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# SUSTAINABILITY AND ENCLOSURE: LAND, INTELLECTUAL PROPERTY AND BIOTECHNOLOGY

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# Land, Intellectual Property and Biotechnology

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Abstract

The tension between enterprise as a means and sustainability as an end is directly related to the tension between rights to exclude others from a stream of private benefits and rights to be included in streams of environmental improvements. Resolving this tension is necessary if we are to square the circle between sustainability and enterprise. I begin for perspective with a brief review of the enclosure of land, and the widely cited notion of the Tragedy of the Commons. I then consider the modern version of the debate, surrounding informatics and, more specifically, intellectual property in plant genomics. The last part of the discussion focuses on a synthesis in which the two faces of enclosure – to be excluded and to be included – are brought together with democratic theory to give "sustainable enterprise" coherence and meaning.

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(This paper may be accessed at: http://www.apec.umn.edu/faculty/frunge/research.html)

*Nature hath neither core nor skin,*

*Is both at once outside and in.*

*Goethe*

# Sustainability and Enclosure

## Introduction

This essay explores a key foundation of enterprise – the property rights which confer entitlements to individuals and firms *to exclude* others from a stream of benefits or rents. These entitlements take various forms in economics and law: title to land and property, patents and copyrights. It also explores an alternative, sometimes neglected but equally important set of rights *to be included* in such benefits streams. These rights to be included can be membership in a common group or club, shareholder status in a firm or corporation, and even citizenship. At first, it might seem that these rights are just two sides of a coin – those who are not included are excluded. But careful analysis suggest that they are different types of entitlements, both of which are vital not only to private enterprise, but to many issues of environmental sustainability.

Sustainable enterprise must be so in two distinct senses. First, a sustainable enterprise must remain profitable to survive and sustain itself. Sustaining the enterprise, in other words, is necessary but not sufficient for sustainable enterprise. A sufficient condition for sustainable enterprise is that it maintain or enlarge the protection of the environment for future generations. There is growing recognition that profit and environmental performance can coexist, and even complement one another. An important link between these two senses of sustainability is technology. Those firms which are most successful as technological innovators are often those that are also leaders in environmental improvement. Environmental improvement, conversely, is often the result of new and improved technology. This link derives in part from the fact that pollution is a form of inefficiency; more efficient production processes are, in a physical

sense, generally less polluting (Georgescu-Roegan, 1971). Because of technology's central role in sustaining the enterprise, and in sustainable enterprise, it is important to know which types of rights to property will best promote innovation and technological change.

Underlying these issues are more fundamental questions. One is whether profit-maximizing firms can respond adequately to environmental challenges where markets are simply missing - for example, air or water pollution. Even in such cases, it may be possible to design market mechanism so that high and low-level polluters can trade pollution rights to their mutual advantage and society's benefit. For these markets to work, the definition of these rights is critical (Casson, 1985). In the case of pollution trading, the entitlement conferred by a pollution "permit" is the right to the benefits enjoyed by the permit-holding firm, as well as the market value of the permit itself. But the value of the permit exists largely because there is a presumption against polluting behavior conferred by statutes such as the Clean Air Act, which entitles citizens to be included in the flow of benefits represented by clean air. In all markets, who has the right to exclude others from a stream of rents or profits and who has a right to those streams is a critical requirement in assuring market participants that their expectations will be met.

Indeed, as Coase (1937) famously observed, firms are themselves based on rules and arrangements which no market, as such, could create. They are institutions which result from shared purposes and common goals, including profit, in which tacit understandings and norms obviate the need for transactions and contracting that are necessary in dealing with "outsiders."[1] My interest here is to consider the balance of

[1] Ronald H. Coase, "The Nature of the Firm." *Economica* (1937). Coase's two most famous articles, "The Problem of Social Cost" (1960) and "The Nature of the Firm" (1937) may be seen as dual pieces. The first

these rights: the negative right to exclude others by enclosing property, and the positive right to be included in a stream of benefits, whether from land ownership or patent rights. I shall be specifically concerned with comparing land and intellectual property.

The tension between enterprise as a means and sustainability as an end is directly related to the tension between rights to exclude others from a stream of private benefits and rights to be included in streams of environmental improvements. Resolving this tension is necessary if we are to square the circle between sustainability and enterprise. I begin for perspective with a brief review of the enclosure of land, and the widely cited notion of the Tragedy of the Commons. I then consider the modern version of the debate, surrounding informatics and, more specifically, intellectual property in plant genomics. The last part of the discussion focuses on a synthesis in which the two faces of enclosure – to be excluded and to be included – are brought together with democratic theory to give "sustainable enterprise" coherence and meaning.

Rights to Exclude and Their Critics: Enclosure of Land

One of the foundation concepts of private enterprise is that property confers exclusive rights. These rights to exclude are founded in an historical tradition of land ownership known as enclosure. Enclosure originally referred to the conversion of common or open fields into private, exclusive parcels of land in which sole proprietorship gave rents and/or management decisions to the owners of the land (Williamson, 1987). These rights to exclude others from a stream of rents were defended as a touchstone of

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analyzes the role of property rights in responding to externalities such as pollution from an industrial process. The second analyzes the "internalities" associated with the creation of firms, which lower the transactions costs of doing business inside the firm relative to business with outsiders, which remains the province of the price system. Both articles concern the boundary conditions of liability and exposure created by property rights. Read together, it is evident that they pertain to the economic advantages of rights to exclude and to be included, respectively.

enterprise, the basis of incentives to adopt new technology and to maintain the land in good stead.

Against this view are longstanding objections to enclosure as conferring a form of monopoly to owners and disenfranchising commoners. No less an observer than John Stuart Mill (1886), in his *Principles of Political Economy*, observed that:

> When the "sacredness of property" is talked of, it should always be remembered, that any sacredness does not belong in the same degree to landed property. No man made the land. It is the original inheritance of the whole species. Its appropriation is wholly a question of general expediency, (p. 142).

The most active phases of enclosure began in Great Britain in the 1500s and extended into the 19th century as ideas of exclusive rights to land evolved. In the lowlands of Great Britain, this process was intimately connected to a set of environmental challenges to arable agriculture. Like the prairies of the American Middle West, a key constraint was excess water and flooding on the flat coastal plains of Norfolk, Huntingdonshire, Lincolnshire, Cambridgshire and Suffolk. These wet marshes, referred to broadly as "fens," required drainage to be converted to arable fields and pastures. H. C. Darby, in his classic treatment, *The Draining of the Fens* (1956), emphasized that such drainage provided an early and profound example of environmental change:

> "The draining of the Fenland is, indeed, one of the mighty themes in the story of Britain. Geographically, it is notable as the re-creation of the physical features of a large area, and a triumphant witness to the power of society in utilizing and subduing its environment" (p. 28).

