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The working agroscape of the Iron Age

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This paper represents an assay into the vexed area of prehistoric and in particular Iron Age agriculture, taking as a premise that farming, in fact, comprises fields, fences and faeces and that settlement is a function of farming rather than the reverse.[1] Necessarily, because the treatment within the confines of this paper is brief when viewed within the overall context of the chosen subject, many of the points will not be as fully developed or supported documentarily as would be the case in a more extended presentation. Consequently this is offered rather more as a polemic than a statement and is designed to provoke argument rather than agreement. The majority of the experimental data from which the arguments are raised is drawn from the current research programmes at the Butser Ancient Farm Research Project, Hampshire. The purpose and methodology employed at the Ancient Farm are fully reported elsewhere (Reynolds 1977; 1979); suffice to state here that it is, in fact, a unique outdoor laboratory devoted primarily to research into prehistoric archaeology and agriculture. The objectives of the research programmes are to invalidate or confirm by empirical testing the hypotheses and theories raised from excavated evidence. Emphasis is firmly placed upon the Iron Age period, although investigations into other periods are occasionally carried out (Reynolds 1978a; Reynolds & Langley 1979). At the outset it is extremely important to stress that the experiments as carried out at the Farm and as severally reported here are designed to test only those areas which can be subjected to testing within a scientific framework. There is no attempt whatsoever to recreate an Iron Age way of life. Indeed the major intention of all the experiments is to remove as far as possible the inherently variable human factor since the data, if they are to have any validity whatsoever, must be comparable from repeated experiments and not unique. The ultimate intention with the Farm, of course, is to be able in the future to construct, from all the data achieved over at least two decades, all the interactive elements of an agricultural cycle and thus to provide a valid and comprehensible basis for a deeper understanding of the prehistoric economy. It is, of course, integral within the intention that all the widely divergent bioclimatic zones as utilised in prehistory should be subjected to the same developed approach as that now in train. At present the *caveat* which must preface any data provided by the Ancient Farm is that those data are relevant to the chalk lands and adjacent soils of central southern England unless otherwise specified.

In this paper the basic cycle of ploughing, planting, crop maintenance and harvesting is presented as carried out at the Ancient Farm. There is, however, little point in reiterating a mass of basic data concerning the field and excavated evidence, so in the present context those quoted are given as examples only.

I PRIMARY SOURCES

The primary sources for agriculture during the Iron Age can be broadly placed in four categories: Celtic, or the more sensible term ancient, fields and so-called ard marks or scores carved into the subsoil; actual remains of ards and iconographic rock carvings; carbonised seed and seed impressions fired into pottery; and finally the evidence derived from pollen grains. There are, in addition, occasional references made by the classical authors to agriculture as practised in northern Europe and Britain. In the case of such references it is important to evaluate each statement both in terms of the writer and the purpose of the text, and in the detail of the observation in so far as it may or may not diverge from the classical system of farming. For example, comments upon known and recognised systems of husbandry are generally not to be expected, whereas any seeming anomaly is likely to excite interest and, therefore, comment. Analysis is necessary, nonetheless, since very few commentators necessarily understood what they saw or recorded. The wide gulf between actual practice and reporting of practice is apparent throughout all periods of history and abundantly obvious in the present day; it is unlikely that reports of two millenia ago were any more valid than those of today.

A. PREHISTORIC PLOUGHS

Ard marks have been isolated on a large number of widely divergent sites both in the United Kingdom and Europe. That they are prehistoric marks is simply attested by the superimposed layers of identifiable date. Generally they comprise interrupted scores in the subsoil, occasionally unidirectional, occasionally sets of scores at right angles to each other, and more infrequently one or more sets diagonally opposed to others. At the outset it is quite remarkable that such marks have survived at all if they formed part of a regular agricultural activity, in that the repeated cultivation of a field with a standard plough would lead to a thorough stirring up of the soil to a consistent depth. The problem here is the assumption that a 'standard plough' would have been used. Ard marks have been identified as early as the Neolithic period, for example, at the South Street Long Barrow, Avebury, where cross ploughing had apparently taken place prior to the creation of the barrow (Ashbee, Smith & Evans 1979, pp. 282–3). Subsequent to an early survey of cross plough marks identified as belonging to the prehistoric and Roman periods (Fowler & Evans 1967), ard marks have been identified not only on chalk and sand subsoils but over the full range of soil types, including the heavy clays, for example, in Northumberland (Gillam, Harrison & Newman 1973, pp. 84–5) and near Bristol on the rheatic clay (Everton & Fowler 1978). Throughout it has been assumed that these ard marks were made by the prehistoric-type ard, the prime evidence for which has come from peat bogs in Denmark. An admirable survey of these has been published (Glob 1951) and several sets of experiments to replicate individual types have been carried out with a variety of results (Aberg & Bowen 1960; Hansen 1969; Reynolds 1966, pp. 61–3), but only Hansen (1969) has partially demonstrated that such an ard, in this case the Hendriksmose ard, could create ard marks similar to the prehistoric examples in sandy subsoil. There is an element of doubt, however, in that only when the topsoil had been removed could the ard cope with the soil structure to produce what, in effect, proved to be non-comparable marks.

Recent work at the Ancient Farm has concentrated upon the Donneruplund ard (Pl. I; Glob 1951). In contrast to problems of traction experienced in earlier experimental work, the plough team, a pair of Dexter cattle which are the nearest modern equivalent to the extinct Celtic shorthorn (*Bos taurus*), has been fully trained over a long period. The choice of the Donneruplund ard as a type was influenced by the discovery in Scotland of a similar beam in Loch Maben (Fenton 1968, p. 150) and of an under share in the Milton Loch Crannog (Piggott 1952–3, pp. 143–4). It shares the characteristics of the Hendriksmose/Dostrup ard types although differing in specific details. The results from the experimental work on two sites, the Ancient Farm itself where the soil, a friable redzina averaging *c.* 10 cm in thickness directly on middle chalk, and the Demonstration Area, with a hill-wash soil *c.* 30 cm deep over chalk, indicate that such an ard, while admirable in producing a tilth suitable for planting crops, does not create any kind of mark in the subsoil. In the former case it simply ripped up the surface of the chalk rock, already subjected to frost action, and left no discernible trace. In the latter, since its consistent penetration at maximum efficiency is only *c.* 15–20 cm, it does not penetrate deeply enough to leave any abiding traces (Fig. 1).

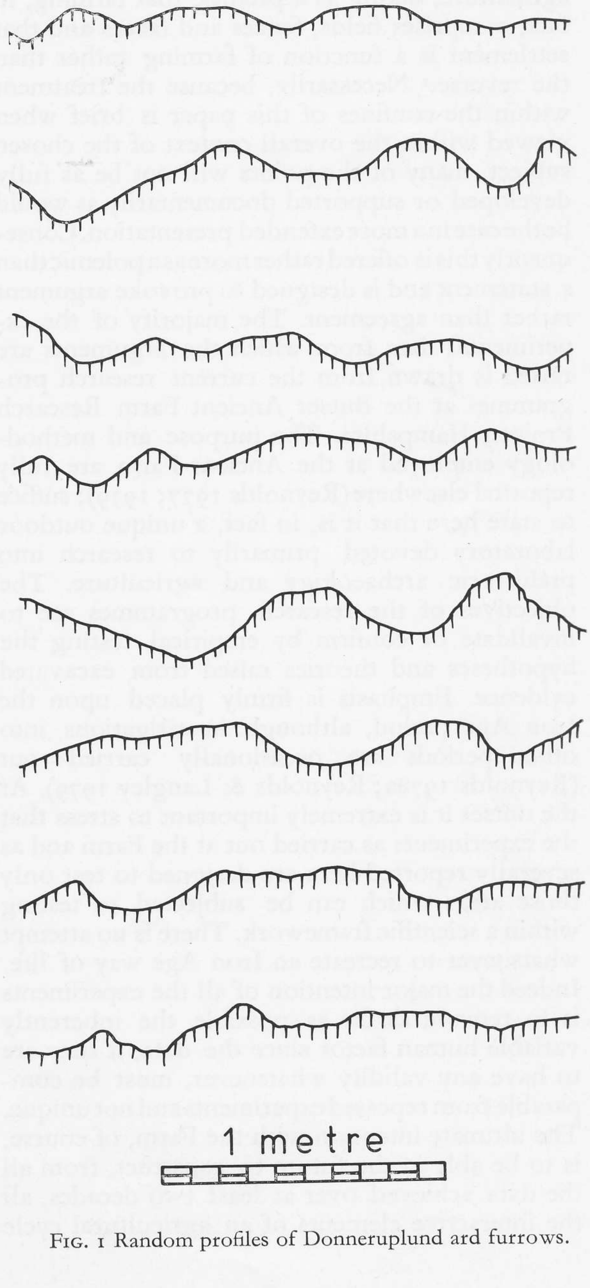


FIG. 1 Random profiles of Donneruplund ard furrows.

