Irrigation and Crops.[1]

THE deleterious effect of irrigation on the soil, and therefore on the crops grown when it is not duly balanced by drainage, are described simply and clearly in an important memorandum drawn up by Dr. B. A. Keen, of Rothamsted, for the Empire Marketing Board. The memorandum is the work of an experienced soil physicist, and deals in summary form with the chemical and physical reasons for the accumulation of soluble salts on the surface of the ground, usually but somewhat erroneously described as 'alkali.' Such concentration can, obviously, only take place where there is great evaporation of soil moisture, but little or no rain to wash the salts away, and the parts of the world where these conditions prevail are somewhat clearly defined. Taking the rainfall map as our guide, it can be seen at a glance that the amount of rain falling in the temperate and tropical regions is generally what may be called ample for crop production. But, round about and just outside the tropics of Cancer and Capricorn, belts of little rain or deserts are met with in the Old World, while in the New such tracts are confined more or less to the western sides of the continents. These conditions are due, in the main, to the distribution of the ocean winds and currents. Clear skies are met with in these tracts, which in the local summer are connoted with intense heat and great evaporation of the soil moisture; whereas within the tropics the amount of cloud is much greater, the retarding force of the sun on vegetation is less, and a greater amount of rain falls.

Dr Keen points out that it has been estimated that one-third of the earth's surface receives 10 inches or less of rainfall in the year, while another third has under 20 inches; also, that at least 100 million acres of the world's crops, or 7 per cent., are under irrigation. This latter figure appears to us to be an extremely conservative figure, that is, if 'irrigation' has the usual meaning. For rice alone would probably account for a good deal more than the area named. In India the great bulk of this crop is irrigated, and there are 80 million acres of rice grown, while there are vast tracts in China and the East generally to be added.

It is, however, evident that it is the first-mentioned third that Dr. Keen has in mind while discussing alkali. He enumerates the factors concerned in the development of successful irrigation projects, and divides these into three main classes: economic, engineering, and scientific. The latter he rightly regards as fundamental, although the others may, in practice, easily become limiting; and classes them, roughly, as the composition of the water used for irrigation, and the chemical and physical properties of the soil, these factors being significant, both in schemes newly laid down and in old-established systems.

The chief part of the memorandum is devoted to the discussion of the importance of these scientific factors. Dr. Keen summarises and arranges, in an illuminating manner, the results obtained by the scientific workers on the spot, chiefly Russian and American, as to the causes of alkali and the scientific methods of fighting it. The effect on alkali land, when irrigation is commenced, is then elaborated in some detail. One important result is the chemical change induced in the constitution of the clay particles, that is, those which, though minute, are capable of aggregation into groups by what is called flocculation—which, indeed, is or should be the object of all cultural operations. Here the 'calcium clay' is in danger of being converted into 'sodium clay,' because of the large proportion of this latter element in the soluble surface salts now let loose in the soil. This change renders flocculation difficult, and the soil becomes sticky and unworkable: and, if it is not checked in time, the presence of carbonic dioxide in the soil air induces a further and more dangerous change, namely, the formation of carbonate of soda, which is both toxic to vegetation and destructive of the physical character of the soil.

The tolerance of plants to alkali is briefly described. The crops mentioned are chiefly those of sub-tropical and warm temperate regions; and Dr. Keen quotes Russell, as giving maize the place of high sensitiveness to alkali, with barley and lucerne less so, while the date palm is mentioned as the least sensitive of all crops grown. The corresponding plants in warmer regions are given as sorghum, cotton, rice, and berseem: this correspondence cannot, of course, apply to the order of sensitiveness, which would probably be rice, cotton, berseem, and sorghum, the latter being among the most resistant cereals to alkali.

In a discussion of the dangers of deterioration in irrigated areas, attention is directed to the harmful effect of the change, from basin irrigation in the Nile Valley, with its beneficent summer fallow, or 'sheraqui,' to perennial irrigation, rendered possible by the larger supplies of summer water made available by the erection of the Assouan dam. It is pointed out that the gradual rise in the water table, lowering as it does the root range of the crops, shows once for all the importance of adequate drainage being provided in all new irrigation schemes. Attention is also directed to the tendency towards the application of excessive quantities of water to the crops, when this is left in the hands of the farmers, the example given being the interesting experiments conducted by the Howards on the growth of wheat in the Quetta valley.

Dr. Keen concludes his paper with brief references to the importance of the study of the duty of water for each crop grown under irrigation, with especial reference to the quantity needed at each stage of growth: the maintenance of tilth in irrigated land and its hindrances; and certain cases where alkali is not responsible for cultivation

[1] Irrigation in the Empire. Memorandum and Questionnaire. By Dr. B. A. Keen. (London: Empire Marketing Board, May 1927.)

difficulties. We presume that the troubles attendant on an undue proportion in alluvial lands of silt particles, that is, those too small to be flocculated, would come under this head. This is one of the main difficulties in many alluvial lands in the tropics.