As early as 1531, Henry VIII had empowered a Commission on Sewers to survey "streams, ditches, banks . . . floodgates, ponds, locks" and other water bodies "to be made, corrected, repaired . . . as the case may require," and to tax and assess local

inhabitants for the purposes.[2] By the end of the 1500s, general recognition of the utility of large drainage projects had grown, expressed in particular by Bradley's 1589 treatise "concerning the state of marshes or inundated lands (commonly called Fens)."[3] The problem, however, was to find the capital and organizational abilities to manage and direct construction of such large projects. The effort required two figures: an "undertaker" (one willing to undertake the project) and an "adventurer" (who adventured their capital). In return, these risk takers required rewards, which were often specified as exclusive rights to part of the land drained and enclosed.

Meanwhile, those who lived without secure tenure on the fens formed a rural opposition who feared for their common rights to hunt, fish, pasture, and cut hay on the ecologically diverse and productive (if often flooded) fenlands. Among the opposition, one 17th Century writer (of the *Anti-Projector)* complained that the enclosing undertakers had "misinformed many Parliament men, that all the Fens is a mere quagmire, and that it is a level hurtfully surrounded, and of little or no value," when in fact it afforded employment to commoners gathering "reeds, fodder, thacks, flags, hassocks, segg, fleggweed for flegeren collors, maltweede for churches, chambers, beddes and many other fenn commodytes of great use both in towne and countreye."[4]

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[2] Quoted in Darby (1956), p. 4.
[3] A complete copy of Bradley's treatise is included as Appendix I to Darby's (1956) volume, *The Draining of the Fens* (1956).
[4] *The Anti-Projector* or the *History of the Fen Project* (1646), p. 8. Quoted in Darby (1956), p. 52. I have attempted to identify these archaic raw materials of the marsh from the *Oxford English Dictionary* and other sources. Reeds and fodder have their modern definitions: thacks is thatch used for roofing; flags are reeds or rushes used for binding or tightening the seams of a barrel, hassocks are clumps of grass, segg is fen sedge, a fern used for thatching. Unfortunately, fleggweed, flegeren collors and maltweede all eluded my search.

Once the fens were drained, the same writer observed, they were planted to "Cole-seed and Rape, they are but Dutch commodities and but trash and trumpery."[5]

Songs and poems were written to disparage the projects and mobilize opposition. One, "*Powte's Complaint*," contained the stanzas:

They'll sow both beans and oats,
where never man yet thought it,
Where men did row in boats,
ere undertakers bought it:
But, Ceres, thou, behold us now
let wild oats be their venture,
Oh let the frogs and miry bogs
destroy where they do enter.

Behold the great design,
which they do now determine,
Will make our bodies pine,
and prey to crows and vermine:
For they do mean all fens to drain,
and waters overmaster,
All will be dry, and we must die,
'cause Essex calves want pasture

. . . .

The feather'd fowls have wings,
to fly to other nations;
But we have no such things,
to help our transportations;
We must give place (oh grievous case)
to horned beasts and cattle,
Except that we can all agree
to drive them out by battle.[6]

Yet economic imperatives were strong. As Europe recovered from the plague population growth increased, contributing to rising grain and meat prices, making arable land more scarce and profitable. Projects thus continued to be organized to drain and

[5] Ibid. It did nothing to reassure the commoners that a chief engineer of the drainage projects was the Dutchman Vermuyden.
[6] "Powte" is the old English word for the sea lamprey. Quoted in Darby (1956), p. 55. Printed in W. Dugdale, *Imbanking and Drayning* (ed.) 1772. First issued in 1662. Second edition revised by C.N. Cole.

enclose the fens through dikes, ditches and canals so that they could be tilled or permanently pastured. Adventurers formed companies which were granted charters from the crown to drain the Fen Districts Levels. In return, these groups were granted private, exclusive rights of a third to two-thirds of the enclosed fields (Albright, 1955, p. 53).

What became of the commoners? Camden's *Britannia* (first published in 1586 and translated from Latin in 1610) dismissed them as "a kind of people according to the nature of the place where they dwell, rude, uncivil, and envious to all others, whom they call 'Upland-men.' (Camden, *Britannia*, quoted in Darby, p. 23). Camden ridiculed these rustic barbarians for stalking game on tall stilts which kept them above water level, and applying their minds only to "grasing, fishing and fowling." In winter, marsh hay was burned off, contributing to a rich soil that was the source of thatch, alders and willows used to build their cottages.[7] By Cromwell's time, the Commissioners and the Court of Sewers were charged with taxing any commoners if their land was "hurtfully surrounded" by undrained marsh. The tax, if unpaid, led the land to be forfeited to the charter companies and King Charles I, who was financially invested in the entire enterprise. Once the local employment effects of the drainage projects wore off, those with common rights (including tenancy grants dating to the ancient Statute of Merton) were essentially disenfranchised. Their rights to be included became null and void.

Under Cromwell's leadership, many of these commoners ultimately sought to drive out the new landlords, in the words of *Powte's Complaint*, "by battle." In 1638, Oliver Cromwell and his family had moved to Ely, near Cambridge, from which seat he would a decade later lead the Glorious Revolution against the king. Although a

[7] W. Dugdale, in 1662, similarly described the commoners as a "rude, and almost barbarons, sort of lazy and beggarly people," (1772), p. 171. Cited in Darby (1956), p. 23, note 1.

substantial property owner himself, among Cromwell's strongest supporters were commoners who had been deprived of their customary rights to fish, hunt, cut hay and pasture cattle in the thousands of square miles covered by the wetland marshes. "Here," as Antonia Fraser wrote in her biography of Cromwell, "from olden times, there were no hedges to mark the map, nor were there any really great houses . . . to overlay the spirit of the Fendweller's" (Fraser, 1973, p. 73). Cromwell argued that the commoners were due compensation, since they did not share in the crops and livestock now produced on enclosed fields. Riots and protests ensued, and contributed to a Civil War, in which king Charles I ultimately paid with his life, and the deaths of 80,000 Englishmen (out of an estimated male population of 1.6 million). Ironically, in 1649, when the Civil War was over and Charles beheaded, it was Cromwell who took over the drainage projects of the Earl of Bedford on the Great Level near Cambridge.