Further experiments with a crook ard of the Hvorslev type (Glob 1951) yielded similar results. Since the ard mark as such is regarded as indicative of arable agricultural practices, it is vitally important that an explanation for their production be proffered. There are, therefore, two basic questions involved. First, the fact that ard marks survive at all causes concern in that repeated ploughing should eventually be self-cancelling. In the majority of cases, however, the marks, once recognised, are quite clear. With a set of unidirectional marks one could quite properly argue that such a set of marks was the result of the last cultivation pass. Although the self-cancelling argument would apply to a standard ard, given the number of cultivation processes required in any one season, when there are multi-directional sets remanent in the subsoil, one must hypothesise an alternative cause. The experiments carried out with the basic ard types available for study show that they are designed to travel through the soil in the horizontal plane. The protruding share, whether it be in the form of a one-piece crook ard or a bar share of wood or metal in a composite ard, is a device intended to hold the ard within the body of the soil. The tilth is produced by the stirring inherent in the flow pattern of the soil around the heel of the ard. There would seem to be omitted from the available evidence a simple 'rip ard'. Such a tool is vitally necessary in the initial process of creating arable land from scrub or woodland and again in the conversion of non-cultivated fallow into arable. There is, however, a certain amount of evidence for such a rip ard, such as a hint of it which can be seen in the Scandinavian rock carvings at Aspeberg, Sweden. This is described by Glob (1951, p. 116) as of the same type as the Donneruplund Dostrup variety, but it would seem to differ significantly in that the stilt and share appear to be a solid unit and seem more like a hook at a much steeper angle to the ground surface than the other representation (*e.g.* Fig. 2).

FIG 2. Aspeberg ard (after Glob).

A similar ard appears on a rock carving from the Val Camonica valley, where the scene is completed by figures following who wield mattock hoes (Anati 1960, p. 116). In addition, a metal, so-called ard tip (Pl. II) recovered from an excavation of an Iron Age site at Slonk Hill near Shoreham, Sussex (Hartridge 1978, p. 98, fig. 11, 4), is very unlike all the other metal objects identified as ard tips and may be from a rip ard. Indeed many of these metal objects are much more likely to be spuds, a simple metal flange mounted on a stick and used by a ploughman to clean the soil away from the ard (Rees 1979, pp. 330–1), which itself may be entirely of wood. There is, in fact, very little evidence of metal sheathing for the Danish ards at all. In the Donneruplund/Dostrup types the bar share is adjustable, and experiments with the former variety (Reynolds 1966) indicate a wear pattern of *c.* 2.5 cm on the ard when used in ploughing approximately half a hectare of light soil overlying limestone. In the case of the Slonk Hill example, the shape and wear pattern is such as to suggest that it would have fitted onto a hook or rip plough such as in Fig. 2 (Reynolds 1978b). Given the following description, it would seem that a metal sheath protection to this type of ard would be much more important than for the previous types.

Within the framework of the present argument it is reasonable to quote a Spanish ard called *el cambelo,* in use today in the mountain region of Lugo province, which comprises a straight beam from the yoke, which is attached to a curved oak bough (Pl. III; Leser 1931). The tip of the oak bough is protected by a metal sheath, similar to the example from Slonk Hill. This ard, in effect a great hook, is used specifically for bringing new ground or old fallow into arable. In practice the tip is dug into the soil and hauled forward by the oxen, commonly a pair of bulls rather than the more usual cows, until it locks under the weight of soil and roots. It is loosened, cleaned and the process is than repeated, leaving interrupted scores in the ground surface. Unfortunately it was impossible to excavate the subsoil here but effectively it penetrated far deeper than any other simple ard, often being buried up to 50 cm. The tip inevitably penetrated into the subsoil and must have created a deep narrow score. In total agreement with the rock carving in the Val Camonica valley, men armed with mattock hoes broke down into a tilth the great clods and turves which were turned up by this ard.

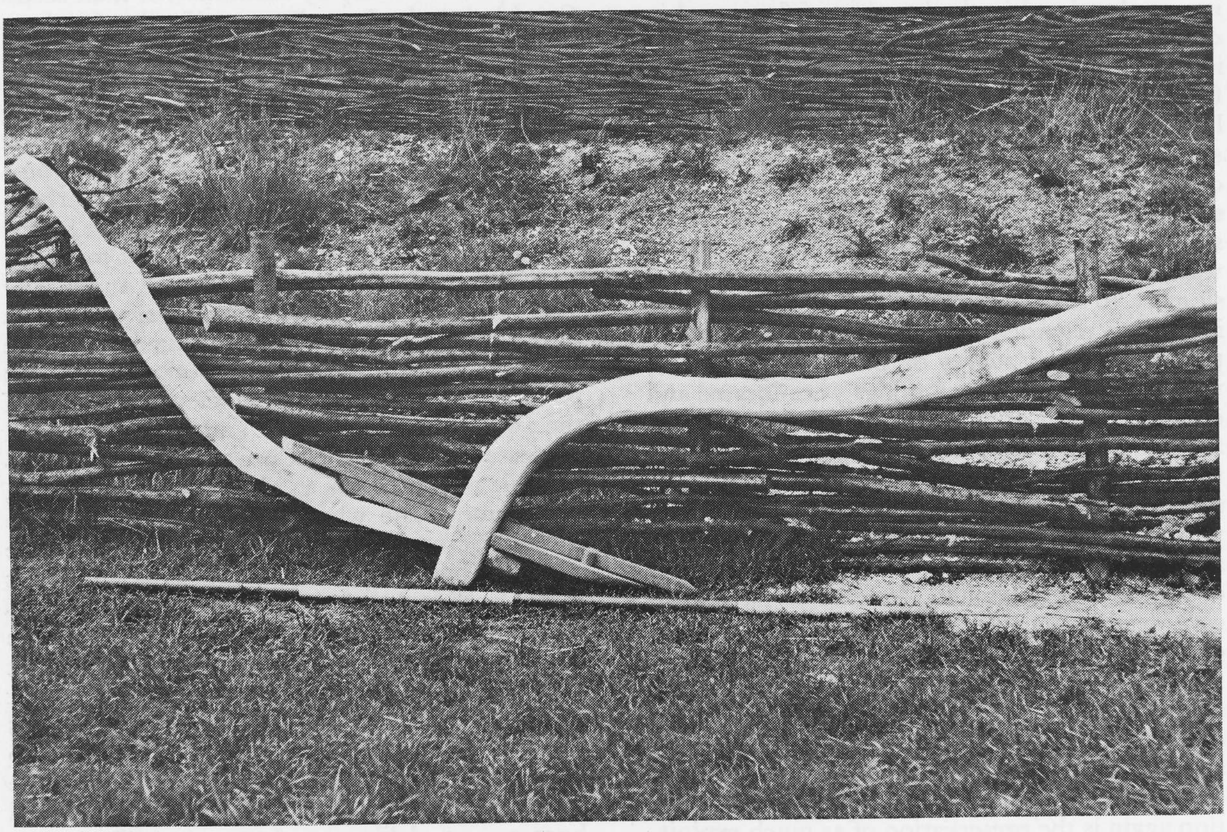
If one gathers these fragmentary pieces of evidence and allies them to the nature of plough marks regularly recovered from excavations, an hypothesis emerges which suggests that the ard marks were created by a rip ard rather than a regular prehistoric-type ard. Certainly the hypothesis accounts for the depth of the scores and their interrupted nature. In the case of unidirectional or criss-cross ard marks one could further hypothesise that such an area was taken into arable once or twice only and thereafter stayed until abandonment as cultivated land. In the case of multidirectional ard marks the theory of regular periods of unploughed fallow could be advanced. Whatever the viability of these hypotheses, it is signal to record that a deliberate investigation by excavation of a group of Celtic fields has yet to be undertaken. Certainly it brings into question the rather facile approach of counting the number of directions of ard marks in an area and equating the result to the number of cultivations.

B. ANCIENT FIELDS

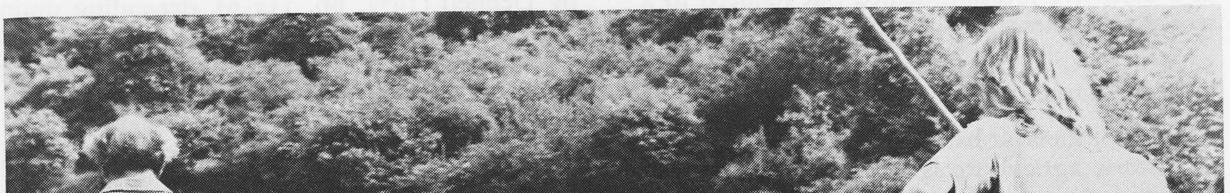
There is abundant evidence for fields in prehistory dating from the Neolithic period onwards, but a survey of prehistoric fields is beyond the scope of this paper. There are two seminal works upon the subject, the first, *Ancient Fields* (Bowen 1961), is described by the author as a primer and not an inventory, and as such is of paramount importance in this largely neglected area of archaeological research. The second is the recent publication *Early Land Allotment* (Bowen & Fowler 1978), which seeks to update the research results achieved since 1961 and is the report of a symposium on ancient fields and land allotment held at Bristol under the aegis of the Department of Extra-Mural Studies of Bristol University. This similarly is an invaluable statement of the present knowledge of the subject. In brief the evidence for prehistoric fields increases in due proportion to the attention focused upon the subject. As, however, the evidence increases and its nature becomes more complex, so the questions which it raises increase. The problem is further exacerbated by the changes in modern farming practices with more land being taken into arable cultivation and the consequent destruction of what little upstanding evidence remains.

