Chapter 3 - Raking the muck-heap: the archaeological recognition of animal husbandry and landscape use

In the previous chapter we examined the ways in which animals can be farmed. This chapter explores how feeding regimes, pasturing practices, methods of containment and handling, housing, and the needs of people caring for animals, can be identified archaeologically. Land use can be considered from the perspective of carrying capacity (e.g. Siracusano 2006), but this can be problematic due to the incomplete picture of settlement density and localised variations in soils and vegetation. This is therefore not an approach utilised here. The exact nature of a given individual system may be non-recoverable. However, it should be possible to make general observations as to its nature and in particular as to the general proportions of arable and pastoral agriculture, degree of integration and scale of production.

3.1 Establishing land use : arable and/or pastoral use of land

> '*although there is plentiful evidence for pastoralism in later prehistoric Britain, with rare exceptions that side of the rural economy has not been proved to have been associated with extensive systems of permanent confined pastures*' (Fowler 1983:107).

In the past fields have frequently been equated with arable cultivation. However, as has been established in the previous chapter, fields and boundaries are a frequent method of stock management, and therefore we should consider the likely use of archaeological examples. This can be done by establishing the evidence for cereal production, identifying specific features associated with cultivation, considering the stock proof construction of boundaries, and identifying whether specific areas of land appear to have been manured. This can be achieved by the consideration of a range of environmental and other data (*cf* Lewis 2008:241).

3.1.1 The presence or absence of an arable economy

Cereal pollen provides general indications of crop cultivation. For example, earlier Bronze Age on-site and off-site pollen samples at Stoke Flat in the Peak District, indicated some cereal production. The land division, consisting of low linear boundaries and small cairns demarcating irregular and rectilinear areas of land, supported by evidence for soil erosion, supported this although evidence for pastoral activities was less clear cut (Long *et al* 1998:516). Crop residues, in the form of plant macrofossils, likewise provide a general picture of arable exploitation and supply species lists, but cannot directly indicate where cultivation occurred. Crop processing leaves different constituents of plant parts at various stages, and identification of the stage of processing can be made from the proportions of plant parts represented. This can be used to identify the economic base of sites, either as producers or consumers (van der Veen 1992). However, calculations of population from utilised areas are generally doomed to failure due to the range of variables. However, calculations of possible arable output from fields on the Yorkshire Moors indicate that the labour needed to cultivate the available area far outstripped the evidence of housing, whilst utilisation of the area for pastoral agriculture was a better fit (Hayes 1981:116-7). In addition, the alteration of plant species composition of grassland caused by grazing (Humphrey and Patterson 2000; Bullock and Pakeman 1997) should be detectable in pollen data.

3.1.2 Clearance and cultivation

Land clearance is often assumed to relate to arable cultivation. However, clearance is desirable for pasture as well (Fowler 1981:18). Clearance is archaeologically identifiable in the pollen record, in the generation of associated features, and via erosion and deposition of soils as alluvium and colluvium. Cairnfields should not be regarded as soley diagnostic of arable (Fowler 1981:18), a state of affairs that has recently been more widely recognised (e.g. Barnatt 2008; Evans 2008). Erosion also need not be related to arable cropping (Herring 2008:80), as discussed below. Removal of woodland across southern Britain was episodic, taking place over a long time span. Therefore, dating of clearance episodes is important in identifying grazed woodland or open grazing either prior to the establishment of field systems or contemporary with them (Richmond 1999). Understanding the proportion and type of tree cover and change over time can be elucidating. However, we must also be aware that areas beyond the obviously cultivated/managed landscape can also be effectively utilised in pastoral husbandry. To assume that areas beyond the bounded landscape were woodland or scrub may well be erroneous. It has been shown that in the Medieval period, terms such as 'forestis' and 'wald' which have been taken to mean woodland, actually describe the tenure of the land, and these areas contained a mosaic of woods, grassland and moor (Vera 2000:113). Also, it is now evident that forests can continue to regenerate and expand whilst being grazed by livestock and deer. The New Forest has been extensively studied and indicates stability in regeneration as long as grazing is regulated and thorny scrub available to shield seedlings (Vera 2000:144-155).

Arable agriculture requires the regular breaking up of the ground surface. Therefore, the most frequent direct evidence of arable land use involves ard and plough marks. Most identified cases involve deep scoring of the subsoil (Fowler and Evans 1967), and may therefore under-represent ploughed areas and are likely to be ephemeral and discontinuous. Also, by the nature of their preservation, they may represent sporadic ground breaking, rather than annual activities. At Overton Down, orientation on the line of the field boundaries implies contemporaneity, but the cross ploughing could relate to as many as five episodes relating to various points in the field's life (Fowler and Evans 1967:291). Prehistoric spade marks in rows, away from a boundary, and cutting into the subsoil at Hengistbury Head, Dorset, may relate to arable or horticultural cultivation, but given the lack of disturbance of what may be an episode of double-digging, it is also suggested that this may relate to clearance of the area (Lewis 2002). Certain identification may not be possible in most cases, which leads us to consider whether digging or ploughing actually equates directly to arable, or whether sporadic breaking up of pasture occurred as part of grassland management. Pernicious perennial weeds such as couch grass can be managed by ploughing up, raking and burning the roots or by bare fallowing and repeated ploughing in the summer months (Henderson 1944:36).

3.1.3 Stock-proof boundaries

> '*Without a fence you cannot fold sheep or cattle on fodder crops; you cannot concentrate pigs on rooting; you cannot even keep goats and chickens out of your garden*' (Seymour 2003:138).

Boundaries are more necessary for livestock husbandry than arable cultivation. Fencing not only removes the time-consuming approach of herding livestock, but also enables better husbanding of the available land (Seymour 2003:138). They play a role in controlling damage by wild species. Wild boar in modern Europe are a considerable cause of damage and loss of arable crops, and are controlled with fencing, baiting woodland with food to lure them away, and heavy levels of culling. However, increased fencing does not appear to actually assist, shifting the areas of damage to adjacent crops; hunting is the most effective control (Geisser and Reyer 2004:939;944). Fencing that is guaranteed to control deer needs to be considerable, with 1.8m high fencing recommended for red deer (Bryce and Wagenaar 1985:97). It seems unlikely that prehistoric boundaries were primarily aimed at exclusion of wild species.

Construction of boundaries is crucial to understanding how they operated. Boundaries have to be of a certain scale and robustness to withstand stock and provide adequate control over them. It has been observed by various commentators that many archaeological boundary constructions are too slight to have provided an adequate barrier (e.g. Fowler and Evans 1967:296), but we may only be seeing part of the picture. Lynchets themselves are the product of ploughing and are not original features of the field. They come into being from repeated use and a degree of settlement permanence is implied in their existence (Fowler 1983:107-8). Lynchets and early Romano-British period fields at Totterdown , Wiltshire, may have had no structure other than that caused by the build up of flinty soil between ploughed areas, whilst at Smacam Down, Dorset the lynchets appear to have been produced by periodic field clearance of stone, apparently indicating unenclosed cultivated areas (Fowler and Evans 1967:298). The original height of structures needs to be considered. A low drystone wall at Fyfield Down was assumed not to have been stock proof as it did not appear to have been constructed high enough and was interpreted as delineating land ownership (Fowler 1983:110). Johnston considers that apparently unstructured stone banks, with a lack of evidence for fences and hedges, precluded their use as stock proof barriers, indicating roles as conceptual boundaries (2005a:219). However, the limited amount of excavation may relate to the lack of identified structures such as hedges and fences.

Boundaries can comprise stone walls, stone or earth banks, earth banks revetted with stone or posts, ditches, fences or unploughed baulks. Drystone walls can be stock proof where there is sufficient stone, but require large amounts of stone and labour. The stone hedge, consists of two walls leaning toward each other which are constructed with a turf, earth and rubble core and a hedge planted on the top. They are, however, not necessarily stock proof; the hedging is the crucial element. Wattle hurdles are relatively rapid to erect, but do not last very long. They can be woven of pliable woods such as willow and hazel, but also holly, ivy, brambles and other creepers. Post and rail fencing covers long distances efficiently and is longer lasting. Wood hurdles are more robust than wattle, are still mobile and longer lasting. They are good for temporary folding of livestock (Seymour 2003:138,140). Hurdling and fencing can be identified in waterlogged wood.

Ditches are the most archaeologically frequent boundary and provide land drainage in wetter areas. However, they tend to be regularly cleared out, in wetlands every few years, and elsewhere once in a generation (Pryor 2006:70). This inevitably makes identification of their dating and longevity problematic. Chadwick comments (2008a:224) that routine ditch maintenance is likely to have been archaeologically invisible. It is the final part of a ditch's life that is dateable, when the system is failing and falling into disuse. Hedgerows can be robust but hard to identify archaeologically, generally in conjunction with a bank or ditch (Pryor 2006:71). To be stock proof, hedges need to be constructed of closely spaced shrub species; thorn bushes are ideal. Hawthorn and blackthorn are currently considered the most appropriate hedge species in Britain (Maclean 2000:25). A variety of other species may be suitable (Table 17), whilst some should be avoided (Table 18). These can be propagated and planted in various ways according to the ground conditions. Thorns can be grown from seed or from cuttings heeled in to low bank; willows root readily from cuttings (Seymour 2003:138; Maclean 2000:44-5, 57). Many archaeologically identified ditches are very shallow and would not control access by stock (Pryor 2006:84). Ditches therefore may have been dug to supply the bank into which autumn hardwood cuttings would be placed. As waterlogging causes these to rot, the bank would ensure drainage whilst the plants became established. Hardwood cuttings establish much more quickly, producing a stock proof hedge in five years, although they need protection. Sheep and especially goats will eat young quickthorns (Pryor 2006:85-7; Seymour 2003:138). The author's own propagation of blackthorn and hawthorn from seed has resulted in plants 50cm tall after four years of growth, and it seems that Pryor's suggestion is eminently sensible. Established hedges can be maintained on a five-ten year laying cycle. This is labour intensive, but lasts indefinitely and serves as a wind break (Seymour 2003:138; Maclean 2000:87). Hedges also supply gathered foods and trimmings for use as fuel. It is these practices that can be identified from charred and waterlogged wood, whilst the presence of hedgerow species in pollen diagrams and wood and plant macrofossil assemblages may be indicative.

Table 17: Plant species suitable for stock-proof hedging (after Maclean 2000).

Species	**Light soils & gravel**	**Loamy & silty soils**	**Chalk & limestone**	**Heavy & clay soil**	**Damp & boggy**	**Windy & coastal**
Field Maple (*Acer campestre*)	*	*	*			
Dogwood (*Cornus sanguine*)			*			
Hazel (*Corylus avellana*)		*	*			
Hawthorn (*Crataegus monogyna*)	*	*	*	*		*
Spindle tree (*Euonymus europeaus*)			*			
Sea Buckthorn (*Hippophae rhamnoides*)						*
Holly (*Ilex aquafolium*)		*	*	*		*
Crab apple (*Malus silvestris*)		*		*		
Blackthorn (*Prunus spinosa*)	*	*		*		*
Dog Rose (*Rosa canina*)						
Willow (*Salix viminalis*)					*	
Alder buckthorn (*Frangula alnus*)					*	
Gorse (*Ulex europaeus*)	*					*

Table 18: Plant species unsuitable for hedging (after Maclean 2000).

Species	**Prone to being browsed**	**Poisonous**	**Invasive**
Common Beech (*Fagus silvatica*)	*		
Purging Buckthorn (*Rhamnus cathcartica*)		*	
Broom (*Cytisus scoparius*)		*	
Common Elder (*Sambucus nigra*)			*
Yew (*Taxus baccata*)		*	
Elm (*Ulmus procera*)			*

3.1.4 Manuring

Manuring is a key link between arable and pastoral agriculture. Whilst arable cultivation provides both food for people and fodder for animals (Reynolds 1987:28), use of manures can also indicate intensification or longevity of arable production, and by necessity, animal management. The methods of identification are described in a later section of this chapter as this issue applies also to the utilisation of animals.

3.1.5 Integrating arable and pastoral Farming

Aside from the problems of obtaining incontrovertible evidence of land use for either arable cultivation or pastoral farming, there is also the likelihood, established in the previous chapter, that many fields, or at least some within a system, may be multipurpose. The advantages of being able to utilise crop residues whilst manuring land have been explored previously, and the arrangements that we might expect to result are explored further below. This is not a new concept. An infield and outfield system was proposed by Applebaum in the 1950's for prehistoric Wiltshire field systems (1954:107). As Fitzherbert says:

> '*The mooste generall lyuynge that husbandes can haue, is by plowynge and sowyng of theyr cornes, rerynge or bredynge of theyr cattel, and not the one withoute the other*' (1534:9).

