geographical Introduction to History*, p. 293.

[2] *The Economic History of China*, by Mabel Ping Hua Lee, p. 26.

[3] Food animals, fowls excepted, are luxuries which must tend to disappear with an increasing population. They are secondary products of agriculture, using up food not much more efficiently than human beings, and forming thereby the most expensive part of our dietary system. It is estimated that it takes eight times as much land to provide a man with a diet wholly of meat as it does to provide him with nourishment from vegetable sources only. There is one serious drawback, as has been pointed out by East: "When man has ousted the ox and pig from the grain-bin because he needs their fodder himself, he has allowed a valuable dietary insurance policy to

where the land is required to do so much as in India. Subtracting the land utilised for supplying overseas markets, we find that what remains does not represent more than two-thirds of an acre per head of population.[1] In 1917–18 the total population in British India was 258,216,617 ; while the net area under crops was only 229,620,075 acres. Thus the total cultivated area diminished to less than nine-tenths of an acre per head of population.[2]

Pastures, their Use and Regulation.—According to Professor Simkhovitch, agricultural countries seek to check soil depletion by keeping cattle about the farm and on the fields instead of sending them to distant pastures. This explains the importance of communal pasture-grounds in the village community of India ; where pasturage encroaches upon human food resources, animal husbandry, which prevents some fields from being cultivated for human food, is given up. This has been the case both in India and China, where the present existence of village community arrangements, with their elaborate rules as regards grazing and the use of meadows, can be accounted for as resulting from soil-exhaustion.

Long Seasons of China.—In China, which lies between 20 and 40 degrees north latitude, the seasons are very long. This accounts for the possibilities of growing two, three or four crops on the same piece of land each year. Further, the abundant rainfall, which falls more exclusively during the summer seasons when its utility in crop production is the highest, contributes to her unusually large yields.

Monsoons and Monsoon Lands in China and India.—The south-eastern monsoon blows in summer from the Pacific to the Chinese coast and brings abundant

lapse. Thereafter he will have to do as Pharaoh did, lay aside food during the fat years,—and storage rates are high."—*Mankind at the Crossroads*, pp. 150, 161.

[1] Holderness : *Peoples and Problems of India*, p. 140.

[2] Pillai : *Economic Conditions of India*, p. 59.

rains. The region that benefits by these rains is limited inland by the edge of the central Asian plateau, and consequently the elevated interior, including Tibet and Mongolia, is very dry, as are also the remote parts of the western provinces of China. The rainfall diminishes also from the tropical downpours of the south to the light summer rains of Manchuria, where the precipitation is comparable to that of the prairies. But, in South and Central China, there is rainfall during the winter months; and this fact, combined with the absence of severe weather, makes intensive agriculture possible all the year round. Large quantities of rape, winter wheat, barley, beans, etc., are produced as winter crops. The south-west wind reaches the west coast of peninsular India as a warm wind saturated with vapour; and this region, which includes Bombay Presidency, has unfailing and very heavy rains. In the evergreen forests of Travancore and Coorg, coffee, tea and rubber plantations are beginning to thrive, while the wild elephant still roves in the distance. Gradually the south-west monsoon is extended over the whole or almost the whole of India. On the amount of rain that this monsoon brings, and on its distribution, the economic life of seven-eighths of the people of India depends. The south-west monsoon may be regarded as comprising two important air currents, the Arabian sea current and the Bengal current. The former covers the west coast and then turns round up the Gangetic valley, supplying with moderate rains the eastern Punjab and the western Himalayas. The Bengal current covers the east coast, Burma, Bengal and Assam, and then is pushed westward, supplying rain to the Gangetic plain. No failure ever is experienced in the east, and rice is the chief crop grown; but jute also is important in Bengal and tea in Assam. Whilst the Bengal current gradually sweeps round and blows as a south-easterly wind up the Ganges valley, the rainfall diminishes in quantity

and certainty from east to west. Here, therefore, there may be whole or partial failure. There is always a downpour on the southern slopes of the Himalayas, giving rise to rivers with a perennial flow. The middle and lower Indus basin is passed by the south-west current to the south, and by the south-east current to the north, so that apart from irregular summer showers it is rainless: here occurs the Thar or Indian Desert. The land in its natural condition produces scrub growth and grazing of a kind, which gives some food to cattle, sheep, goats and camels. The wild ass is still hunted in the deserts of Sind and Cutch. The people of the desert depend more on the produce of their herds than on grain. Excepting a little *bajri* no grain is grown, and there is little means of transport but the camel. The grassy tracts round the Runn of Cutch stretching northwards to Rajputana have bred the finest cattle in India. Although summer rains are the rule throughout India, there are certain regions that have also some rainfall in winter. The south-west monsoon retreating in autumn recrosses over the Bay of Bengal until it is blowing from the north-east, and so gives a winter rainfall to North-Eastern India, Burma and the Carnatic Coast southwards from Madras.

Mediterranean and Asiatic Types of Agriculture.—In the Mediterranean region the summer drought renders agriculture relatively difficult, and often the trees and shrubs stand apart from each other with bare earth between. This as well as the configuration of the coast encouraged from early times the spread of settlements over-sea, if not over-land. The difficulty in producing food grains in quantity compelled the people to supplement the scanty resources of their limited lands by sea-trading, or by holding in subjection the areas outside that of the characteristic climates which were corn-producing. By the side of the cities which flourished by trade there developed garden-farming

and fruit-growing, which gave free scope to individual initiative and management. Thus the agriculture of the Phœnicians, the Greeks and the Romans was far different from the agriculture of the South-East Asiatic sea-board. Throughout South-East Asia the abundant rainfall both in summer and winter, the fertility of the river valleys, and the vast resources of lands, continental in magnitude, early developed a self-sufficing economy. The peoples early settled themselves permanently in fixed areas, rapidly multiplied and extended almost indefinitely on the vast level plains their particular type of intensive cultivation. There was no slow and peculiarly laborious clearing of the forest as in Europe proper, nor again much rotation of crops such as is demanded by the periodic closing and opening of natural vegetation as in the Mediterranean region. The cultivation had not much variety, but it was eminently successful and could maintain a large population.

Adaptation of Agriculture to Climate.—Notwithstanding the copious and favourable rainfall of China, Japan and India, each nation has selected the one crop which permits it to reap the full advantage not only of practically all the rain which falls directly upon its fields, but in addition enormous volumes of the run-off from adjacent uncultivable mountain country. These nations have adapted conditions to crops and crops to conditions until in rice they have a cereal which permits the most intense fertilisation and at the same time the insuring of maximum yields against both drought and flood for dense populations. With the practice of Western nations in all humid climates, no matter how completely and highly they fertilise, in more years than not yields are reduced by a deficiency or excess of water. Rice, which gives a maximum yield, is a good staple crop for dense populations. Where the population is not dense, however, it cannot be grown; for the cultivation of rice demands a large number of

unskilled hands and arduous hand labour over relatively brief agricultural seasons. With a cheap supply of agricultural labour, little manure and with imperfect tools and implements, rice feeds large masses of population. Social cohesiveness among rice-growing peoples naturally is encouraged when a large population is concentrated in small fertile areas, while the flooding of the rice-fields during transplantation develops communal habits of agriculture and communal control of irrigation. It is this social cohesiveness which has governed the characteristic distribution of fields in China, Japan and India. Village communities grew up and have survived the shock and collision of ever-restless political forces, and it is the village communities which made a deliberate attempt to equalise opportunities by distributing plots among the settlers in different soil areas. Again, the selection of the quick-maturing, drought-resisting millets as the great staple food crops in the East to be grown wherever water is not available for irrigation, and the almost universal planting in hills or drills permitting inter-tillage, thus adopting centuries ago the utilisation of earth mulches in conserving soil moisture, have enabled these people to secure maximum returns in seasons of drought and where the rainfall is small.

Thus we find in the Far East, with more rainfall and a better distribution of it than occurs in the United States, and with warmer, longer seasons, that the people with rare wisdom have combined both irrigation and dry farming methods to an extent and with an intensity far beyond anything the Western peoples have ever dreamed, to the end that they might maintain their dense populations.[1] But, on the other hand, dependence upon the monsoon makes these regions especially liable to famines excepting in those areas where flooding rather than rainfall is relied upon for the natural renewal of fertility. In North China the rain-

[1] F. H. King: *Farmers of Forty Centuries.*

fall is concentrated largely in a few summer months; a delay in its arrival means that crops can begin growth in the irrigated fields only. If growth is delayed till July, as often happens, and if July is dry, almost nothing can be reaped from the unirrigated fields. This practically never happens in the South, where the rainfall is less strictly concentrated in the summer months.[1] Similarly in India, which is situated rather on the outskirts than in the centre of the monsoon region, economic conditions depend on the caprices of the monsoon at its beginning in June, or at its end in October. On them, more than on the variations in the total rainfall, hangs the fate of the chief and most important *kharif* crop.[2] In Northern India the great variations in temperature and the rain from the south-west monsoon give the conditions necessary for the double crop system. In Madras, where the climate is marked by more regular and continuous warmth, the distinction between *kharif* and *rabi* crops disappears, leaving only early and late sowings of the same crops.

The periodic opening and closing of the natural vegetation, coupled with the fact that the climatic conditions render agriculture in the South much more difficult than in the North, has developed the highest type of cultivation in India. The principles of manuring and rotation and the need of thorough tillage are well understood, and a neat and thorough system of garden cultivation is here associated with irrigation from wells. The alternate opening and closing of plant-formation, the scattered cultivation and the absence of much level land in Southern India, indeed, present conditions in striking contrast with those of Northern India and in some respects strikingly akin to those of the typical Mediterranean region. Agriculture here had been far less self-sufficient. The sea fisheries early attracted men into adventurous careers, while the

[1] Huntington: *The Character of Races*, p. 170.
[2] *The Imperial Gazetteer*, Vol. III.

south-west monsoon created a flourishing sea-trade carried on largely by native Dravidian craft, which trade contributed notably from very early times to the interchange of ideas as well as commodities, not only in South India but also in the Persian Gulf and along the coast of Arabia, with which the trade principally was maintained. Probably it was by way of these activities, which made Dravidian India known to the outside world much earlier than Northern India, that the rice-crop, indigo, tamarind, wood, sandal-wood, ivory, precious stones and other South Indian products, as well as the compact village organisation, migrated to the Mediterranean region through the Persian Gulf and Arabia, from which pioneer traffic the navigation of the Indian Ocean began. On the Tanjore Delta, however, which is formed by the river Cauvery and intersected by the numerous channels which distribute its waters for irrigation, the people have been stay-at-home and conservative. That vast, level, fertile area, is the site of a very ancient civilization, the home of prosperous little republics, the village communities, and the bulwark of orthodox Brahmanism. The villages in Madura, Tanjore and Tinnevelly are replicas of the village communities of the North, planned after the Hindu scriptures by an aggressive Brahman minority and stamped with Brahmanical distinction in the segregation of the caste wards. Here the Aryan colonists have found a home where conditions are similar to those of the Indo-Gangetic plain, and thus we still find there a social life such as the Hindu lived in the North several centuries ago.

CHAPTER III

ECONOMY OF SMALL FARMING

Agricultural Income and Expenditure in India.—It is very difficult to estimate accurately the present economic position of the small farmer. In India, in particular, statistics are uncertain and do not yield definite information in this respect. The average annual income per head in India was estimated to be Rs. 27/- and Rs. 30/- in 1880 and 1901 respectively. In 1911 the correct figures on the same method have been Rs. 50/-. A somewhat more elaborate method gave for 1911 the figure of nearly Rs. 80/-. In arriving at these figures the total estimated value of agricultural produce is worked out, and on the assumption that the income of agriculturists and non-agriculturists is distributed between the two classes in proportion to their numbers, the average income so-called per head of total population is determined. Thus, if the total agricultural produce or income so-called in 1911 was Rs. 876 crores and the non-agricultural population was three-eighths of the agricultural population, then non-agricultural income so-called is three-eighths of Rs. 876 crores, *i.e.*, Rs. 328 crores. The total income so-called is Rs. 876 crores + Rs. 328 crores = Rs. 1204 crores: this divided by the total population gives a per capita result of Rs. 49·6 or nearly Rs. 50/-. From a careful estimate of the agricultural income of the Madras Presidency in 1921 we arrive at an average income per head of a little over Rs. 100/-. During the last few decades the rupee greatly declined in value, so that the purchasing power of Rs. 100/- was only 40 per cent. greater than that of Rs. 30/- in 1899. Assuming that the income of Rs. 100/- per head per annum of the

Madras Presidency is true for the rest of India, the increase over the 1899 figures does not really mean much progress. Mann and Kanitkar's enquiries (1917) revealed a state of things much worse. They estimated in a Deccan village the average return to a cultivating farmer of Rs. 5–12–0 per acre of cultivation, and the landholder's share as Rs. 2–12–0. The agricultural labourer earned 6 annas and a woman 3 annas. Working out all the items of income, they estimated Rs. 167–13–0 per family per annum or an annual income per head of Rs. 33–12–0. The total amount of indebtedness was Rs. 199–0–0, or a debt of Rs. 39–12–0 per head, of which the rates of interest vary from 12 to 75 per cent. The Census Superintendent of the Bombay Presidency, who directed a similar enquiry (1921) found that the most common level of per capita income in rural localities is about Rs. 75/-. The majority of the families with an income of Rs. 75/- were found to be in debt. Agricultural conditions exhibit large differences in different regions in India and regional surveys will show different estimates of per capita increase accordingly. Rushbrook Williams observes: "Where rainfall is precarious and uncertain, and the soil shallow and poor, the income from all sources per head in a typical village has been calculated at Rs. 33–12–0 per annum as against a minimum of expenditure necessary for real needs in respect of food and clothing at Rs. 44/- per annum." In the Deccan, the cost of living of a labourer's family has been estimated as Rs. 34·65 by Mann. More than 90 per cent. of the total expenditure of the agriculturists in India is spent on staple food, rent and clothing. Very little is available for making permanent improvements for the land, for drainage or irrigation, which therefore depend solely on the manual labour of the peasant's family. Amongst all classes in India expenditure for social and religious ceremonies and caste dinners is excessive and causes a large proportion of family indebtedness.

Importance of the Indian Money-lender.—In every agricultural country debts are incurred by the peasants for meeting expenses of cultivation. These usually are paid off after harvesting. It is roughly estimated that more than three-fourths of the agricultural population of India are embarrassed with debt, and that nearly two-thirds of the debt are secured by mortgage of land. The village money-lender's calling is thus the most important in India. Beside him, the professional class is inconsiderable, the industrial class is insignificant, even trade and commerce take the second place. Mr. Darling has shown that the Punjab is dominated by the money-lender to an extent unknown in any other province. In the whole of India, excluding this province, the proportion of money-lenders to the population is 1 : 367 ; here it is 1 : 100. Although the population of the Punjab is only one-eleventh of the whole, one-fourth of all money-lenders found in British India reside and trade here.

The Lender's Terms: Reasons for Agricultural Indebtedness.—The rates of interest charged by the *Shah* or *Mahajan* range usually from 25 to 300 per cent. In addition to charging exorbitant rates he extorts money under various pretexts and takes from the cultivator bonds on which heavy stamp duties are payable. On the other hand, the borrower's need is irrepressible. Either he will starve or he must give up his land if he cannot get an advance to tide him over his emergency. Again, he possesses nothing besides his small farm which can serve as a security. It is true that he is proverbially honest and straightforward, but the money-lender wants a more substantial guarantee. There are different kinds of loans: grain loans for food, seed loans for cultivation, usually on *sawai* (one and one-fourth) and *deorha* (one and one-half) rates; advances made by middlemen with a view to securing the crops; loans on security of ornaments; cattle and poultry loans, etc., all of which are adapted to

special rural needs and conditions. The reasons which compel the cultivator to borrow are diverse. Some of these are enumerated below:

(1) **Unseasonable Demands.**—The demand for the revenue by a fixed date cannot always conform to the caprices of the Indian seasons. This is true in particular of those tracts of India which are not permanently settled. In the latter the amount of revenue has been fixed in perpetuity and is payable by the landlord as distinguished from the actual cultivator. The landlord usually arranges the *kists* of payment in a way suitable to tenants whose rents fall in arrear and who are not bound or troubled by fixed dates. In the *ryotwari* tracts the duty of assessing the revenue of a district is entrusted to Settlement Officers. Under Temporary Settlements 25 to 50 per cent. of the rental in the case of *zamindari* land may be regarded as the demand, and this demand cannot be adjusted promptly by the slow-moving and impersonal machinery of government to the fluctuations of crops.

(2) **Agricultural Losses.**—The loss of agricultural capital during frequent periods of entire disorganisation due to the caprices of the seasons. Famines sweep away the meagre capital at the disposal of the Indian peasant. In times of famine thousands of cattle die or are sold for a few rupees a head. In 1918 the Bombay Presidency alone lost one million cattle, or one-ninth of its whole stock. In the famine of 1918–19 in one part of one district of the United Provinces (in the Bah *tahsil* of Agra), an inaccessible and inhospitable tract of barren and broken ravines, no fewer than 200,000 cattle of the agricultural classes were lost.[1] Another enemy is disease. The high subsoil water-level in the riverain areas, combined with a heavy rainfall, is as unhealthy for cattle as it is for men.[2] The mortality amongst cattle is terrible and there is no

[1] Smythies: *India's Forest Wealth*, p. 13.
[2] Darling: *The Punjab Peasant*, pp. 32–33.

attempt at segregation of cattle suffering from infectious diseases. The number of veterinary surgeons is exceedingly limited and adequate measures of inoculation and ameliorative treatment cannot be undertaken. Moreover, the religious prejudices of the people prevent drastic measures being taken against any infected village, while the village common-lands spread the infection to the cattle of neighbouring villages.

(3) **Improvement of Credit.**—Mr. Datta in his *Enquiry on the Rise of Prices* writes: "With increased wealth in the country there are now more persons with money to lend than before and they compete with one another in offering loans to the cultivators at lower rates of interest. Owing to an increase in prices, land has considerably risen in value throughout India and now forms ample security for a much larger loan in comparison with what it would have secured 25 years ago; and this increased credit the ryot is far too prone to utilise for foolish and improvident purposes." The temptation is too strong for him to resist borrowing, the dangers of which are unrealised. This applies especially to the case of cultivators with small holdings.

(4) **Legal Changes.**—Many observers ascribe indebtedness also to the changes in the system of inheritance and legal procedure introduced by the British Government. According to the Famine Commission Report, 1880, a rigid and elaborate legal system too often has proved only an additional instrument of oppression in the hands of the more wealthy or better instructed litigants and an additional cause of ruin to the impoverished agriculturists.

The enormous amount of capital borrowed by the peasant or sunk in the purchase or mortgage of land does not therefore benefit the land itself. The only forms of permanent improvement left by the ancestors of the present population are found in the existence of wells and of a few small embankments to prevent floods, in a certain amount of levelling and in the

existence of trees which afford timber and shade. Exceptions to this may be found in the hills where the pressure on resources has led to the laborious terracing of otherwise uncultivable hillsides, and in the canal colonies of the Punjab and other irrigated tracts where a more enlightened spirit is manifest.[1] In Japan labour is spent in providing dykes and ditches for drainage and irrigation in connection with the tiny rice-fields which are levelled and made secure in their places by terracing. The irrigation systems furnish water so abundantly as to force the largest possible crop formation and the drainage canals and flood-controlling dykes allow the cultivation of large areas, which otherwise would be either periodically or permanently inundated. Such improvements in the land have been seen in India only in the canal colonies in the Punjab, in Eastern Bengal and in the Cauvery Delta. North of Basti, in the United Provinces, the landlords have constructed an elaborate canal system, which makes it possible to grow rice under apparently impossible natural conditions.

(5) **Thriftlessness.**—There are certain other circumstances which cause poverty and lead to indebtedness and which have their origin in the habits of the people themselves. In India the limited nature of crops, which entail work only at certain periods of the year, and the abundant harvest, have produced the habit of wasting long periods in idleness, while the social environment and customs encourage thriftlessness. In England, hard times, famine, and privation during the Napoleonic wars, as well as economic stress during the Industrial Revolution, rendered the practice of thrift a necessity. The rise of the middle class and of popular banking in France and Germany similarly was associated with the inculcation of thrift as a national virtue.[2] In India there are no institutions

[1] *Punjab Census Report*, 1921, p. 20.
[2] Cf. Calvert: *The Wealth and Welfare of the Punjab.*

like Banks and Credit Societies in the village which would encourage systematically the deposit of small savings. The Postal Savings Bank never has appealed to the peasants, while the Co-operative Credit Societies are too few. The Hindu joint-family system is incompatible with penalising the indolent and incompetent who feed on the earnings of the more efficient and successful members. The series of seasonal feasts and religious observances, with caste dinners on auspicious occasions, have stimulated family extravagance. All these have played an important part in fostering improvidence, while the facile doctrine of a mysterious, inexorable fate has been the refuge of the weak-spirited and feeble-minded. In most of the provinces in India it has been found that the poorer the family, the larger is the population of children. Whether a large family is a cause or a consequence of poverty is not clear in all classes.

(6) **Fragmentation of Holdings.**—Nor are the laws of succession and the land system without their effects on poverty and indebtedness. Formerly the cultivation unit was the joint-family estate and partition was uncommon. But the tendency towards subdivision, which has become manifest in India during the last few decades, is the outcome of the importation of Western notions of property. The more fertile the land, the greater the increase of population, and the smaller the subdivision of the holding. Subdivision is especially encouraged by the fact that, for the cultivation of rice, the land is broken up into plots surrounded by dykes and channels for the inflow and outflow of water. The fields thus are open and without hedges, and lend themselves to easy and speedy subdivision. The boundaries of the Indian fields are recognised by means of ridges (*mend*) surrounding each plot, to each of which there are four such ridges. Since each plot is held by a different peasant, a man can make out easily where his field lies. After each subdivision, the

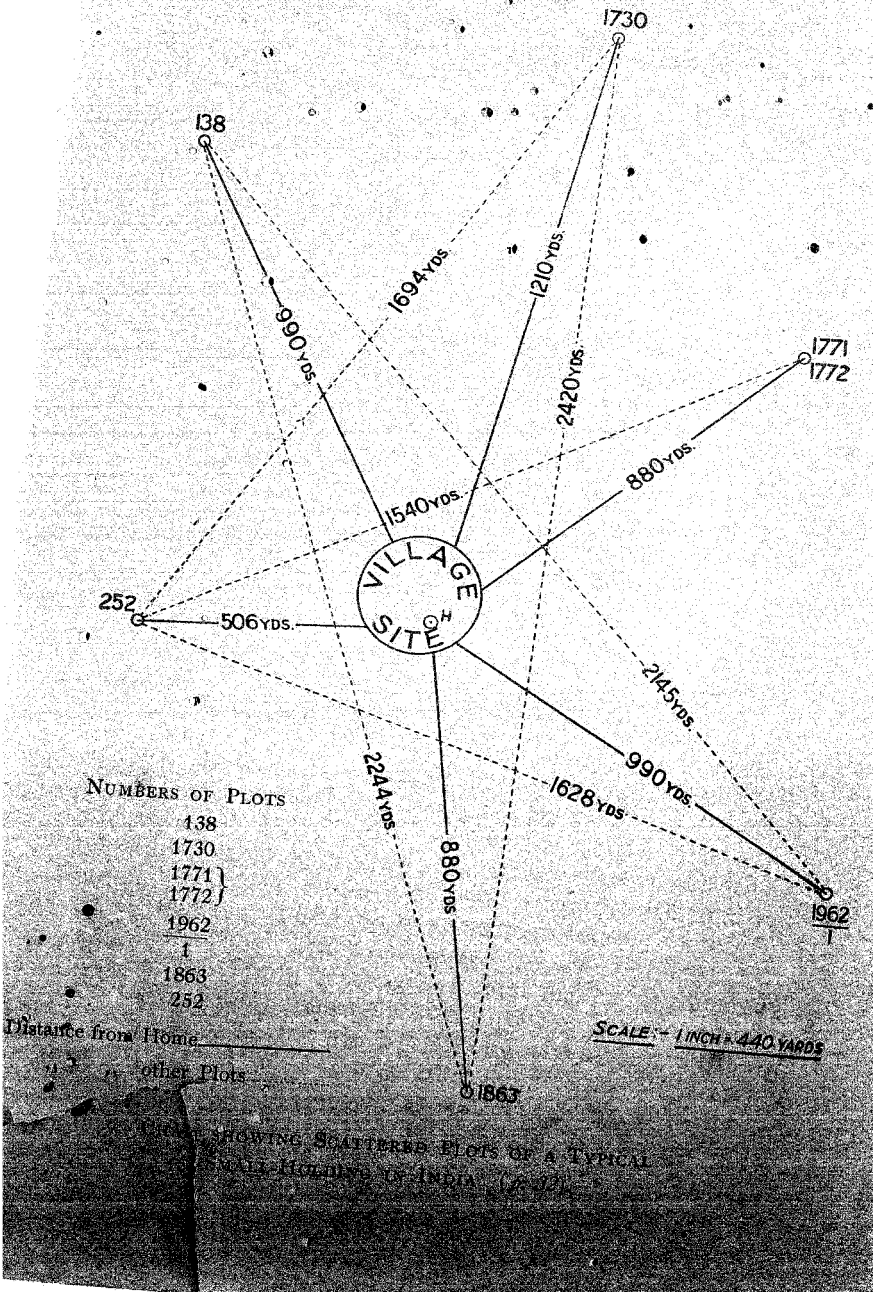
cultivator knows the boundary of his own field. Further, the peasant's farms are not compact, but scattered over the plains. These either have peculiar names, or are termed high or low land, near or distant land, or northern, eastern and western, according to their situation with respect to the village where the peasant lives. Various are the causes which tend to render a peasant's fields so widely scattered (*chhita*). In the village communities there was a deliberate attempt to distribute plots among the settlers in different soil areas so as to allot plots of different degrees of fertility to each. The various classes of soil with vastly different advantages and disadvantages in each village community demanded equalisation of opportunities among a dense population by the distribution of plots of land in different blocks. This enabled a large number of cultivators to share in the more fertile or protected blocks and reduced for the individual cultivators the risks from calamities. The village community also devised means of making holdings compact whilst still securing to each cultivator a share of all classes of soil. Thus the holdings may consist of long narrow strips radiating from the centre, where the village stands, to the circumference of the village lands. Each strip is a holding, or rather a holding unit.

Again, the practice of rotating crops in India, China and Japan could succeed when each cultivating family had several kinds of land suiting various climatic conditions, and this also is responsible for the existing distribution of fields. Indeed, it very often is forgotten that the peasant's holding is economic simply because the plots of lands are scattered in different soil blocks. Where agriculture is so dependent upon rainfall, the scattered distribution of the fields suiting different soil and climatic conditions is a great advantage. Along with scattered distribution, the village community established a careful adjustment of individual and collective rights in arable land, meadows or pastures

and irrigation channels, demanded by the social necessities of a compactly congregated population.

From Maine to Baden-Powell, the economic and geographical conditions, which explain the distribution of fields and compactness of village communities, have not been appreciated, and this explains many of the errors of an individualistic scheme of legislation and land administration introduced by early British officials who were born and bred in the traditions of Bentham and Ricardo.[1] Thus the first thing which strikes a Western observer accustomed to the compact farms of Europe and America is the scattered distribution of holdings and the reform that first comes to his mind is consolidation. The peasant instead of residing in his holding lives in a central *busti*, although it may involve journeys of two or three miles for himself, for his cattle and for his children who bring his noon-day meal to the field. Such journeys are undertaken, however, because it would be more risky under the present conditions of agriculture if his holding consisted of one crop only: say, rice or wheat situated in one zone. In the United Provinces, for instance, owing to the irregularity of the monsoon, rice is a most uncertain crop unless irrigation is available. In a typical rice-growing tract the villages cluster on the high land which is under wheat or other spring crops, the low-lying flooded fields beyond being reserved for rice. Consolidation of holdings would bring the cultivator no nearer his land, unless the style of village architecture were so altered that he could live in the rice-fields; while it would have the disadvantage that the holding, instead of consisting partly of rice and partly of wheat land, would be made up wholly of either one or the other. Over, perhaps, the greater part of the provinces the difficulty of consolidation is one of water. The wells are usually in the village, or comparatively near at hand, the presence of a good

[1] Cf. Mukerjee: *Democracies of the East*.



PLAN SHOWING SCATTERED PLOTS OF A TYPICAL
WILD HOLDING OF INDIA (p. 47).

farm tends to fly into fragments and grows steadily smaller and less regular. As the population increases the holdings on account of the law of succession come to be unduly fragmented and these are relinquished or otherwise made over to the *zamindar*, when they are leased to others who are willing to pay for them. Instances are not uncommon of several landholders owning land in the same field, in which case they make their own selection of peasants who are to hold under them. These and other causes combine to render the peasant's holding quite the reverse of compact. Intensely fragmented plots become irregular and uneconomical, and lead to a waste of time and labour, of cattle-power and manure. Thus the chief explanation of the poverty of the Indian peasant lies in the scatteredness or uneconomical size of his holding. In large parts of the Indo-Gangetic plain the small and irregular fields seriously militate against the maintenance of correct levels and lead to waterlogging, which causes a loss of available nitrogen and hence a poor crop. The maintenance of proper drains and banks to check erosion and prevent waterlogging of the low areas, the provision of suitable roads, footpaths and proper irrigation channels have all been rendered difficult by the present lay-out of the average village. The scattered ownership of small fields also puts obstacles in the way of construction of much-needed wells.[1] The present scattering of parts of a holding in different parts of a village often makes it impossible to build masonry wells, to make permanent improvements, to protect from surface washing, to intercultivate, to organise the employment of hired labourers, or even to adopt really intensive cultivation by hand labour which is the small-holder's supreme advantage. It leads to an enforced idleness in cases where there are too many persons dependent upon the

[1] Cf. Burt: "The Re-alignment of Agricultural Holdings," *The Agricultural Journal of India*, 1916.

small farm. It leaves agricultural profits so small that the least misfortune causes them to vanish. The small size of the holding means also small security for the cultivator and hence a higher rate of interest for the agricultural capital he borrows. Lastly, the smallness of the holding is a fruitful source of friction and litigation and precludes any possibility of the future generation sharing in the labour and investments of the present. In a village in Poona district, Mann instances how the size of the holding has decreased continuously in the last century as below:

Year	Average Size of Holding
1771	40 acres
1818	17½ acres
1820–1840 ..	14 acres
1915	7 acres

Such holdings have been fragmented into 729 separate plots: 463 of these are less than one acre and 112 less than one-fourth of an acre. This excessive subdivision, which has increased progressively under British rule, is recognised as a very serious evil. Keatinge has suggested that an economic holding of good dry land, like the bulk of the land of this village in the Western Deccan, and with an Indian ryot's standard of life, would be about 10 to 15 acres. In the village in question eighty-one per cent. of the holdings are below this size. It means that under the most favourable circumstances by far the larger number of holdings cannot maintain their owners, who consequently must rely on other occupations, either at home or away, to support themselves and their families, whether or not they sublet their holdings.

Sizes of Indian Agricultural Holdings.—The following figures would show the distribution of agricultural holdings in the Bombay Presidency : [1]

Size	Area	Owners
Up to 5 acres	2,029,461	872,485
From 5 to 15 acres ..	4,932,266	529,649
From 15 to 25 acres ..	4,337,143	221,449
From 25 to 100 acres	8,854,144	206,143
From 100 to 500 acres	2,777,005	18,173
Over 500 acres ..	556,593	551
Total ..	23,486,612	1,848,450

Investigations in Baroda have shown the following conditions as regards the size and ownership of the holdings : [2]

No. of districts	4
Total agricultural land, bighas ..	6,249,517
No. of survey numbers	1,292,671
No. of *Khatedars*	318,649
Average land per *Khatedar*, bighas	$27\frac{1}{2}$
Average area for survey number ..	$3\frac{7}{8}$

When the plots of land are very small, the cultivator seldom if at all uses the plough, and depends on his spade. S. Misra has tabulated some figures as a result of investigation into the economic cultivation units in the United Provinces, to which I have added

[1] *Report of the Land Revenue Administration of the Bombay Presidency*, 1921–22.

[2] *Report on the Reconstitution of Small Agricultural Holdings in various countries of Europe.*

District	Average Area in Acres per Cultivator. Intensive	Average Area in Acres per Cultivator. Ordinary	Average Area in Acres per Plough	Number of Cows per 100 Ploughs [1]	Density of Population per Square Mile (Rural Density in parentheses)
Meerut	2·8	10·2	10·4	113	652·3 (545)
Bulandshahr	7·8	18·83	16·77	89	560·1
Aligarh	1·0	16·3	10·39	69	545·6 (455)
Muttra	1·8	11·12	11·47	131	427·0 (350)
Mainpuri	2·0	7·69	6·5	78	446·8
Budaun	2·2	6·5	6·5	81	484·3 (433)
Farrukhabad	2·0	5·38	5·07	87	509·0 (451)
Cawnpore	2·4	5·5	6·0	137	485·1 (392)
Fatehpur	2·0	7·0	7·0	119	397·3
Jhansi	1·5	10·06	8·59	231	166·9 (132)
Jalaun	1·5	8·72	10·46	134	261·7
Gorakhpur	1·3	4·3	4·88	137	721·5 (690)
Basti	1·0	3·1	3·1	124	687·1
13 Agra Districts, average	1·71	8·82	8·24	—	—
Unao	1·8	4·4	4·4	95	458·4
Hardoi	1·2	5·3	6·3	84	465·0
Gonda	1·2	4·49	4 15	174	524·4
Bahraich	2·0	6·0	6·0	213	402·8
Partabgarh	1·8	6·0	6·0	94	592·6
5 Oudh Districts, average	1·6	5·26	5·37	—	—
18 U. P. Districts, average	1·68	7·83	7·44	—	—

[1] Moreland : *Notes on the Agricultural Conditions and Problems of the United Provinces.*

figures for plough cattle and density of population for comparison (see table, page 37).

Uneconomic Holdings in India.—Misra estimates that expenditure on cultivation of land increases by 5·3 per cent. for every 500 metres of distance for manual labour and ploughing, from 20 to 35 per cent. for transport of manure, and from 15 to 32 per cent. for transport of crops. The net yield of a field therefore diminishes with the increase of its distance from the village. The subdivision of plots has been carried to extremes in the eastern districts of the United Provinces. In *tahsils* Bansi and Dom Ariaganj (district Basti) the plots are found to be as small as 25 or 30 square feet. The average area is seven *biswas*. Since the last settlement (1889), the number of *khatas* has increased in Basti district from 800,000 to a million and a quarter. In the trans-Rapti tract there are about 500 agriculturists to the cultivated square mile; in the rest of the district the figure is close on 1,000. The continuous subdivision is in its most aggravated form a most unfortunate development since the last settlement. "Everything is divided—shares, holdings, plots, tenants' houses, groves, ponds and even trees. And where there is no formal partition there is always an informal one."[1] Similarly, the recorded figures in the *Settlement Report of the Gorakhpur District* (*tahsils* Padrauna Hata and Deoria) make the average holding less than one acre; in *pargana* Sidhua Jobna it is 1·3 acres, in *tahsil* Hata it is ·9 and in *pargana* Salempur Majhauli it falls to ·65 acre. The seriousness of this situation will be brought home when we realise that an analysis of the figures contained in the Census Report of 1911, on the assumptions that the average size of a family may be reckoned as five and that about one-fifth of the tenants' holdings are held by landowners or by persons whose main occupation is not

[1] Clow: *Settlement Report of the Basti District*, 1915–1919, p. 15.

agriculture, indicates that the average size of holding required to support a tenant with his family is about three acres.[1]

Burt estimates that for typical canal-irrigated land in the Cawnpore and adjoining districts, eight acres of mixed farming probably represents the area which can be managed with a single pair of good cattle to advantage. With wheat and cotton as the principal cash crops and with the usual percentage of irrigation—the more important subsidiary crops being *jowar* (*A. sorghum*) with *arhar* (*Cajanus indicus*), *gram*, maize and some barley—this area also enables a satisfactory supply of fodder to be grown and would allow of a fair provision of grain for the cattle.

Intensive regional enquiry will reveal that in many tracts of India there is hardly a holding that now will conform in size and shape to economic requirements. Keatinge estimates the average holding of rice-land in Konkan in the Bombay Presidency as only two or three acres, and a single field of an acre often is subdivided into eight or nine separately owned plots. In the

[1] A caveat must be entered. In analysing the figures from the Settlement Reports one must be careful to avoid confusion between holdings and fields (plots). Thus, a holding may consist of any number of fields or plots. It also must be remembered that subdivision of property at partition does not necessarily mean fragmentation of tenants' holdings. A field held by a single tenant may be divided among three landlords and still remain in the possession of one tenant. So far as he is concerned, the only result of the partition is that he pays his rent to three persons, instead of one. One also should take care to ascertain the manner of calculating the number of holdings adopted in the Settlement Reports. Sometimes the average holding is estimated by dividing the total holding area by the number of *khata* entries in the register of tenants (*khatauni*). In this case the average acre would be the average per *khata*, not *khata* in each village; it will depend on the number of landlords per tenant. A tenant may and often does have more than one from whom he holds his land. Moreover he may and often does hold land in different villages. In such cases correct figures can be obtained only by calculating the number of individual tenants contained in the *khataunis* relating to at least a dozen adjoining villages.

Cauvery Valley, in Madras, the average holding is estimated as not exceeding three or four cultivated acres, while in the more thickly populated areas of Bihar, under the *zamindari* system, the tenant's holding averages less than half an acre. In the Punjab the average holding is between eight and ten acres. Individual enquiries in the villages show a worse state of things. In two villages in Hoshiarpur district, holdings average five and a half and nine and a half acres respectively. In eight villages in Jullunder in the Punjab the average field does not exceed one-fourth of an acre. In another village the average is one-seventh of an acre. In a village in Tinnevelly, in the Madras Presidency, 110 agriculturists cultivate an area of sixty-one acres. In another village, out of 1913 plots, 600 plots are under half an acre in size. In a village in Oudh the average size of a holding is estimated by Mr. Saksena as 2·13 acres. The holdings of 40 per cent. of the cultivators are below an acre, the smallest field being ·015 acre only. 68 per cent. of the cultivators hold plots of land scattered in tiny strips. In densely populated China holdings are very small and agriculture is much more intensive than in India; but even there the plots seem to be larger than ours, a family of ten or twelve (including grandparents because of the Chinese family organisation) working two or three acres. Even in the newly settled Punjab, the more fertile the land, the greater is the fragmentation, since fertility and population have gone together. Thus subdivision is the greatest in Central Punjab. In Bihar it has been found in one village that the minimum holding under cultivation is one-sixth of an acre and the maximum about seven acres. The average size of the holding is about one and two-thirds acres. In a village in Puri district in Orissa, where agricultural conditions are less favourable than in Bihar, the size of the economic holding is eight acres. The great majority of the

peasants, more than 90 per cent., I found in possession of smaller-sized holdings separated by a distance of one to three miles, while the poorer cultivators hold plots of one-third or two-thirds of an acre. The strips are sometimes as small as the area of a small room. A large number of peasants in the village have to work as day labourers (*danda muliya*) or husk paddy. In some provinces it is quite usual to find an owner of no more than two acres with three or more separate fields scattered about an area of two or three square miles; it requires little imagination to picture the waste of effort, and the difficulties as to trespassing and rights of way, of which this kind of distribution necessarily must be prolific. The pepper-pot distribution of holdings in scattered fragments thus is responsible not only for agricultural inefficiency, but also for increase of litigation due to trespassing, encroachments, etc., because the fields are at a distance from the homesteads. It is only the new, enterprising farmer who realises the advantage of a farmstead away from a crowded site with its fields close to the farm-house; and thus in prosperous tracts one may notice a tendency for small hamlets to spring up wherever there is a sufficient stretch of good soil with facilities of water-supply to provide a suitably sized farm. In most regions, however, the peasant's home is in the congested village. The women also cannot come and work as they would have done in a home-farm.

Overcrowding in Indian Villages.—There is a further disadvantage arising from the aggregation of homesteads. It results in terribly congested villages in many parts of India. As families multiply in the fertile plains house-sites are split up and the huts often become less and less spacious. The following comparison would be interesting. The site covered by the family residence measures on an average only 237 square yards in Saran and 272 square yards in

Darbhanga, in Bihar. The average homestead in Bakarganj in Eastern Bengal, on the other hand, measures 976 square yards. House-sites in Bakarganj contain only twenty-four persons to the acre as compared with ninety-eight in Saran and one hundred and three in Darbhanga. In Western Bengal, Bihar, the United Provinces and the Central Punjab serious overcrowding is met with in the villages, and every inch of available space within the house-site is utilised to the detriment of health and comfort. House-sites in Eastern Bengal represent a much higher standard of comfort; for the difference in the density of population is not so great as to account for the whole of the differences in area occupied by houses, as shown in the following figures:

	Percentage of Homestead Area	
Bakarganj	6	
Dacca	6	
Midnapur	2	
Saran	2	excluding
Bhagalpur	2	tanks
Birbhum	1	
Orissa	1	
Ranchi	1	

Bengal Homesteads.—In Bengal the houses in which peasants live are usually grouped round a spacious courtyard, cowsheds and outhouses standing sometimes in the same quadrangle but more often a little back from it. The area given up to gardens and tanks is much larger in Bengal than elsewhere. The women of the household take water from the tank within the homestead, to which they can easily go without being seen from outside. In Noakhali, for instance, the total area covered by tanks is no less than one hundred

square miles, but this is altogether abnormal even for Bengal.

Japanese Farms.—In Japan, the average farm consists of about three acres. The majority of peasant proprietors and tenant farmers in Japan cultivate less than two cho (= five acres) and only 4 per cent. cultivate more than three cho (= seven and a half acres) as shown in the following table :

Farmers Cultivating	Percentage of the Total No. of Cultivators
Less than 5 tan ($1\frac{1}{4}$ acres)	36 per cent.
Over 5 tan and less than 1 cho ($2\frac{1}{2}$ acres)	33 per cent.
Over 1 cho and less than 2 cho (5 acres)	21 per cent.
Over 2 cho and less than 3 cho ($7\frac{1}{2}$ acres)	6 per cent.
Over 3 cho	4 per cent.

Chinese Holdings.—In China local conditions show considerable variation and no general statements can be made, but fairly reliable information is available from certain districts. With a view to ascertaining certain agricultural conditions, the China International Famine Relief Commission in 1922 undertook an investigation of 248 villages, comprising 6,482 families, mostly in the Province of Chihli and the remainder in the Provinces of Shantung, Kiangsu and Chekiang. This investigation disclosed that the average size of land holding is 19·5 mow or 3·25 acres and 23 mow or 3·83 acres in Chihli ; 11·11 per cent. of the families in Chihli hold no land whatever. The average size of families is 5·2 persons. More than half of the popula-

tion in Kiangsu villages and more than 80 per cent. in the Chihli villages are below the "poverty line," the investigators having here fixed a standard of poverty to suit local conditions.[1] According to another authority in the central and populous parts of China, these holdings are exceedingly small, often less than an English acre, seldom larger than three or four acres. Most lands yield one or more subsidiary crops in the course of the year, besides the principal crop. On the frontier provinces, where the soil is poorer and the population more sparse, the size of the holdings is in general much larger than in the Central Provinces, and the people would seem as a rule to be better off. But as population increases there seems everywhere to be a strong tendency for holdings to become reduced to the minimum size that will support a single family. The more fertile the soil the smaller the farms and the more minute the subdivisions. How marvellously fertile the soil is under favourable circumstances will be seen from the fact that one mow will support one individual. On this basis a square mile is capable of supporting a population of 3,840 persons.[2]

Western Holdings.—In Germany about 49 per cent. of cultivated soil is laid out in holdings of less than 50 acres, as compared with 16 per cent. in England and Wales. About 60 per cent. of the land in England is subdivided into holdings of from 50 to 300 acres. Germany, on the other hand, has less than 30 per cent. of the land in holdings of from 50 to 250 acres. In England and Wales 25 per cent. of the land forms holdings of over 300 acres: in Germany 22 per cent. is divided into holdings of more than 250 acres.

[1] J. B. Taylor: "The Study of Chinese Rural Economy," *Chinese Social and Political Science Review*, January, 1924.

[2] "Tenure of Land in China and the Condition of the Rural population," *Journal of the Chinese Branch of the Royal Asiatic Society*, XIII.

Sizes of Agricultural Holdings in Western Countries.

England and Wales 1914		Germany 1907	
Size	Per Cent.	Size	Per Cent.
1–5 acres ..	1·1	Under $1\frac{1}{4}$ acres	1·1
5–20 acres ..	5·0	$1\frac{1}{4}$–5 acres ..	4·3
20–50 acres ..	9·7	$12\frac{1}{2}$–50 acres ..	10·4
Total under 20 acres ..	6·1	Total under 20 acres ..	5·8
Total under 50 acres ..	15·8	Total under 50 acres ..	15·8

In the United States the average farm contains 148 acres.

The official definition of a small-holder in Denmark gives about 25 acres as the limit of size; in England it is 50 acres. Professor Macgregor gives the following figures for the sizes of holdings in European countries: [1]

Country	Holdings of 1–50 Acres as per cent. of		Average Holding	Males employed per 100 Acres
	(*a*) All Holdings	(*b*) Cultivated Area		
England and Wales (1914) ..	67	16	62·0	4·6
Denmark (1919) ..	87	55	40·0	5·5
France (1892) ..	93	—	20·25	7·0
Germany (1907) ..	92	45	21·5	6·2
Belgium (1905) ..	95	66	14·5	10·0
Holland (1910) ..	87	—	26·0	9·0

[1] *Agric. Tribunal of Investigation, Final Report*, p. 125; also Venn: *Foundations of Agric. Economics*, chaps. III, IV.

Punjab Small-Holdings.—A comparison may be made with the following figures given by Calvert showing the smallness of the holdings in the Punjab:

Size of Holding	Per cent. of Cultivated Area	Per cent. of Owners
Less than 1 acre	1	17·9
From 1 to less than 5 acres..	11	40·4
,, 5 ,, 15 ,, ..	26·6	26·2
,, 15 ,, 50 ,, ..	35·6	11·8
50 acres and over	25·7	3·7

Size of the Economic Holding in India.—In India, China and Japan two to three acres would be regarded as an average economic holding. As we have already pointed out, the nature of the crop, climate and soil, as well as marketing facilities, have all to be taken into account in the definition of an economic small-holding. The absence of such credit facilities as have been available for small-holders in Europe, and the exceedingly limited development of co-operative methods of purchasing supplies and marketing produce, must be taken into account in India in determining the size of the economic holding. Again the intensity of cultivation is a most important factor. In India the amount of family labour expended on the land is very great, and the smaller the holding the greater the amount of family labour per acre. But, if the holding decreases below an average size as a result of subdivision, a large part of the family labour remains idle or is wasted.

