PART I: INTRODUCTION

CHAPTER I

THE HISTORY OF AGRICULTURE

The origin and development of agriculture is of major significance to archaeology, to agricultural science, and to human history. It is an evolutionary phenomenon. It has given rise to new races, both of plants and of animals, at a rate of change that it is very difficult to match anywhere else in the plant or animal kingdoms. Under its influence, man has also undergone rapid social evolution, and though we have very limited means of assessment, there is little doubt that he has enjoyed substantial genetic change also during the period of agricultural activity.

Agriculture was not the first of man's great achievements. As a hunter and food gatherer he had colonised the world very widely before he became a farmer and he had attained a high standard of technology in making and using tools of stone, horn and bone, and doubtless also of more perishable materials of which we now no longer have evidence. The beginnings of agriculture have only recently been identified. The evidence available to us is archaeological, and consists of the refuse of human communities; bones, grinding stones, pottery on which imprints of grain may be found, and remains of stores of grain or dumps of damaged foodstuffs. There seems good reason to suppose that hunters first became herders, exercising increasing control over the animals they used to hunt until they had established flocks and herds that were dependent upon them for protection, and for the provision of, or for guidance to, food and water. Such a change leaves little evidence in the archaeological record. Whether the goat or sheep bones in a midden were those of a wild animal that was hunted, or a domestic animal that was slaughtered, is impossible to determine with certainty. Opinion can only be based upon frequency of occurrence, proportion of the whole sample that belongs to the putative domesticate, and

so on. However, in the later stages the interdependence of the human community and the livestock population becomes evident beyond dispute. The association between man and the wolf/dog species was established by c. 9000 B.C. Goats and/or sheep were closely associated with man by 7000 B.C. at Jericho, and by 6600 B.C. at Jarmo.

'Our present knowledge of the earliest plant husbandry is derived from four sites in the Near East, of about 7500 to 6500 B.C., viz., Ali Kosh [Khusistan, Iran], Beidha [Palestine], Hacilar in west-central Anatolia [Turkey], and Jarmo in northern Iraq.' (Helbaek, 1966.) These sites were occupied by pre-pottery Neolithic people. A similar culture arose in Greece, and Jane Renfrew (1967) has reported on grain recovered from aceramic Neolithic sites there. In both areas the main cereals were Emmer wheat (tetraploid) and hulled two-row barley. The Near East is the area of distribution of the *Hordeum* and *Triticum* species ancestral to these early cultivated cereals, and in the pre-pottery Neolithic cultures of this area we have the very early stages of agricultural development, the adoption and fostering of wild grasses which developed under care and selection into our major cereals.

Though crop production was based on barley and wheat, a range of other plant remains indicates on the one hand the continued importance of food gathering (Helbaek and Renfrew report finds of acorns and pistachio), and on the other the beginnings of domestication of other crop plants (Helbaek and Renfrew report peas, beans, vetches, oats, and lentils). Moreover, Helbaek has deduced from spikelet morphology that the cereals included a range of types from near-wild forms with a brittle rachis to more advanced forms with the tough rachis characteristic of cultivated races.

Having identified a centre of origin of agricultural practice, one naturally enquires whether it was unique. It may well be argued that a much wider area than the Near East was involved in those beginnings. The Nile Valley, Ethiopia, and Iran and Central Asia, all had agriculture at an early date, and the Egyptian records in particular go back to the Neolithic in the Fayum. Nevertheless, the evidence from crop plants and domestic animals is strong that the agriculture of the Old World originated in a rather limited area in the Near East including

upper Iraq, Palestine and Turkey. This is the area in which the wild relatives of wheat and barley are to be found, and also wild relatives of the cultivated legumes and the major species of domestic livestock: sheep, goats and cattle. Moreover, though cattle are not indigenous in Africa, all the oldest agricultural communities on the continent had them, and it must be presumed that they were brought in from the Middle East.

One other area in which agriculture started independently, and apparently within about 2000 years of the same date, was in lowland, semi-arid Mexico. MacNeish (1964) has excavated caves in the Tehuacan valley, and has reconstructed the beginnings of agriculture there about 7000 years ago. In collaboration with agricultural botanists, particularly Mangelsdorf, he was able to identify the wild ancestor of maize, and to trace the development of the cultivated crop plant from it. He also observed the evidence of the beginnings of cultivation of cucurbits, and of species of *Phaseolus* beans.

Both the barley and wheat system and the maize and beans system originated and developed in areas with a rather dry or even semi-arid ecology, where grasses were the natural dominants under an open tree cover. In tropical forest areas there are farming systems based on root crops, and it has been suggested that they may have arisen independently in several places, notably on the borders of the Amazon forests in South America, and in South East Asia. The history of agriculture in such regions is difficult to determine, since organic remains in these wet countries are lost from the archaeological record.

