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'THE BULL IS HALF THE HERD': PROPERTY RIGHTS AND ENCLOSURES IN ENGLAND, 1750–1850

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‘THE BULL IS HALF THE HERD’: PROPERTY RIGHTS AND ENCLOSURES IN ENGLAND, 1750–1850

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Abstract

This paper proposes that one function of the open fields was to reduce the transaction costs of cow-keeping by lowering commoners' costs of bulling. At enclosure, cow-keeping fell among small owners who, unlike large farmers, had difficulty obtaining bulling services and were not substantial enough to own both the bull and the cow; they were therefore worse off with enclosures. The minimum acreage required to restore cow keepers to their pre-enclosure economic position indicates that even commoners who were given some land at settlement lost out with the change in property rights.

‘THE BULL IS HALF THE HERD’: PROPERTY RIGHTS AND ENCLOSURES IN ENGLAND, 1750–1850

1. Introduction

Historians and contemporaries have argued that small cottagers and landless laborers suffered significant losses at the end of the open fields (e.g. Andrews 1738; Anon. 1772; Hammond & Hammond [1911] 1987; Humphries 1990; Neeson 1993). The root of the problem, Arthur Young surmised, was that cottagers could no longer keep cows for milk due to the unavailability of pasture (Young [1808] 1971:12–13), which David Davies ([1795] 1977:56) argued had “beggared multitudes”. As such, they recommended returning to these villagers access to land that they had lost, with Young ([1808] 1971:15) urging small land plots as part of the enclosure settlement.[1] Presumably, land access could permit the poor to keep a cow or two once again.

Yet the link between cow keeping and small landholdings is a tenuous one. In his travels, Young came across cottagers with adequate land who still chose to sell their cows. For instance, landowners at Barton Mills in Suffolk who received 20–25 acres of good land sold their entire herds of 7–10 heads (Young [1804] 1969a:23). At Baldon in Oxfordshire, “many cottagers … had two, three, or four acres, and they kept cows; now still having the land, they keep no cows” (Young [1813] 1969b:43–4). By the early 1800s, “cottage cow keeping all but disappeared from the scene in England” (Holderness 1989:163), even though very small landholders constituted an important, albeit dwindling, proportion of the rural population (Brodrick [1881] 1968:157–97).

Why did small landholders cease to keep cows? It was due neither to poor relative prices nor changes in tastes: wheat values relative to beef fell considerably from 1660 (Overton 1996:199–202) and there were frequent complaints that milk was unavailable in many areas after enclosures (e.g. Kent 1798; Evershed 1879; Young [1808] 1971:Appendix IV; Davies [1795] 1977; Armstrong & Huzel 1989:735). The nub of the problem was this: having grassland was not sufficient to make dairying profitable since a cow will not lactate unless she has

[1] Moselle (1995) finds that such allotments were used mainly for growing potatoes and other vegetables in Southern England.

conceived. A second input is therefore necessary: the bull.

This paper proposes that one function of the open fields was to reduce the transaction costs of keeping cows for commoners by lowering their costs of bulling. At enclosure, cow keeping declined among small cow owners who, unlike their larger neighbors, had difficulty obtaining bulling services and were not substantial enough to own the bull and the cow. Small cow keepers – who were laborers, small farmers, squatters and tenants – were thus made worse off by enclosure, whether or not they commoned their animals legally. The conclusions here support the findings in Humphries (1990) and Allen (1992) that poorer villagers lost out at enclosure. Furthermore, computations of the minimum acreage required to restore cow keepers to their pre-enclosure economic position indicate that even commoners who were given some land at settlement lost out with the change in property rights.

2. The Economics Of Cow Keeping

The loss of the cow at enclosure was lamented because she was worth up to half the annual wage of an adult male laborer (Andrews 1738; Anon. 1772; Kent 1798; Vallis 1869:15–17; Cobbett [1822] 1979:96). Her products included dung that was used as fertilizer, calves which were usually sold (Turner et. al. 2001:196), as well as milk products from her nine-month lactating period. Cattle-raising had three main economic problems before the development of artificial insemination in the 1940s; each of which could decrease a cow's profitability. The first was the risk of non-conception: as it was uncertain that through natural means alone the cow would successfully conceive, calve and lactate each year, accounting for risks would lower expected values of her income. The second was the economies of scale inherent in bulling that would affect the costs and chances of conception, while the third stemmed from the hold-up problem. While artificial insemination has greatly alleviated these concerns, for the earlier cow keepers such problems were acute.

