Marling in British Agriculture: A Case of Partial Identity*

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There is strong evidence of the utility of chemical knowledge in the investigation of fossil manures.
(William Marshall, 1788)**

Abstract
Marling has usually been viewed by British historians either as a practice of no clearly identifiable purpose, or as an exercise designed to add body to light soils. It has also been presented as a crude, ancient affair, largely irrelevant to modern farming. The suggestion here is that it performed important chemical functions, and that these – most notably the reduction of soil acidity and the attendant liberation of plant nutrients – gave it an important role in improved farming through to the nineteenth century, terminal obsolescence only setting in as supplies of cheaply transportable lime became increasingly available.

HISTORIANS wishing to understand the role of marling in British farming confront at least three awkward considerations. These, to date, have served to deter any general evaluation. First, there is the apparently indeterminate nature of the substance, with attendant uncertainties over function. Second, there is the seeming lack of relevance of a very ancient practice to the increasingly sophisticated ways of enclosed, diversified, rotation agriculture, with its ever-widening range of specialized fertilizing agents. Third, there are quantitative problems in determining the scale of marl's application, the changes in its popularity, and the regional patterns of its use.

We shall attempt, by conceptual and circumstantial means, to clarify the first, query the second, and reassure on the third. It will be shown in the process that marling is an ill-interpreted and underestimated category of improvement. Its use had much to do with the neutralization of land acidity, as distinct from the traditionally-stressed thickening of light soils. This is not to say that its structural effects were insignificant: rather that these may have been comparatively overrated. Writing in 1855, Augustus Voelcker of the Royal Agricultural College had little doubt that the 'chemical effects which marls are capable of producing, when applied to land, are of greater importance than their physical effects'.[1]

Such relief of acidity has been extensively practised for centuries, and it is an oddity of British agricultural historiography that it bypasses any notable documentation or analysis on the issue. This cannot be explained by inconsequence. Soil scientists have pointed out that the amelioration of sour land is 'a fundamental and essential practice', and 'vital to successful agriculture in most humid regions'.[2] Nothing 'affects soils as a plant medium as much as liming acid soils', such work being the critical 'first step' in raising fertility.[3] However, a succession of agricultural revolutions, *pace* Kerridge, Chambers & Mingay, and Thompson, seems to have taken place without anyone bothering much about it.

* I am grateful to Dr R G Wilson of the University of East Anglia for reading an earlier draft and offering helpful comment.
** William Marshall, *The Rural Economy of Norfolk*, 1786, I, p 18.

[1] In John C Morton, ed, *A Cyclopedia of Agriculture*, Glasgow, Edinburgh, and London, VII, p 380.
[2] C E Millar, L M Turk, and H D Foth, *Fundamentals of Soil Science*, New York and London, 1974, p 146; Nyle C Brady, *The Nature and Properties of Soils*, New York and London, 1974, p 404.
[3] Robert S Whitney, foreword to Robert W Pearson and Fred Adams, eds, *Soil Acidity and Liming*, Madison, 1967, p vii; Firman Edward Bear, *Chemistry of the Soil*, New York, 1955, p 237.

I

On the matter of indeterminacy, Sir William Ashley sets the tone when he asks 'just what that mysterious thing marling really was'[4] – and quite fails to answer. Some decades earlier, the American soil scientist Edmund Ruffin noted it to be 'of old and frequent use in English books, with very different meanings', cautioning that those of his compatriots who tried to learn from British experience would be 'more apt to be deceived and misled than enlightened'.[5] Fortunately, however, ambiguity is not universal. There exist in fact two quite separate streams of writing, with only very occasional overlaps: one historical, documentary, and semantically confused; but the other scientific, educative, and conceptually precise.

In the latter – broadening in the nineteenth-century, and displacing premodern, vernacular listing – marl appears clearly as a means of adding calcium carbonate to sour soils, thereby relieving acidity. *Morton's Cyclopedia of Agriculture*, 1855, describes it as 'an unctuous, clayey, chalky, or sandy earth, of calcareous nature'. Marls, though of 'variable character', had to possess 'some portions of lime in their composition' before they merited the name. 'The substances which determine the fertilizing value of marls', wrote Augustus Voelcker in the same publication, 'are exactly the same which affect the value of limestone'. In the 1870s, John Wrightson called it 'a mixture of clay and lime', in which the latter could range from eight to eighty per cent of the whole. 'True marls', however, had to be predominantly calcareous. The 1894 edition of *Johnston's Elements of Agricultural Chemistry* has them 'more or less rich and valuable for agricultural purposes as the proportion of lime increases'. Herbert Ingle, in 1908, classified it with lime, slaked lime, limestone, and chalk as an acidity-reducing application. 'A true marl', wrote Sir Daniel Hall in 1909, 'is a clay containing a variable percentage of calcium carbonate', of especial value on sandy and peaty soils for a mix of chemical and textural reasons. *Fream's Elements of Agriculture* in 1920 said marl 'might be called a calcareous clay', being 'put on land chiefly for the sake of the lime it brings with it'.[6]

