SYSTEMS OF AGRICULTURE AND THE POSITION OF TROPICAL AGRICULTURE*

PART II

ALTHOUGH we have made a distinction between the methods used to prepare the soil for growing crops and the methods to maintain or restore its fertility, agricultural practice is such that both converge into one. The labour of the farmer for the working of his fields at the same time influences the productivity of the soil and what he does to maintain soil fertility has its influence on the growing crop as well as the method used for the preparation of the fields.

All agricultural activities are founded upon existing ecological conditions and their improvement in relation to the requirements of the crops to be grown. As agriculture is an economic occupation and man's existence is dependent upon its results, it is of utmost importance that the result of his labour should be as favourable as possible.

It is therefore a necessity that the farmer's efforts should be in accordance with ecological conditions; he has to make use of them. It is essential that the plants he grows are adapted to these conditions, that the animals he breeds are adapted to the climate as well as to the food that nature offers them.

But although he has to adapt his business to his ecological surroundings, at the same time he will have to intervene in favour of his crops. As soon as he makes a clearing in a forest or burns the grasses of the steppe, he changes the ecological conditions.

We may say that it is impossible for the farmer to have any influence on the heat factor. He can only adapt the choice of his crops and his labour to it. Only in horticulture this factor may be influenced by man. It is different with the light factor. It is possible within certain limits to change the light conditions of a given place. In a forest light may be intensified by clearing, in an open country it may be lessened by planting shade trees for a lower growing crop. Also the water factor may be changed. It is possible to remove water by draining or to supply it by irrigation.

This modification of one factor has its influence on others. When light is intensified by forest clearing, atmospheric humidity, soil moisture conditions and soil properties are changed at the same time and thereby also natural vegetation, apart from the cultivated plants. When soil is drained its properties may change enormously and under certain conditions the heat factor and atmospheric humidity also. The same may be true of irrigation and to a larger degree when more water is supplied. A desert soil may be changed into a mud pool.

Soil conditions are very apt to undergo alterations, not only by the indirect influence of changing light and humidity conditions, but also by the direct influence of labour, by the crops that are grown and harvested, by the application of humus forming material and chemicals.

It does not often happen that a country devoid of forest growth is changed by planting of trees. In most cases where forest is planted to a large extent it is a question of reafforestation. But this is only practised on soils not suitable for agriculture. In naturally forestless countries the natural conditions prevent forest growth and it is not possible to interfere, with the possible exception of certain small areas.

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We therefore may say that, in general, the farmer does not influence the light factor in open countries. But in forest countries it is different.

It is possible that by clearing a part of the forest while provision is made in regard to drainage, and by working the soil, its properties are changed, but the most characteristic feature is the changing of the light factor. This gives agriculture in forests its own character of which we will speak later.

This forest agriculture is limited to certain parts of the world. It can only occur where forests exist, and forest growth is confined by ecological factors, largely of climatic and geographic origin.

The open countries were originally for the most part covered by forest. The western part of Europe, the eastern States of North America, the lowlands of Java and Bengal, southern China, for example, which are now open, once were forested. By the removal of the forest they have not lost their adaptability to forest growth; it is only the interference of man that prevents them from turning to forest again.

Other large areas of the world are forestless as conditions do not allow of forest growth. They are covered with savannah, steppe, bush, or their vegetation is extremely scarce and we call them desert.

It must be clear that the difference between forest country and deforested country is less than between these and countries that are forestless by nature. The landscape of the second may resemble more that of the last but the ecological character of the last differs much from the others. Ecological conditions permitted forest growth in the first and second and prevented it in the last.

What has been the most important factor involved ? In some places it has been temperature. In the extreme north and south and at high altitudes in mountain regions it was the low temperature that prevented forest growth. But this same condition also prevents agriculture proper and it is not possible to influence it.

In other places it has been lack of moisture.

Warming says: "no other influence impresses its mark to such a degree upon internal and external structures of the plant as does the amount of water in the air and soil, and no other influence calls forth such great and striking differences in the vegetation as do differences in the supply of water."

It has been demonstrated repeatedly that, to a certain extent in accordance with the nature of the plant, a larger supply of water yields a richer crop.

And so it is not to be wondered at, that the efforts of farmers in regions liable to water shortage are directed in the first place to measures which will ensure moisture conditions as favourable as possible to their crops. It is self-evident that the cultivated plants of these regions are adapted to their ecological conditions. They are therefore not only drought resistant, but as soon as the moisture supply moves from the optimum to too great abundance their growth will be checked and their yield will diminish. Farmers in these regions however have more to fear from moisture shortage than from excess.

Nature seldom traces boundaries; the transition from one region to another is almost always gradual. And so it is not possible to give the exact limits between the country adapted to forest and the regions where conditions are adverse to forest growth. And so too, agriculture from the steppe may invade the forest country as well as forest invading the steppe. The former however is bound to take place more often, as climatic

conditions may change from one period to another. Sometimes a sequence of years makes farming conditions possible in regions which may be extremely arid in other years. But also, extremely dry years may force farmers back from the forest boundary into the forest.