Success of Small Farming in Germany.—If information were available as to the capital utilised in small-holdings it might be found that labour here is being wastefully employed. In different economic regions and within limited areas agricultural economists would

do well to collect information regarding the optimum system of farm management which utilises land, labour and capital so as to secure the maximum output from each. In India and China, and in a lesser degree in parts of France and in Belgium, intensive cultivation is achieved by prodigal use of labour only—an impossibility in a country like England or Germany with so large a choice of openings in industrial employment. In Germany the medium-sized holding has survived and struggled successfully with the smaller estates as a result of the supersession of hired by family labour. About a century ago the German peasantry not only was freed of its feudal bondage by the memorable edict of Stein in 1816, but also enabled to occupy 1,650,000 hectares of land. Between 1816 and 1865 another 1,760,000 hectares were given up by the peasant farmers because their small farms could not compete with the large landed estates. The opinion of Marx and Engels, that in the sphere of agriculture, as in industry, large-scale production would tend to suppress small enterprises, was fully justified on the basis of conditions as they existed in Eastern Germany in the 'sixties. An area which, under the management of the peasant, could support only 2,000 persons, was found with the application of scientific methods to support more than double that number. But, from about 1865 onward, the large estates suffered from lack of labour, while the small peasant farms had benefited by the application of improved technique of management and began to hold their own. Present conditions indicate that the small farm of from 5 to 20 hectares has the best prospects of success, owing to the abolition of hired labour. Its work is done by the family of the owner, assisted if necessary by near relatives. The object of the law of August 11, 1919, is to replace the *Groszguter*, which, in effect, expelled the population, by smaller estates, adapted to management by family labour. Indirectly, but surely, this

law makes for the abolition of hired labour. The important question is whether this partition of the *Groszguter* into *Kleinguter* will not seriously diminish production. It has not been satisfactorily explained how the small farms of from 2 to 3 hectares have managed to survive. However, it is certain that the estates of from 5 to 20 hectares are at least equal to the *Groszbetriebe* in production. They not only have held their own in all parts of the world but also have increased in number. Eduard David, in his work entitled *Sozialismus und Landwirtschaft*, has explained how this was possible. The decisive factor, in his view, lies in the fact that the productive process in industry is a mechanical one, while that in agriculture is an organic one. Because agriculture concerns itself with the production of living organisms, plants and animals, its labour is controlled by the seasons and laws of reproduction. Agricultural pursuits demand a continual change in time and place of work, which prevents such division of labour as is practicable in industry. This chief cause of the superiority of large-scale production over small in industry is thus eliminated in agriculture. The advantages of improved technical methods, machinery, etc., are just as applicable to the smaller as to the largest estates. To a certain extent the application of scientific methods in agriculture is more successful in *Kleinbetriebe* than in *Groszbetriebe* because in the former the labourers, consisting of the owner and his family, perform their tasks more conscientiously than the hired labourers of the large estates. In animal husbandry, the products of the *Kleinbetriebe* are vastly superior. Co-operative buying and selling among the small farmers has eliminated another advantage of the *Groszbetriebe*.[1]

In India the most economical unit of land for agriculture has yet to be investigated and made out for different regions. There is no doubt that the decrease

[1] Ludwig Quessel in *Die Neue Zeit*, January, 1920.

of the size of the average holding within the last few decades has led to the decrease of the output per man and sometimes of the total output per unit of land. We have no evidence to show the direct effect of further subdivision of the land on agricultural efficiency, nor is it possible to estimate for different crops the distribution of holdings by size. In some of the Western countries the development of agricultural costings shows that great progress has been made in establishing an organisation to help farmers to keep proper accounts. The statistical value of the results obtained is clearly indicated in that they enable administrators to arrive at general conclusions as regards the size of an economic holding and to what extent small, medium and large holdings are affected by varying economic conditions. In India no farm accounts are kept; but the cultivator, although illiterate to a degree, knows the size of an economic holding when particular crops are raised. The Bengal peasant estimates the size of his economic holding in proportion to the number of ploughs he possesses. If he has one plough, he cannot keep up more than ten bighas ($3\frac{1}{3}$ acres) of land. Where paddy is the only crop grown a pair of good animals is considered sufficient for 20 to 25 bighas of land. Ploughs are not reckoned according to the number of those implements of husbandry that a man might possess, but according to the number of plough-cattle that he has, four oxen being the full complement necessary for the management of one plough; that number now has come down, however, to three and even to two in a great many instances, the consequence being that the cattle are overworked. Ten bighas ($3\frac{1}{3}$ acres) of land are the utmost that the Bengal peasant can manage with one plough, and this also is the size of an economical holding in Bengal Presidency, though the average size is much smaller. The Settlement Officer in Rajshahi also has arrived at 10 bighas of land as the size of

the subsistence-holding. Assume that each cultivator has three persons dependent on him. The gross income of the man cultivating 10 bighas is about Rs. 213. There are four persons in a Rajshahi family. We may assume that Rs. 45 per head is the sum required for their maintenance in comfort. Major Jack's figure, excluding rent and purchase of cattle and boat, is a little less, but prices have risen greatly, and this sum represents a lower standard of comfort than Major Jack's figures. Rs. 180, then, is required to maintain the cultivator and his family. We have to add for seed Rs. 5, depreciation on upkeep of cattle and agricultural implements Rs. 13. There is therefore no surplus. A man cultivating 15 bighas has a gross income of Rs. 320. The expenditure necessary to keep himself and his family in comfort is also Rs. 180. Seed costs Rs. 8; maintenance of cattle and agricultural implements say Rs. 20, and his rent is about Rs. 20; so that his total necessary expenditure is Rs. 228, and he has a clear surplus of Rs. 92 to spend on luxuries. It follows from these figures that a cultivator who has only 10 bighas of land cannot afford to pay a higher rent than about Rs. 1–5–0 a bigha without lowering his standard of comfort, and that ten bighas is about the minimum holding at that rent with which a fair standard of comfort can be maintained. Average legal rent in Rajshahi is Rs. 1–1–0 a bigha, but four annas has to be added for *abwabs*. In Rajshahi for each agricultural worker including labourers there are about $8\frac{1}{2}$ acres of ploughed land. A man could cultivate unaided, excepting by his family, at least 5 acres. In Bakarganj Major Jack estimated the size of a subsistence-holding as 3 acres. The average holding in the district contains ·6 acres more under rice than is sufficient for the family subsistence, besides an additional half-acre of garden or miscellaneous crops, while in another half-acre a second crop is taken. The agricultural

family holds on the average in the different subdivisions :

Subdivision	Total Acres	Under Cultivation	Under Winter Rice	Amount Twice Cropped
Sadar	4·43	3·54	3	·96
Patuakhali ..	6·37	5	4·9	·44
Pirozpur ..	4·2	3·3	2·9	·26
Dakshin Sahabazpur	5·8	5	4·3	1·1

In Central and Western Bengal in the *bils* and marshy tracts *boro* is grown, and in the forest-reclaimed *aman* lands, *dhan* (rice) is planted without the assistance of the plough. Thus the proportion of food-producing land to each plough shows here an excess over 10 bighas, and hence the average holding increases in size beyond $3\frac{1}{3}$ acres. On the other hand, the economic holding of a peasant might be smaller than 10 bighas if other crops are grown besides rice. An economical distribution of crops and plots in a Jessore village has been as follows : The total size of the holdings is 7 bighas which is distributed in this manner : *aman* rice, $2\frac{1}{2}$ bighas, *aus* rice, 1 bigha, gourd, *kalai* and mustard, 2 bighas, *mugh*, $\frac{1}{2}$ bigha, and sugarcane, 1 bigha. The size of each cultivator's plot at one spot must vary according to the character of the crop raised. In the case of *aus* rice, the plots are usually of 10 or 15 cottas to 1 and $1\frac{1}{2}$ bighas in dimensions ; a plot of 2 bighas in area is rather unusual. The low *aman* fields are $2\frac{1}{2}$ to 4 bighas in area. In a village in Murshidabad district I found the average size of the holdings to be 10 cottas, *i.e.*, ·20 acre ; but these are widely scattered, sometimes separated by a distance of 2 to 3 miles. The size of the smallest plot is 2 cottas,

i.e., ·04 acre. The peasants attribute fragmentation to subdivision by inheritance and to the necessity of ridging small areas for best utilising the rainfall in rice cultivation. Each family must cultivate 12 to 15 bighas (4 to 5 acres) to maintain itself.

Besides the well-recognised difficulties of fragmentation, the small-holding implies greater exhaustion of the soil. In Dacca such is the pressure of population that only 1 acre in 25 acres of land capable of bearing crops is left fallow every year, compared with 1 acre in 10 in Bakarganj, and 1 acre in 3 in Purnea. The actual current fallow in Dacca is only 14 square miles. This implies that a period of 156 years is required before every acre has been relieved in turn for one year only of its burden of bearing its one or two annual crops. Sizes of holdings and tenancies are given below:

District	Average Size of Holding	Number of Tenancies per Agricultural Worker
Dacca ..	2·88	1·13
Bakarganj	2·51	1·89

The diminutive size of the Dacca holding is due to the extraordinary interlacing of estates and tenures within each *mauza*, which splits up what might normally be a single holding into a series of tenancies. The degree of interlacing is emphasised further by the small size of the fields, which average only ·55 of an acre, varying from ·36 of an acre in Thana Harirampur to ·91 of an acre in Thana Kapasia. In Faridpur the average size of a holding is 1·39 acres. One important reason of fragmentation is the increase of subdivision by inheritance among a preponderant Muhammadan population.

Balance-Sheet of the Bengal Economic Holding.—Let us now estimate the agricultural expenses and the average yield of an economic holding in Bengal of the size already given as ten bighas. We have followed strictly the verbal statements of the peasants in putting down the following items :

Expenses of Cultivation	Rs.	As.
Rent of 10 bighas of land at Rs. 1/6 per bigha	13	–12
Ploughing and sowing by hired labour ..	2	– 0
Seed grain	12	– 8
Weeding expenses	12	– 0
Harvesting expenses	12	– 8
Total ..	52	–12

We do not include the cost of maintaining the oxen, which usually feed on straw, *kuro* and *mar* supplied by the household. A peasant who has no oxen but hires them has to pay 4 as. per diem.

The peasants estimate the average produce of a bigha in normal years as 10 maunds. So the total yield will be 100 maunds. Out of these 30 maunds will be required for domestic consumption and 24 maunds will be kept as reserve stock. The saleable surplus is 40 maunds, which would fetch, at the rate of Rs. 1–4–0 per maund as harvest price, Rs. 50. Thus the expenses of cultivation are nearly or just covered.

Let us now estimate the agricultural capital invested :

1. A pair of oxen	Rs.	60–0–0
2. The wooden plough	,,	1–4–0
3. The *ish* or beam	,,	0–8–0
4. Iron *phal* or ploughshare	,,	1–0–0
5. The handle (*ninjra*)	,,	0–2–0
6. The *yoal* or yoke	,,	1–0–0
7. Ropes	,,	0–3–0
8. *Bidha* or harrow	,,	6–0–0
Forward	,,	70–1–0

	Forward	Rs.	70 –1–0
9. Ladder		,,	0 –8–0
10. Scythe		,,	0–12–0
11. Weeding knife		,,	0 –1–6
12. Baskets		,,	0 –4–0
13. Earthen pans for feeding cattle ..		,,	0 –6–0
Total ..		Rs.	72 –0–6

That is to say, the sum laid out by a peasant in fitting out a plough for cultivation is nearly one and a half times the expenses of cultivation in a year.

Economics of Cotton Growing in Berar.—In a cotton-growing village in Berar we have estimated the costs and profits of agriculture as follows on an average holding of 20 acres, which can be worked by a pair of bullocks. There is a co-operative credit society in the village and the accounts have been examined before its officers :

Yield of Cotton per Tippan	Expenditure per Tippan = 4 acres		
Average produce $1\frac{1}{2}$ khandi = Rs. 125	1. Cutting shrubs ..	Rs.	3–0–0
	2. Harrowing 2 times ..	,,	15–0–0
	3. Picking cotton stalks	,,	3–0–0
	4. Sowing : Seed .. Rs. 5–0–0; Labour, including bullocks .. Rs. 15–0–0	,,	20–0–0
	5. Five harrowings ..	,,	25–0–0
	2 Weedings of grass ..	,,	25–0–0
	Watch and ward ..	,,	5–0–0
	Picking of cotton ..	,,	15–0–0
		Rs.	111–0–0
	Govt. Assessment ..	,,	10–0–0
		Rs.	121–0–0

The net profit is Rs. 20/– for 20 acres. The Kunbi

peasant does extra work in the village as agricultural labourer, or if he belongs to the middle class he does shopping or carting. The interest is not paid regularly, and the mortgage debt is increasing. Wheat, grain, *jowar* produced in the peasant's fields are consumed by the family, while linseed is negligible. Sixteen out of 39 members of the co-operative society are engaged in supplementary occupations, especially carting or work as extra hands, if there is more than one family in the household, on other people's holdings and earn some extra income. Besides domestic consumption of wheat, *jowar* and grain the family would require Rs. 10/- per mensem. Dr. Grierson and Mr. Stevenson Moore estimated that it costs an ordinary cultivator in Bihar Rs. 15/- a year to maintain each person in his family. This estimate was based on the Survey and Settlement Operations of 1893–98. A family in India consists of five persons and would require Rs. 75/- a year to support itself. It is estimated, in the Saran Settlement Report, Bihar, that, since the average profit of cultivation is Rs. 25–10–0 per acre, a family with a holding of three acres would have just a small margin of saving left at the end of the year. As a matter of fact, the family of five persons with so small a holding as this would do practically the whole of the cultivation work themselves and would spend nothing on cultivation excepting the cost of seed. The profits of such a family would amount in an ordinary year to Rs. 30/- an acre and the sum required for their maintenance could be raised from a holding of $2\frac{1}{2}$ acres. This has been taken as the size of the subsistence-holding in Saran. But this estimate does not take into account the inclemencies of the seasons, or the question of indebtedness. Very often the capital is borrowed at high rates of interest. The size of the holding is often much less than ten bighas. Thus, the smaller yield, the high rate of interest, the difficulty in marketing the produce, improvidence and

bad seasons leave the peasant almost nothing to fall back upon.

Remedial Measures.—The solution of the agricultural problem can be provided chiefly by the combination of scientific peasant-farming and the spread of agricultural co-operation. The form of land tenure and the law of inheritance require also to be modified. Above all, there is need of a comprehensive policy of education; for, without a wide diffusion of education among the villagers, neither the modification of rights in land nor the introduction of the economically profitable cultivation unit, neither the facilities given by co-operative credit nor the aids given by improved agricultural implements and methods, can bring about a lasting improvement of the social and agricultural conditions of the country.

CHAPTER IV

ORGANISATION OF AGRICULTURE

Land Settlement and the Status of the Peasant.—The social status of the peasantry depends on the characteristic types of land settlement, which again are connected with social and political history. Throughout Europe, the peasant in medieval times was what we now call a serf, and serfdom consisted essentially in bondage to the soil. This bondage to the soil was fostered by the lords of the land because it was the only way in which they could get their demesnes cultivated. Such a land system goes back in economic history to the effects of the forest environment in Central and Western Europe. In the scattered settlements in the forests, the holders of small property naturally had to depend on the leadership and protection of the lord, who, on the other hand, was only too ready to accept the services of his vassals. They worked his land for him and joined him in common offence and defence; while, agriculturally speaking, such a system prevented constant migrations to new forest clearings and superseded nomadic cultivation by more stable forms of farming. In the fertile river valleys of South-East Asia people swarmed in permanent habitations in relatively small areas and the village settlement partook of the autonomous rather than the feudal type. In the level plains of China and India, the prevailing system was the village community, which protected peasant proprietorship; no [illegible] or noble could usurp the rights of peasants and [illegible]leges of village communities, or incorporate [illegible]gs or village commons with their own [illegible]ter fifteenth and in the sixteenth

centuries, the enclosure of open fields in England and the ravages of epidemics, *e.g.*, the Black Death, caused or hastened the eviction of the peasants, and the development of animal-raising and introduction of commercial crops had a similar effect of consolidating farms into large and adequately capitalised undertakings in most parts of Europe. Throughout Europe large estates permitted tenants and agricultural labourers to be exploited and the agrarian question became a burning question. Thus, as a consequence of the recent European war, almost every country in Europe that possessed large estates has condemned them to be divided and reconstituted into small holdings for individual owners. The problem is to efface the social distinction between the peasant and the labourer, which would satisfy ambition and check social unrest and rural depopulation. In India and China the problem is less to create ownership of the peasant proprietors and more to maintain them without undue subdivision.

Relation of Cultivators to Cultivated Areas in India and Europe.—The recent census gives the following figures showing the relation between the number of cultivators (workers) and the acreage cultivated:

Provinces	No. of Acres Cultivated per 100 Ordinary Cultivators
Assam	296
Bengal	312
Bihar and Orissa	309
Bombay	1,215
Central Provinces and Berar	848
Madras	491
N. W. F. Provinces	1,12[illegible]
Punjab	
United Provinces	

The number of farm servants and field labourers per 100 cultivators is given below, but the accuracy of the figures is doubtful :

Provinces	No. of Farm Servants and Field Labourers per 100 Cultivators	
	1911	1921
Assam	3	3
Bengal	18	19
Bihar and Orissa	47	28
Bombay	67	41
Burma	27	29
C. P. and Berar	86	82
Madras	55	53
Punjab	15	12
United Provinces	22	16

In Germany there are 5·5 acres per person wholly or partly engaged in agriculture ; in Great Britain 20 acres. When those who are permanently employed are compared the figures are 8 and 25 acres respectively. In Bengal, the cultivated area, including current fallow is 28,992,736 acres and the number of males engaged in cultivation of all kinds (including herdsmen) was 9,129,793 in 1911. This is the number of actual workers exclusive of their dependents and gives one worker to every 3·176 acres. In 1921 we find 2·215 acres per worker in agriculture, including cultivator, farm servant, field labourer and grower of special products. In the district of Patna, which is not particularly densely populated, there are 1·88 acres per cultivator and his family. There remain, however, 277,006 field labourers to be supported with an additional 102,309 persons dependent on them. In Madras,

in the districts of Tanjore and Trichinopoly, a *mirasdar's* family must have at least 5 acres to maintain itself without any other resources.[1] In different parts of the Punjab the peasant proprietor commonly cultivates 8 or 10 acres. In Kangra, Hoshiarpur, Jullunder and Rawalpindi the average holding is less than 5 acres. It has been estimated that to live with his family in some measure of comfort a Punjabi requires from 10 to 12 acres of irrigated land. It is in the colonies that the holdings are much larger in area. Thus Darling, after examining the condition of the Punjab peasant in different districts, comes to the conclusion that agriculture on 8 or 10 acres is wholly insufficient, under present conditions, to maintain him in decency, independence and comfort. If there is no other source of income, such as military service or labour abroad, the peasant invariably falls into the clutches of the money-lender. In the richest parts of England 10 acres is considered the smallest area on which a man can support a family without any other industry to help him. Where there is no livestock industry or market-gardening, 20 acres are required. In Europe about 25 acres would represent the economic unit for a peasant who is not a market-gardener.

A comparative study of the size and distribution of holdings in different parts of India shows rainfall to be the dominant factor in determining the distribution of holdings amongst groups of owners. Where rainfall is abundant and certain, the size of the average holding is much smaller than in areas where rainfall is inadequate and precarious. Similarly, along the fertile silt-covered valleys of the rivers, the proportion of small-holdings is much greater than in the less fertile tracts. This explains the contrast between the tiny plots along the banks of the Indus, Jhelum, Cauvery, Godavari, Ganges, Jamuna, Meghna and the

[1] For Bengal, see Thompson: *Census Report of Bengal*, 1921. For Madras, see *South Indian Villages*, p. 227.

Brahmaputra and the larger holdings in the Central Provinces, Central India and the Punjab. On the other hand, where agriculture depends upon well-water and where there is scarcity of rain, small-holdings preponderate because well-cultivation based on bullock power is usually on a small scale. This accounts for the smallness of holdings in the South-Western Punjab and in Bihar. The vicissitudes of political struggles and invasions have led also to grants of lands to nobles, squires and soldiers, and the creation of large estates. Thus the economic effects of migrations and invasions on the distribution of land in villages have to be traced by the careful social historian. Where canal irrigation has been introduced, the scheme of distribution of holdings of course has been upset by artificial causes. Thus the distribution of holdings has undergone significant changes in the canal colonies of the Punjab and the irrigated tracts of the Madras Presidency.

Cultivation and Size of Holdings.—The evils of subdivision due to the parcelling out of shares of holdings among the different members of the family on the father's death are being experienced already in all provinces of India, though they appear in an aggravated form in the densely peopled Gangetic plain. In Gorakhpur district, for instance, the density is 721 persons per square mile, the average holding being less than one acre and in some *tahsils* not more than half an acre. The fragments of land become so small that the cultivator has to dismiss the cattle and use the spade. If this process continued, women in India, as in China, might be compelled to draw the plough. In most districts of the United Provinces and Bihar the average size of holding required to support a cultivator with his family is about 3 acres. In the Central Provinces and Berar, on account of soil and rainfall conditions, the economic holding would be much larger in area than in any other part of India.

In Balaghat, for instance, where agriculture is less intensive and the population sparser, the size of the economic holding which can support a family has been estimated as 15 acres, but in the unproductive *tahsils* it is in the neighbourhood of 20 acres. Thus in the West Wainganga tract, where the average area falls far short of 9 acres, the cultivator has to resort to some subsidiary occupation along with agriculture, such as working in the mines, carting manganese ore or forest produce to supplement his income. Now the density of population measures also the degree of fragmentation. In Balaghat the density of population is only 124 per square mile as compared with 216 in Bhandara district, and 412 and 456 in *tahsils* Bhandara and Gondia. In Amraoti and Akola the density is 176 and 194 respectively. Ellichpur *taluk* of the Ellichpur district showed the highest density in the province, 312 per square mile in 1898. Pressure of space indeed has become acute both in the Maratha plain and portions of the Narbudda plains. Thus, even though the size of the holding may not be reduced in nearly the same measure as in the United Provinces or Bihar, the agricultural drawbacks of the Central Provinces as regards absence of crop rotation and precarious rainfall, will show the evil effects of undue fragmentation much earlier. In Raipore district the average area of the holding of an occupancy tenant is 16 acres, while that of an ordinary tenant may be taken as 10 acres. Formerly there were not a few eight-ox ploughs, but now the plough of land as a unit has decreased in size. At present the average of cattle per plough is barely three, and there are more two-ox ploughs than before. Thus the increase of population and the subdivision of holdings have had their natural result. To substitute the transplanting of rice for broadcast sowing is inevitable if holdings so small are to pay their way. Indeed, improved methods of cultivation and irrigation are absolutely essential to

prevent the effect of fragmentation showing itself in the lowered standard of living of the peasantry. In many tracts the inefficiency of agriculture is due more to the small size and scattered nature of the holdings than to ignorance or want of alertness on the part of the peasants. Such holdings do not afford sufficient work for the cultivator, and leave him almost unemployed during most of the year. Agricultural indebtedness is at once the cause and effect of the excessive division of the holding, and very often enforced idleness and indebtedness go together. Sometimes the division of holdings is due not to the law of succession but to natural causes. In Chutteesgarh, in the Central Provinces, the practice of minute fragmentation of holdings, so that fields are found not exceeding a few poles or about the dimensions of a public dining-table, has arisen because it is impossible to obtain tenants, unless each receives a share in the good or best-lying land. Land near the village is coveted, because when ridged it best utilises the annual rainfall. These stretches then come to be very minutely divided. The soil conditions also make small fields in Chutteesgarh not merely convenient but even necessary. Thus, red soil does not retain moisture, though at the same time surface-water does not percolate freely through it. In soil like this, for rice, it is therefore important to obtain as much surface-water as possible, and this is effected by ridging in small areas. The same trouble is not taken with soil which retains moisture and in which, if surface-water remains long, the crop is likely to rot. In fact, it is always found that where the fields are large, the soil is black, and that where the converse is the case, it is on account of the peculiar attributes of the red soil.[1] It appears that the distribution of infinitesimal areas of holdings scattered over the surface of several square miles is due to the time-honoured practice of redistribution

[1] Chisholm : *Land Revenue Settlement of the Bilaspur District.*

called *lakhabata*. To this subdivision of tenure in Chutteesgarh has been attributed the extent to which broadcasting of rice is practised up to the present day, and the slight hold transplantation has taken on the district; thereby maintaining here a much larger amount of agricultural idleness than is usual in other parts of India.

Peril of the Indian Peasant.—The cultivator working on tiny plots has to borrow, while the creditor pounces on any portion of land he can secure. Even the very rights which the cultivator has in his land and which it has been the object of agrarian legislation like the Bengal Tenancy Act or the Punjab Land Alienation Act to preserve to him, stand in the way of an adjustment between labour supply and demand. For the cultivator does not renounce those rights and go in search of employment in the industrial centres excepting in the last extremity. While he can, he works his own land as field-labourer, or mends roads, digs earth and does odd jobs in his neighbourhood. Not merely the money-lenders but also the new class of under proprietors intercept a large portion of the profits of agriculture. The British land administration has led to new classes of people taking up the status of peasant proprietors. In the Punjab alone the number of persons living on income from rent of agricultural lands has increased from 626,000 in 1911 to 1,008,000 in 1921. These now share what formerly had belonged exclusively to the cultivator, and few are the crumbs they leave for him. Very often such classes do not cultivate the land themselves, or are lacking in thrift. A further leakage of the normal profits of agriculture is due to the absence of co-operative marketing: the grain broker or dealer who advances loans often sells the crops at prices more than one and a half times the rate he offers to the cultivator. The tendency of the non-agriculturist to take possession of the agriculturist's land is increasing in every province,

and is a symptom which gives cause for serious anxiety. Thus the whole question of poverty and agricultural indebtedness is bound up with other intricate problems such as the reform of the land and revenue systems, the consolidation of economic holdings, the increase of thrift and facilities for saving, the introduction of scientific methods and organisation of labour in agriculture and finally the law of diminishing returns.

Agricultural Tools in India.—Agriculture is carried on with the most primitive tools. The peasant maintains himself by crude and comparatively unprofitable agriculture at a low level of existence. He uses bad and infertile seeds and works at great disadvantage owing to the inefficiency of his appliances. Darling observes: "The plough that looks like 'a half-open penknife,' and just scratches the soil; the hand-sickle made more for a child than a man; the old-fashioned winnowing-tray that woos the wind to sift the grain from the chaff; and the rude chopper with its waste fodder, are undisplaced from their primitive but immemorial functions." Dr. Clouston also remarks: "The Indian peasant's tillage implements are so light and small that they do not kill out weeds effectively; nor can they be used for ploughing-under weeds and other forms of leaf manure when that is necessary. Having no breast, the country plough stirs the soil without inverting it, and having no cutting parts it does not eradicate weeds." The argument advanced against the introduction of iron ploughs and other improved implements is that generally they are heavier to pull than those in common use, and are not, therefore, suitable for the draught cattle of this country. The improved implements, however, are appreciably lighter in draught than those which they are replacing. The M. S. N. plough, so familiar in rice tracts in the Deccan, weighs only 24 lbs., and can be drawn by a pair of very small bullocks. Ploughs of

the Rajah and Punjab types which have found favour in the Gangetic valley are not too heavy for one pair of ordinary bullocks. In black-cotton-soil tracts improved iron ploughs have become very popular; thousands now are being sold there every year, and some cultivators of late years have taken to the system of ploughing land on hire with Turnwrest ploughs after completing work on their own farms.[1] The difficulty of expense, however, is almost insuperable for a cultivator with only three or four acres of land. The country plough costs him Re. 1 to Rs. 20 only, and is a tool not to be despised. Other objections to the iron plough which tills much deeper are based on the Indian peasant's anxiety to retain the moisture in the soil and his unwillingness to widen the area to be manured when as often, the stock of manure is strictly limited.[2] In the case of heavy ploughs the advisability of deep ploughing has first to be proved. The drawing capacity of the available cattle and the difficulty of replacing broken spare parts and of carrying out repairs are serious obstacles to the introduction of foreign machinery.

As in the case of plants the improvement of a plough which the cultivator can himself make and repair and which his cattle can draw seems the more hopeful line for ameliorative effort to take.[3] It must be emphasised here that in size and shape the ploughs used in different parts of India differ greatly. Thus the ploughs used in the Saharanpur, Muzaffarnagar and Meerut districts are nearly double the size and weight of the ordinary ploughs used in the United Provinces. They are shod with a horse-shoeshaped piece of iron round the edge of the "tongue," and instead of a small iron tooth are fitted with a long pointed bar of iron which pro-

[1] Clouston: *Times of India Illustrated Weekly*, 4th July, 1923.
[2] Hume: *Agricultural Reform in India.*
[3] *Review of Agricultural Operations*, 1901 and 1902. For Egyptian ploughs in Bombay see *Annual Report of the Department of Agriculture, Bombay Presidency*, 1922-3, p. 126.

jects out behind the heel of the plough and can be forced forward as it wears down. Similarly the *nagar* of Bundelkhand is a heavy plough which stirs up the soil to the depth of a foot whilst being dragged by three pairs of bullocks and worked by nine men. Its advantages are so well appreciated that peasants put their oxen together and plough one another's fields in turn. Similarly, the ploughs used in Bihar are of heavier make than those used in Bengal; while in the Bengal Presidency itself the diminutive ploughs in use in Rungpur, Jalpaiguri or Midnapur, which barely scratch the first two inches of ground, are in striking contrast with the heavier ploughs used in Noakhali and Tippera districts. These differences are due to different conditions of farming. In Northern India the soil is baked harder than in Bengal for instance, owing to longer exposure to the sun, and the *rabi* crop is much more important. Here cultivation is deeper, and the ploughs necessarily are larger. In Bengal the soil is softer, and for an aquatic plant like rice deep ploughing would be disadvantageous, since by exposing too much of the subsoil it leads to rapid draining out of the water. Again, depth generally is attained with the ordinary country plough by a system of ploughing and re-ploughing. Thus, in some districts in Bengal, four ploughings are in practice after rains where the stiff clay is caked without water, each followed by a harrowing. In almost every part of India, the spade is also used by the peasant when the inversion of the soil or deep cultivation is needed. It is made to do the work which in the West is done by the ridging ploughs, broad-shares and hand and horse hoes. The spade is made of different sizes and forms to suit different local conditions of farming. "Comparatively few men in any walk of Indian life hesitate to express views as to what should be done to improve the farming of the country, and very many critics begin to expound their theories by deriding the little wooden

plough of the East," states the *Report on the Agricultural Stations at Tarnab and Haripur*, in the North-West Frontier Province. At Tarnab, this country plough has continued to be the most useful implement, and has maintained its position against many which are much more expensive. Whilst the view still is held at the farm that no cultivator of ten irrigated acres can afford to be without a good steel soil-inverting plough, it is recognised also that none can dispense with the cheap implement, or, indeed, cultivate efficiently without it. Thus the ideal plough, at once cheap and effective, has yet to be invented. None of the improved ploughs have the qualities of lightness, cheapness, efficiency and ease of manipulation and repair to suit the peculiar circumstances of Indian agriculture. The Rajah plough at Rs. 54 is too dear; and, despite all that its advocates can say, the ordinary cultivator is convinced that it requires stronger bullocks than he usually keeps. The Meston plough, the most popular of the improved types in Northern India, is cheap enough at Rs. 18, but is suited to the lighter soils only, and its shares are constantly breaking.[1] Nor should we forget that the village blacksmith is seldom equal to the repairs so persistently required. The peasant sows and reaps by hand, and excepting in the densely populated regions seldom uses artificial manures. His cattle are small and their draught power proportionately feeble. During times of stress their strength is further reduced, and as a result weeds obtain the upper hand and the land is allowed to lie fallow.

Rust and Rat Havoc in India.—Pests, animal and vegetable, work incalculable havoc. The table on the opposite page shows the loss through wheat-rust in one district of the Punjab only.

Wheat-rust is sometimes universal, and if the rate of damage shown were to extend over the broad acres of

[1] Darling: *The Punjab Peasant*, p. 179.

ern India (under wheat) the amount of loss would ›palling. Rats, moreover, are responsible for ›erious damage in almost all parts of India. In districts of the Punjab rats made their presence

stimated Value of Wheat Lost in Lyallpur District through Rust during Spring, 1923.

of ss ation	Average Out-turn per Acre in Maunds	Loss per Acre		Rate per Maund of Wheat	Acreage under Wheat in Lyallpur District	Total Loss
		In Weight	In Cash			
8 t.	8	Mds. srs. 1 7	Rs. as. 4 11	Rs. 4/-	643.773	Rs. 3,017,685 as. 15

so vigorously that the cultivators found it difficult obtain a living and were thinking of deserting ır homes and fields. The following table shows damage done by rats in a single village in the ıjab :

Village Jharauli, P.O. Shahabad, District Karnal.

Name	Crop	Area	Estimated		Actual Yield Value	Net Loss	Per-centage of Damage
			Yield	Value			
S Gaj-endra singh Rais	Inferior millet	Kanals 46	80 mds.	Rs200/- @2/8/- per md.	Mds. Rs. 6 15/-	Rs. 185/-	92
do.	Moth	250	125 mds.	Rs750/- @ 6/- per md.	25 150/-	600/-	80

Experiments show that a rat consumes 6 lbs. of
a year ; and, since the total rat population is estir
at about eight hundred millions, the loss caused t
human community by this animal per year is
Rs. 22 crores.

Agricultural Wastage.—The breed of the
deteriorates, while epidemics lead to a serious de
in numbers of the total livestock in the cou
These losses react unfavourably upon cultiva
Formerly, the farm manure was stored carefull
pits and utilised in the fields, but even this the
tivator now wastes. Continued manuring year
year is the exception rather than the rule, and tl
fore most of the manures applied must be looked
as top-dressing. The result is that there is a ten
for crops to feed near the surface, which
reduces their powers of resisting drought. If a
to resist drought, plant-food must find its way d
into the soil, where the roots of the crop norm
should develop and to obtain this effect reg
and systematic manuring is absolutely necessa
In Japan every morning the peasants carry night
and even urine to their fields for purposes of mani
In India, even cow-dung does not go back to
land, but is used often as fuel, while the oil-cake
exported abroad by local shopkeepers. There
considerable leakage of labour in other directions
well. When the crop is harvested the peasant hims
goes to the market to sell it; there is thus a va
wastage of labour.

Women's Work on the Land.—In many of t
lower castes the women work in the fields or in co
nection with the fish industry, gardening, or go to tl
market; but often the fields are too far from tl
family household; or, again, religious prejudic
supervene and prevent the women folk of the high
grades from doing any useful profitable work out
doors. In Germany the woman assists agriculture b

labour to a considerable extent. On holdings er 12½ acres women do the greater part of the k. Of eight million women who are employed on land in Germany, 4½ millions work on holdings of than 12½ acres. The number of men on holdings er 12½ acres is only 2½ millions. It is the German ll-holding that keeps women on the land, and it rgely from these small-holdings that the women the larger farms are recruited. Nor should we et that the success of the smaller holdings is due ely to the woman's skilful management. In the jab the Jat cultivator, assisted by his wife, succeeds h better on a small holding than the Rajput on a

The Jat woman does not plough, dig or drive , but there is no other form of agricultural labour she does not practise and ordinarily adorn. hile the Jat woman is an economic treasure rahman or the Rajput woman is an economic en. Similarly most of the true cultivating castes the United Provinces employ their women in fields, while the elder children herd cattle for es.

ıtensive Culture—Example of Japan.—Adoption of anced intensive cultivation increases the amount abour per unit of area, but, unless pushed very it also increases output per man. The solution ıot to be found in crowding men on the land n reducing the area under cultivation, but in easing the productivity of land by multiple and able cropping and occupying those prolonged ods which the farmer on his present system spends lleness.

ı Japan great care is taken to get the utmost ible out of the land during the season when litions of moisture and temperature are most urable for growth. Quick-maturing crops are ted; and, that no land-time be wasted, some which may be transplanted is started in a forcing-

bed for setting out between the rows as soon as first crop begins to mature. With individual fertilis it becomes well-rooted and is ready for its most im tant growth by the time the earlier crop has l harvested and the land worked.[1] Much can be d in this direction throughout the Punjab, the Cer Provinces or the Deccan by the introduction of c which require labour in the off-seasons. If scien rotation and artificial manuring were introdu more autumn crops could be grown without preju to the spring crop, the catch crops which are gr near towns after the spring crop has been harve could be encouraged, and permanent improvem could be carried out in the off-seasons which w economise effort in the active seasons. For exa the amount of daily labour saved and the incr irrigation area afforded, simply by the cons of permanent watertight channels in odd time, be enormous. Capital might be employed in pla fruit orchards, which after they were establi would employ less but more continuous labour t wheat cultivation, and yet would yield a gre return.[2] In considerable parts of Eastern Ber the cultivator takes both summer and winter ric the same land. A favourable rainfall enables a wi crop of *aman* rice to be grown after a summer cro *aus* or jute. While the seedlings are in the nur they take up very little space and the fields car occupied with another crop while they are grow The ground is always wet when the summer cro ripe, and it takes only a few days after it has l removed to plough and make ready the fields transplanting. Thus time is economised, while land is made available during most of the year.

Waste of Labour in India.—A very careful estir

[1] Buchanan : " The Rural Economy of Japan," *Quarterly Jo of Economics*, August, 1923.

[2] *Punjab Census Report*, 1921, Chap. I.

of Prof. Bhalla shows, on the other hand, that the cultivator in the Punjab works for 278 days only, taking a normal day of 10 hours. His estimate of work refers, however, to the cultivation of a plot of 13·54 acres. But the holdings often are much smaller, and give proportionately less work to the cultivator. Calvert estimates that the work done by the cultivator does not represent more than 150 days' full labour. In large areas in the Central Provinces the cultivator is idle for nearly nine months of the year. If he grows rice as well as jute, he adds to his time-table a month and a half's work in July and August. In the United Provinces, assuming that the average holding for a family of five is 2½ acres in the medium stiff soil, if the cultivator sows 2 acres with early rice followed by peas, and half an acre with cane, by working alone he would have sufficient to occupy him for 250 days in the year. In the light soil, if he sowed *kodo* and *arhar*, rotating with barley, on the whole 2½ acres, he would have to work on the average only 150 days in the year.[1] According to Dr. Slater, taking the land of South India all round, there is agricultural work for the cultivator only for five-twelfths of his possible working time. Much idle or surplus labour might be utilised for fruit-growing, market-gardening, poultry-keeping, hand-spinning and weaving and other cottage industries; but the waste continues and with this poverty increases.

Co-operation in Decay, and the Conditions of its Revival.—Formerly, the traditions of social and agricultural co-operation were very strong. The combination of peasants for sowing, ploughing, harvesting, digging wells or irrigation channels, building embankments and dams, etc., is met with still, but such traditions are decaying. The village now lacks the solidarity which formerly, being devoted to

[1] *Report of the Revision of Settlement in the Gorakhpur District*, 1919, p. 21.

economic management in a scheme of self-sufficing rural economy, was of incalculable benefit. The system of agricultural co-operation which now has been introduced into the Indian village will prevent a good deal of wastage of labour, although the advantages of co-operative credit have been pressed more assiduously. It is gradually becoming realised, however, that the reorganisation of agriculture supplies the essential economic basis of credit without which the co-operative movement cannot progress in India, and this has been brought home by the fact that the movement has not made the headway anticipated by its supporters, and even in some provinces has gone back. It used to be assumed that co-operative credit, wherever introduced, would prove beneficial. But where agricultural conditions are unprofitable the assistance rendered by the co-operative movement may postpone but cannot prevent the peasant's impending ruin. In many parts of India a most serious problem is presented by the decline of agriculture, and a comprehensive policy of rural reconstruction is needed before co-operation can be brought into effective use. The Registrar of Co-operative Societies in Bombay, for instance, points out that over large tracts of the Deccan a cultivator is unable under existing conditions to make his business pay. Year after year, the out-turn on his land hardly equals the value of the labour and the material that he has put into it; and, if he is in a position to maintain himself and his family, it is not from the business of cultivation but by outside labour undertaken on payment of wages. Under such precarious conditions, where for 50 per cent. of the population in dry-cropped villages agriculture is a losing business, the assistance rendered by co-operative credit cannot convert the agriculturist's loss into a profit and save him from the inevitable end. The soil is expected to suppport a larger population than its nature and the climate will allow, and the growing evil of fragmentation of

holdings makes profitable cultivation impossible for the majority of small-holders.[1] The economic problem can only be solved by agricultural reorganisation on co-operative lines following the traditions of the past, which would be supplemented by arrangements for the co-operative supply of agricultural requisites and the joint marketing of agricultural produce. Tank, canal and well irrigation can be provided for by free co-operative labour; the consolidation of holdings, the removal of weeds, the construction and maintenance of fencing, etc., can be effected by reviving the old communal spirit in definite regional undertakings under proper supervision. All these measures would revolutionise the economy of small-scale peasant farming.

Consolidation of Holdings.—In Japan there are agricultural partnerships and brotherhoods of the most diverse kinds; societies for the improvement of seeds and manures, for killing insects and extirpating weeds, for the insurance and breeding of cattle, for jungle-clearing, for the improvement of village education, for nursing the sick and the aged, etc. The evil of fragmentation is dealt with in Japan by reorientating the old communalism. The Japanese law permits a certain majority of owners in a village to apply for forcible allotment and "restripping" of the land, each man receiving a consolidated block in one or two places, approximately equivalent in area and value to the fields surrendered by him. The farmers restripped are exempted from land tax and special credit institutions are provided to finance them. The law provides also for the construction of roads and canals. In the Punjab, co-operative consolidation by consent has been effected in about 150 villages, where the new allotment of holdings is sometimes subject to reconsideration after four years, but in recently registered

[1] Otto Rothfeld: *Annual Report of the Working of Co-operative Societies*, 1922–23.

societies has been permanent from the first. Broadly speaking, the reduction in the number of fields is from either 10 or 5 to 1, the increase of area is in reverse ratio, and the rent of leased holdings is found to be proportionately enhanced.[1] The work is laborious and intricate, but the benefits conveyed by consolidation are out of all proportion to the expenditure. In two villages of the Batala *tahsil* rents have risen by 25 per cent. and in one by 100 per cent. in the consolidated area. Eight new wells have been sunk in three new villages; in one, 62 acres of old waste have come under cultivation as a result of readjustment; in another a long boundary dispute between Sikhs and Mussalmans has been settled by so consolidating the land as to give each party a separate parcel. One owner whose mortgage debt of Rs. 4,800 was scattered over 40 fragmented acres now has released 24 acres and arranged for the same debt to be secured on 16 acres consolidated.[2] But fragmentation is too widespread to be dealt with by the co-operative movement alone at present, and the aid of legislation is necessary. Egypt has passed the Five Feddan Law to check subdivision beyond the size of the economic holding. In India, where the holdings have become so small that they do not suffice for the maintenance of the peasant's family in large parts of the country, legislative measures for the reconstitution of holdings seem desirable. The modification of the law of inheritance, however, must be adapted to the existing traditions and habits. Thus, instead of allowing every son to inherit some portion of the property, thereby reducing it to small uneconomical fragments, a preferred heir might be created who would take over the undivided property, compensating the other heirs according to the agricultural profitableness of the

[1] Strickland: *Introduction to Co-operation in India*, p. 71.
[2] *Report of the Land Revenue Administration of the Punjab*, September, 1923.

holdings and not according to their selling value. This would prevent the fragmentation as well as the overburdening of the new farmer.[1] Restripping and consolidation then may be achieved gradually by permissive measures, while caste and village *panchayats* may be utilised in effecting voluntary exchange of holdings. Such exchange by mutual consent or through the intervention of the village *panchayat* is an established practice in South India and Orissa.

Rural Communalism a Safeguard to Agriculture.—The break-up of the old rural communalism in India, which has not yet been accompanied by any new conception of social solidarity, has aggravated the agricultural situation. Either the old communal habits now have to be adapted to new social and agricultural needs; or, in the modern co-operative society, our aim should be to adapt, in a manner suitable to modern conditions, the organisation of the joint family, caste and village community. In China the agnatic rural clan serves as a mutual defence or mutual aid association, and its supervision over rural agriculture has prevented the growth of capitalistic interests which disintegrate small farming. Indeed, throughout the East man has been trained to realise that his group—family, clan, caste, guild or village community—is indispensable to his welfare; if he misses his footing and falls into the whirlpool it alone will throw him a life-line. It is to the organisation of these groups for new social endeavours that we more easily may look forward for solving some of the difficult problems of poverty than to the adoption of new institutions and methods which take a long time to become popular and effective in conservative countries.

Dawn of Scientific Farming in India.—Large farming on capitalistic lines is unsuitable for India, where, on account of the pressure of a dense population on the

[1] For detailed discussion of various measures proposed to prevent fragmentation, see *Land Problems of India.*

soil, the pastoral industries cannot be so important as they are in Western Europe or in the sparsely populated regions of the New World. There will be seen, therefore, two movements in Indian rural economy in the near future: First, a gradual development of scientific farming, which means that unskilled farmers will be driven into less fertile lands and ultimately out of the field of agriculture. In parts of the United Provinces, for instance, the Brahmans, the Ahirs and the Saithwars possess at least four or five acres, even in the most congested areas, where the average holding is from 1 to 2 acres. They do not care to scrape a living off two or three scattered *bighas*, but require and find room and a holding on which they can find employment for two or three ploughs. The Brahman's ambition is to be a large farmer, a general mixed farmer and dairy-man; while the Ahir aims to be both farmer and cattle-breeder. The former's *métier* is as a working farmer, with several farm hands under him as permanent labourers. For this he requires a large holding, and men of this ambitious and successful type amount to a considerable number. It is a very valuable type; because it is only when a certain size of holding properly capitalised is reached that labour-saving machinery can come in economically. It is true that, on account of the small size of the holdings and the need of keeping them in the finest possible condition, mechanically driven implements will be unsuitable for reaping, ploughing and preparation of the land. But many of the improved ploughs designed by engineers working in collaboration with agricultural experts in India have opened up a vista of great promise for Indian agriculture. The growth of demand for improved ploughs can well be gauged from the fact that one pioneer manufacturer in Bombay Presidency has a factory with a daily output of 200 ploughs alone, which are sold in the country. Machines for harvesting crops, for cleaning grain, for chopping

fodder, winnowers, threshing machines, etc., adapted to the need of small farming and within reach of poor cultivators, have yet, however, to be evolved. Again, such machines, although useful on large estates where labour is scarce, are likely to upset the rural economy in congested tracts, in the plains, where labour is plentiful.

Methods of Farming Adapted to the Region.—In Japan rice-fields are worked as in India by men and women wallowing in the mud. Rice is weeded and the ground or mud stirred about three times during the summer. Much of this is done with the naked hand. Harvesting and threshing make slow, laborious tasks for muscles alone. A foreign observer remarks: "American agricultural machinery would destroy more than it would produce. The dykes and ditches could never stand it and in the tiny fields too much turning would destroy the whole crop. With horses and wheels on the land the second crop would be impossible. European and American agricultural methods would no more work on a Japanese farm, than Japanese methods would work on a European or American farm. Each system doubtless has defects, which might be eliminated, but on the whole each is pretty well adapted to its environment." These remarks apply also to the Indian system of farming. In the main, there is little to hope in the direction of lightening field labours unless new agricultural machinery is designed. But a great increase in the yield of land is possible by the use of organic manure, the improvement of levelling, drainage and irrigation, and the introduction of rotation of crops, as has been the case in Japan.

Intensive Culture: Results and Possibilities in India.—The enormous increase of yield by proper intensive cultivation will be evident from a comparison of the average yields of the Sugar Experimental Station at Shahjahanpur and the standard out-turn

(maunds per acre) on irrigated land in the United Provinces :

Crop	Shahjahanpur	Standard Out-turn in the United Provinces
Sugarcane	841·0	345·4
Wheat	30·3	15·2
Gram	24·1	11·6

The only crops grown both in India and England on a large scale are wheat and barley. The respective yields per acre are as follows :

Crop	India	England
Wheat	1,919 lbs.	814 lbs.
Barley	1,645 ,,	877 ,,

Not merely are agricultural operations less efficient, but there is wastage of human labour due to want of multiple cropping in many regions. The double-cropped area in the Central Provinces is only 5 per cent. of the cultivated land, and the largest figures come from the rice-growing districts, where the second crop consists generally of a catch crop of linseed or pulse sown shortly before the rice comes to maturity and producing only a few pounds per acre. There is therefore a large amount of agricultural idleness. In the Chutteesgarh division, for instance, after the monsoon crop is gathered, there is very little employment for the agricultural population until the approach of the next monsoon. Agricultural idleness or slackness varies in different provinces and everywhere calls for a systematic organisation of agriculture. Again,

nanical power can be introduced first as a subste for cattle-power in threshing and irrigating in not weather when the available supply of fodder is s lowest. In India the demand for cattle-power t its highest when its efficiency is lowest. In -growing regions where there is a possible opening running power crushing mills or in well-irrigated ts where tube wells have a great future, cheap oil nes might profitably be introduced. Wherever e is hard work in the hot weather and the *rabi* o is important, the demand for agricultural power st thus be supplied by mechanically driven implents which will take a form adapted to irrigating, eshing or preparing the crop, thus freeing the ttle for ploughing and preparation of the soil.

Complications of the Small Farming Problem—the reefold Remedy.—Another movement in our rural onomy will be represented by the gradual shifting of nants and landless labourers into immense stretches f land which are badly cultivated on account of bsentee landlordism or absence of full proprietary ghts of the peasants. On the one hand, unscientific rming, especially when holdings become smaller nd smaller, will lead to an increase of the peasant roletariat when cultivation reaches the stage of iminishing returns. The presence of a landless opulation, on the other hand, cheapens labour elatively to capital and delays the introduction of mproved tools and implements. It is true that ertain types of agriculture depend for their success n a large supply of hand labour, *e.g.*, rice, mulberry, ute, which therefore have found a suitable home in he monsoon regions having a dense population; while dairying, poultry-keeping, and fruit-growing are agricultural industries which respond more to the human factor than to capital. But, in the present condition of Indian agriculture, the introduction of scientific methods and the investment of capital are

retarded by the abundant supply of cheap and effic agricultural labour. Thus the improvement of small farming economy by the adoption of scien agriculture and by co-operative organisation, and redistribution of land rights in the interests of c vators, must go together; for each without the ot must fail, thereby adding to the existing agricultu depression and discontent.