Whatever the historical record, the benefits of enclosure for economic efficiency have been widely asserted, especially by economists and men of commerce. The conventional view is that enclosure freed up surplus labor and made it available to the industrial revolution; it encouraged the modernization of agriculture and animal husbandry (and not incidentally made quite a few adventurers into lords of the manor). Dugdale, in his travelogues of 1657 and 1662, noted the general improvement of lands converted from marsh to arable fields and expanded commodity production by the new landowners, including onions, peas and hemp, flax, oats, wheat, cole-seed and wood, as well as pasture for cattle and sheep (Darby, 1956, pp. 86-92). Boyle, although a skeptic of enclosure, summarizes the conventional wisdom:

By transferring inefficiently managed common land into the hands of a single owner, enclosure escaped the aptly named "tragedy of the commons." It gave incentives for large-scale investment, allowed control over exploitation, and, in general, ensured that resources could be put to their most efficient use. Before the enclosure movement, the feudal lord would not invest in drainage systems, sheep purchases, or crop rotation that might increase yields from the common – he knew all too well that the fruits of his labor could be appropriated by others. The strong private property rights and single entity control that were introduced in the enclosure movement avoid the tragedies of overuse and underinvestment (Boyle, 2003, p. 35).

The empirical evidence in support of these claims (as Boyle recognizes) is considerably weaker than conventional wisdom suggests. In the most thorough assessment of English enclosures in the 18th century, Robert C. Allen of the University of British Columbia decomposed their effects on efficiency and redistribution of rents, using indices developed by Diewert. He found that the efficiency gains on enclosed fields were actually less than on those which remained open. Specifically, Allen analyzed data collected by agriculturalist Arthur Young[8] in the late 1760's on rents, wages and prices as well as quantities of land and labor inputs used on farms. With modern econometric methods, Allen (1982) concluded that "the major economic consequence of the enclosure of open field arable in the eighteenth century was to redistribute the existing agricultural income, not to create additional income by increasing efficiency" (Allen, 1982, p. 950). Other agricultural historians have found that commoners farming open fields did indeed adopt modern agricultural technologies, supporting Allen's finding that common fields actually produced higher yields than enclosed ones. (Yelling, 1977).

In further support of this view, Gregory Clark analyzed data on land markets from 22,000 plots held in England by charities, some common and some enclosed. He

[8] Young was secretary of the British Board of Agriculture, and editor of the Annals of Agriculture from 1768-1770. He traveled throughout England, combining his data and observations into nine volumes of 4,500 pages.

concluded, again based on careful econometric methods, that the "rent gains from enclosure thus seems to be a myth," and that "there was very little private or social gain from enclosing land" (Clark, 1998, pp. 81, 97).[9]

Where rents on enclosed fields rose[10], this may simply have reflected the enhanced bargaining power of landlords under the new regime, as well as the increased demand for grains, meat and wool and the capitalization of higher commodity prices into land values. As Allen concludes, enclosure was justified with efficiency arguments, but its main effect was "to redistribute income to already rich landowners" (Allen, 1982, p. 951).

The Fallacy of the Tragedy in the Commons

Apart from empirical studies, the theoretical case for enclosure is also dubious. Dasgupta and Heal (1979, p. 77), in their treatment of the theory of natural resource economics, commented that enclosure, while "blessed at the altar of efficiency, can have disastrous distributional consequences." Meza and Gould (1992), writing in the *Journal of Political Economy*, argued that even in perfect competition the enforcement of private rights to exclude others may result in inefficient levels of investment in resource productivity. In contrast to the partial equilibrium analysis of Demsetz (1964) and Cheung (1987), Meza and Gould adopted a general equilibrium approach, in which decisions to enclose property and enforce rights to exclude may induce those excluded to overuse other property or may affect the inputs or outputs on the enclosed property, and thus prices (see Appendix I). These price changes then affect the decisions of other property owners to enforce or not enforce enclosure. As a result, there may be too much

[9] In a comment on Clark, Chapman (1999) suggests that the Charity Commission data is unrepresentative and thus misleading.
[10] A fact which led McCloskey (1972, 1991) to claim for efficiency gains.

or too little enforcement of rights to exclude, with multiple equilibria, some of which are socially inefficient.

My own work on the so-called Tragedy of the Commons, and involvement in contemporary debates over the privatization of public lands, also questions the theoretical validity of the claim that resources managed as common property are necessarily managed inefficiently (Runge, 1981; 1986). Garrett Hardin's widely cited essay, "The Tragedy of the Commons" expressed a major conclusion based on what economists often refer to as the "free rider" premise – that individuals find shirking responsibility more beneficial than performing social duties (Hardin, 1968). The argument was developed in terms of the following parable attributed to Lloyd (1833). Imagine a grazing area held in common. According to Hardin's analysis there is always an incentive on common land to graze another head of cattle, regardless of the impact this has on range quality. The reason is that the benefits of the extra animal are captured by the individual grazer while the costs of reduced range quality are spread across all those who share the commons. Since the individual benefits of this behavior always exceed the costs (which are shifted to the community), rational self-interest leads to social ruin. Where lands are held in common, unless strong measures of social control are imposed, overexploitation will result. Only private individual use, imposed by some higher authority, can avoid tragedy. What is curious is that depending on one's bias, either private use or centralized authority emerges as the major lesson. Ironically, this has made the Tragedy of the Commons a popular argument with environmentalists favoring draconian regulatory controls, while

libertarians also use it to justify private property as the only efficient solution (Runge, 1984).[11]

To understand this curiosity, it is useful to examine the premise that each individual will find it rational to free ride when benefits are individual and costs are spread over the entire community. Economic theorists have described the problem in terms of the "Prisoners' Dilemma" game, in which two prisoners are being interrogated after having participated in a joint holdup. Each is promised a particularly lenient sentence if he will turn state's evidence and "rat" on his partner. But if both rat, they both go to prison for a much longer period. The optimal strategy – to keep quiet – is undercut by each prisoner's individual incentive to defect. Furthermore, this is the best strategy no matter what is expected of the other prisoner. Therefore the free-rider or defecting strategy dominates all others. Applied to common property, defection or free-riding spells tragedy in the commons.