Rather than attempt even a brief description of the nature and variety of prehistoric fields, the following theory is advanced as an alternative interpretation of the extant evidence. Much valuable work both of a descriptive and an analytical nature has already been published concerning the 'Celtic' fields of Wessex (Bowen 1975a; Bowen 1975b). Remains of 'Celtic' fields survive in groups, ranging in extent from a few hectares to many hundreds and usually to be found on hill slopes, being identifiable either by the lynchets which separate the fields or by remanent soil marks. Many prehistoric settlements are also to be found on spurs or slopes in the upland area away from the valleys. The simple temptation is to associate the location of the surviving fields, which are generally speaking on light poorish soils, with the supposed light ards of the prehistoric period, and to conclude that the areas where these occur are fully representative of the type of agricultural land utilised in the prehistoric period. The heavy valley clays were once regularly regarded as being beyond the technology of the early farmers and as only coming into cultivation with the advent of the heavy wheeled plough. On flat land like the river valleys, there is hardly any evidence of blocks of fields or even of single fields (Miles 1978), despite the presence of settlements which were clearly based on an agricultural economy (Lambrick & Robinson 1979) and which are similar to the upland examples. The upland prehistoric fields have survived the past two millenia only because these land areas have not subsequently been subjected to intensive arable agriculture, unlike the river valleys where fields associated with the settlements have probably been destroyed.

If, however, one were to suggest that these extant field systems represent the exploitation of marginal rather than prime land by the time of the later Iron Age and reflect land pressure comparable with that of the present day, a different picture emerges. The locations of settlement sites, for example, are specifically arranged to take account of the best land and to maintain it for agricultural purposes. The field systems themselves, laid out as land allotments rather than as arrangements of fields around a farmstead, become more understandable. The increasing recognition of settlement sites in the river valleys attests to the exploitation of these areas, and cultivation marks on clay subsoils (see above) argue an adequate technology. Indeed experiments carried out by the author with a replica Donnerupland ard on boulder-clay land in the Midlands have shown that, given the right soil and weather conditions, such an ard is capable of producing a satisfactory tilth in this heavy soil. If this were the case, in southern England the valley bottoms would represent the prime arable land and the major focus of agricultural attention. Such a pattern of land utilisation and related agricultural production would make more comprehensible not only the classical references to grain and hide exports (Strabo, IV, 5, 2), but also the vast number of grain-storage pits commonly recorded in excavations of major settlement sites like Danebury (Cunliffe 1976, pp. 200–1) in Hampshire, and Gussage All Saints (Wainwright 1973, p. 113) and Maiden Castle (Wheeler 1943, pp. 51–5) in Dorset. It would also explain the seeming anomaly of a full Caesarian legion being deployed to collect cereals during the invasion of 54 B.C. (Caesar, IV, 32, 1). Finally it would provide a much more adequate economic reason for the eventual invasion of Britain by the Romans in A.D. 43. The theory proposes that the landscape was, in effect, an agroscape, that what is generally accepted as merely a subsistence economy was, in fact, a fully operational and successful agricultural industry. Further, one can divide that industry into two component parts, the production element as served by the field evidence and the service element as represented by the hill towns. This is not the place to explore possible population figures, but it would not be unreasonable to think in terms of an overall population in Britain approaching two million in the later Iron Age to judge from the work at present being carried out, for example in Northamptonshire (Royal Commission on Historical Monuments 1980) and in the East Midlands (Pryor 1980).



(a)



(b) PLATE I. The Donneruplund ard (a) Replica (b) Under traction.

It is interesting to explore the theory further at its simplest level in the location of farmstead in deference to farm land in an area where gross industrial success is unlikely to be an indicative factor, such as with settlement patterns in Scotland (more sensibly adjudged to be based upon a subsistence economy because of poor bioclimatic conditions), which would seem to provide a straightforward illustration. The crannog is essentially an artificial island constructed in shallow water to sustain a dwelling and connected, occasionally, to the shore by a causeway. This practice is usually regarded as having been a defensive ploy. In a recent survey of Loch Tay, however, no less than seventeen crannogs were located and examined, eight of which were observed to have timbers and in two of which substantial structural timbers remained (Royal Commission on Historical Monuments 1979). Assuming at least a proportion of these to have been contemporary and the pressure on the surrounding limited area of agriculturally exploitable land to have been considerable, the placing of the habitation sites off the arable land would seem to have been the most sensible maximisation of resources. The same argument could be advanced for the dun, ordinarily situated on an inhospitable rocky eminence and consequently attractive to exponents of the defence theory. The more practical explanation again is the preservation of as much exploitable land as possible. In neither case is the element of a defensive location denied but reduced to a secondary rather than a primary consideration.

C. SEED EVIDENCE

The last of the four basic sources of evidence for prehistoric agriculture is perhaps the most difficult to interpret and certainly the area on which there has been minimal progress in the last twenty years, as the evidence comprises only impressions of seeds fired by chance into pottery and occasional finds of carbonised grain. The standard view is that propounded by Helbaek (1952, pp. 207–9, 231–3), and the evidence is broadly reviewed by Bradley (1978, p. 33). At the present time the majority of the views advanced are entirely suppositious. The best and most reasonable approach, if only because of the nature of the original evidence, is to accept only statements of presence and absence. When dealing with botanical evidence one is involved with the microstate, and broad generalisations are to be avoided. For example, the carbonised seed which survives is by definition anomalous, in that it has been carbonised at all. Similarly seed impressions on pottery can be subjected to location analysis and comparison with carbonised seeds from the site only if it can be proved that the pot was manufactured on that site. Nonetheless, generalisations have been drawn suggesting dominance of different crops at different periods without taking into account possible reasons for the destruction and subsequent recovery by excavation of their seeds. Considering the Iron Age specifically, the dominant wheat cereals are accepted as emmer (*Tr. dicoccum*) and spelt (*Tr. spelta*). It has long been claimed that heating spelt facilitates its processing *i.e.* the awns and glumes can be removed more easily (Helbaek 1952, pp. 201, 232–3), thus providing a possible source of accidental carbonisation. Repeated experiments carried out by the author have, however, shown this not to be the case. The heating process, whether in an oven or on a surface over an open fire, drives off the moisture and in so doing the glumes clasp the seed ever more tightly. On the other hand, it is possible, and indeed quite efficient, to flame off the awns from both emmer and spelt wheats. In this case the awns do not provide sufficient combustible material even to blacken, let alone burn, the glumes. The whole problem of how these prehistoric cereals were threshed has yet to be resolved, but heating is not part of the answer. It might be thought, since most deposits of carbonised seed are recovered from pits, that storage underground might be more suitable for wheat than for barley, but in fact both barley and wheat store perfectly well by this system (Reynolds 1974). It is nonetheless important to attempt to isolate potential reasons for grain having become carbonised, whether it be the result of accidental burning or deliberate destruction. To isolate different stages of crop processing as attempted by Dennell (1972, pp. 152–6), depending upon carbonised-seed evidence, is to avoid the implications of carbonisation. In the following discussion of crop-husbandry experiments as carried out at the Ancient Farm, one hypothesis is advanced as to how cereals might have been carbonised when in association with arable weeds. Significantly perhaps, it is hardly representative of an agricultural process, rather it is confirmed as a by-product.

II. CROP HUSBANDRY

The presence list of crops grown in British prehistory is in itself impressive and, when allied to crop-husbandry techniques, suggests an extremely complex system of crop production. The basic Iron Age list includes emmer wheat (*Tr. dicoccum*; Pl IV), spelt wheat (*Tr. spelta*), club wheat (*Tr. compactum*), old bread wheat (*Tr. aestivum*), barley, both two- (*Hordeum distichum*) and six-row (*H. hexastichum*) varieties, flax (*Linum usitatissimum*), rye (*Secale cereale*), oats (*Avena sativa*) and beans (*Vicia faba minor*; Pl. V). In all probability one can add fat hen (*Chenopodium album*) as a further cultivated crop, although today it is regarded as a weed. The list is extensive and argues for considerable complexity in farm management. Although certain crops, such as barley, are particularly sensitive to a low pH and wheat does not thrive on wet clays or peaty ground, these conditions are the extremes in

Britain rather than the norm. Certainly in southern England one could expect all these crops to thrive.

One of the prime objectives of the work at the Ancient Farm is to explore the potential of the prehistoric cereal types as crops and to provide valid parameters of yield and performance. In this sense the foregoing arguments are largely devoted to the macrostate of the evidence and how the evidence might be broadly interpreted. The remainder of this paper is devoted to the microstate and studies in close detail the evidence and the experiments that have been based upon it. As stated above, the carbonised-seed evidence is significant only in so far as it indicates the presence and absence of particular species. Actual treatments, farm management, field management and crop processing remain matters for hypothesis. The variables are numerous and complex.