Such usage is carried over into dictionaries and encyclopedias,[7] and is also in accord with defining in the United States. Edmund Ruffin set out a clear semantic precedent there in the 1830s and 1840s. Marling, he emphazied, had the purpose of 'simply *making a soil calcareous*'.[8] He set about identifying extensive deposits throughout the southeastern states, offering them as the principal basis for soil improvement and diversified farming on the predominantly acid lands there.[9] Other American commentators, in government or college employ, refined the minimum calcareous percentage to around twenty, while also accepting the possibility of accompanying structural benefits.[10] In France, M Puvis employed simple chemical criteria, writing that the 'object of marling, is to give a soil the qualities and advantages of a calcareous soil'.[11]

[4] Sir William Ashley, *The Bread of our Forefathers*, Oxford, 1928, p 138.

[5] Edmund Ruffin, *An Essay on Calcareous Manures*, (ed J Carlyle Sitterson), Cambridge, Mass, 1961, p 170. See also Marshall, *op cit*, I, p 16.

[6] Morton, *op cit*, VII, pp 370–1, 382, 385; John Wrightson, *Agricultural Text-Book*, London and Glasgow, 1877, p 184; Sir Charles A Cameron, ed, and C M Aikman, reviser, *Johnston's Elements of Agricultural Chemistry*, 17th edn, Edinburgh and London, 1894, pp 201–2; Herbert Ingle, *Elementary Agricultural Chemistry*, 1908, p 114; Sir Daniel Hall, *Fertilizers and Manures*, 1909, p 217; W Fream, *Elements of Agriculture*, 1920 edn, p 42.

[7] The first entry of vol II of the *Shorter Oxford English Dictionary* has: 'Marl...A kind of soil consisting principally of clay mixed with carbonate of lime, valuable as a fertilizer'. *Chambers's Encyclopaedia* declares: 'the presence of a notable proportion of carbonate of lime is essential to marls, properly so called'.

[8] Ruffin, *op cit*, pp 169–70.

[9] W M Mathew, *Edmund Ruffin and the Crisis of Slavery in the Old South. The Failure of Agricultural Reform*, Athens and London, 1988, chs 3,5; ed, *Agriculture, Geology, and Society in Antebellum South Carolina. The Private Diary of Edmund Ruffin, 1843*, Athens and London, 1992, pts I–III.

[10] Mathew, *Ruffin*, pp 76–7. An extreme 'calcareous' position is that of A Gustafson, who writes: 'Marl is unconsolidated limestone'. *Soils and Soil Management*, New York and London, 1941, p 233.

[11] Quoted in *Farmers' Register*, III, 12, April 1836, p 705.

Historical texts, in sharp contrast, tend either to stress the physical or to avoid analysis of function. Elementary science is largely ignored. Marling and liming, when explained, appear not as similar but as opposing categories: the first adding body to soils, the second lightening them. Lord Ernle – whose *English Farming Past and Present* is described by Eric Jones as 'the chief source of the agricultural content of general histories ever since'[12] – has no comment whatever on marl as a chemical agent, though he does usually term it a manure. His contemporary, W H R Curtler, makes numerous references to it in his *Short History of English Agriculture*, and at one point writes of 'the practice of liming and marling', but this quite proper pairing is nowhere elucidated. Sir William Ashley quotes a passage from a farming dictionary in which possible calcareous content is acknowledged, but ignores any inference therefrom. Medieval use is cited in the manner of Ernle, but only as an unspecified 'improvement'. M E Seebohm gives information on changes in popularity, on costs, and on the 'wonders' of its work in Norfolk, confining chemical hints, however, to a single use of the verb 'enrich' and a linking with chalk in a brief citation of Pliny. Ralph Whitlock identifies it as both a manure of unspecified value and as a non-manurial stiffener of thin soils. G E Fussell suggests it was used 'to improve the texture of light land'. Eric Kerridge notes the importance of combining marl with organic matter and manures, as well as its common purpose to increase clover crops, but the chemistry is not explained. When he refers to lime as in part a 'natural successor to marl', being an application that 'sweetened acid soil', the notion is one of temporal sequence rather than of like replacing like. And although Lancashire and Cheshire marl in 1560–90 was 'esteemed in direct proportion to its calcareosity', Kerridge adds no more than that it 'gave body and retentiveness to light soils, and made heavy ones workable and permeable'. David Chambers and Gordon Mingay cite no fertilizing effect whatever from marl, and posit a clear distinction from liming. 'The action of chalk and lime', they write, 'was to break down heavy clay soils to a finer texture and make their natural fertility more readily absorbed by plants; ...Marl had the contrary effect of binding thin and sandy soils...' Mingay himself has little to say on the matter in his 1650–1880 survey: the emphasis, however, is again physical, marl having the possible disadvantage of thickening to excess, 'making light soils too tenacious and awkward to work'. It apparently could 'enrich' as well, but the means are not indicated. Christabel Orwin and Edith Whetham likewise offer only scant comment, and define marling as merely 'the mixing of the underlying clay with light soils'. Jonathan Brown and H A Beecham again contrast lime and marl, the latter being directed 'to light soils to give them body'. Hugh Prince, in H C Darby's *New Historical Geography of England*, does pair the two improvements, usually discussing them together in his text, but without any clarification of the similarities. Acidity-correction is mentioned, but only generally, and as a function of 'mineral manures'. With great succinctness, he writes in 1989 of marl being used 'to improve soil textures and correct acidity'.[13]

