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ORDINARY GENERAL MEETING.*

COLONEL GEORGE MACKINLAY, LATE R.A., IN THE CHAIR.

The Minutes of the last Meeting were read and confirmed.

The following elections were announced :—

MEMBERS :—Rev. J. Marchant; Ebenezer J. Sewell, Esq.

ASSOCIATES :—F. D. Hopkins, Esq. ; James Heaton, Esq.

The following paper was then read by the author :—

OBSERVATIONS ON IRRIGATION WORKS IN INDIA.

By C. W. ODLING, Esq., M.Inst.C.E., C.S.I.

IT is possible that some of those, whom I have the honour of addressing this evening, have lived in India for a longer or shorter period. In that case a portion of my remarks may be superfluous, but I think it will be wise for me to assume that the acquaintance of my audience with India is limited to what they may have read in books or newspapers or heard from friends. To begin with, I may say that the overwhelming importance of irrigation in India is due to the liability of that country to famines. The famine of 1897 and 1898 attracted much attention in England, and large sums were raised by private generosity for the relief of our fellow-subjects in India. This famine, which commenced in the winter of 1897, has only lately come to an end, relief works in the Central Provinces having ceased in 1903. In that famine, food was always procurable at a somewhat high price, but the people who had lost their crops were unable to purchase it, as they had not the wherewithal to do so. At the time, I was residing in what are now called the United Provinces of Agra and Oudh, and I do not think that, in those Provinces, any deaths occurred owing to relief not being procurable. Severe privation was widespread and unavoidable, and unfortunately many persons did not seek

* Monday, 22nd February, 1904.

relief in time. The lesson taught by the Orissa famine of 1866 had resulted in the State fully accepting, in principle, the obligation to provide, in times of famine, the means of supporting life. In other words, to maintain relief works, where wages sufficient for subsistence could be earned, and to give gratuitous relief where necessary. This obligation has, I believe I can rightly say, been acted up to. Owing, however, to the experience gained in this famine and to the labours of a Commission, of which that distinguished official, Sir Antony Macdonnell, now Under Secretary of State for Ireland, was President, I have no doubt that in future famines the management will be more efficient, as regards relief, and more economical in the expenditure to be incurred. My own recollections extend as far back as to the Orissa famine of 1866, in which I am sorry to say that three-quarters of a million of people perished, the greater number of starvation pure and simple. That famine formed my introduction to India, and a very doleful introduction it was. The crops had failed and means of communication, by which sufficient food could be speedily brought into the country, did not exist. Even the road from Calcutta to Cuttack, the capital of Orissa, was unmetalled, and this road is intersected by numerous large rivers which were unbridged. Things are different now. Cuttack is connected with Calcutta, about 250 miles distant, by a railway which extends to Madras. There are two navigable canals, passing from Cuttack to the seaboard, and there is inland water communication, mainly by canals, but partly by rivers and tidal creeks, between Calcutta and Cuttack. In speaking of the canals between Cuttack and the coast, I may advert to the rise of the port of Chandbally, which, when I first saw it, in the year 1867, was a small fishing village with a few mud huts. After the Orissa famine of 1866, a Scotch captain, who had an interest in a small steamer, the *Celt*, which at one time plied on the Clyde, explored the Orissa coast to see if he could find a harbour sufficient to admit a vessel of light draught entering it. Eventually he found that he could navigate the River Dhamrah for 20 miles from the sea to Chandbally, whence Cuttack, 60 miles distant, could be reached by road and other nearer places by rivers or creeks. The result of this exploration was, that in five years, there were three separate lines of steamers running between Calcutta and Chandbally. Up to the time of the opening of the railway, in-so-far as I remember 1900, the usual method of reaching Cuttack, from Calcutta, was by sea to Chandbally and thence to Cuttack by canal.

I have digressed somewhat from my subject in order to bring to notice a typical instance of expansion of trade and the enterprise of the British mercantile marine. I trust that Captain Macneill derived some benefit from his energy, but I fear that the reward for the most part went to the great shipping companies, who reaped where he had sown.

Turning to the more immediate subject of my lecture, I find that in the year 1901–02, which is the last for which I have been able to procure returns, 20 millions of acres were irrigated by works constructed by the Indian Government. The area of England is given in *Whitaker's Almanack* at 32,600,000 acres, so that the area so irrigated in India is equivalent to nearly two-thirds of the area of England. The cultivated area of India is 226 million acres, less than one-tenth of which was irrigated by State irrigation works. The crops irrigated were mainly food crops, other crops such as flax, linseed not used for food do not cover more than about 10 per cent. of the area irrigated, and allowing this margin, the food produced was sufficient to feed 16 millions of people for a year. For some of the smaller works no capital accounts are prepared, but the works, for which such accounts have been kept, had, up to the 31st March, 1902, cost 29½ millions of pounds, and the net revenue, after paying working expenses, was £1,800,000, or upwards of 6 per cent. on the capital outlay. These are, so far as I can give them, the broad outlines of the extent and results of irrigation works already carried out by the Government of India. It is not to be supposed that there are not what I may call private irrigation works, such as field embankments, which impound drainage water, and channels leading from tanks, rivers, and streams. In years of good rainfall these works are said to irrigate some 14 millions of acres; when the rainfall is deficient that area is less by possibly 50 per cent. Wells are also largely used for the irrigation of crops, other than rice, 12 millions of acres being so watered in a normal year. One way or other something like one-fifth of the cultivated area of India is artificially irrigated in ordinary years, and crops over that area of land secured independently of the rainfall.

The crops grown in India may be divided into autumn crops—known as *Kharif*—such as rice, millets, and pulses—and spring crops known as *Rabi*, such as wheat, barley, and linseed. The former are harvested in November and December, and the latter in March and April. Sugar cane and some other crops require a whole year to mature. The chief crops which are irrigated are rice, wheat, barley, and sugar cane.