CHAPTER V

AGRICULTURE AND POPULATION

Productivity and Population.—There are evidences of pressure of population in various tracts in India. At the same time no evidence appears that the limit of agricultural development has been reached so as to interfere with a further increase of population and density. Thus the economic situation can be solved by expansion and intensification of agriculture. In an agricultural country a level surface, fertility of soil and sufficient rainfall favour the concentration of population. On a level plain every inch of the surface is brought under the plough, water can be retained on the land, and permanent land improvements are easy. On the low-lying plains of the Punjab East, the United Provinces, Bengal, Bihar and the strips along the sea coast in the southern part of the Indian Peninsula, density is very high. On the other hand, in the hilly tracts or forested areas in India, the rainfall is high, but agriculture is primitive and density low. On the mountain slopes a heavy rainfall destroys the crops while a short break is injurious to them. But the development of agriculture depends on the gradient of the slopes; and terrace cultivation, as in the Himalayan tracts, in Khasi and Chittagong Hills, in the Nilgiris, the Vindhyas or the Western Ghats, overcomes more or less the natural disadvantages, resulting in the gradual ascent of the population to the hills. Generally, where the surface is uneven, the bottoms of the slopes are extremely fertile and show a large aggregation, while cultivation becomes more difficult in the heights and can support only a sparse population. This explains the

contrast of density between the Indo-Gangetic plain, East (711), with that of the Central India plateau (198).

Rainfall, Irrigation and Density.—Mere fertility of soil is not favourable to high density of population in India, where agriculture depends more on the rainfall and the configuration of the surface than on soil character. Thus the fertile alluvial soil of Sind degenerates into barren desert owing to the very scant rainfall. Similarly, the fertile black cotton-soil is nowhere associated with a density of population approaching that of the lower Gangetic plain. Nor is rainfall by itself an index of the density of population. The distribution of rainfall is more important than its amount, and not only the distribution with regard to time but also with regard to place. A properly distributed rainfall of 40″ is sufficient in most parts of India, and less than this or bad distribution may appreciably affect the success of cultivation and ultimately the density of population. A general correspondence between the rainfall under 40″ and the density of population is noticeable in India :

Deccan ..	30″	..	169 per sq. mile
Rajputana ..	25″	..	131 ,,
Kashmir ..	24″	..	37 ,,
Baluchistan	8″	..	6 ,,

Again, it is not merely a question of rainfall but also of facilities of irrigation. Thus, if we consider both irrigation and rainfall together the correspondence with the density of population becomes evident. This will appear from the table (see page 85) showing the percentage of watered to cultivated tracts and the density of population in the Natural Divisions of the United Provinces.

The apparent exception in the case of the Sub-

Himalaya East can be easily explained. In Basti district the water level is generally high and less irrigation is required. There is one large tract along the Rapti that grows a phenomenal *rabi* crop without any irrigation whatever. Allowing for these facts the watered area in Sub-Himalaya East is actually larger than even Indo-Gangetic Plain East. As agriculture advances the effort made by the cultivator —shown by the extension of cultivation, the improvement of irrigation, and the amount of multiple crops— comes to govern more and more the density of population. Taking irrigation first, the following examples, among others, would show how man can withstand the

Natural Division	Density	Percentage of Watered to Cultivated Tract	Order according to Density	Order according to Watered Area
ntral India Plateau ..	211	67	6	6
do-Gangetic Plain Central	538	91	4	3
do-Gangetic Plain East..	706	108	1	1
do-Gangetic Plain West..	550	98	3	2
ub-Himalaya East ..	586	81	2	5
Sub-Himalaya West ..	437	84	5	4

effects of rainfall. In 1891, Lyallpur in the Punjab was a barren tract with seven inhabitants per square mile; but the opening of canals (1901) increased the density to 187 per square mile. In 1911 it had gone up to 272. In Madras, East Coast South, with a rainfall of only 32 inches, has much the same density as the West Coast with 110 inches. In Gaya, canal irrigation has turned a most infertile tract, a large part of which was sandy and unproductive, into a region of rich fertility.

Cultivation and Density.—Both the increase of cultivated area and multiple cropping explain concentration of population in many parts of India. The following table indicates that the figures of the percentage of

cultivated to total area and of double-cropped area correspond very closely to the order of density of the different divisions in the United Provinces :

Natural Division	Density		Percentage			Double-cropped to Cultivable
			Gross Cultivated to Cultivable Area[1]		Irrigated to Cultivated	
	1911	1921	1909–10	1919–20		
Central India Plateau ..	211	198	77·9	83·3	6·3	4·5(23·4)
Indo-Gangetic Plain Central..	538	528	105·5	109·0	32·1	17·7(15·0)
Indo-Gangetic Plain East ..	706	711	107·2	111·0	44·7	20·5(18·4)
Indo-Gangetic Plain West ..	550	508	103·9	103·7	30·2	14·7(13·2)
Sub-Himalaya East	586	605	118·2	122·0	28·7	29·3(26·1)
Sub-Himalaya West	437	399	101·4	98·7	14·8	17·9(15

It appears from these figures that in the decade 1911–21 there has been an increase of density as well as of the percentage of gross-cultivated (*i.e.*, the double-cropped added to the net cultivated) to the cultivated area in the Eastern Sub-Himalaya and Eastern Indo-Gangetic Plain divisions, which already are the most congested. High and increasing density co-exists with great and increasing intensification of agriculture in tracts which now maintain more than double the number of persons per square mile maintained in agricultural Europe. To take one of the districts of the Western Indo-Gangetic plain, *viz.*, Muzaffarnagar, which records a density of 488 persons per square mile and 711 per cultivated square mile, not very high figures, we find that the movement of population is connected with the agricultural progress

[1] Here the double-cropped area being counted twice causes the cultivated area to exceed, in most of these examples, the cultivable area.

of the district. The double-cropped area has increased 80 per cent. since the last settlement and now averages 165,000 acres, or nearly a quarter of the total area. Connected with this is the rise in the area under *gram* and peas. The area under sugarcane also has shown an increase of more than 50 per cent. and now covers 12½ per cent. of the total cultivated area. The cane crop is the basis of the triennial rotation of crops which is universally aimed at in this district; sugarcane is followed by wheat with double-cropping in the third year, sometimes rice followed by *gram*, sometimes

Area Irrigated from Canals in the Muzaffarnagar District

Year	Total *Rabi* and *Kharif*	Double-cropped Area	Net Irrigated Area	Remarks
1887–88	161,578	5,985	155,598	
888–89	161,046	4,813	156,233	
889–90	207,137	14,216	192,921	
90–91	184,454	12,340	172,114	Net area of last settlement from canals is 244,191 acres
erage	178,554	9,338	169,215	
915–16	261,019	21,252	239,767	
1916–17	237,387	17,141	220,246	
1917–18	265,255	30,709	234,546	
1918–19	322,476	38,804	283,672	Net area of this settlement from canals is 264,759 acres
Average	271,534	26,976	244,558	

one of the millets or autumn pulses followed by peas. Canal-irrigation has risen by about one-third since last settlement; well-irrigation also has increased by about 30 per cent., and 52 per cent. of the normal cultivated area can depend on a reliable supply of water, while there are large tracts in the Ganges *khadir* and elsewhere which do not require any irrigation. The features of the canal-irrigation are not only its extent, which amounts to considerably more than a quarter of a million acres, but also the high proportion (10-11ths) which comes by flow, thus

reducing the labour bill of the farmer to a minimum. The continuous increase of double-cropped and irrigated areas is shown in the table on page 87.

In Bengal also the figures of crop values of different districts, based on area, out-turn and price, correspond very closely to the order of density :

Relative Crop Value per Square Mile Reduced to the Midnapore Standard.[1]

District	Density of Population Supportable on Midnapore Standard	Total Relative Crop Value per square mile Reduced to the Midnapore Standard	Density of *Existing* Population	Percentage of Supportable Increase at Midnapore Standard
Bankura (Sadr Div.)	476	450	361	33
Midnapore ..	528	500	528	0
Nadia	695	658	535	30
Rajshahi	826	782	569	45
Jessore	889	845	593	50
Faridpur	1,198	1,134	949	26
Mymensingh ..	1,143	1,082	776	47
Dacca	1,351	1,279	1,145	18
Tippera	1,512	1,431	1,027	47
Noakhali (Mainland)	1,535	1,453	1,202	28
Bakarganj ..	1,142	1,081	752	52

Broadly speaking, the density of population increases from west to east and from north to south. Some of the fertile, healthy and stable tracts of Eastern Bengal, inhabited also by a fecund population in which the Muhammadan influence prevails, show little sign of having reached equilibrium as regards crop area, out-turn and population. There is still room for further expansion, even to the extent of about 50 per cent. in Bakarganj and Mymensingh districts.

The table on page 89 shows also the correlation between the density of population and the percentages of net-cropped and twice-cropped areas to total area in the different districts in Bihar.

[1] *Bengal Census Report*, 1921.

It is interesting to compare the proportions of the whole area cultivated and culturable in different districts in Bengal, Bihar and Orissa (see table, page 90).

In most of the Bihar districts the land is manured very heavily and the population is sufficiently heavy to enforce the cultivation of all culturable land without rest. In parts of Eastern Bengal, *e.g.*, Bakarganj and Noakhali, there are areas of fertile waste land to which the population can move when the pressure on the soil on any part becomes too severe. The Eastern Bengal districts differ from the Bihar districts

District	Total Area dealt with Statistically	Percentage of Net-cropped to Total Area	Percentage to the Net-cropped Area of the Areas under						Density of Population per Square Mile
			Bhadoi	*Aghani*	*Rabi*	Other Cropped Area	Twice-cropped	Irrigated Area	
...uzaffarpur ..	1,941,254	80	38	48	60	—	46	2	907
...ran	1,633,435	79	41	34	62	—	37	15	872
...arbhanga ..	2,116,390	80	28	63	47	—	38	6	870
...atna	1,322,117	81	13	41	75	2	31	68	763
Champaran ..	2,079,315	70	46	38	55	—	39	2	550
Monghyr (South)	1,498,963	53	19	54	50	1	24	42	517
,, (North)	974,520	69	43	29	66	—	38	3	
Bhagalpur (North)	1,263,994	77	34	60	36	3	33	45	481
,, (South)	1,141,017	56	18	69	48	1	36	36	
Bhagalpur ..	2,405,011	70	27	64	41	2	34	17	481
Shahabad ..	2,726,512	64	10	43	78	2	33	42	415
Purnea	2,871,679	61	34	56	39	—	29	1	405

in the proportion of culturable land which is occupied as homestead. Including the tanks which are part of the homestead, seven times as much land is thus occupied in Eastern Bengal as in Bihar. Excluding tanks, the amount is four times as great. Another feature in Eastern Bengal is the absence of land reserved for pasture. In a country which is always green, pasture, though desirable, is not essential and its absence serves to reduce the amount of culturable land which is not cultivated. We thus see that the

comparative crop-bearing values of the various districts in the United Provinces, Bihar and Bengal, which are the best possible indication of the quantity and quality of the land cultivated, and the quality of cultivation practised, give a very good index to the aggregation of population. In Bihar, if the Chota Nagpur plateau, which includes more than half the area but only one-third of the population of the province, be omitted, the density of population in the other three natural divisions comes to 576 persons to

District	Percentage of Area Cultivated to Total Land Area	Percentage of Area Cultivated to Total Culturable	Percentage of Twice-cropped Area to Net-cropped Area	Mean Density per Square Mile
Darbhanga ..	80	92	38	870
Muzaffarpur ..	80	92	46	907
Champaran ..	70	77	39	550
Bhagalpur ..	70	78	34	481
Saran ..	79	86	37	872
Balasore ..	71	90	1	470
Cuttack ..	70	96	17	565
Puri ..	71	93	7	382
Tippera ..	80	97	138*	1,027
Dacca ..	77	92	35	1,351
Bakarganj ..	70	85	113*	1,061
Faridpur ..	80	92	133*	1,198
Rajshahi ..	75	88	118*	569
Noakhali ..	77	93	150*	1,533
Midnapur ..	66	74	1½	528
Birbhum ..	72	80	2	483

NOTE.—The figures marked with an asterisk represent the total of the percentages of cultivated area found to bear summer, winter, spring and miscellaneous crops.

the square mile, which is much greater than in the United Provinces and nearly as great as in Bengal which includes Calcutta. The *rabi* crop is important in Bihar and the *bhadoi* in Chota Nagpur. But a considerable area, especially in Bihar, is twice-cropped, in which catch-crops, usually *khesari*, are sown broadcast amongst the *bhadoi* on land unsuited to the finer and more valuable *rabi* crops. Orissa is far more dependent on the single rice crop and therefore far more exposed to agricultural distress than the other divisions. Indeed, the measure of both agricultural

prosperity and density is obtained by adding the percentages of the cropped area under *bhadoi* and *rabi* and deducting that under *aghani*. The following table shows for each natural division the percentage of the net-cropped area under each of the three crops, the index number in the manner suggested and the density of population per square mile :

Natural Divisions	Percentage of Net-cropped Area under			Index No.	Density
	Rabi	Bhadoi	Aghani		
North Bihar	53·8	40·3	46·9	47·2	642
South Bihar	70·8	14·6	41·3	44·1	502
Orissa	10·1	15·6	81·3	55·6	486
Chota Nagpur (Plateau), excluding the States ..	14·0	50·4	41·9	12·5	221

In Dacca, 25 per cent. bear two or more crops. This may be compared with 13 per cent. in Bakarganj ; 29 per cent. in Purnea ; 20 per cent. in Monghyr and 46 per cent. in Muzaffarpur. The high percentage in Muzaffarpur is due to the importance of the *rabi* crop. But the *rabi* crop in Dacca is of little importance, its total value being only 7 per cent. of the agricultural produce of the district.

Sub-division	Percentage of Twice-cropped Area to Net Cultivated Area	Area under Jute to Cultivated Area	Density per Square Mile
Manikganj ..	63	11	1,025
Sealo	54	15	823
Harirampur ..	49	08	1,037
Nawabganj ..	45	05	1,380
Rupganj ..	37	29	1,109
Narayanganj ..	35	30	1,527
Srinagar ..	34	19	2,061
Sabhar ..	33	20	709
Raipura ..	31	20	1,006
Munshiganj ..	30	34	1,600
Kapasia ..	19	21	526
Keraniganj ..	16	12	749

The above table shows the correlation between double-cropping and the density of population in

different subdivisions in Dacca, some of which show the world's highest record of aggregation in agricultural life.

The contrast with the different districts is shown as follows :

District	Percentage of Cultivated Area, excluding Orchards, found to Bear				Total of these Percentages	Density of Population
	Summer Crops	Winter Crops	Spring Crops	Miscellaneous		
Noakhali (Mainland)	45	90	14	1	150	1,535
Tippera	44	74	18	1	138	972
Rajshahi	64	29	24	1	118	1,826
Faridpur	36	72	24	1	133	1,198
Bakarganj	11	95	7	—	113	1,081

The above difference is due not merely to the pressure of population, combined with question of convenience, but also to the unequal distribution of rainfall and the flood-water. It is the rain that comes in the months of March, April and May and, again, in September and October, upon which Noakhali, for instance, depends for its peculiar advantage.

District	Inches of Rainfall in				
	March	April	May	September	October
Noakhali ..	2·98	5·01	11·07	16·86	7·66
Tippera ..	2·63	5.93	10·33	10·03	4·79
Rajshahi ..	0·97	1·63	5·74	9·98	3·52
Faridpur ..	2·21	4·13	8·31	8·75	4·38
Bakarganj ..	1·64	3·27	8·58	11·35	6·38

In Bakarganj, on the other hand, agriculture is not entirely dependent upon the local rainfall. Here floods play a more important part than rain in the fortune of crops.

Variations in the Population-Supporting Capacity of Land.—Speaking generally, the economic aspect of

density resolves itself into the question of the productivity of the land under the efforts and the standard of living of the people. The capacity of the land to support the population is measured as regards its extent by the amount of the net-cropped area, and as regards its quality by the organisation of agriculture. All such factors as the methods of agriculture, the distribution of holdings, the choice and rotation of crops, the system of land tenure, the rates of rent, govern the local variations of the distribution of population.

In different densely populated tracts of India the relationship between the population and the standard of living is different also. In the eastern districts of the United Provinces and the neighbouring districts of North Bihar, which, as we have seen, are areas of especially high density, the standard of cultivation is fairly high; but the land tenure, the fragmentation of holdings and the scarcity of pasturage for the cattle have reacted unfavourably on the plane of living. In much of this area the soil cannot bear a greater pressure of population than it supports at present, and an increase of population unaccompanied by better agricultural organisation probably would reduce the standard of living. There is no mineral wealth to develop any occupations unconnected with agriculture, while both labour and industry are stay-at-home. It is from the eastern districts of the United Provinces that a very large number of emigrants to Assam tea-plantations and abroad are recruited. There is also a great increase of sub-letting by the peasants who live on their wages and whose holdings form only a part of their resources. Such industrial concerns as exist are too much confined to the towns—Cawnpore, Jamshedpur, Jamalpur and a few others. At the same time there is a constant drain of labour flowing out of these districts into Bengal and Assam. In the submontane districts of the Punjab, where the cultivator is depen-

dent mainly upon nature, which has been unusually bountiful, cultivation is poor and the peasant's output is low. But, owing to the fertility of the soil, the population is unusually dense and holdings are correspondingly small. Throughout this area the yield per acre is high, but the yield per man is low. In the Hoshiarpur *tahsil* there are 960 people to every square mile of cultivation. In the low-lying riverain country of the Ravi, where little effort is needed to secure a harvest, the density is over 1,000. In the thickly populated part of this area and the Central Punjab, the fertility of the soil has led to increase of population up to the margin of subsistence.

Where density is low economic pressure, however, may co-exist. Thus, in many unfavourable tracts in the Deccan, pressure keeps part of the population at a very low standard of living and is relieved only partially by the flow of the population into the industrial cities of the Bombay Presidency. On the other hand, a low density, the extension of canal-irrigation and multiple-cropping have contributed to a high standard of living of the average Punjabi peasant, "which is distinctly above that of a large portion of the peasantry in Southern and Eastern Europe."

High Density with High Cultivation and High Standard of Living.—But high density need not indicate pressure and low standard of living in India. In parts of Eastern Bengal it has been possible for a population of 1,000 persons to the square mile to go on increasing rapidly and at the same time to maintain a higher standard of living than in Western Bengal, where a population less than half as dense in rural districts remains stationary. The explanation is to be sought in better agricultural methods, the cultivation of a valuable crop like jute, better rotation, the importance of supplementary occupations connected with fishing, and favourable climatic conditions. The following figures represent a phenomenal increase of

population, *thana* by *thana*, in Tippera district, between one census and the next, since 1881 :

Tippera District	Average Density of Population					Total Percentage of Multi-cropped Area
Sardar Sub-Division :	1881	1891	1901	1911	1921	
Comilla ..	774	877	985	1,100	1,173	172·8
Daudkandi ..	699	844	1,007	1,188	1,301	130·7
Muradnagar..	677	786	910	1,043	1,207	160·7
Chandina ..	456	542	644	761	881	164·8
Chauddagram	633	716	819	900	956	156·7
Laksam ..	441	525	634	738	831	139·5
Brahmanbaria Sub-Division :						
Brahmanbaria	637	694	794	885	951	128·2
Kasha ..	727	811	915	1,016	1,078	139·6
Nabinagar ..	734	858	998	1,126	1,063	146·3
Chandpur Sub-Division :						
Chandpur ..	521	711	972	1,149	1,275	138·2
Hajigunj)	462	488	629	747	903	117·1
Matlah)		736	910	1,070	1,217	127·6

Similar evidence of increase in density over the three decades is afforded by the several *thanas* in Noakhali :

Noakhali District	Average Density of Populatfon			Proportional Increase per cent.		Total Percentage of Multi-cropped Area
	1881	1911	1921	1881–1911	1911–1921	
Feni	649	936	1,114	44	14·5	161
Chhagalnaia ..	834	1,056	1,193	26	5·2	140
Feni Sub-Division	720	981	1,112	36	10·7	—
Begamganj ..	586	1,018	1,306	74	20	130
Ramgunj ..	690	1,223	1,370	77	12	143
Lakshmipur ..	587	1,065	1,238	81	12	155
Companyganj ..	591	798	968	35	5	170
Noakhali ..	603	1,027	965	70	5	160
The Mainland	642	1,034	1,202	61	13	150
Sandwip ..	375	647	961	73	38	118
Rest of Island	224	227	—	1	—	113
THE DISTRICT ..	546	824	972	51	13	140

These high densities can be explained only by the fact that agriculture is not dependent entirely upon the local rainfall. There are spring, autumn and winter crops, as well as orchards, and scarcity or irregular distribution of rain cannot affect all the crops. Again, rain is seldom uncertain. Lastly, floods in many districts are of more importance to the crops than rain. Floods with their silt-laden waters penetrate through innumerable creeks to all parts of the area under cultivation and cover it with a deposit so rich as to make artificial manure unnecessary. Floods never fail, and they produce the winter rice crop, while they prepare the soil for all other crops as well. A cultivator in Northern Bengal, on the other hand, fails altogether to get a summer and a winter crop off the same land. In Western Bengal the fertilising floods of Eastern Bengal play no part, while irrigation performs a very minor *rôle* compared with that which it enjoys in Bihar. Yet the distribution of rainfall is of no slight importance to the East Bengal peasant. If the spring rain is too heavy the seeds either rot or are washed away, and if it is too late they cannot be sown in time for the young plants to grow high enough to overtop the flood when it comes. The *aus* paddy, as well as jute sown on river banks and *chars*, depends entirely on the early rain. When the rivers overflow their banks, however, they dominate the situation, for the crops depend much more on the rise of waters than on the local rainfall. If there is early rain to allow the crops to be sown and to make good headway before the rivers rise, and if the rivers rise gradually and not too soon or too suddenly, the entire rainfall of the districts is not very important.

Similarly, in the Southern coastal tracts, including the States of Cochin and Travancore, rural density reaches in parts to 1,000 or even 1,200 persons to the square mile. Here, in addition to the favourable climatic conditions and the physical configuration

of the natural coast strip fertilised every year by fresh alluvial deposits, the steady substitution of more valuable crops such as coconut, rubber and tea for rice has enabled a very closely aggregated population to maintain a comparatively high standard of living. In the Eastern Coast district, irrigated by rivers, tanks and canals, and enjoying the benefits of two rains, the proportion of twice-cropped area is very large. The following would represent the rotation of crops :

Crop	First Crop	Second Crop
Paddy ..	June to September ..	October to February
Bemra ..	April to September ..	——
Cholam ..	Wet : April to September	Dry : October to January
Kambu ..	——	Ditto.
Ragi ..	Wet : May to August ..	Dry: October to December
Cotton ..	September to February	——
Pulses ..	September to December	——
Sugarcane	May to March [1] ..	——

On the Indian Western Coast, the back-waters, and lagoons fed by rivers and separated from the sea by sandbanks fringed with coconut-trees, have contributed to the relatively high crop-bearing value of this area. The low-lying paddy-fields bear their two crops per annum regularly, and wonderfully few coconut-trees support a family.[2] Rubber and spices also are valuable products whose cultivation has increased enormously. In Travancore the sedimental and alluvial soil spread on a flat surface, permitting almost every inch to be brought under cultivation, and provision for irrigation on a large scale, have contributed to the extensive cultivation of paddy and coconut. Tapioca, which was introduced into the State about a generation ago, is grown extensively and is replacing rice among the poorer classes, more than 50 per cent. of the population now living on tapioca. The poor and unirrigated soil in the State

[1] *South Indian Villages*, p. 6. [2] *Ibid.*, p. 240.

is suitable for the cultivation of this crop, which, unlike paddy, does not absolutely require ploughing; hence the cultivator has not to buy cattle and maintain them throughout the year for their services during three or four months only. Paddy-cultivation and cattle-breeding being interdependent, the fall in the former has caused the fall in the latter. But, though the number of persons engaged in the cultivation of paddy has decreased, the population and the area under paddy-cultivation have increased. One reason is the introduction of machinery, which, however, is confined at present to the draining of water from a *kyal*-reclaimed land.[1]

Food Production and its Intensification in India.—Even with regard to food-crops, there is possibility in India of a great increase of productivity of land by the substitution of crops which yield greater food values for those which yield less. The following table shows the food-producing powers of an acre of land under different crops:

Food Product	Food Value per Pound (Calories)	Pounds per Acre (good yields)	Calories per Acre	Ratio on Wheat Basis (fractions omitted)
				Per Cent.
Entire wheat flour ..	1,660	1,800	2,988,000	100
Native beef (as purchased)	1,130	200	266,000	7
Native mutton	1,275	250	318,750	11
Whole milk	325	4,000	1,300,000	43
Corn meal	1,550	3,600	5,580,000	186
Oat meal	1,860	1,800	3,348,000	112
Rice	1,630	2,400	3,912,000	131
Rye meal or flour	1,630	1,800	2,934,000	98
Beans	1,590	2,400	3,816,000	129
Potatoes	325	24,000	7,800,000	260
Sweet Potatoes	480	36,000	14,400,000	482

The German farmer devotes much more ground than the English farmer to crops like potatoes, which produce

[1] *Travancore Census Report*, pp. 6, 160.

human food in large quantities. Middleton estimates that "an acre under potatoes would usually produce ten times as much human food as an acre under good pasture, and an acre under sugar beet may produce from one and a half times to twice as much food as an acre under potatoes."[1] In countries of Western Europe potato, which is a heavy-yielding crop, gradually is replacing wheat. An enormously increased output would be available if potato became popular in the wheat regions of India. The cultivator, however, would have to be taught its proper cultivation.

Subsidiary Industries.—Apart from increasing productivity by introducing heavy-yielding crops, another method of adjusting population to resources is the introduction of various subsidiary industries in connection with agriculture. In small agricultural countries of Europe fruit-growing, market-gardening, dairying and stock-breeding contribute a great deal to rural prosperity. In Japan, though half the land is under rice and heavily manured, two million peasant families, or more than one-third of the whole, find it necessary to rear silkworm as well, and the number is daily increasing. In Bengal and the Punjab, cottage seri-culture is a useful supplementary occupation. In the Punjab many of the silk-rearers raise agricultural capital by silkworm-rearing and use it in leasing a plot of melons; with the money left over they lease a mango orchard, following up this with oranges and maltas; at which stage the seri-culture season is again at hand to provide capital for the next year.[2] In many parts of India fruit-growing might become a highly successful industry, which apart from utilising surplus labour would contribute to round out a balanced food for a population living mainly on vegetarian diet. The utilisation of tomatoes, onions, chillies, mangoes, guavas, etc., all of which grow without special diffi-

[1] Middleton: *The Recent Development of German Agriculture.*
[2] *Report of the Department of Agriculture, Punjab*, 1924, p. 203.

culties, would prevent waste. In Poona fig-culture is a profitable occupation, at which even the smallest cultivator can command his price in the market; what is not sold fresh is dried and then sold, and the small remainder is eaten. In the North-West Frontier Province, foreign varieties of peach and plum, apricot and olive, have been grown successfully in modern gardens. In the Punjab the date plantation has opened out a prosperous industry. Cape gooseberries and pineapples promise to be profitable in Madras, while in Assam varieties of oranges, pears and apples now are being propagated. The poultry industry, which is popular in China and among the Muhammadans in India, is unpopular among the Hindus. Fowls eat or destroy insect pests and thereby, as well as with their manure, enrich the land instead of impoverishing it. Thus it is that poultry-keeping is the most universal and important form of animal industry wherever intensive agriculture prevails. Both poultry-keeping and stock-breeding, which are great resources of the small-holders in Europe, can be adopted only when existing prejudices are outgrown. Even market-gardening is sometimes discouraged for the Hindu by caste rules. Poultry-farming is a feature in the United Provinces, where a considerable grant is made yearly to a Poultry Association.

Population a Regional Question.—We thus see that the menace of over-population which looms large in the writings of some economists does not apply to our country in particular. Greater fertility of soil means no doubt a higher density of population, but the most densely-inhabited tracts are those where along with rich land resources the amount of effort made by the peasantry as shown by crop values is the largest. Thus it is not true that population in India increases and maintains its growth only as the result of natural causes. As in every country, the social reactions of the population to natural resources are witnessed in

India, but India being predominantly agricultural these reactions are evident in the field of the productivity of land. In every country regions vary in economic resources, and population is divided into sharply-defined classes with varying degrees of productivity. Agriculturally speaking, production may range from the collection of herbs and fruits in the jungles to an elaborate system of multiple-cropping with the aid of well or canal irrigation ; while the area exploited may be an arid desert, an uninhabited mountain slope or a populous river valley. In India we meet with all types of cultivation, from the primitive and nomadic forms to a most careful husbandry of all the resources of land and water. In some parts only one harvest can be obtained annually, in others five or even seven harvests in the year are not uncommon. There are localities in Bengal where in almost contiguous fields peasants may be seen sowing paddy, transplanting it and harvesting it. The soil and climate of the United Provinces suit sugarcane almost as well as those of Bengal suit paddy : so that, while sugarcane is being sown in the Rohilkhand Circle, the pressing of sugarcane is being finished in the Western Circle. Thus over-population or under-population ceases to be a general question and need be discussed with reference to a certain region only and the methods of agriculture current in that region. While in some areas the average productivity of the land according to existing agricultural methods fails to support an increasing population and lowers its standards, in others there are along with the increase of population better economic organisation and greater social initiative which, reacting on the mental and the moral equipment of the people, maintain a continuity of progress by successive adjustment of resources to growth. The enterprise and organisation of the peasant in Noakhali and Mymensingh or in Travancore, for instance, in reclaiming virgin lands or the shifting banks of the

mighty rivers or the slopes of the mountain tracts, are well known.

We have seen that some regions where the aggregation of population is exceptionally high are still expanding in population; while the standard of living also is rising, though a density has been reached more than five times that which exists in the agricultural countries of Europe. In Europe it seems that the standard of living has been adjusted to a density of not more than 200 to 300 persons to the square mile: the surplus population flows into the cities, and the standard of living in villages is maintained and even considerably improved. In Germany, according to Trunnier, agriculture alone cannot support more than 250 persons to the square mile. The following table gives the density per square mile of different countries and of provinces in India:

Country or Province	Area of Crops (1,000 Acres)	Population (000's omitted)	Density per Square Mile
England and Wales	30,751	37,885	649
Germany	82,241	60,900	332
Japan	15,370	56,000	376
France	90,910	41,476	195
U.S. of America	955,883	117,858	32
Netherlands ..	5,489	6,865	544
Belgium	4,472	7,465	666
Burma	15,188	13,212	57
C. P. and Berar ..	23,668	15,980	122
Bombay	30,916	26,701	143
Punjab	25,676	25,101	183
Bihar and Orissa	25,616	37,962	340
United Provinces	35,562	46,511	411
Travancore ..	1,962	4,006	525
Bengal	24,469	47,592	579
Cochin State ..	—	979	662

Nature of India's Population Problem.—On account of the natural advantages of large and favourable rainfall, agriculture in India can support normally a much larger population than in the less favoured countries of Europe. The choice of rice as the staple food-crop, the introduction of leguminous and catch crops and the utilisation of organic manure have contributed also to the adjustment of soil resources to a dense population. Moreover, in the historical life of an old domesticated people, the moral benefits of density seemed worth the sacrifices resulting from the inevitable delays and imperfections in the adjustment of soil to population. This view was emphasised by the ethnic tradition. The Dravidian races are the backbone of the Indian peasantry, and, being thoroughbreds of the soil, they are virile and fecund. The prohibition of widow marriage, the dislike of female offspring with its consequences and of infant marriage, which all make for a low density of population, are on the whole the characteristics of the immigrant Aryan stocks rather than the aboriginal tribes and castes. Thus, wherever the aboriginal element is stronger in the village population, density is greater. In the Ganges Valley density increases towards the east, and this direction coincides with aboriginal mixture and preponderance in the course of the eastward driving of the Dravidian peoples. But, though the culture was fashioned by the Aryan, it was not an exotic growth but approximated to the simple plane of living of the peasantry of the land. This social solidarity also discouraged disparity of standards of living among different classes. The standard of life has been simple and not too high for any class. There has been no need, therefore, to adopt the methods recently in vogue in Europe, namely, postponement of marriage and voluntary birth-control, with a view to obtain social recognition. The standard of comfort of the socially superior class spreads downward and

affects the masses, thus contributing to the spreading aversion from large families. In Europe we find sharply defined class-standards of consumption due to the aristocratic character of modern industrial society. Industrial development, by bringing about the concentration of population in a few great cities and creating a chronic house famine and squalor, have led also to a revolutionary change in the outlook of the people towards marriage and fecundity. The urban industrial attitude is yet unknown in India ; and thus, where the population is predominantly rural and agricultural and the standards are still derived from agriculture and the village, the birth-control movement cannot strike root, and the problem of population-growth is the problem of the use of land and the organisation of agriculture.

CHAPTER VI

ROBBERY OF THE SOIL

Civilisation's Debt to the Soil.—Social evolution is a vast process, where massive elemental forces engage in an endless interweaving of region and race, and social deterioration carries the idea of an unravelling of the complex web so woven. Biologically speaking, the organism thrives best when in utilising the forces of its habitat it renders also the most effective service. This is a corollary of that symbiotic relation which interlinks the diverse species of plants and animals of a region in a complex chain of reciprocal service and adaptation. The nature and significance of this reciprocity in organic life and evolution have only just begun to be explored and understood. Thus, in agriculture, the development of bacteriology shows that the soil cannot be properly cultivated unless the farmer, in addition to his seed-crop and cattle, has a stock of the proper bacteria, under the given conditions of climate and crop-rotation, to aid him in preparing the soil and in curing the crops. As Conn observes: "Farming without the aid of bacteria would be an impossibility, for the soil would yield no crops, which once again shows the interlocking of the biotic communities of a given region." The wastage of natural forces makes the life struggle more difficult and decreases unity, vigour and efficiency for future generations. This applies more to men than to plants and animals, and more to settled peoples than to hunters and nomadic and pastoral folks. Thus behind the decadence and fall of empires and civilisations we are being made aware of the ever-recurrent phenomenon of soil-exhaustion. Because of soil-depletion fertile valleys have become low and

desolate, civilisation in its onward march having deserted its old settlements when they no longer were able to yield the crops necessary to maintain human life. Just as the flourishing civilisations of Egypt and Babylonia now are buried beneath vast deserts; so Rome, the proud conqueror of the world, was reduced by soil-depletion to a point of exhaustion which now is recognised to have contributed largely to her conquest by the barbarians. The history of modern industrial England took a happier turn because, when soil-exhaustion made agriculture no longer profitable, her people turned to sheep-raising, which change led straight to her modern career as a manufacturer of woollens and her further industrial development. China has been able to preserve her most ancient civilisation, because she has solved better than any other country the problem of maintaining the fertility of the earth, of the closest utilisation of land and of the best disposition of human waste.[1] For forty centuries the Chinese farmers with rare wisdom have combined both irrigation and dry-farming methods to an extent and with an intensity far beyond anything the Western peoples ever have dreamed, that the dense population of their country might be maintained.[2]

Farming Systems in India.—From the *jhum* cultivation practised by some of the hill tribes of the Sonthal *parganas* and the hills of Eastern Bengal and Assam, to the one-crop system practised by planters, there is an immense variety of systems of farming in vogue in this country. The hill tribes of Garo, Khasia, Chittagong and Rajmahal hills are accustomed to hacking down trees, making holes in the ground, and sowing several kinds of seed without using cattle or regular implements of cultivation. *Rahar*, maize, *jowar*, *mesla pat*, *gram*, cow-pea, cotton, Italian millet, *til*, *aus* paddy, cucumber, country beans and pumpkin

[1] Lee: *The Economic History of China*, Preface, p. 13.
[2] King: *Farmers of Forty Centuries*.

are some of the crops, the seeds of which are put in the holes and the crops harvested as they ripen. On the virgin soils of forests, the result obtained is by no means bad. Terracing of hillsides is also widely practised. Rice and potatoes are grown on hill slopes by clearing and levelling them, while oranges, limes, pears and market fruits are also very profitable. The one-crop system is usually in vogue in new regions. In settling in the Sunderbunds, for instance, one finds the one-crop system of growing rice only pays best. But as population increases, the system is altered. Good cultivators avoid as much as possible growing the same crop on the same piece of land two years in succession. They grow, for instance, jute and *aus* paddy or cotton and *jowar* in succession on the same land. Another principle good cultivators follow is to grow a crop of *rahar* or *sunn*-hemp or a pulse crop for renovating their land. In Chota Nagpur plateau the aboriginal tribes and the Hinduised castes who do not bestow the same amount of care on cultivation as the plain people understand very well the principles of rotation. The system of rotation observed by them may be represented thus :

1st year	Millet	(Manured)
2nd year	Upland rice	(Unmanured)
3rd year	*Urid* (a pulse)	(Unmanured)
4th year	*Gondli* (*Panicum miliare*) followed by oil seeds and pulses.	(Unmanured)

The above rotation is sometimes modified by introducing *urid* in the second year between the millet and the rice, the whole rotation thus occupying the same period of four years as before. The introduction of a leguminous crop between two cereals leaves the soil in a state of manurial equilibrium. The Indian peasant generally cultivates a pulse between two staples. He is not, however, aware of the fact that the roots of leguminous crops are more or less rich in

root-nodules, and that these nodules are caused by bacteria harbouring on the roots as beneficent parasites. These bacteria are able to derive their sustenance from the air, which higher vegetation is unable to do. Thus the larger the quantity of root nodules, the greater the amount of nourishment derived from the air and stored in the soil. The advantage of growing beans and clover is well understood in the West, but *dhaincha* and *sunn*-hemp are far richer in root nodules than perhaps any other plants, and being fast-growing they can be grown just before or after the rainy season as a preparatory catch crop and ploughed into the soil for the benefit of the succeeding crops. *Rahar, mung* and *urd* are other plants richly endowed with root-nodules, which improve the soil. Besides providing the soil with organic matter for nitrification, the *rahar* and *mung* plants serve another most useful function. They are provided with a very deep and extensive root system which penetrates and breaks up the lower soil layers and greatly improves permeability and aeration. Howard observes: "The Indian cultivator cannot command expensive power for such deep cultivation and therefore cannot make use of the brute force methods of the occident. He has unconsciously selected an excellent implement for the purpose, which not only does the work for nothing, but at the same time yields a dividend. No implement yet designed can accomplish the work of the *rahar* crop on the small holdings of the alluvium."

Deep Stirring versus Deep Ploughing.—Considering that artificial manures are not used and that cultivation is carried on with primitive appliances, it must be admitted that the Indian peasant shows not a bad yield. Ordinary ploughing means usually a scratching of the surface, and the yield can be improved greatly in dry tracts by deep ploughing and cultivation. Deep ploughing in dry regions increases the porosity of the soil. On account of shallow tillage the peasant's soil

suffers from lack of aeration ; his lands during the rains are flooded and swampy, while during the dry weather they are baked and hard. Deep cultivation will always have more effect on strong stiff soils than on light ones ; they are the soils that particularly need opening up.[1] An experiment recently conducted at Lyallpur agricultural station, Punjab, shows the following interesting results :

Ordinary ploughing here is done with the Rajah plough to a depth of six inches. In deep stirring a *desi hal* follows in the wake of the Rajah and stirs the soil to a further three inches, while the deep ploughing (9″) was done with a tractor. Deep stirring has given the highest yield.

	Yield of *kappas* per acre		
	Mds.	Srs.	Chas.
Rajah ploughing, 6″	9	18	9
Rajah ploughing plus stirring, total depth 9″	10	22	4
Deep ploughing, 9″, plus stirring ..	8	26	7

It appears from the results that loosening the soil beneath the inverted surface has a beneficial result on the output whilst inverting the lower layers of soil acts detrimentally.

The following statement shows the profit and loss of deep ploughing and deep stirring versus ploughing 6″ deep in the same plot :

Treatment	Average yield per acre	Price of the yield at Rs.17.8.0. per maund	Value of the increased (+) or decreased (—) yield	Cost of these operations	Extra cost of cultivation	Net profit (+) or loss (—)
	Md.sr.ch.	Rs. a. p.	Rs. a. p.	Rs. a.p.	Rs. a.p.	Rs. a.p.
Rajah plough 6″ deep ..	9.26.8	169. 1.6		1.12.0		
Deep stirring 9″	10.22.4	184.11.9	+15.10.3	3. 6.0	1.10.0	+14.0.3
Ploughing with tractor 6″ deep	9.10.8	162. 1.6		5. 9.0		
Ploughing with tractor 9″ deep	8.26.7	151. 9.1	—18. 8.5	7. 3.0	1.10.0	—12.2.5

[1] Benson, quoted in Basu's *Notes on Indian Agriculture.*

Tractors.—Thus while deep stirring shows a gain of Rs. 14. per acre, deep ploughing results in a loss of Rs. 12. per acre. As regards tractors the caterpillar machine appears to give better satisfaction than the wheeled on light sandy soils or in after cultivation, owing to the fact that the wheeled tractor loses some of its power through the wheels not gripping the soil thoroughly. For ploughing hard soils or hauling loads on metalled roads, the wheeled type is likely to give better wear and costs less. As against deep ploughing it is maintained that deep cultivation is not from the point of view of liberating plant food so essential in warm climates as in cold climates. Mr. Mollison's remarks in this connection are worth consideration: "To those who are sceptical I can state that in parts of the Bombay Presidency cultivation by means of indigenous tillage implements only, cannot be excelled in respect of neatness, thoroughness and profitableness by the best gardeners or the best farmers in any other parts of the world. This statement I deliberately make, and I am quite prepared to substantiate it."

Rotations, Mixtures and Fallowing.—The practice of growing different crops in rotation has been known and practised in India from very early times. But the system is adapted chiefly to suit the rainfall or water-supply from the wells or canals. In densely-populated regions the cropping is most intense. It ought to be mentioned here that the superficial erosion of the soil by heavy rain produces considerable deterioration in the quality of land in tropical and sub-tropical regions. Deep ploughing has proved to have little effect in reducing erosion losses, and the only way to reduce the run-off, which has so detrimental an effect, is by selecting a rotation of crops that will ensure the ground being covered as long as possible with vegetation. Three crops are seen growing at the same time in some areas: one ripe for harvesting, another just sprouting and the other at the stage when it is taxing the soil

most. By such multiple cropping, with heavy fertilisation, and by irrigation, the soil is made to do its duty throughout the growing season. In addition to rotation, the practice of growing mixtures is prevalent throughout the country. Common mixtures seen in Northern India are the following: wheat and barley, barley and *gram*, barley and peas, linseed and *sesamum*, etc. The reason for such mixtures is that they represent the farmer's second string. Fallowing also is practised widely, the cattle being tethered in the fallow land for a whole year. A remarkable practice prevalent in Western India is that of conserving the soil-moisture by means of a fine mulch and inter-culturing, which follow the dry-farming principles.

Manuring Practice.—As regards manuring, the practice differs greatly in different parts of India. The most generally used manure is, of course, cow-dung, which is dumped in a common pit at one end of the village to be used by the cultivators as in South India, or is dressed in the fields of the individual cultivators as in other parts. Fresh dung applied to plants has a negative effect; that is, it decreases the yield owing to the denitrifying action of bacteria. For this reason the manure is left to decompose, or ferment, on the dung-heap or the field. Although nitrogen is the most expensive fertiliser and constitutes the most valuable part of farm manure, 30 % of this substance is lost in the dung-heap even on well-managed farms. Further, it has been found by experiment that, when the manure has been dug in, only 25 to 70 % of the initial nitrogen is used by the crop. Thus it may be said that, under the most favourable conditions, barely 17 % of the initial nitrogen of the dung is used by the plants. In Madras experiments on a large scale are being made to ascertain whether it is possible to devise a method of storage which is not too costly for the cultivators and which will reduce the loss of plant-food to a minimum.

Four methods are being tested: (1) The box system, in which the manure is compacted by the cattle themselves; (2) a pit system with urine trap; (3) the pit system with soil; (4) a heap method, in which no precautions are taken either to collect the liquid portions or to protect the manure heap. Preliminary analyses have shown that box-made manure is richest in nitrogen. Dr. Krantz has devised a method for improving the quality of farm manure and increasing the utilisation of nitrogen by plants. The object of the Krantz process is to regulate this fermentation, which it does by (*a*) rendering the insoluble proteins available for plants, (*b*) destroying the denitrifying bacteria, (*c*) arresting fermentation after these two objects have been attained. As a result of this process, the dung keeps well, does not part with any of its nitrogen and supplies to the plants substances that are easily assimilated, thus greatly decreasing the losses on the field. A portion of the field obtains a regular supply of house sweepings, ashes and cattle manure, and cattle and sheep are sometimes folded on the land during certain seasons. Bones also are scattered often on the village grounds and replenish the soil. In Western India the cultivators do not manure at all. The reason is that, in a tract of light and badly-distributed rains, a heavy dressing of manure will render the soil conditions worse for the crops. Mann observes: "The uncertainty of the suitability and timely character of the rainfall makes expensive manuring on dry land a very risky matter. It is far more risky, indeed, than anyone who has had only to do with agriculture in Europe can conceive, and when it involves an out-of-pocket expenditure, as for the purchase of artificial manures, is a perfect gamble." On the other hand, in some tracts it is usual to find heavy dressing with manure. Melons, maize, sugar-cane, cotton and wheat are generally well-manured. In some parts of Eastern Bengal the system of improv-

ing land by drainage or flooding is similar to that practised in Italy and Spain. Farming in India is of various degrees of excellence. Long experience governs the practices of cultivation and the choice of crops, which are admirably adapted to the physical conditions, especially to the quantity and distribution of rainfall. The latter is so capricious that it makes local variations of methods inevitable.

Evolution of Agriculture.—If we look back to the history of culture we shall find that man is learning by a gradual process of trial and error the most careful husbandry of the resources of the region. In the earliest stage, man gathers his food directly from nature; the sources of his food are hunting, fishing and the collection of wild plants. Hunting, by elimination of the less cautious creatures, eventually makes the game scarcer and shyer, so that the tribe may have to look for another food basis. Whether a hunting folk passes to cattle-rearing or husbandry depends entirely on the fauna and flora at its disposal, says Muller-Lyer. He alleges that the plan adopted by the hunting races of driving wild beasts into a huge enclosure, and so preserving them for future use, must have been one of the earliest forms of cattle-rearing. In the pastoral stage, Ross observes, the continual escape of the wilder creatures from the herd and the resultant breeding from the more tractable completes domestication and paves the way to the adoption of agriculture. Even now man roams about with his flocks, which devastate the regions through which they pass. The more man finds, however, that he must live a peaceful settled life, the less lavishly he uses the gifts of the mother earth. At first there is no true agriculture but mere scattering of seeds in fertile soil and the reaping of the bountiful harvest. Then the ground is worked only superficially with the hoe, without plough or draught beast; it receives but little manure, and the area constantly has to be

changed. By degrees man learns that to get the best from the plant it must be nursed. Arable farming is the endeavour of the farmer to make the conditions such that the plant will do what he wishes. His effort is to please the plant. The application of manure and the whole of the operations connected with tillage, which involve an immense amount of thought and labour, are carried out with the object of preparing food materials and a habitat for the plant so that the latter may manufacture the products desired. If he does not provide a comfortable domicile, properly drained and aerated, with adequate food materials and water, the plant retaliates by giving a poor return. In addition, the proportion of the various products yielded, namely, green vegetable matter, seed and fibre, depends on the environment.[1] Nor should we ignore, in this connection, the part played by micro-organisms existing in the soil which can come to man's rescue and help him in increasing the store of his soil nitrogen and in making it available to the crops. Nitrogen fixation by such micro-organisms has been found to be of comparatively great importance in the tropical regions. And perhaps the early growth of agriculture in the monsoon regions may be due to the help that these bacteria gave to primitive man working with the hoe in the swamp rice-lands.

Stages in Agricultural Evolution.—The most important stages through which agriculture has passed are the following:

(*a*) Burning or brand tillage, the crude pasture husbandry, which is used in the first endeavours to wrest land from primeval forest or steppe. Manuring is effected only by the ashes of burnt plants or by pasturing cattle in the field.

(*b*) Hoe cultivation. This also is a primitive effort

[1] Howard: "The *Rôle* of Plant Physiology in Agriculture," *Agricultural Journal of India*, Vol. XVIII, Part III.

towards soil utilisation which was generally adopted in monsoon regions. This was superseded gradually by plough culture.

(*c*) The field system, where the arable land is divided into fields, mostly three—the three-field system—of which the one lies fallow, the second is planted with summer and the third with winter grain; the fallowing saves manure and labour.