In both areas from which we have good evidence, agriculture developed on a sound nutritional base. In the Near East, calorie supplies from cereals were balanced with protein supplies from cereals and from meat. In Tehuacan, maize provided calories, and beans protein. In both, protein supplies were doubtless supplemented by hunting. The spread of agriculture did not, at least initially, involve any sacrifice of nutritional levels. Even in the early agricultural systems based on roots and tubers, with abundant calorie supplies and low protein, the diet was balanced in many places – in the Amazon and Orinoco valleys, on the Caribbean coasts and the West Indian islands, and in coastal South East Asia – by protein from fish.

Consider now the Old World. Once farming had begun, it

spread out from its Middle East centre. It reached Greece very early. It was established in Italy, Central Europe and Germany by 4000 B.C. and in France, Denmark and the British Isles by the latter part of the fourth millennium B.C. (Clark, 1965). New crops were established, including oats and rye, *Brassicas* and beet; and horses and pigs were domesticated as new needs arose and new opportunities offered. The process went on slowly. Iverson (1941) records that the only cereals grown in Denmark in the Late Stone Age were wheat and barley. Oats and millet (*Panicum miliaceum*) appeared first in the Bronze Age, and rye in the Iron Age.

In Western Europe extensive studies by botanists and archaeologists have elucidated the timing and nature of the arrival of agriculture. Farming could only be practised if land could be cleared of forest (Clark, 1945). Evidence of clearings is found about 3000 B.C. all over Western Europe, in a decline of tree pollen in pollen diagrams from lake deposits, often associated with a fine carbon layer. The decline of tree pollen is followed by an increase in the pollen of such species as *Plantago lanceolata* that are common weeds of arable fields. Iverson (1941) has shown that the Neolithic farmers practised a cut and burn shifting cultivation. The carbon layer was from the burn, and the change in the pollen diagram followed from the destruction of the forest, and, after cropping, the abandonment of the land and the shift to a new area. Neolithic farmers found, as shifting cultivators in Africa find today, that after a few seasons low soil fertility and rampant weed growth compelled the abandonment of the old clearing and the felling of a new area. The close correspondence between current practice in Africa and this reconstruction of Neolithic practice in Europe is of great significance. It establishes shifting cultivation as one of the oldest and most persistent systems of agriculture. More than this, if some Western European soils were originally such that only shifting cultivation could be practised, their improvement to the point where they support the current high productivity of Western European agriculture gives grounds for believing that at least the better African soils may be susceptible to similar fertility amendment.

Clark (1965) has remarked on the comparative tardiness of the spread of Neolithic culture south into the Nile valley – and

thence into the African continent – compared with the early and vigorous invasion of Europe, north of the Mediterranean. This rather later agricultural colonisation gave rise to the establishment of crops and stock of European provenance on the Ethiopian highlands, and the domestication and improvement of the African range of crop plants, including *Sorghum* (dura in the Sudan; jowar in India), *Pennisetum* (bulrush, or pearl, millet; bajra in India), *Eleusine* (finger millet; ragi in India), *Dolichos lablab* (beans), *Vigna* (cow peas), and *Dioscorea* (yams). The consequences of this for agricultural botany were recognised by Vavilov, in his designation of Ethiopia as a secondary centre of diversity for many of the Middle Eastern crop plants. For the African crops on the other hand, Africa was recognised as the primary centre.

The south eastwards spread of agriculture brought farming peoples into the Indian sub-continent. Archaeological data are limited at present and further excavation is expected to lead to substantial increases in knowledge. The information now available is summarised by Allchin (1969) and by Vishnu-Mittre (1968). Excavations in Baluchistan have revealed an early agriculture, based on wheat, dated as late fourth millennium B.C. In the north west of the Indian sub-continent (West Pakistan, Kashmir, Punjab, Sind and Rajasthan), the people of the Harappan civilisation (2300–1750 B.C.) practised farming based on wheat, barley and peas of Middle Eastern origin, and sesamum and cotton of local domestication. The extension of farming beyond the Indus valley depended substantially on the addition of new crops to those brought in from the Middle East. Rice first appears in Gujarat in Harappan times. Vishnu-Mittre records *Sorghum* (jowar) from Sind, and *Pennisetum typhoides* (bajra) from Gujarat, also in Harappan times. These cereals are of African origin. They must have been introduced, and there must have been a farming community beyond the Nile valley early enough to have domesticated them and to have passed them on to the Harappan culture.