Incidentally, I may refer to the rainfall which for India as a whole—excluding Burma and the Himalayas—is taken, in a late official publication, as 42 inches for the year, on an average, and to be liable to fluctuation, also on an average, to the extent of about 7 inches only. The variation in separate tracts is very great, and unfortunately, the lower the rainfall the greater its liability to serious deficiency. As an example of the variation in different parts of India, I may refer to Cheera Poonja in the Khusi Hills, where the normal annual fall exceeds 450 inches, and Bikaneer, where it is under 5 inches. There is a large part of India where the rainfall exceeds 70 inches, and where the chance of failure of crops, owing to deficiency of rainfall, is small. Allowing for this tract in which the rainfall is always sufficient, and for the area in which the crops are secured by irrigation, there is the Irrigation Commission, to whose report I am greatly indebted for some of the information contained in this paper, comprising a tract of nearly a million square miles, no part of which is at present secure from drought followed by serious deficiencies in the crops and consequent famine. It is to protect this part of India that irrigation works are required. My own experience has been, that the Government of India have never been unwilling to find the money required to construct irrigation works, from which a return of 4 per cent. on the expenditure might reasonably be expected. In many cases, the return on the capital expended has been greatly in excess of this rate—in fact, as I have already mentioned, the works constructed with the expectation that they would pay at least 4 per cent. per annum, now taken together, return upwards of 6 per cent., but several of the projects have, as remunerative works, failed altogether. The irrigation works in Bengal and Bombay (exclusive of Sind), on which $4\frac{1}{2}$ millions sterling have been expended, return something less than 1 per cent. on their capital cost. The Kurnoul Canal in Madras, which cost $1\frac{1}{2}$ millions sterling, pays about $\frac{1}{2}$ per cent. on that sum.

The profitableness or otherwise of irrigation works depends, naturally, largely on the average rainfall; in the Punjaub, where the fall is low, averaging 10 to 23 inches annually, the return is $10\frac{1}{2}$ per cent. on the capital expended, and the works last constructed—known as the Chenab Canal project—give a return of $18\frac{1}{2}$ per cent. On the other hand the Madras works, which serve a country where the average annual rainfall varies from 30 to 40 inches, gave a return of $9\frac{1}{2}$ per cent., the works last constructed, amongst which is the Kurnoul project, to

which I have previously referred, not however having proved to be remunerative.

The fact is that, except in very dry localities, it is not easy to say how far canal water will be taken advantage of. When the Sone canals, with which I was for many years connected, were constructed, the opinion of the Engineers and the Civil Officers was that spring crops, such as barley and wheat, would, if anything, be more irrigated than rice, for which it was supposed the rainfall, which averages about 42 inches in the year, would in many places be sufficient. The Lieut.-Governor, Sir George Campbell, insisted that the canals should be designed with regard to the supply of water, available in the river in the cold weather, when spring crops are irrigated. On the other hand, Colonel (now General) Rundall, R.E., the chief adviser to the Government of India, advocated the canals being constructed chiefly with a view to rice irrigation, with which he had long experience in Madras. The Lieut.-Governor's views, as might be expected, prevailed, and the canals were restricted in size, and otherwise designed, in accordance with the Lieut.-Governor's opinion, as to the work which they would be called on to perform. The actual result has been, that the rice irrigation is limited only by the amount of water available. So far as water can be guaranteed for rice, the cultivators eagerly avail themselves of it, and double the area of this crops could be irrigated, if water could be supplied. In regard to spring crops, wheat, barley, and the like, there is in most years little demand for water, not one-tenth of the area for which water can be supplied is usually irrigated. It is not by any means a matter of obstinacy or prejudice, as where water is beneficial it is taken and, in some cases, lifted by mechanical means 6 feet or more, at a cost of treble or quadruple the amount of the water rate. Once in seven or eight years, when the winter rains fail entirely, the whole of the water which the canals can supply for spring crops is used, but, generally speaking, it is the rice irrigation only that counts. These canals, I may remark, pay at present 2 per cent. on the capital outlay, but there is little doubt that had they been designed with reference mainly to rice irrigation, the return would be double. As it is they will, before many years have passed, probably pay from 3 to $3\frac{1}{2}$ per cent. on the outlay incurred, and in years of famine the value of the crops saved cannot be disregarded, in fact, from one point of view, it is the greatest benefit they confer on the country.

It is stated in a Government resolution, that for the year

1901–2, the value of the crops in India as a whole, raised by the aid of irrigation from the works, for which capital accounts are kept, is estimated at nearly 42 crores of rupees (28 millions of pounds), or about 95 per cent. of the capital outlay expended on them.* There is, in fact, a return from canals, quite independent of the actual money receipts, in the food raised by their help, at a time when it is most required. That eminent statesman, Lord Curzon, who as Viceroy now so worthily controls the Government of India, has fully recognized this fact, and irrigation works are being pushed on as fast as plans can be prepared, without too much regard to their character as remunerative works.

The State irrigation canals usually directly depend for their supply of water on rivers. There are a few small canals, fed from reservoirs and tanks, but the irrigation canals in India are in the main supplied directly by rivers, some of which are snow fed and give a sufficient supply of water all the year round, whilst others can be depended on for a full supply only during the rainy season, that is from July to October. The rivers of India have many peculiarities, perhaps the most striking being, that it is difficult, during flood time, to know where they will be the day after to-morrow. The Ganges has been known to change its course, by as much as 2 or 3 miles, in the course of one rainy season. The Indian rivers are a study in themselves. An Engineer, who built one of the largest railway bridges in India, at the ceremony when the bridge was opened, remarked that he had watched that particular river as a cat might watch a mouse, for three years, and was then as far from knowing what change might occur in its course, during a single rainy season, as he was when he first saw it. The non-snow fed rivers, which are those with which I am best acquainted, are frequently dry, almost always fordable in the dry weather, whilst in the rains, they may be anything from 1 to 3 miles wide, with a raging current, between 8 and 20 feet deep, passing down them. A journey in the rains from Calcutta to Cuttack used, before the days of railways or the rise of the port of Chandbally, to be attended with many possible troubles, not the least of which was the chance of being detained, with no shelter but a palanquin, on the banks of a river for 48 hours. One particular river, with which I am acquainted, the Byturnee, which in the summer may be crossed on stepping stones, has

* *Government of India Resolution*, No. 1213 C. W.—I. of 10th September, 1903.

within my own knowledge in 1868, overflowed its banks, so that a European, who was staying, with his wife and child, in a travellers' rest house some eight miles away, had to take shelter on the roof, where I am sorry to say the child died.