It is a human trait to adhere to the cultivated plants and domesticated animals that form the economic outfit of a farming community. They always followed human tribes on their wanderings. And so too, in invading the forest country the steppe farmer took with him his grain seeds. And so they came to grow under ecological conditions which were different from those in their home country. The humidity factor was different, in some places it was in excess. And here farmers had to adapt their methods to these conditions; they insisted on the cultivation of crops from an arid country in a more humid one and so they had to take care, that no adverse conditions should arise from the larger humidity. They had to get rid of excess of water. Where this was not possible by the topography of the country they did not settle.

It will be clear that in those parts of the forest adapted countries bordering the steppe region, about the same agricultural methods are and were practised as in the dry regions. But where humidity increases the farmer has to provide in a more or less thorough way, artificially arid conditions. It is of course not possible to influence climatic conditions, but by draining the soil it becomes possible to grow crops, which originated in arid countries. Where drainage was not possible the country remained for long uninhabited by farmers. Other factors were necessary to bring these parts of the country into use.

Cultivating the soil of a humid country has a different effect from that in an arid one. The properties of the soil are changed very much more, its fertility is influenced much more strongly. Farming methods must be adapted to these differences.

In the south-eastern part of Asia however conditions differ greatly. The forest country of this part of the world is separated by an enormous mountain barrier from the steppe regions. On the other hand it is the place of origin of a grain which is adapted as well to swamp conditions as to those of dry soil, provided there is sufficient moisture.

Here too forest disappeared and an open country was established in its place. This country has much greater rainfall and humidity than the European forest countries. Even if man had tried to drain the valleys and plains, it would have been impossible in the wet season. But rice, adapted to swamp conditions does not need drainage. And so especially the low regions, exposed to inundations, were sought by farmers to raise their grain crop. And where the topography of the country prevented swamp formation in a natural way, man, by building dams and ditches, made swamps even on terraced hillsides.

There are of course between these rice fields more or less extensive areas which cannot be irrigated. In as far as they too are used for crop raising do they belong to the same farming category as arable fields in western Europe. But more than that in the same region perennials are also grown which, for the most part, require ecological conditions that may be called forestic. So we find in many places of south-eastern Asia three different systems practised often by the same farmer.

But rice culture on land in swamp condition dominates the whole.

In the desert cultivation is not possible if water is not supplied by man. And as of course the quantity of water to be found is very limited, cultivation is also limited to certain relatively small parts of the desert.

It is not only the humidity factor that influences plant growth in the desert, but radiation as well. The great aridity of the soil, the very low atmospheric humidity and the cloudless sky expose plants to an intensive action of light as well as of heat. Differences between day and night temperature are enormous and the dry atmosphere causes a transpiration such as is only to be found here.

Only a limited number of plants are adapted to these extremes, notwithstanding artificial irrigation, of which the date palm is the most useful. It also provides shelter to other plants growing in its shade.

The influence of the desert reaches farther than its own borders. Desert winds may cause desert conditions at large distances, necessitating planting only such plants as are able to withstand them and providing shelter for less hardy ones.

As has already been indicated stock raising finds its place in these agricultural conditions.

Summarising we find the following results:

A.	*Forest Agriculture.*	
	1. Mainly on forest soil.	Livestock restricted to small animals; of not much importance.
	2. Plants requiring forest conditions.	
B.	*Agriculture in arid regions.*	
	1. Stock raising. Cultivation of crops not of much importance.	Livestock the dominant factor.
	2. Dry farming.	Livestock of not much importance.
	3. Irrigated farming.	Livestock of differing importance.
C.	*Agriculture in humid regions on dry soil.*	
	1. Arable farming preponderent.	Livestock not important.
	2. Mixed farming.	Livestock very important.
	3. Pasture farming. Cultivation of plants not important.	Livestock the dominant factor.
D.	*Agriculture in humid regions on irrigated soil.*	
	1. Only rice cultivated.	Livestock of not much importance.
	2. Rice alternating with other crops.	Livestock of more importance.

Each of these systems shapes the farming of the regions and determines its possibilities of development. It is impossible that a country adapted to agriculture of the second type should develop along lines followed by countries of the third or fourth type. Stockdale was therefore right when studying conditions in Sierra Leone and looking for a model by which these could be improved, he turned to those countries where the ecological conditions of farming are approximately the same. The problems of Sierra Leone are not solved by the introduction of new crops only but by the introduction of a system of which these crops may form a part.

But the farming system limits also the possibilities of production of the persons occupied in farming as well as of the land. We should take care not to compare farming types which differ in grade of development, but only those types which are at about the same stage of advancement. It would be wrong to compare results of native herding in East Africa with Japanese rice farming or with grain raising with modern implements on the American plains. But we may compare the last two. And then we see that some systems make possible a very large production per man and that other systems do not give that possibility; and at the same time we see that production per unit of area does not need to run parallel with production per man.

These facts have had and, so far as the structure of a country is built on agriculture, will always have an enormous influence on density of population and distribution of population, and thereby also on the economic and social structure, not only of the farming population but of the whole country.