A. CLIMATE

The obvious variable in any agricultural study is the prevailing climate. Much has been made of the importance of climatic change in prehistory, quite properly in that even a slight increase in annual rainfall can make previously exploitable land areas quite unusable. An obvious example is the abandonment of large areas on the harder rocks in the south-west of England by about 1000 B.C. Similarly, when using the empirical approach, results can only have validity if produced with a similar prevailing climate. Consequently the research pattern devoted to crop husbandry at the Ancient Farm is restricted to the Iron Age when the climate was directly similar to that of today. Thus the major variable can be viewed as a constant in this sense, but a quite critical constant, in that its annual effect upon crop production must be monitored and that the experiments themselves must be conducted over a long period of time in order to experience the great variety of weather patterns which exists within any overall climatic pattern. That the research dates from 1972 is significant in that during the last eight seasons of work, extremes of the normal climatological pattern have been more frequent than usual. Ironically Tacitus (XII, 3) described the weather in Britain as *foedum*, the most acceptable translation of which is 'foul' and a description with which hardly anyone would disagree.

B. LAND MANAGEMENT

1. *Manuring*

Other variables belong almost exclusively to the sphere of land management. Soil preparation has been discussed above and it is sufficient to report here that replicas of the basic varieties of prehistoric ards, ranging from the crook ard to the bow ard, and beyond to the Roman-type winged ard as described by Virgil (I, 267), have all been tested in as close a manner as possible to that hypothesised for the periods in question, and all have been found to be satisfactory in the production of a suitable tilth for seed planting. The question of the manuring or non-manuring of the land is also fundamental in terms of expected yields. It has been argued that manuring undoubtedly took place in the Iron Age (Bowen 1961, p. 6), the manure being derived from a central midden. To date, the location of such a midden has yet to be isolated on the majority of settlement sites, although a considerable step forward in this respect has recently been made: phosphate analysis of an Iron Age settlement site at Fengate, near Peterborough, showed that in certain round houses phosphate levels were high while occupation débris was low; in others the reverse obtained, with low phosphate values and high incidence of occupation debris (pers. commun. F. Pryor). The implication of this analysis is that certain structures could have been used for overwintering, or indeed all-year housing, for animals, while others were regular houses. Such a system would allow for the concentration and accumulation of dung, which could thereafter be spread on the arable fields.

2. *Sowing methods*

Other variables include the method of planting and the weight of seed sown per unit area. Here there is considerable confusion in the absence of any real documentary evidence or specific artefacts indicative of agricultural practice. The popular concept of the sowing of seed is invariably the broadcast method, although as a practical proposition this is only one part of a process which requires the further harrowing or ploughing over the seeded tilth. There is as yet no evidence for a prehistoric harrow nor any indication of the practice in the iconographic material. In certain parts of Europe, notably Ireland, this problem is overcome by dragging a thorn bush or baulk of timber across the field after sowing. Again simple experiments by the author have shown that broadcasting seed onto a prepared tilth leads to a 98 *per cent* loss of seed sown. Broadcast seed subsequently dragged over by a thorn bush has a loss rate of 70 *per cent* of seed sown and by a heavy baulk of timber of 65 *per cent*. All these figures would seem to be entirely unacceptable, in that the loss is abundantly obvious and the cause of that loss, bird depredation, equally so. Reploughing of the tilth after broadcasting the seed brings a different difficulty. Given a worked tilth, the soil is relatively loose and, unless the soil depth is insufficient, the ard types, with the possible exception of the crook ard, produce furrows up to 20 cm deep. This not only puts the seeds into crude rows, which is the object of harrowing, but also plants the majority too deeply in the ground. The result of this is retarded and limited germination and overall crop

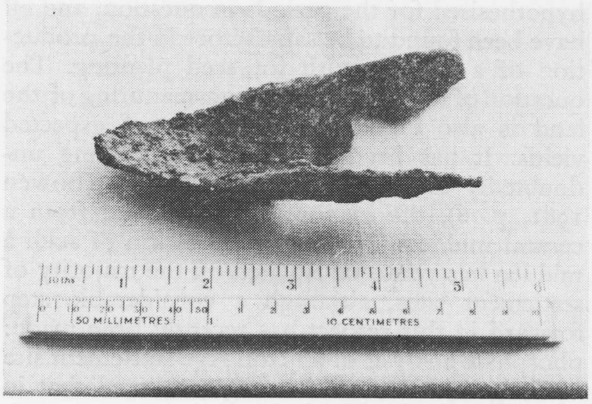


PLATE II (above). The Slonk Hill ard tip.

PLATE III (right). *El cambelo.*

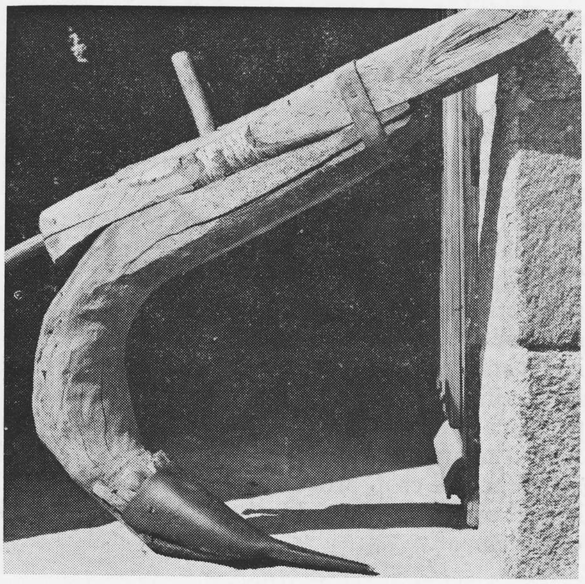


PLATE IV. Emmer wheat (*Tr. dicoccum*).

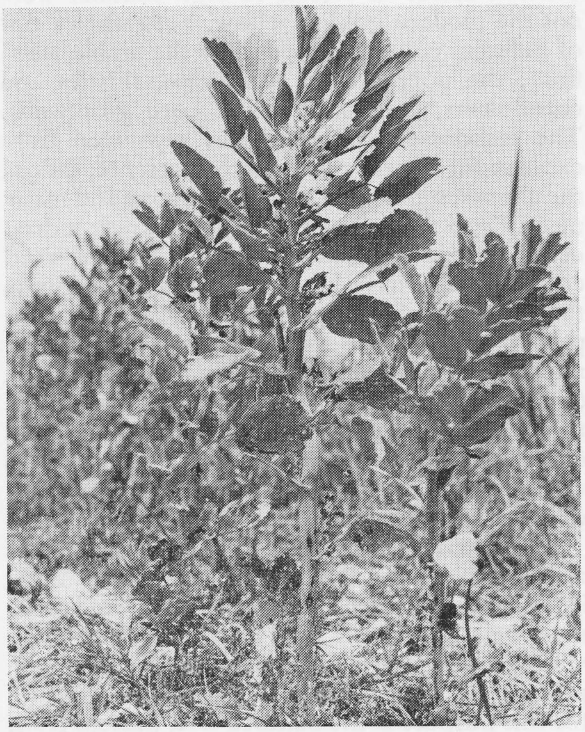


PLATE V. Celtic beans (*Vicia faba minor*).

PLATE VI. Charlock (*Sinapis arvensis*).