The rivers, in the deltas of Bengal, frequently become narrower as they approach the sea, with the result that in the flood season they overflow their banks for long distances, and for 30 to 50 miles, they form seas of water with villages, dotted here and there, on hillocks, appearing above the water. At that time of year the difficulty, when travelling in a boat, is to be sure you are in the river and not sailing over what ought to be dry land, with the chances, should the flood subside, of finding your boat stranded two or three miles away from the river bank. Such rivers are frequently embanked, but the general result of such embankments is only to intensify the flood lower down the river, the flooded country on each side, when open, performing the office of a reservoir and impounding the water, until the flood commences to subside, when it gradually passes away. Here in England the banks of rivers are usually the lowest parts of the country and are apt to be flooded in wet years, like the last; in deltas, the reverse is the case, the banks of the rivers are frequently the highest parts of the country, as the silt has accumulated there more than elsewhere. In flood time the water in the rivers is heavily charged with silt, and when it overtops the banks, its flow being diminished in speed, the greater part of the silt, which is only held in suspension, when the velocity of the water is considerable, is forthwith deposited. Some portion of the finer particles of the silt of course remain, and are gradually deposited on the fields, which, in the course of long years, are raised also. Deltas are, in fact, the product of river silt. Even outside the deltas proper the Indian rivers have, what in England would be looked on as eccentricities, the River Sone, for instance, being $2\frac{1}{2}$ miles wide at Dêhri, the site of the weir, from which the Sone Canals take off, whilst 60 miles lower down, where the East India Railway crosses it, that river is 6,000 feet wide only. The deficiency in width is partly made up by greater depth.

The rivers of India, from an irrigation point of view, may be divided into two classes, those whose source lies in the snow-capped mountains of the Himalayas and those which rise in the hills situated in the interior of India. The said hills, it may be mentioned, are anything between 4,000 and 8,000 feet in height, whilst many of the peaks of the Himalayas are more than 20,000 feet in height. In the case of rivers whose source is

in the Himalayas whilst the volume of water varies, it is always considerable, the lowest discharge being in April, before the snows commence to melt: in the case of rivers whose source is the hills in the interior of India the discharge is greatly restricted from November to March, and during April, May and June, many rivers are almost dry, a large river, the Mahanuddy, for instance, which is nearly two miles wide in an ordinary flood, becoming fordable from April to June, and being then only a few hundred feet in width.

In Bengal proper, rivers are very numerous and the meeting place of the community, especially the women, who carry water from them for domestic use and take advantage of the opportunity to chatter with their neighbours. They are also much resorted to, by both sexes, for bathing purposes, a pastime which cannot always be indulged in in safety, many of the rivers abounding in alligators, who are given to devouring children and do not disdain adults when children are not to be had. I have shot several alligators and found inside them bangles and other feminine ornaments, indicating that they had quite their share of female flesh. One river in Orissa is known as the Kimeria-Kimer, being the Ooriya term for alligator. In that river bathing places are frequently fenced round with bamboos, a practice which I notice has been copied at Folkestone, iron bars taking the place of bamboos, but I have not heard of alligators appearing at that place.

I now turn to the great irrigation systems of India on which, as I have previously mentioned, nearly 30 millions sterling have been expended. The water is in nearly every case obtained from some great river, and the usual course is to build a wall—technically known as a weir—across the river, so as to raise the water and keep it permanently raised, some 10 or 12 feet above the river bed. The designing and building of these weirs affords full scope for the engineering abilities of the staff of engineers employed by the Government of India in the Irrigation Branch of the Public Works Department. Essentially, a weir comprises the wall mentioned, which is usually built on wells, the foundation being generally sand, and slopes of heavy stone, in front and behind. Work is carried on when the rivers are at their lowest, say from November to May, so that the season of heavy floods is escaped. I am not going to inflict on you any technical engineering details, but I may perhaps say that there are occasionally incidents connected with the construction of these large works, which cause anxious moments to the resident staff. I was at one time

Resident Engineer in charge of the construction of the weir across the Brahminee, a river 4,000 feet wide. This is not a snow-fed river, and usually from December to June it is nearly dry. In this year, however, a heavy flood occurred in January, and as I had two railway lines laid across the river bed and in use, its effects were disastrous. The lines were submerged and the movable plant, including portions of railway waggons, swept down the river, and gradually picked up miles away. A flood in that month of the year was an unheard-of occurrence. Fortunately for me the Inspector-General of Irrigation was present, and I think that my predominant feeling was rather more one of satisfaction, that he was there to witness the incident, than distress at the occurrence, which was in itself sufficiently annoying, as all work stopped in June, and a great deal of leeway had to be made up. Cholera was another peril to which we were not infrequently subject. The work-people took the matter in their own hands, and after a few cases dispersed. I have myself known, on one canal under construction, the work-people to diminish in two days from upwards of 20,000 to one-tenth of that number. I may perhaps say that, on such occasions, there is a good deal of amateur doctoring, and that a pint of rum will, so far as my experience goes, cure any case of cholera in an adult, provided, and the proviso is important, that the person experimented on has never touched alcohol before. Such persons, I may add, are in some parts of India by no means rare.

The water in the river having been raised to a sufficient extent canals are dug, which extend many miles in length, and compared with those common in England, are of great size. The canal with which I was most concerned was 80 yards wide at water line, and there are many much larger. The discharge, 3,000 cubic feet per second, was sufficient to cover 18,000 acres of ground with water 4 inches in depth in 24 hours, and as rice, the crop with which we were mostly concerned, can live without water for 12 to 14 days, the crops on 220,000 acres could be saved independently of the rainfall. A canal on the other side of the river was capable of irrigating something more than half this area, so that crops on some 350,000 acres were safe. Our chief difficulty, when the canal first commenced to run, was with silt, which was deposited in large quantities in the first mile of the canal, reducing its depth by one-half, in times of flood, when much silt was deposited. After a time, the engineers in charge, managed to so arrange the supply, that the water which entered contained less silt, and that such silt

as it did contain was carried on to the fields, where it was useful as a fertilizing agent. The chief part in this reform, which saved much expense in dredging, was taken by a gentleman whom I see present this evening. Weeds were another of our difficulties. The moment the water was clear and the supply low, so that its velocity in the canal was small, they commenced to spring up, and I can, having seen this example, well understand how weeds have actually blocked and in fact extirpated rivers in Central Asia and Egypt. The peculiarity of the weeds, at least those with which I am personally acquainted, is that so far as screw steamers are concerned they only materially impede the progress of the boat when it is travelling with the current. I remember on one occasion taking a distinguished party some 50 miles, in a small steamer up a canal; the journey was performed with no trouble, and indeed we had not much difficulty during the first 40 miles of the journey back, but it took us quite four hours to do the last 10 miles, and as I was in charge of the canal I was not a little mortified. I mention the circumstance as a good example of learning by experience. The weeds I may say have been much diminished by the measures taken to prevent silt deposit and what is perhaps of nearly equal importance, paddle steamers are now used. Weeds have very little effect on the progress of paddle steamers, and after such a lesson I took all possible precautions for the future. The canals with which I have been personally connected, have locks, and are used for navigation as well as for irrigation. There is considerable doubt as to whether this is a wise arrangement, as with a navigation canal it is desirable to keep the velocity of the current as low as possible, whilst in respect to canals, for irrigation only, a high velocity is desirable, so that the canal may not be larger than is necessary, and, further, the higher the velocity the more silt the water will carry on to the fields.