[12] Eric Jones, *The Development of English Agriculture, 1815–1873*, 1968, p 55.

[13] Lord Ernle, *English Farming Past and Present*, 5th edn, 1936, pp 10, 31, 51, 94, 100, 109, 174, 192, 369; W H R Curtler, *A Short History of English Agriculture*, Oxford, 1909, p 251; Ashley, *op cit*, pp 137–48; M E Seebohm, *The Evolution of the English Farm*, 2nd edn, 1952, pp 51, 83, 105, 161, 183, 215, 249, 300, 336; Ralph Whitlock, *A Short History of Farming in Britain*, 1968, pp 68, 92; G E Fussell, 'Crop Nutrition in Tudor and Early Stuart England', *Ag Hist Rev*, 3, 1955, pp 99–101 (the same author's *Farming Technique from Prehistoric to Modern Times*, Oxford etc, 1965, being equally uninformative on functional matters); Eric Kerridge, *The Agricultural Revolution*, 1967, pp 246–9; J D Chambers and G E Mingay, *The Agricultural Revolution 1750–1880*, 1966, p 62; G E Mingay, ed, *The Agricultural Revolution*, 1977, pp 22, 35; Christabel S Orwin and Edith H Whetham, *History of British Agriculture*, Newton Abbott, 1971, p 382; Brown and Beecham in G E

In regional and non-English studies, Prince, again, in a paper on pits and depressions in the Norfolk landscape, briefly remarks that there are variations in meaning from calcareous to non-calcareous. R A C Parker's *Coke of Norfolk* – potentially an informative study, given the fame of marling at Holkham – has much detail on its tenancy aspects and costs, but on function the author suggests it to be a question of 'claying...a process involving digging up certain useful types of subsoil and mingling it with the topsoil. The effect, especially on poor light land, was highly beneficial, one application fertilized and strengthened the topsoil for a period of some years'. The notion of a partly manurial function is there, but without specificity. The contributors to the fourth volume of *The Agrarian History of England and Wales*, covering 1500 to 1640, make odd references to marling in different counties, but only as something that vaguely improved soils, increased harvests, and cost a lot to apply. The subsequent volume, 1640–1750, is much the same by style of comment, with an occasional emphasis on marl's usefulness on sands and gravels. Brian Short, a geographer, gets closest to some chemical evaluation in his essay on southeastern England when he writes: 'The use of marl is widely documented, although much non-calcareous clay was undoubtedly applied, since the chemical composition was not understood'. The comment, however, reveals only by inflection. David Grigg and David Thomas, in their respective books on South Lincolnshire and Wales, mention it as an undefined practice in other parts of the country. Ian Whyte, writing of seventeenth-century Scotland, has an unusually generous two paragraphs on the subject, but the detail is thoroughly structural in emphasis. James Handley, using contemporary reports on eighteenth-century Scottish farming, lists the use of clay marl in Berwickshire and shell marl in a number of eastern and southwestern counties: the first doing 'much to improve', and the second representing a 'valuable preparation'. J A Symon, in another study of Scottish farming, has the interesting index reference: 'liming...use of marl for', but the text has no comment whatever on chemical matters.[14]

There are two notable exceptions to this tendency either to ignore marl's functions or to cast it as largely structural in importance. Michael Havinden, in a chapter on Devon liming for W G Hoskins's 1974 *festschrift*, makes it clear that 'lime...ground chalk, marl and calcareous seasand' all have the same purpose of neutralizing soil acidity, and takes the trouble to set out the general manurial implications of that acidity, historians having 'not always fully grasped' their significance. Of all calcareous agents, 'chalk and marl have been historically by far the most common...' Robert A Dodgshon, writing of the Scottish Borders, is similarly clear and explicit on marl's chemical functions. It certainly had textural effects, but it also, with lime, 'corrected any tendency towards calcium deficiency, and thereby acidity' as well as 'making available for plant growth a wider range of nutrients like phosphate'. Dodghson's remarks along these lines, however, are very abbreviated; and

Mingay ed, *The Agrarian History of England and Wales, VI, 1750–1850*, Cambridge, 1989, p 280; Hugh Prince. 'England *circa* 1800', in H C Darby, ed, *A New Historical Geography of England*, Cambridge, 1973, pp 413–6; Prince in Thirsk, *op cit*, p 45.