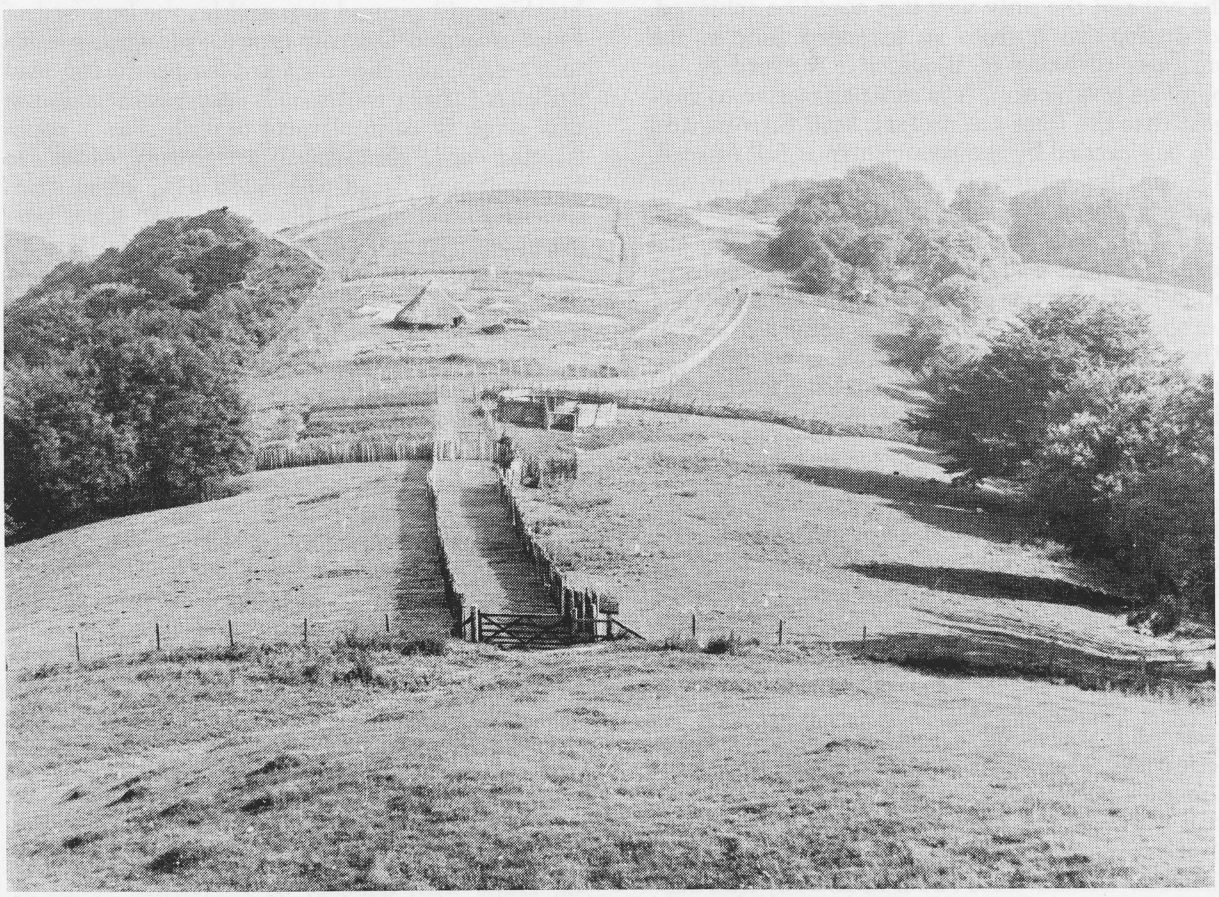


PLATE VII. General view of the Butser Ancient Farm research site.

loss. Yet the Litsleby (Sweden) rock carving of an agricultural scene (Fig. 3) may hold the key to this problem. The ard shown is undoubtedly a

FIG. 3. The Litsleby ard (after Glob 1951).

crook ard, which experiments show produces a narrower and shallower furrow than the other varieties. The critical factors are the angle between the share and the beam and the difficulty in keeping the ard travelling through the soil as opposed to skipping over the surface. It is quite impossible to use this type of ard as a sod breaker. The particular points which may help in understanding the sowing process are two-fold: first the possible bag carried by the ploughman and second the lines drawn beneath the feet of the cattle. Careful examination shows a line emanating from the ard, both fore and aft, as if the artist wished to indicate that it was produced by the ard and the only way this could be achieved, to distinguish it from an extended foot to the ard, was to bring it, illogically, forward of the point of production. It is most attractive to suggest that the lines are, in fact, seed furrows and the bag carried by the ploughman is full of seed. The phallic nature of both the ploughman and cattle suggests a fertility ritual which would accord well with the overall scene, although the presumed leafy bough carried in the ploughman's other hand may have little ritual significance. The author observed a ploughman using an ard of Roman type drawn by a pair of cows in Lugo province in Spain. He, too, carried a leafy twig, the purpose of which he explained was to deter flies from irritating the team.

If one accepts the explanation offered of this scene, it is the most successful system of planting the seed of cereals and indeed of other crops. The whole essence of agriculture, the *raison d'être* of farming, is to provide and maintain the preferred habitat for the selected plant. Modern agriculture depends almost entirely upon chemical controls to provide this habitat, so successfully that modern cereals are drilled in rows some 10 cm apart and are effectively monocrops and competitorless. This situation can influence appreciation of agricultural processes of the past. Less than forty years ago, however, and in many places even more recently, the picture was quite different. Cereals were sown in rows spread sufficiently widely apart to allow for manual weed control. Fields of cereals in high summer were not the modern golden yellow, but rather a riot of different colours provided by the arable weed flora; the poppies and buttercups, thistles and cornflowers, corn cockles and corn gromwells. The carbonised-seed record as recovered from excavations clearly attests to the presence, indeed the abundant presence, of all the above and many more. Crop control is of vital importance; indeed cereal production without some degree of weed control would have been impossible, not only in the early part of this century but millenia into the past. This statement can be further underlined by referring to one specific arable weed, charlock (*Sinapis arvensis*; Pl. VI). It is virtually impossible to eradicate by manual control and should initial control in the early part of the season not be carried out, it can be so abundant as to choke a cereal crop completely.

The variable of sowing, therefore, can be reduced to a logical and sound hypothesis. What little evidence there is suggests that seed drils may well have been used and that these drills were set sufficiently widely apart to allow human passage for weed control. The most obvious tool for this purpose is the mattock hoe, present from the Neolithic period onwards. Different types of prehistoric ards, far from being a sequential development from simple to complex, may actually represent contemporary tools but for different purposes: the rip ard, as suggested above, breaking old ground into arable; the bow ard of Donneruplund/Dostrup type for ploughing fields into a tilth; and the crook ard for producing seed drills. A further tool which deserves inclusion at this stage is an implement described as a rope-traction ard, discovered at Satrup Moor in Germany and dated to *c.* 4000 B.C., which consists of a heart-shaped blade with two holes near the upper part and a long slender handle (Fig. 4). Experiments with this implement have been carried out by Axel Steensberg (1973), with the blade pulled through loose soil by one man pulling on a rope attached to the blade by the holes, and another man pressing the implement into the ground. Similar blades, but of stone, have been recorded from the Orkney and Shetland islands at a much later date. As an ard it would depend heavily upon the ground being loose and easily worked. The rope-traction device hardly fits into a developmental pattern and, even given the above suggestion of contemporaniety of ards, would still seem to be supernumerary as an ard. Steensberg suggests its use as a device for drawing a seed drill, and it would additionally have been ideal for weed control. The very length of the handle allows the correct angle of slice for the blade, and even the wear marks on the handle for hand positions and the wear marks on the blade accord with such a usage; thus the two men rather than animals could manœuvre within the growing crops with delicacy of movement resulting in minimal damage. Indeed the whole process of

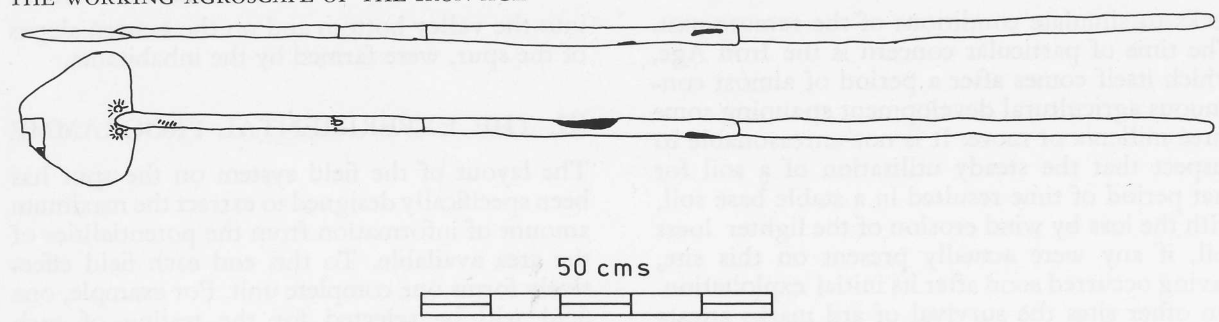


FIG. 4. The Satrup Moor rope-traction ard (after Steensberg 1973).

weed control would be radically accelerated. If this is a reasonable interpretation for this tool, it would predate the patent wheeled weeding blade by some three millenia.

The intensity of sowing in prehistory represents another variable which is almost impossible to resolve. Today the conservative sowing rate for modern cereals averages some 130 kilos per hectare (120 *lbs* per acre), with seed drills set some 10 cm apart. This intensity is the direct result of the modern reliance upon chemical fertilisers, herbicides and pesticides, and seeks to obtain maximum returns by regarding the soil as a vehicle to carry the input of nutrients rather than as a major element in the process. In effect, given the most liberal chemical farming system, it would be possible to grow heavy-yielding crops on gravel chips, which would simply provide a material support for the root-stock of the plants. In the early-nineteenth century the standard sowing rate in Sussex on a tilth was some 3 bushels per acre (Young 1813a, p. 85) and this assumed hand hoeing in the spring. Seed drills were set some 20 cm or wider apart to allow for hoeing. If weed infestation was high, a second and third hoeing were recommended. At this time in the development of agriculture, however, the seed drill was being introduced and with it all the usual controversy associated with a new machine (Young 1813b, p. 135). The average distance between seed drills seems to have been *c.* 25 cm on good soil and *c.* 18 cm on poor soil. Sowing always assumed subsequent hand weeding and hoeing.

3. *Planting Time*

Besides the variables of manuring and sowing' the third most significant variable is the time of planting. Traditionally wheat can be sown in the autumn or the spring. The introduction of spelt wheat has been suggested to bring in the principle of autumn sowing as a concomitant factor with the climatic deterioration in the early Iron Age (Applebaum 1954, pp. 103–5). It is, of course virtually impossible to prove the time of sowing chosen in prehistoric times, although the presence of one particular species of arable weed within the carbonised record may indicate the likelihood of autumn sowing (see below).