The main canals leading off from the rivers having been constructed, branch canals taking off from them are excavated, and other channels, known as distributaries, are again dug leading off from the branch canals, until the water is delivered well into every village, which may be taken as an area of say 2,000 to 3,000 acres. From these distributaries channels are led into the fields; these minor channels have usually been made by the villagers, but the tendency is now for water to be led to each holding by channels made when the distributaries are constructed. Here I may perhaps mention that upwards

of 40,000 miles of canals and distributaries have been constructed at the expense of the Government of India.

When a canal has been built, so far from the difficulties being over, my experience has been that they are about to commence. After all a canal and its appliances can be carried out with the ordinary difficulties attendant on the construction of a large engineering work. Rivers, large or small, are crossed by weirs or aqueducts, the slope of the canal is kept at that necessary to give the desired velocity to the water, masonry falls or waste weirs being built should the slope of the country exceed that given to the canal, and finally, escapes are provided into which water not required can be discharged. One thing I may perhaps mention, which is, that if there is a weak spot in the works the water will find it out, and that the work, both as regards material and workmanship, must be first class. In common with railways, canals have been of great use to the country in introducing masonry, iron and woodwork, of a class which had never been previously seen in many districts. When the canals were completed the workmen remained and used for other works the skill they had acquired whilst employed on canal construction.

I will give one concrete example of indirect material advancement consequent on the building of a canal. In 1872 I was employed as Resident Engineer on the construction of what is known as the High Level Canal between Cuttack and Bhadrak. A weir across the Pattia river was one of the works, and large quantities of stone were required—this stone we obtained from an estate known as Sokinda. Now in Sokinda, which is in British territory, but at that time in reality ruled by a landholder, a direct descendant of the ancient chiefs, such a thing as a cart was unknown. Pack bullocks were employed for the transport of grain and such commodities as had to be moved. The contractors I employed commenced by importing 2,000 carts, and in June, when the working season expired, these carts were not considered worth either moving or storing, and they were sold, to what I may call the aborigines, for what they would fetch. In subsequent years a similar course was followed, and there has been no lack of carts in Sokinda since.

The canal banks, I may add, are in some cases high, the width is considerable, and the quantity of earth to be moved any distance from 20 to 100 yards and any height up to 20 feet, large. All this earth is carried on women's heads in baskets, wheel-barrows being unknown, indeed there is a tradition that wheel-barrows were once sent out from England for a railway,

but the coolies, who promptly removed the wheels, found them heavy and inconvenient to carry on their heads, so the experiment has not been repeated.

Returning to the stage following the completion of the canal, the next thing is to dispose of the water, and an elaborate organisation is necessary. To begin with, the system of farmers occupying some 50 to 1,000 acres, the buildings requisite for which have been supplied by the landholder, is unknown in India. The land is occupied in small plots of from 2 to say 10 acres by cultivators (*ryots* is the usual name for them) who have built and own all the buildings on the land. The land in Bengal and Upper India is the property of a landlord, whilst in Bombay and South India it usually belongs to the State. Under any circumstances the cultivator pays rent to the landholder, and usually cannot be evicted so long as the rent is paid. In many cases the rent cannot be raised except at stated intervals, and then only if the yearly value of the land has been increased by some agency other than the labour of the cultivator. I have spoken of landlords, but it is necessary to say that in India, broadly speaking, the State is the sole landlord, the so-called private landlords (*zemindars*) having the right only to a share of the rent. This share has in some cases been permanently settled, and in other cases for a term of years, usually thirty. Where the settlement is for a term of years, the State usually receives half the rent paid by the cultivators to the *zemindar*, but where the settlement is permanent the share, which was originally 90 per cent., has grown,* till in 1893 it was found that for four districts in Behar, the government out of a rental of about 240 lacs of rupees received 34 lacs, and the *zemindar* retained the remainder. The assessment under which Government received $\frac{9}{10}$ of the rents paid by the cultivators, erred probably on the side of excess, though the *zemindars* had their homestead land and all waste or common land revenue free. It cannot be said that the share Government now receives errs on the side of excess, indeed the complaint made by those provinces in which the permanent settlement does not exist is that Bengal does not pay its fair share of the general expenses of the Indian Empire. I have no personal acquaintance with these parts of the country, Bombay and Madras, where the Government deals directly with the cultivator, but the settlements are in such cases always, I believe, for a term of years, and I gather that, though the rents imposed are not

* Supplement to the *Calcutta Gazette* for October 25th, 1893.

excessive, the rigidity with which they are exacted, be the seasons good or bad, might with advantage be modified.

Tenants holding directly from the State have an advantage inasmuch as they are required to pay a fixed rent only, without the addition of presents known as *salami* or *awabs*. Cultivators dealing with a landlord are expected to present gifts, on the occasion of a birth or marriage in the landlord's family, or their own, or whenever a decent pretext can be found for exacting an extra payment. The reasons given for levying these gifts sometimes border on the grotesque. I was at one time living with a magistrate in charge of a subdivision of a district, who in the course of an inquiry found that illegal cesses, under thirteen different heads, had been imposed on the cultivators. On one occasion the landlord had, long years previously, entertained a magistrate, and had since levied yearly a tax to compensate him for the expense which he had incurred. The poles which supported the telegraph wires passed through his land, and, under the name of *tar kercha*, telegraph tax, he imposed a cess of 1*s*. 6*d*. a pole on those of his tenants who occupied fields in which the telegraph poles were fixed. He paid nothing himself towards the cost or working of the telegraph line, and, indeed, was entitled to compensation, if he cared to claim it, for the trifling area of land occupied by the poles. The possibility of levying an extra cess was too good to be lost. A donation to a school was followed by an annual cess about equal in amount to the donation. It is fair to say that these gifts were in some cases regarded by both parties as the equivalent of an increased rent, which might possibly have been legally demanded, but which would certainly have been resisted and involved both sides in heavy legal expenses. In moderation the cultivators do not object to occasional gifts which have become customary.