Dr. Keen thus includes only a part, although an important part, because of the costly irrigation projects entered into, of the irrigated areas within the British Empire. This is probably because the Marketing Board has in view other discussions on the remaining portions. But the author has probably purposely limited himself to the rain division mentioned above, and confined himself in India to the rainless Indus plain, thus leaving out the greater part of the Gangetic plain, where alkali conditions have probably been the bugbear of agriculturists almost since prehistoric times. Leaving, then, these narrow limits, some further remarks may be made on alkali conditions found within the tropics, and then on some further lessons which may be learnt from irrigation generally in other lands in the tropics.

Alkali is of much less importance within the tropics, partly for the reasons already mentioned, but also because of slope, and the washing-out effect of the greater volume of rain falling every year. But it is just as liable to present itself, wherever the rainfall is scanty and the evaporation great, as it is in the typical desert regions dealt with by the author. The writer of this article had the interesting experience, during the last seven years of his work in India, of fighting this evil; and growing sugar cane, one of the least resistant of crops, on saline land the irrigation of which was from a series of more or less brackish wells. It would be a mistake to assume that the people of India, with their highly developed systems of agriculture, have made no effort to counter the action of this insidious enemy to crop production. The remedies employed are practically endless, varying from simply scraping away the efflorescence (by which with little labour one-third of the salt concentration may be removed at a time), through palliatives such as carting silt on to the ground in their annual cleaning out of the irrigation tanks, introducing a rotation with some salt-resistant crop, such as irrigated ragi (*Eleusine coracana*) or even growing babul (*Acacia arabica*) for a term of years, and thereby making a profit out of it, or digging in a green manuring crop, to flooding the land when it is possible to do so. Many of these remedies were tested by the writer, with varying results; and ultimately success was obtained by enlarging and using the well which had the sweetest water and using it in sufficient quantity to mitigate the evil effects of its brackishness, green soiling, and introducing a suitable rotation after it, with sorghum immediately before planting the sugar cane.

Irrigation extends throughout the length and breadth of India, and is not owing to any deficiency in the total annual rainfall, but rather to its unequal distribution over the year. This is characteristic of the Old World continental masses, as contrasted with the New, where the rain is more or less equally distributed. India (and many British African colonies) is in the region of periodic rains; there is usually a short period each year when heavy rains fall, this being followed by a longer period of little or no rain. The growth of crops during the rainy season is insufficient to provide food for the great mass of population, and the excess water has thus to be conserved as much as possible for growing additional crops during the rainless period also. This, of course, is more especially the case with crops requiring much water, such as rice, which is grown in six inches of flowing water throughout its growing period, and sugar cane which, in the peninsula at any rate, needs water at frequent intervals throughout the year. The large area under rice has already been referred to, and there are some three million acres of sugar cane grown in India. Alkali is rarely a matter of serious moment in the peninsula, either as regards rice or sugar cane, or the various other crops irrigated; and much the same applies to the great irrigated areas farther east.

The duty of water is known in a rough-and-ready way for most of the crops grown, that is, the small quantity needed at first, the great increases when the roots have developed and the leaves reach their maximum expanse, and the shutting off of water when ripening approaches. But there is a fine field open for scientific study in this matter; for example, along the lines adopted by the Howards, as to whether equally good crops of rice may not be obtained by using less water, and thus extending the area, which is badly needed: most of India is very like a desert when the dry spell has had sway for some time. Much of this irrigation is on undulating land, and full advantage is taken of this: the Indian cultivator, without the aid of instruments, has an uncanny knowledge of the problem of leading the water from field to field in the right direction. There are few of the great flat areas of the reclaimed deserts referred to by the author, and the gradients of rice are surprisingly steep in places.

Attention may be directed, in conclusion, to the work done in recent years in the Hawaiian Islands, where the crop is almost entirely sugar cane, and where the theory and practice of irrigation has been very fully worked out as regards this crop. In three of the four islands of the group where the sugar cane is grown, the great proportion of it is irrigated. There is a plentiful supply of rain brought by the trade winds and falling on the east sides of the islands, but the amount drops practically to desert conditions on the west. This is countered by collecting the surplus rain on the eastern side and carrying it by tunnels through the mountains and by aqueducts across the valleys from one side to the other, until actually more cane is grown on the western side than the eastern. Seepage is countered by lining the channels with reinforced concrete made in slabs on the spot. It was found that the grit in the water seriously abraded the sides of the canals, so a system of settling tanks has been instituted with very satisfactory results. But the most remarkable fact is that irrigation has been found to pay, even where the rainfall is heavy enough to grow luxuriant crops of cane. This can only mean that the duty of water has been very carefully worked out.