4. *Soil Type*

The final and perhaps most significant variable of all is the soil itself. There is little doubt that the soil structure now present on the chalk lands of southern England is little different from that of the Iron Age, despite the possibility that earlier there was a loess covering (Limbrey 1975). The major difficulty lies in locating areas which have not been subjected to heavy chemical farming with long-term surviving effects.

The soil type of the Ancient Farm is a typical friable redzina. The site itself (Pl. VII) is on a spur jutting northwards from the main mass of Butser Hill. The history of its use as farmland is a little difficult to reconstruct. Within living memory it has served as poorish grazing land, simply because it is virtually impossible to get powered vehicles on to it for most of the year. It has been suggested that a root crop was planted on the spur in 1947, but there is no evidence of any plough action in the underlying chalk surface. Similarly for the same reason no new lays of grass have been put down and it has not been subjected to classical attention. Since 1972 and the inauguration of the Ancient Farm even the effects of drift from modern spraying have been avoided with the co-operation of the local farmers. It would seem, therefore, that the site represents a 'survival niche' within an extremely modern agricultural landscape. Certainly the presence of a rare and diverse flora typical of old chalk downland supports the contention of its freedom from modern contamination. The presence of a prehistoric settlement site of Bronze Age/Iron Age date is attested both by surviving earthworks—an unfinished ditch and bank and a dished house platform—and an overall distribution of prehistoric pottery sherds (Reynolds, in preparation). The nature of the archaeological evidence suggests that erosion, if any, has been minimal and that the soil depth, now *c.* 10 cm, is close to that of the later Iron Age. It is, of course, virtually impossible to determine whether the nature of the soil is precisely the same as that of the Iron Age, but it is as near as one could hope to achieve in a countryside which has been subjected to so much agricultural development.

Indeed this raises a fundamental question of direct relevance to any empirical study which seeks to simulate conditions of the remote past. The time of particular concern is the Iron Age, which itself comes after a period of almost continuous agricultural development spanning some three millenia or more. It is not unreasonable to suspect that the steady utilisation of a soil for that period of time resulted in a stable base soil, with the loss by wind erosion of the lighter loess soil, if any were actually present on this site, having occurred soon after its initial exploitation. On other sites the survival of ard marks attests to the working of soil of a sufficiently shallow depth to allow the marks to be formed. Similarly the vast majority of Iron Age sites on the chalk lands are single-layer sites where it might be argued that soil loss has been minimal. Further, ignoring the potential effects of increased levels of radioactivity in the soil caused by man's determined suicidal tendencies, there is real doubt as to the long-term effects of chemical farming. It would seem that for the chemicals themselves to be effective for crop production, annual applications are required and that traces would be eradicated within approximately twenty years. The greatest threat posed by chemical farming is the breakdown of the root bonding of the soil itself: by exterminating competitors of the preferred crop, only the root structure of the crop is available to bind the soil and increase its crumb structure. Certainly erosion today is a far greater threat than at any other time in history.

Consequently, if the land utilised for experimental purposes has been grassland, ideally undeveloped, for the past twenty years, in all probability it will retain a root-bonded soil structure and basically comparable nature to that of any agricultural land type not subjected to modern chemical farming. Similarly, since agricultural practices have altered very little in real terms from the late prehistoric period to the present century, there is little reason for such soils to be widely divergent from soils utilised in late prehistory. Apart from erosion, which is unlikely given an agricultural system which of itself cannot eradicate a competitive weed flora and, therefore, has an abundant root stock to minimise soil loss, there is little which can fundamentally alter its nature. Thus the area selected for the Ancient Farm is particularly suitable, in that it is virtually entirely undeveloped according to both living memory and the known estate records. Ironically, since it is a settlement site, it is most unlikely that the spur itself was used as an area of arable agriculture even in the Bronze Age/Iron Age period. No evidence for prehistoric agricultural activity has yet been revealed by excavation. Nonetheless, the land sloping to the east has traces of ancient fields, as indeed do the southern slopes of Butser Hill (Piggott 1930, pp. 197–8). There is little doubt but that the settlement site on Little Butser was indeed a farmstead and that the surrounding areas, primarily those to the north into the valley bottom and on the eastern slopes of the spur, were farmed by the inhabitants.

III. THE EXPERIMENTAL PROGRAMME

The layout of the field system on the spur has been specifically designed to extract the maximum amount of information from the potentialities of the area available. To this end each field effectively forms one complete unit. For example, one field will be selected for the testing of each specific question which is raised. In all there are five fields and five specific functions. In this paper one field in particular will be quoted in detail, although reference to others will occasionally be made. This field has been selected to study the important question of soil exhaustion. As a land area 30 metres × 30 metres it has three distinct planes, one to the west, one to the south and one to the east, with an initial uniform soil depth of *c.* 10 cm. In the autumn of each year since 1972 it has been planted with emmer wheat (*Tr. dicoccum*) and spelt wheat (*Tr. spelta*).

The objective is to assess the yield levels of the prehistoric cereals grown annually on the same field without any kind of added nutrient. To this end the following constants within the experimental programme have been maintained: the field is hand tilled using spades and mattock hoes; the seed is sown in seed drills set 20–25 cm apart at the rate of 62 kilos per hectare (56 *lbs* per acre). This equates to one spikelet containing two seeds for emmer and three seeds for spelt placed 2.5 cm apart in each drill. The drills average 5 cm in depth. The crop is hoed and hand weeded, once in April and twice in May of each year. The data extracted from the programme include analysis of the weed infestation of the crop, the heights achieved by the crops and the relevance of competitive weed flora to the fruiting height, the yield factor achieved on each of the three planes of the field, quinquennial soil analysis and subsequent analysis of the ear length and weight of the samples, number and weight ratio of seeds to other material and subsequent germinability. For correlation with these data, daily climatic records are taken from a standard meteorological weather station located within 40 metres of the field.

It is impractical to present here the full records from this one field alone or even to attempt a full analysis of the data achieved. The following series of tables is designed simply to illustrate the nature of the data, all of which will be available for study in due course, and to point out the main development trends. Each set of data has been deliberately collected to provide answers to specific secondary questions related to the primary one concerned with crop yields.

A. CROP YIELDS

The expectation at the inception of the experimental programme was for a steady decline in gross yield over a relatively short period of time estimated as ranging between three and five years. The most serious problem encountered with modern continuous cropping of the same cereal is the occurrence of a disease called take-all, which usually attacks the root stock of the plant in the third and fourth years, severely reducing the yield and occasionally negating it altogether. It can be eradicated by persisting in a continuous cropping programme; after sustaining one or two bad harvests, the crop can continue to be grown without further threat of this disease. A break in the pattern, however, even for one season, is thought to readmit it to the soil. To date there has been no appearance of this disease within the research fields and, given that there have been eight seasons of continuous cropping, it is unlikely now to affect the crop. The major argument, however, for the likelihood of a decline in yields is that of soil exhaustion. Although it has been argued that manuring was carried out in the Iron Age, this enriching treatment was not carried out with this field in order to accelerate the exhausting process.

It should be emphasised that each season is different and the primary differences in crop yields are caused by the weather patterns experienced during each season. During the past eight years there have been extremes of weather conditions recorded, some of which have directly affected the crop yields. The obvious example is the drought of 1976; less obvious, but equally as critical, was the extremely cold period of six weeks in January and February 1979 when the surface ground temperature rarely exceeded 1°C, and the crop was effectively destroyed at this time (although see below). Similarly during the season 1980, a protracted period of cold dry weather during April and May caused severely retarded crop growth and increased the length of the season, already on average three weeks longer than the maturation time required for modern hybrids, by a further two weeks, leading to the harvest not being gathered until late September.

The yield from each harvest is calculated by collecting samples from 5-metre squares selected from each sector of the crop using random-number tables. Sectors are assigned to each different plane within the field and the following table indicates the crop yields from the eastern

Cereal type	SPELT		EMMER	
	tonnes/hectare	cwts/acre	tonnes/hectare	cwts/acre
1974	2.3	18.3	3.7	29.8
1976	0.8	7.2	0.7	6.4
1978	2.5	20.1	2.6	20.8
1979	0.7	6.2	0.4	3.3
1980	1.4	11.4	1.6	13.0

TABLE 1. Crop yields: Field II, Butser Ancient Farm.

sloping plane or sector of the continuously cropped field.

The relatively large fluctuations over the five years given in the table are directly attributable to the weather patterns, rather than to any other single factor. The results can also be expressed in a different manner from these absolute figures by representing them in the more traditional ratio of yield return to seed sown, giving a different picture, especially when compared with the yield tables of the seventeenth century.

Cereal type	SPELT	EMMER
1974	37:1	59:1
1976	14:1	13:1
1978	40:1	41:1
1979	12:1	7:1
1980	23:1	26:1

TABLE 2. Ratio of crop yields to seed sown: Field II, Butser Ancient Farm.

Cereal type	WHEAT	BERE
1655	2.4:1	5.9:1
1656	2.2:1	4.0:1
1657	2.8:1	4.3:1
1658	2.0:1	5.3:1
1659	2.9:1	8.0:1
1660	2.9:1	5.6:1
1661	2.9:1	4.1:1
1662	2.4:1	4.4:1

TABLE 3. Average yields from the Dundas estates near South Queensferry (Scotland), where yields were obtained 'with more advanced arable farming techniques' (Whyte 1979).