[14] Hugh Prince, 'The Origins of Pits and Depressions in Norfolk', *Geography*, XLIV, 1964, *passim*; R A C Parker, *Coke of Norfolk. A Financial and Agricultural Study 1707–1842*, Oxford, 1975, p 8; Joan Thirsk, ed, *The Agrarian History of England and Wales, IV, 1500–1640*, Cambridge, 1967, pp 42, 61, 68, 75, 159–60, 167, 659; *ibid, V, 1640–1759 (I Regional Farming Systems)*, Cambridge, 1984, pp 64–5, 70, 146, 213, 258, 271, 274, 286, 299, 395; David Grigg, *The Agricultural Revolution in South Lincolnshire*, Cambridge, 1966, p 63; David Thomas, *Agriculture in Wales During the Napoleonic Wars*, Cardiff, 1963, p 177; Ian Whyte, *Agriculture and Society in Seventeenth Century Scotland*, Edinburgh, 1979, pp 208–9; James E Handley, *Scottish Farming in the Eighteenth Century*, 1953, p 206; J A Symon, *Scottish Farming Past and Present*, Edinburgh, 1959, pp 147, 149, 471.

Havinden's, while admirably full, precede an analysis of liming rather than marling.[15]

II

Can the historian's neglect of chemical aspects of marling be attributed, in part at least, to the bias of the contemporary commentators so often used as sources? Early farming reporters, after all, had little access to, or understanding of, such disinterested science as existed – chemistry being a particularly late developer in its alliance with magic, astrology, and alchemy. There seems little point in documenting the deficit for John Evelyn, John Fitzherbert, Francis Home, and others so liberally quoted in historical texts. Matters improved somewhat towards the end of the eighteenth century, but before Humphry Davy there were no articulated notions of acidity or amelioration.[16] Nathaniel Kent, reporting on Norfolk in 1796, noted that there were two main sorts of marl, but his evaluation got no further than declaring it 'a treasure'. William Pitt, writing of Staffordshire in 1813, mentioned an unspecified 'true marl', but gave no chemistry. Thomas Batchelor, in the same year, commented on marl's benefits on light sandy soils in Bedford, but although saying it was a clay with a small quantity of chalky material, offered no appraisal of the calcareous component. In Kent, John Boys witnessed a large chalk trade along the Thames and across to Essex, but the resultant 'immense improvements' were undefined. In Northumberland and Westmorland, shell and rock marls were used with 'advantage', according to J Bailey & G Culley and A Pringle respectively. Even James Caird, as late as 1850–51, ignored chemical purpose – retrospectively acknowledging the 'firmness' imparted to the light soils of Holkham, and judging marl to be out-of-step with 'the modern system of agriculture' in Staffordshire. Marling and liming, he observed, could be critical in the reclamation of Lancashire peat bogs, but the acute acidity of such lands in their original condition was obviously not understood.[17]

Scottish reports, however, have much mention of shell marl and a notable appreciation that these were – anticipating the title of Edmund Ruffin's pioneering American study[18] – 'calcareous manures'. Shell marls were very popular in Dumfries, said Dr Singer, and were viewed as being more durable than lime. In Galloway, the Rev Samuel Smith observed that shell marl caused an 'astonishing luxuriance of the crops', this creating 'an universal eagerness to procure it'. Marl had 'vast benefit' in Argyll, according to the Rev John Smith; and shell sand there greatly helped corn and meadow land. Robert Kerr, for Berwick, considered shell marl slower, but more permanent, in its effects than lime. In Nairn and Moray, wrote the Rev William Leslie, it had notable 'fertilizing influence'. In Caithness, John Henderson commented on its usefulness on thin soils. James Robertson, reporting on Perthshire in 1813, noted that shell marl not only pulverized the soil (in the manner historians usually attribute to lime), but that it also prepared the vegetable food for

[15] Michael Havinden, 'Lime as a means of Agricultural improvement: the Devon example', in C W Chalkin and M A Havinden, *Rural Change and Urban Growth 1500–1800. Essays in English Regional History in Honour of W G Hoskins*, 1974, pp 104, 109; Robert A Dodgshon, 'Land Improvement in Scottish Farming: Marl and Lime in Roxburghshire and Berwickshire in the Eighteenth Century', *Ag Hist Rev*, 26, 1978, p 2.

[16] For extensive review, see G E Fussell, *The Old English Farming Books, from Fitzherbert to Tull 1523 to 1730*, 1947; *More Old English Farming Books, from Tull to the Board of Agriculture 1731 to 1793*, 1950; *The Old English Farming Farming Books, III 1793–1839*, 1983.