It is not the kind of crops grown which exercises the main influence, but the system of which they form a part. It is not the wheat that makes the farming community of the American plains take a different shape from that of France, but the system of farming.

It has been the possibilities and limitations of the agricultural systems that have forced nations to take different paths of development in history. Where there were definite limitations nations were forced to look for other means of existence, and where with such limitations the possibilites of developing a highly specialised type were favourable, development of trade accompanied that of farming (Norway, Holland). In countries, however, which possessed possibilities of many kinds rural occupations were always predominant.

Scientific research and the application of its results originated in the countries of western civilisation, where agriculture belonged to the third system. And even here it is only recently that the problems relating to pasture farming have been understood to be different from those of arable or mixed farming. The problems of the second system, of agriculture in arid countries, have not long been the subject of scientific research, the United States taking the lead in it. Still more recent is the investigation of agriculture in forest countries and it is mostly by the interest of European enterprises in the tropics that attention has been drawn to it. The fourth system, however important it may be, is the last to which attention has been paid and that only recently.

It is not to be wondered at that many problems are not yet solved. With regard to the first and the last system we may even say that very much has still to be done to formulate the questions that need research.

There are of course many points common to all these systems, and they are all manifestations of the same kind of business; they all occupy themselves with the production of plants and animals by man for his own benefit.

The principles of the study of plant diseases and pests do not differ from one system to another, and the same is true with regard to animal diseases and to questions of animal and plant breeding. It may be that special adaptations are necessary for studying special diseases or special insects, or that selection methods differ more or less according to the type of plant to be improved, but it is not the agricultural system as such which influences these working methods, but the biological make-up of the individual species.

There is still more conformity between the study of these systems and that of the types of soil.

Agricultural science however is not a mixture of these different branches of knowledge, nor even a synthesis of them. It has its own object; agriculture as it is practised.

Where is now the position of tropical agriculture ?

It will be clear from the foregoing that there is not such a system, differing from others, that could be called a tropical one.

Agriculture in the tropics is not a unit. It is not possible to put into one system the farming of the Sudan, the herding of Kenya, the "ladang" of Malaya, the rice farming of Burmah, the plantation farming of Australasia.

When we study the different forms of farming in the tropics we can only conclude that they too belong to one of the systems mentioned.

These systems do not conform to geological conceptions. The third system, mainly limited to countries inhabited by Europeans, is also practised in the tropics; the second is not limited to North America or Australia but is practised in the African and Indian tropics as well; the last is not limited to the tropics but stretches from the South of Asia along its east coast near to the Vladivostok region of Siberia.

Perhaps we may say that the tropics are richer in agricultural systems than other parts of the world, as ecological conditions offer more divergence.

What then is the reason that agriculture in the tropics is still always considered as something standing apart and having its own character, forming more or less of a unit ?

It seems that two causes may be responsible for it; in the first place the circumstance that science got in touch with agriculture in the tropics mostly on behalf of European interests and in the second place because botanists started the first investigations.

The first contact with agriculture in the tropics was of a purely commercial character, products of native agriculture being brought to Europe and America. The increasing demand for these products caused the traders and the European governments to promote their production. It was botanists who went in search of the plants, who produced the desired products, and the botanic garden took an active part in the distribution of the plants to other tropical countries.

Not much later European enterprises were stated in the tropics to produce the products which till that time were obtained only from the natives. Much capital was invested and they were exploited for a profit. An agricultural enterprise was thus established differing in many respects from the farming business of the European countries of that time.

When difficulties arose in the production process they were mostly caused by plant diseases and insect pests. And so the second contact of science with agriculture in the tropics was of a botanical and entomological character. When first quality soils were no longer easily found soil science stepped in and when competition began to require lowering of the cost of production selection specialists were engaged.

But all this scientific work on agriculture in the tropics had to do only or almost only with that peculiar form that was created by European enterprise. And when tropical agriculture is discussed it is generally this form of agriculture that is meant. This "tropical agriculture" however is only a small part of agriculture in the tropics, it belongs for the most part to the system A, mostly A 2 and only a part of this, as its peculiar organisation differs very much from that of the native A 2 system.

It was not until Colonial Governments began to take an interest in native agriculture and European agronomists were engaged on behalf of this native business that it became clear that native farmers by centuries of experience had developed systems that are in accordance with ecological conditions.

It is not long since native agriculture was still looked upon as backward compared with plantation agriculture and that a solution was thought to be found when native farmers applied the same principles to their business as are applied in European enterprises. In most of the advanced colonial countries this idea has been abandoned. Native agriculture has been recognised as principally right and all experts on this subject agree that it has to be developed along its own lines.

It is therefore, on behalf of the most important branch of agriculture in the tropics, the native one, of utmost importance that the methods and principles of native farming should be studied. These studies should not be of botanical or agro-geological character but should be carried out by agronomists. And as a result of their investigations they will be able to ask for special research on botanical or other lines.

In some Colonial countries the organisation of the Department of Agriculture is based on these principles.