Cows that do not conceive will not produce milk and calves, and will be a net loss to farmers; hence the bull's role in insemination is vital to cattle profitability. The optimal rate of production for a cow is a calf each year (Noakes 1986:40). Non-conception risks are determined by the length of the mating period, the cow's calving period, the bull's quality and incidences of miscarriage

and illness. The longer the mating period and the better the bull, the smaller are the chances of non-conception. Risks of miscarriage are real and significant: they occur in 30–35 percent of all bovine pregnancies today, with most of the embryos dying within the first two weeks (Noakes 1986:49). During the eighteenth century, the risk of non-conception was about two-thirds.

Dairying costs are therefore a function of the costs of providing and maintaining the cow and the costs of insemination. Income comes from dung and the expected income from calves and milk, which is subject to risks of non-conception, miscarriage and other accidents. As will be seen in Part 3, the calculated values of a cow in the historical literature tend to assume that calving rate was unity and that there were no costs to bulling; thus inflating her income contribution to the cottager.

One important way to deal with non-conception risks was to pick a good-serving bull, which unfortunately was not an easy task. It was difficult to judge the quality of bulls and to control their unreliable breeding behavior (Cochrane 1946:259). Bad-breeding males had severe repercussions: one caused two separate 20-head herds to miscarry in two years (Wedge 1794a:35). Age is also an important criterion as a young bull may be dominated by cows and may suffer low libido, while males older than four years were slow and heavy and could not serve as efficiently (Noakes 1986:121, 129; Russell 1986:133–4). Another way was to increase mating opportunities. As pregnancy lasted 280 days, the cow has a "window of opportunity" of just 85 days a year (Noakes 1986:30, 40), during which she has three to four ovulations; hence the greater the access females have to the male during this period, the higher the chances of attaining the optimal rate of reproduction.

Another problem in dairying is achieving economies of scale in bulling without running the risk of exceeding the bull's capacity. Since sperm triggers off the dairying process and is needed during a relatively short time period and in relatively small amounts, sharing the bull among a herd of cows is economical; otherwise, capital invested in the male would be underutilized. While economies of scale raise profitability by reducing per unit costs of bulling, at herd sizes larger than optimal, returns are lower due to higher risks of non-conception. This is because bulls "do not waste their seed on mere sexual gratification" (Urquhart 1983:89) and will only select cows that are in heat. Hence it is likely that ovulating periods are missed especially if there are too many to serve. In general, for a bull running with a herd of cows, the optimal number of females was about 20 in the eighteenth century (Fussell 1966).

The third problem stems from the perfectly complementary, non-

substitutable inputs of the bull and cow. Unlike the sheep and the mare, the cow's products of veal and milk depend on the male. This situation presents a hold-up problem: since the cow keeper's profits rely on the availability of a small number of bulls, he faces the risks that the bull-owner might raise bulling prices, or withhold access to the animal, after the specific investment in cows has already been made. Hence, theories of property rights predict that both animals will be jointly owned and production vertically integrated in order to avoid the hold-up problem (e.g. Klein et. al. 1978; Williamson 1985). Otherwise, transaction costs in monitoring and enforcing agreements to prevent a hold-up will be higher than under joint ownership.

In all, the short period for conception, the importance of obtaining a suitable bull and of caring for pregnant kine, as well as the means to overcome the problems of economies of scale and hold up, mean that reproduction in the cattle economy involves substantial risks and transaction costs for small-scale owners.

3. Income from Cow in Common Fields

One function of the commons was to solve the three inter-related problems in cow keeping.[2] This section shows that common fields, through its institutions of provision and control, effectively reduced bulling costs and non-conception risks, achieved the required economies of scale as well as solved the hold-up problem. These were important functions, given that a barren cow in the eighteenth century was a net liability as she gave only 3,000–4,000 kilograms or 6–8s worth of manure, but consumed £4 in rent and feed (Slicher Van Bath 1963:293; Humphries 1990).

At first sight it appears that the common-field system severely disadvantaged the cow keepers. The village bull was kept on special grounds and was strictly off-limits, except during the mating season from May to July. Since most cows calved in March or April, the mother with a late delivery risked being barren until the following May, leaving the cottager with a net liability. (Fussell 1935; Fussell 1966:57–8; Russell 1986:133–4; Trow-Smith 1959:164)

Moreover, the hold-up problem in the common-field village was especially

[2] Other functions include achieving economies of scale in pasturing (Dahlman 1980) and insurance provision (McCloskey 1989).

acute as small cow keepers rarely possessed bulls and instead relied on a very small number of males within the village. There were many references to the village, parish or manor bull (e.g. Havinden 1965; Ashby 1974:162; Coldicott 1979:42–3; Lewis 1996:9).[3] In Myddle, Shropshire, probate inventories reveal that there were just two bulls to the area's 73 cows from 1664–1701 (Hey 1974:66); in Essex, there were 21 bulls to 707 cows between 1660 and 1719 (Steer 1950:54–5). Of 1,523 inventories, some 867 listed cows of which 779, or about 90 percent, did not mention bulls.[4]

Bull owners, on the other hand, were wealthier: "The possession of bulls was usually as certain a sign of economic prosperity in an inventory, as was the desire to be buried inside the church in a will an index of social status" (Spufford 1990). Bulls were recorded in 88 of the 1,523 inventories, with all but eight estates worth at least £100; a substantial sum when a laborer earned a mere £3 each year in the seventeenth century (Rogers 1887:671). As bull owners invariably also had cows, the situation of bilateral monopoly did not arise and, coupled with the lack of competition in the bulling markets, cow keepers were likely to be the disadvantaged party vulnerable to *ex post* opportunism by bull owners if market transactions were undertaken.