An agriculture equipped with such a diversity of crop plants, from the Middle East and Africa as well as indigenous, can hardly have been the earliest in the region. Moreover the fragment of cotton textile found at Mohenjo-Daro and examined by Gulati and Turner (1928) was the product of a sophisticated

textile craft. Evidently, farming cultures earlier than the Harappan are still to be discovered.

It was rice that made possible the colonisation of the wet lands, and the African cereals, *Sorghum* (jowar), *Pennisetum* (bajra) and *Eleusine* (ragi) that led to the establishment of farming on the rainfed lands of the peninsula. In the post-Harappan (Chalcolithic) age (1750–1000 B.C.) rice spread widely. The third African cereal, *Eleusine* (ragi), appeared, together with lentils and linseed from the Middle East and the indigenous species of *Phaseolus* and *Dolichos* (pulses). The sites from which agricultural remains of this period have been recovered extend as far south in the peninsula as Mysore.

In livestock also, India added substantially to the list of domesticates. Sheep, goats and cattle may have come in with the earliest farmers, but the zebu was domesticated in India from native wild stock, as was also the buffalo. And by 2000 B.C. India had domesticated the jungle fowl, to give the ancestors of the modern hen.

Spread in the New World was necessarily north and south. It gave rise quite early to the South American cultures on the west coast and on the Andes. Their importance lies mainly in the substantial additions to the list of crop plants that were made in South America, the tomato, the Lima bean, the groundnut and the New World cottons, and also the high altitude group of crops including *Chenopodium*, potato, *Oxalis*, *Tropaeolum* and ulluca. From South America also came the guinea pig and the domesticated cameloids. It is worth noting that America north of the original centre of agriculture has added nothing except perhaps the turkey to the repertoire of crops and stock.

The practice of agriculture released the human population from a very strict limitation on its numbers. In the New World, MacNeish (1962, 1964) has estimated the population in the Tehuacan valley at successive stages in its cultural development. As hunting and food gathering bands, there was subsistence for only a very few, widely scattered family groups. They occupied large territories over which they roamed according to season and to consequent supplies of food and water. With the beginnings of farming, greater production, storage of food, and the elimination of the need for nomadic wandering, made

population increase possible. The small family bands became small communities. As they expanded they met other like communities, and MacNeish gives reasons for suggesting that different bands having domesticated different plants, the range of cultivated cucurbits and legumes arose from the exchange of their separate domestications between groups. Irrigation early added yet another major resource to the community, and the development of crafts became possible with the enhanced food supply. Over 8000 years MacNeish estimates that the carrying capacity of the Tehuacan valley increased about 5000 fold. Thus agriculture made possible the emergence of large human communities in place of the scattered hunting bands of the palaeolithic. The production of more food with less effort released some people to specialise in crafts and services, and gave rise for the first time to groups that did not grow their own food. These were the beginnings of towns.

The spread of agriculture over the world led to the establishment of farming communities in very diverse circumstances and the subsequent history of agriculture is in fact the history of local adaptation and of progress stimulated or inhibited according to local circumstances. Nevertheless there is throughout a common thread, which is the interaction between farming on the one hand and crafts, industries and services on the other. The demand of urban communities for food and for industrial crops has been the great stimulus to agricultural innovation, and agriculture has been equipped for high production with the products of urban crafts and industries. The relationship between rural and urban occupations is one of complementation and mutual stimulus.

One of the great episodes in British agricultural history was the agricultural revolution that is called the New Husbandry. On the farms of eastern England, consolidated by the enclosures, a group of far-sighted landlords and farmers initiated in the latter part of the 18th century a new system of crop husbandry, linked with a much intensified system of stock keeping. The intensification of the crop rotation and the improvement in both feeding and breeding of livestock were but a part of the New Husbandry. An essential feature of the system was the careful conservation of the elements of fertility by folding sheep on the land and by wintering cattle in yards and distributing the manure

on the fields. The New Husbandry was developed under the stimulus of the Industrial Revolution, with its growing urban population, increasing in wealth, and demanding larger and better supplies of food. Moreover, as farming and industry developed, the manufacture of implements and machinery contributed industrial resources to the advancement of farming.

