

economical in preventing erosion, and it is suggested that terracing, contour ridging, planting along contour strips alternating with strips left in bush or grass, and the use of a grass-sod of species having a prostrate form through which the crop is planted in shallow holes should, among other methods, form the subject of experiment. No cultivation of temporary crops should be permitted above the 500 feet contour, but the cultivation of orchard crops such as tonka beans, limes, &c, might be allowed between the 500 feet and the 800 feet contour, provided the soil was protected by an adequate grass cover and drains were properly aligned and constructed. Above the 800 feet contour no cultivation of any crop other than cocoa should be permitted, and as much of the land as possible should be allowed to revert to forest. The process of reversion to forest could be accelerated by tending operations such as vinecutting, removal of excess coppice shoots, &c. Whatever form of control of cultivation in the foothills is adopted, there is no doubt that the sooner the control begins the better for the welfare of the Colony.

Acknowledgment. The writer wishes to acknowledge the help and encouragement given by Professor Hardy, who suggested the writing of this paper, and to express his thanks to Mr. E. J. Wortley, Director of Agriculture, and Mr. R. L. Brooks, Conservator of Forests, who kindly criticised the paper during its preparation, (*Tropical Agriculture*, Vol. XVI No. 10, pp. 230—232).

The Rape of the Earth.

A WORLD SURVEY OF SOIL EROSION.

By G. V. Jacks and R. O. Whyte, London, Faber and Faber Ltd., 1939. pp. 301

and Index, with 47 photographic reproductions. Price 21s.

(Review P. H. in *Tropical Agriculture* Vol. XVI No. 10. P. 223—225.)

In the opening chapter of this book, Mr. G. V. Jacks, the Deputy Director of the Imperial Bureau of Soil Science at the Rothamsted Agricultural Experimental Station, England, gives a very readable account of the modern aspects of soil erosion, in which he particularly stresses the broad economic relationships of the problems of land maintenance. "As the result solely of human mismanagement, the soils upon which men have attempted to found new civilizations are disappearing, washed away by water and blown away by wind...Already...nearly a million square miles of new desert have been formed, and a far larger area is approaching desert conditions". Despite the invention of efficient agricultural implements, the introduction of better varieties of crops, and the increased use of manures, the average output of the land per unit area taken the world over, is rapidly diminishing: this is mainly attributed to the ravages of soil erosion which "is altering the course of world history more radically than any war or revolution". Nevertheless, soil erosion is a beneficent process without which the world would long ago have died, being Nature's way of discarding its old worn-out skin and renewing its living sheath of soil from the dead rock beneath. In Nature, it takes place slowly, so that equilibrium is always maintained between soil removal and soil formation under particular conditions of climate. *It is the great acceleration of erosion through human mismanagement that has changed the process into "one of the most vicious and destructive forces that have ever been released by man"*. Deforestation, the destruction of natural herbage by over-grazing and excessive cultivation may so hasten soil removal that fertile land, taking centuries to form, may be entirely lost within a year or even a few days.

Until recently, soil erosion was regarded merely as a local matter, but it is now recognised as "a contagious disease, spreading destruction far and wide",

and affecting almost every contagious disease, soil erosion is most easily checked in its early stages: when it begins to threaten an entire social structure, its control becomes very difficult, though at this advanced stage it may have assumed such serious and spectacular proportions that eventually whole nations, have been roused to exert supreme efforts to combat the menace to their economic security. Thus, in the United States of North America, soil erosion has become a dominant factor in national life and here the greatest attention is now being paid to solution of its many problems.