The common-field institutions of provision and control, however, managed to avert such problems. The first step was to ensure that the bull was shared. Landowners were obligated by village laws to provide him even though it was "a personal loss to the owner" (Rogers 1881:331). Individually, cow keepers would have found it costly to ensure that these obligations were fulfilled and each had the incentive to free-ride on others' efforts because the bull was a public good. There was therefore an economic rationale for collective institutions to enforce provision, such as village juries which were empowered to fine landowners who failed to provide the common male. For example, Robert Ekins was

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[3] The proverbial parson's bull was no longer used in common fields by this period. Guides and treatises on the duties of the churchwardens did not discuss the responsibility of keeping bulls (e.g. Paul 1793; Anon 1844); instead the task had fallen to a landlord or the villagers themselves (Russell 1986:150).

[4] Inventories from: Oxfordshire 1550–90 (Havinden 1965); Telford, Shropshire 1660–1750 (Trinder & Cox 1980); Clifton and Westbury, Bristol (Moore 1981); Evington 1557–1819, Braunstone 1532–1778, Glenfield 1542–1831, Kirby Muxloe 1547–1783, Great Stretton and Ratby 1621–1844 (Wilshere 1982, 1983a, 1983b, 1983c, 1984a, 1984b); Winteringham, N. Lincolnshire 1650–1750 (Neave 1984); Whitby, N. Yorkshire1700–1800 (Vickers 1986); Buckinghamshire 1661–1714 (Reed 1988); Smethwick, S. Staffordshire 1647–1747 (Bodfish 1992); Northeast Cheshire 1600–1760 (Groves 1994); Bowdon, Cheshire 1600–89 (Groves & Higginbottom 1997)

fined 13s 4d in 1740 for failing to put a bull and a boar out on the commons, an obligation which was attached to the land he occupied. In Raunds, Northamptonshire, another was presented for levying a charge on his bull that he was obligated to provide free (Neeson 1993:131, 147).

The village also reduced non-conception risks by designating officials to pick a good bull which involved much skill. It should not only display characteristics of strength, such as a thick neck and strong legs, but must also be "nowise imperfect in his private parts" (Fussell 1937; see also Mortimer 1761:226; Barlow 1819:24–5). By appointing parish officers, such as "eveners" at Wigston and constables at Bodicote (Hoskins 1957:241–2; Russell 1986:153), to undertake this responsibility, villages allowed the acquisition of skills through division of labor. Using the local bulls also economized on search and information costs as the officers would be able to hear of and see the bull's quality more easily. Since the main way to judge a male's potential was the quantity and quality of his daughters' milk yields, which were themselves highly variable (Orr 1918:196; Fraser 1972:142), knowing the bull owner's herds provided crucial information. There were instances when juries kept out inferior bulls, which in addition to the breeding controls, were moves to ensure that young, impotent or sterile males were not used. Indeed, in 1787, the Laxton jury framed by-laws to regulate the quality of the bulls and rams used, as well as to punish owners who put diseased beasts onto the commons (Orwin & Orwin 1967:161; Neeson 1993:132).

The most important institution of control was the stint, which prevented overstocking by controlling the land-to-animal ratio, but also "over-bulling" by ensuring a manageable male-to-female ratio, since too large a harem would be detrimental to productivity. The individual commoner stood to gain by putting in more cows than his allowance, which would raise non-conception risks for all kine, hence giving the village collective incentives to enforce the stint. This implies that associated institutions such as penalties were needed to overcome the strict dominance of individual strategies by promoting greater assurance in the collective agreement (Stevenson 1991:27; Ostrom 1990:46–50). Indeed, overstocking fines were severe and ranged from 3–15s, while parish brands and personal marks that each villager had to make on the livestock, to avoid a 18d fine, lowered enforcement costs by acting as clear signals of the right to common (Foot 1794:69–70; Steer 1950:59; Hoskins 1957:241; Wilks & Bray 1983:57–8; Neeson 1993:146).