3.2 Having herds: keeping and managing livestock

3.2.1 Establishing species and understanding aims

The presence of species and their relative proportion in the animal population is best established with faunal remains. However, a variety of other information can be used to indicate the presence of particular species; hoof prints can be measured and identified to species (Evans 1984:25). Certain invertebrates can be indicative of particular livestock. The presence of sheep, or at least fleece, can be inferred from the presence of keds or fleece louse (Amorosi *et al* 1998:49). Head biting lice can indicate cattle (Schlevis 2000). Dung beetles (*Aphodius* spp.), more abundant on organic farms compared with extensive rough grazing (Hutton and Giller 2003), may have the potential to indicate the intensiveness of cattle production. Indirect data can be obtained from material culture relating both to the arable economy (e.g. querns), and more particularly the exploitation of animals. Spindle whorls and weaving combs can indicate exploitation and the probable presence of sheep and goats, as can residues of dairy products (Copley *et al* 2005a; 2005b; 2005c).

Faunal remains cannot be used to estimate actual stock numbers, due to the partial nature of assemblages be it through taphonomic and diagenetic issues or depositional practice. Neither are most faunal assemblages closely chronologically focussed. However, animal remains not only confirm the presence and relative importance of a species, but also supply information on herd structures and culling policies. Further information on the manner in which animals have been kept can be suggested by some pathological conditions. The mortality profile of a species in a given assemblage is the result of a combination of factors and choices that reflect both the 'aim' of husbandry (the product) and the 'strategy' for obtaining it (husbandry practice). For example, in order to maximise herd growth, cows must be allowed to live until the end of their reproductive life. Keeping older animals may be advantageous as their additional experience assists efficient pasture use (Bailey 2005:116).

Only a few bulls are required, one for 30-50 cows, with a couple of young 'understudies'. All other males would generally be castrated or slaughtered before maturity in pastoralist societies. However, the age of slaughter is affected by differing emphasis on meat or milk. If dairy products provide a large proportion of the diet, optimum meat weight of animals is less crucial (Reid 1996:49-52). The range of practices associated with the management of sheep is given in Table 19. Each strategy leads to a different culling profile, but mixed production 'aims' are difficult to interpret. In addition, there may be statistical problems with the kill-off curves produced by the ethnographic models on which we rely. Rather than attempting to match curves to a particular production aim, grouping data into age classes may assist. Milk production should give an over-representation of the very young, wool the very old, and meat production a balance between age groups (Marom and Bar-Oz 2009:1185-6). However, deaths not only reflect production aims, the majority of which were not specialised, but numerous subtle choices of husbandry and management.

Table 19: Flock management strategies for sheep

Ethnographic Model	Strategy	Cull peak	Reference
Payne (Turkey)	Specialised meat production	Between 1 and 3 years	Payne 1973
	Wool production	Some lambs killed in first year	
	Milk production	Males culled in first three months	
Redding (Near East)	Optimization of energy production	Early weaning and culling of males at 1-2 years	(Redding 1981, quoted by Marom and Bar-Oz 2009:1184-5)
	Optimization of herd security	Sub adults culled at 2 years	
Vigne and Helmer (France)	Type A meat	Lambs culled 0-3 months	Vigne and Helmer 2007
	Type B meat	Lambs separated from milking ewes then culled 1-2 years. Peak of worn out ewes at 2-4 years.	
	Wool utilisation	Peak at 4-6 years	

Culling of young calves has been regarded as indicative of dairy production as this is the pattern produced by modern farming. McCormick (1992:202-3) has challenged this as early Irish texts indicate that cattle would not let down milk without the calf present. This, however, seems to have been overcome in medieval England, and other strategies such as using the calf skin are also attested. Very high numbers of neonatal cattle, and animals under one year of age, are represented in Bronze Age and Iron Age assemblages in the Western Isles. Due to the marginal nature of the area, this has been interpreted as due to the constraints of winter fodder availability. Historical records indicate limited hay making and the poor condition of animals at the end of winter (McCormick 1998). Large numbers of calves may indicate lack of dairy production and larger numbers of sub-adults, its presence (McCormick 1992:207; Halstead 1996:25). However, lipid analysis at Cladh Hallan dating to the Bronze Age/Iron Age transition contradicts this (Craig 2003). A range of strategies may have been employed in mainland Britain. Duration from birth to weaning can be examined with study of intra-tooth variation of nitrogen isotope ratios (Ballasse *et al* 2001). Early weaning of Neolithic cattle at Bercy, France suggests the importance of dairy products in this economy (Balasse and Tresset 2002). Lipids of ruminant dairy fats can be identified in pot sherds, and indicate that dairy production was widespread in prehistoric Britain (Copley *et al* 2005a; 2005b; 2005c).

Medieval stocking and productivity at North Curry on the Somerset Levels gives useful information on expected herd structures in a non-intensive system. The herd over the winter of AD1325-26 consisted of 36 or 39 oxen, 1 bull, 11 cows, other younger heifers and steers (two-year olds and yearlings) and 10 calves remaining at Michaelmas (23rd September) AD1325, despite the herd being utilised for the production of butter and cheese (Thompson 2002). Where large numbers of animals are required for traction, it seems that ways can be found of retaining calves whilst utilising dairy products. Subtleties in kill off profiles may be difficult to detect but clear patterns at least indicate deliberate rather than random strategies.

Seasonality of killing raises some interesting issues. It has been previously assumed that autumn culls were required because supplementary winter fodder was not available, and all but the breeding stock had to be killed (Ryder 1981:183). However, other practical issues such as meat storage and herd management choices are also in play, which have been mentioned in the previous chapter. The practicality of consuming meat before it went off might mean that full utilisation of meat was more feasible at a time of year when even the entrails would keep longer (Forbes 1998:29). Tibetan nomadic pastoralists hardly kill any animals over summer as they are either still productive, can be milked, or are gaining weight from readily available forage. The peak in culling occurs late enough in the year that meat will freeze, but before animals begin to lose condition (Ekvall 1968:48). It is also notable that feral Soays on St Kilda, have a high natural loss in the first year of up to 50%. These natural winter deaths may mimic autumn culling (Ryder 1981:183).

Inter-site differences in age groups may indicate that cohorts of animals were being moved between them and consumed in different locations (Reid 1996:49-52). This spatial analysis moves beyond the consumption and discard practices of individual sites. Significant proportions of immature animal bone in southern African assemblages occur at elite centres, in contrast to non-elite sites. Cattle can be regarded as being important both as a resource but also for their socio-political role. The implication is that, the younger the animals are slaughtered, the more wasteful and exploitative are the power relations; subsistence economies would only slaughter at the optimum weight. Relations between sites would be expected to change cattle exploitation patterns. '*No site within a complex system is likely to be managing its* *herds and slaughtering animals in isolation, without the influence of other sites in the region*' (Reid 1996: 48-49).

Some pathological conditions may assist in considering how animals were managed. Dental enamel hypoplasias are related to developmental stress during formation. It is not a randomly occurring event (Dobney and Ervynck 1998; 2000), but the location on the tooth and in the tooth row in pig teeth indicate particular causal events including birth and weaning. As such it is useful in examining changes in nutritional and other stresses with populations (Dobney *et al* 2002:36). A reduction in incidence in the later Middle Ages was linked to increased pig housing and regulation of feeding (Ervynck and Dobney 1999; Teegan 2005a). Differences between the pattern of hypoplasias in Anglo-Saxon material and 15th -16th Century Flemish pigs suggested that the former were 'semi-natural' in their husbandry, whilst the latter were more controlled (Dobney *et al* 2002:45). Hypoplasias in cattle teeth could be utilised to indicate stresses during the period of tooth formation but this is difficult to achieve with confidence from macroscopic analysis alone, especially given the frequent deep formation of cementum (Keirdorf *et al* 2006:1693). Stable isotope analysis can indicate the difference in diet in cattle before and after weaning by examining samples from teeth (Zazzo *et al* 2006).

Metrics are able to elucidate general changes in animal populations, particularly when considered over time. The changing size of pigs has, for example, indicated domesticated exploitation and husbandry in the Italian Neolithic, and Bronze Age metrical data are able to demonstrate differences between domesticated livestock and wild boar. As other evidence suggests a largely free range management system (Albarella *et al* 2006:221), it indicates the degree of control that was still exercised over the animals. Changing prevalence rates of pathological conditions related to use for traction and overgrazing may also elucidate how the use and pasturing of animals changed over time.

So far in this discussion wild species have been conspicuous by their absence. Absence of evidence will become a theme in discussion of the role of non-domestic species in prehistory, as they occur in low frequencies throughout the period and there is a general lack of information about them. Fowler (1983:199) falls into the trap that many writers encounter in assuming that because a wide variety of potential mammal, avian and aquatic resources were available they must have been utilised. Inevitably, the role of wild species of mammals, in particular, will depend on the degree of unenclosed land in a particular landscape, and the nature of that landscape, but the type of animal remains deposited (i.e. antler rather than bone), the way in which that is deposited, and how it has been treated, will always tend to inform us more on ideology than economy. This is, however, and area in which other information, for example from isotopic studies of human remains for dietary contribution can assist.

3.2.2 Identifying management methods : foddering, pasturing, housing and handling

Feeding the herd

It is possible to identify the use of grazing and other fodders in a variety of ways, which are summarised in Table 20. It is also possible to determine between the contents of dung of grazed and fodder fed animals, and this may have archaeological application (Anderson and Ertug-Yaras 1998:108). Different foddering strategies between wild caprines and those fed fodder, have been identified using $\delta^{13}C$ and $\delta^{15}N$ values from their molar teeth, identifiable due to the smoothing effect on the carbon uptake by overwinter foddering (Markarewicz *et al* 2006). Seasonal sheep/goat foddering can be identified from oxygen and hydrogen isotopes (Kirsanow *et al* 2008). Grazing or fodder fed sheep and goats can be considered using dental microwear analysis (Mainland 1998a), whilst stall-fed or rooting pigs can be differentiated by the same method (Ward and Mainland 1999).

Table 20: Identification of grazing and fodder utilisation.

Feed type	Applicable methods
Pasture	Pollen; dental microwear
Cut fodder	Plant macrofossils; invertebrates; dental microwear
Leafy fodder	Pollen; plant macrofossils; dental microwear
Crop residues	Plant macrofossils; dental microwear

Pryor (1996:322) has proposed that in parts of lowland England the increasingly elaborate division of landscapes after the early 2nd Millennium indicate the need for careful pasture management. The main indicator that has been used to identify grazing land is pollen analysis. This is generally not available on a localised scale, but does provide information on the proportion of a given locale that was under grassland, and can provide information on the intensity of grazing and change over time. Pastoral activity is difficult to specifically identify in the pollen record, because many plant species associated with grazing can occur in ungrazed grassland or disturbed ground situations (Long *et al* 1998:516). The poor chronological resolution of pollen diagrams can also limit interpretation, as can the way in which plant species respond to grazing pressure. In the Scottish highlands, observation of the results of removal of sheep showed that whilst there was some increase in scrub development, the effect was not rapid, possibly due to continuance of heather burning and grazing by red deer (Hope *et al* 1996).

The accumulation of alluvium and colluvium has the potential to assist in understanding landscape use. Grazing and trampling of vegetation in forests can lead to localised erosion (Limbrey 1978:22-3). Heavy and intensive grazing increases erosion and runoff, although pastures under high intensity but low frequency systems produce less runoff than moderate but continuous grazing (Blackburn 1983:123-4). Clearings increase localised flows in streams but the effect of crop cover at differing times of year is poorly understood. Grass cover seems to decrease surface flow, but gullying occurs in arable and badly used and heavily grazed pasture. These effects vary depending on the underlying geology and soil types (Limbrey 1978:23-24). Grazing of grass within woodland can provide fodder, but causes suppression of tree growth, as saplings are also eaten, especially by sheep. The amount of forage available is directly proportional to the amount of canopy cover, and grazing generally needs to maintain low numbers of animals per hectare to be sustainable (Adams 1975:144,148). This type of change may also be detectable in pollen curves. In attempting to refine understanding of the relative quality of grazing, dental microwear may be of use as it can distinguish between diets of leafy and grassy hay and grazing and between rough and good pasture (Mainland 1998b:57). This has, however, had limited application, and can be complicated by ingestion of soils by grazing sheep (Mainland 2003).