(*d*) Meadow husbandry, by which a few years of pasture alternate with a few years of grain culture. Mixed cropping also may be practised which to some extent serves the purpose of (*e*).

(*e*) Rotation of crops. This distinguishes between plants which enrich the soil, such as clover, tobacco and pulse, and plants which impoverish it, such as grain, oil-plants, flax and hemp; and these are changed in regular rotation. The fallow year is abolished; the increase in the output of forage makes stall-feeding possible, and the land generally is cultivated more intensively, thus leading to greater demands for labour, capital and improved agriculture.

(*f*) Horticulture, prevalent as in Japan and China and in the well-irrigated regions of India, which is far superior to all other forms of cultivation of the soil.

Rise of Intensive Agriculture.—As man finds that he cannot overrun an unlimited area for food, intensive agriculture is initiated, and this leads to a denser population than hunting, pasturage or hoe-culture. Since greater care is bestowed on the land, there is more abundant return which leads to the fixity and consequently greater progress of civilisation. The alluvial soil is far less dependent on manures than other soils, reducing the labour and expense of cultivation to the minimum. But even the most fertile soil cannot bear continuous exhaustion. Thus in the richest

valleys the land is allowed to lie fallow or bear a rotation of crops.

Population-bearing Capacity of Land under Various Conditions.—According to Semple the approximate number of persons who can be supported under the different stages of economy is as follows :

Hunter tribes require from 70 to 200 sq. miles per capita.

Hunter tribes, employing some primitive agriculture, $\frac{1}{2}$ to 2 sq. miles per capita.

Pastoral nomads have a density of 2–5 per sq. mile.

Pastoral nomads, practising some agriculture, 10–15 per sq. mile.

Agricultural people with primitive methods, 5–15 per sq. mile.

Agriculture with European methods in colonial lands, 25 per sq. mile.

Agriculture as practised in Central Europe, 100 per sq. mile.

Agriculture as practised in Southern Europe, 200 per sq. mile.

Agriculture with some industry, 250–300 per sq. mile.

Industrial districts, 500–800 per sq. mile.

The population which is supported by intensive agriculture as practised in India and China is even considerably greater :

Agriculture as practised in Eastern Bengal, 1000–2000 per sq. mile.

Agriculture as practised in Central China, 3,500 per sq. mile.

Pastoral Industry in Evolution.—In the hunter stage, which is a stage of culture universally passed through in the transition from animal existence to that of men, man kills first whatever animals he meets with. Gradually he learns to discriminate between tolerant animals which he protects and intolerant animals against which he wages war. Then he finds that it is

more useful to breed the gregarious animals and succour their young, even for the purpose of consuming their flesh. In this cattle-breeding stage, man first slaughtered animals at all periods of their lives and exhausted pasture-lands. Gradually he has developed care of gregarious animals, breeding of stocks for particular conditions of climate, and their improvement, to which entomology, with its discoveries relating to insect carriers, and veterinary science, now are contributing. Rich pastures have followed as a result of the expenditure of much capital, labour and skill.

"Robber Economy" a Cause of Migration.—The pastoral industry, when carried on by extensive as contrasted with intensive methods, involves essentially destructive exploitation of the natural vegetation—is, in fact, a mode of "robber economy." Like all forms of such "economy" it tends to be short-lived, for it destroys the natural balance upon which it depends. It seems therefore that it is not necessary, as often has been done, to postulate marked climatic changes to account for the migrations of pastoral peoples in the earlier days of history. Such movements may originate in a season or successive seasons of extreme drought, but it is not necessary to regard drought as the sole cause, which should be sought rather in the cumulative effects of mismanagement of grazing lands and the progressive decrease in the "economic value" of annual rainfall.[1]

Fish Conservation.—As fisher, man has killed distinct species of fishes by reckless fishing during the breeding season or by indiscriminate capture of spawn. But gradually there arises the need of discriminate fishing and protection and artificial breeding of fish.

Natural Bounty Foiled by Human Waste.—As an agriculturist man often uses wasteful methods, thereby impoverishing and exhausting the soil which ultimately

[1] *The Scottish Geographical Magazine*, Vol. XXXIX, p. 193.

refuses to yield. Often also the natural fertility of the soil discourages skilful agriculture and manuring, as the result of which the soil becomes gradually barren.

Recent investigations into the composition of river water in India have brought to light the significance of this bounty of nature in supplying nitrogen in large quantities to the soil. Ross and Bagchi have collected statistics showing the analysis of the water of the Ganges and the Son at different seasons of the year. Their results have been much more far-reaching than they have anticipated. The reaction of the water during the cold weather is alkaline; but, beginning about April, and stopping about October, the reaction is acid. This acidity is caused by the precipitation of free nitric acid with the rain and it is found that such precipitation of nitric acid is associated with thunder-storms more than with the rains of the monsoons. As the acidity becomes greater, the content of calcium nitrate increases also. The analyses in three separate years have shown almost identical results. In a single hailstorm as much as one-eighth of a ton of nitric acid may fall to the square mile. Herein lies the explanation why the land in the plains of India, though it gets little or no manure, still retains its fertility. Statistics showing the precipitation of nitric acid in England give a figure only about one-eighth to one-tenth of what is found here. And yet it is this bounty of nature which is responsible for the backwardness of farming methods in the river valleys, where the population is densest. A considerable portion of Northern and Eastern Bengal has its fertility renewed every year by a deposit of silt during the rains, rendering the soil less dependent on artificial appliances. In considerable tracts the land is washed away every year, and manure if applied would not be here of much use. But instances are not wanting of manure easily available being wasted even in places where its use is certain to be attended with good results.

A full crop in most parts of Bengal requires good and well-distributed rainfall and a moderate inundation. The greater the dependence of the harvest on the local rainfall, the greater the importance of manuring and irrigation. Thus, as regards their skill in the art of agriculture, the peasants of Rajshahi district are in a backward condition when compared with their brethren of the Burdwan and Hughli districts in Bengal. The system of cultivation followed by them is more primitive and is confined to the growing of fewer crops. The time-honoured and routinist practices here continually impoverish the soil, and the proportionate yield would have diminished to a very serious extent but for the fertilising silt and replenishing water. Thus those regions of India which have to struggle with drought and infertility show improved farming practice, which if adopted throughout the country would have rationalised our agriculture.

CHAPTER VII

PERMANENT AGRICULTURE

Phosphate Exhaustion and Supply.—Conflicting theories are held regarding the fertility of soil in India. Some experts hold that the evidence of soil-exhaustion must be accepted as final. This evidence is not based merely on the theory that, while much is being taken out of the soil, very little is being put back; but also on practical demonstrations of increased production resulting in some areas from generous and continuous application of manures. Soil surveys carried out recently by the Madras Department of Agriculture have brought prominently to notice the fact that soil-exhaustion in respect of phosphates is not localised but spread all over the Presidency. The extent of the phosphate deficiency in the rice-growing tracts can be gauged from the following:

Areas Surveyed	Phosphate Deficiency per cent.
Godavari Delta	23
Kistna ,, ...	33
Guntur ,, ...	33
Tanjore	80
Periyar Tract	70

An investigation in Sabour shows that the soil contains only 0·11 per cent. of total phosphoric acid, a value which is however probably higher than would be given by many other soils in Bihar to-day. The phosphoric acid in the rice grown at Sabour is always

far lower than in Hawaiian rice, which is grown on soil containing 0·48 per cent. of P_2O_5.[1]

It appears that in most of the paddy-growing tracts of India where cereal crops are taken in endless succession the soil is depleted mainly of phosphates. Fortunately, such soils are rarely deficient in lime as well; so that these soils respond readily to the application of manures.[2] The results of experiments show that the phosphate has been exhausted more rapidly than the nitrogen and now has become a limiting factor, under which the addition of nitrogen alone produces but a small increase of crop, whereas the effect of phosphate becomes more marked each year. Thus the percentage of nitrogen or potash in the grain has not been increased by the addition of either or both of these substances to the plots. Again, the percentage of phosphates in both grain and straw varies with the amount of phosphate available, the average difference in the case of *cholam* between the phosphate and non-phosphate plots being 60 per cent. in the grain and 122 per cent. in the straw. The addition of phosphate also has enabled the grain to take up a further supply of potash, though the difference is not in this case anything like so marked. The figures in the table on the following page show that paddy crops manured with phosphatic manures have been found by analysis to contain more phosphoric acid than a crop which had been manured with a non-phosphatic manure.

The importance of an adequate supply of phosphate is thus two-fold, for not only does any deficiency reduce the yield, but also it seriously lowers the food value of the crop both in grain and straw. It may be suggested that the increase of leprosy in the rice tracts of Northern Orissa, South-Western Bengal, Deccan

[1] Davis: "The Phosphate Depletion of Bihar Soil," *Agricultural Journal of India*, 1917, p. 181.

[2] *Proceedings of the Board of Agriculture in India*, 1919, p. 90.

and Madras, is connected with exhaustion of soil and deficiency of food values of rice grains. Perhaps it is argued that any deficiency of nutritive constituents in rice can be made up by supplementing the diet, as is usual, with other foods. But many of these foods also, such as pulses grown on impoverished soils,

Manure Applied	Percentage of P_2O_5 contained in the Grain
I. No manure	0·33
350 lb. of superphosphate	0·54
250 lb. of mineral	0·51
250 lb. of bone-meal	0·58
II. No manure	0·37
Green manure, 2000 lb.	0·33
Green manure, 2000 lb. plus 80 lb. sulphate of potash	0·41
Green manure plus bone super	0·54
Green manure plus sulphate of potash plus bone super	0·52

probably are deficient in phosphates and fall short to a corresponding extent of their full nutritive value. A deficiency of phosphate in cattle-food limits the growth of cattle and the yield of milk. It is well known that, on the poorer soils, cattle diminish in size and also yield far less milk.

Doubts as to Soil Exhaustion in India.—Other experts hold, on the contrary, that there is extraordinarily little evidence to show that the soils in many parts of India are liable to rapid exhaustion if not manured; on the other hand, there is a great deal of evidence to show that their recuperative powers is very high and their response to good cultivation large. The Cawnpore farm contains plots which have been sown with wheat annually for 35 years. All have been unmanured for

six years and some for much longer periods. In 1917, a plot which had been unmanured since 1883 yielded 1766 lb. of wheat per acre, a plot unmanured since 1898, 1742 lb.; and two plots unmanured since 1908, 1754 lb. and 1700 lb. per acre respectively.[1] It is interesting to compare these figures with the average yield of 1555 lb. of wheat from an acre of land as recorded in the *Aiyan-i-Akbari*.

Problem of Soil Exhaustion—Natural Recuperation.—The problem cannot be solved by any arithmetical theory of agriculture. The texture of soil varies in different parts of India and the practice of deep or shallow ploughing and its discontinuity alter the accounts between the crop and the soil. Under the conditions of Indian agriculture, fertility is maintained by the introduction of leguminous crops and fallows, combined with a limited amount of cattle manuring.

On alluvial lands or wet soils the conditions of nitrogen fixation are far different from those on unirrigated lands or dry soils. In certain districts of the Punjab wheat follows wheat in continuous succession without any addition of manure. Investigations made in nine different localities have shown that, between April and October, the nitrogen content of the soil, on the average, has doubled itself. But the most striking example of the natural recuperation of Indian soils seems to be the Sind fallow. On this tract very fine crops of millet are grown continuously without manure or a leguminous rotation. The land, however, is rested for at least two years between the crops.

Nitrogen Fixation and Green Manure.—The nitrogen fixation processes in these soils urgently call for investigation.[2] Nitrogen fixation is found to be active

[1] *Proceedings of the Board of Agriculture in India*, 1919, p. 83.

[2] G. E. C. Howard, in *Proceedings of the Indian Science Congress*, 1924, p. 260.

in river silt and a vigorous growth of algæ occurs in this medium in diffused light. More than double the quantity of nitrogen is fixed in the light than when the silt is kept in darkness, thus affording evidence of the symbiotic relationship existing between the algæ growth and that of azotobacter. The symbiotic relationships with algæ are naturally of extraordinary interest in India where these organisms are present in every soil, and it can be only a matter of time and further research along the right lines before we are able to indicate in what manner the management of the soil may be modified so as to increase the amount and rate of nitrogen fixation taking place naturally therein.[1]

A typical curve for nitrate accumulation has been obtained at Cawnpore. In Upper India conditions for nitrate accumulation are favourable at two seasons: (1) immediately after the first rains of the south-west monsoon in June or July; and (2) at the beginning of the cold weather season in October. These months coincide with the beginning of the two agricultural seasons and occur just before the sowing of the cold weather (*kharif*) crop and the summer (*rabi*) crop.

The system of agriculture at present practised in Upper India has established a position of equilibrium in which the nitrogen removed by the small crops produced, and the inevitable losses of nitrate by leaching and imperfect surface drainage during the rains, are balanced by the recuperative agencies which add nitrogen to the soil. There is no evidence that cultivated land is either losing or gaining in fertility. Much of it seems to have reached a position comparable to the permanently unmanured wheat plot at Rothamsted, which for the fifty years preceding 1911 gave an average yield of 12·5 bushels (equal to

[1] *Annual Report of the Board of Scientific Advice for India*, 1922–23.

9·45 maunds) per acre.[1] Moreover, the inclusion of a legume, which enriches the soil in nitrogen, or, again, the system of fallowing, under which nitrogen losses occur, influence greatly the recuperative power of soils. It has been proved in the chemical laboratory that wet-land paddy does not take up its nitrogen in the form of nitrates, and researches on the biological activity of swamp paddy-soils made by Harrison and Subramanya Ayyar have shown further that very large quantities of free nitrogen are given off from swamp paddy-soils, and that these quantities are much greater in soils which have been manured with green leaves or bulky organic manures. Pot experiments conducted by them showed also that the addition of sulphate of ammonia to green leaf as a manure caused a very large increase in crop and that by the use of a nutrient solution, where the nitrogen was supplied solely in the form of ammonium sulphate, it was possible to raise a crop of swamp paddy in soil conditions which gave practically no crop when the manure consisted of green leaves. Green manure crops grown on the fields and puddled in green, improve the texture of the heavy clayey soils. In years of heavy summer showers, when the physical texture of the soil is spoiled, the benefit of green manuring may not show itself, but its effect is not lost. Sowing green manure crops in the standing crop of paddy accordingly is recommended by all agricultural chemists.

The amount of nitrogen fixed by the leguminous green manuring plant, *dhaincha*, for instance, when grown in nitrogen-free sand, has been studied in Bihar. It was estimated that a 50–60 day plant gave on the average 2·62 grains of nitrogen and 0·074 lb. of green matter. Thus the profit and loss account cannot be gauged without reference to the physical properties of soils, the conditions of rainfall and irrigation, deep or

[1] Clarke and Banerji: "Some Aspects of the Nitrogen Problem in India," *Agricultural Journal of India*, 1922, Vol. XVII, Part I.

surface tillage, the rotation of crops, the use of green manure, fallowing, etc., adopted in different parts of the country.

Another most remarkable result has been the re-establishment, by a single ploughing-in of a green manure, of the fertility of a series of plots "phosphated" five years ago which had to all appearance, through repeated cropping, dropped to a lower scale of fertility, the non-phosphated check plots showing no such results. The importance of the results from an economic point of view alone has led to the initiation of experiments designed to throw light on this interesting problem, with special reference to the possibility of bacterial intervention playing a considerable part in the matter. A field-scale experiment confirmed the conclusions drawn from small plots in the previous season that in using *sannai* as a green manure it might be advantageous to combine with this operation the separation of the stems as a source of fibre, the tops and leaves alone being buried in the soil.[1]

In the Punjab a fixation of nitrogen amounting to an increase of 30 per cent. of the total amount in the soil has been observed to be common, and in one instance it reached 75 per cent. without the addition of any carbohydrate. These figures represent enormous quantities of nitrogen which would take impossible sums of money to purchase in the form of manures, and show not only the vital part played by soil bacteria in the agriculture of North-West India, but also the great possibilities which may follow on an investigation into the controlling factors.

Importance of Nitrogen Research.—Generally speaking, it may be said that the solution of low agricultural yields in the plains of India lies not in manuring, but in an investigation of the conditions governing nitrogen fixation and the conditions under which nitrogen losses occur. Where such conditions are favourable, the

[1] *Review of Agricultural Operations in India*, 1922–23, p. 54.

land does not show any decline of fertility, though it may be without manures for a long period. In areas of deficient or precarious rainfall, on the other hand, plants have to live on a deep-root system. It is in these regions that the absence of continued manuring is accompanied by loss of fertility. Manuring here becomes merely a top-dressing and the result is that there is a tendency for crops to feed near the surface, which greatly affects their powers of resisting drought. If the crop is to resist drought, plant-food must find its way deeper into the soil where the roots of the crops normally should develop. Thus, in most parts of the Bombay, Deccan, the Central Provinces and the Madras Presidency, the evidence of soil exhaustion is forthcoming in the absence of regular and systematic manuring, or of deep tillage.

Pusa Experiments in Green and Chemical Manuring.—Experiments have been conducted in some permanent plots at Pusa with a view to determine (*a*) the specific effect on soil fertility of the more important organic and chemical manures applied alone and in various combinations on a two-year four-course rotation; (*b*) how far soil fertility is affected by growing in rotation leguminous crops (1) removed from the land, (2) returned to the land in the shape of green manure.

The following series is a comparison of the croppings under a purely cereal rotation against those from rotations which include pulse crops. The cereal rotation is one of alternate crops of maize and oats, whilst one leguminous rotation is maize, *rahar*, maize and oats over a period of two years, and the other is one of maize, *rahar*, maize and oats and peas. That is, one rotation is to evaluate the effect of a deep-rooted pulse crop, and the other to test the effect of a combination of deep and shallow-rooted pulse crops. Of these the former corresponds to the no-manure plot of series *A* and *B*.

The results obtained are as follows:

A. Effect on Cereal Crops.

Treatment	Plot Nos.	MAIZE					OATS				
		Yield per Acre		Percentage Increase or Decrease		Ratio	Yield per Acre		Percentage Increase or Decrease		Ratio
		Grain	Straw	Grain	Straw	Grain / Straw	Grain	Straw	Grain	Straw	Grain / Straw
No legume in rotation ..	11A, 11B	726	1,793	—	—	1 / 2·47	446	926	—	—	1 / 2·08
Deep-rooted legume in rotation	13A, 13B	783	1,774	+7·9	−1·1	1 / 2·26	485	1,094	+8·7	+18·2	1 / 2·26
Deep and shallow legume in rotation	14A, 14B	839	1,799	+15·5	+0·3	1 / 2·14	322	683	−27·8	−26·2	1 / 2·12

B. Effect on Leguminous Crops.

The only comparison which can be made in this case is the yield of *rahar* when grown in an otherwise purely cereal rotation and of *rahar* when grown in a rotation which also includes a shallow-rooted legume.

Treatment	Yield per Acre			Per cent. Decrease			Ratio
	Grain	Bhusa	Stalk	Grain	Bhusa	Stalk	Grain / B + S
Rahar and cereal crops only ..	772	1,353	3,567	—	—	—	1 / 6·46
Rahar with cereals and peas ..	698	1,305	3,550	−9·5	−3·5	−0·5	1 / 6·97

C. Conclusions.

Regarding maize, it is evident that the benefit due to the inclusion of legumes in the rotation is positive so

far as the yield of grain is concerned, but the increases obtained are not of great magnitude and there is *practically no change in the weight of straw produced.*

No valid comparison can be made in the case of oats, for the reason that in the rotation which includes both deep- and shallow-rooted legumes the oats are grown as a mixed crop with the peas, and this alone is sufficient to account for the definite decrease observed. The average crop of peas taken off these plots is 179 lb. grain and 335 lb. straw per acre, *i.e.*, the total mixed crop was 501 lb. grain and 1,018 lb. straw. All that can be said is that the introduction of a deep-rooted legume into a cereal rotation has resulted in a slight increase in the crop of oats produced.

Green Manure Experiments: Effect of Green Manures alone and in combination on Cereals.

Treatment	Plot Nos.	MAIZE					OATS				
		Yield per Acre		Percentage Increase		Ratio	Yield per Acre		Percentage Increase		Ratio
		Grain	Straw	Grain	Straw	Grain / Straw	Grain	Straw	Grain	Straw	Grain / Straw
No green manure or legume	11A, 11B	726	1,793	—	—	1 / 2·47	446	926	—	—	1 / 2·08
Green manure, no legume	12A, 12B	1,040	2,038	+43·2	+13·7	1 / 1·90	690	1,143	+54·5	+52·6	1 / 2·05
Green manure and legume	15A, 15B	1,069	2,251	+47·2	+25·5	1 / 2·10	718	1,357	+60·8	+46·6	1 / 1·89
Green manure, legume and superphosphate	16A, 16B	1,458	2,841	+101	+58·4	1 / 1·95	1,451	2,330	+225·3	+152	1 / 1·60

Natural *v.* Commercial Manures.—Agricultural experts find commercial fertilisers less useful than

natural manure of animals fed on the soil. Manure adds bacteria as well as chemical food. It helps to keep a proper alkalinity in the soil. It adds various ingredients that help to form humus in the soil, resulting in a better texture and more lasting benefit.

Investigators seem to agree that in the case of the leguminous crop in the rotation large quantities of nitrate impede nitrogen-fixation. Thus farmyard manure is found more suitable for legumes than commercial fertilisers and oil-cake. Manuring the leguminous plant in the rotation is a fairly common practice in India. *Rahar*, the chief leguminous crop of Northern India, is sown often with maize on manured land; while, on the Frontier, the most profitable method of maintaining the fertility of the soil is to manure leguminous fodders such as lucerne or Persian clover.[1]

We know now that, in the matter of crop production, it is not only the chemical ingredients of the soil that count. The study of the biological changes in the soil is bringing to light the conditions of absorption and assimilation of food by plants. Deep tillage for the free aeration of soil, application of lime to remove acidity and increase bacterial activity, inclusion of a legume in the rotation of crops to enrich the soil in nitrogen, subsoil drainage to prevent the accumulation of injurious alkali salts on the surface-layer—these are some of the improvements in agriculture introduced as a result of soil research in these fields.

Dry Farming.—In America, the study of physical properties of soils has received special attention and the system of dry-farming is the direct outcome of this study. Dry-farming is nothing more than the scientific treatment of soil. It is practised in dry and arid

[1] Howard: *Bulletin* 119, Agricultural Research Institute, Pusa, 1921.

regions, where the rainfall is scanty. The method consists in so manipulating the soil as to conserve the little moisture that is available, by deep and constant cultivation of the soil. In this way arid lands which have been considered unprofitable have been brought under cultivation. It is rather remarkable that in India, where the saving of water is so important in areas of deficient or precarious rainfall, hitherto no systematic study has been made of the applicability of dry-farming methods. The black cotton-soil areas of the Deccan especially need very careful investigation in this respect.

Monsoon Regions and Wet Soil Conditions.—In the monsoon regions bad soil conditions induced by the abundant rainfall and the rise of the subsoil deserve special attention.[1] The conditions under which nitrification, nitrogen-fixation and denitrification take place on wet lands have not been investigated at all. During the rainfall, many of the plants live entirely on the surface roots, being deprived of the active lower root system, which perishes. To this may be due the widespread prevalence of surface cultivation in India, since deep cultivation would do the surface-rooted plants more harm than good, apart from bringing about a more rapid evaporation. Herein is seen the need of studying the texture of the soil, aeration and other physical conditions. The agriculture of Northern India as a whole is characterised by great variety of cropping, coupled with distinctly short growing periods, which not only impose severe limitations as regards choice of varieties but also make the crop unusually dependent on an adequate supply of moisture and plant-food at certain critical stages of growth. Burt points out that with exceedingly deep soils the probability of nitrates being entirely lost to the soil by drainage is small, but

[1] N. K. Pillai: "Recent Soil Researches and their Application to Practical Agriculture," *Agricultural Journal of India*, Vol. VIII, Part IV.

from the standpoint of a particular crop it is important that an adequate supply of nitrate should be within root-range at certain periods, *e.g.*, at tillaging time for wheat and barley. The bearing of this requirement on irrigated cultivation is obvious. In heavy rainfall tracts the nitrates move during the monsoon to a considerable depth from which in normal seasons they do not rise with soil moisture to within root-range. This has a direct bearing on cultivation and manuring during the monsoon period.

Soil Bacteria and Nitrogen-Fixing Legumes.—Again, the biological changes that take place in swamp rice soils ought to receive special consideration. The study of the micro-organisms found in wet rice and jute lands, and their classification into beneficial or deleterious organisms, bring to light special circumstances and conditions of rice and jute agriculture. Recent investigations have shown that the algal film on the rice, like green plants, is a source of bacteria and brings about nitrogen fixation as well as a continuous aeration of the roots of the rice plant and of the subsoil. Thus the requirements of the algal film as regards minerals and light, the part it plays in the growth of the crop in such operations as green-manuring, and the various methods by which its activities can be increased, are matters which may easily prove as important in rice production as the selection of a higher-yielding variety of paddy.[1] Successful agriculture is, indeed, indissolubly bound up with the problems of the proper handling of bacteria in relation to the soil and plants, and of nitrogen used as a food for the draught animals and as a food for the crops in the form of manure under any given conditions of climate and rotation of crops. It is now becoming manifest that bacteria are associated ultimately with many normal processes which are going

[1] Howard : *Crop Production in India*, p. 114 ; Jatendranath Sen : *A Study in the Assimilation of Nutrients by the Rice Plant*.

on in the soil, water and elsewhere, and that they are fundamental to the processes of agriculture. It is also practically certain that nearly all soils contain bacteria capable of living in symbiosis with leguminous plants. Nearly all soils, excepting extremely sandy soils that support little or no vegetation, will support leguminous plants and develop tubercles on their roots. Not all species of legumes, however, are capable of developing root-tubercles equally well in all soils. Some soils will support luxuriantly species of beans, peas or clovers, producing a large crop, developing quantities of tubercle and fixing an abundance of nitrogen, while the same soil will not support other species of legumes. It becomes evident that there are different types of leguminous bacteria, each adapted to different species of legumes. Thus the problem of determining the best practical method of making use of the power possessed by legumes of fixing nitrogen through the aid of tubercles, which will make possible a cultivation of the soil without exhausting its nitrogen, resolves itself into the following: (1) Selection of legumes which grow luxuriantly on soils not particularly well fertilised and which, at the same time, produce the most abundant tubercles upon their roots; (2) Ensuring the presence of bacteria appropriate to the particular legumes (soil inoculations with legume earth are often adopted); (3) Green manuring, which consists in allowing the legume to grow luxuriantly and then in ploughing the whole crop into the soil, when it is brought within reach of the soil bacteria; (4) Reaping legumes and feeding them to animals, the roots and stubble only being ploughed into the soil, and then returning to the soil the portion fed to animals in the form of manure. By maintaining a proper balance between plants and bacteria under any given condition of soil, climate or crop-rotation, we may secure for the next crop a store of nitrogen considerably in excess of that before possessed by the soil, and thus make

agriculture possible without soil exhaustion.[1] In India climatic conditions and the high temperature of the soil enormously enhance the activity of soil bacteria and with it the importance of such methods of adding to the fertility as depend upon their action. All this involves the necessity of due consideration when introducing Western agricultural methods into the East. In the West complete drainage and cultivation are the foundations of successful farming; in India, although the same operations generally will result in an increase of crop and of apparent fertility, yet the ultimate result easily may be deterioration in the condition of the soil due to over-rapid formation of nitrates, and their loss in drainage-water, and to the rapid decrease in the content of organic matter in the soil accompanied by loss of tilth and of nitrogen-fixing power. In unirrigated soils of the Gangetic alluvium, the growth of cold-weather crops is sometimes considerably prejudiced by the undue concentration of nitrates in the surface-layer, leading to the formation of a highly superficial root system incapable in many cases of obtaining sufficient moisture from the subsoil to secure complete growth. On the other hand, there is the practice known in the Shahabad District as *nigar* of running off the water from the rice-fields some time before maturation of the crop; it appears probable that this method results in the formation of nitrates which are supposed to conduce to proper ripening of this crop, although fatal in the earlier stages.[2] King observes: "It is a noteworthy fact that the excessive development of alkalies in India, as well as in Egypt and California, are the results of irrigation practices modern in their origin and modes, and instituted by people lacking in the traditions of the ancient irrigators who had worked these same lands thousands of years

[1] *Vide* Lipman: *Bacteria in Relation to Country Life*; and Conn: *Agricultural Bacteriology*.

[2] Hutchinson: "Biological Factor in Soil Fertility," *Agricultural Journal of India*, 1925, p. 272.

before. The alkali lands of to-day, in their intense form, are of modern origin due to practices which are evidently inadmissible and which in all probability were known to be so by the people whom our modern civilisation has supplanted."

Indian Manure Economy.—N. G. Mukerjee has observed of Indian agriculture: "The farmer aims at doing without manures (the English term for commercial fertilisers), as much as possible, at keeping up the fertility of land simply by feeding his cattle on nourishing oil-cakes and utilising all the cattle dung, urine and litter in manuring the fields." It is only in the case of rice and sugarcane that he uses nitrogenous manures, and such manures as he uses are generally either cakes or green manures, the former of which supply phosphates and potash as well as nitrogen, and the latter, although their stimulating effect is mainly due to their nitrogen content, supply so small quantities that this stimulation is of a low order and not comparable in soil-exhausting power with that of other manures of high nitrogen-content. It is well known that in Bihar, where cultivation has reached a high standard of perfection and maintains one of the densest populations in India, the ryot has at hand a cheap nitrogenous manure in the form of *shora* (saltpetre) but does not use it as manure even for valuable crops.[1] He applies liberally lime and silt deposits on overflowed or irrigated lands. He avoids the use of purchased manures also by growing leguminous crops, such as *rahar* and *sunn*-hemp, and by adopting a judicious system of rotation.

Chinese and Japanese Manure Husbandry.—King wrote of the Chinese farmers: "Centuries of practice had taught the farmers of the Far East that the culture and use of the leguminous crops are essential to ensuring fertility, and so the growing of legumes in rotation

[1] Hutchinson: "Nitrogenous Fertilisers," *Agricultural Journal of India*, 1919, p. 204.

with other crops very extensively for the express purpose of fertilising the soil is an old, fixed practice." Apart from the large use of leguminous crops in India and China, the Chinese diligently husband and utilise every substance convertible into manure. During the summer months all kinds of vegetable refuse are mixed with turf, straw, peat, weeds and earth, collected into heaps, and, when dry, set on fire; after several days of slow combustion the entire mass is converted into a kind of black earth employed for the manuring of seeds. Oil-cakes, horn, hair and bones are highly valued, and so is soot, and especially ash. Dung of all animals, but more especially nightsoil, is esteemed above all other manures. Thus, in China, "everything which can be made edible serves as food for man or domestic animals. Whatever cannot be eaten or worn is used for fuel. The wastes of the body, of fuel, and of fabric worn beyond other uses are taken back to the field; before being taken there they are housed against waste from weather, compounded with intelligence and forethought and patiently laboured with through one, three or even six months, to bring them into the most efficient form to serve as manure for the soil or as feed for the crop." Similarly in Japan almost nothing, certainly not nightsoil, is wasted. Issuing from every town daily may be seen strings of manure-carts on their way to the surrounding villages, where what cannot be used at once is carefully stored in concrete cistern or sunken butt. In this way over £20,000,000 goes into the soil every year.[1]

Soil Conservation a World Concern.—Some day man's greatest concern must be the conservation of soil resources. In new regions and virgin settlements, man farms without any reference to the conservation of fertility. His yields during the first few decades may be good, but then there is a decline till the yield sinks below a point where there is no profit for the

[1] Robertson Scott: *The Foundations of Japan.*

farmer. The expression "permanent agriculture," is thus a real contribution to the discussion of rural economics in an age when the world's increasing population and pressure on the plane of living demand a wise conservation of soil fertility for coming generations. As Bailey observes: "This phrase is important, both because it demands the facts and also because it sets ideals for the future. It is the highest expression of being our brother's keeper—the brother who is yet to come. It suggests the most perfect altruism, and the truest socialism. Some time this will be the greatest concern of government in the time when the concern of government coincides with primary concern of mind."

Nightsoil and Animal Manures.—It has been said that permanent agriculture has been developed in China, Japan and Korea. There is a difference between Indian and the Chinese or Japanese agricultural conditions, and the difference lies largely in the utilisation of animal and human excrements. There is no reason, apart from prejudice, why the methods of utilising nightsoil adapted by the Chinese and the Japanese should not be followed in India.[1] East observes that there is no other way to keep up productivity for a really extensive period as civilisations go. Hitherto, the stock-farming system has been recommended as involving the least waste of soil fertility. Grains were to be fed to the stock, and the manure of this stock returned to the land as fertiliser. But this system must pass. It is suitable for a new country only. In populous districts the beef animal must not compete with man for cereals. And, as it passes, the tremendous engineering schemes for transporting the waste of human activity to the sea also must pass. The engineer must join forces with the

[1] Cf. "The Nitrogen Problem in Indian Agriculture (a symposium)," *Proceedings of the Tenth Indian Science Congress*, pp. 242–61.

farmer and evolve an innocuous system which will keep our soil assets intact for future generations.[1] By some preliminary treatment, such as composting, as is carried out by the Chinese, the risk of infection can be minimised. We have a great deal to learn, not merely from the methods of agriculture of the Chinese and the Japanese, but also from their patience, persistence and elimination of all unessentials and their painstaking care to the smallest details. In India, the cow manure that ought to go to the fields is being used as fuel. Thus the cultivator has given up a time-honoured salutary treatment of the soil, depriving it of almost its only source of fertilisation, while he has not profited at all from the experience of European agriculture as regards the efficacy of commercial nitrogen, potassium and phosphate fertilisers.

Waste of Soil Resources in India: Suggestions for Conservation.—The introduction of commercial crops also has upset the ancient system of rotation which served very well for fertilising the soil. The burning of dung and other wastes and the export to foreign countries of bones and oilseeds in recent times imply the robbery of the soil's fertility. If oil only were sent abroad the oil-cake would have remained for the fields and bullocks. Similarly the export of rice, wheat and other food grains affects the crop yield.[2] There are abundant supplies of waste organic matter such as paddy-husk, ground-nut husk, sugarcane trash, grasses of various kinds and many other substances, and it may be possible to bring about a similar fermentation of such materials as has been accomplished at Rothamsted in the preparation of artificial farmyard manure. An important source of soil renewal, within the means of the cultivator in many parts of India, is compost made from all kinds of waste

[1] *Mankind at the Crossroads.*

[2] For a description of various nitrogenous residues in India, see N. V. Joshi: *Agricultural Journal of India*, 1920, p. 398.

vegetable matter, wood ashes and a certain amount of cow-dung after the manner in vogue in China and Japan. Very promising results have been obtained by the use, in suitable proportions, of Pusa soil (rich in carbonate of lime), wood ashes, cow-dung and various vegetable waste materials (dry leaves, grass weeds and the crop residues not eaten by cattle).[1] But, as a rule, the waste vegetable matter is destroyed by the cultivator. Similarly, outside the village the bones of the cattle are allowed to decay in piles and thus a valuable source of manure runs to waste. All these represent an improvident use of soil resources, heedless of the interests of the generations as yet unborn, and cannot but react unfavourably on the civilisation of the future, which will show a continuously increasing pressure of population upon the soil.

Deterioration, Animal and Human.—The gradual destruction of forests has not only made fuel scarce and led to the use of cow-dung as fuel, but also has stinted the opportunities of grazing. The ascent of the cultivated lands to the hillsides and the use of land for food crop instead of fodder, due to the increasing pressure of population on land, have led to the neglect of cattle-food and the deterioration of cattle. With feeble cattle, tillage becomes more shallow, and this in turn easily exhausts the soil. Men deteriorate also in their physique. The daily diet of the peasantry gradually is being deprived of milk, *ghi*, *dahi* and fish, which fetch higher prices in the city markets.

Hookworm and its Extermination by Mass Treatment.—The cultivator's predisposition to such diseases as hookworm, malaria, or *kala-azar*, have reduced greatly his efficiency as a worker, and contributed not a little to the stationary condition of our agriculture. It appears that the most important single factor in localising hookworm is the amount of rainfall. Inves-

[1] R. V. Norris and A. Howard: *Proceedings of the Tenth Indian Science Congress*, pp. 249 and 256.

tigations show that from sixty to eighty per cent. of the peasantry in Bengal, Bihar and the United Provinces, and one hundred per cent. of the peasants in some districts in Madras, are infected with hookworm, which renders them incapable of hard work. Freedom from hookworm infection diminishes the sickness and mortality rates and increases the marketable value of labour. It has come to be realised that in hookworm control it would be strategic to treat by vermicide all the people in a community within as short a period of time as possible, so that soil-pollution and soil-infestation should terminate abruptly, and without risk of reinfection of those already treated. Mass-treatment of entire communities is recommended wherever it is practicable. In India, where the infection is so large, and in China, where agriculture is economically possible through the use of human excrement only, nothing short of mass treatment of communities will rid the soil of hookworm larvæ.

Floods, an All-India Problem.—All parts of India now suffer from devastating floods, and these leave a legacy of disease and soil-exhaustion. In some areas floods lead to soil encrustation; in others the flood-water, which might be utilised to flush the malaria-breeding pools and replenish the soil with fertilising silt, is allowed to run to waste. Thus the rescue of agriculture is connected not merely with soil research, but also with agricultural and irrigation engineering and an all-round systematic programme of regional improvement.

CHAPTER VIII

CRIME AGAINST TREE AND WATER

Regional Programmes.—Man is a prodigal son of nature in more ways than one. Not only does he dissipate or exhaust without replenishing the resources of nature, but also he upsets the normal equilibrium of the different levels of the region he inhabits, liberating destructive forces which ultimately engulf his carefully wrought handiwork, his civilisation. Nothing but reconstruction of a life process equivalent to the natural balance in the organic world round him can re-create civilisation. Thus regional programmes, comprising the whole setting of man's life and development within the physical resources and the fauna and flora of the region, ought to be in the forefront of national policies. Such a programme should survey, for example, a whole valley section, comprehending the hills, the valley, and the coast together with temperature, humidity, direction of winds, hydrographical conditions, the system of drainage, the course of rivers, geological strata, etc., and should look forward towards the harmonious adjustment and control of the different levels of the region.

Protective and Conservative Functions of Forests.—Take first the hills. It is only recently that we have begun to perceive the ruin caused by a reckless destruction of the forest. A well-known authority observes: "By protecting mountain slopes against excessive soil waste, the forest protects the lowlands upon which this waste would otherwise be deposited, and the rivers whose channels it would clog. It is well within the truth to say that the utility of any system of rivers

for transportation, for irrigation, for water-power, and for domestic supply depends in great part upon the protection which forests offer to the head-waters of the streams, and that without such protection none of these uses can be expected long to endure." The effect of forests on the watersheds of streams has been likened to that of a huge sponge, which during the heavy rains absorbs a considerable portion of the excess water, and holds it in storage to be given out slowly and fairly constantly during the succeeding periods of drought. The mechanical force of the rain-fall is checked by the trees themselves, and by the forest litter which covers the mineral soil; and the soil itself is rendered more porous by the roots of the trees and the infiltered products of decayed vegetable matter. Thus forests tend strongly to prevent both floods and droughts, or at the very least to lessen their severity. They also prevent the process of erosion of the hill-sides and thus the silting up of the rivers with the matter washed from deforested watersheds. Attention also may be drawn to the dependence of artificial irrigation upon the forest; to the influence of the forest in changing surface into subsoil drainage and thereby influencing the water storage of rivers; to its ability to prevent the encroachment of sand-dunes on the coast, and to fix wind-driven sand in the interior; to the shelter which forests, or even a few rows of trees, afford to agriculture from the cold dry winds of winter; and to many other similar duties which the forests can be made to perform. Both in China and India, we are witnessing to-day the effects of the denudation of the mountain slopes.

Forest Destruction in China, and the Penalty.—In most of the provinces of China and in the densely-populated parts particularly, the treeless mountains rise naked from the treeless plains. The deficiency of adequate timber and fuel not only depresses the standard of living of the people, but also there is

constant danger from floods and droughts.[1] In Shantung, one of the most densely-populated regions on the surface of the earth, the hills generally are very barren, owing to the ruthless cutting of all timber and the long-continued raking of the ground for leaves and grubbing of the soil for roots, the great population being sorely pressed for fuel. This process has robbed the soil of a natural fertiliser and lessened its ability to retain water, so that the hillsides are the more rapidly made bare and the stream-beds raised, thus contributing to a chronic condition of floods and famine. Were China's hills clothed in forests, the Yellow river would not have been a constant menace to millions of people who live in what may be its next river-bed. It is confined to its present course by huge dykes that tower over a million homes. The Yellow river can be quelled only by the tremendous labour of the Chinese coolie who has confined it within earthen embankments, built often in breathless haste by tens of thousands of workers. Ross describes graphically the effects of the destruction of forests in China: "In China deeply gullied plateaus, guttered hillsides, choked water-courses, silted-up bridges, sterilised bottom lands, bankless wandering rivers, dyked torrents that have built up their beds till they meander at the level of the tree tops, and mountain brooks as thick as pea soup testify to the changes wrought once the reckless axe has let loose the force of running water to resculpture the landscape. From the once-wooded hills opposite Hong Kong the soil has been washed away till the country is nothing but granite boulders. North of the Gulf of Tonkin, not a tree is to be seen and the surviving balks between the fields show that areas once cultivated have become waste. Erosion stripped the earth down to the clay and the land had

[1] Sherfesse: "The Industrial and Commercial Importance of Forestry in China," *Chinese Social and Political Science Review*, September, 1916.

to be abandoned. One hears of districts, once populous, in which the mountains are dry, grey skeletons, the rich bottom lands lie smothered under silt, and there is now one family to four square miles."

Forest Destruction and its Results in India.—Similarly, India, especially in the zones of precarious rainfall in the Deccan and in the North-West, has been injured by the destruction of her forests; the effects of denudation are visible not only in these areas but also in many others. In the country as a whole the proportion of forest land to total area (*i.e.*, 25 per cent.) is ample, but the distribution of forests is irregular. Thus, the pressure of population on the forests is visible in parts of the Central Provinces and the Deccan, and the less fertile parts of the densely-populated plains of the United Provinces and the Punjab. In these regions the destruction of forests means a lowering of the standard of life of the peasantry, the burning of cattle manure as fuel, mud hovels, and half-starved, puny cattle, apart from its ulterior effects on the amount and distribution of rainfall. The great, densely populated Gangetic plain is practically bare of forest growth. The area of the United Provinces is, roughly, 100,000 square miles, with a forest area of 7,000 square miles, or 7 per cent. only. This in itself by all standards is inadequate. Moreover, the great majority of the forests are concentrated in the sparsely-inhabited hills or submontane tract. Thus the inhabitants of the densely populated plain, for want of wood, have to burn the cattle manure for fuel, thereby destroying the fertility of their fields, and are forced to live in miserable mud hovels which contrast sharply with the bamboo cottages of other parts of India.

Ravine-lands of India.—Again, waste lands of a peculiar type, the desert-like ravine-lands, on which only the stunted *babul*-tree grows, are spreading far and wide along the banks of many rivers, such as the Ganges, the Jumna, the Chambal and the Son, where

once there was smiling plenty; and this is due to rapid deforestation. In the district of Muttra, for instance, as late as the final quarter of the eighteenth century, the forest of Barsana played an important part in the battle between Imperialists and Jats. There are now no forests. The only woodlands are the better-timbered specimens of the western commons, and the small artificial plantations of fruit-bearing and other trees, covering an insignificant area of 4,000 acres.[1] The ravines of the rivers are characterised by the total absence of cultivation—the soil is unculturable with nodules of *kankar*. The slope causes denudation and brings into the whole length of the river-face a large amount of *kankar* and gravel. Sandhills also alternate with ravines, and this depends on certain conditions in the direction of the stream. Where the river flows in a sweep or curve, ravines are found almost invariably on the concave side, whilst on the opposite or convex side sandhills are as characteristic a feature. On a change in the direction of the curve ravines and sandhills change places also, and in the few instances where the river preserves a straight course for any distance ravines and sandhills occur on both banks. Thus many of the villages rise up bare and devoid of trees even in the Doab. Moreland observes: "The gradual loss of fertile land caused by the extension of ravines is in the aggregate serious; the fact that the loss is gradual enables the population affected to adapt itself to the changed conditions, but the evil is of sufficient general importance to justify continued efforts both to utilise the land already ravined and to prevent or minimise further extensions." It has been estimated that the total area of such desert-like and inhospitable ravines in the United Provinces is between half a million and a million acres. The evil of the extension of ravine land, however, is not confined to the United Provinces but is increasing

[1] *Statistical Account of the N. W. P. of India*, Volume VIII, p. 15.

in almost all the level plains of India. A characteristic of most rivers flowing through the soft alluvium of the Gangetic plain is the very inadequate area of forest lands protecting the banks and headwaters and drainage area generally. In many parts, the vegetation on the neighbouring lands is of a very poor description after centuries of abuse, and the rainfall flows away with great rapidity, thereby increasing the volume and violence of the torrents, and leaving their beds dry a few hours after a storm. The banks of the Ganges, and its tributaries in many parts, now are so completely drained that they have become almost destitute of vegetation excepting for a desert flora, and even this is disappearing. The absence of protective vegetation on the banks, and the resulting rapid flow or rush of water from the comparatively high flat plateau to the river through the soft alluvial soil, has resulted in the formation of a vast and intricate network of ravines. These ravines extend for a distance varying from a few furlongs to a few miles on both sides of the rivers and their tributaries; they often start suddenly at the edge of cultivation with a drop of some eighty feet or they may be less severe, and they pursue a meandering course, joining up with other systems, eventually falling into the main river. Standing on any high ridge or promontory, the scene of arid desolation that meets the view is beyond description. As far as eye can reach, parallel to the river, is the wild tangle of barren ravine lands, thrown into greater contrast by the narrow belt of vivid green cultivation along the lower flats of the main river, across which again the interminable ravine-desert stretches to the horizon. One of the chief causes of intense ravine erosion has been the unlimited and uncontrolled grazing of countless flocks and herds of all sorts of animals (cattle, buffaloes, goats, sheep, camels, asses, etc.) throughout the year. These ravine tracts were once—many years ago—a great breeding

ground for cattle, and still produce a magnificent class of goat. In the ravines, with the hardening effect of the tread of the animals and rapid drainage, the monsoon rains penetrate to a depth of a few inches only, and this quickly dries, leaving a soil almost destitute of moisture down to the underground spring water level 100 feet or more below. Smythies observes: "Anyone who has seen a sudden and heavy downpour of rain turn these dry ravines into roaring cataracts of liquid mud; anyone who has seen a ravine dry half an hour before, bringing dead camels and oxen, and becoming dry again in half an hour; anyone who has been washed off his feet and nearly suffocated in the racing mud, will be convinced for all time of the terrible damage that results from the removal of vegetable growth and of the urgent need for reclaiming and afforestation of these ruined areas."[1] Even more extensive than the ravine lands of the Jumna are those of the Peninsula, of the Central Provinces, Bombay, Central India and Gwalior. In the black-soil areas of the Deccan, in Bundelkhand, in the Nermudda districts we find as a rule the formation of gullies and declivities and deep and rich soils being scoured by uncontrolled drainage. In some areas the soil of whole valleys has been removed by denudation, and the rocky subsoil left maintains with difficulty a thin covering of scrub.[2]

Catastrophical Changes Caused by Forest Destruction.—It is well known that in parts of Persia, Arabia, Syria and Egypt and other countries, where formerly rich vegetation used to flourish, the careless hand of man destroyed trees so prodigally that the natural conditions of countries suffered disastrous reversion; thus these countries became dry and sometimes uninhabitable. Spain during the Moorish occupation

[1] Smythies: *Indian Forest Records*, Vol. III, Part VIII, pp. 8 and 9.