Interestingly, the individual who had the strongest incentive to enforce the rules was the bull owner. He would not provide a young bull as groups of cows

could terrify an immature male into permanent celibacy; moreover, as overuse is a debilitating factor (Noakes 1986:129–130), he would seek to control the user effects on his capital good. Since bull owners were the richer villagers, they would have held disproportionate powers within the community and were better placed to enforce the stints. By binding the interests of the powerful with those of small owners, the common-field institutions were an uncanny way to ensure that the dairy economy was not only self-sustaining but that it also yielded income at low variability.

Bull owners also had two other incentives to honor their obligation, making the bulling contract self-enforcing to some degree. Firstly, as cow keeping was an important activity for the less well-off, sharing the bull would be far cheaper for the larger landowners than an increase in parish poverty accompanied by higher levies on their land. The link between bull provision and the poor was evident at Drayton in the 1740s, where responsibility for the bulls laid with the overseers (Russell 1986:152). The second motivation was that the bull owner, who also owned one of the largest herds in the community, stood to lose the most with the absence of a male. He would supply the beast because his individual gain exceeded the provision cost, which was about the cost of a cow. This is one instance in which the small can "exploit" the great systematically (Olson 1965:22–36). It is therefore unsurprising that the cottagers and landless laborers opposed enclosures, which meant that they could no longer "exploit" richer villagers by free-riding on collective goods for which they bore little or no cost.

The common cowherd also played an important role in the cattle economy. By moving the herd systematically around the commons, he raised mating chances by ensuring that he had "fine and big" bulls near the cows to mate when they would (Oschinsky 1971:283) and cut the chances of bovine miscarriages by tending to in-calf cows. His role cannot be underestimated: a full-time worker was able to raise calving rates to 100 percent on a royal manor near Norwich (Campbell 2000:148). Herding had another important benefit: it reduced non-conception risks by giving cows that suffered miscarriages additional chances at conceiving.

Although quantitative data are sparse and scattered, anecdotal evidence suggests that non-conception risks were significant despite these measures. Data from two farms in the cheese-making parishes of Aston-by-Budworth and Crowley in Cheshire between 1751 and 1766 showed average calving rates of 79.8 and 89.5 percent respectively (Foster 1998). A less specialized farm in 1680s saw eight cows providing four to seven calves each year, or a calving rate

of about 50–88 percent (Thirsk 1984:191). Such calving rates were similar to those of previous centuries: A survey of English counties in the period 1288–1315 indicates rates of 60–73 percent a year (Campbell 2000:145). Farms in the late 13th century had reported drastic variation in reproduction rates of as low as 28.6 percent in Stevenage and 40 percent in Rossendale, while others in Cuxham and Wellingborough had perfect calving rates (Trow-Smith 1957:117ff). Such ranges were also evident in developing countries of recent times. Calving rates were about 40–50 percent in tropical areas of Latin America and 60–70 percent in more temperate ones; overall the continent reported rates of 45–60 percent (Jarvis 1986:43, 129). In Nigeria, a survey of 12 herds found reproductive success of 64 percent (Fricke 1979:127); while in China, it was 66 percent for small herds of mixed-bred cows and 75 percent for larger herds of purebreds (Simpson 1988:167). In the absence of better data for small, unspecialized herds in pre-industrial England, the rule-of-thumb that only two in three cows would calve successfully in any given year will be used.

While the above institutions constituted a form of social contract, they were an arrangement that did not include performance guarantees. Indeed, the high and fluctuating risks meant that it was difficult to write a complete contract between bull and cow keepers of the common fields, beyond basic provisions of supply and control. However, there were some arrangements which facilitated risk-sharing between bull and cow keepers such as the reduction or cancellation of rents in the fifteenth century for cows that did not conceive (Ault 1970), as well as herd leasing contracts in the nineteenth century that allowed the lessee to avoid paying rent for barren cows (Horn 1978).

To understand why laborers did not keep cows after enclosure, we must calculate the change in the profitability of dairying. The place to begin is the contemporary estimates of profits (Table 1). Usually eighteenth-century writers ignored the non-conception problem and assumed that calving was risk-less, but small farmers had to deal with the reality of non-conception risks of about one-third. Table 1 reports new estimates of the profit of a common-field cow, taking into account that only two-thirds of cows would provide income in any year. As legal common rights were attached to cottage tenancies, the cost of cow keeping would be the opportunity cost of leasing out the right to pasture at about 5s (Neeson (1993:90) puts it at 2s–8s), as well as costs of winter feed at about 70s for 2½ tons of hay (Prothero 1887:310–1; Humphries 1990). Estimates of revenue, which are from the late eighteenth century, have not overestimated the true values because advancements in breed and management techniques made before 1750 meant that common-field cows were not inferior to their descendents.

These technological advances included the extension of milking from five to eight months in the late sixteenth century (Seebohm 1952:199–204) and the widespread use of younger bulls in the Midlands and other areas by the mid-eighteenth century (Russell 1986:131–150).