The fact that many common property regimes do survive and even prosper, coupled with the unsettling authoritarian implications of the Tragedy of the Commons, suggests an alternative paradigm. I have termed this the Assurance Problem, after Sen (1967). In its n-person game theoretic form, the Assurance Problem (AP) may be contrasted with the Prisoner's Dilemma using Schelling's description of binary externalities (1973). In Figure 1, the payoff to agent n+1 of managing a commons jointly, rather than enclosing it, is shown by the C schedule, while the free riding or defection strategy (spelling tragedy) is shown by the D schedule. This is the n-person prisoners' dilemma (PD). The PD always results in payoffs to defection dominating

[11] Hardin's somewhat opaque solution to the dilemma called for "mutual coercion, mutually agreed upon." The peculiar, if not nonsensical, character of this phrase illustrates the tension between *dirigisme* and private decision.

cooperative management, no matter how many others in a group of size n are expected to cooperate. If each agent is similarly situated, all will defect and the commons will be a tragedy.

In Figure 2, by contrast, the decision of agent (n+1) depends on his or her expectation of the number of others expected to cooperate. If a critical mass do so (shown as point m), then agent (n+1) will too, and tragedy can be averted because defection or free riding is not a dominant strategy past switch point or threshold level m. This is the Assurance Problem (AP). In contrast to the PD, which has a unique and inferior equilibrium, the AP has multiple equilibria, including those in which individuals cooperate rather than defect. Such cooperation may include joint enterprises organized as common property.[12] Many things may cause the payoff functions of agents to more closely resemble Figure 2 than Figure 1, including institutional arrangements which reward cooperative management due to the advantages conferred by the right to be included in a common enterprise.

[12] A further irony of the use of the Tragedy of the Commons' as justification for imposing private, exclusive property rights is that the joint undertakings of teams of adventurers during the enclosure movement became classic examples of "public goods" problems in which shirking or free riding was a major constraint to success. On the distinction between commons problems and public goods, see Sandler and Arce (2003).

Figure 1. n-person Prisoner's Dilemma

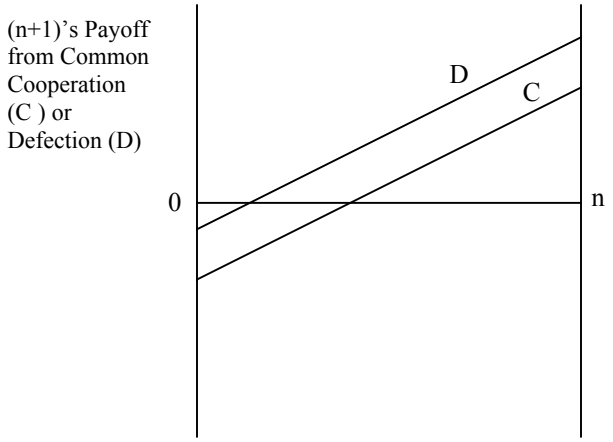
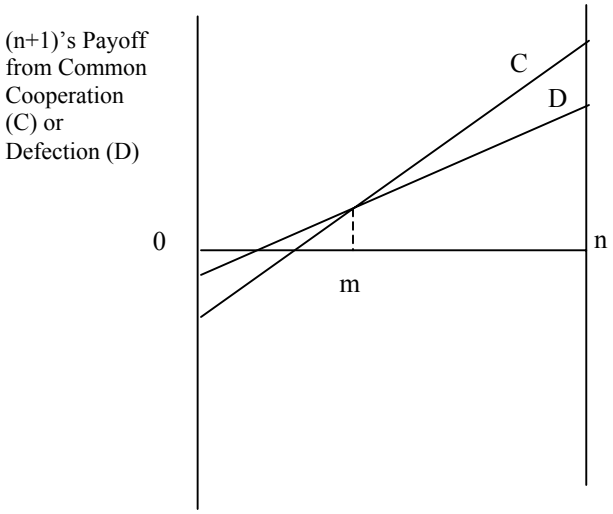



Figure 2. n-person Assurance Problem



The Enclosure of Ideas: Intellectual Property and Genomics

In the modern period, issues of intellectual property rights have renewed the debate over enclosure, this time not over land but over information and ideas. The long and interesting record of land enclosures is worth considering in our own time because we have entered what Boyle (2003) calls a "second enclosure movement" revolving around intellectual property. An active part of this debate relates to biotechnology and plant genomics (Ghijsen, 2002). Here too, it is argued that without secure rights to exclude others from a stream of rents or benefits, firms will underinvest in new and promising technologies, slowing productivity gains and scientific advances.

The virtue of enclosing ideas also has its distinguished doubters. Adam Smith was skeptical of patents over ideas, due largely to his general suspicion of collusion and monopoly. Although monopoly patents may secure to the monopolist the returns necessary to spur investment, Smith was doubtful that they necessarily encouraged efficiency, innovation and development.[13]

Thomas Jefferson, writing critically of exclusive patents over intellectual property, said in a widely cited 1813 letter to Isaac McPherson:

> "If nature has made one thing less susceptible than all others of exclusive property, it is the action of the thinking power called an idea, which an individual may exclusively possess as long as he keeps it to himself; but the moment it is divulged, it forces itself into the possession of everyone, and the receiver cannot dispossess himself of it. Its peculiar character, too, is that no one possesses the less, because every other possesses the whole of it . . . Inventions then cannot, in nature, be a subject of property.[14]

[13] Smith wrote in *The Wealth of Nations* that monopolies should be temporary. If maintained the result would be to tax individuals "very absurdly in two different ways: first, by the high price of goods, which, in the case of a free trade, they could buy much cheaper; and secondly, by their total exclusion from a branch of business which it might be both convenient and profitable for many of them to carry on (Smith, Book III, p. 339, cited in Boyle, 2003, p. 55, note 87).

[14] Letter from Thomas Jefferson to Isaac McPherson (August 13, 1813) in *The Writings of Thomas Jefferson* (A.E. Berghed), 1907:333-34. Cited in Boyle, 2003, p. 53.