[2] Howard: *Crop Production in India*, p. 14.

was fertile in those regions which are barren to-day, because the forests were destroyed. Such destructive changes even now are visible on the flanks of the Himalayas, the Vindhyas and the Ghats in India, in Asia Minor and Greece, and on the slopes of the Alps, the Apennines, the Pyrenees and other mountain ranges in Southern and Central Europe. The echoes of catastrophes in these regions are frequent. In the tropical regions the vegetation not only conserves the moisture and ensures fertility by spreading a covering of silt which produces a marked effect on the richness of a soil, but also it prevents the ground from being overheated by the tropical sun. Dr. Parkes says: "In the tropics herbage cools the ground both by obstructing the sun's rays and by aiding evaporation and nothing is more desirable than to cover, if it be possible, the hot sandy plains of the tropics with close-cut grass. Thus, wherever in the tropics the vegetation is scanty, drought and inundation alternate, as in many parts of Southern India, South Africa and Australia. In West Africa the forest stands are abandoned, without any attempt at protection, to devastation and wanton destruction at the hands of man, clearing by the natives, brushwood fires, grazing, improper felling by the Public Services, colonists, exploiters of forests, etc. Hence the climate is changing, the rainfall is decreasing and becoming irregular. The duration of the river floods, often a factor of fundamental importance to agricultural prosperity, has also been changed." Further, the sand is reported to have made considerable advances, so that the desert is extending towards the South. The Salub, both in Mauritania and the Sudan, formerly was much more wooded and hence better irrigated and more thickly populated than it is at the present day. The loose sands, set free by the disappearance of the acacia, which bound them together, now have resumed their march under the action of the north-west wind and

already have extended a noticeable distance towards the south-west. Nothing but a chain of forest reserves can hinder their further progress. In short, deforestation has reached the point of destroying the equilibrium between the factors determining the climate and hydrographical conditions of the country, thus imperilling its agricultural future.[1]

Floods Due to Deforestation in India.—When forests are cleared at the source of the rivers, the latter become less navigable in the upper waters and the floods in the lower parts become more serious. Scott observes: "The first result of the removal of the growing timber is the disappearance of the roots of trees, which formed a network to hold the soil together. The rain falling on the bare hillside sweeps off the earth with the loose gravel and boulders, and deposits it on the plains below, filling up the river-beds or at least producing serious shoals." Thus the denudation of the hillsides is followed by the extremes of flood and drought. The gradual silting up of the rivers Godavari and Kistna, Mahanadi and Brahmani, Baitarni and Son, is due to the denudation in the highlands and the *ghats* resulting from the increase of cultivation on the hillsides. The floods of these rivers now have become frequent and disastrous. The increased suddenness and violence of floods in hill-streams as an immediate consequence of the destruction of forests, and the ascent of fields to their catchment areas, have been noticed in many parts of India. The continuous grazing of the cattle destroys forest growth and leaves the hills more or less unclothed, so that the rains from the hills come down with greater violence and fill the rivers with silt from deforested hillsides. The terraced rice-fields of the hill-villages on the frontiers of the expanding population also become little tanks during

[1] Mangin: "The Forestry Question in French West Africa," *Comptes Rendus des Séances de l'Académie d'Agriculture de France*, Vol. X, No. 20.

rice cultivation, since the peasant wants to store as much water as possible for the benefit of his crops. When the monsoon rain comes on suddenly, it bursts practically all the field-ridges and carries with it in a torrent the previous rainfall collected in the water-sheds. This increases both the volume and the intensity of the floods. Floods, for instance, in the hill-streams which open into the Bhagirathi in Bengal, those like the Goomtee and the Gogra which open into the Ganges, and the tributaries of Jumna in the United Provinces, or, again, those of South India, have increased in violence, causing great havoc from year to year.

Diminished Rainfall through Denudation in India.—Evidence of the diminution of rainfall due to denudation is accumulating from various parts of India. Mr. Robertson, the Superintendent of the Government Farms at Madras, found that during the last thirty years a large area of land had been denuded of trees, partly in view of an extension of arable culture and partly to provide fuel for the railways and for domestic use. Seven hundred thousand acres, originally covered by jungle scrub and coarse grass, had been brought under the plough during the preceding eighteen years; and, being now bare for two-thirds of the year, this seemed likely to affect climate. The people unanimously declared that the rainfall had been diminishing gradually during the last twenty or twenty-five years, though it was not always referred to deforestation. Reports have been received as to the continuous diminution of rainfall in the Bellary district during recent years. The rainfall not only has become lighter, but also more irregular, with the increased destruction of forests by wood-cutters and charcoal-burners and the indiscriminate grazing of cattle, sheep and goats. Denudation of the ceded districts of the Madras Presidency is continuously on the increase, covering with sand fresh areas of formerly culturable land. In

Kanara also the destruction of forests on the hillsides has led to the abandonment of once-famous spice gardens.[1]

Sir Richard Temple observes: "The Southern peninsula of India has been, or is being, denuded not only of its forests, but also of its jungles, its groves, its brushwood, its trees. The denudation has been, I understand, going on near the sources and in the upper courses of many rivers which water the country. If it were to proceed unchecked there would be imminent danger of the rivers running dry by reason of the catchment basins and the drainage areas near their sources being rainless. The progress of the country causes the price of timber and firewood to rise. The introduction of railways has, in the absence of any coal mines, greatly augmented the demand for fuel. Strong temptations are thus inevitably offered to the people at large to fell, cut and lop recklessly, to bring every log, stump and stick to the market, to dig out the very roots of the jungle, so stopping any chance of reproduction, without thought for the future. Any thoughtful spectator may perceive that, according to all meteorological experience and to the almost certain teaching of proved facts, these fine districts were not destined by nature to be the prey and sport of famine and scarcity, but have been rendered subject to these calamities by the thoughtless action of man." [2] In the intermediate and the dry zones of the Deccan the effects of denudation gradually have been realised. The Ratnagiri is now almost bare up to the crest of the *ghats*, and here the effects of denudation have shown themselves not merely in the silting up of the principal streams of the district but also in the increased areas of bare, hard earth. In the north-west of India the baneful results of deforestation also are evident.

[1] See Ribbentropp's *Forestry in British India* for a detailed description of the local influence of denudation.

[2] *Vide* "Appendix D," *Famine Commission's Report of 1880.*

Thus, the Hoshiarpur *chos*, though situated in a rich agricultural country in the North of India, nevertheless, owing to the fact that the hills from which they spring are composed to a great extent of very friable and sterile sandstones, provide one of the most remarkable examples of the injury which may result from denudation caused by the destruction of forest growth. Similarly, the ever-increasing amount of arid land in the northern and western parts of the United Provinces of Agra and Oudh is the result of man's abuse. Even in the Allahabad district nearly 20 per cent. of the land is incapable of cultivation and 15 per cent. more is uncultivated. Of these areas respectively more than 230 and 240 square miles are situated in the trans-Jumna tract, in the wilds of Khairagarh and Barah, and in the Arail ravines along the Tons and Jumna. The rest of the barren area consists chiefly of the extensive ravine-lands along the course of the Sasur-khaderi and Mansetta rivers, on the north bank of the Jumna and north of Kara and Shahzadpur. Here the soil is covered with nodules of *kankar* exposed to the rapid surface drainage. The saltpetre plains are common in the western part of the Doab and the eastern half of the Sikandra *pargana*. Trowseed says: "The forests where the Emperor Babar hunted the rhinoceros are now a waterless tangle of ravines," and "the beautiful country along the Foot Hills is now buried under sand and gravel."[1] According to this writer the devastation he deplores is due to "fire and axe." By river-bed erosion the Jumna has been lowered 50 feet during the last 500 years, because the torrents are unhampered by the roots of the plants and trees which man, without discrimination, has destroyed. There has also been a corresponding sinking of the water-level. The cold-weather level of the Jumna in the Etawah and Jalaun districts is often 120–200 feet below the general level of the surrounding region. The sinking of the bed of

[1] Article in *The Indian Forester*, August, 1921.

the river is draining the country and the well-water levels are sometimes as low as 200 feet. The banks of the Jumna in the Agra, Etawah and Jalaun districts are now so exhaustively drained that they have become almost destitute of vegetation excepting a desert flora, and even this is disappearing. In the district of Etawah the desert is increasing rapidly. The rate is calculated to be two hundred and fifty acres per annum. The same is the case in the *terai* lands of the Dehra Dun and Saharanpur districts. The vegetation on the neighbouring hills is of a very poor description after centuries of abuse, and owing to much of the soil having been carried off the water flows in torrents and leaves the beds dry a few hours after a storm. The submontane rivers have been changing their courses continually, causing the land to be covered with a deep boulder deposit. Sudden floods are common and are destructive to irrigation works.[1] In the Muttra district the increasing irregularity of the rainfall has brought about a general economic deterioration. Before 1845 there was no canal and the number of *pakka* wells was far smaller than at present. Complaints of waterlogging and inundations were common. Now periodical shortages in rainfall have made the region dry. The following statement gives the average rainfall of the Muttra district during the last fifty years :

Year	Rainfall	Year	Rainfall
1863	28·51	1868	15·31
1864	19·48	1869	22·43
1865	16·66	1870	22·53
1866	27·9	1871	27·15
1867	28·84	1872	28·33

[1] Benskin : "Afforestation in the United Provinces," *Agric. Journal of India*, 1918, pp. 688–9.

Average Rainfall—contd.

Year	Rainfall	Year	Rainfall
1873	42·02	1896	15·10
1874	39·59	1897	28·93
1875	29·1	1898	22·26
1876	21·55	1899	16·19
1877	13·66	1900	20·59
1880	13·62	1901	13·80
1881	27·42	1902	22·80
1882	26·02	1903	22·40
1883	14·13	1904	35·20
1884	28·12	1905	10·20
1885	24·11	1906	26·64
1886	27·43	1907	15·04
1887	35·50	1908	41·56
1888	25·68	1909	29·51
1889	22·28	1910	28·24
1890	29·75	1911	20·75
1891	26·82	1912	23·52
1892	28·82	1913	10·13
1893	27·31	1914	28·83
1894	30·05	1915	15·(?)
1895	22·03		

Between 1863 and 1893 the rains failed five times. From 1894 to 1915 the rains failed seven times. Between 1863 and 1878 the average rainfall was 25·13; now it is 23. Thus has been witnessed not only an extraordinary increase of irregularity but also a diminution of rainfall within a short series of years.

Let us take another district, Fatehpur. The following table gives the years of drought and scarcity:

1881–2	1907–8
1896–7	1913–14
1905–6	

The lowest rainfall recorded was 13·40 inches in 1880. The average monthly rainfall in inches for the period of nearly 40 years is as follows:

January	·75	August	10·81
February	·46	September ..	5·24
March	·27	October	1·62
April	·20	November ..	·20
May	·34	December ..	·19
June	3·84		
July	9·96	Total	33·88

Not only does the rain come with great irregularity as regards the months of the year, but also the local distribution of the rain has become extraordinarily capricious. In the greater part of the district the water-level now averages from 35 to 50 feet and in some portions has fallen as low as 75 to 80 feet. The strain on the cattle is intense, and it is pitiable to see the immense amount of labour involved in raising even a moderately good crop on the small patches of cultivation. The fodder supply also is often scanty owing to the fact that the grass soon dries up for want of moisture. Each year as the cost of cattle and well implements rises, the amount of land which can be irrigated profitably by bullock-power from the ordinary well becomes less; and, if the district is to be protected from the vicissitudes of drought and famine, recourse must be had to the application of mechanical power to lift-irrigation.[1] To minimise extensions of the ravine-land the essential point is to reduce to the lowest possible amount the run-off from the land lying above the ravines and the drainage into them. This result is attained by the field embankments of Bundelkhand. The construction of such field-embankments and storage *bunds* on the ravine tracts of the United

[1] See G. R. Dampier: "Report on the Deterioration of the Muttra District," *Proceedings of the Legislative Council, U. P.*, July, 1916.

Provinces is necessary to hold up water and conserve the grass and water-supply for cattle. The present unsatisfactory state of things is due to the opening up of ravines by torrential rains which are unchecked owing to the policy or want of policy of deforestation.[1] In Bombay, the Central Provinces and Gwalior, properly constructed embankments stretching across valleys have controlled the drainage and checked erosion, recreating fertile land. Indeed, in the worst cases of soil denudation, the effective remedy would be the system of embankments provided with spill-ways, which are sufficient to check the run-off and erosion and assist absorption. The real cause of the malady, however, must be traced to the forest denudation at the head-waters and on the banks of the rivers, and it is essential that it should be dealt with there also.

Protection of Land by Law in Switzerland.—The federal law of Switzerland of October 11, 1902, on the protection of land in forested and pastoral regions, is certainly the most coercive type of legislation in the world, but also is the most effective measure for the preservation of mountain soils. Switzerland, in 1838, gave another example of wise foresight in a political conflict of pastoral origin which led to a struggle between the partisans of large and small pasture animals, the Horn-manner and the Klauen-manner. The federal council settled the strife in favour of the partisans of cattle. It withdrew the mountains from the systematic devastation of sheep and goats and gave the impulse to the exploitation of cattle, which assures the preservation of the soil and the fortune of the country.[2]

Forest Protection and Afforestation Schemes.—All civilised countries have adopted measures for the

[1] *The Agricultural Journal of India*, 1918: Article on "The Afforestation in the United Provinces," by Benskin, p. 685; P. Basu: "Agricultural Improvements in India," *Proceedings of the Seventh Indian Economic Conference*, Bombay, p. 25.

[2] Brunhes: *Human Geography*, p. 349.

protection of forests, whose value towards the maintenance of agriculture and development of industries have received tardy recognition. Schemes of afforestation are being carried out in various countries in the world. Perhaps the most ambitious effort at afforestation on a national scale is seen in an Eastern country, Korea, under the Japanese administration. The results expected from afforestation—apart from the supply of timber, fuel and forest products of all kinds essential to the development of industries—are as follows:

(1) Modifications of climate—
  (*a*) Value of trees as wind-screens;
  (*b*) Tendency to increase equability of temperature;
  (*c*) Probably a slightly increased rainfall, since the bare granite rocks when heated tend to check condensation.

(2) The prevention or at least reduction of both floods and droughts and the silting up of river-bottoms, by checking the rapid run-off of water from the hills. This of itself will be an immense gain to agriculture, but in addition it should be noticed that—

(3) Afforestation is considered a necessary preliminary to the extensive irrigation schemes by which it is hoped to increase the agricultural area of the country. These depend upon the construction of irrigation reservoirs which at present it is almost useless to make owing to their being silted up quickly by the torrential run-off of water.

(4) The development of cattle and sheep pasture.

(5) The preservation and improvement of the supply of fish in the rivers and estuaries through the more even flow of water.

(6) Importance also may be attached to the improvement of health through pine forests, both by

their effect on the purification of the air and by the beauty which they give to the landscape.[1]

Irrigation Systems of India.—In India large tracts depend either partially or wholly upon irrigation, and the water is derived from rivers, tanks and wells. The Indian rivers which feed the canals used for irrigation are of two classes. The Ganges and Indus, and their tributaries, are fed by the snow which falls on the Himalaya mountains and by the plentiful summer rains of the moonson. The water-supply of these large rivers cannot be affected materially by the small forest area which it may be possible to place under good management on those mountains; but between these huge streams a large number of smaller rivers exist, the drainage area of which is situated in the lower hills and which join the main streams below their debouchment from the mountainous region. Of the other rivers which are used for irrigation, the most important are the Son in Bengal, the Mahanadi in Orissa, and the Godavari, Kistna and Cauvery in the Madras Presidency. These rivers and their feeders rise in the hills of Southern and Central India, which derive their water-supply chiefly from the summer rains of the south-west monsoon. In regard to these rivers there is good ground for believing that their water supply is affected largely by the forest growth on their catchment area. As population has increased, cultivation has extended to the lower hill forests where the streams depend upon the monsoon rainfall. Thus denudation as well as the building of terraces for farming has done these rivers great damage.

As regards the larger tanks which are fed by springs and streams, these benefit greatly by thick forest-growth on their catchment area, while denudation affects them directly. Lastly, the area irrigated from

[1] Roxley: "Afforestation in Korea," *The Scottish Geographical Magazine*, January 15, 1923. Cf. also *Report of the Reconstruction Committee* (Cd. 8881).

wells in the different parts of India is very large. Thus, in the Madras Presidency, two million acres are irrigated from wells, while three million acres are irrigated from rivers and tanks. There is no reason to believe that forest-growth on level ground has the effect of raising the subsoil water-level, which is tapped by the wells; but wells are frequently dug at the bottom of a valley or near the bed of a stream, and in such places there is ground for believing that the underground water stratum which is tapped by the wells will be supplied more plentifully, and that the supply will be maintained longer during the dry season if the hills which surround the valley are placed under careful management, or at least protected against systematic devastation by grazing animals.[1]

Afforestation and Sylviculture in the West, and in India.—In most of the countries in the West sound sylviculture and afforestation have been incorporated into the national policy. France has afforested over three million acres in the last century, and thereby has brought back a considerable area of disused agricultural land into cultivation. Germany has added over a million acres in the last fifty years; but "the great increase in her timber production was secured not so much by increasing the area of forest as by improving the methods of sylviculture. By this means, the production of existing forests has been increased three-fold during the past 75 years." Of the 600,000 acres of afforested land in Denmark, 200,000 were added between 1868 and 1908 by afforesting heath land, and about 75,000 acres are now in process of afforestation. In India, only sporadic attempts have been made, where forest management is undertaken, to establish the normal increment. Checks, however, have been provided against over-cutting, while a regular output has been rendered available for the timber industry. Revenue fellings, disguised under the euphemism of

[1] Brandis: *Progress of Forestry in India.*

" the Selection System," have been the rule, while the " proportionate representation of the age-classes " and " the maintenance of the yield " have formed the shibboleths of the day. The problem of regeneration for long has been considered for the time being beyond the region of practical politics. Investigations, however, are progressing in respect of important forest trees and the peculiarities of varying localities, with a view to introduce more rational systems of forest management. Artificial regeneration for *sal*, teak, *deodar*, etc., is being studied, and working plans to adopt the concentrated natural regeneration of a single species are being introduced. It has been found that *babul*, *shisham*, teak, etc., grow to a height of between twelve and twenty feet in three years. On the hills the *Eucalyptus globulus* grows quickly and in dry lands tamarisk is such a tree. The investigations of R. S. Troup have set up a new standard, and these and other studies have given a considerable impetus to the development of novel sylvicultural systems adapted to each important species and to the peculiarities of varying localities.

Fruit-Culture and Plant-Breeding.—Much also is gained from producing a greater and greater proportion of fruits and olives, etc., by careful cultivation and selection instead of clearing up everywhere the hillsides for tillage and grain products or allowing the flocks of cattle to be driven to the mountains, exposed to excessive denudation, where they browse or trample down the seedlings. Recent discoveries in economic botany have shown the great importance of experimenting and plant-breeding with wild varieties of plants, vegetables and fruits, and remaking them in their native habitat for the use of man and animal. Much valuable work in this direction has been done, for instance, in the Straits Settlements and Federated Malay States, and in the Gold Coast Colony where the introduction of rubber and cacao has created new

wealth. In each case the plantation product is better and cheaper than the wild product, partly because all the most accessible areas of the wild product have been plundered already, and partly because, in the wild state, one rubber or cacao tree may be half a mile from the next, but on the plantation, the distance between them is merely a few feet.[1] One more important use of the mountains is for terrace cultivation, especially in connection with artificial irrigation. The soil is retained by terrace walls and on gentler slopes by embankments (*bunds*), while gravitation is a cheap and effective method of irrigation. Some of the most elaborate methods of terrace agriculture and irrigation are found among the hill tribes of India. In Assam in particular many of the devices of retaining and leading water along the irrigation channels have excited the admiration of foreign observers.

Jhum Culture in Bamboo Areas.—Both the interests of forest preservation and those of cultivation have been reconciled in the case of the Kukis and other nomadic tribes in the Chittagong hill tracts. Each village community has a certain area of hills over which it possesses the right to *jhum*, with certain village sites. In *jhuming* the tribe usually selects a bamboo forest which is felled, allowed to dry in the sun and then fired, reducing all but the large trees to ashes and incinerating the soil to the depth of an inch or two. As soon as the rain falls seeds are sown with the *dao*. The bamboo has a wonderful recuperative power and in five to seven years the land *jhumed* is quite ready for re-*jhuming*. Meanwhile the village has removed to another site to follow the same method of cultivation. To the hillman, the bamboo is invaluable. Not only is his house made entirely of bamboo, but also his baskets, bows, arrows, fencing and even water-pots are made from it. Water can be boiled and rice cooked in lengths of green bamboo, and it provides a mortar in which to

[1] Lyde: *Man on the Earth*, p. 64.

crush up condiments. The natural features of the hill tracts are such that *jhuming* must be the principal method of cultivation. The absence of stone, the light nature of the soil and the steepness of the hillsides make cultivation by terraces an impossibility. And as tree forest is not *jhumed*, which would cause irreparable damage and make recovery as tree forest practically impossible, such a method of cultivation, though it encourages nomadic habits, is a suitable method of settlement for these hill tribes.

CHAPTER IX

USE AND ABUSE OF WATER

Mistakes in Canal Irrigation.—Man is a criminal not merely against forests but also against rivers, and this also has its Nemesis. Unconsciously he works no little havoc by altering the river and drainage system. It is true that irrigation gives greater security to agriculture in lands of scanty rainfall and hence establishes civilisation on more stable foundations. Where agriculture is based on abundant rainfall, and the natural fertility of land, there is little incentive to industry and enterprise among the people. Thus the backward state of agriculture in the rich deltas may be contrasted with the careful and painstaking cultivation around the wells on the fringe of deserts and arid wastes, or the skilfully contrived system of irrigation on the terraced hillsides throughout the country. But canal-irrigation in the plains, though it has undoubted value in times of drought, especially in regions of precarious rainfall, often discourages high cultivation. In some of the districts of the United Provinces, for instance, a peasant's site in well-irrigated villages is surrounded by a large maize-potato-tobacco *gauhan*. The outlying fields are carefully cultivated, but the treble-cropped *gauhan* takes up most of his energy. In canal-irrigated villages, on the other hand, the number of waterings available is not sufficient for treble-cropping, but may suffice for a double crop of maize, corn or sugarcane. Thus it is only in the precarious regions that canal-irrigation aids substantially in the speedy recovery of deteriorated villages, while in zones protected by rainfall it leads often to agricultural decline. In the Punjab, the

contrast between agriculture based on well-irrigation in the Eastern districts and the canal-agriculture in the colonies is vivid. There is no doubt that enormous waste of water takes place wherever canal-irrigation is in vogue. It has been estimated as a result of recent experiments that the amount of excess water applied to crops like wheat in Northern India is from 30 to 50 per cent. Where the cultivator is assessed, however, not by the amount of water used but by the area irrigated, waste is inevitable. An excess of water is used as a substitute for good cultivation. Weeding is neglected and little or no attempt is made to break surface crusts for promoting soil aeration and for economising water. This leads to the speedy destruction of the aeration of the subsoil. The crops are forced to develop surface roots, and ripening can be brought about only by using relatively abundant quantities of water. Thus the greater the supply of water the greater the clamour for it. In addition to the loss of water and bad tilth there is occasionally serious damage done to agriculture through water-logging and denitrification.[1] Diseases such as wheat-rust also have tended to lower the yield of irrigated wheat, particularly in years when the spring rains are abundant. Howard observes: "The irrigated crop as a rule does not appear to be quite at home. Ripening is frequently delayed and the quality of the produce is apt to be irregular and inferior."[2] Again, waters for irrigation purposes which might be quite safe in some soils would be injurious in others. The chief factor probably is the subsoil and its tendency to give good or bad drainage. Irrigation water of a relatively high saline content may be used in summer with greater safety where winter rains are heavy, than in localities where they are light. Irrigation water highly charged

[1] See *Triennial Review of Irrigation in India*.

[2] Howard: "The Irrigation of Alluvial Soils," *The Agricultural Journal of India*, 1917, p. 185.

with saline matter should be used freely rather than sparsely. Small quantities of water lead to rapid concentration of salts under the influence of surface evaporation, whereas abundance of water tends to retain soil moisture at the requisite degree of dilution.[1] Again, unscientific canal-irrigation has led to the decline of waterways and consequent deterioration of agriculture. The system of canals which affects the natural drainage system by deviating too much from the river courses or the system of railways without culverts and with bridge pillars on rivers have led in India to the silting up of rivers and waterlogging in low and humid districts. The rivers bring down from the mountains an enormous quantity of silt. On the plain the slope is much more gentle than in the hills and there are frequent breaks, and hence the river-beds are raised. On the other hand, the canals in the upper reaches of the rivers have been constructed without an adequate appreciation of the importance of free and unhindered courses for the various rivers that have been used, or without sufficient precautions against obstruction. Thus the entire natural drainage system has been upset. The interference with drainage lines caused by the canal and its distributaries has tended to intensify the effects of the excessively wet seasons causing the depreciation in *bhur* and *tarai* tracts in the United Provinces.[2]

Alkali Lands.—Alkali lands are common not only in the United Provinces of Agra and Oudh, but also in various parts of the Punjab, Sind and the North-Western Frontier. In Bombay in the valley of the Nira alkali salts appeared with the canal, and large areas here, as in the district of Kaira, are charged with alkali. Over 5,000 acres of formerly cultivated land

[1] A. J. Parkins: *When is Water Safe for Irrigation Purposes?* Bulletin, Department of Agriculture, South Australia, Adelaide, 1924.

[2] *Final Settlement Report of the Farrukhabad District*, 1903. See Leather: *Investigations on Usar land in the United Provinces.*

under the Nira valley is now useless. Even where the amount of salt is not sufficient to cause crops to fail it adds progressively to the difficulties of obtaining a first-class crop; more and more manure is required for the purpose; and, accordingly, the already very high cost of cultivation tends to increase. The rise in the subsoil water has also made the canal area unhealthy, and what formerly was a district very free from malaria is now one of the most malarious in the Deccan.[1] Generally speaking, however, alkali interferes with agriculture to an important extent only on the alluvium of the Indo-Gangetic plain, particularly in North-West India.[2] Where population is dense in the tracts where useless alkali lands occur, they become a serious menace to economic life.

Canals and Waterlogging.—A similar deterioration of lowlands due to the construction of canals has been witnessed in Bihar. It is true that drainage channels have been constructed, but these have not prevented the waterlogging in certain areas caused by the obstruction of the natural drainage resulting in raising of the subsoil water-level and greater humidity. The Son canal, for instance, which is the most important canal in Bihar and Orissa, is in its main western branch constructed across two drainage lines, *viz.*, the Kao and the Dharamwati, while the waterway provided is not sufficient for heavy rainfall. The result is that the country round Sasseram remains flooded at the time of heavy rains, causing deterioration of the rice tracts. It is recognised that the construction of a canal at right angles to the general direction of the water-courses of a country is a very difficult problem and cannot be undertaken without the most disastrous results unless it is done with full understanding and appreciation of the difficulties that have to be faced,

[1] Mann: "Economic Conditions in some Deccan Canal Areas," *Agricultural Journal of India*, 1919, p. 804.
[2] Howard: *Crop Production in India.*

and at the same time with the engineering knowledge required to overcome them. This has been the case also in China, which now is tasting the bitter fruits of its mistakes in this respect.[1] It also is true that hydraulic engineering was not the forte of the race of engineers of India who constructed the Indus, the Ganges, the Jumna, the Son and other canals. The excessive silt and the insufficient outlets which, as we have seen, are due to unskilful and perhaps reckless interference by man, have led to frequent inundations taking place, usually along one or two rivers at the same time, but occasionally simultaneously along all the rivers. The rivers now have no alternative but to leave their beds and overflow the country, destroying crops and property. Again, canals tend to raise the spring-level of the surrounding country. Plain it is that the rise of this level, by connecting the drainage basins and bringing the water through strata formerly untouched by any percolation save that of the rain-fall, must increase the chance of certain salts and other deleterious soluble matters reaching the drinking-wells and affecting the public health. Thus, even where there has been no interference with natural lines of drainage, the subsoil percolation from the canal—or, in other words, the rise which the canal causes in the spring-level—is a cause predisposing to the spread of fever epidemics.[2] In the Punjab, where the irrigation system is most elaborate, whole districts are ravaged by malaria and other fevers. This, as we have pointed out already, is not without its effects also on agriculture. In all light-soil tracts the construction of the canal increases the surface-water so considerably that in wet years cultivation becomes unprofitable and decline is exceedingly rapid.

Salt-encrustation and Waterlogging.—There is yet another cause of deterioration. Throughout Northern

[1] *Vide* H. Van Der Veen: *Some Aspects of Chinese Life and Thought.*
[2] *Statistical Account of the N. W. P. of India*, p. 25.

India, in tracts containing *reh*, the effect of the canal is to bring the latter to the surface so that it shows up very distinctly in a canal-irrigated village, and the complaint of the villagers that *reh* has increased seriously since the introduction of canal-water is well founded. The emergence of *reh* after the rains, when the rice crop is growing, causes great deterioration, while no other crop can stand the salt at all. Even if the canal is not made in such tracts, it is most desirable to maintain regular observations of the water-level in wells, at intervals along the tract, and, when a distinct rise is observed to be in progress, to clear out the interrupted drainage lines and thus facilitate escape of the water; the clearing of these lines is not desirable while the water-level stands low.[1] The problem of waterlogging and salt-encrustation, indeed, is becoming increasingly important in the Punjab. Speaking about this evil in one particular tract, the *Report of the Department of Agriculture, Punjab*, observes: "It is said that before the opening of the Lower Chenab Canal the soil of a number of villages of the Gujranwala district was quite productive; well-water being used for the purpose of irrigation. But ever since the coming into existence of the above canal, the subsoil water-level of these villages has been rising gradually and at present it is two to three feet when the canal is running. This has led the soil to deteriorate. Of late a fresh factor has come into play. The waterlogged soil continues to give crops for some years, when it begins to develop *kallar* patches which increase in dimensions every year. As a consequence most of the land of these villages is not only waterlogged but alkaline as well. The problem is therefore not only one of draining the soil, but of removing this *kallar* as well." The following table showing results of analysis of different types

[1] Moreland: *Notes on the Agricultural Conditions and Problems of the United Provinces.*

of soil in that area indicates the quantities of salts which chiefly are instrumental in giving rise to *kallar* conditions, *viz.*, the carbonates, bicarbonates, chlorides and sulphates of sodium, and the total content of alkali salts. Roughly speaking, a soil showing a total alkali salts content of ·1500 per cent., or thereabouts, rests on the border-line of a normal and a *kallar* soil.

Description of Soil	Depth from which Sample of Soil was taken	Total Alkali Salts	Sodium Carbonate (Na_2C_3)	Sodium Bi-Carbonate ($Na\ HC_3$)	Sodium Chloride (NaCl)	Sodium Sulphate (Na_2S_4)
Canal-irrigated, normal ..	1st 6 ins.	·2757	0·0042	·2150	·0025	·0540
Do. ..	2nd ,,	·1880	*Nil*	·1344	·0016	·0520
Do. ..	3rd ,,	·1572	*Nil*	·1008	·0014	·0550
Kallar lands ..	1st ,,	·5706	0·0106	·3600	·0140	·2460
Do. ..	2nd ,,	·4594	0·0058	·3420	·0304	·0790
Do. ..	3rd ,,	·3619	0·1060	·2064	·0019	·0475
Well-irrigated, normal ..	1st ,,	·3463	·0106	·1806	·0056	·1495
Do. ..	2nd ,,	·3073	*Nil*	·1376	·0050	·1647
Do. ..	3rd ,,	·2048	*Nil*	·1376	·0044	·0628

Waterlogging Problem.—The waterlogged condition here is being brought about systematically by seepage from the canal, and the combined effect of waterlogging and rise of salt has caused, and still is causing, the land to go out of cultivation. Recently there has been a great extension of the area affected, especially of the Upper Chenab and Upper Jhelum Canals. On the Upper Chenab Canal the evil of waterlogging is making its appearance near Harpoki and at the tail below Mangtanwala, and also in the reach along the Main Line Upper and near Chichoki Malian, Main Line Lower; while on the Upper Jhelum Canal it is spreading in the reach of the canal below Khokhra, between miles 53 and 63. The remedial measures hitherto adopted of cutting-off irrigation on the one hand and on the other of intersecting the affected areas by surface-drains and discharging them into one or

other of the natural drainages, have not been wholly effective. Proposals also for restricting irrigation in some distributaries as a precaution against swamping are being worked out. It is doubtful whether the methods adopted by the Irrigation Department will prove a panacea. For certain classes of soils and for certain geographical conditions the remedy is undoubtedly effectual; but it is yet to be established that the drains as at present designed will restore areas where the waterlogged portion is below the level of a main canal on one side and a river or other natural drainage on another. In such cases it appears that the cause of the evil is the seepage from the main canal, and not excessive watering by irrigators; and, though the action of the Irrigation Department in closing distributaries where seepage drains are cut may slightly reduce the water-level, it certainly will aggravate the efflorescence of saltpetre and general deterioration of the soil. The problem here can be attacked at enormous cost only by making the irrigation channel itself watertight as far as possible, while the drains also should be made as deep as possible considering the configuration of the country. In 1908 a Drainage Board was constituted in the Punjab. In the Government Resolution on this subject it is stated that waterlogging is due to many other causes than seepage or over-irrigation from canals: for instance, imperfect natural drainage or the obstruction of natural drainage by roads, railways, irrigation channels or *zemindars'* embankments. The evil is of steady growth in parts of the province and in some places threatens not only the prosperity but also the health of the rural population and involves besides serious loss to Government revenue. Hitherto it has been dealt with only spasmodically. There has been no settled policy either for investigation or for action. It is timely, therefore, for the question now to be taken up for the province as a whole.

Both in Sind and in Oudh extensive developments in canal-irrigation are expected within the next few years. In both these regions the texture of the soils is distinctly heavier and the permeability less than in the areas hitherto served by perennial canals. Howard observes: "If, as appears to be the case, poor soil aeration is found to be an important factor in the production of alkali, we must expect that the institution of perennial irrigation on the stiff soils on the left bank of the Indus and in parts of Oudh will lead to the formation of alkali land on a large scale in a comparatively short time unless means are taken to maintain soil-aeration." [1]

The whole problem of the proper and economical use of canal-water in India requires reconsideration. There is no doubt that over-irrigation in many regions leads not only to the waste of a vast volume of water but also to poor cultivation, and sometimes to the extension of useless alkali land which necessitates an expensive drainage system for its reclamation. The water demands of the various crops require closer investigation, and the possibilities of water-saving by a combination of fodder-production and improved methods of agriculture should be explored in irrigated regions.

Sale of Water by Volume.—All these enquiries perhaps will involve a revision in the system by which the canal-water is provided and the land revenue assessed under irrigated conditions. The Irrigation Commission long ago suggested the substitution of the sale of water by volume for the present method of assessment according to the area watered and according to the crop grown. In the old settlement reports of the Punjab districts we occasionally come across village communities which distribute the water of the small channels according to a time-table keeping in view the water requirements of the various fields. Similarly, in the village com-

[1] *Crop Production in India*, p. 48.

munities of Southern India, the irrigation-man who is in the employ of the whole village regulates the supply of water in every possible way, and in the season of rains might be said to hold the safety-valves of the tanks and other reservoirs in his hands. He actually holds the *tuba*, or key of the channel pipe, and distributes the water to the fields of all persons in just proportions, so that crops may not be dried up. He inspects the *bunds*, channels, and sluices of tanks, and, if he finds any irregularity, reports it immediately to the headman. A wrong method of assessment has discouraged water-saving and led to a permanent loss of fertility of the cultivator's holding. The sale of irrigation-water, not only to village communities but also to co-operative irrigation societies, would fit in very well with the traditions of Indian rural self-management.

Irrigation Management in Java.—The best example of the management of irrigation comes from Java, where a great saving of water is effected and extensive areas are thrown open to irrigation. In Java the district irrigated by a given river is subdivided into secondary squares, which as a rule are bordered by discharge canals whose size depends on field conditions. The secondary squares are again subdivided into tertiary squares, the so-called terminal squares. In these terminal squares, whose size lately has been fixed as generally as possible at about 100 hectares, the irrigation-water is conducted on the land directly from the so-called tertiary canals. The irrigation canals are provided, wherever necessary, with gauges for proportional division of the water. The capacity of the canals is regulated according to the crop requiring most water, namely rice, for which crop the fields must remain inundated for some time. The quantity of water depends in the main on the porosity of the soil, the gradient of the land, and the height of the ground water, which again depends on the local rainfall. On

an average a supply of 1·5 litres per hectare per second for the full period of irrigation can be considered as sufficient in the plains. The comparatively small quantity absorbed by the plant during its growth and the quantity lost by evaporation (about 0·45 litres per hectare per second during the west monsoon, the season when rice is chiefly grown) may be considered as practically stable for the whole of Java. The magnitude of the irrigation and flood control work may be judged from the fact that the irrigated districts for which permanent works are now in use have an area not far short of 803,000 hectares (2,000,000 acres), while districts for which permanent works are under construction or are being planned amount to 783,000 hectares.

Waterlogging and Waterways Problems of Bengal.—Another way in which improper control of natural drainage has led to the deterioration of agriculture is seen in the deltaic area in Bengal where embankments and artificial deflection of the general drainage by roads and railways have led to rapid silting up of the rivers and waterlogging. In Bengal many healthy and fertile districts have become malarious and are devastated by *kala-azar* and hookworm as a result of waterlogging. Agricultural work suffers since the farmers are attacked at harvest-time, and a heavy toll is taken of the young. There is a steady exodus of the richer and more adventurous people who seek healthier homes. Village homesteads are deserted. The villages, being left to a residue of the poor and wretched who age rapidly and die young, sometimes bring the cities which they surround into desolation and decay. In Western and Central Bengal the problem of waterways has become serious, and unless it is met by a bold and systematic policy the agricultural decline which in some districts has set in cannot be arrested. The gradual decline of the rivers will be evident from the following tables.

From 1822 to 1884, *i.e.*, for a period of 63 years, the Bhagirathi was closed for boat traffic for 20 years; from 1885 to 1923, *i.e.*, for a period of 38 years, it was closed for traffic for 23 years.

Condition of Waterway	Bhagirathi	Jalangi	Mathabhanga
From 1822 to 1884 = 63 years			
	Years	Years	Years
A. Closed in dry weather ..	20	43	54
B. Open withd epth of 1½′ ..	2	5	3
C. Open with depth of 1½′ to 2′	17	4	3
D. Open with depth of 2′ to 3′	24	11	3

BHAGIRATHI

From 1885 *to* 1923 = 38 *years.*

A. Closed for 23 years.

Year	Depth
1890 ..	0′–3″
1896 ..	0′–3″
1897 ..	0′ 0″
1899 ..	0′ 3″
1901 ..	0′ 3″
1902 ..	0′ 3″
1903 ..	0′ 0″
1904 ..	0′ 0″
1906 ..	0′ 6″
1907 ..	1′ 3″
1908 ..	0′ 6″
1910 ..	1′ 0″
1912 ..	1′ 0″
1913 ..	1′ 2″
1914 ..	0′ 8″
1915 ..	1′ 0″
1916 ..	0′ 3″
1917 ..	0′ 3″

A.—*contd.*

Year	Depth
1918 ..	0′ 0″
1919 ..	0′ 0″
1920 ..	0′ 0″
1921 ..	1′ 3″
1922 ..	0′ 6″

B. Open with depth of 1′ 6″

1885–1905.

Year	Depth
1889 ..	1′ 6″
1905 ..	1′ 6″

1906–1923.

Nil.

C. Open with depth of $1\frac{1}{2}'$ to $2'$.

1885–1905

Year	Depth
1892 ..	1–9″
1898 ..	2′ 0″
1900 ..	1′ 9″

1906–1923.

Nil.

D. Open with depth of 2′ to 3′.

1885–1905.

Year	Depth
1885 ..	3′ 0″
1886 ..	3′ 3″

D.—*contd.*

Year.	Depth.
1887 ..	3′ 6″
1888 ..	3′ 0″
1891 ..	3′ 6″
1893 ..	3′ 3″
1894 ..	3′ 6″
1895 ..	4′ 0″

1906–1923.

Year	Depth
1909 ..	4′ 6″
1911 ..	5′ 6″
1923 ..	4′ 0″

JALANGI

The Jalangi river up to 1878 had a separate entrance near the village of Jalangi, which now has become the entrance of the Mathabhanga. After 1878 a new entrance opened which shifted between Akriganj and Lalgola Ghat.

1885 to 1905 = 20 years.

A. Closed for one year only.

Year	Depth
1899 ..	0′ 9″

B. Open with a depth of $1\frac{1}{2}'$

Year	Depth
1902 ..	1′ 6″

C. Open with a depth of $1\frac{1}{2}$ to 2″

Nil.

1906 to 1923 = 17 years.

A. Closed for 17 years.

Year	Depth
1908 ..	0′ 9″
1910 ..	1′ 0″
1912 ..	0′ 6″
1914 ..	0′ 9″
1916 ..	0′ 6″
1917 ..	0′ 3″
1918 ..	0′ 0″
1919 ..	0′ 6″
1920–1923	0′ 0″

B. Open with a depth of $1\frac{1}{2}'$

1913 ..	1′ 6″

1885–1905—*contd.*

D. Open with a depth of 2′ to 3′

1885 to 1898

1901

1903 to 1905

1906–1923—*contd.*

C. Open with a depth of $1\frac{1}{2}$′ to 2′

Nil.

D. Open with a depth of 2′ to 3′

Year	Depth
1906 ..	4′ 0″
1907 ..	3′ 6″
1909 ..	2′ 6″
1911 ..	2′ 6″

MATHABHANGA

1885 to 1905 = 20 years.

A. Closed for 16 years

Year	Depth
1888 ..	0′ 1″
1889 ..	0′ 3″
1891 ..	0′ 0″
1892 ..	0′ 1″
1893 ..	0′ 0″
1894–7 ..	0′ 0″
1899 ..	0′ 6″
1900 ..	1′ 0″
1901 ..	0′ 6″
1902–3 ..	0′ 0″
1904 ..	0′ 1″
1905 ..	0′ 0″

1906 to 1923 = 17 years.

A. Closed for 15 years.

Year	Depth
1906 ..	1′ 0″
1908 ..	0′ 0″
1909 ..	0′ 3″
1910 ..	1′ 0″
1911 ..	1′ 3″
1912 ..	1′ 0″
1913 ..	0′ 6″
1914 ..	0′ 9″
1915 ..	0′ 0″
1916 ..	0′ 3″
1917–23	0′ 0″

B. Open with depth of $1\frac{1}{2}$′

Year	Depth
1907 ..	1′ 6″

C. Open with depth of $1\frac{1}{2}$′ to 2′

Nil.

D. Open with depth of 2′ to 3′

Nil.

The Bhagirathi embankment was breached in the following years (as reported by Col. Colebrook) :

1796	1874
1827	1885
1856	1890 (highest on record)
1871	1907

River Embankments and their Drawbacks.—The causes of breaches are not far to seek. Where embankments are constructed these exclude all fertilising silt from the countryside and serve to increase the liability to inundation of places on the lower courses of the rivers. The silt that otherwise would have been spread over the banks is laid for the most part, by reason of these embankments, on the river-beds, which in some places have been raised in this way to the level of the country beyond the embankments, if not higher, thus greatly reducing the water-carrying capacities of the channel, on the one hand, and increasing the liability to inundation of the land on both sides, on the other. In case of extraordinarily high floods the rivers break through the embankments and spread devastation over much larger tracts, sometimes finding new channels of their own through new country. Secondly, the embankments prevent the annual flushing of the natural drainage channels of the country during the rains and cause malaria and other epidemics. Thirdly, the enormous quantity of fertilising silt brought down by the rivers is carried on to the sea, which does not receive anything but returns it to the land as a festoon of islets at the mouth of the river. Thus the length of the rivers increases ; but, the total fall from the hills to the sea remaining the same, there is a decrease in the slope and consequently in the current, which further leads to an increase of silt deposit in the river-beds themselves. The famous Sunderbunds, for instance, occupy a flat plain of recent alluvial origin, and still in the process of formation,

by the gradual deposition of silt brought down by the Ganges and Brahmaputra rivers and intersected by a network of rivers and channels. The erosion which takes place along the banks is counterbalanced by fresh deposits of alluvium in the form of *chars*, usually near the centre of the mouths of the estuaries. When these *chars* become islands they intercept the seeds of trees and other plants carried down by water and thus in time become covered with forest growth and merge into the forest tract as a whole. Thus the main estuaries, as well as the *khals* or side-channels, are full of islands on banks, which vary in composition from hard sand along the sea-face to soft mud farther inland, and frequently form barriers across the mouths of the larger rivers, constituting a danger to navigation.[1] In many of the districts in the interior of Bengal and Orissa, the rivers and streams everywhere are in a state of slow decline, leaving agriculture without its mainstay, and making navigation sometimes absolutely impossible. During summer there is widespread scarcity of drinking water and irrigation practically ceases, while during the rains there are frequent and devastating floods. Between an excess of water at the height of the flood season and a deficiency at other times, the peasant begins to miss the blessings of the deltas and gets only their curses. The country is absolutely a flat, level plain. When the natural outlets are choked the mighty rivers not only overflow their accustomed courses and channels, but also flood the lesser rivers, streams and ditches and turn smiling regions into a vast lagoon. It takes a long time for the peasantry to recover from such havoc, apart from the cumulative effects of fevers.

Perils of Unscientific Irrigation.—Ross gives notable instances of ruin caused by artificial irrigation. "In countries like California and Turkestan artificial irrigation in unskilled hands may in time make arable land

[1] Troup: *Sylviculture of Indian Trees.*

unfit for cultivation. When there is insufficient incline or where the sinking away of an excess of water is prevented by an impervious 'hard pan,' the water dissolves the salts in the subsoil and, by capillary action, carries them in solution to the surface where evaporation forms a layer of dense salt. Near Tashkent there is an area of 100 square miles of fertile land which has become swamp in consequence of the ignorant use of irrigation-water. In all irrigated districts of Turkestan may be seen wide areas converted into swamps and breeding-places of fever, or covered with salt and made infertile." Similarly, the British irrigation-engineering in the basins of Northern India and in Egypt, of which the engineers are justly proud, will yet produce but mushroom growth if this process of irrigation is followed within a few years by the formation of salt crust, waterlogging, and epidemics of fever.

Malaria Research and Reduction Operations.—Malarious soils are mostly marshy. A study of observations made in different regions where malaria prevails shows that damp ground, especially when not cultivated, is a nursery of malaria; particularly if it happen to have a high soil temperature, say about 60° F., and vegetable impurities in the soil area. Recent experiments carried out by Captains Hodgson and King, of the Indian Medical Service, showed, however, that the larvæ of mosquitoes flourished in water of certain temperatures only; that as the temperature rose above 80° F. the larvæ suffered, until at 95° and upwards they rapidly expired. These observations showed something more, namely, that owing to rapid evaporation small pools of water remained much cooler than large expanses, a notable case in point being that of small hoof-marks in grass, where the water was 9° cooler than that in a large pool close by. Here, then, was an explanation of a phenomenon already widely observed, that in wet countries malaria diminishes with an increase of the quantity of water

on the land; thus a key to the problem was in their hands. If conditions are such that the water cannot be got rid of, the alternative is to alter its character; that is to say, to convert the numberless shallow pools with a maximum edge and comparatively low temperature, which form with the rise of the flood-level at the beginning and its fall at the end of the rainy season, into large expanses of water with a minimum edge and a higher temperature. This can be done with the assistance of the irrigation engineer only, whose aim must be to cover the land with carefully devised systems of embankments and sluices, by means of which he can hold up the water on the surface of the country at convenient levels during the wet season, and flush the land clean with the approach of the dry months. Now, the staple crops of Bengal—jute and rice—are crops which grow in standing water, so that if the outflow and inflow of the water be regulated scientifically it should be possible not only to destroy the mosquito-larvæ and maintain the level of water suitable for the production of good crops, but actually to improve the fertility of the land by compelling the inflowing water to deposit its silt upon the fields.[1] The investigations of Harrison and of his staff at Coimbatore in Madras on the gases of swamp rice soils have drawn particular attention to the importance of the oxygen supply to the roots of the rice crop by means of a slow movement of aerated water through the upper layers of mud in which this crop grows. The roots of rice must have a constant supply of oxygen. Since they are immersed in mud and water, the only way this substance can be provided is in solution in water which must move slowly through the soil. Thus inundations slowly change the water and renew the supply of dissolved oxygen for the roots of the

[1] Ronaldshay: *India*, pp. 283–84. Ronaldshay expressed his indebtedness to the painstaking research of Dr. Bentley regarding the causes and prevention of malaria.

rice.[1] Investigations in the area irrigated from the Eden Canal system have shown that fields receiving river-water yield 25 maunds of paddy per acre, whereas they give only 16 maunds per acre when cultivated with rain-water. Similarly, jute exhausts and impoverishes the soil to a much greater extent than most crops; and, excepting in the case of *chars* flooded annually, and very low lands which derive similar benefits by drainage, it is in very few instances only that it is grown on the same land for more than three years consecutively. Nearly 95 per cent. of the net cropped area in Bengal is occupied by wet crops consisting mainly of rice, with a smaller proportion of jute and sugarcane in certain areas. The bulk of these crops occupy the land during the wet season when the rainfall is heavy, the rivers are in flood and the subsoil water-level is nearest the surface. In those parts of Bengal which are supplied amply with water, at this season of the year enjoying a sort of natural flood of flush-irrigation, malaria is reduced to a minimum by the abundance of water, while at the same time the wet crops are greatly benefited. In the Punjab and the United Provinces the introduction of perennial irrigation for dry crops has led to water-logging, concentration of salts near the surface and malaria. On the other hand, flush-irrigation as practised in the Madras deltas does not cause any increase of malaria. Similarly, *reh* is practically unknown in areas where flood or flush irrigation is practised for the growth of wet crops. From facts such as these Bentley concludes: (1) that the sort of irrigation required in Bengal, for the joint purpose of improving agriculture and reducing malaria, must be of a very similar kind to that of Madras, or Sind, or the Punjab inundation canals, *viz.*, flush or flood or inundation irrigation; (2) that it must aim at the utilisation of the largest possible amounts of water

[1] Quoted in Howard: *Crop Production in India*, p. 17.

that can be drawn off with safety from rivers *during* and not *after* the flood season; and (3) that in these circumstances there is no need to worry about the subsoil water-level being raised too high; on the contrary the aim must be to raise it and keep it as high as possible during the wet season so as to benefit crops and reduce malaria.[1] Rice, particularly certain long-stemmed varieties, can keep its head above steadily rising floods till the stalks of the plants have grown to surprising lengths; but, if the flood comes suddenly, as the floods of hill-streams generally do, and completely submerges the plant, it cannot grow as it does so long as its head is above water. Paddy may live under water for about ten days; but, if the flood does not subside within that time, it is a total loss. In Bengal several flooding schemes have been carried out in malarious places for the purpose of reducing malaria. The objects have been: (*a*) to reduce the water-edge (which is the place where the mosquitoes breed under the protection of the grass and weeds which grow there) of the small pools by joining them up into larger bodies of water; (*b*) to substitute silty water, in which anopheles mosquitoes do not breed, for clean water in which they do; (*c*) to silt up small hollows that can be disposed of in this fashion; (*d*) to maintain the water-level in the inundated area at the best level for the achievement of these objects, and also so far as possible so as to suit the rice crops wherever they are being grown; (*e*) to arrange for the rapid complete discharge of the water on the land at the end of the rains, when the floods in the rivers have subsided. The methods by which these objects are attained are simple, and consist of sluices at the inlets and outlets to and from the controlled area, with the necessary drains and channels.[2] The phenomenal improvement

[1] *Malaria and Agriculture in Bengal*, Chapter IX.