While it is claimed that seventeenth-century Scottish wheat yields were poor and suffered from an inferior position in a rotation sys em (Whyte 1979), a comparison with bere suggests that a reasonable return was achieved with the results of emmer and spelt wheats even at the worst levels experienced in the programme of 1979 when prolonged frost action burned the crop.

Since one objective is to assess the exhaustion factor, soil analysis is undertaken on a five-yearly basis. Table 4 indicates that only minimal changes have occurred between 1972 and 1979.

The percentage of organic matter, given in the first column, may be regarded as a high level, indicative of a long period under grass without cultivation. Normal modern figures of 2–5 *per cent* of organic matter are characteristic of long-term arable cultivation. It can be seen that a slight decrease in organic matter has occurred, but only af.er a prolonged period will it be possible to assess 'normal' organic levels in the soil with this cultivation pattern. It would be valuable to compare levels of organic materials in soils in northern Spain, where a 'prehistoric type' of cultivation has persisted over millenia. Certainly it is important to attempt to assess the levels of organic material in prehistoric fields, since it has a direct bearing not only upon the natural nutrients available, but also upon the likelihood of rapid erosion. The remaining measurements in Table 4 are designed to represent available

	% Organic Matter	Potassium ppm	Potassium index	Phosphorus ppm	Phosphorus index	Copper ppm
1972	24.3	234	2	16.2	3	4.14
1979	20.3	140	2	21.0	4	3.84

TABLE 4. Soil analysis: Field II, Butser Ancient Farm.[2]

Cereal type		Height range in centimetres 50–59.5	60–69.5	70–79.5	80–89.5	90–99.5	100–109.5	110–119.5	120–129.5	130–139.5
EMMER WHEAT	no. of	3	28	53	102	122	105	53	24	10
SICCO WHEAT	examples	26	60	105	165	128	16	—	—	—

TABLE 5. Stand heights in centimetres, 1980: Field VI, Butser Ancient Farm.

nutrients, the index given being devised by the Agricultural Development and Advisory Service. In brief, the potassium levels are generally adequate though low, phosphorus levels are adequate and copper is probably adequate; normal copper levels would be *c.* 20 parts per million, whereas a deficiency would probably be *c.* 2 parts per million.

In brief there is no real indication of crop-yield deterioration caused by soil exhaustion, nor of soil exhaustion itself. The vagaries in yield are directly attributable to climatic extremes. It is fortunate that the past eight years have been so varied, as otherwise these conclusions could only have been reached after a much longer period. Of particular interest is the absence of take-all, for which no explanation can be offered at this time.

B. STAND HEIGHTS OF CROPS

The problems raised by the carbonised seed found on archaeological sites generated the secondary question of what influenced the stand heights of the cereal crops. The normal sample of carbonised seed is a mixture of cereals and arable-weed seeds, the latter being abundant both in quantity and species numbers, raising the question of how the admixture actually occurred. The classical references indicate that the Celts reaped only the heads or spikes of the cereals (Diodorus Siculus, V, 21, 5; Strabo, IV, 5, 5); their comments would seem to have validity as the descriptions are of a practice at variance with the normal Roman harvesting system. Accepting, therefore, that this was the harvesting procedure, we sought to simulate it as accurately as possible in our experimental pattern. The end product of the first year's harvest of the experimental programme carried out by the author in 1969 at the Avoncroft Museum of Buildings near Bromsgrove, Worcestershire, showed a pure crop. In simple terms only the cereal spikes were collected and contaminant weeds, although present within the crop, were totally avoided, primarily because the great majority did not reach the same height as the cereal. In subsequent seasons at the Ancient Farm the same results have been achieved. Each season the crop has been carefully measured in the field and observations made of any competitive weed flora which have reached a sufficent stand height to interfere with the harvesting process. Prehistoric cereals differ from modern cereal hybrids in that the varying heights of the tillers of an individual plant have a much wider range. Table 5, comprising the data from two directly comparable plots from another research field at the farm, demonstrates this variation.

The figures represent 500 measurements of spike-bearing tillers recorded from a random transect across each plot. It is clear that the average stand height of the modern hybrid sicco is substantially less than that of the emmer and that the range is more concentrated. While such figures permit other assessments, the prime consideration here is the ease of harvesting. In this case, because of weed infestation in the lower levels of the standing cereal, a significant proportion of the cereal spikes within the range 50–70 cm would have been missed by the harvesters. This aspect has been investigated (see below) but the results cannot be viewed as universally applicable since, once the prehistoric-type cereal ripens, the stalk immediately below the spike becomes extremely brittle and the spike is readily broken away from the stem, even by wind action. A further variable is the effect on the crop of harvest mice and other rodents.

C. WEED CONTAMINATION

As mentioned above, the harvests gathered following the methods described in the documentary material have been pure. The solitary exception has been the presence of black bindweed (*Polygonum convolvulus*) which uses the cereal as a support and is virtually impossible to disentangle from the cereal spikes. The harvester is well aware of its presence, but can do little other than gather it along with the cereal. Other weeds certainly appear at the harvesting levels, but are so significantly different from the crop that avoiding them is an easy matter. The most common of these competitors on chalk lands are the thistles (*Cirsium spp.*), poppies (*Papaver spp.*), fat hen (*Chenopodium album*) good king henry (*Chenopodium bonus-henricus*), charlock (*Sinapis arvensis*) and hedge mustard (*Sisymbrium officinale*). Within the lower levels of the crop are to be found the typical arable weeds like corn flower (*Centaurea cyanus*), corn cockle (*Agrostemma githago*), corn gromwell (*Lithospermum arvense*), buttercup (*Ranunculus spp.*) field pansy (*Viola arvensis*) and the like. Because many of these are now virtually extinct in the British countryside, it has been necessary to generate a conservation and propagation programme at the Ancient Farm for these now-rare species, in order to provide the correct competition for the cropping experiments. It is interesting in this connection to record that so common are seeds of corn cockle (*Agrostemma githago*) in the carbonised-seed record, that they have even been considered as a potential food supply and their protein value has been analysed (Renfrew 1973, p. 195). In fact, in common with a large range of arable weeds, their seeds are poisonous (Forsyth 1968, p. 47).

1. *Straw Preparation*

The harvesting process, however, leaves a secondary and almost as valuable a crop, the straw, still within the field. The normal requirements of an agricultural community for straw hardly need to be stressed, and there can be no doubt but that the straw was carefully collected after the cereal harvest itself. Since the first harvest has but one major contaminant, black bindweed (*Polygonum convolvulus*), it would seem almost impossible to correlate it with the normal mixture of carbonised seeds recovered from excavations. On the other hand, the straw harvest would appear to be the obvious vehicle by which such a variety of species, including the cereals themselves, as indicated by Table 6, could have been transferred into the settlement areas. The analysis of the straw harvest has sought to identify and quantify the nature of the material. The normal practice has been to cut and bundle the straw into sheaves and transfer these from the field into either a storage unit or a stack. Each season a number of sheaves selected at random are analysed for total seed content. Table 6 gives two examples of sheaf analysis from the field in question.

	SHEAF 1	SHEAF 2
weight of sheaf	3.5 kg	3.25 kg
total number of straws	1672	1604
number of rachis ends	272(16)	543 (22)
number of cereal seeds	61	178
total number of cereal seeds	77	200
ARABLE WEEDS		
Sisymbrium officinale	2100	9200
Odontites verna	22	22
Papaver rhoeas	270	7550
Sinapis arvensis	15	25

TABLE 6. Sheaf analysis: Field II, Butser Ancient Farm, 1978.

The number of rachis ends is recorded because during harvesting the spike infrequently breaks at the base, leaving the base spikelet attached to the stalk, and occasionally the base spikelet contains a seed. The extremely low numbers of seeds recorded for charlock (*Sinapis arvensis*) are only to be expected, as the seed of this plant is dispersed from a pod, which is released by a trigger mechanism initiated by wind movement of the crop. At and just prior to harvest, the characteristic noise of the exploding pods can be heard. Similarly, the vast majority of the seed pods are triggered during harvesting and the subsequent transporting of the straw. Table 6 while representative is, of course, not an exhaustive analysis.

An hypothesis, presaged above, which could account for the carbonisation of cereal and arable weed seeds together and their subsequent discovery in archaeological contexts, involves an activity which has little or nothing to do with harvesting or food processing. There is ancient documentary evidence referring to the thatching of houses. While other materials like reed, heather or even bracken can be used for thatch, there is little doubt that straw was commonly used for this purpose. Indeed, given the stand heights recorded in Table 6, the prehistoric cereal types are ideally suited for this purpose. Straw has to be carefully prepared prior to its use as thatch: the major process involves the removal of all foreign material, stems of weeds and grass, and all seeds, as the presence of the former causes rotting within the straw bundles, and the latter encourages rodent infestation. To facilitate the cleaning, the straw is normally soaked with water, which allows the other material to be drawn out of it easily and aids the bedding down and bonding together of the straw upon the roof. The waste product of this process comprises a mass of wet vegetation, the disposal of which could be by simple bonfire. In such a slow-burning bonfire, anaerobic conditions regularly obtain in which carbonisation occurs. The seeds recovered from excavations are usually the very hard varieties, which by their nature lend themselves to such carbonisation. This hypothesis has been tested and apparently validated at the Ancient Farm under a pilot scheme, although a full and quantified experiment has yet to be carried out.