Jefferson's views have modern adherents who fear that enclosing the genetic commons through intellectual property claims to genomic information will confer monopoly power and close out developing countries from biotechnology and its benefits (Falcon and Fowler, 2002; Herdt, 1999; Tansey, 2002). More importantly, Jefferson's view of the impossibility of enclosing ideas suggests that these claims may simply be unenforceable (Runge, et al., 2003, p. 96). Despite Jefferson and others' reservations concerning the difficulty of building walls and dikes around ideas, there is no shortage of enthusiasm by modern day undertakers and adventurers for this effort, especially in the biotechnology sector. The essential question is whether the record of enclosure in land, involving far fewer efficiency gains than imagined, will be repeated in the new regime. Perhaps the elements of common property management, revolving around rights to be included in benefits streams, have greater relevance to the modern era than imagined.

In fact there is a distinguished intellectual tradition in economics arguing that patents are not necessary to innovation at all. After all, patents are a phenomenon of the last two centuries, and technological innovation is thousands of years old. Arnold Plant of the London School of Economics (whose student Ronald Coase would do much to establish the importance of property rights in economics) argued convincingly that the absence of patents and copyrights had not deterred innovation in the 19th century (Plant, 1934a, 1934b). In fact, in the 19th and early 20th centuries, long before patents on plants or their genetic materials were contemplated or possible, open sharing of biological information was encouraged by societies of husbandry, through exhibitions and state and county fairs, and through newsletters and meetings of interested growers. In apple production, for example, private breeders developed new fruit varieties from the 1700s

onward (Stallman, 1986). The American Pomological Society annual meetings resulted in thousands of reports on varieties tried and tested. As Tuckey (1976) wrote:

> If one wonders about the great amount of talent and energy that went into the appraisal of varieties of fruit at this time, it must be remembered that during this period variety selection established the foundation of the commercial fruit industry in America. America had no native pear, peach, apple, plum, cherry or grape varieties of consequence. The New World required new varieties, and it was the ardent band of fruit lovers of a century and more ago that did the laborious testing, sorting, and cataloguing which was so essential.

Indeed, the fertility of an intellectual commons as a seedbed for new ideas is in many respects the reason universities exist, and why balkanization of knowledge within departments can easily overtake the advantages of specialization. This perspective was also reflected among leading legal minds' opinions on intellectual property law. Boyle remarks that "It may sound paradoxical, but in a very real sense protection of the commons was one of the fundamental goals of intellectual property law," citing Justice Brandeis's 1918 dissent in *International News Service v. Associated Press* (240 U.S. 215), in which he wrote that "[t]he general rule of law is, that the noblest of human productions – knowledge, truths ascertained, conceptions, and ideas – become, after voluntary communication to others, free as the air to common use." In marked contrast, the new vision of intellectual property seems "to be shifting from Brandeis's assumption that the 'noblest of human productions are free as the air to common use' to the assumption that any commons is inefficient, if not tragic," (Boyle, 2003, p. 40).

While there are many sub-spheres in which this change is underway, the one of interest here is plant genomics and bioinformatics, where like computer software generally the line is blurred between computer modeling and biological research, just as "digital production techniques blur the line between listening, editing and recreating,"

(Boyle, p. 40). The question posed by Boyle and other critics of the Second Enclosure Movement is whether, given the public value of information contained in human and plant genomes, its enclosure will necessarily promote efficient social outcomes. "More property rights," Boyle writes, "even though they supposedly offer greater incentives, do not necessarily make for more and better production and innovation – sometimes just the opposite is true" (2003, p. 44). This argument has been developed forcefully by Heller and Eisenberg, writing in *Science* (1998) and the *Harvard Law Review* (Heller, 1998). After briefly discussing their critique, which they term a "Tragedy of the AntiCommons," I will develop an argument for the common use of genetic information, based on the idea of positive network externalities, or as I shall characterize them – internalities.

Heller and Eisenberg (1998) argue that in response to U.S. government policies, the National Institutes of Health and major universities are building technology transfer offices to patent and license their discoveries, so that upstream research in the biological sciences is increasingly enclosed, shutting off access to other researchers both in the U.S. and abroad. "The result," they argue, "has been a spiraling of overlapping patent claims in the hands of different owners, reaching ever further upstream in the course of biomedical research," (1998, p. 698). Two mechanisms further this enclosure. The first, known as "concurrent fragments," began with NIH's 1991decision to patent anonymous gene fragments on expressed sequence tags (ESTs). Although NIH abandoned this effort several years later, and is now hostile to such enclosure, private firms stepped in to file patents on newly expressed DNA sequences and gene fragments before their commercial potential was even understood or known. These claims have largely been supported in

decisions by the U.S. Patent and Trademark Office (PTO), which in principle could deny them. The consequence has been to raise the risk and expense of bringing new genomic innovations to market, reinforcing the power of large (and largely monopolistic) companies in biotechnology, especially in the pharmaceutical industry.

The second mechanism, known as "stacking licenses," involves the use of "reach through license agreements" (RTLAs), which give owners of a patented invention used in upstream research the right to reach downstream to collect rents, royalties or options on subsequent discoveries. Although justified as a mechanism to raise venture capital for smaller firms based on potential downstream rewards, RTLAs may result in overlapping and inconsistent claims on downstream commercial activity. Like Gulliver, downstream commercial entrepreneurs may awake to find themselves bound by hundreds of legal threads. The uncertainty resulting from this nightmarish possibility is a further drag on innovation and investment.

This state of affairs has led leading economists openly to question the conventional wisdom (especially in the economics profession) that enclosure and private rights provide crucial incentives to innovation. Paul A. David (2003) argues that in the life sciences (biotechnology, pharmaceuticals and medicine), where industry funds about 25 percent of university research, patent claims are "perceptibly encroaching upon the culture of academic research and challenging the ethos of collaborative, open science" (p. 2). In the quarter-century since U.S. passage of the Bayh-Dole Act of 1980, authorizing universities to seek patents on federally funded innovations, the delays created in gaining

access to information when patents are pending has lengthened steadily.[15] This has created "formidable barriers to the ability of academic researchers to rapidly access new research tools and results," (David, 2003, p. 8).

The perverse incentives created by the tragedy of the anti-commons corresponds to a game in which rather than seeking to coordinate around a superior outcome, agents feel that because competing firms are rushing headlong to enclose intellectual property, they must also, lest they be left behind, even if this is an inferior equilibrium. Better to be worse off together than worse off alone. This defensive patenting strategy, when observed by others, simply reinforces the belief that it is an imperative.[16] As in cases of free rider behavior, if others are expected to free ride, the assurance problem (AP) predicts that the representative agent will free ride as well, leading to an inferior equilibrium (Runge, 1984).