[2] Williams: "Recent Progress in Sanitary Engineering in Bengal," *Surveyor and Municipal and County Engineer*, August and September, 1922.

in the malaria of a town as a result of such procedure is illustrated by the experience of Kumarkhali, a small town situated on the river Gorai in the hyperendemic malarious area of Bengal.[1] A channel has been cut from a point in the town towards the river. When floods come down during the monsoon season, water in the river rises and passes in large quantities into the town and all its tanks, ponds, etc., leaving only the houses and roads above flood-level. The following figures show remarkable progress:

Spleen Index

Year	Under One Year	One Year to under Five Years	Five Years to under Ten Years	Total
1918 ..	60·6	80·7	80·1	77·8
1922 ..	8·5	9·3	15·1	11·5

Where there was most "flood flushing," the improvement was greatest; in places where for engineering reasons this could not be satisfactorily arranged the improvement was less.

Rate of Spleen Index Decrease

Ward	Per Cent.
3	4·9
5	5·0
2	15·8
1	28·8
4	33·9

Russian Lagoon-Irrigation.—Attention might be drawn in this connection to the purposive flooding of an area with water known as "liman" or lagoon-

[1] Brahmachari: "Flood Flushing and Malaria in the Kumarkhali Municipality," *Calcutta Medical Journal*, August, 1923.

irrigation in Russia, from which we may draw important lessons for dealing with our water-supply. In Russia this area may be meadow-land or hayfield, or it may be destined for the sowing of wheat or some other grain. The soil of the temporary lagoon, saturated with water, retains enough moisture to render the crop practically independent of rainfall during the summer months. The lagoon is formed by damming the current of an adjacent stream; or, water may be conducted to the area to be flooded from a reservoir at a higher level. The flooded area, of course, also has to be embanked, to prevent a too rapid flowing away of the water. After two or three weeks, sluices are opened to allow the lagoon to empty itself. The formation of lagoons for the purpose of flooding rice and jute fields would contribute to the improvement of the water-supply in many parts of India. In hilly districts a terrace system might be employed in conjunction with lagoon-irrigation, the same water being used successively at several different levels.

In addition to the use for irrigation by flooding *in situ*, the formation of lagoons at the higher levels relieves the strain on reservoirs lower down. The Russian irrigation engineers have found that the amount of solid matter suspended in the water is almost equal in importance to the fertility of the soil as the water which conveys the silt and moistens the ground. Thus, irrigation with renewal of soil becomes a variant of lagoon irrigation. This is also the characteristic type of irrigation in Eastern Bengal, Sind and Egypt. It is, again, well illustrated by the *warf*-farming of the estuary of the Humber.[1]

India's Water Problem and its Solution.—In India, investigations taking the form of land-surveys, hydro-geological researches, studies of the soil, surveys of the

[1] For a classification of methods of irrigation and ameliorative measures in Russia, see Eden and Cedar Paul and Professor Kostyakoff: *The Restoration of Agriculture in the Famine Area of Russia*, pp. 78–80, 165–6.

courses of the larger rivers and their off-shoots, "broads" and "marshes," investigations of fisheries, etc., have not as yet been carried out in accordance with a carefully designed plan. Edward Buck long ago recommended the construction of drainage maps with a view to ascertain the direction of the run-off of surface water. The Indian Sugar Committee also recommended drainage surveys. After drainage surveys the next step will be the preparation of elaborate maps of river systems, swamps and fisheries. After such preliminary surveys, the construction of canals and embankments, roads and railways, as well as dams with their flood-gates in the level plains, as well as in the delta and the alluvial strip, may be undertaken. Such measures not only will lead to a more efficient irrigation-agriculture, but also will improve, as we have seen, the health of the country, which is now a series of shallow, mosquito-breeding pools.[1] At present it is the interference with the natural drainage which is responsible for the instability of agricultural conditions. Radical measures also are necessary for dealing with the water-supply in the higher parts of the river-basins. The most important of these measures will be the following:

1. To utilise the ravines in all possible ways, and especially by the building of dams in their higher parts, both for the storage of rainfall and for the safe-guarding of the lower parts of the valley. The ravines, as well as canals, are responsible for a great drying of

[1] Where rice is grown to perfection there is little malaria; where the crop is cut off from the necessary inundation, malaria is rife. Howard suggests that the same rule applies to dry crops like wheat. Perhaps the intense malaria which often follows in the wake of the canal in North-West India is not altogether due to the mosquito, but is a consequence of the lowering of quality of food grains grown under canal-irrigation. The subject is one which calls for early investigation, and it is hoped that McCarrison's interesting work on the influence of soil conditions on the nutritive value of Indian food grains will be continued and that the investigation will be widened to embrace the effect of the quality of wheat on resistance to diseases like malaria.

the soil. They cause a fall in the level of the ground-water; through them large quantities of water run to waste; they lead to wash-outs; and they lead to the silting up of the river-beds. Ravines are set thickly in the Bombay Presidency, Central India, parts of the Central Provinces and Madras, and near the banks of the large rivers traversing the great alluvial Gangetic plains. Various engineering works are needed in them all, which can check and convert the erosion in the ravine beds into deposition by the formation of *bunds* or dams across the ravines, while the erosion on the sides and at the heads of ravines is to be checked by creating an adequate covering of vegetation.

2. The construction of dams across the stream to act as buffers to the floods; and which will counteract to a certain extent the disastrous consequences of the bursting of the smaller tanks due to heavy rainfall in the fields in the higher reaches of the rivers; the formation of great reservoirs where water can be stored for the irrigation of adjacent areas, either from natural heads of water or by pumping up water to the higher levels. The Kannambadi Dam in Mysore, the Bhakri Dam in the Punjab, the Sukkur barrage in Sind, the Nil Mula scheme in the Western Ghats, the Chhindwara scheme in the Central Provinces and the Koyla Valley project are full of potentialities. But they use only a fraction of India's vast water-power. At the head of the deltas of the rivers Godavari and Krishna *anicuts* have been thrown, by means of which an enormous quantity of water which otherwise would have been wasted is carried to the fields by a network of canals. In the Godavari delta there are 370 miles of main canal, of which 339 are navigable, and 840 miles of distributaries. Both here, as well as in the delta of Krishna, the great irrigational system has not only brought about remarkable material prosperity but also has bestowed

immunity from malaria which formerly was seriously rife.

3. The construction of new and the conservation of old tanks and embankments. Regular tanks and *bund* works now are undertaken by the Government, though on a scale quite incommensurate with present needs. There is, however, no class of land improvement more useful than this. By means of these works many acres of land have been rendered fit for cultivation, and capable of withstanding the effects of drought in most unpromising tracts of country, such as the barren uplands of Bombay, the Deccan and Central India. In more fertile tracts also they render possible the cultivation, in the *rabi* season after the close of the monsoon, of the more valuable wheat crop in place of the less valuable millets and other monsoon crops. In South Bihar (Gya, Patna, Shahabad), Chota Nagpur and elsewhere in Bengal, and in the Mirzapur district of the United Provinces, they secure the rice crop against the vicissitudes of ill-distributed rainfall. In hilly situations cultivation generally is impossible without terracing on an extensive scale, and *bunding* occurs extensively in most submontane tracts. In Java, one of the conditions of planting new forest-lands is the provision of a suitable system of terraces combined with surface-drainage. Without this the soil cannot be preserved on the hillsides. Examples of soil erosion are to be seen in India on the tea-estates in Assam and Darjeeling, on the rubber-estates in Travancore, on the hillsides in Kashmir and in Kumaon. Terracing combined with surface drains now must be recognised as absolutely essential to prevent permanent damage to the Indian plantations. In the valleys embanked fields provided with shallow surface drains serve the purpose of checking soil erosion. Ravine-lands occur, as we have noticed, in many parts and excellent examples of reclamation of such lands are afforded by the Government Dairy Farm at Allahabad

and the formation of *bunds* or dams and afforestation in the Etawah district, the most important and successful afforestation work in India, where the secret of success lay in the retention of the monsoon rains, combined with dry-farming and weeding of young seedlings and plants. The main value of the embankment consists in the prevention of the escape of rain-water until the soil has been thoroughly saturated, in the permanent storage of moisture, and the consequent raising of the subsoil water to the benefit of well-irrigation in the vicinity.

4. The construction of canals and the use of canal-power to produce electricity for agriculture and industries as well as for navigation.

5. The regulation of the flow of the rivers and streams; the cleaning of their channels; the construction of reservoirs for feeding the channels when the waters are low; and the prevention of silting-up. Many of the Indian rivers run through a flat country; and when the water has eroded away two banks in succession, the rivers become very broad in some parts and so narrow in others that a wave becomes impossible. Thus the waveless rivers become inadequate to clear large tracts of country flooded by continuous rains. A number of dredgers need to be mobilised to alter the river-bed at the curves to a scientific shape, so that the pressure of the water may be received by the bed of the river instead of by the bank, and the water be able to pulse away with great rapidity. The reservoirs constructed on the sides of rivers may be utilised for providing power by allowing the water to flow from one reservoir to another, turning water-wheels in its progress, and from the large reservoir back to the river at low tides. It is estimated that the river Exe in England could be made to supply 6,000 horse-power permanently by using five square miles of land now submerged at half-tide. For this project, the river would need proper reclamation, a process that would

result in an actual saving of land greater than the area mentioned.[1]

River Regulation in Bengal.—Dredging operations have made the channels of the Hughli and the Karnafuli in Bengal safer and easily navigable. O'Malley observes: "That the Hughli is navigable by sea-going steamers is one of the many triumphs of human skill over the obstacles imposed by nature; for its passage is rendered difficult not only by reason of its rapid currents and the rise and fall of the tides, but also by shoals and shifting sand-banks. The most notorious of these are the James and Mary sands (*jalmari*)—deadly waters which owe their formation to the intrusion of the waters of the Damodar and the Rupnarayan." But the regulation of the Nadia rivers, the Bhagirathi, the Jalangi and the Mathabangha has not been successful. The regulation has been local and isolated and not followed up by supplementary works. Regulation works in rivers carrying down considerable quantities of detritus, should not stop short at isolated local improvements in depth, but should be carried out as a complete scheme with a view to the uniform discharge of the detritus by securing uniformity in velocity. Adjacent plains should not be shut off from the channels. In the Nadia river not only are the plains in different levels of the river shut out by artificial *bunds*, but also the channels sometimes are contracted unduly by means of *bamboo* (locks) and *jhamps* (mat screens). As a result the shoals shift and the channels sometimes become choked with vegetation. The circuitous course of some of these rivers renders useless the regulation works, which therefore should be supplemented by straight cuts so as to shorten and deepen them; or the concave banks might be protected by screens, stakes or stones; or, again, a flatter training-bank might be built in front of the

[1] Lieut.-Commander Williams: *Floods, Water-Roads and Water-Shortages.*

concave bank. But the greatest difficulty in the amelioration of the rivers is the detritus brought down by the Ganges and the hill-torrents due to the denudation of the mountain-sides. Along with a systematic policy of afforestation, the erection of a dam at a suitable place across the valley of a hill-stream behind which the descending silt accumulates and of another dam at a fresh spot as soon as the space behind the previous one is filled-up would arrest the denudation of alluvial lands as longitudinal embankments protect natural banks where, subject to erosion, submerged dykes of rubble or mattress protect beds from being scoured beyond the proper depth. Such training-works have been adopted with great success in the large rivers of Germany, the Danube, the Missouri, the Isar and the Mississippi, and have contributed to the improvement of navigation and traffic and the control of floods. Canalisation of rivers by means of locks, weirs and level reaches also has been most useful in many rivers of Europe where, owing to unfavourable conditions, training-works are unable to effect any adequate improvement. Thus it has enabled irrigation to be extended to the upper portions of rivers and to their tributaries, which training-works would fail to ameliorate. These are some of the methods necessary to improve and control rivers with which are indissolubly bound up the problems of agriculture, irrigation and rural transport in India. The problem of waterways is enormous in the country, for we see here all stages of river life—the hill-torrents flooding their banks and destroying villages, the great waterways gradually being silted up, the smaller rivers so much choked with vegetation as to have scarcely any flow of water, channels in which only a few *bils* remain to mark the deeper portions of old river-beds, and, lastly, dry beds and shifting banks now brought under cultivation. The problem of waterways can be mastered by a complete and systematic policy only, which

addresses itself to rivers in all their stages, from the deforested hillsides at their source to the ever-receding sand-banks in the sea.

India's Task.—India has before herself a great and arduous task, especially in view of the disastrous condition of her water-supply at the present time. She has to carry out extensive undertakings for the regularisation of the flow of surface waters and rivers, for an increase in the humidity of the climate and for the right utilisation of the water for agriculture; and all these objects will require study, organisation, personnel and means in correspondence with their elaborate complexity, gigantic scale, and imperial importance.

CHAPTER X

REGIONAL BALANCE OF OCCUPATIONS

Balance of Rural Land Utilisation and its Disturbance. —Coming from the mountains through the river system to the plains, gradually we are realising that the integrity of the different levels of the region must be preserved. Luxuriant woods, verdant pastures and fertile fields help one another, and the story of agricultural decline is connected with deforestation in the heights, the substitution of pastures for tilled fields, or, again, the robbery of the soil by inefficient farming methods and the introduction of the one-crop system by manufacturing and commercial interests. It is true that geological changes or climatic modifications have contributed to the decay of societies, especially in marginal regions. Such is said to have caused the fall of ancient civilisation in Central Asia, Chinese Turkestan, Cambodia, Central America and Bolivia. But more often the violation of the natural balance between the integral sections of the region, or the sacrifice of one section to another, which are man's outrages, have brought into operation forces which have deteriorated and even completely desolated the earth. In Mesopotamia the pasture-land overwhelmed the tilled land when the nomadic races and flocks trampled down agriculture and destroyed the elaborate irrigation system. In England in the fourteenth century the demand from the Continent for English wool, and still more in the sixteenth century the development of wool manufacture at home, resulted in the conversion of fields into sheep-pastures and the enclosure of much common land, upsetting the normal balance of occupations. In ancient Spain the tilled

land climbed the heights, replacing the forests, when eventually the lapse of tillage, the death of olives, etc., and the falling of terrace-walls gave denudation free play. In the United Provinces of India we are witnessing to-day the gradual ascent of cultivation to the mountains, the transformation of hill-slopes into red laterite desert and almost complete conversion of pastures into tilled lands. The reduction of open grazing-lands and inability to devote any but a mere fraction of the holding to fodder-crops, have resulted in impoverishment of cattle and reduction of their numbers. The extent of culturable wastes and their relation to the number of cattle, district by district, is indicated in the following table:

Cattle in the United Provinces

District	Head per 100 Acres
Gorakhpur	421
Aligarh	395
Jaunpur	373
Gonda	367
Meerut	358
Partabgarh	353
Ghazipur	298
Rae Bareli	267
Cawnpore	253
Muzaffarnagar	239
Shahjahanpur	201
Kheri	174
Banda	135
Mirzapur	105
Jhansi	60
Total Province (excluding hills)	206

Compare in the first place, these figures with the English figure of 4 head to 3 acres or 1·33 head per acre.[1] In Bengal the number of cattle is even less

[1] Leake: "The Cattle Problem of the United Provinces," *The Agricultural Journal of India*, July, 1923.

adequate and the quality of the local breed much worse than in the United Provinces and Bihar. Their size is smaller and their livelihood more precarious. In parts of Eastern Bengal the land never is ploughed until a good shower of rain has softened it. This explains why the miserable animals of the delta appear to be able to do as much work as the finer beasts of the North. In Western and Southern Bengal, however, the rain cannot always be depended upon to make ploughing easy, and the supply of cattle also is quite inadequate and allows nothing for casualties, even supposing all to be employed exclusively in cultivation, though as a matter of fact many are used solely for carts. The following figures are taken from the reports of the Settlement Officers :

District	Acres of Cropped Land per Bullock
Noakhali	4·56
Dacca	3·76
Faridpur	3·68
Midnapur	3·78
Rajshahi	2·40
Monghyr	4·76

Neglect of Pasturage and Fodder Crops in Bengal.—In many districts in Bengal cows are yoked to the plough. Every available inch, it might be said, of the land that is fit for cultivation and not required for human occupation is brought under the plough or planted with fruit-bearing trees. Public grazing-grounds are non-existent. Every pathway or cattle-track is narrowed down by the cultivator whose field is on either side, until barely room is left for two persons to pass each other on foot. The banks of tanks and the slopes of the embankments of public roads are the only grazing-grounds and the cattle subsist mainly on straw, paddy-husks and the coarse grass which grows in tanks almost silted-up. Just after the rice crop has been cut they get enough to eat,

but at other times of the year are half-starved. The lack of sufficient pasture, the absence of good fodder and the inability of the peasants to stall-feed their beasts have led everywhere to the deterioration of cattle. The provision of ample fodder is the basis of good agriculture, for without good fodder we cannot have efficient draught-cattle. Sooner or later, therefore, Indian cultivation must include some method of mixed farming, whilst a knowledge of the most suitable fodder-plants is essential. The present system of cultivation in India, with the chronic shortage of manure, is largely dependent on leguminous rotations. Thus leguminous fodder should be produced according to the irrigation facilities and agricultural conditions in different localities. For the irrigated tracts, a leguminous fodder is required which will grow freely at a time when there is least demand on the water. Lucerne, *bersiem*, *shaftal* and turnips may be tried. For tracts dependent on the monsoon, a leguminous fodder-plant is required to take the place of a fallow in the rotation. Fodder-crops might well be substituted for some of the poorer grain-crops. There is need also of a study of the indigenous fodder-grasses and leguminous plants of different localities which may prove valuable.

Impoverished Soil and its Reactions on Food and Health.—The fodder deficiency in India is not wholly one of quantity but there is also a great deficiency in quality, notably in proteid matter.[1] This is not without its effect upon the health of man. It is suggested that diseases like red-water, hot water, fluke and tuberculosis in sheep and cattle are related to the absence of iron in the herbage on which the affected animals live. Thus the deterioration of cattle-food and weakness of cattle are important factors in human tuberculosis. On the other hand, if a field be rich in

[1] Matson: "Quality Deficiency in Fodder Supply," *Proceedings of the Tenth Indian Science Congress.*

all the essential mineral constituents in an assimilable form, and a green crop be grown and ploughed in, then a cereal crop be grown, this cereal crop will be immune to rust, to say nothing of other parasitical diseases. Recent medical researches in the tropics have shown a relation between beriberi and rice as a staple food. Even leprosy is said to be connected with the use of rice grown in old and wasted paddy-fields. This seems to be accounted for principally by the fact that rice is notoriously deficient in mineral matter and nitrogen, or, in other words, the substances which ordinary crops extract from the soil. Rice is not incapable of taking up the required minerals ; but, the paddy-fields having remained unmanured for hundreds of years, the soil has been exhausted of those mineral constituents. Proper manure in all probability would render rice a more wholesome food than chemical analysis shows it to be at present.[1] We thus realise that the deterioration of agriculture and pasturage and consequent impoverishment in milk and vegetables are connected with the deterioration of man and his susceptibility to various wasting diseases.

Greece and Malaria.—In Greece, Strabo noticed that in his time nearly all the mountains seen from the coast were denuded, while the valleys and plains were ravaged by malaria. Ross explains thus : " What had happened was that the rush to the cities left the countryside short of labourers, so that pastures replaced tilled fields. Every summer, when the plain was parched, the herds were driven to the mountains where they browsed or trampled down the seedlings, the result being that in time the forest perished. Then the soil, no longer bound in place by living roots, began to wash down the slopes until the mountains died. Swamps formed and whole districts had to be abandoned on account of malaria." Of Modern Greece a large portion is waste, being rocky or marshy ; only

[1] Wright, quoted in Dubash : *Town Planning and Vegetation*.

about 25 per cent. of Old Greece is culturable. The methods and implements of agriculture are very primitive, there is little use of manure or scientific rotation of crops. In Thessaly the wooden ploughs used differ little from those of more than 2,000 years ago.

Rome and Soil Exhaustion.—In the early Roman Republic, as in China and Japan to-day, a four-acre plot was deemed enough to support a family. But the allotments of the Gracchi were twenty acres in extent, those of the truimvirs thirty acres, those of Cæsar forty acres. Before the imperial period the scantiness of the grain crops contrasted so harshly with the tales of earlier fertility that agricultural writers generally held the theory that mother-earth was approaching old age; that, like a woman, she had reached that point in her life when one ceases to bring forth. Simkhovitch, reviewing the fall of Rome, attributes it to soil-exhaustion. Soil-exhaustion doubtless brought on profound social changes such as the turning of tilled land into pasture, the indebtedness and ruin of the Latin yeoman, the growth of great estates, the formation of the urban populace, the exaction of a grain tribute from the provinces, the deliberate conquest of grain-producing countries, and the degeneration of Rome into a huge parasite, as Seneca puts it, "on the spoils of nations." But, since Rome sucked food from the provinces, the shadow of soil-exhaustion presently fell upon them also. Sicily, Sardinia, North Africa, Spain, became for Rome the granaries which in Sophocles's time they had been for Greece, and paid the penalty of non-conservative agriculture. Only Egypt, annually re-fertilised by Nilotic slime, escaped exhaustion.[1]

Agricultural Progress in Europe—Havoc of the War.—Such phenomena by no means have ceased to recur

[1] Quoted from Ross: *Principles of Sociology*, Chap. XLIII, which interesting work I have used freely.

in modern times. In most parts of Europe the land is not naturally fertile. The system of land-tenure also tends to reduce farming efficiency. But the recent agricultural development of Belgium, Germany, Denmark and France is a triumph of skill in the selection of seeds, careful preservation of natural manure, use of artificial manures and agricultural organisation. In Belgium more manure has been put on to the land than in any other country. But the last war wrought great havoc. Fertile fields in Belgium and France which had been records of centuries of laborious husbandry were devastated. It is estimated that in France over eight and a half million acres, of which nearly five million were arable, were devastated by the war. Elaborate levelling and clearing operations are necessary before these fields can be ploughed. In the Ardennes the actual damage to the land was slight, but the small hardy horses, which formed the main stock, and which were extensively reared, were carried off; the characteristic industry thus receiving a fatal blow. The Germans in some regions also destroyed the fruit-trees, especially the cherries which played an important part in rural economy, an injury which it will take years to repair. In other countries it was not possible during the war to get sufficient artificial manures, basic slag or even oil-cake for cattle-food, and there was not available the labour required to keep the land cleaned and drained. It was stated, in evidence before the recent Commission on Agriculture in England, that, owing to these causes, fertility had decreased, and it might take as much as five pounds sterling per acre to restore it to its pre-war state.

Rise of Exploitative Agriculture.—Coupled with the recent recurrence of soil starvation, we have other forces which have been long in operation and are upsetting the natural balance of the regions in Europe. For a long time past the different types of agriculture, the three-field system, grass husbandry, etc., have been

adapted more and more to capitalistic development. This is especially the case with the newest form of agriculture, which is influenced rather by the state of the market than by an arranged succession of crops.

In the temperate zones, the predominance of industrial and manufacturing enterprise has led to the neglect of home agriculture, and to dependence on the raw materials and foodstuffs of the tropical regions or other less developed countries which are more fertile or where the food production is above the normal requirements of the people. In the tropics the European seeks the raw material from the savage and at the beginning of colonisation the natives procure these products without much difficulty by simply "gathering" them. Stimulated by the prices offered, they are not long in reaching destruction-point. Of course, in time, cultivation will be started which will yield a regular product, but in the meantime incalculable natural wealth, which might have been conserved for lasting use, is disappearing entirely. In tropical countries destructive exploitation shows at its worst in connection with rubber, gutta-percha, and the *Raphia vinefera*, the young leaves of which the natives gather without restraint, although there is an increasing industrial demand for the inner bark.[1] Such devastation gradually gives place to the plantation system, which is a system of one-crop agriculture, founded on world-wide trade but having no reference to the soil conditions and possibilities of the region, or to its adaptive rotation of crops. The planting of one profitable, easily-grown, money-crop year after year, though its yield becomes less and less, is governed by the needs of the world market, irrespectively of the needs of soil-preservation of the region.

Exploitative Agriculture and Soil-Exhaustion.—In newly-settled countries also, where land is cheap and labour and skill not easily obtainable, it may be more

[1] Brunhes: *Human Geography*, p. 339.

economical for the present to bring new land under cultivation for production for outside markets than to manure the ground which has borne crops; but this implies a reckless exploitation of soil, which must redound to the discredit of this generation before future generations. Thus, when four families support themselves respectively on a 2,000-acre ranch, as in the American West, or on a 160-acre farm, as in Canada, or on a 20-acre farm, as in France, or on a 2-acre garden farm as in China, Japan and the fertile parts of India, there is no questioning the fact that the Chinese, Japanese and Indian type and conditions of cultivation are fundamentally different.[1] In America, if sufficient humus is provided, by the ploughing in of plant roots, leaves, manure, etc., and the soil is not allowed to wash away, agriculture, with crop rotation, may continue on the same fields for indefinite periods, as in parts of Europe and Asia. The violation of these simple rules of soil preservation already, in a few decades, has brought irreparable ruin to many American fields, especially in the South-Eastern States. The keeping of livestock is the type of agriculture which best preserves the soil, because it permits the return of manure to the land and thus tends to maintain fertility.

Uneconomic Meat Production.—This leads us to the interrelations between cultivated plants and domesticated animals of the same region. In newly-settled countries, where land is cheap and plant products abundant, man has adopted the wasteful method of growing corn and feeding it to cattle and then eating the cattle. Now, one ox eats as much as five men and requires five times as much land for its support. It has been calculated that an ox represents 150 days' rations for an Argentine cowboy *versus* 10 years' rations for the Easterner. A physiological table of food values shows the sufficiency of vegetable food. Thus

[1] See Russell Smith's *Industrial Geography*, p. 40.

the luxury of meat-consumption is indulged in the newer countries by a most wasteful utilisation of space. On the other hand, densely-peopled countries which cannot afford the reckless exploitation of the land maintain far more numerous dairy cattle, which also enrich the soil by returning manure to it. According to the Report of the Land Engineering Committee one-third more cattle can be carried on an arable than on a grass farm. As a matter of fact, the proportion is larger, as can be seen in Denmark, which is a country entirely given over to dairying, and yet there are very few acres of grass in the whole country. In the East the dense populations can be maintained only by the essentially vegetable diet and the omission of animal-raising. Even in the West dense populations will inevitably find meat scarcer and scarcer, even with more intensive agriculture, and have to depend more and more on meat imported from countries which are inhabited by sparser populations and have adopted reckless methods of soil-exhaustion.

Intensive Food Production.—Speaking of Chinese horticulture, Hahn observes: "That two and a half acres of poor garden land produces more than an equal area of good pasture land is known to every peasant, but we have never troubled to draw any deductions from this." Simon reckons that, after the introduction of intensive horticulture, France could easily feed two to four times her present population. In England the Board of Agriculture has recently pointed out that information, made available by research and experiment, is sufficient to show that the number of cows which can be maintained on the produce of a given area of land is from two to three times greater when that land is under the plough than when it is under grass, and that it is possible for a small-holding of from 15 to 25 acres to be made an economic undertaking. Meanwhile, just the reverse happens in the Old World.

Spread of Commercial Agriculture.—The introduction

of non-food crops in India, or the commercialisation of agriculture which has followed the success of the plantation system throughout the tropics generally, is disturbing the South-East Asiatic type of agriculture, and bringing it more and more within the whirlpool of commercial agriculture. This completes the cycle of world-wide exploitation of other types of regions by the industrial communities of the temperate region. By their dependence for foodstuffs, raw material and meat on newly-settled lands or countries which have a more fertile climate, they have organised world economy on a wasteful use of the resources of the earth. In ranches, plantations, prairies and backwood clearings, the subservience of the peoples of backward regions to the manufacturing nations of the West is brought about and maintained by pioneering enterprise and finance capital, and the growth of timber camps and plantations, mining cities and industrial towns and their eventual preponderance over the rural areas make the restoration of regional integrity more and more difficult in this age of easy communication by sea and land. The equilibrium of the world is disturbed, and this leads to great suffering even as the balance of occupations within a region is upset in the same process followed by internal social upheavals.

CHAPTER XI

FAMINE

Man's Improvidence and its Fruit.—We have examined some of the ways in which man's unskilful and improvident interference with Nature recoils upon his prosperity. Man denudes the mountains of forests, trees, and shrubs for his timber and firewood, thus making his country a prey to droughts and floods. He upsets the natural system of drainage; and his waterways, instead of blessing him with fertilising silt, work havoc with his crops and property. He constructs railways and canals unscientifically, and the rivers dry up or become stagnant, bringing widespread pestilence. Trees and water were in plenty before. They depend upon each other; but, through the fault of man's own deeds, these fail him now. He ignores or disobeys the laws of health and sanitation, and falls a victim to epidemics which take yearly a toll of several millions. He exhausts the soil for centuries and leaves the coming generations to suffer the penalty. He divides and subdivides his land in order to inherit a mathematically-accurate portion of a joint holding until his plot becomes too small to support his household. He grows commercial crops for the market at the behest of the middleman and in time of scarcity finds that these cannot feed him. The technicality of law tempts him to gamble with his rights and thus to court his own insolvency. His land, no longer inalienable, becomes an additional instrument in the hands of the money-lender or the lawyer to bring about his ruin through the offer of easier credit. The attractions and pleasures of the city, which now has become the

paradise of fashion and luxury, beguile him to extravagance. His caste dinners enjoined by religion compel him to run into debt. To avoid loss of family prestige or self-respect, he mortgages his land. The customs which formerly humanised his relations with the landlord and tenant are superseded when between them stands an army of capitalist middlemen who give the land to the highest bidder. Where the duty of assessing the rent is entrusted to the Settlement Officers, they look to the demands and exigencies of the administration only. He must pay the tax-gatherer, and no steps are taken that the demand is so timed and adjusted as not to drive him to the money-lender, even temporarily, for means to meet it. Five men cannot pay a direct tax in money, amounting to 40 per cent. of the gross produce, and the interest of old debts at 25 per cent., upon three acres of over-cropped soil, without danger in a bad year of catastrophe.

Crux of India's Famine Question.—This is the crux of the famine question in India. It is inextricably interwoven with the problems of our precarious rainfall, exhausted resources, spendthrift land management and unsound finance. No one factor is responsible for famines. All are individually or collectively responsible for the inability of the masses of the Indian peasantry to support themselves so soon as the conditions of a deficient harvest are established.

Fifty Years of India's Famine History.—Let us review briefly the history of famines during the last fifty years. From 1876 to 1924 famines of more or less intensity occurred in different parts of India. The following ought to be mentioned:

(1) The famine of 1876–78, which affected an area of 250,000 sq. miles. The total mortality amounted to five and a half millions.

(2) The Bihar and Madras famine of 1888–89, which affected an area of 3,500 sq. miles containing a population of little over a million.

(3) The famine of 1891–92, which affected an area of 50,000 sq. miles inhabited by a population of seven millions.

(4) The famine of 1896–98, which affected a population of 45·7 millions. It was the severest famine that the country has ever known. The maximum number on relief was 3·89 millions.

(5) The famine of 1899–1901, which affected a population of 25·1 millions. It is estimated that the reduction of population due to this famine was nearly ten millions. The maximum number on relief was 4·60 millions.

(6) The famine of 1907 in the United Provinces. Bad crops in 1905, followed by a poor harvest in the spring of 1906, led to a famine in Bundelkhand and the south of the Agra Division. Prosperity was restored by good crops in the following autumn and spring; but in 1907 the monsoon failed entirely in August, causing a severe famine, which continued until a good autumn crop was harvested in 1908.

(7) The famine of 1913–14 in the United Provinces in the Jhansi Division, in Rohilkhand and in parts of the Agra and Allahabad Divisions.

(8) The famine of 1918–21 in Bombay, the Central Provinces, Hyderabad and Madras. The complete failure of the monsoon of 1918 resulted in famine in Hyderabad and Madras. The situation was worsened by the delay in the north-west

monsoon. The early months of 1919 saw famine declared in four districts in the Central Provinces, one district in each of the Bengal and Madras Presidencies, three districts in Hyderabad and in certain parts of Central India and Rajputana. The cropped area in Madras fell in one year by nearly three million acres. The tracts worst affected were the East Coast North and the Deccan Divisions. In the Ganjam district, there was severe distress over more than 1,000 sq. miles and the numbers in daily relief rose to over 150,000 in October, 1919. It has been estimated that the actual loss due to failure of crops in the famine of 1918–19 was at least 150 crores of rupees and probably nearer 250 crores. The monsoon failed again in 1920, when famine or scarcity was declared over a considerable area in the Central Provinces. By the end of 1920 nearly 100,000 persons were on relief. During 1921, famine was declared in three districts of the Central Provinces, in three districts of the Madras Presidency, in one district of Bombay Presidency and in part of Beluchistan. The greatest number of persons on relief of all kinds was 45,000, a figure attained during the week ending June 18th, 1921.

Modern Famine Relief.—Although the worst horrors of famine have been mitigated as a result of improved means of communication which bring grain to the famine centre from distant markets, the tale of suffering is long. Famine relief no longer is afforded, excepting under special circumstances, by supplying grain, the ordinary trade channels being found adequate to meet the demand. It takes the form of the provision of employment for those who cannot find work. The Famine Commissioners have recommended a policy of prudent advance, starting from a large and expansive

plan of relief and secured by liberal preparations, constant vigilance and a full enlistment of non-official help. The wage-scale has been revised; the minimum wage has been abolished in the case of the able-bodied, payments being made proportionate to the task performed, and provision has been made for the exclusion from relief works of those in a position to maintain themselves. The relief system is enlarged by proposals for dealing with a fodder famine. Famine relief as now administered is elaborate though not as elastic as is sometimes necessitated by acute local conditions. Those who cannot work on the central relief undertaking are relieved, as a rule, in their villages; but children and weakly persons are specially dealt with. Everything depends, however, on the experience, the energy and the sympathy of the officers who have to face a heartrending situation which develops with unforeseen rapidity and on a gigantic scale.

Famine Disease, Mortality and Birth-rate.—No imaginable system of relief, repeat the Famine Commissioners, will meet completely all the various degrees of privation and suffering which a famine produces. It seems worth while to quote an authoritative opinion on famine mortality. "Dysentery and diarrhœa are peculiarly famine diseases, directly caused by insufficient and unwholesome food or by reduced powers of digestion and assimilation as the result of continued privation. Again, it is practically impossible to prevent the outbreak of cholera when large masses of men are collected together in the hot weather under famine conditions: but efficient organisation and careful sanitary arrangements can stay the spread of the epidemic and when these precautions are not taken a considerable share, at any rate, of the resultant mortality must be deemed to have been preventible. Of fevers it can only be said that they often are in origin climatic, but that their fatality is, owing to the

reduced power of the people to resist them, largely due to famine." The disaster from famines thus registers itself in periodical increase of mortality. Such increase of mortality is due not merely to direct loss of life by actual starvation, but also to the prevalence of what have been referred to as famine diseases due to impaired bodily metabolism.[1] Famines cause heavy mortality among the old and the very young, *i.e.*, at the two extremes of life. They leave a greater proportion of able-bodied men in the country, among whom the removal of prudential restraint following a period of forced inhibition of sexual life leads to an abnormal increase of fecundity. Thus a famine period usually is followed by an abnormal increase in the birth-rate.

Movement of Population During and After Famines.

Province	Famine Year	Variation of Population per cent.		
		1881–91	1891–01	1901–11
Bombay ..	1876-77	+15		
	1899-01		−6	+6
Madras ..	1876-77	+15·7		
Mysore ..	1897			+18·1
C.P. and Berar	1896-99			+17·9

Famine Demoralisation.—The incidence of famine diseases has not yet been investigated. The increase of death-rates in regions which have just recovered from a famine, from diseases like dysentery and diarrhœa, as well as from wasting diseases originating in malnutrition, needs enquiry. Attention also should be drawn to the mortality among different social layers, and the factor of malnutrition as causing predisposition to, and deaths from, the ordinary endemic diseases.

[1] Holderness; *Narrative of the Famine in India in 1896-7*, ch. IX.

Again, the increase of birth-rate in these regions has to be studied with special reference to the different strata of the peasantry. It is the agricultural labourers who seem to suffer the greatest distress during the famine, and it is they who recover most quickly and multiply beyond the limits of subsistence. Among the agricultural labourers and the inferior peasants there is no desire for the standard of comfort. In normal years they do not obtain anything beyond the bare minimum of subsistence, while during a famine there is engendered a hopelessness of outlook which persists and dominates their behaviour even later. There is neither fear nor hope, neither prudence nor a standard of living, among these classes. Famine and diseases work havoc and reduce them to a state of complete disorganisation. The very irregular and catastrophic nature of the positive checks to multiplication discourage an adjustment of population. Thus the only factor which can restore the staying-power of the people is lost sight of and some of the worst effects of famines become still more manifest.

Measures for Agricultural Improvement and Famine Prevention.—We need not discuss the economic measures necessary to prepare the people so as to avoid, as far as possible, distress and economic loss when there is a partial or extensive failure of crops. We refer here only to the new and appropriate agricultural measures without which it would be idle to expect the rationalisation of our rural economy. The consolidation of holdings, the organisation of rural credit, the improvement of rural transport, the co-operative purchase of seeds, manures and implements and co-operative sale of produce, the approximation to a fair economic rent, the development of a higher standard of living and comfort—all these are necessary that the peasantry may accumulate a fair reserve stock and purchasing power to carry them over scarcity or famine conditions. We need not dwell on these.

Among desirable agricultural measures we must reckon: (1) improvement of methods of tillage and adoption of those suitable to the local soils; (2) improved rotation of crops; (3) restoration of fertility to the surface and to the exhausted deeper layers of the soil; (4) building embankments for regulating the run-off water from land and the checking of erosion; (5) retention of moisture in the soil and its utilisation by means of improved tillage instruments; (6) afforestation; (7) new irrigation schemes and further well-boring; (8) introduction of drought-resisting crops; (9) improvement of grass-lands and utilisation of special emergency fodders; (10) improvement of stock-breeding by introduction of carefully selected breeders; (11) introduction of special emergency food; (12) improvement of inhospitable soils—measures for cultural improvement of wet lands and saline or alkaline wastes; (13) improved methods of storage and handling grain crops; (14) inauguration of land settlement and land construction works, etc., so as to lose as little rainfall as possible; (15) introduction of early varieties of crops for after-famine use. The agrarian transformation implied by the above measures can be undertaken by the Government only, and any effort in these directions must be based on the co-operation of the Agricultural and Co-operative Departments, and of the peasants themselves in co-operative societies and associations. It cannot be gainsaid that the country now exhibits a great hiatus between agricultural demonstration and agricultural practice; and, so long as this hiatus persists, no policy towards the prevention of famine can be effective. The only method of avoiding it is the organising and utilising of village *panchayats*, union boards, agricultural associations and bodies of cultivators in the form of co-operative societies.

Agricultural Co-operation in India and its Development.—Throughout India *panchayats* already exercise,

or are about to be given, extensive powers in connection with civil administration, sanitation, communications and education. In the Central Provinces "irrigation *panchayats*" assist the Irrigation Department in the control of irrigation in villages commanded by Government tanks. But, of all provinces in India, it is Madras which has best maintained the old and essential traditions of rural co-operation. In most villages, the *Samudayam* or common pasture-ground for the grazing of village cattle is maintained. A part is leased out to defray common village expenses. The *panchayat* looks after the work of a whole array of village artisans, servants and functionaries. It supervises the construction, maintenance and re-excavation of irrigation channels, the repairs of the village guest-house and temples, the distribution of charity among beggars, learned men and pilgrims, the feeding of travellers, village entertainments and recreations, etc. Communal labour very often is employed, each acre of land contributing a certain quota of labour for repairing tanks or irrigation channels. Irrigation associations called *sethis* still are to be met with in the southern districts of Madras. Villages are divided according to the number of tanks for irrigation purposes, and each of these divisions is managed by a *sethi*. All the cultivators whose lands are irrigated by the particular tank or tanks of the ward are members of the *sethi*. The *sethi*, under the leadership of the headman called *karaiswan*, regularly meets to arrange for the repair and maintenance of the tanks under its particular jurisdiction. When the funds of the *sethi* are deficient, other *sethis* give them loans or contributions, and there is often found a good deal of co-operation among the different irrigation associations of a cluster of villages, which much lightens the work of the irrigation of lands under their command. In Bombay grass-lands are fenced and grazing and cutting controlled by the village *panchayats*. Thus grass-lands are enormously

improved by rest and thereafter by rotational grazing and cutting. The case of the village of Pimpalgaon Baswant in the Nasik district, where about 800 acres of grass-land are administered by the village co-operatively on the old *panchayat* system, may be adduced. Annually 200 acres are set apart for grazing and 600 for cutting. Four watchmen at Rs. 10 to Rs. 12 per mensem were kept for the six months when the grass was on the ground to prevent trespass.[1] In Bengal in the district of Birbhum many village agricultural associations have taken up the question of re-excavation of irrigation tanks on these lines, collecting contributions in proportion to the amount of land irrigated and executing the work. Considerable progress has been made both in Birbhum and Bankura districts in solving the problem of irrigation with the help of Co-operative Irrigation Societies, and the example of these two districts has spread to the neighbouring districts of Hughli, Burdwan and Midnapore. In the Bombay Presidency, proposals for irrigation societies are being considered by the Co-operative Department, in which oil-engines are to be set up on large wells or tanks to irrigate the land under their command. Two joint cultivation societies have been registered, one of these in a tract liable to famine where an oil-engine has been erected to irrigate part of the land taken up by the society. The ordinary wells irrigate small areas of 25 to 50 acres round each large well. To irrigate more extensive areas we should either have to increase the number of wells or to arrange that each well gives a larger supply of water. This is just where tube wells come in as the great agent for agricultural improvement in well-irrigation areas. In Jamuna-Gangetic alluvium there now is relatively little more development possible in the direction of canal-irrigation from the superficial water supply. There remains

[1] W. Burns: "Grass-land Ecology," *Proceedings of the Tenth Indian Science Congress*, p. 45.

only the subterranean supply from which further supplies can be drawn. The percentage of irrigated to non-irrigated land in such areas furnishes a rough indication of the relative difficulty in raising water. Thus, the difference between Mirzapur with 7·8 per cent. only of its cultivated area irrigated by wells and " other sources " and Benares with 5·75 per cent. so irrigated is due clearly to the difficulty of well-construction in the two districts. From wells, which supply more than half the irrigated area, from " other sources," which supply nearly another quarter, and from canals too to a certain extent, water can be obtained by lift only—that is by labour or work.[1] It has been found by careful comparison that the power-pumping plant, when an oil-engine is the prime mover, can be run much more economically than the bullock-driven plant. Altogether some 16,000,000 acres of cultivation are estimated to be dependent on well-irrigation ; and some 6,000,000 cattle are required to work the pumps. In some parts the cattle used in water-lifting represent an inordinately large tax on the land and the place of cattle might be taken in very many cases by small engines. It is also necessary to ascertain to what other branches of agriculture mechanical motive-power is applicable. Next in importance to irrigation we have sugarcane crushing, where the oil-engine effects a large saving. In the Bombay Presidency there is quite a number of small businesses where oil-engine, oil and flour mill, ginning machinery and rice-hulling machinery have been set up and utilised by the ryots to the mutual advantage of ryots and mill-proprietors.[2] Already some progressive farmers in Gujarat are using power-pumps with advantage ; but, owing to the heavy initial expense of these appliances, they are not within the means of

[1] See Leake : " Trend of Agricultural Development in the United Provinces," *Agricultural Journal of India*, 1923, p. 16.

[2] See " Oil Engine," *Agricultural Journal of India*, 1918.

petty cultivators. The Co-operative Power-Pump Societies, however, have solved this difficulty, and the Government of Bombay have decided to advance loans up to 75 per cent. of the value of wells and power-pumps to these societies. In addition to these efforts, there are larger projects, such as dams across *nalas* and series of embankments in certain villages, which are to be carried out on a co-operative basis. The Local Government recently has sanctioned the appointment of an Agricultural Engineer who will examine these schemes, and it is hoped that this appointment will enable more rapid progress to be effected. It is essential that both in respect of design and of execution all the ameliorative famine measures adopted shall accord with a well-considered plan drawn up by those having expert knowledge of the problems involved. The advice and guidance of officers of the two Departments of Agriculture and Co-operation, as well as their co-ordination, are necessary; while the appointment of an Agricultural and an Irrigation Engineer for inaugurating land settlement, land improvement and land construction works may be necessary in every province. Bengal with her waterlogging and floods, and the Deccan with her precarious rainfall, for example, call each for a different class of expert for considering large schemes; while the deserts of Sind and Rajputana require experts versed in an entirely different group of problems.

CHAPTER XII

EQUILIBRIUM OF VILLAGE AND CITY

Regional and Seasonal Occupations and their Co-ordination.—We have seen that social decadence is brought about when the balance of occupations and folks is upset by encroachment of the economics of one or other of the levels in the region on that of another. The problem of constructive economics is to follow the methods of ecology in restoring the balance. On hill and mountain slopes the continuous grazing of cattle and ascent of the cultivated fields lead to deforestation, which brings about floods and droughts in the plains. Similarly, the industry of the smelters and iron-workers falls victim to exhaustion of fuel through wood-cutting without forestry. Hence the conflict between the miner and the wood-cutter. But re-afforestation is not merely an aid to agriculture but also lifts the timber and mining industries to a higher level, while the harnessing of waterfalls brings electricity to the looms and lathes of hill-folks, as well as supplying motive-power for manufacturing industries in the plains. The damp side of a mountain range generally is covered with timber, and has its mineral wealth washed bare (*e.g.*, gold on the west side of the New Zealand Alps), while on the dry side there is only just sufficient moisture for pasture (as on the eastern slopes of the N. Z. Alps). Thus the respective industries are complementary. Again, winter is the season for cutting timber in the forests, and this can be done by the same men who work in mills when the river (which may be frozen every winter) is open, as in the case of the Canadian rapids. In the same way the peasants of Jura during summer are farmers or shepherds and

in winter veritable industrial workers in wood, also watch-makers and stone-cutters. In Germany, woodlands provide much winter employment and thus reduce the proportion of labour expense falling on cultivated land. This combination of forestry and agriculture, the former providing winter and the latter summer employment, enables large tracts of poor land in Germany to support a considerable rural population. In Britain similar tracts of country are almost uninhabited.[1] In India the railways and roads at the foot of the Himalayas are blocked half-yearly with sawyers, carters, carriers and every form of labour, first in their migration to the forests after the winter crops are sown in November and again in their migration back to their homes in time for the harvest at the end of March. It is a feature common to most Indian forests, a great influx of labourers working furiously for a while to render available for the industrial life of the country the valuable products of the forests, and then departing with their well-earned wages with the ripening of the fields to harvest, or when the terrific heats of summer or the tropical rains of the monsoon render further jungle work impossible.[2] Men are thus like deciduous trees, which are physiologically different in winter and summer. Thus it is difficult to exaggerate the importance to the farmer of arable land of such industries as provide work for rural labourers in the winter months. The shepherd is the enemy of the hunter because he follows the woodcutter. But scientific forestry with game preserves may satisfy both. The hunter will have his game but not livestock, while the shepherd will live on good terms with his neighbour, the huntsman, since his domesticated animals are tempting and easy victims of the carnivores. On some Scottish estates, the

[1] T. H. Middleton: *The Recent Development of German Agriculture*, p. 41.