[17] Nathaniel Kent, *General View of the Agriculture of the County of Kent*, 1796, pp 22–3; William Pitt, *General View of the Agriculture of the County of Stafford*, 1813, p 168; Thomas Batchelor, *General View of the Agriculture of the County of Bedford*, 1813, pp 494, 500; John Boys, *General View of the Agriculture of the County of Kent*, 1813, pp 158–9; J Bailey and G Culley, *General View of the Agriculture of the County of Northumberland, 1813, p 184; A Pringle, General View of the Agriculture of the County of Westmorland*, nd, p 324; James Caird, *English Agriculture in 1850–51*, 1852, pp 165, 229, 274, 276.

[18] Ruffin, *op cit.*

absorption by the roots of plants. He also noted its power on light soils, warning at the same time – and thereby anticipating future pedological science – that very heavy doses could lay waste the land. Sir George Stewart Mackenzie was even more specific on this important point for Ross and Cromarty: 'The benefit or mischief to be expected from the use of marl, seems to depend upon the quantity of vegetable matter in the soil'.[19] Scanty organic resources, now rapidly released by the action of calcium carbonate, could be depleted to the point of premature soil exhaustion.

Among English commentators observing, if not necessarily comprehending, the chemical effects of marling, Arthur Young and William Marshall were the most notable. Young's 1804 *General View* of Norfolk contained numerous remarks indicative of calcareous purpose. He wrote of 'marl and chalk' as a pair, specifying white marls, chalky marls, and white chalky marls. The principal ones that lay along the rivers, and were therefore available for transport, were decidedly white and chalky. There was also 'claying', which Young said was a common synonym for marling: but 'clay' was really 'clay marle' – 'from the quantity of calcareous earth it contains'. Clay marls of different colours at Besthorpe and Snetterton all fermented when tested with acid, proving calcareous content. And marling was guaranteed to dispose of sorrel – the classic indicator of soil acidity. Corn marigolds, also common on sour soils, were removed as well. The improvements that had won Norfolk most fame, between 1730 and 1760, were, he recorded, the enclosing and marling of thin-soil wastes, heaths, sheep-runs, and rabbit warrens – all, as we now know, open, heavily-leached lands of marked acidity. Marl, Young noted, could also be used to advantage on strong soils – hardly in need of thickening. Its occasional application in repeated doses, in combination with farm manure, as well as its contribution to good leguminous crops at Holkham, likewise signalled chemical function.[20]

Marshall's observations for Norfolk in the 1780s are the most decidedly chemical of all. Marl, he pointed out, was applied because of its 'fertilizing quality'. Structural effects were not mentioned. There were two sorts: chalk marl from the centre and north, and clay marl from the eastern coastal areas. It is clear, from modern geological study, that the first was dug from Cretaceous chalk *in situ*, and that the second came from the so-called 'Marly Drift' or 'Chalky Boulder Clay', of glacial origin.[21] Marshall examined samples of the chalk marl from the Whitlingham pits near Norwich, pronouncing them 'the purest calcareous earth I have yet analysed'; and from the Swaffham area, where he found 'nearly pure' calcium carbonate. Clay marls were analysed from Thorp village in the north-east of the county and Hemsby on the coast north of Yarmouth. Of the former, he wrote: 'it is highly probable, that the soluble matter of this marl is a pure, or nearly pure, *calcareous earth*'; and for the latter, he estimated a composition of roughly forty-five per cent chalk, with the remainder largely clay. Of the two categories, chalk marl was in the wider use, dug from field pits all over west and

[19] Dr Singer, *General View of the Agriculture, State of Property and Improvements in the County of Dumfries*, 1812, p 331; Rev Samuel Smith, *General View of the Agriculture of Galloway*, 1813, pp 45–7, 209–10, 213; Rev John Smith, *General View of the Agriculture of the County of Argyle*, 1813, pp 210–11, 215 (also mentioning, p 217n, an extensive trade in sea-shells around the Solway coast, and over to the Isle of Man, their effect being 'great on barren heathy land'); Robert Kerr, *General View of the Agriculture of the County of Berwick*, 1813, p 374; Rev William Leslie, *General View of the Agriculture of the Counties of Nairn and Moray*, 1813, p 281; Cpt John Henderson, *General View of the Agriculture of the County of Caithness*, 1812, p 179; James Robertson, *General View of the Agriculture of the County of Perth*, Perth, 1813, p 317; Sir George Stewart Mackenzie, *General View of the Agriculture of the Counties of Ross and Cromarty*, 1813, p 208.

[20] Arthur Young, *General View of the Agriculture of the County of Norfolk*, 1804 (1969 reprint), pp 2–3, 10, 12, 341, 364–5, 406–7, 409–10, 411.