As I have said, many, probably most, of the cultivators are protected from eviction so long as they pay their rents, and many even against any arbitrary increase in rent. On the other hand there are tenants at will, but whatever the tenure, the cultivator owns his own house, and it is with him, and not the landlord, that the Irrigation Officer deals. The crops differ in different parts of India, but so far as irrigation is concerned the difference, broadly speaking, is between those parts where the only irrigation that counts is rice, and Upper India where the spring crops are equally, if not more important. My own experience has been in those parts of the country where the main irrigation is of rice. Under any circumstances the water

has to be supplied to the field channels in sufficient quantities, and in due season, the area irrigated has to be measured and assessed, bills for the sums due have to be made out and delivered to the person who is liable, and finally the money has to be collected. When things have settled into what may be called a state of routine, incessant care, watchfulness, and industry are sufficient to keep the system going with a moderate number of complaints, many of which will be found to rest on some real grievance. Such a system takes time and actual experience to evolve. The persons who will have to pay are not always helpful. In the case of one village, I found that the persons who had been returned as liable to pay water rates, were for the most part dead, and the few persons who were still living, were inhabitants of neighbouring villages who were not on good terms with its present inhabitants. In the end a system fairly satisfactory alike to cultivators and to Government is arrived at.

The work to be done in managing canals is heavy, and unfortunately, in Bengal at least, it involves daily travelling and exposure during the most unhealthy time of the year, July to September, when not only is the heat oppressive but the atmosphere is saturated with vapour. There is another side to the story, and I do not think I know anything more enjoyable than an Irrigation Officer's tours in January and February. The air is then bright and crisp, I have heard it likened to champagne, the temperature in the daytime pleasant, and at night just sufficiently cool to render a fire, a bonfire, in front of a tent if under canvas, desirable, though perhaps not necessary. The crops then on the ground, mainly wheat and barley, remind one of the old country, and the cultivators are always desirous of having an interview with the canal engineer, who, on his part, is glad to become personally acquainted with as many as possible of the people, for whose benefit his active life is spent, and with whom it is a pleasure to deal in their own villages. There they are usually truthful, and to no one more so than to the officers, on whose zeal so much of their welfare depends. In law courts it is a different story. The same men who, in their own villages would be ashamed to deviate from the truth, consider themselves in no way disgraced by committing perjury in court in the interest of themselves or their friends.

The influence of canals is unfortunately not for good in all directions. Rice is a far more certain crop than wheat or barley; it is not liable to blight, red dust, or numerous other

diseases to which cereals are subject. It also requires less labour, and is therefore the popular crop. In the case of the Sone canals, over 100,000 acres of rice has displaced wheat, barley, and other spring crops, though it may be doubted if it is, from a health point of view, good for the country to have this area of land covered with 4 to 5 inches of water for three months of the year at least.

To show the effects of canals in the Punjaub, which is a country of scant rainfall, I may refer to the Chenab Canal, which has cost about one and three-quarter million pounds sterling, and commands an area of 4,700 square miles—more than the area of Yorkshire—three-fifths of which was irrigated in the year ending 31st March, 1902, yielding a revenue of 18·8 per cent. on the capital outlay. More important than the financial result is the fact that a barren plain, inhabited by a few thousand nomads, has been rendered available for cultivation, and even now supports a population of nearly a million of inhabitants. Works of this character do much to justify English dominion in India, and to show the advantage of Western civilisation. I need scarcely say that all irrigation projects will not be so remunerative, in fact some of them may fail to do more than pay working expenses. But the indirect benefits are so great that there is abundant justification for their construction in those parts of the country where scarcity is frequent, and such works are feasible.

India, I may say, is pre-eminently an agricultural country, and interests in the land are widespread, so that any measures which will render it more fruitful, reaches all classes of the community. There is the same, and possibly greater reluctance, to adopt new methods of cultivation which are not altogether absent in a country so far advanced as England. So far as irrigation is concerned, there has been nothing new to learn in using water periodically to mature the crops. In places where the rainfall is sometimes sufficient, there has, however, been at first, considerable reluctance to pay for a commodity which has hitherto been regarded as a free gift from above. But it is, sooner or later, recognised that the certainty of good crops and the convenience of obtaining water when required are worth a price, and eventually water rates are paid, if not cheerfully, without any particular difficulty.

The charge for the water supplied is low. For rice, which must constantly be kept in a depth of from 4 to 6 inches of water, the rates vary from two shillings an acre in Orissa to

8*s.* 4*d.* in the Punjaub. It is not likely that water could be supplied for this crop from wells, by any mechanical means, at a price which the cultivator could afford to pay; for spring crops, which require less frequent waterings and smaller quantities of water, wells are at present largely used, and it is possible that windmills or some other power may in time supplant animal power which is now used. In Madras there is no special rate for water, the charge for which is amalgamated with the land revenue.

I have before mentioned that one of the duties of the great majority of women in India is to draw and convey to their dwellings the water required for domestic use. Where the spring level is high, that is where water is within 20 to 25 feet of the surface, most cultivators have a well of their own, and the burden on their womankind is not great, but there are parts of the country where it is necessary to sink wells to a depth of 100 feet or more to obtain water. In these places wells are costly to construct and are few in number. The High Level Canal, in Orissa, passes through a locality of this description, and previous to its construction the women, who lived in the villages near it, had to go from 1 to 3 miles for water, which they carried on their heads in large earthen vessels. The exercise, no doubt, gave them a very erect carriage, but it was exceedingly burdensome. The canal was accordingly looked on as a perfect godsend, and the satisfaction of the women at its advent was doubtless great, though owing to their retiring disposition the canal engineers did not hear their views on the matter. The village priest was, however, much struck with the blessing that had been bestowed on them, and whenever he saw me he uplifted his hands and solemnly blessed me for the boon which he thought I had been the means of obtaining for his flock. It is something to have the value of one's work recognized, and I always felt grateful to the old man for his benediction.

I hope that I have not wearied you with the somewhat technical language the subject on which I have been speaking has compelled me to adopt. Irrigation officers are all enthusiasts, and it is something to have adopted a career in which there can be no doubt that the work carried out has been for the good of the country in which one's lot has been cast. There is the further and more general question, whether with all the great things which England has done for India, of which irrigation is only one, it is, as has been asked by an eminent publicist, possible to render the country prosperous in the sense that frugal comfort will be the reward of industry.