It is a peculiar circumstance that the systematic intensive cultivation of soils, successfully evolved in Western Europe where modern civilization had its birthplace, has proved elsewhere to be unsuitable as a basis of economic development. No sooner has European civilization been established in a new country than soil erosion, the invariable destroyer of past civilizations, has set in with usual disastrous results. The probable reason for European immunity to soil erosion lies in the fact that the system of cultivation that was evolved in Western Europe is particularly adapted to the prevailing climatic conditions; it has been the aim there always to maintain soil fertility, and, if possible, to augment it since the profits gained usually vary in direct proportion to the amount of labour put into the land. In other regions, notably the New World, circumstances have been entirely different; profits have been made mainly by exploiting virgin soils, notably prairie grass lands. Such treatment rapidly exhausts even the most fertile soils, which soon become eroded beyond repair, a result attributable to the "general maladjustment of land-utilization practices to the natural environment" since man has not yet proved himself capable of modifying European agricultural systems to suit the new climatic and economic conditions.

Loss of soil fertility is generally accompanied by loss in soil stability, caused primarily by the removal of protective natural vegetation. This deterioration in physical properties is the invariable precursor of erosion, and is manifest chiefly in a reduction of water-holding capacity favouring run-off rather than downward percolation and storage of rain-water. The deterioration is progressive and soil erosion in consequence becomes more and more devastating until finally deep gullies dissect the once fertile fields and recurrent floods overflow the country. "The consequences of erosion by water may be summed up as the localized reduction of productive capacity due to direct losses of soil and of soil moisture, and the general dis-organization of whole regions resulting from the cumulative dislocation of the natural water regime".

Wind erosion though less widespread differs but little from water erosion in its ultimate effects, and, like it, "upsets the equilibrium existing between "the life and the climate of a region". Together they have "made a knowledge of the underlying principle of human ecology one of the most urgent needs of mankind"; ".....unprecedented land wastage.....has set us, with our vast powers, a task that can profitably occupy the surplus human energy released.....by the advance of science". "New outlooks, new aims and new knowledge will be required before the earth is again fit to rear.....another civilization".

These few quotations from the introductory chapter amply indicate the outlook of the authors of this long-needed book. The chapters immediately following are devoted to the presentation of facts concerning different geographical regions that serve as illustrations to the general theme. In Chapters II to V, Europe and the Mediterranean Region, North and South America, Africa, Australia and New Zealand are considered in detail by Mr. R. O. Whyte, Deputy Director, Imperial Bureau of Pastures and Forage Crops, Welsh Plant Breeding Station, Aberystwyth, while India, China and Japan are dealt with by Mr. Jacks in Chapter VII.

The chapter following (Chapter VII), by Mr. Jacks, discusses the influence of soil on erosion, and attempts to define such terms as "erodibility" and "soil structure". It is here pointed out that "The more favourable the natural external conditions (climate, slope, vegetation) are to erosion the more erosion-resistant the soil itself will become", an axiom which is well illustrated by the characteristic occurrence in the wet tropics of non-plastic, crumb-structured red earths which are known to be little affected by erosion.

The principles of soil conservation are next considered briefly (Chapter VIII G. V. Jacks), with special reference to the now well-known methods of terracing, contour-forming, strip cropping, and damming for flood control in river valleys. The reclamation of gullies and the value of grass and of trees in soil conservation schemes are discussed in four more chapters, and dunes and deserts form the topic of Chapter XIII, all by Mr. Whyte, while some special aspects of conservation (flood control, Chapter XIV; road construction, Chapter XV; and wild-life preservation, Chapter XVI) are next considered by the same author.