[21] See, for example, Horace B Woodward, *The Geology of the Country Around Norwich*, 1881, pp 115–28; B W Sparks, *The Ice Age in Britain*, 1972, pp 146–9.

central Norfolk and traded down-river from the great excavations along the eastern exposures of the Cretaceous in the vicinity of Norwich. Like Young, Marshall noted that acid-loving plants such as corn-marigolds – and smart-weed and couch-grass as well – were the best indication of ground in need of attention; and that the repetition of marling was found to 'generally answer'. Marl, indeed, seems to have the *principal* method of liming the soil, lime proper being 'in good repute, though not in general use...'[22] A lot of the lime that was applied probably came from the kilns that old maps and geological reports show were located at marl pits. It is, therefore, clear from Young, and very clear from Marshall, that in this most famous of English improving counties marl was a calcareous application with acidity-reducing effects. It is odd that historians have failed to relay this fact.

The solution to the conceptual problem is simple. Scientific literature and the often-differing resources observed in farming reports suggest a two-part subdivision, structural and chemical. 'Structural' concerns the lightening as well as the thickening of soils, by sand and shell marls for the first, and by clay marls for the second. 'Chemical' has mainly to do with acidity-relieving functions, and the diverse, important benefits that will be set out in the fourth section below. They can also extend to directly nutritional purposes, calcium being a minor plant food.

The historiographical problem to date, apart from that of crude listing, has been not so much that of wholly erroneous attribution of function as one of strangely blinkered partiality. Historians have too often fused the different sorts of marl into one category, according it the single and comparatively uninteresting purpose (and *that* only partial even in structural terms) of adding mass to thin soils. In consequence, a very large body of farm improvement – itself, as we shall see, underlying so many accompanying advances – has been disregarded.

No reservations, incidentally, are necessary concerning the imposition of abstract scientific usage on the real world of the farmer. Not only was calcareous manuring a concrete fact, but scientists were for the most part engaged in the study of the practical world around them: experimenting with crops and soils, and instructing farmers and agricultural students in better methods and understanding. Their terminology was not devised in closed laboratories.

III

The literature on agricultural history abounds with reference to marling's obsolescence. This, however, has a good deal to do with the partial identity discussed above. Clearly, ideas of relevance and modernity are heavily dependent on assumptions of function. Soil-thickening is not a very momentous agricultural issue, the bulk transfer of soils having an elementary crudity that contrasts ill with most recent farm improvements. There is mere digging, rather than production; laborious transport; little evident science; no obvious institutional or social import; and no parliamentary curiosity. In addition, structural marling has a built-in obsolescence, being – in contrast to acidity-reduction – a possible once-and-for-all job.

Ernle, while noting the continuation of marling into the nineteenth century, tends to characterize it as an essentially medieval improvement: 'obsolete' in the fifteenth century; 'ancient but almost obsolete' in the eighteenth; its use in both centuries being limited and revivalist. 'It is surely a remarkable fact', says Ashley, 'that the practice of marling was for a time adopted in England, and then given up for centuries'. References to it, he suggests, were already

[22] Marshall, *op cit*, I, pp 16, 22–4, 26–7, 150, 154, 156; II, p 99.

rare by the late Middle Ages. Renewed popularity came with extended grain production in the seventeenth century, but by the twentieth it was again 'pretty generally abandoned'. Kerridge comments on widespread use in seventeenth-century Lancashire and Cheshire, though, by 1630 or so 'the vales had largely been cleared, the basic marling completed, and the second phase of chalking and liming entered'. Chambers and Mingay write: 'Marling had died out and been revived more than once since its earliest known use in prehistoric times'. They observe its patchy reappearance in the seventeenth and eighteenth centuries, and subsequent decline in the nineteenth. Thompson accords it no place whatever in his manure-related 'second agricultural revolution' of 1815–80.[23]

In the United States, by contrast, marling has been given a role of great importance along the eastern seaboard as lately as the nineteenth century. American farm historians write variously (if exaggeratedly) of marl-based revitalization, renaissance, and revolution in the Upper South.[24] Marling was a modish practice, and – by physical circumstance and documented result – well worthy of implementation.[25] Comparisons with Britain are not rendered invalid by environmental and economic dissimilarities. Both the Upper South and Britain had cool-temperate climates, a proclivity towards soil acidity, and mixed grain-and-livestock farming regimes. Slavery presents no problems, since marling and liming were most common in states with a high proportion of free labour, and common practice as well in non-slave states farther up the eastern seaboard. Virginia and Maryland, the main marling areas, were also the states where Peruvian guano, the most advanced application of the mid-nineteenth century, found its liveliest Southern markets.[26] Edmund Ruffin, the planter who promoted the calcareous question, was no primitve backwoodsman. His book, pamphlets, reports, and diaries, as well as his distinguished *Farmers' Register*, show him to have been a subtle scientist of great literacy and sophistication: 'the father of soil chemistry in America', as Gilbert Collings has termed him.[27] And it is of interest that he learned much from British experience, attributing his main ideas to Humphry Davy, and reproducing hundreds of fragments from Scottish and English farming journals in his *Register*.[28]