[2] Smythies: *India's Forest Wealth*, p. 15.

practice of alternating gathering and beats has solved the difficulty of co-ordinating the claims of sheep-rearing and deer and grouse shooting. The segregation of forest blocks for preventing the spread of fire is useful for rides, cutting, etc. Everywhere the raw material provided by the forest renders most important service to industrial development. All manufacturing nations therefore are alive to the economic importance of forests and forest conservancy. In Germany the forests often are seen stretching right into the industrial cities, providing the industries with raw material at their very door. It was estimated that in Germany before the war three million persons depended on the forests, in some way or other, for their livelihood.

Pastoralist *v.* Peasant—the Australian "Squatter."—Similarly, the shepherd with his nomadic flocks and the peasant tied to the soil are at endless strife. The conflict between the settled Arabs and the pastoral Bedouins is proverbial. Control over the oases in waterless steppes enables a Bedouin sheikh family to establish easy command over the intervening tracts. The peasant, peaceful and non-aggressive, yields easily to the warlike shepherd. In the American West the big rancher often used his numerous cowboys and gunners to ruin the "homesteader" and chase away the small cattleman so that he might himself grow rich on grazing stolen from public lands. In Australia adventurous sheepmen early pushed on into the public domain in advance of the government surveys, and "squatted" with their flocks on vast areas from which their shepherds excluded all settlers. Whole districts of valuable crop country lay untilled in the hands of pastoralists, who soon became wealthy and powerful men. When the State later attempted to resume its rights over these tracts the "wool kings" were too strong to be dispossessed, and the government had to content itself with exacting a small rent from the area occupied.[1]

[1] Ross: *Principles of Sociology*, p. 327.

Intensive Agriculture Reconciles Shepherd and Peasant.—In Asia, throughout the history of the whole belt of steppe-lands from Mongolia to the Atlas, there has been a constant struggle between settled agricultural communities and pastoral nomads. It is true that agriculture and settled conditions gradually encroach upon nomadism, but pastoral nomads still cover larger areas than any other economic type, excepting that of primitive agriculture. It is traceable to the permanent unsuitability of many areas of dry steppes for settlement, and also to the resistance to change which comes from isolation. Other causes are religious fervour and the desire to maintain purity of race and integrity of the social system. As in the case of miner and wood-cutter, wood-cutter and hunter, hunter and shepherd, the manners of life and economic interests of shepherd and peasant are indeed poles asunder. But intensive agriculture dissolves their latent feud. The breeding and rearing of cattle became an agricultural industry, giving milk and draught cattle, hides and skins to the peasant, while as cultivation becomes more and more intensive to satisfy the needs of dense populations, stock-raising for meat is given up. Beneficial effects of the contact with a more advanced economic type are shown in the extension of oasis cultivation through irrigation by the French in the Algerian desert; the similar Russian development of Turkestan; and the incursion of agriculturists from China proper into Mongolia.

Plantation System and Kindred Abuses.—Primitive agriculture, which means tropical or sub-tropical agriculture (in the Sudan and Malayasia originally "hoe-culture"), similarly has been invaded by plantation industries, which involve the concentration on one tropical crop or product under skilled scientific supervision in relatively small areas.[1] But the superimposition of the plantation industry has been accom-

[1] Andrews: *Geography*, p. 86.

panied by deterioration of the soil as well as by grave social unsettlement and injury. Wherever the plantation system has developed, the native races have been exposed to a drastic and rigorous process of dispossession from their ancestral lands. The disintegration of tribal organisation of agriculture and agrarian communism coupled with labour-abuses has been responsible mainly for an economic set-back, the restriction of labour supply and the dislocation of industry in places where such abuses have been most flagrant. Here is only one instance of the conflict between economic types in the tropical and sub-tropical world, which to-day is demanding anxious consideration from philanthropists and statesmen alike. Such conflict between types of occupation and folks at different stages of social development is seen not merely in the van of civilisation in mountainous fringe, in forest, steppe or prairie, where the pioneer settler or squatter meets people whose manner of life he does not understand or believe in, but also in the rear of civilisation in old countries. Here also the disparity of levels and economic standards in different region-sections is clearly discernible and governs their mutual intercourse.

Dairy Industry Reconciles Shepherd, Peasant and Manufacturer.—But the most striking conflict that has emerged in settled society is that between the manufacturer, on the one hand, and the shepherd and peasant on the other. The contrast between types of cattle required for milk or for meat, and also between the conditions which are required for each type, shows the difference between standardised production as in a capitalistic industry and individual treatment. But the production of milk and the manufacture of butter and cheese near industrial towns mark the reconciliation between the needs of dairying and agriculture generally and those of the manufacturing stage. Thus while the institution of huge herds for

the purpose of food in sparsely-populated grass regions of the world, or again their mass movement from dry ranching-lands to richer soils for fattening, resemble the methods of mass-production, and have been aided greatly by development in mechanical skill with special reference to the invention of refrigerating machinery and of special vessels, the co-operative creameries and milk-supply societies have resulted from a high degree of success achieved in the keeping of dairy-cattle and the cultivation of fodder, as well as in the application of the domestic system to milk-production for the markets. It is thus that in Denmark we find an organised and very remunerative cattle industry near the great industrial centres of Europe. In India the soundest method of achieving the improvement of cattle is not through meat but through the milk-supply. Efficient milk-supply demands a regular and sufficient fodder-supply which will be forthcoming if the standard of milk-yield can be raised and the dairy industry sufficiently organized to enable the village milk-producer to obtain a price for his milk more in proportion to its value in town markets than the price he now obtains.[1]

Economics of Meat Production.—The wastefulness of meat-production from the standpoint of natural resources has been pointed out recently by many writers in the West, and such waste is intolerable in a country where population is dense and the main source of agricultural power is and must remain the bullock. It is estimated that about 24 per cent. of the energy of grain is recovered for human consumption in pork, about 18 per cent. in milk, and only about 3·5 per cent. in beef and mutton. In other words, the farmer who feeds bread-grains to his stock is turning up 75 to 97 per cent. of them to produce for us a small residue of roast pig, and so is diminishing the total stock of

[1] See *Report on the Administration of the Department of Agriculture*, 1923; also *Agric. Tribunal of Investigation, Final Report*, p. 358.

human food. The hog is the great competitor with man for the higher grades of food, and in swine husbandry, as ordinarily conducted in the West, men are in danger of paying too much for the roast pig. Cattle and sheep, on the other hand, although less effective as converters, can utilise products which man cannot use and so save some of their potential value as human food. From this point of view, as well as on account of the importance of milk, the high economy of food production by the dairy-cow deserves practical consideration, although of course the large labour requirement is a counterbalancing factor.[1] The fostering of milk-supply schemes and the organisation of the dairy industry near town markets thus represents harmonisation of the needs of a dense agricultural population, for whom cattle is the chief source of wealth, and the city-dwellers, who cannot get milk save at an exorbitant price.

Urban Exploitation of Peasant and Land.—At the manufacturer's behest the peasant grows fewer crops and keeps more land in permanent pasture. Moreover, he cultivates fewer food-crops and more raw materials for which cities clamour. With the growth of industrial towns there is a continual removal of crops and dairy produce, especially the latter, from the villages, and this impoverishes both soil and pasture. Gradually even the cereals as well as the cattle-food grown on impoverished soils become deficient in nutritive constituents and this reacts upon the health of men as well as of farm animals in both village and city. The balance of occupations also is upset to the detriment of rural consumers. Formerly, the peasant was in the hands of the village usurer and starved when his crops failed or his money-lender refused further credit. Now, the world which needs his produce gives him some credit, though at a price. But he does not understand the market, and is helpless

[1] "Roast Pig," *Science*, 1917, 160.

in face of its impersonal forces and the trained skill of the middleman. Worse still, he often is subject to an agricultural manufacturing concern like the jute-mill or the sugar-factory, or a firm exporting foodstuffs abroad, which takes his produce and dictates prices. These parties often make contracts with the peasant in advance for the crop and reduce him to an out-worker, very much like the hand-loom weaver. Indirectly, they sometimes govern his choice of crops by mortgaging his land, so to speak. It is thus the peasantry are made to suffer from speculative dealings in food-grains which bring about fluctuations in their prices. To prevent speculation in the cereal trade between the various states of the Union, America has passed a law forbidding the transmission by post or in trading between the several states by telegraph, etc., of communications dealing with the making of any contract for the purchase of grain futures or giving information as to the state of the market and the prices quoted for such transactions. The cultivation of non-food crops must be on a large scale, incompatible with small-holdings. Thus this tends to increase both cost of living and monopoly of land. Modern industry in its first phase encourages high prices, as well as large estates, and is an enemy of the peasant proprietor. Kropotkin contends that the ruin of village communities in Europe was due to the wresting from them of lands. "The village communities had lived for over a thousand years; and where and when the peasants were not ruined by wars and exactions they steadily improved their methods of culture. But, as the value of land was increasing in consequence of the growth of industries, and the nobility had acquired under the state organisation a power which it never had under the feudal system, it took possession of the best parts of the communal lands." It is the increasing domination of the city industrialists and traders over hillsides, pastures and tilled lands, which has led to

their exploitation, heedless of the requirements of each integral section in the region. This urban dominance brings about the destruction of forests for sale of timber in distant markets, the substitution of non-food for food crops, the growth of large estates, the rise of a class of landless labourers, the neglect of intensive agriculture and the concentration of effort on one kind of crop or product in one region.

How Landlordism Feeds Industrialism.—Conversely, it is the class of landless agricultural labourers which proves the breakdown of small farming economy and which ceaselessly is poured from the countryside that feeds the industrial machine. Where the agrarian and social conditions are such that agricultural slavery is the rule, emigration and opportunities for free labour, in industry or mine, work towards social uplift. Thus the Santal, Kol, Gond and other aboriginal peasants have been converted gradually from tenants into bond-slaves in parts of Bihar and Chota Nagpur. But the *kamioti* system which has reduced the aboriginal and semi-aboriginal tribes of Chota Nagpur to a most degrading poverty and slavery is practically non-existent in the neighbourhood of the coalfields and of the mica industry. In Chota Nagpur forced labour in the form of *kamioti* and arduous labour under most depressing conditions mutually help each other. The pioneers of reclamation have been the free aboriginal and quasi-aboriginal tribes who had been organised in village communes; but the alien landlordism has attacked their *ryotwari* rights, expropriated them and reduced them to serfdom, bringing about agricultural depression. Thus the development of coalfields and mineral industries by aboriginal labour has accompanied the reverse process in agriculture. It is not uncommon in Chota Nagpur to find villages entirely deserted by the peasants and thrown out of cultivation altogether in recent times on account of the oppression practised by the landlords, while new

mines and mineral industries are started not far off. The system of land tenure either encourages expropriation of the peasant or an excessive subdivision of holdings which leaves him insolvent and helpless. Small-holdings below the economic size would keep labourers on the landlord's estate without making them independent of the necessity of labouring on their landlord's lands. Thus the aim of the landlords has been to keep the holdings small and raise the rents as high as possible. The machinery of commerce neglects also the food requirements of an essentially agricultural population. At the same time the organisation of rural credit is upset by the introduction of exploitative commercial and trade interests. All this ensures a perennial supply of labour from the fields to the city workshops. The Indian mill-hand primarily is a cultivator who returns to his home in his native village as soon as he has been able to lay by sufficient money after providing for his own expenses and his regular remittance to his family, who seldom accompany him to his *chawl* or *busti* near the factory. The *ghatis* who swarm into the Bombay cotton-mills are usually cultivators of holdings too small to afford them a subsistence ; and as a rule they are heavily indebted to money-lenders with whom their connection persists in their city environment. Only a small proportion of workers in the coalfields in Bengal reside permanently at the mines. The rest are usually small cultivators who return to the villages for the cultivation and harvesting of their crops.[1]

Disorganisation of Rural Industries.—The development of factory production has disorganised rural arts and handicrafts. When industries subsidiary or supplementary to agriculture decline the peasant's economic strength is diminished. In many regions specialisation has gone too far, and the peasants have been reduced to hewers of wood and drawers of water for the city.

[1] Mukerjee : *Principles of Comparative Economics*, Vol. II.

The variety of village production is unknown and people concentrate their efforts on some purely extractive industry like agriculture, mining or lumbering. In India Mahatma Gandhi's cult of *Charkha* has been preached to restore the economic independence which the peasant has lost, while his insistence on the ancient simple and low standard of living has stood for a denial of those comforts which are supported by town industry rather than rural industry.

Other Depressing Influences.—Two other processes, accompanying the advance in manufacturing production, also have contributed indirectly to the decline of agriculture. There is a vast and increasing traffic between regions, countries and climates, but cheap and easy transit in villages still is lacking. Light railways, steamers and canal traction, which play an important *rôle* in the development of rural traffic, have been comparatively neglected. In India the railway has been developed at the cost of the waterway, while freights have been so arranged as to encourage exports. In America it is only recently that the Inter-state Commerce Commission has interfered with the discrimination in freight rates which once almost forced business to gather about the great terminals, and enabled it now to spread to towns included in districts of equal tariffs. Secondly, the introduction of agricultural machinery, driven by power, has released a large number of farm-hands from rural work for urban pursuits.

Co-operative Food Distribution.—The restoration of the balance between the agricultural region and the manufacturing region has been a foremost object of modern social programmes. Much may be expected from the garden city movement, the arts and crafts movement, farm colonies and co-operative societies. All these, however, may modify but do not end the conflict between the agricultural and the manufacturing region. A more effectual solution of the conflict lies

in the change of technic conditions in villages. The development of workshops and small industries in villages will accomplish a great deal in the equalisation of opportunities for effort and employment throughout the country. The modern system of distribution and sale is so cumbersome and complicated that it leads to exploitation of both producer and consumer. The farmer does not get a fair price, while the consumer in the city is ill-supplied with poor milk, fruit and vegetables at a high price. Thus the present system of food distribution is responsible for the fact that one half of all the fruits and vegetables raised in the United States never reach a consumer. This is more or less the case also in every other country. The campaign to " grow your own food," now at its height in America, seeks to develop the local food supply with the primary object of supplying local needs by establishing in every small country town a food-standardising plant to serve as a kind of food clearing-house. By giving to the farmers near every centre of population the local market for twelve months in the year, it would aid greatly in the intensification of agriculture and in its adjustment to need. This arrangement would eliminate the waste of vegetables so common in farmer's gardens, since the farmer is not in a position to handle a small surplus. It would reduce waste of labour and money by eliminating the middleman's interference and profits. The eliminated middleman, of course, then could enrich society by producing something himself, instead of concerning himself needlessly and uneconomically with the productions of others. In the United States, Denmark, Germany, Belgium and the British overseas dominions, rapid strides have been made in the development of co-operative marketing. In Denmark the system of co-operative marketing was encouraged chiefly by her dependence for export on foreign markets, but other countries not possessing this incentive nevertheless have shown

remarkable progress in agricultural co-operation. The great co-operative dairying undertakings which supply New York and other towns with milk are conspicuous examples of co-operation among farmers. Co-operative development in Germany and Belgium has led to far-reaching improvement in the organisation of trade in all home-grown products. The tendency in these countries is to establish the position of co-operative marketing organisations by membership contracts which have the effect of compelling farmers, during certain stipulated periods, to deliver all or an agreed proportion of their produce to their societies. The use of such contracts may be stated as follows: (1) To assure in advance a steady volume of business and to admit of appropriate planning and organisation; (2) to furnish a basis for credit, since the contracts in reality are an added security for banking operations; (3) to enable the supply of produce to the markets to be regulated; (4) to put the societies in the best position to influence their members as to the most desirable types and varieties of produce; (5) to give a basis for collective bargaining with buyers; and (6) to discourage attacks by competitors. The co-operative marketing association established on such a basis starts with a definite volume of business which reduces its risks and simplifies the work of organising its plant, its management and its markets. It also renders to small farmers indispensable services, which may include the bulking of produce to secure favourable transport rates; the classing, grading, preparation, packing and despatch of produce; as well as services such as storage, preservation, carrying over of stocks, search for trade outlets, advertisement and the regulation of the flow of produce into markets in accordance with the estimated demand. A further aspect of co-operative marketing undertakings is that, as compared with the middleman system, they represent the producer's interest and his effort to control, so far as

he is able, the marketing of his own produce. They are, therefore, an indirect measure of the margin of marketing costs; they constitute a producer's method of testing the reality and necessity of the marketing services which intermediaries commonly render in placing produce in the hands of consumers; they test each link in the marketing chain and their natural outcome would be to reduce the number of such links where possible.[1]

Regional Planning.—The development of a co-operative marketing system on national lines must be accompanied by a constructive policy of regional planning with its business and industrial zones and belts of farms and playgrounds, which constitutes the only solution of the problem of food supply along with that of urban congestion. In Belgium, where transport has been aided by a network of light railways, the factory workers live on the land to a degree unknown elsewhere. With his plot of ground there is room for production by the aid of women and children, old persons and, in his spare time, by the artisan himself. The garden products, with poultry, hares and possibly cows, are great additions to a low wage and they conduce to the intensity of culture that gives a large return per unit of land. Under prevailing circumstances we have on the one hand slums and hopelessly crowded cities and, on the other, broken homesteads and deserted villages. In Germany, the scheme for the garden girdle of Kiel is of great social significance. Kiel, Bremen, and other places in North Germany express their zeal for out-door exercise by gardening. The effort increases the food-supply. Kiel intends to turn this taste of its citizens to account by a zoning scheme. The industrial and residential sections of the city are to be regulated; the existing gardens, public and private, are to be extended, allowing for forest and park reserves, and the city ultimately will

[1] See *Report on Co-operative Marketing of Agricultural Produce in England and Wales*, 1925, pp. 12–13, 166 and 173.

feed itself by its own efforts. All is calculated to a nicety. City refuse will be deflected inland, by an extensive canal, pumping and treatment system; water conservation will be undertaken, model gardens will be established, tool factories will operate, an agricultural society will be formed, prices will be regulated, etc.

Rural-Urban Problem: A Solution for India.—A scientifically planned city community and a scientifically planned rural community in India alone can restore the balance between the rural and the urban economy. The Gangetic locations may become almost one continuous series of garden cities with their tributary farms, while the plains in the interior may carry on an intensive-extensive agriculture with only enough manufacturing to meet some local needs and to occupy that part of the population which is dependent upon agriculture but not directly engaged in it. The advantage in transport afforded by waterways (rivers and canals) should be utilised in the redistribution of industrial and manufacturing cities to ensure our living with the least waste of effort. Nor should our factories and industrial establishments be segregated in a few huge cities. They should meet surplus labour of the overcrowded plains half-way in towns and small cities, and facilities of land and water transport should be opened out for them to secure a more economical distribution of population. The easy distribution of electric-power and the use of motor trucks bring with them social and agricultural benefits which we can perceive with difficulty in the present era of steam and iron, rail and factory concentration. With increased use of electricity as a motive-power of industry, industrial establishments will be decentralised. Oil, gas, and water-pressure engines, owned and operated like the power-houses by villages, also are available, and their increased use as cheap, easily worked and efficient machines for all purposes will be of enormous social and economic significance to the countryside.

CHAPTER XIII

REVIVAL OF COTTAGE INDUSTRIES

Difficulties of Small Industries in India.—The decline of cottage and village industries in India has weakened the economic position of the small farmer whose energies are not absorbed entirely by agriculture. A wide-spread pessimism regarding the conditions of cottage-production has been encouraged by the decline of handloom-weaving in particular. But the substitution of mill-products for the products of the cottage-looms during the last few decades of the 19th century was due to certain special factors which are by no means universal. In other fields cottage industries have held their ground, not merely in India but also in Europe. Those types of cottage industry which are associated closely with farming, and for which highly finished tools are not indispensable, have not ceased to flourish. Thus the production of articles of domestic consumption, the various branches of the wood industry, pottery, weaving, bamboo-work, metal-work, etc., are meeting the competition of large-scale production with comparative ease. It has been estimated by Mr. Ewbank that nearly 17,000,000 people are employed in small workshops in India. It is true that in many of the artistic and skilled industries former aptitudes have been lost and tools and methods have been simplified, but along with an increase of population there often has been witnessed an increase in unskilled occupations in the villages availing themselves of raw material on the spot. In Germany small-scale industries continue to employ about two-fifths of the entire population and embrace more than 90 per cent. of the industrial establishments. Similarly

in Denmark 80 per cent. of all establishments employ fewer than five workers apiece. In most of the cottage industries of India the main cause of deterioration is want of convenient credit. Not only are the artisans unable to effect sales on account of their poverty, which forbids them to employ travelling agents or otherwise advertise their wares, but also the very quality of these wares suffers owing to their inability to afford the best materials and tools, or to exploit their own ideas. Most of the artisans are indebted to the *mahajans* and all have to work to order only. Such middlemen, who care for nothing but their immediate profits, have no interest in the beauty and excellence of the products, and encourage the production of plain, utilitarian and cheap work.

Co-operation and Credit Facilities for Small Industries.—In continental Europe the governments of many countries have been developing handicrafts by encouraging the artisans with grants of machinery. The Government of Hungary, for instance, supplied within a period of ten years (1899–1909) 1,922 craftsmen with machines of the aggregate value of 3,762,567 crowns. Only in 48 cases had the machines to be declared forfeited because the craftsmen in question were unable to use them or keep them permanently at work. Out of the 1,922 craftsmen, 434 were iron and metal workers and 390 were engaged in the clothing industry. Besides such direct aid as the grant of machinery or loans, the governments in the various countries in Western Europe have organised co-operative credit societies among the artisans and granted loans and machinery to the members through these associations. Artisans' societies have been started in different parts of India on the basis of share capital or unlimited liability or on both. In Burma the home industries of Mandalay have a number of small societies financed by loans from government. In Bengal industrial unions have been formed with

a view to solving the difficulty of financing these societies. Such societies have proved in their own way to be very useful to the humble artisan classes, but the by-laws of Industrial Societies need to be far more elastic and adaptive to the special needs and conditions of different crafts. Thus the societies should lend on invoices, labour bills, or any prospective claim sufficiently recognised. Swiss Banks advance money on cocoons, secured by the undertaking that the spun silk shall not leave the spinners' house till the debt has been repaid. A great deal may be expected by more convenient and popularised banking for the weavers in Dacca, Murshidabad, Madura, Benares and other centres. Weavers should be encouraged to buy their cotton or their raw silk through the Co-operative Societies or through a secondary body to which the society may be affiliated. Advances in cash, and capital for the purchase of silk and cotton yarn and improved appliances for looms, may be given and the weavers should be discouraged from selling goods independently and encouraged to sell them to the Societies which are offering them the valuable material service. Similar societies of dyers, leather-workers, wood-workers, metal-workers, printers, etc., are co-operating with good or ill fortune in the various provinces of India ; success or failure depending entirely upon the elasticity of such societies and the convenience they afford to the members. In Burma the cottage industries of weaving, pottery and lacquer-work have been selected for development by co-operative methods, and societies now are encouraged to own factories where all but those whose integrity is above suspicion are compelled to work. A very interesting association is the Mandalay Artists' Society, which is composed of portrait-painters and mosaic workers and is under efficient management. It buys its requirements co-operatively on a small scale and undertakes contracts. In Orissa there is an industrial

society at Baidyarajpur for the production and sale of bell-metal utensils. Raw materials are obtained direct from Calcutta at wholesale rates and given to the members together with some advanced payment. The members are paid their wages for the finished products brought to the society, which go partly or in full towards the repayment of the advances, and the society sells the goods through hawkers. Co-operative societies possessing their own machines, oil and gas engines and providing electric light and power for the artisans, secure in agricultural countries of Europe the same economies of production and opportunities as to invention and improvement of processes and utilisation of work which are normal to the large-scale industry. Where co-operative organisations do not show initiative and the capacity for taking risks, trading firms may be encouraged to step in between the artisans and Co-operative Associations. An instructive feature of the Swiss silk-weaving industry, which employs nearly 34,000 rural workers, is found in the fact that both expensive looms and costly material are lent to the peasant workers by the commercial undertakings, who in this case are middlemen whose function is beneficent. The annual trade turn-over reaches 266·1 million francs. The introduction of cheap gas and oil engines and of electricity as a motive-power in small production has been an important step in the resuscitation of village industries. In Bengal the question of introduction of cheap electric power to large weaving centres is being explored.

Organisation of Rural Industries.—The want of a central trading organisation has been a chief defect of cottage production. Isolated and unrelated cottage industries lend themselves easily to exploitation by middlemen. In Germany the Associations of small producers buy raw materials in common, use machines in common and sell their products in common. The commodities produced belong to the individual artisans.

As long as we do not expect the requisite capital and trading capacity from the Co-operative Societies themselves, the necessity of setting up special machinery for the sale of products of the cottage industries is obvious. A noteworthy feature of rural industries in Switzerland is that they have organised themselves on the commercial side into a trading co-operation known as *Kanferbunde,* with branches. In Germany commercial organisation left to free-lance middlemen has reacted unfavourably on the conditions of sections of workers in some of the industrial groups. The Home Industries Department in Mysore has achieved remarkable success in popularising the wares of village industries. The success of the Indian Pavilion in the Empire Exhibition in establishing contact for the products of the cottage and village industries of India with the world's markets would not have been possible but for the existence in the different provinces of Industries Stores and Emporiums such as the U. P. Arts and Crafts Emporium at Lucknow and the Punjab Arts and Crafts Emporium at Lahore. It is necessary, however, that a central buying and trading organisation, once established, should be utilised in working out a constructive policy of commercial and technical information and guidance without which the industries will remain unrelated to the exact nature of demand or the cost of production abroad. Germany's Joint Board of Crafts, through its Provincial Crafts and Home Industries Department, has set out to supply commercial and technical information and to advocate changes of policy whether in the adoption of new processes or new forms of industries. It has commanded respect by the commercial and technical value of its information and the wisdom of its recommendations. A rapid and flexible development of rural industries and the smooth decentralisation of many urban industries has been attributed to the ready acceptance of its guidance by all concerned. Such a

Central Intelligence Agency should embrace the following matters in its field of operations: (1) Advising on improvement and reconstruction of processes in village and cottage industries as in the case of Dyeing, Leather, Glass, and Cloth Printing. (2) The introduction and application of modern mechanical implements and tools not yet used in Indian cottage production; *e.g.*, the introduction of the fly-shuttle-loom in weaving, of gauges, improved saws, planes, tables and lathes in wood-working, punching and shape-making machines, improved moulds and lathes in metal-work; improved oil-presses and power-crushers of sugarcane, etc. (3) The introduction of improved designs, especially in artistic industries. (4) Collecting and diffusing information on commercial subjects, including market intelligence, foreign competition, methods of organisation and propaganda.

Successful State-aided Rural Industries in Germany.—The *Development Commissioners in England* reported that the magnitude of the results achieved in Germany as regards the development of rural industries was due not so much to coercive action on the part of the State in shepherding these industries, or to any direct or indirect assistance from tariffs, as to the steady and strenuous diffusion through specially created services of advice, information and education. Many industries however, were "created" by State-aided action: for example, watch-making in Saxony; the making of pencils in Bavaria; ivory, tortoise-shell, mother-of-pearl industries in various centres, etc. Thus rural industries have been newly introduced on a large scale in whole districts where the best advantages offered.

Rural Industrial Policy for India.—A forward industrial policy not only would revive important industries founded on the traditional scale, but also would create new industries around natural resources and the supply of skilled artisan labour. State aid and initiative might introduce profitably in the

villages of India such crafts as toy-making, artificial flower making, cardboard-box and light packing-box making, straw-plaiting, fruit-basket making, lace-making, knitting of all kinds, etc., which employ thousands of artisans in the villages in Western Europe. Where hereditary skill is available, the establishment of such industries may have no reference to land occupations. But, since in India cottage industries serve mostly as buttresses to the cultivation of land in small holdings, new industries can be introduced successfully only where they fit in well with the work on the land. Thus basket-making, rural woodwork, bamboo and straw weaving, inferior cutlery, have the most promising future, and these will derive further support from the economic collaboration of all members of the family, including the women and children.

Technical Instruction.—Another very important direction in which Government aid is required would be in the organisation of technical instruction. Not merely is there the need of establishing technical schools in all the industrial and artistic centres, but in addition the educational programme in the primary and secondary stages needs reorganisation to allow of boys receiving manual training and instruction in industrial handicrafts. At present in all industrial and technical schools there is a tendency to separate the artistic and the practical, the design and the work. The teaching of art should go hand in hand with the proper teaching of a trade, and every student should be encouraged to make manufacture artistic, and at the same time to command its price in the market; so that immediately on leaving the school he can command a fair income, producing neither unsaleable artistic work nor following slavishly the old conventional patterns and designs which cramp artistic freedom. Such schools ought also to preserve close and intimate relations with the traditional technical

and artistic skill and achievement of the neighbourhood. Each group of industrial workers and artisans should be welcomed to the technical school, and there should be held continuation classes specialising in the different lines of training appropriate to different classes of cottage and artistic industries.

CHAPTER XIV

RURAL RECONSTRUCTION

Machine Age of Agriculture.—The last century witnessed in Europe along with the Industrial an Agricultural Revolution whose effects are equally far-reaching though often neglected. Extension of crops such as beet and potato, specialisation on leguminous crops, advance of market and catch crops, chemical as well as bacteriological restoration of the soil-surface and subsoil drainage, development of dairying and gardening industries: all these movements point to an imperceptible rural transformation which began early in the nineteenth century and was nearly completed towards its close. Above all, the use of the huge power-driven machine has revolutionised farming practice. In India, the following programme among others has been suggested by the Indian Industrial Commission as coming within the scope of power-driven machinery in connection with our agriculture:

1. To lift water for irrigation from wells, channels, tanks, water-courses and rivers;
2. to improve the land by draining low-lying ground and water-logged soil and keeping down the level of saturation in canal-irrigated tracts; and in certain parts of the country by deep ploughing;
3. to prepare crops for the markets in the most profitable forms. This includes such operations as fibre and oil extraction, wheat-grinding, paddy-husking, coffee-pulping, tea manufacture, and, most important of all, sugarcane crushing;

4. to prepare materials required in agriculture, such as bone-meal for manure, and crushed or chopped cattle food.

Agricultural Changes in the West : Hydro-electricity in Rural Industry.—Agriculture in the West has become less rural than it was. It has come into the mechanical and business life of the city. It has become industrialised and commercialised by its intercourse with the capitalism of the town. The co-operative movement also has made great progress and this has served as a check on the exploitation of the peasant's isolation and ignorance, a guarantee against abuses in a commercialised agriculture. Agricultural factories have been established in the villages and there is close linking up of fields and workshops. Beet factories, breweries, jam factories, etc., grow in the villages and thus avoid transportation expenses. Hydro-electric development is proving a great aid to the development of agriculture and village industries. In Switzerland, the loom of the lace-maker and the machine of the watch-maker in the home are driven by hydro-electric energy. Such energy goes even into the farm and house of the peasant. Thus grain is threshed, butter is churned, water is pumped, food for cattle is prepared and the farmer is relieved of his most arduous labour. Much of this development of water-power is due to the policy of Government regulations and the payment of royalties to the estate by the users of water. In Loire and Haute-Loire (St. Etienne), in France, out of 35,000 silk-ribbon-weaving-looms the electrically-driven looms number 23,450. The hydro-electric plant at the river Loise supplies the power ; the Edison Electric Company fits the special motor to the homestead loom at a cost of £19 (or charges 8s. 6d. hire fee per month), and the output is increased by 25 per cent. Piece-rates average 6s. 9d. per day. In Lyons District (Croix Rousse),

55,000 hand-looms for silk are worked rurally either in cottages or central sheds in which the workers use the common power and work on their own account, just paying rent for looms. Recently, the Ministry in France has approved the grant of a loan of one thousand two hundred million francs, with interest at 4 per cent., to the community in general, to the syndicate and to the municipal associations, with a view to the extension of electric power in the country districts.

Hydro-electric Possibilities in Rural India.—Not merely along the Himalayan range but also in the plains hydro-electric development has great potentialities as an aid to the development of cottage industries and to life in rural areas. With well-designed reservoirs in the plains, the cheapness, handiness and versatility of the implements to which electricity can be applied may contribute largely to the maintenance of agriculture and industrial development in the villages. In this respect it will co-operate with or perhaps supersede oil and gas engines, which so far are pre-eminently the motors of the small industry and workshop. It will be supplied also to work the lifts of the canals and for effective traction, and to factories near the canals, and thus will assist the tendency of well-appointed canals to check the intensive concentration of industry.

Along with a careful hydro-electric survey, a hydro-geological survey is necessary to find out where conditions are suitable for carrying out hydro-electric development in connection with canals and irrigation works. An all-round development of rural life through reorganisation of agriculture and village industries is possible only when improvement schemes are considered and inaugurated not piece-meal but as part of a systematic general programme in each province or region.

There is no doubt that large hydro-electric power would be available even in the plains by utilising the slope of the ground, the construction of dams and the

regularisation of storage of water. Such reservoirs on suitable sites would be of the utmost value for irrigation purposes, as well as for the regulation of floods at certain seasons. Examination by experts shows that in a large number of cases reservoir sites of large capacity can be found in many parts of India. The difficulty that the rivers are subject to very heavy floods is not insuperable. Various instances will be found in the hydro-electric survey reports published by the Government of India where methods of development have been suggested as possible in the lower reaches of the rivers. The falls of irrigation channels also may be utilised. The available power in the United Provinces alone has been estimated to be 8,950 kws. Preliminary investigations already have been undertaken with regard to water-storage and water-power. Such surveys are to be supplemented by economic investigations into the value of submerged land, the comparative prospective value of an industrial outlet for electric power, and of irrigation in the surrounding villages, etc.

Modern Rural Developments.—Engineers in Germany, Italy and Russia anticipate great results from the utilisation of water-power for small industries as well as for agriculture along with large irrigation projects. Unfortunately, in our country experts work isolatedly and fail to achieve the success which their co-operation in definite regional improvement undertakings might have brought. The success of the Germans in providing cheap power for farms through co-operative societies and other agencies for the supply of electricity deserves special mention. A revival of wind-power is beginning. Wind-motors now raise water for market-gardening in Dresden and Guernsey. Wind-motors have been used successfully on the east coast in India. The association of electricity with the free and inexhaustible wind will be an additional facility making for decentralisation. The problem of

utilising sand, heath or marsh land has been approached with all the means and technical knowledge of modern times. When marshes cannot be drained they are utilised for fish culture or the introduction of aquatic vegetables. Where the principal difficulty in controlling the waters is caused, as in Bengal and Italy, by aquatic plants that grow in the marshes, the most effective means of combating the menace has been to employ the water-buffalo. These animals breed wonderfully in the marshes. They are driven into the canals and marshes of Italy, where they swim about with evident enjoyment, and while paddling around uproot the plants with their hoofs. Introduction of defensive vegetation against sand has contributed to the reclamation of new land or to increased fertility of old. Sheep-rearing and cattle-breeding also have made immense strides. The average weight of the sheep and cattle, and the quantity of meat and milk per acre, have increased amazingly. In the industrial age railways, harbours, roads and all the machinery of transport had been improved beyond recognition, but water transport had been abandoned to neglect. Then came concentration on rivers and canals. Inland navigation, heavily subsidised by the State in both France and Germany, has developed prodigiously. Development of light railways in Belgium and road traction in the rest of Europe also are contributing to keep men on the land and away from the cities. The motor-express or farmer's truck everywhere has revolutionised the conditions of supply and marketing in the villages, with significant social and agricultural results. Scientific agriculture and improvement of technic conditions in rural life diminish economic contrast between city and country. Thus Ross observes in America: "Rusticity has well nigh vanished from our Western states. The farmer is becoming an entrepreneur with an attention to the market which makes him a sort

of cousin to the business-man. As farm homes improve and farmers have money to spend, the country gains in prestige and hence in hold on its young people. High-priced farm lands necessitating the use of improved machinery, thoroughbred live stock, scientific methods and good business judgment challenge the more capable young men." Trolly, telephone, rural free delivery mail and the automobile link them closely with other farmers and with town. Thus in the more prosperous agricultural regions it is the restless rather than the ambitious who go to the city.

City and Village Antagonism in Europe.—The struggle between city and village has reached a critical stage. From time immemorial, wherever economic life has been differentiated to some extent, the relations of the urban and the rural population have been sharpened to the point of antagonism. The urban dwellers of ancient Rome despised peasants as rustics. The basis of the prosperity of Rome, however, was the small yeoman farmer, called in Greek "the man who works with his own hands." Imperial wars and conquests took him away from the land, which then was cultivated by gangs of slaves, mostly foreign. Agriculture so conducted naturally proved unprofitable, and the village declined. From Roman times the cultivator has been the target of no little amount of sarcasm in city-bred literature. The preponderance of the feudal estates contributed in no small measure to keep the tillers of the soil in ignorance and servitude. But the last war has brought about a great restitution. The agrarian question, which has burned or smouldered in Central Europe for more than a century, is being solved with a boldness and zeal which formerly had been reserved for urban consumption only. Every country in Europe, which formerly possessed large estates, has condemned them now to division into small-holdings for individual peasants. A newly aroused, class-conscious peasantry, strengthened by

the more recent cry of communism and regionalism, has organised itself into wide-spread unions, often aided by organised labour of cities. A recent writer thus describes the nature of the coming conflict: "More important than political freedom, more urgent than reform in education, more desired than change in government, more longed-for even than abolition of compulsory military service, was ownership of the land. Now it is precisely out of the sense of new possession that the present conflict between city and country in Europe has assumed an exaggerated form. The city is trying to govern the policy of the country, and one reason why the country resists is because of the new-found sense of ownership of the peasant. The governments of most of the countries of Europe are more or less anti-agrarian, and the situation has in some places developed into a veritable *impasse*. Because the agrarians of Europe have always possessed a class-consciousness they have always formed a political block. For a hundred years agrarian parties have been more or less influential in European politics and not infrequently they have held the balance of power." [1]

Peril of Agrarian Discontent.—Throughout Europe there are wide-spread unions and associations, not solely for the promotion of general social and economic interests of agriculture, but also for purely political purposes. The activities for rural credit, co-operation and such purposes, religious zeal and political propaganda, all have intermingled, resulting in an awakening of the countryside in deplorable strife with urban marketing, transportation and credit interests. In India the land system perpetuates an unfair distribution of the surplus, while the co-operative movement and agricultural organisation have met with limited success. Land is passing more and more into the

[1] A. E. Taylor: "Conflict between City and Country in Europe," *Saturday Evening Post*, August 14, 1920.

hands of the non-cultivating, rent-receiving and middleman class. On the one hand, an increasing class of field labourers recruited from an impoverished peasantry ceases to find adequate support in agriculture alone. On the other hand, India is not industrialised enough to absorb the latter, while emigration overseas has been subjected recently to restrictive policies. The problem of an agricultural proletariat therefore is fast becoming acute. There arises the further danger of the class-consciousness of the urban proletariat being inculcated among the peasantry, and this already threatens to become a serious social and political menace. A great deal can be achieved by scientific farming and agricultural co-operation, but the social crisis cannot be prevented without some land adjustment and reorganisation of holdings and the rehabilitation of some form of real village self-government. India no longer can ignore the hardly-won lesson recorded in recent social and agrarian legislation of the smaller agricultural countries in Europe, with their more populous countryside, and their experiments and tendency away from urbanism. In Central and Eastern Europe, which are not yet industrialised and urbanised, the peasantry still are found organised in patriarchal households and village communities, and the evils of urbanism have not appeared among them, nor do the economic forces dominate their agriculture.

Socialist Policy for Agriculture.—Everywhere a great problem in agriculture is to reconcile certain non-economic values, which are of great social importance, with the laws of economics. We need not dwell on the importance in India of social or traditional motives, not fully economic in their nature (*e.g.*, the social advantages attaching to family proprietorship and village communalism), which must preclude agriculture from becoming a purely economic business. Another social value, which some socialists in the West are

regarding as important, applies more to a densely populated country like India, *viz.*, the retention of a numerous population on the land as an end in itself, under sound conditions, and able to hold its own without discontent and without sinking to the level of a depressed class. Ultimately the rural population produces food for the town consumer, and the socialist's contention is that it is well worth the while of the State to pay a high price for the retention of the population on the land. The socialist's dream is to organise agricultural industry as a whole from the top downwards, *i.e.*, from the product placed on the market down to the soil on which it is sown and the man who sows it. This involves a series of State monopolies, the regulation of wages by means of State boards, and also State valuation of land. A guild structure sometimes is contemplated, the landlord still playing his part, but unable to raise rent, saving for new improvements and under the control of land courts. County agricultural committees, to which farmers and workers each would nominate one-third of the members, the remaining third being appointed by government, would build up the organisation of agriculture as a national service. The whole scheme is made dependent on the stabilisation of prices through government control of agricultural food imports (wheat, flour and meat), which would be an integral part of any reform.[1] It is proposed also that electric power should be provided for the cultivators from national power stations. Such are some of the constructive remedies proposed for the reorganisation of agriculture by the socialists, who reject such remedies as co-operative exploitation of the land by small producers' societies, land tenure reform and wages regulation, which they consider as mere palliatives, if separately applied.

[1] Independent Labour Party, Agricultural Committee: *A Socialist Policy for Agriculture.*

Western Portent of the "Green Rising."—In the meantime, in Central and Eastern Europe, there has emerged a movement which will be as important in its consequences as the Industrial Revolution or the Great War—the upheaval of the peasantry called the Green Rising. This has meant a vast defeat for Bolshevism and "Big Business" and a vast victory for the peasants, who have won it in a sort of awful silence. This victory has been won not merely by a more equitable land adjustment which has strengthened the position of the tenant, but also by the gradual transformation of guilds and communes into co-operatives, which can compete successfully with private undertakings.

Regional and Co-operative Agricultural Policy for India.—In India, the social or traditional values which agriculture represents are still preserved in village communities, guilds and brotherhoods, and it is these which have served so far to protect the rural population against exploitation. The reorientation of castes, guilds and village communities into co-operatives is not a difficult task. In South and Western India, the guilds mould the whole social life of their caste or region, and develop a professional conscience which is an important factor in social progress. In a certain sense castes in India are local federations on a minute scale; some of them are linked with regional federation as groups having the same social standards of action and of ideals. Group organisation in the West takes the form of syndicalism, guild socialism or sovietism; in India it is rather a form of regionalism, and a class-cleavage which is not in its origin economic. Groups belonging to the same neighbourhood, groups belonging to a particular social stratum, groups united by a community of pursuit or interest form what is virtually an autonomous unit, subdivided it may be, and even mutually encroaching, while units unite in a loose federalism in which the central authority is a

convenience rather than a state.[1] In such a system, amenable as history shows to infinite modification, we can look forward to the preservation of the non-economic values associated with agriculture and its protection against the inroads of industrial, capitalistic economics. The co-operative farm undertaking community cultivation, as in Italy, will take the place of the village community. In Italy, there are regions where village communes have entered into partnership for land improvement or for public services, and Government has encouraged and even requested such partnership.[2] Regionally and co-operatively organised, the village communities can work a given industry to far greater advantage than each can work it separately; or a scheme may be carried out on a large scale for some improvement, which, on a smaller scale, would produce little or no result: an irrigation-dam or an embankment of the region, an organisation to reclaim a marsh or to fight malaria, a central power-house to electrify a large zone by means of water-power or local coal-bed, distributing current for the looms and the lathes of the whole zone. Or, again, the guilds and co-operative societies may be developed into regional associations of producers and consumers which will eliminate the middleman and bring urban and rural production into more intimate relationship with the needs of town and village. There are many activities, actual or possible, which can be run regionally, many directions for peasants and townsmen to take in their team-work together. Thus, good sense and a desire for fairness on the part of both villagers and townsfolk can be evoked more easily through the uplift of the communal and regional spirit, round definite regional tasks. The regional and co-operative motives are very strong to-day, and have survived the recent urbanism. These alone can secure a mutuality of

[1] *The Glasgow Herald*, reviewing *Democracies of the East*.
[2] Lloyd: *The Co-operative Movement in Italy*, ch. IV.

benefits between the small town and the adjacent country. These alone can eliminate the increasing strife between town and country by evolving common interests and justice in the distribution of the country's material and moral resources. To-day the relationship of city and village is that of exploiter and victim; and we witness a gradual exhaustion of the soil of life that must require constant replenishment by the return to it of life in a never-ending cycle of reciprocal service.