In contrast, exploiting intellectual property as a commons may promote positive network externalities resulting from information sharing by a "club" whose members have rights to be included in the common pool of information.[17] Rather than an "externality," it would be more appropriate to term the advantages of a club-network,

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[15] See R. Henderson, A.B. Jaffe and M. Trajtenberg. "Universities as a Source of Commercial Technology: A Detailed Analysis of University Patenting, 1965-1988." *Review of Economics and Statistics* 1998: 119-127.

[16] Governments may find themselves caught in the same perverse dynamic as firms. The European Union's Directive on the Legal Protection of Databases of March 11, 1996 originated as industrial policy to confront perceived superiority of on-line electronic databases in the U.S. by establishing *sui generis* copyright protections which departed from longstanding principles of intellectual property law. By blurring the line between protecting expression and protecting ideas, and between original and pre-existing expression, the Directive seeks to limit reuse of databases unless payment for licenses occurs. In reaction to the Directive, the U.S. Congress, at the request of the U.S. Patent and Trademark Office, introduced various bills (H.R. 3531-Database Investment and Intellectual Property Piracy Act of 1996, and numerous successor bills, such as H.R. 345 – The Collections of Information Antipiracy Act of 1999, and H.R. 1858 – The Consumer and Investors Access to Information Act of 1999 (David, 2003, p. 15).

[17] On club goods and collective action generally, see Richard Cornes and Todd Sandler. *The Theory of Externalities, Public Goods and Club Goods*, 2nd ed. Cambridge, UK: Cambridge University Press, 1996, and Todd Sandler, *Collective Action: Theory and Applications*. On the theory of network externalities, see Katz and Shapiro (1985).

including many sorts of common property, as "internalities." This is clearly the concept behind Coase's idea of the firm – an entity within which tacit understandings, mutual expectations, and common goals obviate much of the formal contracting that would characterize arm's length dealings with outside agents. The internal economies resulting from such networks require a degree of loyalty and trust, but the benefits of reduced transactions may be very large indeed. These benefits confer real value to the rights to be included in the club-network.[18] The collective willingness to pay to be part of this club is likely to significantly exceed individual firm's willingness to pay to exclude others through patents or other forms of exclusion and enclosure. David writes:

> Viewed from this perspective, the current rush to tighten the copyright regime and encourage strict enforcement of "anti-piracy" provisions of all kinds, may at some date in the not-so-distant future come to be perceived as having been a serious mistake, not only because its consequences were injurious to the conduct of open science, but because they were antithetical to the development and exploitation of new and more profitable business opportunities (David, 2003, p. 12).

What does the trend toward enclosure of intellectual property in the life sciences, genomics and information science generally have to do with environmental sustainability? First, it may materially slow the engine of research and development, resulting in less rapid use of powerful technologies in service of the environment. Their potential is illustrated by biotechnologies under development to genetically engineer microbes which consume and neutralize toxic wastes, or which confer salt-tolerance to plants such as rapeseed, allowing them to be grown on saline soils while remediating the soils themselves. Second, the new enclosure movement may create rights which, even if

[18] Even the largest and loosest of such club-networks, such as citizenship, may confer substantial benefits, both tangible and intangible. Apart from whatever tangible government benefits (Social Security, etc.) are conferred by U.S. citizenship, it is apparent that global demand for such status, based in part on intangible benefits, well exceeds the supply. Willingness to pay to be included in such status daily causes illegal immigration and risk of life.

they do not end certain public or private classes of R&D, raise transactions costs so high as to shut out and essentially disenfranchise smaller firms or public sector scientists, many of whom are working at U.S. universities. In the same sense as enclosure of land, they may transfer rents to the counterparts of large landlords, but be socially inefficient. Third, they may lead directly to losses in the capacity to manage and apply information with material environmental benefits. A specific example, offered by David, is the privatization of Landsat data under the Land-Remote Sensing Commercialization Act of 1984. This act transferred management of Landsat data from NOAA in 1985 to a joint venture of Hughes and RCA, the Earth Observation Satellite Company. Landsat data, critical in many environmental assessments of deforestation, soil depletion and species extinction, rose in price ten-fold, from $400 per image to $4,000. Hughes' and RCAs' rents clearly rose, but the result on university researchers and smaller companies was "devastating" (David, 2003, p. 12).

The Right to be Included

The force of my argument is that a preoccupation with the right to exclude or enclose property – real or intellectual – should not neglect the real and important benefits associated with rights to be included, resulting from membership in a club-network. Common property, whether real property rights to joint use of marshes and fens in the 17th and 18th century, or open software and other rights to be included in a flow of genomics and bioinformatics research in our own, are all rights to be included (as is membership in a smaller group or firm or university department). In a slightly different (but highly relevant) context, A. K. Sen writes of the right to be included in a flow of economic benefits – especially food. As he shows in his study of famines, it is not

necessarily the physical shortage of food, but the absence of rights to be included in sustenance that results in hunger and starvation (Sen, 1981). In concluding this essay, I draw together the idea of a right to be included with a tradition in political theory, and end with a summary view of the need for a balancing bundle of exclusive and inclusive rights as an approach to sustainable enterprise.

Oxford philosopher Isaiah Berlin's famous essay, *Two Concepts of Liberty* (1958), distinguished "negative" liberty (freedom *from* interference by others) from "positive" liberty (freedom *to* engage in or be part of a stream of benefits). Berlin's primary claim was that in contrast to negative liberty, positive liberty was subject to debasement in the name of a higher rationality, which in totalitarian or fascist hands could deny present freedom in the name of some greater ultimate freedom, often a distant utopian future. Here, I am concerned with the balance between the negative aspects of a right to exclude others from property, to be free *from* their claims to its benefits, and the positive right to be included in a stream of future benefits, to have a right *to a share* of a common pool of resources or information.[19]

Environmental quality and environmental sustainability require a balance in the bundle of rights conferring exclusion and inclusion. On the side of exclusion, there is no question that private rights to property, real and intellectual, will continue to be asserted, and to confer tangible benefits on holders of such rights. However, the case linking these rights to innovation and technological change is far from certain. In some cases, there

[19] C.B. MacPherson (1973), in a strenuous critique of Berlin's division of liberty and a defense of some forms of positive liberty, describes one part of positive liberty (one of three sub-types) as "the democratic concept of liberty as a share in the controlling authority" (p. 109). This is most closely aligned with my own emphasis on rights to be included. He goes on to say that the distinction between positive liberty as having a right to a "share" (he does not mean common stock, but he could have) and negative liberty is "sharp and clear" (p. 109). His central concern, like mine, is that rights to exclude can function as impediments to access by others to a stream of benefits (see MacPherson, 1973, Essays III and V).

may be a strong basis for the connection, but the burden of proof should be on the enclosing firm, and the granting authority. At a minimum, positive profit streams may sometimes demand exclusive rights. Since sustaining the enterprise is a necessary, if not sufficient, condition for sustainable enterprise, an argument for such negative rights continues to exist.