Britain was in at least one respect a more suitable place for marling improvement than the American South by the nineteenth century. It had a much better transport infrastructure, thereby – after centuries of acute haulage difficulties – rendering marling and similar onerous practices feasible well away from sources of supply. In the United States, the natural river system along the Atlantic seaboard was only impressive for communications purposes in the border states and north to New York, and was weakly supplemented by man-made waterways.[29] Many in Britain took advantage of the superior facilities. A huge chalk trade was conducted across the Thames estuary from the cliffs of North

[23] Ernle, *op cit*, pp 51, 94–5, 174, 369; Ashley, *op cit*, pp 138–9, 141–2; Kerridge, *op cit*, pp 247–8; Chambers and Mingay, *op cit*, pp 62–3; F M L Thompson, 'The Second Agricultural Revolution, 1815–1880', *Econ Hist Rev*, 2nd ser, XXI, i, April 1968, pp 62–77.

[24] Kathleen Bruce, 'Virginian Agricultural Decline to 1860: A Fallacy', *Agr Hist*, VI, 1932, p 3; Avery O Craven, *Edmund Ruffin, Southerner*, Baton Rouge, 1932, p 64; Clement Eaton, *The Growth of Southern Civilization, 1790–1860*, New York, 1963, p 179; Ruffin, *op cit*, introduction by J Carlyle Sitterson, pp vii, ix; William Kauffman Scarborough, introduction to *The Diary of Edmund Ruffin*, I, Baton Rouge, 1972, p xvi; Avery O Craven foreword to *ibid*, p xiii.

[25] Mathew, *Edmund Ruffin*, chs 5, 6.

[26] *Ibid*, pp 114–7, 165, 212; Weymouth T Jordan, The Peruvian Guano Gospel in the Old South', *Ag Hist*, XXIV, 1950.

[27] Gilbert H Collings, *Commercial Fertilizers*, 1947, p 337, fig 119.

[28] Ruffin, *op cit*, pp 35, 40–1, 52–3, 61, 71, 124, 159, 161; David F Allmendinger Jr, *Ruffin, Family and Reform in the Old South*, New York and Oxford, 1990, p 29; *ibid* (ed), *Incidents of My Life. Edmund Ruffin's Autobiographical Essays*, Charlottesville and London, 1990, pp 171, 194–6, 202–3; W M Mathew, 'Edmund Ruffin and the Demise of the *Farmers' Register*', *Virginia Magazine of History and Biography*, 94, i, 1986, pp 1–24.

[29] Mathew, *Ruffin*, pp 157–9; 'Agricultural Adaptation and Race Control in the American South. The Failure of the Ruffin Reforms', *Slavery and Abolition*, VII, 1986, pp 136–7.

Kent to Essex.[30] William Marshall and Arthur Young documented the river trades in Norfolk, distances of over forty miles often being covered between marl pit and farm.[31] The diggings at Horstead on the Bure, in the same county, have left a landscape known as Little Switzerland, with deep, curved cuttings channelling back from the river.[32] The very large excavation at Whitlingham has been recorded in a striking John Sell Cotman painting of 1808.[33] The marl was wherried around a useful system of rivers, broads, and inshore waters, coming, in R N Bacon's words of 1844, 'in some places to the door of the farmer, while at other points...laid up on staithes or wharves until required for use'. The Peak Forest canal, running from Derbyshire into Cheshire and Lancashire, was welcomed by Henry Holland in 1813 for 'the opportunity which is afforded of conveying marl at a slight expense to places where that valuable article is not met with'. Towards the end of the eighteenth century, a canal was constructed from Carlingwark Lock to the River Dee in Kirkcudbrightshire, and marl from the loch boated to farms up to twenty miles away.[34] Marl also was shipped around the French countryside. A recent study of the Canal de la Sauldre south of Orleans shows that the waterway was primarily intended for marl transport, and that as late as 1874 marls made up to ninety per cent of the tonnage transported.[35] In the United States, it was no accident that marling was largely confined to the few tidewater areas where freight costs were low.[36] In the sense, therefore, that extensive intra-regional and inter-regional transport improvement was a feature of advanced capitalist economies, and that widespread marling depended on cheap carriage, the practice, in any geographically generalized sense, could only be a modern one.