TABLE 1
New estimates of the value of a common-field cow

Place, date of publication	Revenue (£)	Contemporary estimate of a common-field cow's value (£)	New estimate (£)
Northumberland (Bailey & Culley 1797:285)	8	4.25	1.61
Suffolk (Young [1794] 1969b:40–1)	8.625	4.875	2.03
Leicester (Monk 1794:42)	9.5	5.75	2.62
Bedfordshire, 1798 (Holderness 1989:182)	10.375	6.625	3.20
Buckinghamshire, 1798–1804 (Holderness 1989:183)	14.35	10.6	5.86
Rutland, 1797 (Winchil-sea; Humphries 1990)	8.33	4.58	1.83
Welton, 1797 (Brownlow; Humphries 1990)	7	3.25	0.94
Burleigh, 1796 (Crutchley; Humphries 1990)	7.50	3.75	1.28
N.A., 1801 (Sinclair; Humphries 1990)	10	6.25	2.95
Mean		**5.55**	**2.48**

Table 1 shows that dairying in the commons was profitable even if the profit was less than some writers estimated. A cow's expected income was much lower than £7–£10, or half a male worker's wage (Humphries 1990; Shaw-Taylor 2001); but she was still important to the family income of cottagers and

gave an annual expected rate of return of 25 percent on a capital value of £10 (Vancouver 1795:120). This significant rate of return is indicative of the quasi-rent that a monopolistic bull provider might attempt to expropriate.

The estimates in Table 1 excluded bulling costs, which in the commons were subsidized fully by the bull owner. These costs included feed, capital, labor and depreciation costs. Such expenditure exceeded the £4 a year spent on keeping a cow because the bull required a few acres of pasture to himself as well as specialized skilled care. Following Bowden (1990:295) and Allen (1992:172), costs of bull feed at 1750 will be regarded as 2⅓ acres of open pasture at 9.13s per acre and one acre of meadow at an average open land price of 8.91s a year. Labor costs are estimated from wages of agricultural laborers (Prothero 1917:542) with a wage premium of about 9.5 percent (based on BPP 1861(L):580–91). Capital depreciation was high: a yearling bull cost about the same as a cow at £10–£12, while a four-year-old not used for breeding was sold at £4–£4.50. (Russell 1986:134) Other costs included interest at 5 percent (following Vancouver 1795:120) as well as costs of fencing and housing him in a hovel, which was usually about 16½ by 7 feet for oxen (Trow-Smith 1959:191) and taken for simplicity to be about 2.33s annually.[5] The herd size served by the bull will be calculated as 20 cows a year and about 60 over his entire career. As Table 2 indicates, the social bulling cost was rather significant at £0.36 (or 7s 2d) per cow:

TABLE 2
Costs of common bulling, c. 1750

Itemized costs	Total costs (£)
Bull feed over three years:	4.53
Labor costs over three years:	7.74
Depreciation of bull (years one to four)	6.75
Interest, housing and fencing costs	2.84
Total costs over three years	21.86
Annual bulling costs per cow	0.36

Source: See text.

[5] Estimate by Bowden (1990:295) for equipment and other costs.

Cow keepers' access to the common bull was thus a subsidy provided by the bull owner. If they had to bear the bulling costs as they had after enclosure, the net value of a cow would be lower but she would still be profitable. The significant subsidy was why commoners mainly used the shared bull and inventories showing that parishes had only one or two bulls indicate that the rental market, if existent, was thin and was used only occasionally by villagers (Neeson 1993:132).

4. Income from Cow with Private Provision of Bull

With enclosure, private bulling services were available to the small cow keeper mainly through renting by time to serve one or more cows. There was a wide range of rental prices quoted: Robert Bakewell charged five guineas per cow to use his famous longhorn bull, Twopenny (Pawson 1957:55; Trow-Smith 1959:53–6); while only 1s was charged in Shropshire and North Riding; 2.5s in Bedfordshire and Huntingdon; and 5s in Lincolnshire (Russell 1986:145; Tuke 1794:62; Batchelor 1808:156; Parkinson 1813:60; Young [1813] 1970:331). It is therefore difficult to pinpoint average bull rental rates, which depended on the bull's age, progeny and breed. Cost calculations in Table 3, however, indicate that bulling costs in 1800 did rise after enclosure. Feed and labor expenditure were higher because of rent and wage increases even with equal input amounts (Allen 1992:172; Bowley 1900:145); while interest and other costs were inflated from Table 2 at 1 percent per annum. Assuming the typical bull had not been genetically improved, depreciation was taken at £7.50, or the difference between a bull in service and one sent for fattening (Vancouver 1795:120; Russell 1989:135). Again, the bull was taken to serve 60 cows during his three-year career. Thus, bulling costs would increase from £0.36 in 1750 to £0.54 (10s 10d) in 1800, and even higher in 1850 because of rising rents of enclosed land.