INDEX

Aboriginal peasants as serfs, 223
Abwabs, 50
Acacia as sand-binder, 148–9
Afforestation schemes, 157–8; in Etawah district, 188
Agrarian politics in Europe, 243–4
Agricultural and manufacturing regions in conflict, 225; village workshops and small industries the solution, 225–6
— capital, Indian peasant's, 53
— co-operation declining in India, 73–4; development of, 210–14, 226–8; revival must be based on profitable cultivation, 74–5
— costings, 49
— decline and violation of regional integrity, 192
— *Department*, 7, 214
— engineers, 214
— history, neglected by economics, 1, 2; of Europe, 57–8, 243
— holdings, Indian: economic sizes, 35, 39, 40, 46, 48, 49–52, 60; exchange of, 77; fragmentation of, 30, 33–5, 61–4; scattered, 31–3; Settlement Report figures, 39*n.*; sizes, figures of, 36–8, 39, 40, 46; uneconomic, 38–41, 60
— income and expenditure, 24–5; in cotton-growing, 54–6; on average economic holding, 53
— indebtedness, 26–33; and fragmentation, 63; and unchecked exploitation, 64
— loans, 26–7
— losses, 27–8
— machinery, Indian Industrial Commission's programme for, 238–9; not yet adapted to small culture, 78–9; openings for, 81, 213; promotes agricultural unemployment, 225
— proletariat, a pressing problem, 245
— revolution in Europe, 238
— tools, 65–8
— wastage: of food in distribution, 226; of labour, 72–3; of material, 70, 118, 138–9; of method, 117–18
Agriculture: all types of, seen in India, 101; beginning of civilisation, 2–3; commercial, 201–2; Eastern and Western, 4, 6–7, 79, 134, 200; evolution of, 113–15; exploitative, 199–200; hampered by conditions, 93; importance of forestry to, 216; interrelation of with civilisation, 34; methods of, adapted to region, 79
Ahirs as farmers, 78
Algæ and azotobacter in symbiosis, 124
Alkali lands and agriculture, 166; *canals* a cause, 165, 167–8; King on general cause, 134–5
Allahabad, reclamation of ravine-lands in, 187
Animal husbandry and food production, 17, 201, 218; economic, on dairy farms, 201; in Denmark, 201; in Germany, 48; in newly-settled countries, uneconomic, 200–1; modern developments in, 242; reconciles shepherd and peasant, 218
Arable farming as pleasing the plant, 114; carries more cattle than grass-farming, 201
Arhar, 39
Artisans' societies in India, 231
Aryan ideas and low density, 103
Asia, economic map of, 8–9
—, South-East: dense population and *intensive agriculture of*, 3, 15–17; favourable agricultural conditions in, 20; land settlement, autonomous, 57; standard of cultivation compared with Western, 4
—, South-West, scattered fields of, 4–5
Asiatics, mainly agriculturists, 14
Assam: emigration to, 93; fruit-growing, 100; monsoon, 18; tea-estates and soil-erosion, 187; terrace cultivation, 161
Australian "wool kings," 217

Babul-tree, 144, 160
Bacteria, soil, activity of in India, 134; indispensable to agriculture, 105, 132–3; leguminous, different types of, 133; nitrogen fixation by, 114, 126; supplied by leguminous crops, 107–8; supplied by rice, 132
Badagaz, 13
Bailey on permanent agriculture, 137
Bamboo, *jhum* culture of, 161; uses of to the hillman, 161–2
Barley yields, English and Indian, 80
Baroda holdings, 36
Basti district, subdivision in, 38–9; water-level of, 85
Bedouins, 11; and Arabs, 217
Belgian co-operative marketing, 226, 227; free factory-workers, 228; intensive culture, 47, 198; light railways, 242; war havoc, 198
Bellary rainfall, affected by deforestation, 150
Bengal: acreage per land-worker, 59; Bakarganj subsistence holding, 50–1, 52; cattle deterioration, 193–4; co-operative irrigation, 212; cottage seri-culture, 99; crop value and population, 88, 92; Dacca fragmented holdings, 52; economic holding, 49, 53–4; electric power for weaving centres,

Bengal—*cont.*
233; emigration to, 93; expert advice needed in land improvement schemes, 214; Faridpur holdings, 52; floods, 150, 178; fragmentation, 52; grazing and fodder deficiency, 194–5; homesteads, 42–3; hookworm, 140; industrial unions and credit, 231–2; Jessore plots and crops, 51; malaria flooding schemes, 182–3; miners, 224; monsoon, 18, 19; Murshidabad holdings, 51–2; paddy-growing, continuous, 101; ploughs and ploughing, 49, 67; Purnea fallowing, 52; rainfall distribution, 92; Rajshahi subsistence holding, 49–50; re-excavation of tanks, 212; rice, jute and sugarcane growing, 180–1; river regulation, 189; Son river, affected by denudation, 158; Tenancy Act, 64; water-buffalo and marsh-land, 242; water-logging, 173; waterways decline, 178
—, Central: food crops, 51; waterways problem, 173–7
—, East, 6, 29; crop value and population, 88; double-cropping, 72; feeble cattle, 194; fertile waste-land, 89; fertilising floods, 96, 118; fertility and farming of Rajshahi, Burdwan and Hughli, 119; flooding and draining, 112–13, 184; high density and cultivation with high standard of living, 94–6; homesteads, 42, 89; pasturage absent, 89
—, North: fertilising silt, 118; no double-cropping, 96
—, South: cattle supply, inadequate, 194
—, West: cattle supply, inadequate, 194; dry conditions, 96; food crops, 51; overcrowded villages, 42; stationary population, 94; waterways problem, 73–7
Bentley, Dr., on flood-irrigation for Bengal, 181–2
Berar: advanced cultivators of, 6; cotton-growing economics, 54–5
Beriberi, poor rice and, 196
Bhagirathi river decline, 174–5; embankment breached, 177: floods in hill tributaries of, 150; poorly regulated, 189
Bhalla on Punjab cultivator's year, 73
Bigha (one-third acre), rent and produce of, 53
Bihar: agricultural organisation needed, 92; agricultural slavery in, 223; crop value and population, 88, 89–91; *dhaincha*, 125–6; economic holding, 61; economics of subsistence holding, 55–6; Gaya, fertilised by canals, 85; holdings, 40, 55; homesteads, 41–2, 89; hookworm, 140; manuring, 135; *nigar*, and nitrate formation in Shahabad, 134; Patna, acreage per worker, 59; phosphatic deficiency in rice soil, 120–1; ploughs, 67; *shora* (saltpetre) not used as manure, 135; tanks and
Bihar—*cont.*
bunds and the rice crop, 187; water-logging, 166–7; well-irrigation and size of holdings, 61
Biological soil study and its benefits, 130
Birth-rate after famines, 208, 209
Black cotton-soil, 84, 131
Bombay Presidency: advanced cultivators of, 6, 110; Agricultural Engineer and improvement schemes, 214; agricultural income, 25; climate, 18; co-operative irrigation societies and well-irrigation, 212–3; co-operative power-pump societies, 214; embankment remedy for denudation, 156; famine losses, 27; holdings, sizes of, 36; Konkan holdings, 39; land improvement by tanks and *bunds*, 187; mill-hands, 224; Nira canal and alkali lands, 165–6; oil-engines, economy of, 213; *panchayat* organisation of grass-lands, 211–12; plough factory, 78; ravines, 186; soil-exhaustion question, 127
Bones exported, 138; wasted, 139
Brahmans as farmers, 78
British India: Land Administration and increase in non-cultivating ownership, 64; population and cultivated area, 17
— irrigation-engineering, 179
— overseas dominions and co-operative marketing, 226
Buck, Edward, and drainage maps, 185
Bundelkhand: denudation in, 147; field embankments of, 155
Burma: cottage industries developed co-operatively, 232; Mandalay Artists' Society, 232; monsoon, 18, 19; small industrial societies and government loans, 231
Burning or brand tillage, 114
Burt on Cawnpore economic holding, 39; on nitrates, 131–2
Butter-making in Tibet, 12

Calvert on Punjab cultivator's year, 73; on Punjab small-holdings, 46
Canadian farm, 200; winter and summer industries, 215
Canal construction, 188
— transport, neglected in India, 225; should be developed, 229; Western development of, 242
Canalisation of rivers, 190
Carnatic coast, 19
Caste and women's work, 70–1
Cattle-breeding, recent progress in, 242
— deterioration in India and the cause, 139, 193–4; improvement through milk-supply, 220; neglect in U.P. and Bengal, 193–5; Swiss exploitation, 156
— disease, 27–8
Cauvery delta, 29; valley holdings, 40
Cawnpore nitrate accumulation curve, 124; unmanured wheat yields, 122–3

Central Provinces and Berar: average holding uneconomic, 62; density of population, 62; double-cropped area, 80; economic holding largest in India, 61–2; embankment remedy for denudation, 156; forest destruction, 144; fragmentation and its palliatives, 62–3; irrigation *panchayats*, 211; ravines, 186; jute-grower's idle time, 73; soil-exhaustion question, 127; suggestions for economic cropping, 72
Cereal and pulse experiments, 127–9
China: clan co-operation, 77; cultivable ground, 16; domesticated animals, 16; economic holding, 46, 200, 201; forest destruction and the penalty, 142–4; holdings, sizes of, 43–4; holdings, sub-division of, 44; hookworm question, 140; horticulture, 201; intensive agriculture, 3, 14, 15–16, 18, 47, 106; land settlement, 57, 58; legume-growing for fertilisation, 135–6; lessons for India, 138; long seasons, 17; manure husbandry, 136; mistakes in water-engineering, 167; monsoon region, 18, 21–2; nightsoil manure, 16; plots larger than in India, 40; poultry, 100; rainfall, 17, 18; rice-growing, 20–1; soil conservation, 106; terraced hillsides, 15; women as plough-cattle, 61
China International Famine Relief Commission investigation, 43–4
Chota Nagpur: agricultural slavery in, 208–4; agriculture and population, 90, 91; four-year rotation, 107; tanks and *bunds*, 187
Chutteesgarh, an illustration of fragmentation, 63–4
City and country, conflict of, in Europe, 243–4; contrast decreasing in America, 242–3; reconciliation possibilities in India, 229, 248–9
Civilisation, re-creation of, 141
Civilisations, fall of, and natural changes, 192; soil-exhaustion, 105–6; violations of natural balance, 192–3
Clouston on Indian tillage implements, 65
Cochin State: fertility and double-cropping in, 97; high cropping, density and standard of living, 96–7; rice culture, supplemented by more valuable crops, 97
Coconut cultivation, 97
Coimbatore oxygenation research, 180–1
Colebrook, on Bhagirathi embankments, 177
Commercial agriculture, penetrating the East, 201–2, 203; wasting world's resources, 202
Communalism in decay, 5–6; proposed reorganisation, 77, 248; safeguard to agriculture, 77, 247
Complementary occupations, 215
Conn on bacteria, 105
Consolidation of holdings, a doubtful measure in India, 32–3; co-operative, in the Punjab, 75–6; Japanese, 75
Co-operative Department, 7, 214
— development of industries in India, 233–3; of village communities, 248
— marketing associations, 227–8
— marketing development in the West, 226–7
Cottage and village industries and factory competition, 224–5, 230; decline of handloom-weaving exceptional, 230; generally holding their own, 230–1; lack of credit the chief difficulty, 231; middleman's debasing influence, 231; need of a central trading organisation, 233–4; policy and scope of such organisation, 234–5; State aid and initiation of new industries, 235–6; technical education, 236–7
Cotton-growing in Berar, 54–5
Cow-dung, most general manure, 111; used as fuel, 70, 138, 139, 144
Credit facilities for small industries, 231–2
— improved, a temptation to borrow, 28
Crops that improve the soil, 107–8
Cutch, desert of, 19

Dacca, double-cropping and population in, 91–2
Dairy-farming, economics of, 201; harmonises needs of village and city dwellers, 221; reconciles shepherd, peasant and manufacturer, 219–20; solution of India's cattle problem, 220
Dam construction in India, 186
Darjeeling tea-estates and soil erosion, 187
Darling on primitive agricultural tools, 65; on Punjab average holding, 60; on Punjab money-lenders, 26
Datta on improved credit, 28
David on difference between agriculture and industry, 48
Deccan: agricultural income and cost of living, 25; black cotton-soil areas and dry farming, 131; denudation, 147, 151; economic holding, 35; forest destruction, 144; land improvement by tanks and *bunds*, 187; low density with economic pressure, 94; malaria in canal area, 166; M.S.N. plough, 65; rainfall, 214; soil-exhaustion question, 127; suggestions for improved cropping, 72
Decentralisation of factories, 229
Deep cultivation, harmful to surface-rooted plants, 131
— ploughing and stirring experiments, 109–10; value of, 130
Deforestation (*see* Forest destruction)
Deltas, backward agriculture in, 163
Denmark: afforestation in, 159; agricultural development, 198; cattle on arable land, 201, 220; co-operative marketing, 226; holdings, sizes of, 45; small industries, 231

Denudation or soil erosion, 110, 149; forests as preventives, 141, 142, 143–4; on alluvial lands, 190
Desert-dwellers, 10–11, 13, 14, 19
Dhaincha, a nitrogen-fixing plant, 125–6
Diet, impoverished, of the peasantry, 139; vegetarian, for dense populations, 201
Diseases of cultivation, 139–40
Distribution and sale, elimination of waste in, 226–8
Doab, ravine-lands in, 145; saltpetre plains of, 152
Drainage, natural, dependent on subsoil, 164; interference with, causes waterlogging, 165, 166, 173, 203; regular observation necessary, 168; surveys and restorative procedure, 185
Dravidian races, virile and fecund, 103; sea-trade, 23
Dredging necessary in India, 188; successful in Bengal, 189
Dry farming: mulching and interculturing, 111; secret of, 130–1
Dry regions, prevention of soil-exhaustion in, 127

Eastern food crops, 20–1
Ecology in economics, 215
Economics, conflict and reconciliation in, 215; urbanism of, 1, 2
Eden Canal rice-growing investigations, 181
Education, chief remedy for uneconomic agriculture, 56
Egypt: British irrigation-engineering in, 179; irrigation with renewal of soil in, 184; only unexhausted granary of Rome, 197
Egyptian Five Feddan Law, 76
Electricity production by canal-power, 188; from waterfalls, 215
Embankments check soil erosion and conserve water, 187–8
Emigration from United Provinces, 93
England: cattle, number to the acre in, 193; cattle on arable land, 201; economic holding, 201; nitric acid precipitation, 118; pastoralisation and balance of occupations, 192; soil-exhaustion, 106; *warf*-farming, 184
England and Wales: economic holding in, 60, 201; holdings, sizes of, 44, 45; intensive culture impossible in, 47; wheat and barley yield compared with Indian, 80
Erosion of soil by rain, 110, 149; preventive action of forests, 141, 142, 143–4
Europe: agricultural development and havoc of the war, 197–8; agricultural revolution, 238; class-standards, 104; co-operation, machinery, and loans for small industries, 231; co-operative societies, 233; cottage industries, 230, 235–6; economic holding, 60; forest management, 216, 217; "Green Rising," 247; large estates, origin and reconstitution of, 57–8; medieval land settlement, 57; population density and standard of living, 102; river regulation, 190; ruin of village communities, 222; rural industries, 99; small holdings, 45; thrift, 29; urban economics, 1, 2
Europe—*cont.*
Ewbank on small workshops in India, 230
Exchange of holdings, 77
Exe, English river, and its potential reclamation, 188–9
Exploitative agriculture, a capitalistic development, 198–9; creates tropical one-crop plantation system, 199; develops soil exhaustion, 199, 200

Factory production *v.* rural industries, 224–5, 230–1
Fallowing, 111, 115, 125; in Sind, 123
Famine Commission Report, 1880, on legal intricacies, 28
— diseases, 207–8
Famines, havoc of, 27; history of in India, 204–6; modern relief in, 206–7; mortality in, 208; peasant behaviour in, 209; programme of co-operative agricultural improvement as preventive, 209–10, 214
Far Eastern *v.* Western agriculture, 21
Farming methods adapted to region, 79; systems, various, in India, 106–8
Farmsteads, self-contained, 41
Fatalism of Indian peasant, 6, 30; of Japanese, 15
Fatehpur rainfall irregularities, 154–5
Fertility as a cause of backward farming, 118, 119, 163
Field system, 115
Filipino rice terraces, 15
Fish conservation, 117
Floods, an All-India problem, 140; caused by deforestation, 149–50; unscientific canal-engineering a cause, 166–7
— that are more important than rain, 96
Fodder, basis of good agriculture, 195; displaced by grain, 139, 193; leguminous proposed, 195; quality deficiency in, and its reactions on man, 122, 195, 196
Food animals, uneconomic, 16–17*n*.
— distribution, exploitative and wasteful, 226; to be remedied by co-operation, 226–8
— producing value of an acre under different crops, 98
Foot Hills country, a desert, 152
Forest clearing and rough cultivation by hill tribes, 106–7
— destruction, catastrophical changes caused by, 147–8; causes extremes of flood and drought and silting of rivers, 149–50; havoc of, in China, 142–4, India, 144, and West Africa, 148; mountain sides defertilised by, 148; ravine-lands caused by, 144–5;

Forest destruction—*cont.*
sands liberated by, 148–9; timber and fuel motive of, 151, 203, 215
— management in India, 159–60; regeneration problem, 160; sylvicultural investigations, 160
— protection laws, 156–7
Forestry, scientific, reconciles hunter and shepherd, 216–17
Forests, bind desert sands, 148–9; cool and conserve tropical soils, 148; distribution of, in India, 144; protective functions of, 141–2
Fragmentation of holdings, 30, 33–5; in Bengal—Dacca, 51–2; in C.P.—natural causes illustrated in Chutteesgarh, 62–4; in Gangetic plain—Gorakhpur, 61; in Japan, how dealt with, 75; in the Punjab, co-operative consolidation applied, 75–6; legislation necessary, 76–7
France: afforestation in, 159; average farm, 200; hydro-electricity for cottage looms, 239–40; inland navigation, 242; intensive culture, 47, 198, 201; war havoc, 198
Freight rates, equalisation of, 225
Fruit culture *v.* denudation, 160
— growing as supplementing agriculture, 99–100; on hillsides, 107
Fuel and deforestation, 150, 151, 203, 215

Gandhi's cult of *Charka*, 225
Ganges, fed by Himalayan snows and summer rains, 158; floods in hill tributaries of, 150; problem of detritus, 190; ravine-lands of, 146
Gangetic areas, bare of forest growth, 144; exposed river-banks of, 146; improved ploughs in, 66; nitrate trouble in, 134; rainfall of, 18; subdivision in, 61
Garden culture of China and Japan, 14; favoured for exercise in Germany, 228
Gaya, fertilised by canals, 85
Geographical features of Asia, 8–9
Germany: acreage per land-worker, 59; afforestation and sylviculture, 159; agriculture and population, 102; co-operative marketing, 226, 227; forestry with agriculture, 216; forests and industries, 217; havoc wrought to Belgian and French agriculture, 198; holdings, sizes of, 44, 45; inland navigation, 242; Joint Board of Crafts, 234; Kiel zoning scheme, 228–9; potato-growing, 98–9; small farming, success of, 47–8; small industries, 230; small producers' associations, 233; State-aided rural industries, 235; Stein's edict, 47; water-power, electricity and wind-power for small industries and agriculture, 241; women on the land, 71
Godavarí irrigation works, 186
Gorakhpur holdings, 38, 61
Grain dealers, exploitative, 64
Grass lands, *panchayat* management of, 211–12
Grazing facilities in India, reduction of, 150, 193, 194
— unregulated, a cause of deforestation, 215; and of desiccation, 146–7, 149, 150
Great Britain: acreage per land-worker, 59; unutilized land in, 216 (*see* England)
Greece, ancient, and malaria, 196; modern, primitive agriculture of, 196–7
Green manuring, 107; nitrogen-fixation by, 125–6; of rich soil, produces disease-proof grain, 195–6; Pusa experiments in, 127, 129; rationale of, 107–8; refertilisation by, 126
"Green Rising" in Europe, 247
Grierson and Moore on cost of living in Bihar, 55
Group organisation in West and East, 247
— solidarity of the East, 77; of India, 247–8
"Grow your own food" campaign, 226
Guernsey, wind-motors in, 241
Guilds and castes, possible reorientation of, as co-operatives, 247; regional development of, 248
Gujarat, power-pumps in, 213
Gwalior, 147; embankment remedy for denudation, 156

Hahn on Chinese horticulture, 201
Hailey on Indian agriculture, 33
Half-nomads, 11
Hand agriculture, 79, 81
Harrison and Ayyar's researches in manuring swamp paddy-soils, 125
Harrison's investigation of oxygen supply to rice, 179–80
Harvesting forest and field in alternation, 216
Hedin, Sven, on the nomad, 11
Hill and plain populations, 83–4
Hillside cultivation, forest destruction and floods, 149–50, 215
Himalayas: forest destruction on, 148; hydro-electric possibilities, 240; labour migrations, 216; monsoon rains, 18, 19; snows of, feed Ganges and Indus, 158
Hindu caste prejudices, 100
Hodgson and King's experiments on mosquito larvæ, 179
Hoe cultivation, 114–15, 218
Hookworm in India, 139–40, 173; mass-treatment for, 140
Horticulture, 115, 201
Hoshiarpur *chos*, 152
Howard on *rahar* as natural plough, 108; on quality of irrigated crops, 164
Hughli river, successfully dredged, 189
Hungary: grants of machinery to artisans in, 231
Hydraulic engineering, inefficient, 167
Hydro-electric possibilities in rural India, 240; preliminary surveys, 240, 241

Idleness, agricultural, enforced by fragmentation, 34–5, 63, 64; seasonal, 73; to be reduced by organisation, 80
India: cultivated area and population, 17; excessive social expenditure, 25, 30, 203–4; famine history, 204–6; forest destruction, 144; income and expenditure, 24; intensive agriculture, 3, 15, 16–17, 47; irrigation systems, 158–9; land settlement, 57, 58, 244–5; land value, increased, 28; large families and poverty, 30; monsoon region, 18–19; monsoon variations, 22; relation of cultivators to acreage, 58; relation of labourers to cultivators, 59; rice-growing, 20–1; small farming problem and threefold remedy, 81–2; smaller holdings, smaller output, 48–9; surface cultivation, 131; terraced hillsides, 15; Western methods unsuitable, 6–7, 79, 134; wheat and barley yield, 80
—, Central: land improved by tanks and *bunds*, 187; ravines in, 186
—, North or Upper: British irrigation-engineering, 179; conditions favouring double-cropping, 22; mixed crops, 111, 130; nitrate accumulation seasons, 124; nitrate equilibrium established, 124; soil, crops and ploughs, 67; variety and conditions of cropping, 131; wheat-rust, 68–9
—, North-West: alkali lands in, 166; forest destruction in, 144, 151–2
—, *South*: *coast strips of high population* density with high cultivation and high standard of living, 6, 96–7; exchange of holdings, 77; garden cultivation, 22; guilds, 247; hill-stream floods, 150; idle or surplus labour, 73; regulation of irrigation-water, 171–2; Todas, 12–13; village communities, 5–6
—, West: conserving soil-moisture in, 111; guilds, 247; non-manuring in, 112
Indian economic holding: Bengal, balance-sheet of, 53; capital invested in, 53–4; cotton-growing on, in Berar, 54–5; size factors, 60–1; sizes of, 46, 48, 49–52
— mill-hand, a cultivator, 224
— Pavilion at Empire Exhibition, 234
— peasant's attachment to the land, 64; improvidence and its fruit, 203–4; subjection to manufacturer and middleman, 221–2 (*see* Peasantry in India).
— Sugar Committee and drainage, 185
Indo-Gangetic plain: alkali and agriculture on, 166; Aryan traditions of, 23; rainfall, irrigation and density in, 84, 85; results of density in, 6
Indus river, 158
Industrial societies, inelastic, 232
Industrialism: adverse to marriage and fecundity, 104; encouraged expropriation of land, 222; European economics and, 1, 2; inimical to
Industrialism—*cont.*
village and agriculture, 7, 222; led to destructive exploitation of land, 222–3
Inheritance, law of, modification desirable, 76–7
Inland transport in Europe, 242
Intensive culture and labour, 47; increases output per man, 71; increases with density, 85–92; reconciles peasant and shepherd, 218; results of, illustrated by Shahjahanpur Experimental Station, 79–80; rise of, favouring density and civilisation, 115–16; secret of, illustrated by Japan, 71–2
Iron deficiency in cattle-food and tuberculosis, 195
Irrigation and rainfall in relation to population density, 84–5
— by flush, flood or inundation, Bentley's conclusions on, 181–2
— canals: benefit dry and precarious regions, 163; discourage high cultivation in the plains, 163; encourage waste of water, 164; risk of in light-soil tracts, 167; scientifically managed in Japan, 172–3; supplemented by wells in Bombay, 212–13; unscientific, disturb natural drainage, 165, 203, -create alkali lands, 165, 167–8, -promote malaria and fevers, 166, 167, 203, -and cause waterlogging and floods, 166, 167
— *Commission and sale of water*, 171
— engineers, 214
— man of South India, 172
— sources in India: Himalayan rivers, unaffected by forests, 158; monsoon rivers, affected by interference with forests, 158; tanks, directly affected by denudation, 158; wells, dependent on subsoil water-level, 159
Italy: village communes in co-operation, 248; water-buffalo, improver of marshes, 242; water-power for small industries, 241

Jack, Major, on Bengal subsistence holdings, 50
Jalangi river, decline of, 174, 175–6; poorly regulated, 189
James and Mary sands, 189
Japan: agricultural co-operation, 75; economic holding, 46; farms, sizes of, 43; foreign farming methods, inapplicable, 79; intensive culture, 14, 71–2; irrigation and drainage, 29; lessons for India, 138; manure husbandry, 136; physical features and people, 14–15; "re-stripping" of land, 75; rice-growing, 20–1, 78; silkworm-rearing supplementing rice culture, 99
Jat woman, an asset to her husband, 71
Java, irrigation in, 172–3; terracing and *bunding* in, 187

Jhum cultivation, 106; of bamboo by the Kukis, 161–2; suitable for the locality, 162
Joint-family system, Hindu, 30
Jowar or *juar*, 39
Jumna river, floods in hill tributaries of, 150; lowered water-level, creating desert, 152–3; ravine-lands, 147
Jura peasantry's summer and winter industries, 215–16
Jute-growing, 73, 180, 181

Kala-azar and waterlogging, 173
Kallar soils caused by canals, 165–6, 167–9
Kamioli (forced labour) system, 223
Kanara spice-gardens, abandoned through forest destruction, 151
Kankar (limestone) on ravine-lands, 145, 152
Karnafuli river regulation, 189
Kashmir, soil erosion in, 187
Keatinge on Konkan rice-land holdings, 39; on Western Deccan economic holding, 35
Kharif (autumn, winter, cold weather) crops, 22, 124, 216
Kiel zoning scheme, 228–9
King on alkali lands, 134–5; on Chinese leguminous rotations, 135–6
Kirghiz steppe region, 12, 13
Konkan rice-land holdings, 39
Korean afforestation, 157–8
Krantz system of manure conservation, 112
Krishna irrigation works, 186
Kropotkin on land expropriation under industrialism, 222
Kukis, Chittagong hill tribe, 161
Kumarkhali, flood-flushing for malaria in, 183
Kumaon, soil erosion in, 187
Kunbi peasant's balance-sheet, 54–5

Labour, family *v.* hired, in Germany, 47–8; forced, in Chota Nagpur, 223
Lagoon irrigation in Russia, 183–4; probably adaptable to India, 184
Land-assessment and peasant solvency, 204
— improvement, permanent, 28–9
— revenue demands, unseasonable, a cause of borrowing, 27, 204
— settlement, ethnological study of, 1; peasant status and, 57–8
— tenure, inequitable, 224
Landed property as adapted to agriculture, 4–5
Landless labourers, 81; feed industrialism, 223–4; problem of, becoming acute, 245
Landlordism, oppressive, 223–4
Large estates in Europe and the war, 58, 243
— farming unsuitable for India, 77–8
Legal changes and indebtedness, 28, 203
Legumes and soil bacteria, 133
Leguminous crops, manuring of, 130
— purpose of, in rotation, 130
Leprosy and poor rice, 121–2, 196
Lift-irrigation, 159, 213, 238
Lime in agriculture, 130, 135
Lop Nor and the Lopliks, 13–14
Lower Chenab Canal, waterlogging and *kallar* caused by, 168–9
Lyallpur, experiments in deep cultivation at, 109–10; made populous by canals, 85

Macgregor on European holdings, 45
Madras Presidency: agricultural income, 24–5; canal irrigation, 61, 85; climate and garden cultivation, 22; Cauvery valley holdings, 40; diminished rainfall in deforested districts, 150–1; flush-irrigation, 181; fruit-growing, 100; hookworm, 140; irrigating rivers and denudation, 158; manure-storing experiments, 111–12; *panchayats* and *sethis*, 211; phosphate deficiency, 120; ravines, 186; soil-exhaustion question, 127; Tanjore and Trichinopoly economic holding, 60; Tinnevelly holdings, 40; well-irrigation, 159
Malaria and ancient Greece, 196; immunity from, of Godavari and Krishna deltas, 186–7; in canal areas, 166, 167; in silted and waterlogged areas, 173, 177; research demonstrates the remedy of flood-flushing, 179–83
Manchuria, 18
Mann and Kanitkar's economic enquiries, 25
Mann on diminishing holdings, 35; on manuring dry land, 112
Manual training in primary and secondary schools, 236–7
Manure, chemical, not used in India, 135, 138
—, natural, conserved in Japan and China, 70, 136; formerly conserved in India, 70; fresh, decreases yield, 111; Krantz process, 112; preferred to commercial, 129–30, 135; night-soil, the coming fertiliser, 137–8; nitrogen losses, 111; nitrogenous, in India, 135; phosphatic, important to rice, 121; storage experiments in Madras, 111–12; substances used for, 111, 112; value of, 130
Manuring, continuous, necessary in dry regions, 127; in rice-growing, experimental, 121, 122, 125, 126; surface, in India, 70, 127; varied practice, in India, 111, 112–13, 135
Marsh-land utilisation and the water-buffalo, 242
Marx and Engels on large-scale agriculture, 47
Mathabhanga river, decline of, 174, 176; poorly regulated, 189
Meadow husbandry, 115
Meat production, uneconomic, 200–1, 220–1

Mechanical substitutes for cattle-power, 81, 155, 213, 238
Mediterranean agriculture, 19–20; conditions of, paralleled in South India, 22
— traffic with India, 23
Mesopotamia, pastoral invasion of, 192
Middleman, elimination of, 226, 248
Middlemen, beneficent, in Switzerland, 233
Middleton on potato and sugar-beet, 99
Migration of pastoral peoples, 117
Milk production, economic, 221; the way to improve cattle in India, 220
— wine, 12
Millets, staple Eastern dry crops, 21
Miner *v.* wood-cutter, 215
Misra, S., on transport cost, 38; table of U.P. holdings by, 36–8
Misunderstanding of Indian conditions by British officials, 32
Mixed crops in India, 111, 130
Modern methods and appliances for small industries, 235
Mollison on Indian farming, 110
Money-lender and peasant, 6, 64; most important calling in India, 26; rates of interest, 26
Mongolia, Chinese in, 218; climate of, 18: nomads of, 10–11, 218
Monsoon countries, 8, 17–19
—, created sea-trade, 23; irregularity of, 21–2; rivers fed by, 158; summer, from S.E., 17–18; winter, from S.W., 18–19
Moreton on ravine-lands, 145
Mosquito larvæ and temperature, 179
Motor trucks, 229, 242
Mountain industries, complementary, 215
Muhammadans and subdivision of land, 52; and poultry-keeping, 100
Mukerjee, N. G., on Indian manure economy, 135
Muller-Lyer on cattle-rearing stage, 113
Muttra, deforested, 145; irregular and diminished rainfall of, 153–4
Muzaffanagar, agricultural development increasing with density of population, 86–7; irrigational features, 87–8
Mysore Home Industries Department, 234

Nadia river regulation failure, 189
Natural balance of a region and its violation, 192–3
Nermudda districts, denudation in, 147
New Zealand Alps, 215
Newly-settled lands, wastefully exploited, 199–201, 202
Nightsoil as manure in China, 16, 136, 138; in Japan, 70, 136; must supersede animal manure, 137–8; prejudice against in India, 137
Nira valley canal and alkali lands, 165–6
Nitrate difficulties due to modern irrigation practice, 134–5
— supply in the monsoon period, 131–2
Nitric acid precipitation, 118
Nitrification on wet lands, not investigated, 131
Nitrogen fixation by bacteria, 114; by green manure, 125–6, 133; in the Punjab, 123; on wet lands, 131; problem of best method, 133–4; processes, study of, 133–4, 126
— supply, equilibrium in, established in Upper India, 124; experiments on in swamp paddy-soils, 125; percentage of lost in manure, 111
Noakhali, population increase and multi-cropped area, 95
North-West Frontier Province: alkali lands in, 165; fruit-growing, 100; legumes grown with manure, 130

Oasis cultivation, 14, 218
Occupations, seasonal and regional, and their co-ordination, 215–17
Oil and other small engines for rural use, 81, 212, 213, 229, 233; electricity and, 240
Oil-cake and oil-seed, exported from India, 70, 138
O'Malley on the Hughli, 189
One-crop agriculture, 106; in new regions, 107; leads to decline, 192; plantation system and, 218–19
Orissa: Baidyarajpur bell-metal society, 232–3; decline of rivers and streams in, 178; crop value and population, 90–1; exchange of holdings, 67; holdings in, 40–1; Mahanadi river, affected by denudation, 158
Oudh holdings, 40; question of canal-irrigation, 171
Overcrowding in Indian villages, 41–2
Over-irrigation, 164, 171
Over-population, 100; a regional question, 101
Oxen, feeding and hire of, 53

Panchayat, best maintained in Madras, 211; organise grass-lands in Bengal, 211–12; utilisation of, in coming agrarian transformation, 210
Parkes on tropical forest, 148
Pastoral industry in evolution, 116–17; mismanaged, a cause of migration, 117
— nomads, life conditions and seasonal movements of, 9–13; obnoxious to peasants, 192, 217, 218; settlement of, by intensive agriculture, 218
Pasturage regions, continuous, 9
Pasture-grounds, communal, 17, 211
Peasant proletariat, 81
— *v.* pastoralist, 217; reconciled by intensive agriculture, 218
Peasantry in Europe, formerly despised and oppressed, 243; growth of, in class-consciousness and political power, 243–4; still simple in Central and Eastern Europe, 245; upheaval of in the "Green Rising," 247

Peasantry in India, in decline, 5–6; in peril through exploitation, 64, 221–2, 244–5; necessary reforms for, 245; openings for mutuality with townsfolk, 248
"Permanent agriculture," a pregnant phrase, 137
Phosphate-exhaustion of rice-soils, 120–1; reduces yield and food-value, 121–2; remedied by phosphatic manures, 121, 122
Plant-breeding in Malaya and West Africa, 160–1
Plantation culture of rubber and cacao, 160–1; of rubber, gutta-percha and *Raphia vinefera*, 199
— system abuses, 218–19
Plough, Indian wooden, cost of, 53, 66; criticised, 65; defended, 67–8; varieties of, 66–7
— measurement of land, 49; appreciated in Bengal, 51; depreciated in C.P., 62
Ploughing, deep, where advantageous, 108–9, 110; detrimental in Lyallpur, 109
—, followed by deep stirring, 109–10
Ploughs, improved, in India, 66, 68; Meston, 68; M.S.N., 65; Punjab, 66; Rajah, 66, 68, 109; Turnwrest, 66; various objections raised to, 65, 66, 68; vista of promise from, 78
Poona fig-culture, 100; village holdings, 35
Population-bearing capacity of land, 116
— density in India: birth-control unnecessary, 103–4; comparative table of, 102; cultivated area and multiple-cropping and, 85–92; fertility with low cultivation and, 93–4; governing factors of, 92–3; high, with high cultivation and high standard of living, 94–6; highest, where rich land is best exploited, 100–1; low, may co-exist with economic pressure, 94; not beyond feeding limits, 83; racial differences and, 103; rainfall and irrigation and, 84–5; relieved by emigration, etc., 93; soil resources adjusted to, 103; standard of living and, 93; varies with regional productivity, 83–4, 93–4, 101–2
— pressure in C.P., 62; in Gangetic plain, 6, 61, 84
— problem of India, 103–4
Potato-growing in Europe, 98–9; suggested for Indian wheat regions, 99
Poultry-keeping, 100
Poverty and large families, 30
— problem not simple, 65
Power-pumps, co-operative supply of, 214; economy of, 213
Punjab: alkali lands, 165; Arts and Crafts Emporium at Lahore, 234; average holdings, 40, 60; canal colonies, 6, 20, 60, 61; consolidation of holdings, 75–6; cottage seri-culture and fruit-growing, 99; date plantations, 100; dominated by moneylender, 26; economic holding, 60; fertility and density with low cultivation, 93–4; flush-irrigation, 181; forest destruction, 144; fragmentation, 40; Jat women on the land, 71; Land Alienation Act, 64; Lyallpur canals and density, 85; Lyallpur experiments, 109–10; malaria and fevers in canal areas, 167, 181; nitrogen fixation, 126; non-cultivating owners, increase of, 64; prosperous peasantry, 94; rat damage, 69–70; small-holdings, 46; suggestions for economic cropping, 72; unmanured wheat, 123; well *v.* canal irrigation, 163–4; waterlogging and salt-encrustation, 168–70, 181
—, Central: fertility and population in, 94; overcrowded villages, 42; subdivision, 40
—, South-West, well-irrigation and size of holdings in, 61
Punjabi peasant, prosperity of, 94
Pusa manuring experiments, 127–9
— soil, 139

Rabi (spring) crops, 22, 124
Rahar and *mung*, improvers of the soil, 108
Rahar in Northern India, 130
Railways and wood fuel, 151; freights of, encourage exports, 225; unscientifically built, affect rivers and drainage, 165, 173, 203
Rainfall, adaptation of cultivation to, 113; and surface-rooted plants, 131; diminished by deforestation, 150; distribution of, more important than amount, 84; dominant factor in distribution of holdings, 60; irregularities of, at Muttra and Fatehpur, 153–5; less important than floods in E. Bengal, 96; relation of, to population density, 84; supplemented by irrigation, goes with greatest density, 84–5
Rains, course of, in India, 18–9
Rajputana, desert of, 214
Rapti tract, self-irrigating, 85
Ratnagiri, denudation of, 151
Rats, damage by, 69–70
Ravi area, density due to fertility, 94
Ravine-lands, along river-banks in India, 144, 146; distribution of, 144, 147, 186; due to deforestation, 145; harm done by, 185–6; infertile, 145; reclamation of in Allahabad and Etawah districts, 187–8; sandhills and, 145; storage *bunds*, field embankments, etc., as remedies, 155–6, 185–6
Re-afforestation, 215
Red soil and ridging, 63
Redistribution (*lakhabata*), a cause of fragmented holdings, 63–4

Regional levels, natural balance of, 192; violation of and its results, 192–3, 215
— planning for India, 228, 229; illustrated from Belgium and Germany, 228–9; solution of rural-urban problem, 229
— reconstructive programmes, 141, 247–9
Regionalism, Indian form of group organisation, 247–8; reconciler of town and country, 248–9
Reindeer, 12
Rent-receivers and the small-holder, 5, 6, 64, 204
Reservoirs and power-production, 188
Revenue inequity, 204
Rice as staple crop for dense populations, 20–1
— cultivation, basis of S.E. Asian agriculture, 3, 4; deep ploughing disadvantageous to, 67; double-cropping in E. Bengal, 72; favours small farming and communalism, 4, 5, 20–1; one-crop, on the Sunderbunds, 107; oxygen supply to, through inundation, 180–1; *phosphatic manure a necessity*, 121, 122; river-irrigation advantages, 181; tanks and *bunds* insure against drought, 187; transplanting *v.* broadcasting in, 62, 64
—, phosphoric acid in, 120–1; results of deficiency, 121–2
— plant, behaviour of in floods, 182
River-banks, unprotected, in India, 146
— embankments, a cause of silting, floods and disease, 177–8
— valleys, fertile, and sizes of holdings, 60–1
Rivers, canalisation of, 190; detritus-laden, regulation of, 189, 190; man's *criminality* against, 163; *silting of*, and its causes, 149, 165, 173; tortuous, treatment for, 189–90; training works for, 190; waveless, in India, and their correction, 188
Robertson on *diminished rainfall* and deforestation, 150–1
Rome and soil-depletion, 106, 197; granaries of, 197; prosperity of, based on small yeoman farmer, 243
Ross and Bagchi on *nitrogen precipitation*, 118
Ross on deforestation and malaria in Greece, 196; on domestication, 113; on forest destruction in China, 143–4; *on perils of unscientific irrigation*, 178–9; on the quickening of country life, 242–3
Rotation of crops, economical method of, 15–16; effects of, 4–5; in Chota Nagpur, 107; *prevents soil erosion*, 110; Pusa experiments in, 127–9; system of, upset by commercial agriculture, 138
— stage in agriculture, 115
Rothamsted artificial farmyard manure, 138; unmanured wheat plot, 124–5
Runn of Cutch, cattle of, 19
Rupee, decline in, 24
Rural economics, bears on civilisation, 3; corrects urbanism, 7; Eastern, 5; neglect of, 1–2; social value of, 2, 7
— industries, disorganised by factory production, 224–5; important to the farmer, 216; in Bombay, machine-using, 213; in Germany, State-aided, 235; State-aided forward policy suggested for India, 235–6; supplement agriculture, 99–100; technical instruction also necessary, 236–7
— transit, neglected in India, 225; revolutionised in the West, 242–3
Russian colonists on Kirghiz steppes, 12; lagoon irrigation, 183–4; water-power anticipations, 241
— Turkestan, 13–14, 218

Saithwars, 78
Saksena on Oudh holdings, 60
Salub, becoming desert through deforestation, 148–9
Samudayam, common pasture, 211
Sand, defensive vegetation against, 148–9, 242
Saran, family cultivation in, 55
Scattered fields of the Indian peasant, 31; an adaptation to climatic conditions, 31–3; consolidation a doubtful measure, 32–3; drawbacks of, 33–5, 41; increase transport cost, 38
Schools and technical instruction, 236–7
Scott on deforestation, 149
Scottish forest estates, 216–7
Semple on population-bearing capacity of land, 116
Seneca on parasitical Rome, 197
Serfdom and European land settlement, 57; in India, 223
Sethis, irrigation associations, 211
Settlement Officers and rent assessment, 204
— Report figures, 39*n*.
Sewage disposal, coming revolution in, 137–8
Shahjahanpur Sugar Experimental Station, 79–80
Sheep-rearing, recent progress in, 242
Siberia, 9, 10
Silt deposit and the decline of waterways, 177–8
Simkhovitch on animal husbandry, 17
on fall of Rome, 197
Simon on intensive horticulture, 201
Sind, alkali lands in, 165; canal-irrigation question, 171; desert of, 19, 84, 214; fallow between millet crops, 123; flush irrigation in, 181, 184
Slater on waste labour in South India, 73
Small farming problem of India—threefold remedy, 81–2
— industries, co-operation and credit facilities for, 231–3; difficulties of, 230–1 (*see* Cottage and village industries, Rural industries)
— *v.* large farms, 47–8

Smythies on deforestation, 147
Socialist policy for agriculture, 245–6
Soil conservation, a world concern, 136–7; simple rules of, 200
— erosion checked by terracing and embankment, 187
— exhaustion and past civilisations, 105–6; in India, conflicting views on, 120, 122–3; natural recovery from, 123; nitrogen the solution, 126–7; of exploitative agriculture, 199–200; preventive measures against, in dry regions, 127; shallow tillage as a cause, 139
— study, needed in India, 131
Soils, red and black, 63
Son canal, unscientific construction of, causes waterlogging, 166
Spade culture in India, 67
Spain, forest destruction in, 147–8, 192–3
"Spares and repairs" problem of foreign machinery in India, 66, 68
Speculation in "futures," American law against, 222
Specialisation, excessive, 224–5
Spring-level, rise in and disease, 166, 167; sanitary effects of flood-flushing, 182
Standard of life, simplicity of in India, 103–4, 225
Statistics and Tables:
Acres of cropped land per bullock in Bengal, 194
Bengal rivers, decline of, 174
Cattle in U.P. and England, 193
Crop rotation in E. coast district of S. India, 97
Crop value and population, Bengal, 88; Bihar, 89; Bengal, Bihar and Orissa, 90, 91
Cultivated area and population, U.P., 86; countries and provinces, 102
Cultivators and labourers, 59
Cultivators and land areas, 58
Double-cropping and population, Bengal, 92; Dacca, 91
Famines in India, 205–6
Food-producing value of an acre, 98
High density with high cultivation and high standard of living in Bengal, 94–6
Holdings, sizes of, India, 36–8; Western countries, 45
Hookworm incidence in India, 140
Income and expenditure, India, 24–5
Intensive agriculture and population, U.P., 86–8
Irrigation and population, U.P., 85
Phosphate deficiency, Madras, 120
Phosphate manuring, paddy, 121, 122
Population densities and crop areas, 102
Population movement during and after famines, India, 208
Pusa experiments in green and chemical manuring, 127–9
Rainfall and population, India, 84
Rainfall distribution, Bengal, 92
Statistics and Tables—*cont.*
Rainfall variations, Fatehpur, 154–5; Muttra, 153–4
Small-holdings in Europe, 45; Punjab, 46
Spleen index decrease due to flood-flushing, 183
Wheat-rust and rat havoc, 69
Stock-farm manuring, uneconomical, 137
Strabo on Greece, 196
Subdivision of land, 20; a modern tendency in India, 30, 35; aggravated, in Gangetic plain, 61; encouraged by rice culture, 30; extreme, in U.P., 38; in Bengal, a cause of fragmentation, 52
Sub-Himalaya East, largely self-irrigated, 84–5
Subsidiary industries, 99–100
Subsoil drainage, 130, 164; interference with a cause of disease, 166, 167
Sugar-beet, food value of, 99
Sugar culture, intensive, in U.P., 79–80
Sunderbunds, formation of, 177–8; one-crop rice-growing in, 107
Surface-rooted plants and surface cultivation in India, 131; over-watering and, 164
Swine in China, 16; in the West, 202–1
Swiss banks and advances on cocoons, 232; conservation of mountain soils, 156; hydro-electricity for cottage industries, 239; *Kanferbunde* of rural industries, 234; silk-weaving industry and beneficent middlemen, 233

Tanjore delta, bulwark of Brahmanical India, 23
Tanks and embankments in barren and dry tracts, 187; in hill and vale, 187–8; re-excavation of in Bengal, 212
Tapioca-growing in Travancore, 97–8
Tarnab Agricultural Station and the Indian plough, 68
Tax demands, ill-timed, 204
Tea-estates and soil erosion, 187
Technical schools proposed for India, 236–7; should combine art and trade teaching, 236
Temple, Sir Richard, on denudation in India, 151
Terraced hillsides, 15, 29, 83, 107, 161; effect damage to rivers, 158; embankments on, 187; water-storage on and its risks, 149–50
Terracing with surface drains essential to Indian plantations, 187
Thar, or Indian Desert, 19
Thriftlessness of the peasant, 29–30
Tibet, Buddhist nomads of, 11–13; climate of, 18
Tinnevelly holdings, 40
Tippera district, population increase and multi-cropped area, 95
Toda villages, 12–13
Town and country, reconciliation of, in joint regional activities, 248–9
Tractors, wheeled *v.* caterpillar, 110

Trade wind zones, 14
Trading organisation, a need of rural industries, 233–5
Transport factor in cultivation costs, 38
— in villages, neglected, 225; Western development of, 242–3
Travancore and Coorg forests, 18
Travancore State, fertility and irrigation in, 97; high cropping, density and standard of living, 96–8; paddy cultivation and cattle-breeding in, 98; rubber estates and soil erosion, 187; tapioca-growing in, 97–8
Trees, Indian forest, 160
Tropics, exploited wastefully, 2, 199, 202; plantation system and economic conflict in, 218–19
Troup, R. S., sylvicultural work of, 160
Trowseed on havoc of denudation, 152
Trunnier on German agriculture and population, 102
Turkestan, blight of unskilful irrigation in, 179; shepherds of, 10

United Provinces: agricultural organisation needed, 93; alkali lands, 165; aridity caused by denudation, 152–6; Art and Crafts Emporium at Lucknow, 234; average economic holding, 61; canal system north of Basti, 29; cultivator's working year, 73; drainage interference by canals, 165, 181; emigration from, 93; enterprising Brahman farmers, 78; famine losses, 27; field embankments and storage *bunds* for ravine-lands, 155–6; fields replacing pastures—decline in cattle, 193; floods, 150; forest area inadequate, 144; hookworm, 140; hydro-electric possibilities, 241; intensive culture and density, 85–8, 90; —— at Shahjahanpur, 79–80; Mirzapur tanks and *bunds*, 187; overcrowded villages, 42; ploughs, 66–7; poultry-farming, 100; rainfall and irrigation as affecting density, 84–5; ravine-lands, 145, 152, 155–6; rice-growing risks, 32, 187; small-holdings, 36–7; subdivision of holdings, 38; sugarcane culture, continuous, 101; treble-cropping, 163; women on the land, 71
United States: average farm in, 45; co-operative dairying, 227; co-operative marketing, 226; freight rates, equalisation of, 225; "grow your own food" campaign, 226; law against speculation in "futures," 222; quickening of country life, 242–3; ranch farming, 200, 217
Urban exploitation of peasantry and land, 221–3
Urbanism of current economics, 1–2, 7

Village community, basis of Indian democracy, 5; in decline, 5–7; *panchayat* organisation in, 211–12; protective against exploitation, 247;
Village Community—*cont.*
reorganisation on regional and co-operative lines, 248; revival of, bedrock of reform, 5

Waste in distribution and its correction, 226–8; of soil resources in India, 70, 138–9
Water and waterways problem of India: complete and systematic policy required, 190–1; drainage surveys and maps as preliminaries to construction work, 184–5; making canals and utilising them for transport and power, 188; reclamation of ravines, 185–6; 187–8; river conservatism, 188–90; stream dams, storage reservoirs and irrigation canals, 186–7; tanks and embankments, 187–8
Water-buffalo in Bengal and Italy, improves marshes, 242; in China, 16
Water for irrigation: assessment by area and its results, 164, 172; proposed sale by volume, 164, 171, 172; saline, how to be used, 164–5; village communal regulation of, 171–2
Waterfalls, harnessing of, 215
Waterlogging, due to unscientific canal irrigation, 164, 165, 166, 168; other causes of, 170, 173; problem of, in the Punjab, 169–70; remedial measures, 170, 171
Water-power for small industries, 241
Waterways problem in Bengal, 173–7
Weavers, credit and co-operation for, 232
Well-irrigation and size of holdings, 61; by bullock-power in Fatehpur district, 155; in Bombay—economy of the power-pump, 212–3
Wells, inspection of water-level in, 168
Western agricultural changes, 239
— farming methods inapplicable to the East, 7, 79, 134
— rivers, regulation of, 190
Wheat cultivation, 3; basis of Western agriculture, 4; favours large-scale farming and class disparity, 4; facilitated in India by tanks and embankments, 187; importance of nitrate in, 132; yields in England and India compared, 80; yields on Cawnpore farm without manure, 122–3, 124–5
Wheat-rust havoc, 68–9; in irrigated wheat, 164
Williams on agricultural income, 25
Wind-motors in Europe and India, 241
Women's work on the land, 61, 70–1
World economics and peace, 2; exploitative agriculture a disturbing influence, 201–2

Yaks, 11
Yellow river in China, a menace through forest destruction, 143

Zungarian "gates," 13

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