Pollen in Bronze Age sheep/goat dung in northern Italy with twigs and anthers of hazel indicate that the animals ingested catkins as well as beech twigs (Haas *et al* 1998:83;

Karg 1998:88). Low level utilisation of leafy fodder and forest grazing may have little impact on tree cover, although more intense use can affect soil quality or structure, and general thinning has less impact than clearings (Limbrey 1978:22-3). Taking leafy fodder can have a considerable role in restricting woodland. Pollarding and coppicing a variety of tree species in the Pindos Mountains in northern Greece to provide winter fodder for sheep had a measurable effect on tree cover (Hall 2005). Grazing of young shrub species can also have a marked effect, and these are very palatable to sheep (Magda *et al* 2009). This may be archaeologically visible in reduction of growth-ring width in trimmed trees, and a pollen profile that mimics tree cover reduction (Halstead and Tierney 1998:75).The degree of exploitation may be detectable in an invertebrate assemblage, as ecological diversity is promoted by longevity of woodland and lack of large scale anthropogenic activity. The range of species is restricted when woodland is browsed by animals (Smith and Whitehouse 2005: 157).

Identification of stored, cut fodder largely depends on the interpretation of plant macrofossil assemblages. We should expect to see plants and plant parts most likely to provide animal fodder, such as stems and internodes of arable crops and grasses. In addition, invertebrates can be helpful due to the particular preferences of different species. Determining between coleopteran assemblages associated with stored hay, farmyard manure and other deposits have, however, proved problematic due to the fact that functionally different environments can offer a similar habitat to the various species. However, ‘barn beetles’ can still be useful in identifying dry materials (Smith 1998:65,69). Cut fodder has been inferred from the insect population at Wilsford Shaft. Abundant remains of species that are associated with long meadow grass and coarse herbage imply the cutting of vegetation (Osborne 1969:564).

Agricultural residues were certainly an important source of nutrition utilised in the classical Mediterranean (Foxhall 1998). Use of arable residues in modern India can account for 40-60% of the dry matter content of fodder (Parthasarathy Rao and Hall 2003:189). Utilisation of chaff as animal fodder may result in plant macrofossil assemblages where chaff is scarce: it is not available to be burnt and preserved (Campbell 2000). This has been used to explain the pattern of cereal parts in charred seed assemblages, but may not provide the full story. The presence of grain can convincingly be argued to be as a result of the scale of production and consumption rather than a particular activity (Jones 1998; van der Veen and Jones 2007:425), and this should be borne in mind when assessing the balance of arable and pastoral agriculture at a given location.

Containing animals - form and function?

'It does not unreasonably limit or distort our interpretations to assume that each component of a field system had a reason, meaning or function, and every field system an agricultural logic bound by economic, social, cultural, ritual and customary constraints' (Herring 2008:70).

Prehistoric fields and boundaries occur in a variety of forms, shapes, and methods of construction (Fowler 1983:108). Pryor comments (2006:82) that animals only need to be kept in fields once their numbers reach a point that grazing has to be managed, but whether boundaries were stock proof has a direct bearing on the degree of supervision and labour that was needed on a daily basis. Animals roaming freely would require herding. Field and enclosure shape has been considered to largely be related to date, or occurring sequentially, with amorphous shaped enclosures being succeeded by irregular/rectangular fields and 'planned' rectilinear ones (Fowler 1983:128-9). Irregular shapes of fields have also been assumed to relate to the seasonal and 'piecemeal' nature of their construction (Harvey 1980:44). However, the reality appears to be far more complex. Fields and boundaries were probably only in rare cases laid out in one operation in the form that we now perceive them. The likelihood is that in most cases, even where they appear 'planned' the archaeological resource is the result of a long process of development, adjustment, alteration and accretion (*cf* Chadwick 2008b; Barnatt 2008: 50). However, the general form which boundaries take, and the final form which they developed into reflects the aims of communities, albeit over time. The discussion of fields has often disconnected the architectural structure of fields from the activities they contained (Lewis 2008:239). We therefore need to consider how landscape layout reflects organisation of the farming task.

We struggle when using terminology to describe bounded spaces. Defining the differences between enclosures and fields can be problematic due to their variety. Johnson and Rose (1994:59) suggest that a 'field' could be:

'a defined area where cultivation and controlled grazing can take place', whilst 'enclosures' are defined as ' areas where the more intensive processing, sorting and corralling of animals takes place, where animals are protected, and the domestic areas (including garden plots) are in turn protected from the animals',

whilst size may assist in suggesting function. However, this is problematic as these activities may occur in a number of locations, and it does not address identification of land use. Here, the term 'field' is used where a parcel of land is part of a sub-divided system of land use, whereas 'enclosure' describes isolated or unattached bounded spaces. When we think of fields, we have a tendency to envisage a roughly rectangular or sub-rectangular defined space which fits with the features of the natural landscape. This is inevitable given the modern British landscape that we are familiar with. However, if we deconstruct what those spaces are used for, their form can be suggested to relate to choices of livestock management and handling.

The square or rectangular shape of many Bronze Age and Iron Age fields has been explained as the result of using the ard. The need to cross plough in order to achieve a suitable tilth would result in a square field, whilst the mouldboard plough, being difficult to turn, created longer fields (Harvey 1980:42-3). However a later second millennium BC enclosed area at Glenree Co. Mayo, which is partly overlying and possibly contemporary with cultivation, is irregular and sub-oval (Fowler 1981:19). In an arable field, prior to the advent of heavy duty ploughing equipment, shape would be largely irrelevant. Where fields or enclosures have been constructed with an evident design which is not, or only partially, dictated by the natural landscape, or earlier constructions, other motivations are likely to be in play. Some of these are social in origin and referred to below, but we should also consider the influence of topography and utilisation of ditches for drainage. Boundaries may follow the lie of the land, especially when there are obvious topographic features such as cliffs, sharp contours and watercourses. However, where these are not present, the arrangement of boundaries will have been arrived at for other reasons. Ditches are useful for drainage as much as creating bounded spaces, but their organisation can be equally enlightening. Two approaches employed in the Romano-British period have been identified on the Wentlooge Levels in Gwent. One is rectilinear, narrow spaced and systematic, whilst the other is irregular; one ignores the natural creeks, whilst the other utilises them. The systematic approach may represent a single episode of construction, whilst the other may be more piecemeal (Rippon 1999:109). On the other hand, irrigation of pasture may have been employed and it has been suggested that greater quantities of flood deposits than expected at Flag Fen may have been a result of deliberate manipulation (French 1992).

Where bounded spaces were intended for a pastoral or dual arable/pastoral use, their design is likely to have been influenced at least in part by the needs of livestock. We can therefore consider the morphology of fields and enclosures from the point of view of the animal. Figure 6 shows the method of movement of animals within a rectilinear enclosure. This utilises the sides and corners of the space to achieve a funnelling effect. This relies on the field of vision of the animal, and as a herd animal cattle and sheep have a 'collective flight zone' (Grandin 1980). Livestock have wide angle vision. Cattle and pigs have a visual field in excess of 300 degrees. In sheep, the visual field ranges from 191° to 306° depending on the amount of wool on the head. They have a point on the edge of their vision, within a distance that depends on how used they are to people and handling, that once breached they will seek to move away from *en masse*. In extensively reared animals this flight zone can be as much as 90m, or as little as 1.5-8m in intensively reared cattle (Grandin and Deesing 2008).

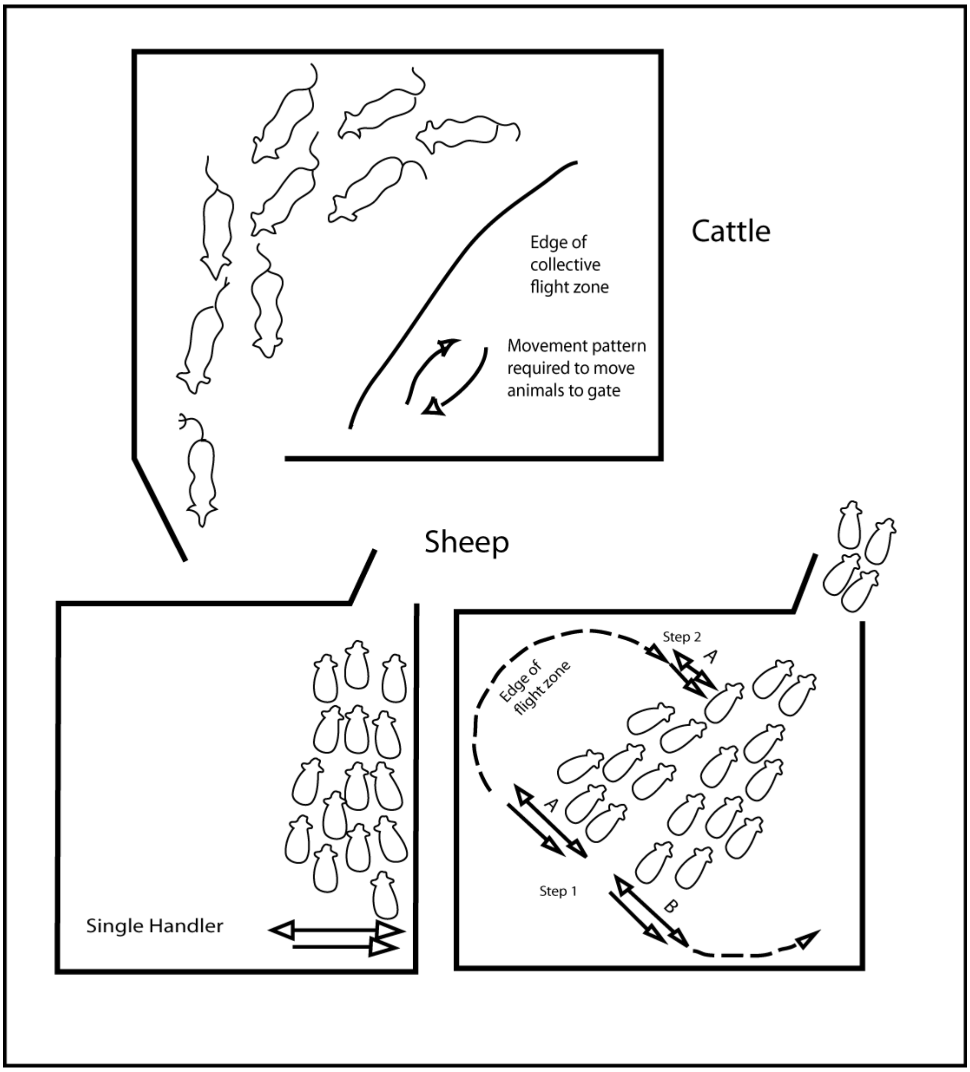

Figure 6: Movement of livestock within land parcels (After Grandin.com)

Rectilinear systems of land parcels are common across southern Britain from the Middle Bronze Age onward (Yates 2007). 'Celtic' fields are also well known, particularly in Wessex, and generally assumed to be Iron Age or Romano-British in date. They are often straight sided and between 0.1 and 0.4ha, commonly surviving on slopes as lynchets. They are defined by banks and occasionally walls. Blocks of fields vary between a few hectares and many hundred (Bonney 1978:49). Very few have received extensive excavation so we do not know the full range of construction, contemporaneity, or use. An interesting example of field layout has been discussed for Lawford, Essex. A sequence of boundaries on low-lying land adjacent to the River Stour was recorded from aerial photographs (Figure 7). One space surrounds an earlier group of barrows, and the arrangement of the boundaries, with continuous rounded corners of adjacent enclosures forming staggered angles, facing them, has been taken as an indication that the barrows are effectively on the 'outside' of the system. Clear and regular breaks are identifiable as gateways, allowing access into the field system and within it. Staggered angles have been suggested to be access points to fields, but this indicates that this is not the case. The area of the barrows, enclosed and subdivided itself, may well have itself provided rough grazing on '*a bit of old pasture too bumpy to be ploughed up*' (Fowler 1981:27).