On the side of inclusion, the demand for environmental sustainability is about the right of individuals and firms to be included in a stream of environmental services over time, including clean air, remediated soils, and protected lands and species.[20] While these rights to be included may be asserted by the public sector through statute and regulation, they may also take the form of common pools or club-networks in which firms' or individuals' rights to be included allow vital information sharing. This appears increasingly to be the case with genomics and biotechnology information, where the internalities of information sharing can increase the pace and propel commercialization of technological innovations by avoiding the fragmentation and stacking discussed above. If this is so, then sustainable enterprise will require righting the balance in the bundle of these rights, and a reassertion of the private and public efficiencies gained from real and intellectual assets treated as common property.

[20] It might be argued that such positive environmental rights to be included are also subject to Berlin's debasement in the name of a utopian future. This tendency should be taken seriously, but not so seriously as to create the strawmen of "ecofascism" or to deny the role of such positive freedoms in environmental improvement and stakeholding.

## Appendix I

Meza and Gould (1992) consider the choice between enclosure of some n sites or not. Equilibrium requires that labor earnings W are set equal to the value of marginal product (VMP) in each of two sectors: (1) manufacturing ($VMP_x$) and (2) production on enclosed land ($VMP_p$). These in turn must be set equal to the value of average product on common or unenclosed land ($VAP_c$).

$$W = VMP_x(L_x) = VMP(L_p) = VAP_c(L_c). \quad (1)$$

If there are N possible sites of enclosure, and n of them are enclosed, the market clearing condition is:

$$\bar{L} = L_x(W) + nL_p(W) + (N-n)L_c(W) \quad (2)$$

where $\bar{L}$ is the fixed supply of labor, $L_x$ and $L_p$ are the demands for labor in manufacturing and on enclosed sites, and $L_c$ is the number of laborers remaining on common property. Given n, (1) and (2) yield solutions for W, $L_x$ and $L_p$ and $L_c$.

The equilibrium value for n, the number of enclosed sites, depends on the rents from enclosed land, less the costs of arranging for and enforcing private rights. This could include the construction and maintenance of drainage systems, as well as monitoring private lands once enclosed. If construction and enforcement is costless, gross rents depend on how many owners enclose their property. Labor supply to the land resource is

$$S(W) \equiv \bar{L} - L_x(W) \quad (3)$$

With diminishing marginal returns to manufacturing, $L_x$ is decreasing and S is increasing in W. Equilibrium therefore requires that:

$$S(W) = nL_p(W) + (N-n)L_c(W) \quad (4)$$

When W and gross rents R are graphed as a function of n, the number of enclosed sites, it is apparent that rents R and construction and enforcement costs E together define the payoff to enclosure (Figure 3). Since W and n satisfying equation (4) also satisfy (1) and (2), their values will equilibrate manufacturing and the labor market, defining a general equilibrium.

The equilibrium wage occurs where the horizontal sum of the VMPs for each site equals the supply of labor, at $W_p$, and A+B equals the aggregate rent accruing to owners of enclosed land. Individual rents per site are (A+B)/N. If no owners enclose their land, and it remains common property, its value is set by average product VAP, and the equilibrium wage is $W_c$. If a single owner were to enclose, he would have to pay $W_c$ to bid labor away from common property, yielding a rent A/N. Clearly, rents are greater under enclosure than under a common property regime since (A+B)/N > A/N, consistent

with McClosky's (1972, 1991) arguments. But the rent earned is greater if all sites are enclosed than if only one landowner encloses his site, suggesting the appeal of large projects of enclosure as undertaken by adventurers such as the Earl of Bedford. As the number of enclosed sites increases, the aggregate employment of labor falls on all sites, as does the wage, consistent with the disenfranchisement and calls for compensation by commoners supported by Cromwell. The rent to landowners increases with the number of enclosures from a minimum of $A/N = R_c$ to a maximum of $(A+B)/N = R_p$.

In Figure 4, the relationship between rents to enclosing owners and the extent of enclosure n is shown by the rent curve $R_c$ $R_p$. If construction and enforcement costs are less than the rents paid under common property, i.e., if $E < R_c$, all owners will enclose their sites; but if they are greater than the rents paid once enclosure has occurred, none will enclose, i.e., if $E > R_p$. Multiple equilibria can occur if construction and enforcement costs fall in between the rents under common property and full enclosure.