The social consequences of unchecked soil erosion must necessarily be profound, since they arise from the maladjustment of agricultural communities to their environments. Maintenance and restoration of land fertility often involve an alteration of the conditions of land tenure. Two main sociological problems are outlined and discussed by Mr. Jacks (Chapter XVIII) in this connection; the first concerns semi-arid grasslands; the second problem, and the more difficult one, concerns the tropics, exemplified particularly by East Africa. In the first example, people of European stock who occupied *semi-arid grasslands* easily accommodated themselves to their environment and usually assimilated the native races. Their struggles and progress in Russia and in North America are related in Chapter XIX, where the varying degrees of economic success of different political systems (capitalism, collectivism, socialism) are fully described. In the second example, Europeans who colonized *tropical Africa* exercised little caution, believing that the luxuriant vegetation, which is so characteristic of most parts of the tropics, indicated potentially rich soil that could be directly exploited without fear of deterioration. The fallacy of this assumption has been increasingly recognised in recent years, for the rapid onset of soil erosion has made the European settlers and administrations fully alive to the impending disaster. Moreover, the colonists have not been able to assimilate the native populations which subsequently became segregated in reserves where they now practise a mixture of traditional shifting cultivation and modern agriculture highly conducive to soil erosion. The development and ecological results of this relationship in tropical Africa, are clearly described by Mr. Jacks in Chapter XX, comprising one of the most illuminating sections of the book, "Only exceptionally is the white man or the black man the dominant species in a tropical environment ... (In Africa), shifting cultivation ... was the only system under which (native) races could safely cultivate the tropical forest, and nomadism the only system under which the grassland could be safely pastured... To-day, shifting cultivation, the sign of man's subordination to the vegetation, has become a principal cause of soil exhaustion and erosion in Africa, due to the shortening of the soil's resting period necessitated by increasing populations and the general tendency toward a more settled mode of life since European occupation ... The white man's burden in the future will be to come to terms with the soil and plant world, and it promises to be a heavier burden than coming to terms with the natives". "It seems as though mastery over tropical soils must be secured with the help of the ecologist rather than of the engineer ... the crying need ... is for more biological science". "Human dominance has its allotted period in the biological succession of a region, and we do not know enough about ecology ... to be able to skip the intermediate natural

stages between dominance by forest or savannah and dominance by man". ... " We have to learn not only the appropriate agricultural systems and operations, but also what type of society — tribal, feudal, despotic, democratic or otherwise can co-exist on the soil during its transition from a plant-dominated to a man-dominated type ".

One solution of the African problem is segregation, by means of which native and European agriculture may each develop along distinct lines, but the need for soil conservation promises to be the factor which may decide whether this will be a successful solution, for erosion control requires unified treatment and co-ordinated land-utilization practices within each natural region. It is clear that the success of any scheme for permanent soil conservation in East Africa will depend on adjustments in the system of land tenure. Thus, the communal or tribal system fails where land is limited in extent, because soil exploitation soon results in erosion, but individual land ownership is not much better, since the greater the number of properties there are, " the more difficult it is to secure adequate co-operation between the landholders ". " A system of land tenure analogous to mediaeval feudalism might well develop as a way out of the impasse created by soil erosion and the conflicting demands of the indigenous and exotic races on the land ". The authors suggest, therefore, that " some system which will leave the responsibility for organising and the power to enforce soil conservation in the hands of a few, while the many do the work ", may well be the future basis of land tenure in tropical Africa under European influence.

The political and social consequences of soil erosion in South Africa, having nearly reached catastrophic imminence, are dealt with in a separate chapter (Chapter XXI) by Mr. Jacks, who comes to the conclusion that the best solution of the difficulties might be " the development of some system of land tenure whereby absolute control of all the land is vested in that class of the dominant race which shows itself capable of organizing for the perpetuation of conservative land-utilization", though it is not suggested that such a solution would be socially the most desirable.

In the concluding chapter, Mr. Jacks further discusses the significance of the paradoxical situation that has arisen in the world in which some of the most densely populated lands still have great reserves of fertility, whereas, in the new countries, rich lands have had to be abandoned to desert only a few decades after their settlement. Recovery by means of vast schemes for irrigating the semi-arid plains in Russia and North America may be feasible, and may induce a reversal of migration of populations back to the land. A dense population is the best insurance against erosion; for this reason, no great future is indicated for civilization in the tropics until the native races have reached a relatively advanced stage in social evolution.

In stressing the very important political and social consequences of land deterioration and soil erosion, the authors of this book have opened up the broader humanitarian aspects of agricultural science in world economy which no serious student of agriculture can afford to reject. (*Tropical Agriculture*, Vol. XVI, No. 10, pp. 223—225).