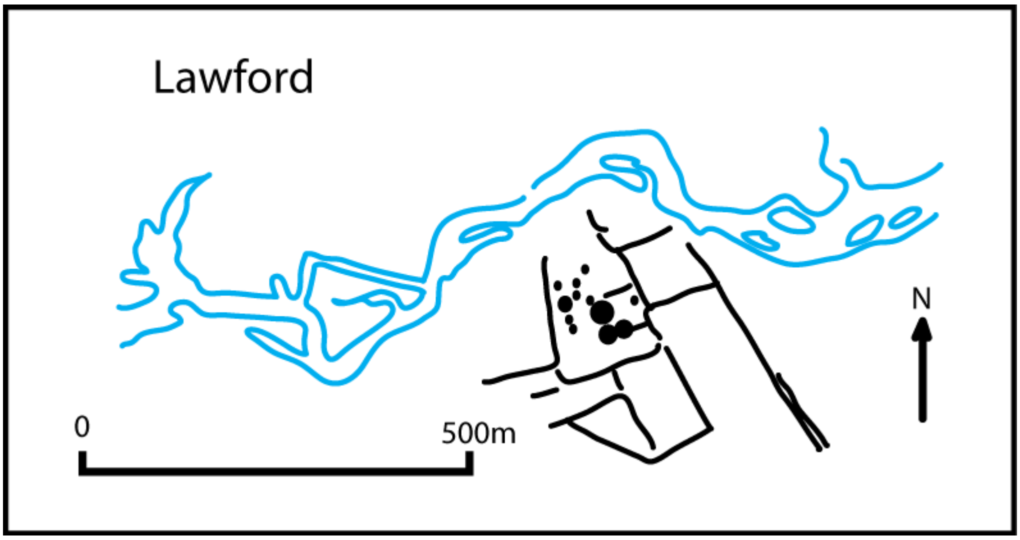

Figure 7: Field boundaries, Lawford, Essex. Not only does this system reference earlier landscape features, but also displays a logic in what is 'inside' and ' outside' and the method by which it is possible to move from one parcel to another (after Fowler 1981:27).

'Ranch boundaries' or linear ditches appear in the same areas as 'Celtic' fields but in an apparently more restricted zone in Hampshire and Wiltshire and Dorset east of the river Stour (Bonney 1978:50), although they may have been more widespread. They have been described as 'a remarkable carving up of the landscape' and tend to meet at nodal points, many of which later became hillforts (Bowen 1975:51). Irregularity of long earthworks may imply construction in phases (Bradley and Richards 1978:53).They vary in length but often extend for kilometres, sometimes straight and sometimes sinuous (Bonney 1978:50). They are assumed to relate to animal containment but how is not clear (Bowen *et al* 1978:149) and this may be a more evident case for territorial division as it is difficult to see the localised function with relation to animals.

Enclosures that apparently contain nothing have often been interpreted as stock corrals, but evidence to confirm this is problematic. A number of hilltop enclosures in Southern Britain dating to the later Bronze Age and Iron Age have been interpreted in this way. Many seem to have developed into hillforts and the pastoral origin of their use may relate to the development of focal places in the landscape (Fowler 1983:193-5). However, arguing from lack of evidence is difficult and how these enclosures fit within their contemporary landscape and land use needs further clarification.

Rounded designs rather than rectilinear systems are not necessarily a less sophisticated form of construction. Not only does it take less boundary distance to enclose a given area, but curvilinear forms, given the behavioural characteristics of stock, have been demonstrated to allow ease of livestock handling, reducing the distance walked and the number of people needed to operate the system (Weller 1982:67). Modern research into low stress livestock handling has led to the development of curvilinear enclosures and handling equipment (See Figures 8 and 9). Curves lead the animals to think that they are heading back to where they came from (Grandin and Deesing 2008). Given the widespread distribution of similar features historically and archaeologically (e.g. curvilinear enclosures with dependent interior buildings from the Bronze Age Negev have been interpreted as relating to pastoral husbandry (Rosen 1988:502)), it seems likely that there is a functional element in their design.

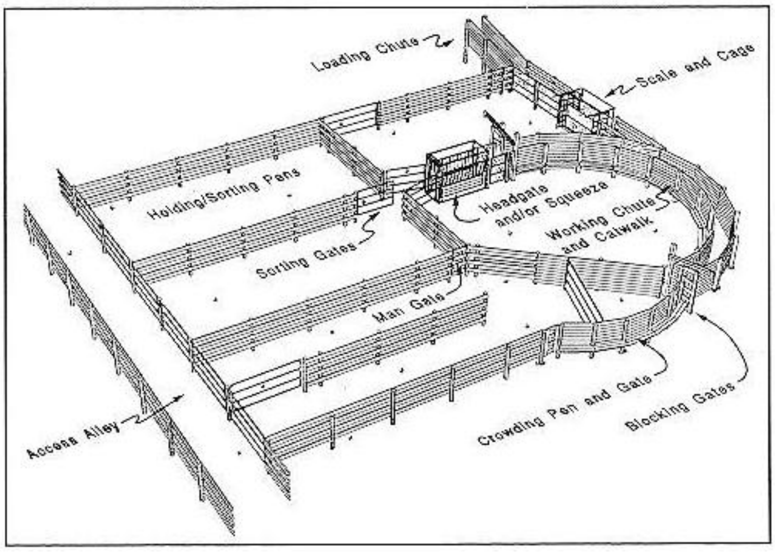

Figure 8: Cattle handling system (Grandin and Deesing 2008)

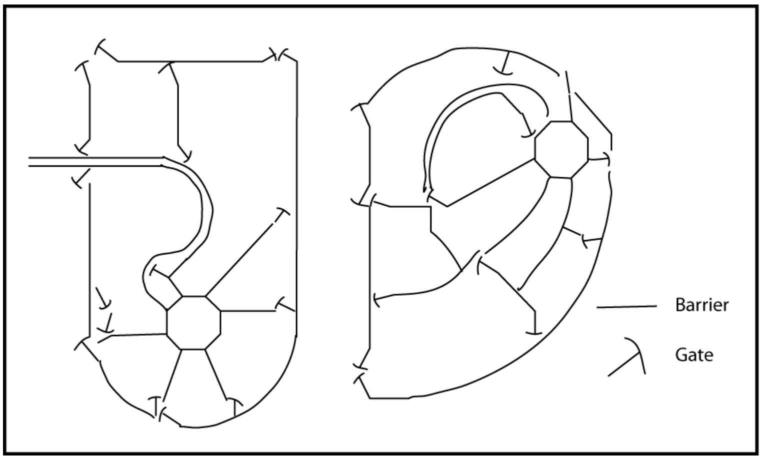

Figure 9: Curvilinear stock handling equipment layout (After proway.com.au). Note how the layout utilises a combination of straight edges and curved space.

Rounded enclosures often occur ethnographically. Maasai herders are semi-nomadic and utilise sheep, goats and cattle. Settlements are laid out around a central cattle enclosure constructed from encircling buildings, smaller pens and thorn hedges (Shahack-Gross *et al* 2003:440) (Figure 10) . Livestock are herded together despite the fact that each household is economically independent. Settlements are short lived, occupied for an average of 4 years. They are organised around the needs of livestock but follow rules that reflect the social organisation (Shahack-Gross *et al* 2004:1396). This use of space has been shown to be traceable in abandoned settlements by micromorphology and presence of phytoliths, due to the heavy build up of dung within the enclosures (Shahack-Gross *et al* 2003:453)

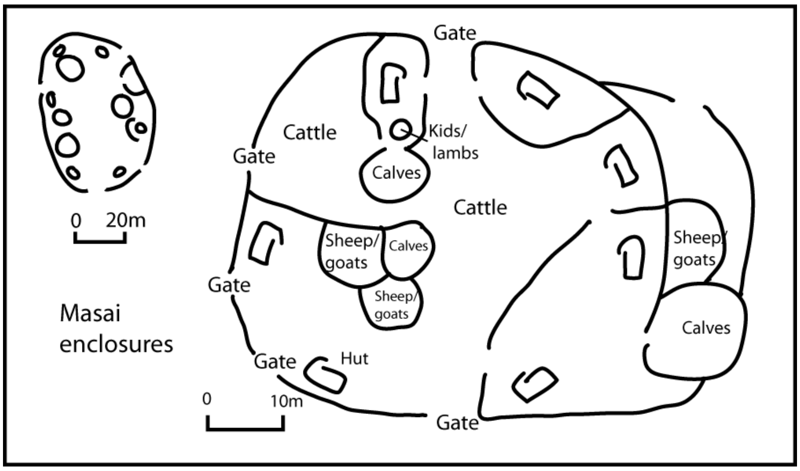

Figure 10: Maasai enclosures, Kenya (After Shahack-Gross *et al* 2003:441,444).

Large,regular, and robustly constructed stone enclosures at Fonni, Sardinia (Figure 11), found in a largely pastoral mixed sheep and cattle economy, involving summer transhumance, were used for handling cattle and providing shelter at night or in bad weather. There are spatial differences, with cattle kept close to human settlement in stone walled fields and sheep further away, possibly relating to the use of cattle as work animals. Some of the more distant corrals were for milking sheep into the later 20th Century, and there is some variation in form including construction in perishable materials in low lying areas (Mientjes 2004:171,173).

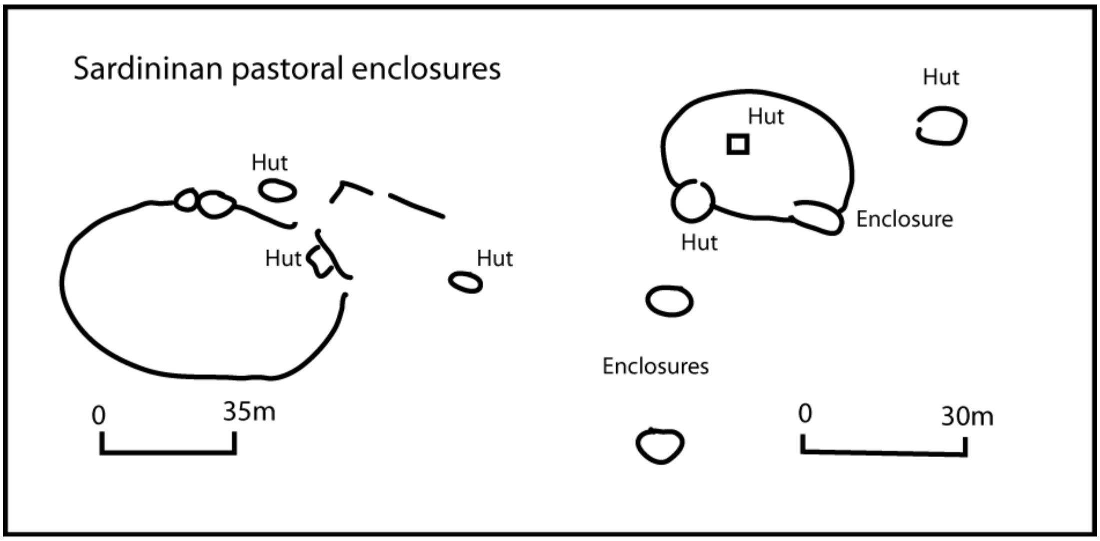

Figure 11: Livestock handling enclosures, Fonni, Sardinia (After Mientjes 2004:177). The central hut was used by the shepherd, whilst other enclosures are all for stock handling.

Similar enclosures with slightly different interior spatial arrangement, and often ephemerally constructed have been recorded in the Pindos Mountains, Greece (Chang and Tourtellotte 1993). These are related to transhumant summer upland pasture exploitation and demonstrate that elements occur repeatedly including overnight stock pens, handling pens and housing for lambs and people (See Figure 12).

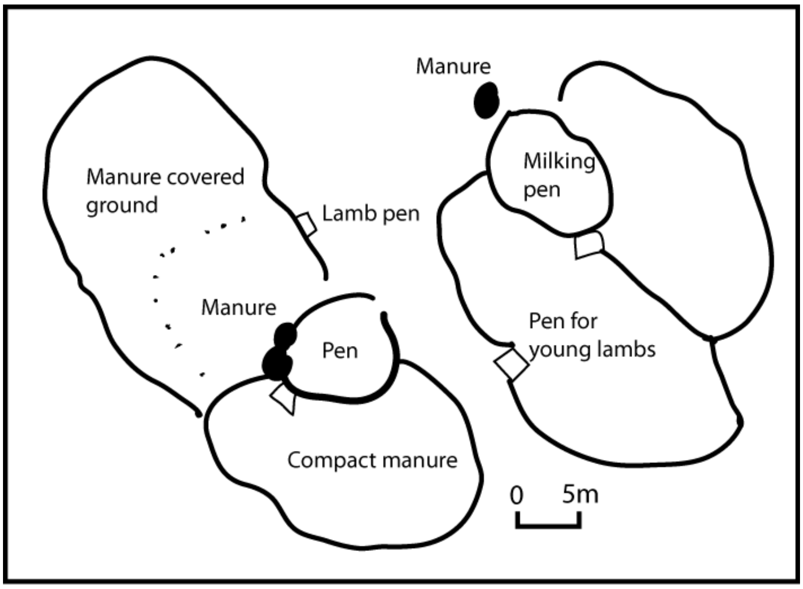

Figure 12: Summer upland pastoral site, Pindos Mountains, Greece. They are often constructed of stone with a brush fence and have a gate with a central pole that enables closing to sort and handle animals (After Chang and Tourtellotte 1993:258, 260).

