

An Introduction to
TROPICAL
AGRICULTURE

by

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PREFACE

THE late Sir Harold Tempany was engaged for a number of years in compiling material for this book, embodying his wide knowledge and experience of tropical agriculture. It was at his request that I attempt to complete his work and bring the subject-matter up to date. I have been compelled to condense a great deal of his manuscript to make room for new material, but have retained the original concept and approach to the subject. I have been encouraged in my work by the conviction that Sir Harold not only visualised something new in agricultural literature, but was presenting a point of view which should be of great value to students, agricultural officers and administrators in tropical countries.

My work has presented many difficulties with which I should have been unable to contend but for assistance from a number of scientists. Mr. D. Rhind, O.B.E., read the early revised drafts and made many valuable suggestions and corrections; he also brought up to date the chapter on agricultural research. Dr. G. Watts Padwick has given me generously the benefit of his wide knowledge of tropical agriculture and I am most grateful for his kindly advice and encouragement, particularly during the final stages of revision. A number of other scientists have been so good as to read my revised drafts of chapters on which they possess expert knowledge, including Mr. D. S. Ferguson of Sir Bruce White, Wolfe Barry and Partners, on irrigation and drainage, Dr. S. P. Wiltshire of the Commonwealth Mycological Institute on pests and diseases, Mr. Marshall of the Colonial Office on animal husbandry, Mr. G. V. S. Harford, Dr. E. A. Parkin, Mr. T. A. Oxley and their colleagues in the Department of Scientific and Industrial Research on storage of crop products, while Mr. Surridge read Sir Harold's draft of the chapter on land tenure and uses and made suggestions thereon. I am particularly grateful to Dr. H. Greene of the Rothamsted Experimental Station who contributed the chapter on tropical soils and provided the

illustrations for this chapter. In recording my gratitude to those who have given me of their time and the benefit of their knowledge, I am conscious of the fact that they render this service as a tribute to the memory of Sir Harold Tempany. It is also in this spirit that I have tried to complete the work initiated by my former chief.

D.H.G.

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(Photograph: H. Greene)

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(Photograph: H. Greene)

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(Photograph: H. Greene)

- V. Sudan: the Gezira south of Khartoum. Between the Blue and White Niles there is a former flood plain of which the upper part is a brown, moderately alkaline, moderately saline, moderately calcareous clay which is sticky when wet but cracks deeply in the dry season. Such soils have been called black cotton soils. The Gezira soil has been described as a takyrs type of solonchak. The canalised area gives valuable crops of cotton, grain and forage. See Tothill, J. D., 1948. *Agriculture in the Sudan*.

(Photograph: F. C. Bawden)

INTRODUCTION

A WIDE range of crops is grown in the tropics which cannot be produced elsewhere. It was the demand for such products rather than the quest for gold and treasure which inspired the voyages of early navigators and which led them to establish trading posts and plantation industries in many countries. With the passage of time the demand for tropical agricultural products greatly expanded and is still increasing.

While in many tropical countries there are important mineral and forest resources and also great possibilities for industrial development, progress and prosperity in most regions is bound up with the development and improvement of agriculture.

There is no foundation for the belief, formerly so widely current, in the high and inexhaustible fertility of tropical soils. It is true that cultivation standards are high and yields consequently good in a number of plantation industries, but the greater part of tropical production is in the hands of smallholders whose standards are usually primitive and yields low. Living standards are also below the minimum usually accepted in more advanced communities; if these are to be improved there must be a corresponding improvement in crop production, for obviously in countries dependent on agriculture, high standards are incompatible with poor agriculture.

The basic principles underlying agricultural practice are universal, but their application under tropical as compared with temperate conditions is markedly different. In the tropics high temperatures and the amount and incidence of rainfall create conditions not encountered in temperate regions; they determine the characters of soils and influence the choice of agricultural methods and crops grown. The physical configuration of the country and the character of its natural vegetation in conjunction with climatic conditions, endemic diseases and pests of human beings, livestock and crops may exert a preponderating influence on development. Economic and social factors may also play an

important part; the character and density of population will affect supply of manpower; conditions of land tenure, social and even superstitious and religious customs may influence the type of cultivation. Facilities for processing, marketing and transporting crops and for financing agriculture may decisively affect the issue and the provision of agricultural, medical, educational and other social services may also exert a profound influence on agricultural practice.