TABLE 3
Costs of private bulling, c. 1800

Itemized costs	Total costs (£)
Bull feed over three years:	10.81
Labor costs over three years:	9.61
Depreciation of bull (years one to four)	7.50
Interest, housing and fencing costs	4.67
Total costs over three years	32.59
Annual bulling costs per cow	0.54

Source: See text.

The calculated long-run competitive price of 10s 10d was close to the ½ guinea charge Young ([1784] 1996:109) reported for Suffolk, but was significantly less than the one guinea fee in Northumberland, Lincolnshire and Lancaster (Bailey & Culley 1797:125; Young [1813] 1970:328; Holt 1794:143). The higher charges were partly the result of barriers to entry in local markets for insemination which stemmed from difficulties in transporting the bull and partly due to the hold-up problem.

Besides the loss of the subsidized common bull, the cow keeper also had to internalize new costs of monitoring mating activities and of negotiating, policing and enforcing bull-hiring contracts that were hitherto not part of his outlay. These new transaction costs would have raised the cost of cow keeping after privatization.

One problem with rentals was the increase in the cow's non-conception risks. The female whose mate was hired would have spent the least time with him, compared to the shareholder's cow and the common-field beast; hence, should she miscarry, she could not conceive again unless her owner re-hired the bull. One way to increase calving rates was to raise the likelihood that the cow was in heat when she was taken to the bull. However, bovine oestrous behavior is notoriously difficult to read even today (Cleveland-Peck 1979:79; Boyd

1984). Cow keepers traditionally had twice-daily observations that resulted in a 24.4 percent rate of non-detected oestrous (O'Farrell 1984), which was problematic as there were just four to five oestrous between calving and mating in optimal reproduction.

Indeed, over the mating season, reproductive risks could increase by more than half: the cottager leasing the bull must hire him six times to match the reproductive capability of four mating chances in the common fields.[6] This means that calving rate would fall from the two-thirds in the commons to ½ under private rentals. Table 4 recalculates the value of a cow in post-enclosure circumstances, assuming that her productivity and revenue remained unchanged, and that feed costs were two acres of enclosed pasture at 24.77s per acre and one acre of enclosed meadow at an average land price of 19.54s (Allen 1992:172). The expected value of a cow would fall by half after enclosure with bull hiring costs at £0.54 and with greater non-conception risks. Coupled with the fact that the bull may not be available for hire at short notice, the difficulty in obtaining income from the cow after enclosure is obvious.

On the whole, a cow's expected income would decrease by £1.31 after enclosure. Due to the fixed costs of bulling, cottagers who had smaller returns from common-field cows lost more at enclosure than their neighbors with higher incomes from cow keeping. However, the general conclusion that the cow remained profitable after enclosure still held: on average cow keeping's contribution to family income would be £1.17, or more than three weeks' wages of a male adult laborer. With the price of a cow around £10, the cow's annual expected rate of return after enclosure fell to 12 percent from 25 percent for a common-field cow.

[6] Taking missed detection at 24.4% for rentals only and miscarriage at 35% for cows under both regimes and assuming independence of events, calving rate with a hired bull after six rentals was equal to the calving rate with a common bull after four opportunities.

TABLE 4
Comparison of cows' annual income under commons and rentals

Source(s), with date of publication	Expected income under commons (£)	Expected income with one rental (£)	Percentage change
Northumberland, (Bailey & Culley 1797:285)	1.61	0.52	−68
Suffolk (Young [1794] 1969b:40–1)	2.03	0.83	−59
Leicester (Monk 1794:42)	2.62	1.27	−52
Bedfordshire, 1798 (Holderness 1989:182)	3.20	1.71	−47
Buckinghamshire, 1798–1804 (Holderness 1989:183)	5.86	3.69	−37
Rutland, 1797 (Winchilsea; Humphries 1990)	1.83	0.68	−63
Welton, 1797 (Brownlow; Humphries 1990)	0.94	0.02	−98
Burleigh, 1797 (Crutchley; Humphries 1990)	1.28	0.27	−80
N.A., 1801 (Sinclair; Humphries 1990)	2.95	1.52	−48
Mean	**2.48**	**1.17**	**−53**

If repeated rentals were required, the cost difference arising from the two organizational systems would be substantive: to achieve a calving rate equal to that of the commons which provided cows with four mating opportunities, six rentals were necessary at a total insemination cost of £3.24. Such expenditures would mean that the cow was not profitable in almost every case after enclosure, unless there was a significant increase in productivity or output prices. It is of little wonder then, that many small cottagers did not retain their cows after the abolition of commons even though they held the necessary land to pasture the animals.