There are certain parts of India, Eastern Bengal for example, where this standard is always reached, as the rainfall is invariably sufficient to mature the crops. But there are parts of India where a perceptible proportion of the population is always on the verge of starvation, and where actual distress follows a deficiency of rainfall. Irrigation will do much to remedy this inequality. It is not a panacea for all evils, and there are parts of the country where any irrigation schemes are quite impracticable. The necessities of life are few and simple in such a climate, and in those parts where the means of earning the little required to procure them can be made secure, I know no country where the mass of the people live in greater comfort. Railways have done much to render famines, like those of old, impossible; great industries like those connected with tea, mines, jute, indigo, and other articles have done something to provide employment for the population, who have, in parts of the country, multiplied beyond the power of the soil to support all. There are large tracts of the country still awaiting cultivation, and it is to be hoped that with the freer means of communication, the people will be less reluctant to change their domicile. This is to some extent already happening, as large numbers of labourers have migrated to the tea districts and mines, whilst a beginning has been made in colonizing the waste lands of Burmah. It would not be right in this paper to omit to refer to the marvellous effect irrigation canals have had on the wild frontier tribes, whose constant fighting seems to be partly due to want of sufficient occupation. The Swat Canals, near Peshawar, may be taken as an example. They were constructed with armed guards protecting the work-people, and ever since their construction have been the scene of murderous conflicts. They have, however, turned a tribe of marauders into a prosperous agricultural community. The same result has followed the construction of canals in Beluchistan and elsewhere on the frontier.

My paper has dwelt exclusively with the material wants of the country, the other and not less important spiritual wants, which are more commonly the themes under consideration at this Institute, I leave to other hands, merely mentioning them here, to show that they have not been forgotten.

DISCUSSION.

The CHAIRMAN.—I am asked to mention that besides members present we are favoured with the presence of visitors, who, I hope, will take part in the discussion and add to its interest as having been engaged in the construction of important works on canals in India. I will therefore call on Mr. Buckley to help us in starting the discussion.

Mr. R. B. BUCKLEY.—Sir, I have just noticed that Mr. Odling, towards the close of his paper, mentions that irrigation officers are always enthusiasts. I am an irrigation officer. Now my experience is that sometimes you get an enthusiast to talk to you on his hobby in a manner which is not always advantageous. However, strengthened by your kind support, I venture to make some criticisms on this paper.

I have known Mr. Odling for some thirty years, and have worked under him and with him, and therefore know how well he does his work.

I think the paper seems to throw a little too much importance on the work done by the British Government and by engineers in India in irrigation. Irrigation is rather treated here as though the works that conferred benefit on India had been originated and constructed by the British Government—indeed I think the very words are used. That it is not altogether true. Mr. Odling mentions one case where the works paid as much as 18 per cent., which is quite correct; but some four or five of them were not initiated by the British Government, but by the natives long before our time; and if we have done many useful works for India, as is the case, we have learnt a good deal from our native subjects before we begun to improve on their methods.

Irrigation is not new, as the paper leads one to believe, but it is very old; in fact, what little I know of the garden of Eden I am much inclined to think that probably the cutting of small channels was known at that time. I suppose the first natural overflow of the Ganges and the Indus would help to show the advantage of artificial channels. The Egyptians appear to have cut channels from the Nile to irrigate their land, and the Babylonians constructed a great many in the valley of the Euphrates some 300 years B.C. Certainly in India

they speak of two or three crops a year instead of one. Again, about 200 A.D. the Rajah Chandra Gupta constructed some of those works that originated in India. Then again, Tamarlane, who conquered India, had encouraged irrigation works. The first year a man was to have his land free; the second year he could pay what he liked, and the third year he had to pay taxes. But since those days, of course, there has been a great advance in irrigation—one hears of it all over the world.

On the second page of the paper the author refers to famine. It has been stated by the first Famine Commission that one acre of food grains irrigated will feed from two and a half to three persons a year, and I thought that perhaps a few results would be interesting to this meeting. Taking the five principal provinces of India, the area which is represented by irrigation works is about $16\frac{1}{2}$ million acres. Taking that standard of two and a half to three persons an acre being fed per year, these irrigation works will feed about 42 millions of people for one year. The actual population of these provinces is about 200,000,000. So that, approximately, one-fifth of the population has its food supplied by works administered by the Government works of India.

Now the action of irrigation works in reference to famine is, I think, often misunderstood. It is a common thing to hear people who are not acquainted with the details to say, "Why don't they construct more irrigation works here and there and so prevent famine?"

It is one of the most remarkable things I know that people always think if you want to save a country from famine you have only to catch irrigation engineers and irrigate the country; but they forget the fact that you cannot irrigate the land without water. There are many parts of India where water is not available and you cannot, therefore, irrigate the whole country. That proportion of the people who can be protected from famine is, no doubt, considerable; but the actual proportion which is afforded is really somewhat larger, because there are other means which afford an increase of food supply. But it is certainly a fact that although irrigation works will, in a particular district, when constructed, entirely prevent famine in that district, they will not prevent famine very far beyond its own area. I mean they will protect a zone beyond it, but not much more than that. I am afraid as to the deaths at Orissa in 1866, it is a

fact that they died of starvation, because they could not carry the food to the people. There was any amount of food around them, but it could not be carried there. The same thing applies to-day, and in this country we are in precisely the same condition. We could not live on our own food supply, we have to import it, and if from any cause the means of communication were interrupted, we should starve as the people of Orissa starved.

Mr. Odling has referred to the areas irrigated. I wish to show you, briefly, how great an advance has been made. The old works, to which I referred a little while ago, irrigated, in 1855 or 1856, about four million acres only. Shortly after that, Lord Mayo introduced a system by which immense prominence was given to irrigation works. In the next four years that figure of four million acres had risen to ten millions, and then, in a few years, to twenty million acres. Lord Curzon in the Report of the Commission lately sitting proposes to expend another £30,000,000 (29½ millions is the figure given by Mr. Odling as the cost up to March, 1902) in increasing the irrigation works of India. I am glad to see that those works are not to be gauged entirely by their financial results, but they are to be constructed if they are likely to produce results beneficial to the people.

There is another point upon which I think the paper does not give you sufficient clearness of ideas as to the size and volume of these works that are referred to. It is always very difficult to speak on technical subjects in a way that those not acquainted with them can follow. Mr. Odling speaks of the discharge of a canal being 3,000 cubic feet per second. Not many here, perhaps, know what that means. I propose to compare it with this little river here, the Thames. Now the Thames, at Windsor, or about there, has an ordinary discharge of about 1,000 cubic feet a second.

Mr. Odling, in mentioning these canals, speaks of them as carrying 3,000 cubic feet. I am glad to say I succeeded at one time, when water was badly wanted, in securing 4,000 feet. However, that is three times the size of the Thames. The Ganges carries about seven times the amount of the Thames at Windsor. The Chenab canal that Mr. Odling mentions carries no less than 10,800 cubic feet a second.