Such, indeed, is the case. Every estate is mapped out with contour lines, and a whole series of canals, ditches, and so on, is drawn on these plans; and the amount of water given to each field or section is frequently measured, and recorded throughout the growth of the canes. Numerous curves are prepared, on which a great deal of information is presented. One of the most remarkable of these is the curve of *profitable* irrigation which can be applied for each month of the twenty-four during which the cane is in the ground. Few countries can follow Hawaii in the vast expense involved in its irrigation system, but many useful suggestions would doubtless be obtained from a careful study of the work done in this group of islands by all interested in the duty of water. The difficulty, mentioned by Dr. Keen, as experienced in cultivation because of the irrigation channels, lastly, is got over in various ways: by the obvious one, of using elongated plots as units; by movable pipes for the last distribution of water; and even by the use of overhead water sprinklers, also removable, in place of irrigation furrows.

C. A. B.

The Future of the Smithsonian Institution, Washington.

MEN of science in Great Britain had regretfully known for some time, through correspondence with friends in the United States, and by sundry opportunities of personal intercourse and discussion, that all was not well with the Smithsonian Institution in respect of its future scope and activities—that, notwithstanding the achievements of the past eighty years (it received its charter in 1846), perplexing uncertainties had now arisen regarding the specific objects which the organisation should direct and control. The Smithsonian is, in fact, at the cross-roads of endeavour, largely due to the very magnitude and completeness of its early conceptions.

Aware, in fullest measure, of their onerous responsibilities, the Chancellor of the Institution, Chief Justice Taft, and his colleagues on the Board of Regents, decided to summon a conference of representative American citizens, professional and lay, "To advise with reference to the future policy and field of service of the Smithsonian Institution." This conference took place at Washington on Feb. 11 last. Only three days earlier the death had occurred of Dr. C. D. Walcott, who had been Secretary of the Institution since 1907. From the report of the proceedings, which is now available, it is evident that the problem set, in chief, the provision of adequate funds for maintenance and continued development, received sympathetic recognition. Among those present were such well-known men as Dr. W. W. Campbell, President of the University of California; Mr. Robert W. Bingham (Kentucky); Mr. Charles F. Brush (Ohio); Dr. Simon Flexner, Director of the Rockefeller Institute for Medical Research; Mr. Robert P. Lamont (Illinois); Dr. Merriam, president of the Carnegie Institution; Mr. Ogden L. Mills (New York); Dr. H. F. Osborn; Dr. S. W. Stratton, president of the Massachusetts Institute of Technology; Dr. George E. Vincent, president of the Rockefeller Foundation; Dr. W. H. Welch, of Johns Hopkins University; and Mr. Robert Winsor (Massachusetts).

The Smithsonian Institution is everywhere such an accepted factor in the world of science that few, perhaps, are immediately prepared to recall its initial testamentary story, or the genesis of the foundation which perpetuates the name Smithson.

James Smithson was an Englishman. In his earlier years he was known as James Lewis Macie, his mother being the widow of James Macie, a country gentleman, who had resided near Bath. Born in 1765, young Macie was in due course entered at Pembroke College, Oxford, as a gentleman commoner, graduating there in 1786. Chancellor Taft, in his opening address to the recent Conference, recalls, neglecting needless reticence, that Macie was the natural son of that Hugh Smithson who, from the baronetcy of the realm, became the first Duke of Northumberland. At Oxford, Macie showed a marked predilection for scientific studies, and, as Dr. R. T. Gunther has recently pointed out (NATURE, April 2, p. 492), opportunities for such pursuits actually existed at Oxford at the period of his entry. Finally, in digression, the bar sinister on Macie's escutcheon was met, after his father's death—the precise date is unknown—by a successful application to the Crown to assume the name of Smithson.

Our Royal Society elected Macie a fellow on April 19, 1787, when twenty-two years old, and on the subjoined certificate: "James Lewis Macie, Esq., M.A., late of Pembroke College, Oxford, and now of John Street, Golden Square, a gentleman well versed in various branches of Natural Philosophy, and particularly in Chymistry and Mineralogy, being desirous of becoming a Fellow of the Royal Society, we whose names are hereunto subscribed do, from our personal knowledge of his merit, judge him highly worthy of that honour and likely to become a very useful and valuable member—Richard Kirwan, C. F. Greville, C. Blagden, H. Cavendish, David Pitcairn."

The first scientific paper of the newly elected fellow was read on July 7, 1791, before the Royal Society, and in the name of Macie. It was published in the *Philosophical Transactions*. According to the late Dr. S. P Langley, the name of Smithson is first certainly known to have been used by him in connexion with his second communication to the Royal Society, read on Nov. 18, 1802.