The sum of these and other, possibly less important, factors determines the pattern of agricultural development; it is therefore important that the incidence and probable effects of each factor be known and assessed before developments are undertaken; failure to do so may be productive of costly failures.

It is proposed to discuss these factors in the following pages rather than to describe the cultivation of individual crops. Details of crop production are given only to illustrate the general theme. Throughout, emphasis is laid on conditions in the British Commonwealth, many of its constituent countries lying within the tropics or sub-tropics. Much information concerning agricultural conditions in these territories is available and has been freely drawn upon. Reference has also been made to conditions and experience in other countries wherever this appeared desirable.

It is hoped that this attempt to provide a logical and coherent account of the background to agriculture in the tropics, showing its main points of divergence from agriculture in other latitudes, may be of value not only to students but also to agricultural officers who sometimes experience difficulty in appreciating conditions in territories other than the one in which they are working.

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I

THE TROPICAL BACKGROUND

I

CLIMATIC AND VEGETATIONAL FACTORS

Temperature—Rainfall and Atmospheric Humidity—Wind—
Humidity—Vernalisation and Photoperiodism—Influence of
Vegetation on Climate—Penetration of Rainfall in the Soil—
Eco-climatic Conditions—General Conclusions

CLIMATIC factors primarily determine the natural vegetational characteristics of a region and hence the type of agriculture that can be practised. The character of the soil also has a powerful influence and is largely determined by climatic conditions since soils derived from identical parent materials may show great divergencies according to whether they have been formed under hot or cold and dry or wet climatic conditions.

The main climatic factors are temperature, rainfall and atmospheric humidity, light intensity and duration. Hildreth and his co-workers (90) have pointed out that temperature determines the regions north and south of the equator in which particular crops can be grown, rainfall and atmospheric humidity determine the distribution of plants within particular temperature zones, while light intensity and the duration of illumination profoundly affect plant behaviour. The incidence of all depends on latitude, distribution of land and water surfaces, altitude, physical configuration of the country and character of natural vegetational cover, although the latter is mainly determined by climate.

TEMPERATURE

The tropics may be roughly defined as the area lying between the latitude $23\frac{1}{2}^{\circ}$ north and $23\frac{1}{2}^{\circ}$ south (i.e. the tropics of Cancer and Capricorn). Within this region, although conditions show very marked variations dependent particularly on the magnitude and incidence of rainfall, the characteristic feature is that at low elevations temperature is uniformly high. Annual and diurnal variations occur, the magnitude of which varies at different points

and increases as the northern and southern boundaries are approached but, at sea level, the temperature rarely falls much below 60°F.

The sub-tropics lie immediately north and south of the tropics; their limits are less exactly defined but are usually taken about 35° north and south of the equator. Sub-tropic summer temperatures may be considerably higher than in the tropics, because of the greater length of summer day and the consequent longer period of sunshine, but they have also a winter season which becomes more pronounced the nearer the limits are approached.

In both the tropics and sub-tropics maximum temperatures show considerable variations; where atmospheric humidities are high, as occurs near the sea or in the vicinity of large open sheets of water, temperatures never rise as high as in places where humidity is lower, and seldom exceed 100°F. Where humidity is low, much higher maximum temperatures occur and shade readings of 130°F. or more have been recorded. This effect is caused by the high specific heat of water which prevents the temperature of sea and inland bodies of water being raised to such high levels as the adjacent land: moreover, high humidity raises the specific heat of the air while, in addition, air with a high moisture content is less pervious to solar radiation and cuts off a higher percentage of it than is the case when humidity is lower. Consequently, extensive water surfaces act as thermal regulators and limit temperature ranges. The effect is well shown in island regions such as the West Indies, in the coastal regions of continental areas such as West and East Africa and also in the vicinity of great inland sheets of water such as Lake Victoria. At Entebbe on the north shore of Lake Victoria, the mean annual daily temperature range is 15.3°F., the mean maximum being 78.6°F. while at Soroti 100 miles north-east and approximately 200 feet lower, the daily range is 22.4°F. and the mean maximum 86.2°F.

Expanses of rain forest can also act as thermal regulators; the perennially moist conditions and the continuous transpiration from their leaves raise atmospheric humidity and give rise to effects similar to those occasioned by sheets of open water. Removal of forest cover may therefore occasion considerable variation in the temperature range.

Temperatures depend on elevation and decline with increase in altitude. The rate of decrease varies with conditions; in equatorial regions it approximates 3° to 4°F. for each 1,000 feet