There is a spatial difference in utilisation between the different landscape zones in the Pindos. The high altitude lands that are used in the summer, have fewer structures associated with the livestock enclosures although there are permanent summer villages. On the lower slopes, agriculture includes some arable cultivation, whilst in the valleys there is greater cultivation and winter foddering of livestock on arable fields (Chang 1993:695). It should therefore be feasible to postulate a similar system from the arrangement, density and location of these types of enclosures and groups of buildings. It should be noted, however, that the examples here relate to both transhumant pastoralists and semi-nomadic herders. The needs of the animals remain the same, but the scale of land use can differ.

Field Elements

Features incorporated into fields and field systems are a vital part of how fields operate. Smaller enclosures within systems may have functioned as paddocks and pens. Droves are essential for enabling animals to be moved into, out of, and around systems, whilst other features that may be identifiable include gateways, crushes and races. These should not be considered in isolation but how they work in the overall layout, and relate to settlement, topography, the size of the land parcels and water availability. Many of the features would have operated with a variety of equipment that are infrequently available for study, for example hurdles and gates (Smith 1996:216), but post- and stake-holes should be identifiable. Different species require different handling and housing as outlined in the previous chapter, so that whilst some features can be multipurpose, others will indicate greater suitability for one species over another, generally postulated on the basis of size.

Gateways

The location of gateways on field boundaries can be telling, especially in rectilinear fields systems. Gate position is largely irrelevant for arable cultivation. Gateways in the middle of a field boundary allow stock to spread out, whilst corner entrances enable the sides of the field to be used as a funnel and stock moved through the gateway with the minimum of people (See Figure 7 above). Predominantly corner entrances can be regarded as diagnostic of a system designed for stock handling with the minimum of people, and in fact, rectilinear fields with straight sides are a pre-requisite of this. Corner entrances on fields were recognised by Pryor (2006:101) as a key feature of a livestock handling system at Storey's Bar Way. At Lawford, Essex, all but two of the field entrances are in the corner of the field. In some cases the plots are small and there are multiple entrances. The relationship of the fields, gates and unenclosed land led to the conclusion that the fields were used for pastoral agriculture (Fowler 1981:27).

Pens and paddocks

As has been commented on above, variety in land parcel size may relate to function, and the type and numbers of livestock being handled. Size in relation to other field system features may inform about the scale and organisation of a system. Identification of pens and paddocks (areas utilised for the close observation or handling of animals) is largely dependent on size. Modern recommendations for penning sheep in a collecting yard is two sheep per metre (Goodwin 1979:159), although given that Bronze Age and Iron Age sheep were small we might assume greater densities. Pryor estimates that four primitive sheep per square metre can be confined without stressing the animals, and the size of stock handling equipment is directly related to the species and number of animals being handled (Pryor 2006:105).

At Fengate the ‘stockyards’ were between 50m and 100m square (Pryor 1996:319). Areas for holding cattle under 270kg are currently recommended as being 1.4m^2 for immediate handling and 4.5m^2 overnight (Grandin and Deesing 2008). The problem is of course that without knowing which species was being penned, it is not possible to make any inferences about numbers. In large scale systems, one might expect animals to be handled in batches and this might be identified by having yards where the entire group can be confined, smaller ones for batches of animals to be held, and the handling areas where they would be closely confined enough to be handled (Pryor 2006:106). As the terms ‘pen’ and ‘paddock’ should only be used as a description of possible function, parcel size is referred to in this study as, very small (enclosures of less than 0.1ha), are small fields (0.1-0.5ha), medium (0.5ha-2ha) and large (greater than 2ha). This is an arbitrary set of divisions that is purely presented for ease of discussion.

Smaller stock pens can occur in curvilinear plans. Figure 13 shows a sheep ‘stell’ used for overnight penning and feeding sheep of a type frequently used in the Highlands in the last few centuries with a central hayrick (Weller 1982:65). It should be considered whether this use might explain archaeological examples of smaller curvilinear enclosures, *c*15-20m in diameter.

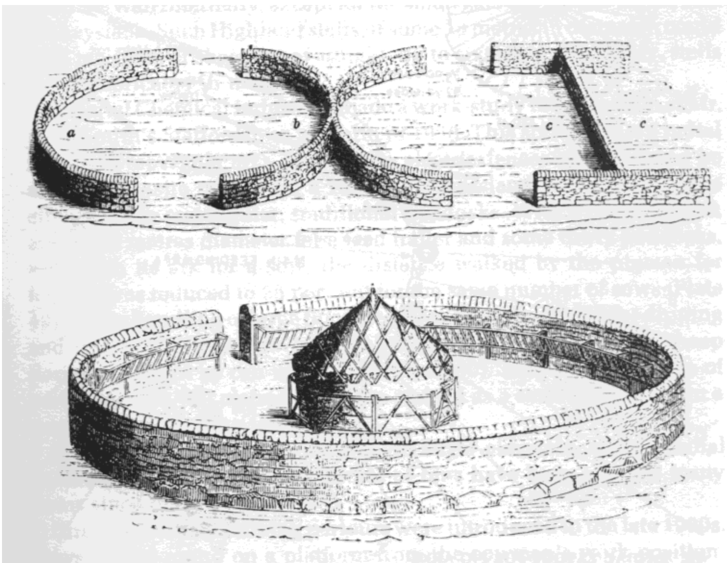

Figure 13: Sheep stell (Weller 1982:65, After Stephens, 1871 Book of the Farm).

Tracks and droves

Identification of double ditches within field systems has been postulated as field enlargement, although the effort for the land gained has been questioned; the reality of these as track ways is now widely recognised. In the Fengate Main Drove case, its use for the movement of large numbers of stock was confirmed by phosphate analysis, and evidence of trampling (Pryor 2006:94-96). The degree of erosion in the Fengate Main Drove indicates very large numbers of stock being moved. Fowler (1975:47) notes track ways on the Wessex downs as being generally about 6 m wide between the ditches. He suggests tracks of 12m across are drove roads, whilst noting that very wide ways up to *c*30m are related to Romano-British settlement. Medieval and post-medieval roads and drove ways often have funnel-shaped entrances at the point that they enter unenclosed land and commons in order to facilitate livestock movement (Rippon 2004:21). The arrangement of tracks in relation to open land has also been recognised in the Fens, where drove ways ‘open’ onto the unenclosed low lying areas (Pryor 2006:94).

Handling and housing

Shelter for animals can be provided by trees, hedges and walls. However, a variety of other structures identified in relation to settlement and within field systems may relate to other aspects of livestock handling and management.

Lambing pens

The need to avoid chilling of lambs at birth and the historical use of pens to provide shelter has been touched on in the previous chapter. Ethnographically, newborn sheep are placed in the corners of huts (Abruzzo, Italy; Saractchiani, Greece), in the corner of a tent (Rajastan India; Baxtyâri, Iran), in a small cave (Baxtyâri, Iran), or in a small stone circle within an enclosure (Shagni, Northwestern Afghanistan) (Tani 2002:115). There is no reason to suppose that these methods were not used in the past. Archaeologically we might expect small structures that supply confinement and control to promote proximity. An archaeological example of a close confinement structure for newborn lambs at Abu Gosh dates to the Pre-Pottery Neolithic B and comprises a small subcircular stone-built enclosure *c*2m in diameter within a larger enclosure (Figure 14; Tani 2002:119).

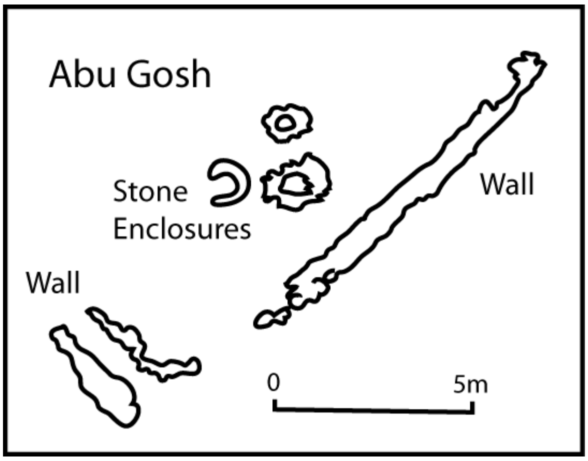

Figure 14: 'Lambing pens' at Abu Gosh (After Tani 2002:119).

Housing

The previous chapter has established the efficacy of housing particular livestock (i.e. goats) or at particular times (e.g. lambing).There have been occasional suggestions that structures may relate to animal husbandry. Johnson and Rose in their survey of Bodmin Moor (1994:49) deliberately prefer the term 'hut' to describe structures in preference to 'house' as '*the latter term implies a habitation, and in architectural terms a certain status*'. Double walled huts in Perthshire, with a few metres between the inner wall of the house proper and the outer surrounding wall, have been suggested to supply a small, closely controlled garden plot (Johnston 2005a:219). They might equally be spaces for animal housing, and we should consider the practicalities of spaces for plants or animals. The post-medieval pig sties at The Lease on Bodmin Moor sties were constructed from boulders and slabs (Lake 1989:38). Additionally, it has been suggested that if manure were a major product, it would be easier to collect it from housed animals (Reynolds 1987:41) and *'the practice of confining animals may even have been introduced for the very purpose of obtaining animal dung*' (Bakels 1997:444). We should consider the use of a variety of other archaeological features in this regard. The use of pits for the storage of silage was mentioned in the previous chapter. In addition, Doyle (1870:16) recommends that cottage farmers should take care in collecting up manure, and should store it in pits lined in puddle clay and covered over.

Housing for animals can be achieved either by making space within buildings utilised by people or within separate constructions. Housing animals within the same building as people has been a very long lived and widespread practice in northern Europe, taking advantage of the higher body temperature of cattle; the development of houses that were accepted at a high social level in the south west of Britain in the medieval and post-medieval period indicate that the arrangement did not carry any implications of poverty (Lake 1989:74-76). Many of these buildings have central covered drains for waste management (Lake 1989:77), which may assist us in identifying the practice. Long houses used to house both people and animals come into existence in the Netherlands in the Middle Bronze Age (Fenton 1981:214); this has been seen as a 'cultural' desire to house animals, but functionally there is little change from the Early Bronze Age (Arnoldssen and Fontijn 2006:296). Long houses were used to house stock in Denmark in the Bronze and Iron Age, including Nørre Tranders, where the building was destroyed by fire with the human and animal occupants within it. Some continental examples include hoof prints and stalls (Guttmann 2000:230), but examples of possible cohabiting in Britain are more scant (Sørensen 2007:331).

The identification of buildings relating to specific farming functions, such as barns, byres, pigsties and sheds has been lacking (Fowler 1983:89). A building in an annex attached to a roundhouse at Hod Hill was identified as a stable by the excavator, but this is a rare example (Fowler 1983:91), and may be a dubious identification. Annexes attached to roundhouses on Skomer, Dyfed, have been identified as sheep pens, and given that they are very small, regarded as an indicator of the scale of the pastoral system (Pryor 2006:146). Considering Early Iron Age roundhouses, and comparing them to ethnographic use, Pope (2007:217-219) has suggested a reflection in the architecture of the use of the peripheral space for animal stalling. Use of the cellular lower floors of brochs in Atlantic Scotland for animal housing has been suggested (Armit 2002:16; Sharples and Parker Pearson 1997:259); a similar explanation would be valid for wheelhouses and other similar structures.

It has also been demonstrated that floors where stabling has taken place can be differentiated from house floors by micromorphology, phosphate analysis, and in stables where the phosphates are enhanced, enhanced pollen preservation and additional plant macrofossils (MacPhail *et al* 2004). In Iron Age northern Gaul plant macrofossil data seems to indicate that some buildings appear to have been used as byres (Haselgrove 2007:506). 'Houses' may have been used in a more flexible way than we assume, either at different points in their life cycle or alongside their use as dwellings. We need to entertain the possibility that animal stabling could be a contemporary or secondary use in some cases. We should also begin to consider whether certain pathological conditions identified in bone can alert us to animals having been housed. For example, fractures of the hind leg in pigs has been suggested to relate to tethering (S Hamilton-Dyer pers.comm.), whilst abnormal wear to the teeth in horse has been related to 'crib-biting', chewing fixed wooden objects such as posts or buildings (Moore-Colyer 1994:2-3).