To be sure, where landlords provided bulls at low rents, such as in North Riding and Lincolnshire where only a few shillings were charged (Tuke 1794:62; Young [1813] 1970:331), income from cows would have remained high and many cottagers did continue to keep them after privatization. Cheap services were offered on some estates, e.g. in 1751 a tenant at Coton Hall Farm

in Shropshire paid just 1s for Lord Stamford's bull (Russell 1986:145). After Aston-by-Budworth enclosed part of its commons, Sir Peter Warburton provided a ley with a bull to service and feed his tenants' cows for £1 per animal during May-November 1749. These arrangements led to more owners of small herds in Aston after enclosure than in neighboring Crowley, which did not have the leys and had only three farmers with three cows each in 1757. Of 47 cow keepers in all, Aston had 21 who had three cows or fewer, clearly showing the importance of the commons as further enclosures in 1765 cut the number of small holdings to six (Foster 1998:16–7, 66, 70–1).

5. Predictions

One prediction is that enclosures brought about greater integration of cow and bull ownership as well as the concentration of cow holdings in fewer hands. Institutions after enclosure raised either the costs or non-conception risks of a cow, or both; and the end of the commons meant the loss of relational contracts governing the means of sharing, so the hold-up problem would have arisen. Except for a thriving rental market in studs, there is little information about the industrial organization of bulls after enclosures. However, farm records and observations by agricultural reporters, such as Young and Vancouver (1795:120), attest to the keeping of non-stud bulls by farmers to prevent hold up. Another means of avoiding the problem was the purchase of pregnant cows, as was the practice on Essex farms (Shrimpton 1977:304). Since it was relatively simple to verify the pregnancy stage of a cow, the price system in these market transactions would render relevant information as well as distribute risks among the parties. For both these "spin-offs" and more conventional dairy farms, one could expect that average holding of cows to rise to obtain economies of scale.

Although detailed and consistent data on cattle holdings from 1600s–1900s are not available, the weight of popular opinion and available evidence indicate that herd sizes did rise after enclosures. Before 1750, few farmers had more than a dozen cows in milk, with the majority owning just five to eight beasts, but by 1840–70, most herds were between 12 and 35 cows, with the mean at 15–18 animals. Probate inventories also show rising herd sizes in early eighteenth century (Yelling 1977:158–9; Holderness 1989:163). In Essex, there were very few large herds in the late 1600s, with the recorded average of five cows in 100 in-

ventories and only two out of 122 having more than 20 heads of kine. By the 1800s, herds had at least 12 cows (Trow-Smith 1957:194; Shrimpton 1977:304). Where previously cottagers and laborers owned small herds of one to five cows (Everitt 1967), nineteenth-century post-enclosure communities had holdings with a minimum of nine to 12 beasts. For instance, Young noted that even the smallest holdings in Oxfordshire had at least 13 cows, with the largest having 100 (Young [1813] 1969b:270–83). In his travels around England, he noticed some very large dairies (Young [1784] 1996: *et passim*). In Staffordshire, the range was from 10–70 per herd, while farms in Nottinghamshire had nine cattle on average in the eighteenth century (Pitt 1796:132; Mingay 1989). Obviously, only a few of these farms could have belonged to small landholders.

To be sure, the trend of increasing herd sizes was evident in the century before the period under review due to piecemeal and private enclosures; for example, some areas such as Myddle, Shropshire specialized in dairying by the late fifteenth century. In the northwest Midlands between 1660 and 1740, herds, like farmland, were engrossed into larger holdings as farming was increasingly specialized; a trend that continued after the parliamentary enclosure movement. The same could be said for the East Midland uplands (Hey 1974:61; Hey 1984; Mingay 1984).

Yet if one considers the many single-cow holdings which have escaped records, such as those that were commoned illegally, the average number of cows per herd prior to enclosures would have been even lower. Single-cow herds were most affected by enclosures as their marginal costs, in terms of procuring the bull, were much higher than bigger holdings which benefited from scale economies.

6. Cottagers' Welfare Losses

The computations above show that cottagers, tenants or landless laborers who had no land after enclosure and hence stopped keeping cows lost £2.48 per animal, or the expected value of the common-field cow. For these individuals, Humphries' (1990) conclusion is fundamentally correct. Villagers who received no land at the settlement had a significant decline in their economic position: close to seven weeks' wages were forfeited or a reduction of 14 percent in annual income. Such deprivation was alarming enough for contemporaries in the

late eighteenth century, such as the Earl of Winchilsea, Nathaniel Kent and John Sinclair, to issue calls that these cottagers be given three acres so that they could keep a cow again (Slater 1907:130–9). The welfare losses of common cow keepers without land after enclosure were therefore unambiguous.