2. *Spike Analysis*

The harvest itself is subject to further analysis, primarily devoted to the spikes. Random selection of individual spikes from the yield samples is made, and these samples are weighed and measured, the seeds counted and expressed as a weight ratio of the waste material of glumes, palea and lemma. The whole problem of identifying the techniques used in the threshing of prehistoric cereals is a major research objective of the 1980s. Archaeologically there is virtually no evidence which might throw light upon the method and carbonised seed is unlikely to yield any clues because of the difficulty of isolating the original cause of carbonisation, especially as the hypothesis posited above suggests that the carbonised seed may well be entirely non-representative of the gathered harvest. Analysis of the seeds recovered from the straw sheaves suggests that there is no quantifiable difference in size and maturation quality from those of the real harvest. It may, with more precise excavation techniques now being employed, eventually be possible to isolate activity areas within a settlement by the nature and the distribution patterns of artefactual evidence. To date, however, this is a proposition rather than a reality. It would be extremely unlikely that it would be possible to isolate evidence for the location of a thatcher's activity, primarily because the normal practice is to prepare the straw on site. Given the average life span of a straw roof to be fifteen to twenty years, the activity is so infrequent as to render identification extremely difficult. On the other hand, it may well be that processing areas did exist and that preparation of straw for thatching was an annual activity.

With regard to the intended harvest, the awns, the easiest waste product generated of the spikes of emmer and spelt wheat, are the least detectable. It is still a matter for conjecture whether the seeds of these cereals were entirely extracted from the spikelet, although the remains of carbonised bread from archaeological sites, notably Meare and Glastonbury (Bulleid & Gray 1911–17, pp. 87, 629), suggest that spikelets rather than naked seeds were ground on the querns. It is the practice at the Ancient Farm to sow them in spikelet form.

The spike analysis, quoting only one example from the 1978 harvest of the eastern sector of the field cited throughout this paper, shows the average number of seeds per spike to be thirty-two. This figure, given a yield of some 2.6 tonnes per hectare (20.8 cwts per acre), would yield approximately sixty-five million seeds per hectare, which instantly puts into perspective the paltry quantities of carbonised seed ordinarily recovered from archaeological excavations. Against these gross sums, it is most unlikely that a representative sample of the original harvests can ever by achieved.

3. Sowing Dates

Reverting to the potential value of the carbonised seeds of arable weeds for indicating functional or activity areas, one factor has emerged from the research at the Ancient Farm during the past five years. Immediately to the north of Field II, which is devoted to autumn-sown cereals, a further field, Field IV, was created for spring-sown crops separated from Field II only by a 1-metre-wide strip of turf. Field IV has three crop variables, two process variables and two treatment variables which involve manuring and non-manuring, as opposed to Field II, which receives no nutrient additives at all. The effect of manuring upon crop yields is striking with, in one particular season, over 8 tonnes per hectare being recorded for spring-sown emmer wheat.

The comparative analysis of weed flora in Field II and Field IV has revealed that the winter-sown crop is pervaded by cleavers (*Galium aparine*), while this plant is entirely absent from the spring-sown field. Table 7 gives the results of the last two seasons' surveys of three randomly selected metre squares per sector in both fields.

Sector		*East*	*South*	*West*
1979	Field II	136	179	85
	Field IV	0	0	0
1980	Field II	84	109	63
	Field IV	0	0	0

TABLE 7. Incidence of *Galium aparine*: Fields II and IV, Butser Ancient Farm (numbers represent individual fruiting plants).

A graph of the germination dates characteristic of this plant shows a major peak at the end of March and the beginning of April, with a minor peak in late October. Normally Field IV is cultivated at this time prior to spring planting early in April and consequently should any plants be on the point of germination they are eradicated by the cultivation, as is shown by its absence from the spring-sown field. By contrast Field II is planted in early October and thus the seeds are undisturbed at the dates of both peaks of germination, allowing considerable numbers to escape the hoe and hand weeding which is carried out in late April and May. It is not shown in Table 6, but it does occur in the harvest and, although it is a ground-hugging species, it is regularly collected along with the straw harvest. Its presence, therefore, in the carbonised-seed record may well be considered as an indicator of autumn or winter planting of cereal crops.

The introduction of spelt wheat has been considered to mark the advent of winter sowing of cereals (Applebaum 1954, pp. 103–5) and it is regularly regarded as responding to the challenge of winter rather than spring sowing. The yield table above would, however, seem to disprove this supposition, since spelt is regularly outperformed by emmer, whether spring or autumn sown. The greatest advantage offered by autumn sowing is the spreading of the work load, both at sowing time as well as at harvesting.

One final comment concerning both emmer and spelt wheats is their remarkable resistance to cereal diseases like rust and mildew. Throughout the history of the project and in work for some four seasons before it on a variety of different soil types, no incidence of disease has been observed. Similarly these cereals are much more resistant than modern varieties to cereal-aphid infestation. Einkorn (*T. monococcum*) is virtually totally resistant to aphid attack.

CONCLUSION

This paper has sought to present elements of both a working landscape in the broad sense and the fundamental functions of a field in the narrowest sense. The hypotheses, raised initially from the empirical approach inherent in the methodology employed at the Butser Ancient Farm, are important for any appraisal of prehistoric, and particularly Iron Age, agriculture. One suspects that the landscape in this later period of prehistory was to all intents and purposes totally exploited and, therefore, controlled. No reference has been made in this paper to silviculture, which, of itself, is a major study, but because timber represented the basic working medium, as steel and plastic do today, there can be little doubt that woodland, just as were the arable and pasture, was planned, husbanded and cropped intensively. The title to this paper coins a new term, normally an unforgiveable offence given the flexibility of the English language. In mitigation, however, and by way of a gentle defence, the term 'agroscape' describes the condition of the Iron Age landscape as postulated here. The definition of a landscape divided up into fields or controlled blocks of land which were artificially imposed upon the terrain sums up the argument. One could perhaps further modify it with the adjective 'manicured'. Because the whole of the agricultural system was labour intensive and, in view of the increasing evidence being provided by archaeological survey for a high population density at that time, it is extremely likely that all resources were fully exploited. Indeed such a 'manicured agroscape' survives to this day in the more remote areas of northern Spain, including ard cultivation and ancient-type fields, lynchets and trackways, as well as coppiced woodlands.

The second part of this paper focuses upon the nature of agriculture as evidenced within the narrow confines of a field. Some results of the experimental research have been given to underline the paucity of our real knowledge of the extent of agricultural achievements under a truly labour-intensive system. The gross yields—the results given here are extremely conservative and refer principally to a field which is not favoured by added nutrients—are striking in terms of the quantity and quality. More surprising perhaps, because they are achieved on land avoided by modern agriculture. The *caveats* recorded above need, however, to be restated here to stress that any agricultural research must be carried out for as long a period as possible for the results to have any validity. The Ancient Farm, given its bold objectives, is now only in its ninth season. It may be that after another ten years research, many of the hypotheses raised here will need to be modified or even radically altered. On the other hand they could as easily be confirmed if not actually increased in numbers.

The most disturbing factor which emerges from the research patterns to date, is the superiority of the figures of yields of crops grown by Iron Age techniques over the documented results from subsequent periods of history. Indeed it is only in this century that similar results can be found in the records. It is not certain when the prehistoric cereals, emmer and spelt, were superseded by other varieties, but certainly their disappearance could well mark the beginning of the deterioration. The varieties at present being studied are morphologically very similar to those exploited in prehistory and the succeeding Roman period, both here and in Europe. Their successors, like the rivet wheat of the seventeenth and later centuries, are not as large either in seed or spike. It is most likely that agricultural development has been subjected to peaks and troughs of productivity, partly resulting from variations in the available cereal types. The present-day development of hybrids moves from generation to generation of hybrid cereal varieties, with their specific characteristics being enhanced or retarded according to practical requirements, such as yield, stand height, food value or milling quality. While this can be regarded as a logical response to market demand, it is interesting to report that in a controlled experiment in 1980, spring-sown emmer wheat outperformed one of the most modern spring-wheat varieties, sicco. As a counterbalance to this result, there is no doubt but that harvesting techniques in the modern, as opposed to the prehistoric period, would need to be developed to cope with the nature of the emmer wheat plant. It is, perhaps, not unreasonable to conclude by suggesting that in the later Iron Age and the Romano-British period agriculture in this country reached a peak of achievement which was not surpassed until the present century.

FOOTNOTES

1. This paper is based upon a lecture presented on 28 April 1979 to a joint meeting at York of the Yorkshire Philosophical Society and Group 4 of the Council for British Archaeology.
2. Analysis by R. S. Tayler, Department of Agriculture and Horticulture, University of Reading.

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