The Thames, at flood, has been gauged to discharge from 11,000 to 12,000 feet a second; so it will carry, when doing its worst, about

the same as the Chenab canal. But there is one canal, not in India, which outstrips all these, viz., a canal in Egypt. which in times of its maximum discharge carries as much, I believe, as 30,000 cubic feet a second—more than double what the Thames carries in its maximum flood.

I think that gives some idea of the magnitude of the works constructed in India.

The Chenab canal, that Mr. Odling refers to, was constructed in the Punjaub. Before that canal was made the country was an entire waste. I do not think there was any village in it at all. If there was it consisted of two or three huts here and there. A certain number of nomads, as Mr. Odling says, wandered about the country, feeding their cattle where they could get a little grass or food for them; but, practically, the place was a desert. Mr. Odling has told us that there are now 1,000,000 people there. In the paper read by Mr. Preston the other day he said that the canal irrigated 1,900,000 acres, and it was estimated that it would irrigate 2,900,000. Now most of us know something of Egypt. The culturable area of Egypt is about 5,000,000 acres, and that of the Chenab canal, which is one canal constructed in India by the British Government, will irrigate just about one-half the entire culturable area of Egypt. There are at present 1,000,000 people living where there were perhaps a few hundred who lived there before, and that canal will, in the course of a few years, when developed, be able, probably, to support a population of at least 5,000,000 or 6,000,000. The entire population of Egypt is 6,000,000. That one Chenab canal is supporting, not in the same luxury perhaps and not producing such luxurious crops as Egypt, but it is supporting a population of over 4,000,000 in comfort.

Mr. Odling referred to the duties of irrigation officers, and he mentioned that his pleasantest time was in the cold weather. I must take some exception to that, because the pleasantest time I ever knew was during the last famine in Bengal. It was my duty to travel and find work for the famine-stricken people, and I saw the threshing floors, but there were no crops and no work. My duty led me down to the canal that Mr. Odling has quoted, and I there found the whole country in crops and the people well fed and contented. This was at the time of year that Mr. Odling speaks of as being so unpleasant. The crops were luxuriant and the area well irrigated;

but you had only to travel, in some cases 100 yards or 300 yards, outside the area where water had not reached, and the crops were almost invisible. That was a time when the whole country was wealthy and happy; but I went in the time of famine when the canal was not only bringing happiness and prosperity to the people who won the food; they were not only well fed themselves, but they got double and treble the price for their produce and sold with enormous benefit to themselves. The happiest time I ever spent was in going over that country and observing the prosperity of the people. I never enjoyed anything more than seeing the result of these labours in the happiness they brought to the inhabitants of India.

Sir CHARLES STEVENS.—Mr. Chairman, I was hoping that I should be crowded out by Mr. Buckley and other experts who are here, because Mr. Buckley's speech was very much more interesting and important than anything I can say.

I was glad to receive Mr. Odling's invitation to come here to-day, because I knew that I should have much to learn from my old colleague, as I may call him; and, again, I thought I should have this opportunity of congratulating the Institute on having a paper from one of our chief Indian authorities on this very important subject.

Mr. Buckley has anticipated me in more than one remark that I was thinking of making. I was glad to find that Mr. Odling laid stress on big figures, because an English audience, as a rule, has very little idea of the work that has to be done in India. When Mr. Odling spoke of a tract of nearly a million square miles unprotected, I think that people who have lived all their lives on the British Isles, the total area of which is about 122,000 square miles—will have some slight idea of the country of which engineers have yet to deal. I do not know whether this estimated area includes the very large area which is either occasionally or constantly protected by private people. There are some large works which have been constructed after the model of the Government works; but I am referring more particularly to the minor works of which one sees hundreds or thousands, perhaps, in the country which are constructed in places where nothing on a large scale could possibly be carried out.

On going through the country we see little rivers and streams

embanked where water is preserved not only for the usual domestic purposes, but to keep alive the crops and preserve them from drought, and the advantageous influence of those must be very large. When one compares the areas that have already been irrigated by these works with the millions of acres that are said yet to be left, I think one should bear in mind that irrigation works are valuable not merely for the actual quantity of crops which they are instrumental in growing, but also that those additional crops afford a margin or reserve for future times of scarcity.

I quite agree with what Mr. Buckley said—in fact, it is a commonplace now I think—that so far as we know there was never yet a time when there was not food enough in India to actually feed the people; but the difficulty has been that of communication or transport. That was the difficulty, as we have heard in Orissa, and the difficulty in the great Behar famine in 1873. In the year 1897–98, the time Mr. Buckley was speaking of just now, we passed through a time of as great scarcity as that of 1873; but everything went comparatively smoothly. Unfortunately, as Mr. Buckley said, the threshing floors were empty and the people thin; but still, somehow or other, the food got there, the difference being that railways now permeate that country, which in 1873 was not the case. So that what the Government had to do was to find the money. The traders found the means of transport, and the Government was spared the great labour and anxiety of providing the food. That same office was, to some extent, but to a much less extent, of course, performed by the canals and railways.

The SECRETARY.—I have to read a note of apology from Sir Colin Scott Moncrief, who was expected to be here this evening and whom we should have welcomed to speak on Mr. Odling's paper: "I am very sorry to have to tell you that I cannot come to Mr. Odling's lecture to-morrow. I had fully counted on doing so; but an intimate friend has suddenly died and I must attend her funeral to-morrow at Hitchin at 3 o'clock."

On the part of the Council and myself I may express our obligations to Mr. Odling for undertaking to prepare this paper for the Institute. [Applause.] I knew when I asked him to do so that he was just the man to do it well, and I think you will all agree with me that he has fulfilled our highest expectations.

He has told us, and so have Mr. Buckley and Sir Charles Stevens,

a great many details about irrigation works, much of which is new, I have no doubt, to most of us; but perhaps I might be allowed, sir, to refer for a moment to the physical conditions which have rendered irrigation in India, as well as in other countries, possible or feasible.