However, welfare losses were also suffered by small farmers who retained their cows and landholdings after enclosure. For commoners who had land before and after privatization, their rent gains from the change in property rights must be compared with their losses from cowkeeping: they would be indifferent to enclosure if net rent increases equaled either the loss of their common-field kine at £2.48 each, or the income loss from private bulling (£1.31). Using data from Clark (1998), rent gain per acre was £0.388 in the first decade of the nineteenth century. Thus, the acreage required to restore these small farmers to their original economic position was 3.38 acres for each cow kept after enclosure, but up to 6.39 acres for each beast given up. As rent gains rose in the remainder of the nineteenth century, these acreage requirements would fall correspondingly.

Data from Allen (1992:176–7), which calculates changes in farming profits in different land use areas, bear out a slightly different conclusion (Table 5). In heavy arable regions, cottagers lost the least at enclosure: they needed close to 5 acres to compensate the loss of one cow; if they had kept their cows, only 2.57 acres were necessary to offset losses. However, much more land would be necessary if the farming regions were light arable or pasture. In light arable areas, profit gains were just 2s per acre: the commoner with the loss of a common-field cow worth £2.48 would thus require 25 acres as restitution; if he had retained a cow, 13 acres would be necessary. As for pasture areas, the loss was unequivocal: in Rutland, for instance, enclosure brought about a fall in profits, over and above the loss of kine; while in Huntingdon where there were no profit increases the cottager bore certain losses.

TABLE 5
Profit increases from land compared with losses
in cow keeping income, c. 1806
(in £ per acre)

	Heavy arable		Light arable		Pasture		
	Open	**Closed**	**Open**	**Closed**	**Open**	**Closed**[7]	
						Rutland	***Huntingdon***
Revenue	4.23	4.74	4.39	4.18	3.86	3.24	3.59
Costs	3.12	3.12	3.20	2.89	2.83	2.33	2.56
Net Profit	1.11	1.62	1.19	1.29	1.03	0.91	1.03
Change in Profits	0.51		0.1			−0.12	0
Acres to offset losses, if cow retained	2.57		13.1		N.A.		
Acres required, if cow not retained	4.86		24.8		N.A.		

Source: Allen (1992:176–7)

These calculated acreage requirements drive home the welfare losses suffered by the commoners. It was rare that small cow keepers received and retained ownership of the necessary acreage at settlement to avoid losses of one or two cows: if common rights were upheld, most owners had merely two to three acres in compensation, or more commonly less than an acre (Yelling 1977:230). In the South Midlands in 1800, only 1.8 percent of farms in enclosed parishes were between five and 15 acres (Allen 1992:73–4). Across the country in 1870, more than half of all farms had less than 20 acres, with a quarter having fewer than five acres (Overton 1996:175). For instance, at Wigston, of the 99 villagers given land at the enclosure in 1765, 50 received fewer than 10 acres (Hoskins 1957:263). Hence, the vast majority of cow keepers who lost their animals suffered substantial welfare losses. Indeed, the high minimum acreage required to make cow keepers indifferent to the property rights changes implied that the number of villagers who were immiserized by enclosure extended beyond those traditional constituencies that had lost access to land. Small farmers with good-sized plots of up to 25 acres in some farming regions were also net losers.

[7] Enclosed by parliamentary acts.

7. Conclusions

Common-field institutions ensured the stable supply of the bull and permitted the herd to remain with him for a prolonged period of time. They also solved the hold-up problem through village by-laws, which aligned *ex ante* incentives, abated the opportunism of the bull owner and provided *ex post* mechanisms to regulate the use of the shared male. Enclosures, on the other hand, ended these institutions regulating commonality and took away the basis for the co-operative management of the bull. The consequences would be a lower expected value of a cow, even with adequate pasture. As such, further responses to enclosures took the form of partial or complete vertical integration whereby scale economies were achieved under unified bull and cow ownership. This meant that cow-keeping ceased to be an option, not merely for those villagers who had no land at enclosure, but also for many small landholders who could not support the optimal herd size by themselves or in a small group. In arable regions, small farmers who lost cows needed 5–25 acres as compensation, while those who retained their kine required 2½–13 acres of land at the settlement. Otherwise, like their counterparts in pasture regions and like the commoners who were uncompensated, they suffered welfare losses at enclosure. This means that many more commoners lost out at enclosure than previously thought.

These findings have four key implications. Firstly, they suggest an additional function for the common fields: they enabled the efficient sharing of the male by separate owners of the cow and bull. Secondly, the economic value of common rights laid in their commonality due to scale economies. Even in cases where cottagers received individual compensation, some value derived from the organizational surplus of the common fields was lost. This further implies a third point: where institutions mandated common access to resources among members of unequal standing, their end would mean that the inferior party (in this case, the cottager) would lose more, since he stood to gain more with cooperation. Finally, this paper suggests an answer to the puzzlement of the good Arthur Young: to understand the economic decision of some cottagers to end cow keeping after enclosures, one needs to look, not just at the bull and the cow, but also at the birds and the bees.

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