Recent agricultural history can only be studied in terms of the relation between farming and the urban markets which it supplies. In the advanced, high productivity agriculture of Western Europe and North America is to be seen the integration of productive farming with productive industry, with the greatest development of the use of industrial inputs to gain high farm output. By contrast, the low yield agriculture of most of Asia is geared to static and tradition-bound urban communities which contribute only the traditional inputs of a static and exploitive agriculture. Only where modern industrialisation has gone on, and where modern medicine has cut down death rates and given rise to a population explosion, has there arisen the stimulus of changing and increasing urban demand. There, after an initial delay that raised serious problems in food supply, agriculture is responding with increased productivity. In great areas of the world, however, there are still communities that are only one step ahead of self sufficient subsistence. These are countries with poor land, small populations, and only the beginnings of urban development. They have advanced initially by producing crops that could be sold in the markets of the world's industrial countries, and they have had in exchange the infrastructure of development: law and order, education, transport systems, and a limited supply of consumer goods.

In the advanced countries all the major establishment costs of agriculture have been met and written off. The land has been cleared and levelled, water control undertaken by drainage or by irrigation, and a sound system of soil management set up. It has been calculated that in Britain, if bare land were taken and capitalised with roads and buildings, at current farm incomes the investment would only pay if the land cost nothing. This amortised capital is a great advantage. The emerging countries have only gone part way along the same line. In opening new land, and in developing old land to higher standards of produc-

tivity, this basic capital has to be found, put in, and written off in due course.

The beginning of modern agriculture in Britain was the establishment of conservation by the closing of the fertility cycle, and returning to the land those elements of fertility that are removed in cropping and may be returned as human and animal wastes. The first step in agricultural advance in any developing country is the establishment of the principle of conservation. This includes conservation of soil, of water, and of nutrients. Fertility levels are stabilised in various ways. In shifting cultivation with a sparse population, fertility decline under cultivation is balanced by regeneration under bush or forest, provided that the period of regeneration is long enough. Under ancient farming systems with a dense population, the tendency is for land to be degraded to a basic fertility level, where losses are balanced by gains from casual return of wastes to the land, from the decay of parent rocks, and from biological fixation of nitrogen. Under such circumstances there may arise forms of fertility transfer, as in the concentration of fertility round Indian villages. This is what happens on the better and more stable lands. On less stable land, there may be no end to degradation, with 'bad lands', gullied and almost impassable, or rock surfaces left behind and the human population gone. Stopping this kind of accelerated soil deterioration is not unduly difficult. The next consideration is to hold the water on the land long enough to allow adequate percolation into the soil. Water conservation is a major contribution to stability. It may indeed alter the situation out of all knowledge, as for instance in northern Nigeria where water control made worthwhile pest control and the application of fertilisers and manure (Lawes, 1968).

Conservation of the elements of fertility follows. Composting of all available organic wastes was advocated by Howard at Indore in India in the early 1930s, but it was never adopted in Indian farming practice. In current thinking there is a strong tendency to pass over the conservation stage in the amelioration of tropical soils and go straight to the stage of improvement by fertilisers. Improvement by chemical fertilisers pre-supposes soil in good structural condition to begin with. In drawing on temperate region experience, insufficient allowance has been made in the assessment of the advances gained from fertilisers,

for the sound state of the soils to which they have been applied. The change in Norfolk farming, for instance, in the 1920s and 1930s (see Rayns, 1961) was mounted on the soil conditions built up by more than a century of conservation of the elements of fertility under the principles of the 'New Husbandry' established by the Norfolk improvers. In the developing countries this conservation period has not been experienced, and in attempting to get from an exploitive to an improving agricultural system in one stride, the conservation of organic matter must not be overlooked.

Fertility improvement depends on the maintenance of a balance both between fertiliser elements, and between fertilisers and crop varieties. When in 1916 Biffen at Cambridge released Yeoman, the first of the high yielding wheats, its success was limited by the limited amounts of land of high enough fertility to exploit its merits. Now that high fertility levels have been established in Britain, their exploitation depends on the strains of crop plants of high yield potential, that have been bred in recent years. History repeats itself. In India the new wheats, like Biffen's Yeoman, only yield as they should on highly fertile soil and with high fertiliser application. The historical record is clear. High fertility levels and high yield potential must go together, and the plant breeder and the agronomist have always been partners in the improvement of productivity.

In the long history of advancing productivity in British farming, the improvement of livestock has gone on in parallel with the improvement of crops. Stock and crops were integrated in a single farming system, partly because livestock – first oxen and then horses – were the source of power on the farm, and partly because the system involved the use of grazing, both of waste land and of sown crops, for the production of meat or dairy produce. The integration served also the purpose of fertility conservation, since much of the fertility taken from the soil was returned as manure.

In modern times the replacement of horses by tractors as a source of power, and the advocacy of specialisation on economic grounds have led to the abandonment of mixed farming on many farms. The simplicity of a system in which a farm is organised for crops only, and the advantages to a farmer seeking to equip his farm with a limited outlay of capital, are attractive.