Now, you cannot have irrigation without abundance of water from rain. Where does the rainfall of India come from? No doubt some of those present are perfectly familiar with these matters, with the great physical arrangements which Providence has made for the supply of water to tropical regions without which they would be waste deserts; and India is a splendid example of the operation of this physical machinery which has been set in motion from the earliest times; in fact, since the present distribution of land and sea came into existence. The water that falls on the surface of India comes, I need hardly say, from the ocean; but the question arises, why does it come at particular seasons constituting monsoons? That may not be so generally known. In these parts we have a rainfall at all times of the year and we are not surprised at it;—though we have been at the amount we have had lately! But why in the case of India, and in the case of the Abyssinian mountains, does the rain fall at certain seasons of the year? It comes about in this way. It is a splendid result of the combined action of the power and influence of the sun's heat and the relative distribution of land and sea. During the spring, when the winter is over, the sun is gradually rising towards a vertical position, and it pours down its rays with irresistible power on the vast area of land exposed to them between the two great arms of the Indian Ocean.

It is remarkable that the sun's rays pass through the air without imparting to the air additional heat—at least to any appreciable degree—but their effect is to warm the surface of the land, and in this way the air overspreading its surface. The effect of this is to cause the heated air to rise and so to draw in the winds from the Indian Ocean heavily charged with moisture and moving over the lands to the north-east, and forming great masses of cloud which gather over the Ghauts and along the flanks of the Himalayas. The air becomes oppressive, but relief is found in grand displays of electrical phenomena. The rain falls in torrents accompanied by thunder and lightning, imparting verdure to the parched lands and filling the rivers and pools with much needed supplies of water.

This is the character of the "south-west monsoon," but there are sometimes localities where the rainfall is deficient or absent, and here it is that irrigation is so beneficial. The north-east monsoon which occurs during winter is of less importance, and is owing to the higher temperature of the air over the ocean, which results in a reverse direction for the air over the land.

I may add that the Nile receives its periodic supplies from the Abyssinian highlands, mainly through the Atbara, in consequence of the relative positions of land and sea west of the Indian Ocean being similar to those on the east, and the same effects of the sun's heat arise on both.

Colonel HENDLEY said that Mr. Odling and Sir Charles Stevens had both referred to the unhealthy condition of the rice tracts which were irrigated from the canals, but he would like to ask Mr. Odling whether it was not true that the canals themselves in certain districts had not, at least in the past, been responsible for increased unhealthiness owing to their having produced waterlogging of the soil, and if this was the case, whether steps had not now been taken with success to overcome this evil.

I should also have liked, had there been time, to have asked whether the construction of canals in the more arid regions of India had not materially improved the climate especially by leading to increased rainfall. At page 161 reference is made to the pleasure derived by the canal engineer from his friendly intercourse with the people at his tent door. It is such intercourse that encourages loyalty to the Government, but unfortunately frequent transfers, which are the rule in these days, threaten to destroy it. It would be interesting to know whether the irrigation officers are less often moved than those of other departments. Very few names now become household words amongst the peasantry as was the case in the past, when the man who was left long enough in a district to do something for the people was never forgotten. For example, Colonel Dickson, the father of modern irrigation in Ajmere Merwara in Rajputana, who died about the time of the Mutiny, is still spoken of with regard, and a light is, or was, until recently, kept burning at his tomb—in Bewar.

Mr. Odling has dwelt much upon the magnificent triumphs of engineering which many of the great irrigation works are. As an outsider I have greatly admired them. Who can but wonder, for

example, at the canal near Rurki, which runs *under*, *over*, and *through* a river, or at the grand waterways in Orissa and the Sone works. It is not a small thing moreover that the sides of the canals are generally covered with fine trees which, besides being most valuable, add greatly to the beauty of the country.

Mr. ODLING.—The canal districts were at one time very unhealthy, but where they have been drained the health of the districts has greatly improved. In some cases the soil is five inches under the water for a great part of the year. I am, however, bound to say that in those districts where there are natural rice lands they are just as unhealthy as those lands that have been artificially fitted for rice irrigation.

I have one other remark to make, and that is that Mr. Buckley has very properly pointed out that the canal system did not originate with the British Government. In fact it took its start in the time of Alexander; but there were large works in the south of India that have been greatly improved by the British Government.

Sir Charles Stevens mentioned the importance of communication. I rather dwelt on it in the paper. The system of railways has been a good deal developed of late years and will continue to be so.

Mr. Buckley also well stated that while the canals will do something for the people, nothing but their own providence will ensure complete protection from famine.

I take the opportunity of thanking the meeting for the great kindness with which they have received my remarks.

NOTE.

The following returns from the Department of Revenue and Agriculture, give the latest results of irrigation in India.—E. H.

From the Department of Revenue and Agriculture at Calcutta the complete Agricultural Statistics of India for 1897–98 to 1901–02 have been received in two volumes—one for British India, and the other for the Native States. The volumes give details relating to provincial and district areas, crops, live stock, implements, the incidence of land revenue assessment, varieties of tenure, and other subjects. The following table is a complication of the figures relating to crop areas in British India in 1900–01 and 1901–02:—

AGRICULTURAL AREAS IN BRITISH INDIA.

	1900–1.	1902–3.
	Acres.	Acres.
Total	546,114,173	550,315,716
Forests	66,305,506	66,363,530
Not available for cultivation	135,864,477	135,359,092
Cultivable waste	104,727,080	107,525,236
Fallow	42,212,336	42,144,323
Sown with crops	197,115,565	199,710,722
Irrigated	30,056,002	32,619,781
Rice	69,026,273	70,067,328
Wheat...	20,103,024	18,606,958
Other grain crops	92,915,849	88,325,309
Sugar	2,651,379	2,596,592
Coffee	133,529	120,343
Tea	502,173	495,539
Other food crops	6,518,771	6,183,494
Oilseeds	12,913,372	11,967,839
Cotton...	9,609,820	10,301,059
Jute	2,102,236	2,278,330
Other fibres	511,253	564,045
Indigo...	977,349	792,179
Opium...	621,891	607,418
Tobacco	973,441	952,245
Fodder crops	3,022,585	2,944,148

The area of the Native States in 1901–02 is returned at 53,973,702 acres, of which 4,009,956 acres are entered as under forests, 10,743,854 as cultivable waste, 12,457,436 as not available for cultivation, 14,159,772 as sown with crops, and 5,252,525 as fallow. Of the cultivated area, 1,947,400 acres were irrigated in 1901–2, as compared with 1,740,462 acres in the preceding year. There were 801,283 acres under rice, 611,242 under wheat, 10,962,997 under other grain crops, 57,408 under sugar, 125,157 under coffee, 536,104 under other food crops, 892,243 under oilseeds, 420,991 under cotton, 39,082 under other fibres, 8,062 under indigo, 67,797 under opium, 25,522 under tobacco, and 138,861 fodder crops.