Races

Races, narrow corridors for selecting and handling individual livestock discussed in Chapter 2, can be recognised from their ground plan, and the way that they relate to adjacent land boundaries and associated features. At Storey's Bar Way, associated with the field system, was a section of ditch 25m long that lay parallel to one of the field boundaries, at *c*1.5m separation. At its southern end it opened onto an arrangement of entrances into the adjacent land parcels. This has been identified as a drafting gate, a three way arrangement that allows animals to be separated into adjoining fields (Pryor 2006:105).

More complex systems are used for animals less used to being led, whilst simpler ones are suitable for those where halter led animals are common. In modern systems for cattle, shutes of 6m minimum length are recommended, increasing to 15m for large numbers of stock (Grandin and Deesing 2008). Pryor (1996:319) cites a 7m drafting race as being suitable for handling 250 sheep, whilst an example 35m long is used for 2000. As these structures can be used for both cattle and sheep, their length relates more to the number of beasts in the herd or flock, rather than the species. The width of the shute is probably most diagnostic, but we must be careful to take account of the smaller size of prehistoric livestock. We should also be aware that races may occur in a range of shapes. Curved races (Weller 1982:67) are effective because they lead animals to believe that they are turning and they cannot see people ahead of them. However, the curve cannot be too tight as it may appear to the animal to be a dead end (Grandin and Deesing 2008).

3.3 Identifying husbandry strategies

> '*There is no simple or perfect method of classifying temperate agricultural systems, where the enterprise of individual farms is subject to almost infinite variation within the narrow bounds set by the limited available range of crops and animals*' (Campbell *et al* 1996:137).

Having established the presence of animals in a landscape and the likely use of individual features and landscape elements in their husbandry, we need to turn our attention to understanding how the three main strategy types, or their variants, may be identified. Transhumance/nomadism and intensive systems, occupying opposing ends of the spectrum are defined first, before considering extensive exploitation, which may only be identifiable by the fact that it lies between the two extremes.

3.3.1 Recognising transhumance/nomadism

Archaeologically we might recognise transhumant strategies in different ways. One of these is evidence for seasonal occupation or use. Unenclosed settlements on the Upper Thames Valley gravel terraces at Farmoor, Oxfordshire, in an open, grazed, landscape, were flooded regularly suggesting seasonal, summer, occupation. Transhumance has also been suggested in the area for the later Bronze Age and Early Iron Age from ring ditches at Port Meadow, Oxford which flood in winter (Robinson 1978:37). It can also be suggested by boundary arrangements or the lack of them. Fleming (1998) suggested that large scale Bronze Age systems, with apparent integration of open areas, indicate that bounded spaces developed as part of a change to self-contained sedentary communities from cyclical movements of people through unbounded areas.

3.3.2 Recognising intensive agriculture

Archaeologically we might expect to detect intensive systems via a number of routes. The degree of integration with arable cultivation is key, including the need for manuring and the production of surplus fodder. Intensive cultivation tends towards a greater number of plant species, rather than high volume monocultures (Jones 2005:167-70). In recent Greece, mixed farming exhibited a wide range of smaller numbers of species, animals consuming surplus grain, spoiled and failed crops, and fodder crops that could be consumed by people in times of need (Halstead 1996:22-23). The archaeological identification of intensive systems therefore needs to integrate several lines of evidence, the physical remains of structures, evidence for manuring, and archaeobotanical and zooarchaeological information (van der Veen 2005:160).

Prehistoric British systems of small sized fields alone have been assumed to indicate a preference for intensive production, although it has been further assumed that outputs were low due to lack of manuring (Barker and Gamble 1985:21), an assumption that may now be regarded as questionable. One hypothesis applied to small later prehistoric fields (Reynolds 1987:44) is that rotation through a series of paddocks was practised, with the benefit of manuring, reduction in parasite load and regeneration of grazing. Where these small paddocks display the range of livestock handling features noted above, this seems an extremely likely interpretation. Increasing complexity in landscape features may be an indication of inter-relatedness of systems and intensity. For example irrigation of 19th Century British meadows was most extensively utilised in the intensive sheep-corn husbandry systems which relied on sheep manuring of arable land and demanded provision of supplementary feeding to keep higher sheep numbers (Cutting and Cummings 1999:163).

Ethnographic research indicates that intensive land use tends to involve sequences of smaller fenced enclosures, which might be regarded more as gardens than fields (Jones 2005:165). However, smaller fields are not the only way of achieving intensive production. Nineteenth Century advice on cottage farming (five-twenty acres) recommended avoidance of boundaries in order to save space (Doyle 1870:5-6). Nevertheless, the location of settlement in relation to enclosures is important in understanding the organisation of labour, as intensive cultivation requires high labour and resource inputs; small scale 'gardening' has often been interpreted as the preserve of women as it relates to the domestic sphere (van der Veen 2005:159). Small scale intensive farming suits household scale organisation and is compatible with childcare and utilisation of child labour (Bogaard 2005:179-80). In a study of cultivation in Evvia, Greece, Jones (2005:167-170, 172) demonstrated the relationship between location of plots close to settlement with smaller size and greater manuring and richer soils, in contrast to less-manured, larger fields at some distance from settlement. She observes that there is a commitment to particular locations in the amount of inputs invested in small plots. This type of arrangement necessarily has implications for understanding the animal husbandry regime, as it supplies information as to the closeness to settlement that animals were kept in order to generate the manure required to intensively fertilise fields.

Some indications of the intensity of production may be obtainable from faunal assemblages. Due to the increased complexity of keeping a wider range of species affecting the amount of labour required, assemblages dominated by one species might potentially relate to extensive but specialist herding, whilst a diverse assemblage might indicate a mixed regime. Subdividing herds so that animals most in need (e.g. pregnant and lactating females) get the best pasture, may produce assemblages at neighbouring contemporary sites with differing age profiles. Changes in body size might elucidate general nutritional levels (Halstead 1996:24-25). Often, it is a change in the pattern of assemblages compared to alterations in settlement arrangement and other factors that informs us. Faunal data for the Greek Neolithic seem to indicate a reliance on single species at 'open' sites, overwhelmingly sheep and goats, which contrasts with Bronze Age assemblages associated with more complex structural evidence containing more mixed species and ages, possibly indicating a change from mobile extensive systems to a more integrated and possibly intensive, localised agriculture (Halstead 1996:30-31).

3.3.3 Recognising extensive agriculture

One of the most immediately evident features of extensive agriculture will be the scale of area that it covers. By their nature, extensive systems must be large. This is of course only fully definable when there are boundaries. Evidence for arable agriculture is likely to be slight; even if it formed part of the system, extensive cultivation is by its nature diffuse spatially and temporally. The amount of area covered can also be compared with the density of identified settlement; large areas of land and few houses may indicate a low population and is likely to reflect the animal population.

3.3.4 A bit of both?

Whilst full integration of pastoral and arable husbandry, in which both enterprises are taken forward on an intensive scale, are possible, a more frequent and likely scenario is one where there is an element of both, and one takes the lead. The most likely way is where small scale but intensive arable cultivation is carried out in conjunction with larger scale and extensive animal husbandry. This enables the pasturing of animals on a variety of pastures of varying quality, whilst taking advantage of their by-products to the full, concentrating them on a small area. Mixed farming requires close integration of the arable and pastoral husbandry so that the two systems are entirely complementary; it requires control of fallow grazing and alternation between arable and temporary pastures as well as a greater use of fodder crops, in conjunction with stall and sty feeding, especially in winter (Campbell 1997:228-9). This also requires investment in infrastructure such as byres, stables and other methods of protecting livestock. In the English medieval example, in general terms the more extensive the system, the less integrated the arable and pastoral sectors, sometimes acting as almost independent enterprises. In English medieval arable systems, very high proportions of cattle, up to 40%, were draught animals (Campbell 1997:232), only required because of the intensity of arable production.

Far from being uniform, there was a great deal of local, and regional diversity in systems in medieval England (Campbell 1981b:112). The main elements, such as strip and holding organisation, and access and regulation of grazing, can be expressed in differing functional attributes that could be combined in different ways as shown in

Table 21. What this demonstrates is that the operation of a system is achieved through interplay of the physical organisation of landscape and practice and the social regulation of the system. Choice in one area leads to adaptation in the other. Elements of this approach have been noted in a wide variety of locations globally (Campbell and Godoy 1992:100).

Table 21: Elements of Medieval English common field systems (after Campbell 1981b:113-4).

Element	Attribute
The Waste	Communal ownership of the waste
Field Layout	Arable and meadow characterised by a combination of closes and unenclosed strips
	Arable and meadow characterised by a predominance of unenclosed strips
Holding Layout	Holdings made up of an irregular distribution of strips
	Holdings made up of a regular distribution of strips
Fallow Grazing	Full rights of common pasturage on the harvest aftermath
	Limited rights of common pasturage on half year fallows
	Limited rights of common pasturage on full year fallows
	Full rights of common pasturage on half year fallows
Regulation of Cropping	Imposition of flexible cropping
	Imposition of a regular crop rotation
Mode of regulation	Seignorial regulation of certain collective activities
	Communal regulation of all collective activities

We can begin to see the application of some of these ideas to southern British field systems. Bronze Age field systems on the Marlborough Downs appear to form independent blocks around the known settlements. Weakly developed lynchets are interpreted as relating to cultivation technique, or rotation of cropping with periods of fallow and the folding of stock. Better developed lynchets occur closer to the settlements. The fields nearest to settlement have greater concentrations of pottery surface finds, possibly relating to more frequent manuring. This layout, with access to grazing on the high ridge provides an inbye and open grazing system consistent with the sheep husbandry implied by the faunal assemblage. Cattle, apparently kept for dairying were also present. The necessity of access to water, is suggested to imply the use of the upland farms for over-wintering in byres and yards and summer use of lowland pastures, although specific land use has not been identified (Gingell 1992:156).

3.3.5 Recognising extensive and intensive pastoral husbandry: 'organised landscapes'

Consideration of the layout of farming landscapes can be approached by considering it on a number of levels. A clear method of doing this is that employed in landscape character analysis, with the landscape type of an area at the highest level, informed by the nature of **components** (e.g. settlements, fieldsystems), made up of individual **parcels** (e.g. field), in turn constructed from **elements** (e.g. gateway, boundary) (Rippon 2004:19-22). This has to be approached with the full knowledge of the problems of the likely continual development and changing meaning and function of prehistoric landscapes as described by Gosden and Lock (2007:279). The individual function of elements and parcels has been considered above, and having established those, we need to consider the way in which they relate to each other in a given landscape.

The arrangement of components

'*On nine out of ten farms, the best field is the one next to the buildings, for the simple reason that it has had more than its fair share of muck*' (Henderson 1944:101).

As has been discussed above, the arrangement of fields, particularly in relation to settlement can elucidate their use. Groupings of buildings have often been referred to as farmsteads, but with little understanding of how they function. Understanding their spatial arrangement and use would be helpful. 'Farms' can be understood at three levels, the 'catchment area' attached to a community, a single or group of buildings central to a local agrarian economy, and several related buildings with various functions (Fowler 1983:80-81). Early medieval Irish enclosed settlements (*les*) referred to in literature, archaeologically recognisable as raths, appear to have been used as farmyards and contained sheep and calf pens, pig sties, constructed of wattle and occasionally roofed and dungheaps. Ploughing within the enclosure was regarded as shameful, and a garden area was often situated outside, with evidence of use of raised beds eight feet wide. The area immediately around the *les* was enclosed land with other functional buildings scattered amongst it and some terms appear to refer to an infield/outfield arrangement (Kelly 2000:364-6,70).

Where an infield-outfield system has been suggested for prehistoric agriculture, it has been assumed to rely on regular cultivation near to settlement and shifting cultivation further away (Harvey 1980:43). It may, however, be detectable as arable production immediately around the core and extensive grazing further away. Evidence for close handling of stock or protective stock raising strategies may be detected archaeologically in settlement layout and concentrations of dung residues (Shahack-Gross *et al* 2003). Other communal functions can also be postulated. At Fengate, East Anglia, the arrangement of land parcels in relation to droves is key to understanding the landscape and purpose of the entire site. A series of ditched and hedged fields and paddocks with ditched drove ways developed during the Bronze Age. This extensive system of large scale land division has implied large scale livestock husbandry, in that case probably of sheep, with associated yards and features directly related to the handling of animals (Pryor 1996:314-5). The layout of the central drove way is key, with entrances allowing at various times, access to a sequence of fields or paddocks, identified as stockyards. Various features of entrances and droves indicate a number of stock handling processes (Pryor 1996:316). We also need to consider the nature, resource potential and utilisation of the land 'outside' of a bounded system. Sources of water, woodlands providing grazing, cut fodder and mast, or seasonally available grazing on uplands and wetlands, may be identifiable beyond the enclosed area, with the locations of drove ways and funnel entrances indicating whether or how animals may have been moved in and out of systems.