Figure 3. Wage Determination Under Enclosure and Common Property

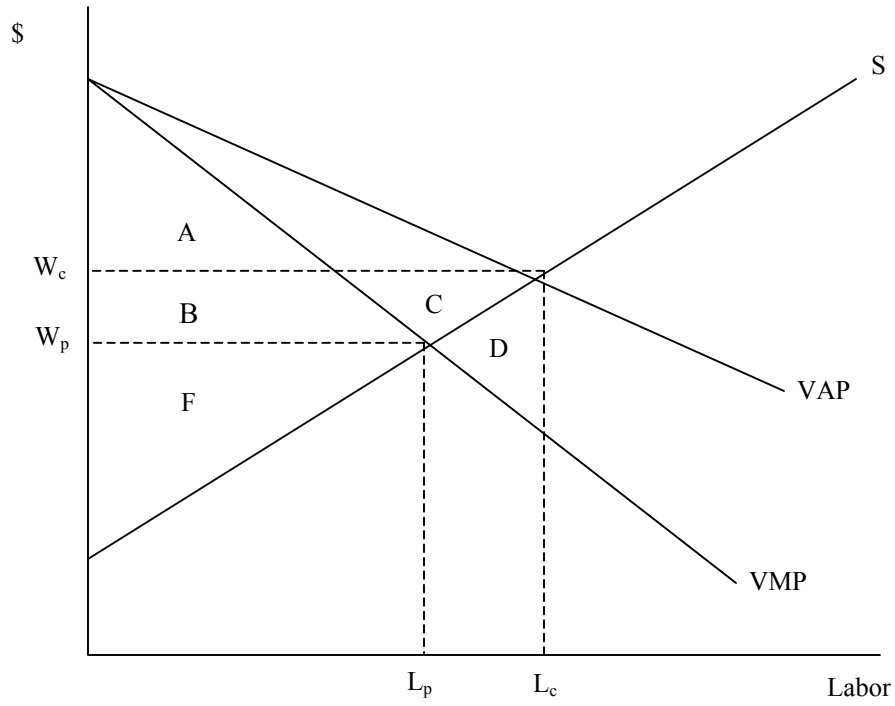
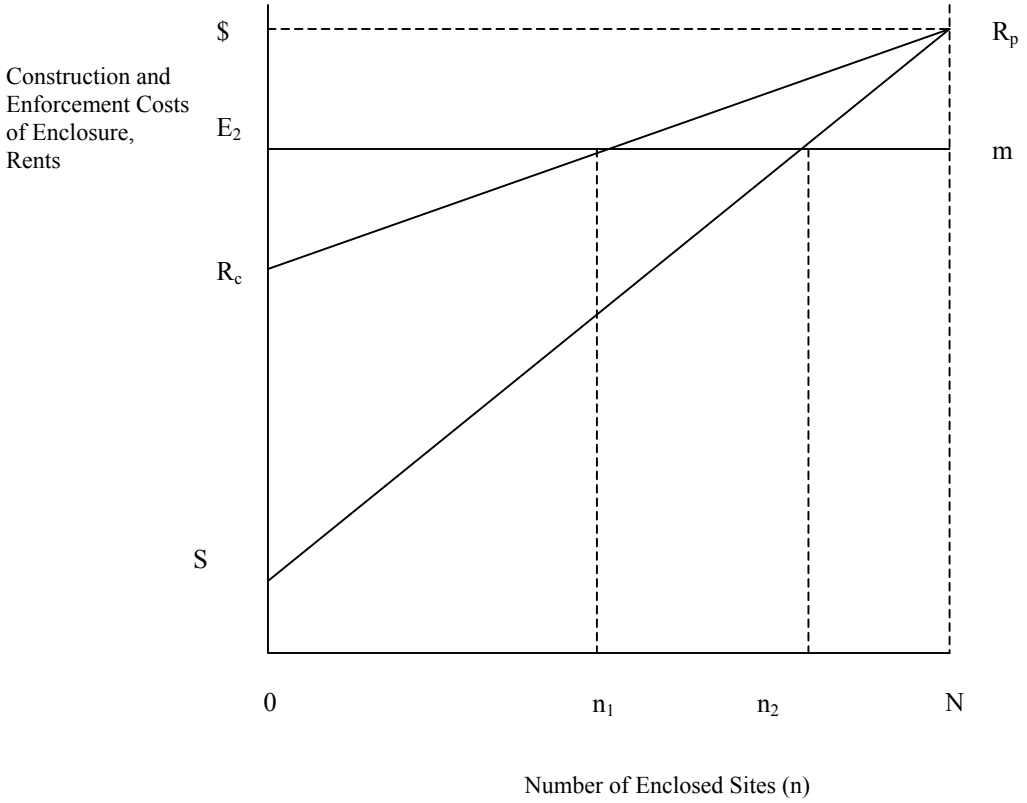


Figure 4. Rental Gradients from Enclosure and Common Property




Consider construction and enforcement costs at $E_2$. If all sites are enclosed, no agent can benefit from not enclosing since $R_p > E_2$. But if no sites are enclosed and common property prevails, no agent has an incentive to enclose, since $E_2 > R_c$. There are two equilibria, both locally stable in n, one of which involves no enclosure (n=0) and one of which involves complete enclosure (n=N).

Using a simple assessment of welfare gains based on Figure 3, gross social benefits of total enclosure, *without* accounting for construction and enforcement costs, are A+B+F. When all land is retained as common property, these benefits are B+C+F. The net gain of enclosure over common property is the difference in these quantities:

$$(A+B+F) - (B+C+F) = (A-C) \quad (5)$$

When construction and enforcement costs are incurred to enclose all N sites equal to NE, the social advantage of enclosure is positive so long as

$$NE > (A-C) \quad (6)$$

Meza and Gould (1992, p. 568), remark that the gross benefits (A-C) of enclosure are less than aggregate rents at the common property wage $W_{c1}$, since (A-C) < A for all positive values of C. They then let the construction and enforcement costs $E_1$ equal the net gain per site, which is less than the rent at the common property wage $W_c$, as in Figure 4.

$$E_1 = (A-C)/N < R_c \qquad (7)$$

The following results then obtain.

I. If $E < E_1$, there is a unique equilibrium with all sites enclosed that is socially preferred to common property.

II. If $E_1 < E < R_c$, there is a unique equilibrium with all sites enclosed, but it is socially inferior to common property.

III. If $R_c < E < R_p$, there is a common property equilibrium that is socially preferred to the equilibrium of full enclosure of all sites.

IV. If $E > R_p$, there is a unique common property equilibrium that is socially preferred to enclosure.

Cases I and IV are cases of full enclosure (I) and no enclosure (IV) (common property) equilibrium. In other words, if construction and enforcement costs are low (Case I), enclosure is socially preferred. But if they are high (Case IV), common property is socially preferred. Case II, however, shows that when construction and enforcement costs fall in the range between $E_1$ and the common property rent $R_c$, an equilibrium results in which enclosure of all sites is socially inefficient. Case III shows that when construction and enforcement costs fall in the range between the common property rent and the full enclosure rent, common property is more socially efficient. Some enclosure, in other words, may be worse for society than common property, especially where construction and enforcement costs are high. The problem, from the point of view of enclosing landlords, is that unless they are assured that all sites (or at least a critical mass) will be enclosed, given construction and enforcement costs, it may not pay to enclose at all. Here again we see the multiple equilibria and role of expectations characteristic of the assurance problem (AP).

In sum, enclosure is not necessarily socially efficient. One of its primary consequences is to displace labor from enclosed land, which (depending on the elasticity of its supply) will either move to the manufacturing sector, or remain on whatever land is left unenclosed, or both, generally at lower wages.

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