Regularity need not have any real relationship to use. However, it has been observed (Campbell 1981a:17) that the irregularity of layout of fields in medieval Norfolk posed few problems for the arable economy but created considerable difficulties in organising grazing necessitating the creation of social controls to enable grazing land not under arable production. Functionally, the organisation of space and hierarchy is more important than the shape of the arrangement. Both rectilinear and rounded systems have strong points. It is therefore likely that the shape of systems actually reflects preference and other social constructs, although fewer people are needed to move animals in rectilinear systems. An interest in regularity and systematic organisation of boundary arrangements on Middle Bronze Age sites has been noted in the Netherlands (Arnoldssen and Fontijn 2006:296). The clustering of buildings within field systems occurs in the Middle Bronze Age but not earlier, despite the animal bone information indicating that both the EBA and MBA economies were dominated by cattle (Arnoldssen and Fontijn 2006:301). The regularity of features and components as being the result of a mixed farming regime is rejected in view of the evidence for structuring the landscape as a whole (Arnoldssen and Fontijn 2006:306). However, whilst this may be true, it did actually provide an integrated and organised farming 'opportunity', and this should be seen as another area in which the ideological and practical enmesh. The problem lies in the chronological resolution available, without which we are unable to disentangle which came first, the economic change or the ideological one.

We may be able to make additional social inferences, if we can identify the use of particular components of a given system and determine whether they were communal or dispersed. It has been noted that in Britain since the medieval period, communal ownership or working of land has a tendency to lead to large communal buildings for the storage and processing of products (Weller 1982:36-41), but these as yet are elusive in prehistory. Whilst there is little to indicate that ownership was communal in the earlier period (Moore 2007a:274), it has been noted that the partitioning of space in later Iron Age settlements, within larger sites such as hillforts, and close fences around buildings, may not only be functional, but may relate to the changing perception and definition of the household (Moore 2007a:273). This may have been a result of increased tension over land or population pressure, or given the non-defensive nature of some of these boundaries, an increased desire to mark social space, although this does not imply a rigid hierarchical social organisation (Moore 2007a:274). Cunliffe (2000) has suggested that similar changes in the Danebury landscape mark a shift from communal land ownership to private ownership.

3.4 Using Herds

In the previous chapter we identified the range of possible uses for animals and their products, and those for which we have historical documentary evidence. One of the dangers, and one into which many have fallen in the past, is to assume that because something was available, it was used. Not only do we need to establish clearly the evidence as to whether and how resources were utilised, but, possibly more interestingly, in some cases consider why some were not. The range of products identified in the previous chapter are presented in Table 22, along with some of the methods that we might employ in establishing their utilisation in the past, and which are discussed below.

Table 22: Animal products and methods of identification

Product	Method (s) of identification
Meat	Faunal remains – butchery; lipids from pot residues; stable isotopes from human remains
Milk	Culling profile; lipids
Wool	Culling profile; combs and spindlewhorls
Hides/skins	Faunal remains - butchery
Horn	Faunal remains - butchery
Bone	Worked bone objects
Manure	Soil micromorphology; soil chemistry; insects
Traction	Faunal remains – pathology; harness fittings
Other labour	Faunal remains – pathology
Warmth	Co-housing with people
Waste Disposal	Faunal remains – gnawing by dogs or pigs
Ideology	Depositional practice

3.4.1 Using the beast - labour

Whilst plough and ard marks and some material culture, such as harness fittings, can provide us with indications of the use of larger animals for riding and pulling vehicles, most evidence comes from pathological changes in faunal remains. Cattle did not evolve to pull loads and the abnormal stresses can lead to pathological bone responses, although similar indications can be created by other factors such as age, sex and weight (Bartiosiewicz *et al* 1997). Exostoses on the distal phalanx have been used as indicators of use in traction (Bartosiewicz *et al* 1997:58-9; Higham *et al* 1981). However, these occur in a range of variation that can be seen to occur naturally (Johannsen 2005). Changes to metapodials, leading to spreading of the joint surface and exostoses occur due to additional weight from traction (Bartosiewicz *et al* 1993). Lipping also occurs on phalanges (de Cupere *et al* 2000), and calcaneii (Telldahl 2005:65). Osteoarthritis in the hip joint and lower leg has also been identified as having a traction-related aetiology (Groot 2005:56). Some spinal anomalies may also relate to traction (Fabiš 2005:61-2).

The identification of the use of dogs for herding or guarding is problematic. Despite their usefulness in this regard, their utilisation can only be inferred. Higher rates of pathology in dogs compared to other smaller animals, has been suggested to result from their greater proximity to people and possibly use in herding (Groot 2008; Teegan 2005b).

3.4.2 Using the body – meat, horn, hide and bone

The utilisation and consumption of the body will generally be indicated by faunal remains; distribution of body parts, burning and butchery. However, the presence of some arthropod faunas can indicate the waste of processing carcases (Schlevis 2003). Some material culture may relate to the manner of cooking (e.g. roasting spits, flesh hooks (Burgess and O'Connor 2004; Needham and Bowman 2005)), and the processing of meat and other body products can be investigated using lipid analysis from ceramic vessels (Dudd *et al* 1999). There is a broad correlation in the frequency of Neolithic pot sherds demonstrating use in processing a particular species and the faunal information, apart from a slight under-representation of pigs in some contexts. This has suggested that lipids could be used as a proxy where faunal remains do not survive (Mukherjee *et al* 2008:2072). The amount of porcine adipose fats in a selection of British Bronze Age pots indicates that pigs were possibly more important than indicated by the faunal remains (Copley *et al* 2005b:510;512). Very few British Iron Age vessels had been solely used for the processing of pig fats (Copley *et al* 2005a:489).

Stable isotope analysis of human remains has become important in determining the greatest component of diet (Sealy 2001), and can also be applied to residues on pottery (Hart *et al* 2007). There is a progression of values through the trophic levels from herbivores to omnivores to humans (Reynard and Hedges 2008) and this is particularly useful in exploring the utilisation of marine resources. Fish and shellfish provide a valuable source of nutrition, whilst sea mammals provide a number of resources. Seals are a particularly blood rich mammal, although the marrow content of bones is low (Boyle 2005:85). Whale bone contains a fatty substance in the fine trabecular structure, the head contain more than 80% of the oil (Monks 2005:138). It is possible to examine ratios of stable isotopes of $\delta^{13}C$ and $\delta^{15}N$ to understand the proportion of diets obtained from marine as opposed to terrestrial resources (Craig 2003:94). For example, human bone from Wetwang Slack, East Yorkshire Middle Iron Age cemetery gave no evidence for a significant marine component in the diet, nor did it show differentiation in consumption by age or sex (Jay and Richards 2006).

3.4.3 Using dairy products

Dairy products have been attested by lipid analysis in Britain from the Neolithic onwards (Copley *et al* 2005c). A significant proportion of southern British Bronze Age pottery was used for dairy processing (Copley *et al* 2005b:510); dairy products were processed in smaller vessels than used for cooking meat products (Copley *et al* 2005b:512). The presence of milk proteins in Late Bronze Age/Early Iron Age pottery at Cladh Hallan appears to confirm the interpretation that large numbers of juvenile cattle remains were the result of dairying (Craig 2003:93). A large number of Iron Age vessels from southern Britain have also produced evidence of use of dairy, as well as meat products. The number of vessels which were used for dairy products has suggested that milk was obtained from sheep as well as cattle (Copley *et al* 2005a:489-490), although we do not know enough about the possible production rate from specialist herds, the rate of reuse of pots, or indeed specialist function that predisposed their use in dairy processing. In later prehistoric pottery from the Western Isles a monoclonal antibody was utilised to demonstrate the presence of bovine milk, whilst variations in the values may relate to foddering animals in this marginal environment, possibly utilising seaweed or fish waste either fed to animals or used as fertiliser, although this does not appear to have been a frequent practice (Craig *et al* 2005:99). In early 17th Century Berkshire, cattle yielded a gallon a day (4.55 litres) (Thompson 2002). At this rate of production it seems likely that much would be processed rather than consumed fresh, and we might expect to see the containers which were used well represented.

3.4.4 Using Manure

The variety of materials that can be utilised in manuring land have been discussed in the previous chapter. Considering the importance of animal by-products in manuring practice, generally present even when other materials are mixed with it, it is important to be able to identify not only the practice, but the possible proportions in order to establish the importance of animals in relation to arable cultivation. There are also implications that can be drawn in the presence and absence of other materials, e.g. crop residues used for composting were not being utilised as animal fodder. In concentrations it also provides information on housing as well as other practices relating to its symbolic value or use. Manuring is also important to understand given that it can be demonstrated that it alters the nitrogen isotope content of cereals and could contribute to elevated levels in people consuming them, producing a pattern that appears to reflect a diet with a large proportion of meat (Bogaard *et al* 2007). However, in some marginal areas there will inevitably be a shortage of fuel, and some of the possible substitutes for wood will either compete with fodder use or utilise animal manure (Carter 1998).

There are a number of ways in which manuring can be suggested in general terms. Potsherds have been a standard method of identifying manuring, for instance domestic waste in EBA ploughsoils at Phoenix Wharf, London (Guttmann 2005:231). Mixtures of refuse may also be indicative. Bones were used in manures in Dorset in the mid-19th Century, whilst solid manures were composted together with burnt clay, ashes and bone dust in alternate layers (Fussell 1948:56). Soil accumulation has been seen as manuring evidence in the Thames Valley (MacPhail *et al* 1990:63), whilst nitrophilopus weeds in plant macrofossil assemblages may indicate manured soils (Guttmann 2005:227; Buurman 1988). Simple measures of organic content are unlikely to be of assistance due to the varying decomposition rate of various fractions and the complexity of that decomposition (Evershed *et al* 1997:486). The variety of specific materials, and methods that can be employed in their identification (Table 23).

Table 23: Manuring materials and methods for their identification

Material	Method (s) of identification
Animal manure	Lipids; soil chemistry; invertebrates
Human faeces	Lipids; soil chemistry; invertebrates
Silts	Soil Micromorphology
Chalk or lime	Soil Micromorphology
Calcareous sands	Soil Micromorphology
Turf and peat	Soil Micromorphology
Hearth ash	Plant macrofossils; soil micromorphology
Seaweed	Plant macrofossils; soil micromorphology
Bone and food residues	Faunal remains

Crops and crop residues	Plant macrofossils; soil micromorphology
Other plant residues	Plant macrofossils; soil micromorphology

Dung pellets themselves are rarely preserved and can be difficult to identify to species, and identifiable plant parts are often not represented. Housefly pupae from Switzerland have been taken to indicate that manure was from stalled animals as they would not colonise pats in the field (Nielson *et al* 2000). Weed seeds can be present through dung, rather than as crop processing waste (Charles 1998:114-116). Where utilised for fuel, animal dung is likely to provide a fair proportion of charred plant macrofossils and can elucidate the relationship between pastoral and arable husbandry (Charles 1998:111). Mixing of chaff from one crop with the grain of another at Abu Salabikh was regarded as deliberate mixing for fodder and being derived from dung (Charles 1998:119). Hall and Kenward (1998; 2003) have summarised (Figure 15) the wide range of foodstuffs that may be preserved as part of stable manure and relating to feeding regimes of livestock, as well as the considerable range of organisms that might be associated with it, and draw attention to the economic implications of manure occurring in one location.

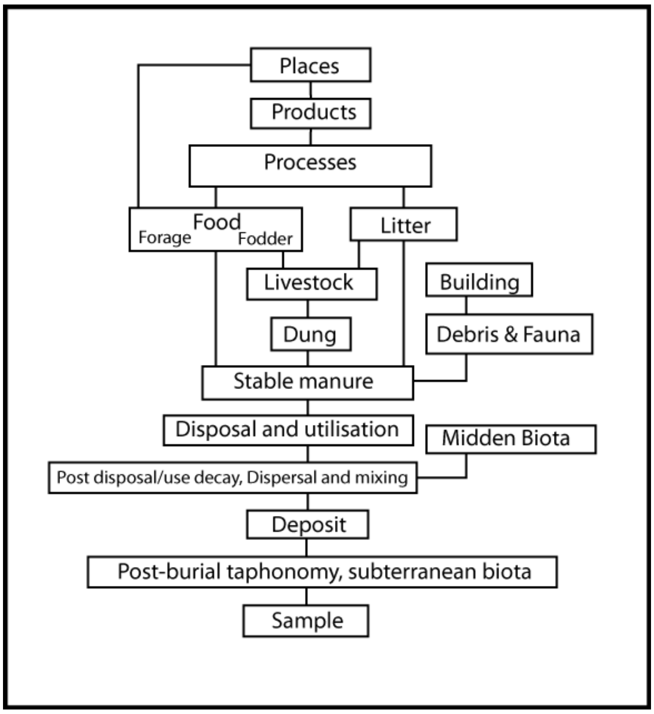

Figure 15: Hall and Kenward's (1998:124) summary of processes and materials relating to 'stable manure'.

Fuel residues can be detected by soil micromorphological studies and elucidate the degree of application of burnt plant materials (Guttmann *et al* 2005:70). Micromorphological analysis of soils can be employed to understand manuring. For example soils at Toft's Ness , Sanday, Orkney could be shown to have been cultivated and had midden material added in the Neolithic/Early Bronze Age, whilst the later Bronze Age/Iron Age soils indicated cultivation and plaggen manuring (use of composted turves) (Simpson 1997; 1998; Simpson *et al* 1998). Micromorphological analysis of Settlement Age sites on Iceland indicate variable use of animal manures as fuels in more marginal settlements (Simpson *et al* 2003:1413). However, structures observed in modern agricultural soils cannot be uncritically applied to ancient ones, where processes and treatment may have been different. At Papa Stour, soil micromorphology failed to find any discernable difference between known types of tillage, although manuring could be detected when it contained a mineral component (Davidson and Carter 1998:827,837). Multi-element soil analysis can be effective in indicating patterns of use of space, although relating particular suites of elements to a particular input is more problematic (Wilson *et al* 2008:423). High levels of phosphates are generally thought to derive from manure but could derive from a number of sources (Guttmann *et al* 2005:69). Calcitic spherules are also found in animal dung, but are soluble (Guttmann 2005:227).

Lipid analysis can be combined with inorganic chemical analysis of soils to consider more fully activity areas (Simpson *et al* 1999; Hjulström and Isaksson 2009), and to identify between animals and human faeces, but this is not routine due to cost and time constraints. Different sterols and bile acids are present in faeces of omniverous and herbivorous mammals, including humans, and can be retained in archaeological soils (Guttmann *et al* 2005:69-70), although the mechanism is poorly understood (Bethel *et al* 1994:630). The presence of coprostanol and other 5β-stanols are associated with human faecal deposition, whereas ruminant animals produce a spectrum dominated by 5β-stigmastanol, due to the large amount of plant sterols ingested; pig faeces are harder to distinguish from human (Bethel *et al* 1994:628,630). The ruminant origin of manure and persistence of stanols has been demonstrated from soils with known manure application in the 19th Century at Rothamstead

Experimental Station (Bull *et al* 1999:90). Application to areas of historic known use in Orkney indicates manuring declined with distance from the farmstead, whilst Bronze Age and Iron Age deposits at Tofts Ness, Sanday suggests human faecal matter was applied to soils (Bull *et al* 1999:92). However, whilst these methods have been used in Northern Britain and in Europe in particular (Guttmann *et al* 2005:70-73), they have not as yet been applied to field soils in south western Britain.

Generally, firm identification of manuring requires a range of techniques to be brought to bear, and this has inevitably had limited application. Manured and non-manured soils at Butser Ancient Farm, indicated elevation in potassium in manured soils, coinciding with enhanced magnetic susceptibility, and enhanced occurrence of stanols. Phosphorous enhancement was however undetectable (Evershed *et al* 1997:493-4). Identification of penning areas has been made from microlaminated soil structures, concentrations of phytoliths, phosphates and dung spherulites (Canti 1997), although there are different problems with each of these methods. Consequently, adding the examination of nitrogen isotopes of bulk soil samples has begun to be employed to identify areas enhanced by dung. Dung is ^{15}N enriched in comparision to fodder and can be identified as greater than the surrounding soils (Shahack-Gross *et al* 2008). One explanation for the gradually changing proportions of ^{15}N in soils from the Neolithic to the Roman period in Europe is a gradual increase in manuring (Hedges and Reynard 2007:1249). Examples of possible cases of manuring of fields have been postulated for the Netherlands, where environmental data have indicated use of water plants on soils, or refuse including bone, pottery and plant remains incorporated into cultivation horizons (Bakels 1997:443). Bracken pollen and plant parts associated with ard marks at Machrie Moor Arran were taken to derive from cut bracken (lack of rhizomes, indicates it was not growing in the field), possibly having been used as bedding for animals and reused as manure. Concentrations of pollen occurred within a structure at Cǔl a'Bhaile, Jura, but was scare outside the enclosures (Guttmann 2005:71; Stevenson 1984), implying housing.

3.4.5 Using the idea

That animals accrue meanings beyond their economic role is a given. They may have signified any number of things to the people that husbanded them, and in the case of wild species, hunted or observed them. We may be able to recognise differences in the way in which animals were viewed from how they were treated in life. For example, species may have variations in the incidence of traumatic injury that indicate how they were kept (e.g. over crowded pigs may injure each other (Goodwin 1973:121,136; Bushby 1988:143,156), whilst dogs may be injured either in the course of being used for livestock herding, or because of human violence (Teegan 2005b). The degree to which veterinary treatment was made available (Udrescu and van Neer 2005) can tell us about an animal's perceived value, be that economic or as a companion. The possibility of specialised treatment and therefore 'meaning' can be approached by comparison of the depositional location, treatment and taphonomic state of different species in a given locale. It is widely accepted that animal remains were involved in practices involving 'structured deposition' throughout the Bronze and Iron Age (Brück 1999; Hill 1995a; Randall 2006). Whilst associated bone groups (ABGs) are apparently the most evident form of special treatment, these can originate in a number of ways and should not always be assumed to relate to ritualised or symbolic practices (Morris 2008a:382-3). On the other hand disarticulated material can be 'special' too. The precise combination of content, and relationship to context and other materials and objects, should be considered on a case by case basis, a biographical approach (Randall 2010; Morris 2008a:384). However, ritualised actions might be expected to produce a repetitive suite of elements.

Feasting can be difficult to isolate from more general consumption practices; this is made more problematic as it might be regarded as a by-product of economic concern, or an important ritualised activity in its own right. Crabtree (2004) moved from the former to the latter explanation for feasting at Iron Age Dún Ailinne. Depositional behaviour can be complex and is actually only the final episode; animal remains may have been involved in a variety of activities including ritualised or symbolic ones. Animals, like people have biographies, both before and after death (Hambleton forthcoming). Likewise, Lauwerier (2004) discusses the problems of separating 'offerings' from 'normal' waste. Contemporaneity of slaughter may assist in identifying sacrificial behaviour (Wilkens 2004:75). This type of activity and subsequent deposition may involve a greater representation of 'unusual' species (Green 1992:126; Hill 1995a:95; Lauwerier 2004:71), but these are still a small proportion (Morris 2008:102). Material from temples and shrines, and in graves are more obviously involved in a definable ritual behaviour (Lauwerier 2004; Lentaker *et al* 2004). However, sometimes identification of buildings as special can rest on information from the animal remains (*cf* Alcock 1972), and clear identification of ritual structures can be problematic (Wilkens 2004:75). The approach taken here is to assess the possibilities of structured discard behaviour in context on a case by case basis.

3.5 Dealing with the data

The complexity of the available information and its varying availability militates against a formulaic approach. A number of models may well apply within and between regions and over time. Consequently, a site by site, locale by locale, approach is necessary, integrating all of the available lines of evidence to provide a narrative explanation of the most likely model of land use and animal-human relationships. Chadwick points out (2008b:6) the problems with regarding changes from one landscape layout to another as compartmentalised episodes, highlighting their constantly developing and changing structure and meaning. Boundaries have biographies too (Chadwick 2008a:219). There are similar problems with other classes of data; for example most faunal remains are the result of accumulation. We are, in this respect, limited by the resolution of the data that has been collected. We must also be careful not to make assumptions about successional development of what we might perceive to be more 'developed' features or approaches. However, by integrating the available information, an area, regional and temporal picture can be built, and enables new questions to be postulated. Although full reconstruction of any system is not feasible, we can approach issues of aim, husbandry strategy, and degrees of integration of arable and pastoral agriculture. How this is examined in the succeeding chapters is shown in Table 24, which summarises the preceding discussion.

Evidence such as animal bones and plant macro-fossils, largely recovered from settlements rather than fields do only inform us inferentially as to land use (Lewis 2008:240), but this does not preclude its use, as long as the relationships are understood. Having established the evidence for land use, and the aims and manner of animal exploitation, we can move towards understanding the overarching strategy in terms of transhumance, extensiveness, intensiveness, and integrated systems, and begin to consider questions of overall scale. A wide variety of variations on these themes, with greater or lesser arable aspects are to be expected at different times and in different places.

Table 24: Use of data to address questions related to animal husbandry in the south west of Britain. NB The presence of no single data type should be regarded as diagnostic.

Data Type	Establishing pastoral utilisation of land	Establishing arable utilisation of land	Understanding the aims of animal exploitation	Husbandry methods	Integration of pastoral and arable agriculture
Regional environmental data (pollen)	X	X		X	X
Boundary construction	X	X		X	
Topography		X		X	
Water availability	X			X	
Soil types		X			X
Soil movement		X			
Cultivation features		X			
Type, shape and size of fields	X			X	X
Gate location	X			X	X
Tracks	X			X	X
Stock handling features	X			X	
Animal housing	X			X	X
Landscape arrangement				X	X
Relationship to settlement				X	X
Faunal remains	X		X	X	X
Foot prints	X				
Invertebrates	X			X	X
Soil Chemistry			X		
Micromorphology		X	X		
Plant macrofossils		X			
Wood				X	
Lipids			X		
Stable Isotopes			X		
Manuring		X	X	X	X
Material culture			X		

The role of social objectives and choice in any given locale can then be considered in relation to change in landscape layout. For example, actual land use at Wyke Down, Dorset appears to have remained largely unchanged after enclosure (Lewis 2008:242). However, rather than indicating that agricultural activity is not relevant to boundaries, it can rather be seen as a change in method of achieving an unaltered aim. The scale of systems needs to be viewed in relation to how 'full' the landscape is. Small systems in empty landscapes may imply utilisation of 'common' land; small systems in crowded landscapes are more likely to be intensively farmed. Large scale systems require cooperation both in their construction and operation, whilst small scale systems are more likely to be operable by smaller groups. By identifying the combinations of these features we can then postulate strategy (Table 25).

Table 25: Application of data types to husbandry strategy. NB The presence of no single data type should be regarded as diagnostic.

Data Type	Intensive Mixed	Extensive	Extensive or Transhumant	Extensive with arable element
Small scale field systems	X			
Large scale systems		X		X
Small fields	X			X
Large Fields		X		X
Mixture of field sizes	X			X
Isolated enclosures			X	
Stock handling features	X	X		X
Stock proof fences	X	X		X
Unenclosed grazing		X	X	X
Arable cultivation	X			X
Manuring	X			X
Small fields around settlement	X			X
Scattered houses		X	X	X
Single livestock species		X	X	X
Multiple livestock species	X	X	X	X
Water	X	X	X	X

There are limitations to the understanding which is possible, as it is not clear how we could detect the effects of instability of farming systems. A balanced and fully functioning system could not appear fully formed, and landscape utilisation would need to cope with the fluctuating needs of the community, as well as fluctuating labour supply, variations in the weather on an annual basis and the effects on flocks, herds, and crops. If we consider the land in terms of carrying capacity we are only able to calculate an average, and a bad average at that. However, if we consider the necessity of flexibility and sustainability (and an indication of this is the long duration of use of some field systems), we should assume that most systems operated at below their maximum, or indeed their average possible output, unless we can begin to see indications of over exploitation.

Utilising this approach, the following chapter examines the landscape of Cadbury Castle, Somerset, in order to test whether it is useful in the analysis of a reasonably well explored series of landscapes. The subsequent chapter then broadens the analysis to apply the approach to the Bronze Age and Iron Age landscapes of the wider south west of Britain.