Adding to this the *perennial* need to attend to soil acidity, we can dismiss any idea of marling as an intrinsically pre-modern affair, of no interest to historians of recent British agriculture. It only diminished in relevance as the growth of a manufacturing lime industry offered the farmer an alternative abundance of cheap, easily transportable calcium carbonate. Soil neutralization, as we shall see below, was an essential component of advanced mixed farming with fertilizers and legume-break rotations. It was no accident that one of Norfolk's greatest nineteenth-century marlers, John Hudson of Castleacre, was also one of the leaders of a deputation to Downing Street in 1852 to plead the case for larger, cheaper supplies of imported Peruvian guano.[37] Hugh Prince draws attention to the successes of mid-nineteenth-century agriculture on sandy soils where 'repeated applications of large quantities of marl and lime' were combined with 'regular dressings of farmyard manure and imported fertilizers'.[38]

An important consequence of dismissiveness towards marling has been the lack of quantification for amounts applied and for regional patterns of use. There are, of course, fundamental problems to do with the absence of official or production statistics for a non-imported, dug commodity. Historians, however, have probably been more deterred by lack of interest through category ambiguity and allegedly marginal

[30] Daniel Defoe, *A Tour Through the Whole Island of Great Britain*, 1927 edn (first pub 1724), pp 99–100; Boys, *op cit*, p 149.

[31] Marshall, *op cit*, II, p 99; Young, *op cit*, pp 406–8.

[32] Robert Malster, *Wherries and Waterways*, Lavenham, 1971, pp 72–3.

[33] Reproduced in Prince, 'Norfolk Pits', plate 4.

[34] Henry Holland, *General View of the Agriculture of Cheshire*, 1808, p 312; Jean Lindsay, *The Canals of Scotland*, Newton Abbott, 1968, p 179; R N Bacon, *The Report on the Agriculture of Norfolk*, 1844, pp 6–7 (evidence of use on a farm-by-farm basis also appearing in answers to the questionnaires on which Bacon based his study: MSS Richard Noverre Bacon, 2 vols, 1844, Norfolk and Norwich Record Office).

[35] Keith Sutton, 'A French Agricultural Canal – the Canal de la Sauldre and the Nineteenth-Century Improvement of the Sologne', *Ag Hist Rev*, 21, 1973, pp 54–55.

[36] Mathew, *Ruffin*, chs 7, 10.

[37] W M Mathew, *The House of Gibbs and the Peruvian Guano Monopoly*, 1981, p 159; see also Caird, *op cit*, p 168.

[38] In Thirsk, *op cit*, 1989, p 80.

modern importance. If, by a different view of the practice, research is deemed worthwhile then much progress can be made. Robert Dodgshon, pointing to a 'serious' historiographical 'neglect' of marling and liming[39], has shown how effectively the evidence from reports and farm records can be aggregated into intelligible generality. My own American work, combining the use of similar sources with speculation from local geological and pedological circumstance, has permitted some quite confident conclusions on popularity and function. Canal, river, and railway toll data can yield much additional information, given marl's necessary dependence on low-cost transport.

IV

Mistaken or partial ideas of function not only contribute to restricting notions of marginality and obsolescence; they also result in the wrong issues, or an unduly narrow range of issues, being analysed. Indeed, so 'structural' have been the preoccupations of historians that even lime's well-known chemical functions have tended to be subordinated to notions of soil-lightening. This might be rectified in future research, and the calcareous question related in practical agricultural terms to the particularities of local climates, soils, and crops.

Acidity, being an intrinsic feature of farmland in damp, temperate climates, is widespread in Britain.[40] Agriculture has been affected in a variety of ways.[41] Direct effects, from hydrogen-ion concentration, are of no account. Indirect effects, however – through the reduction of nutrient availability and the increase of toxicity – can be very serious. Supplies of nitrogen and phosphorous, two of the three main plant foods, are curtailed. Available soil nitrogen depends on microbial activity in the ground, converting organic matter into nitrites – the soluble form in which they are most easily taken up. The required bacteria, however, are highly sensitive to acidity, even at moderate levels. Their restriction or absence not only affects the breakdown, and therefore efficiency, of farmyard manure and nitrogenous fertilizers, but the operation of nitrogen-fixing as well. The latter deficiency means that leguminous crops, such as peas or clovers, cannot easily flourish, depending as they do on bacterial activity on their roots. 'Nitrification and nitrogen-fixing', observes Nyle Brady, 'take place vigorously in mineral soils only at pH values well above 5.5'.[42] Anything worse than slight acidity, therefore, can impede two vital categories of farm improvement: fertilizing and leguminous rotation, with obvious implications for livestock production and internal manure supplies.

As for phosphorous, the problem arises from the common presence in acid soils of aluminium and iron in solution. These combine with phosphorous to form particular phosphates whose solubility is so low that plants can use them only very slowly or not at all. Phosphorous in the soil, therefore, gets trapped, and additions of fertilizers such as bones, superphosphate, and phosphatic guano, can be wasted expenditure. 'If', writes Emil Truog, 'lime produced no other benefit than its favourable influence on phosphate availability, it would usually pay to use it'.[43] When elements such as calcium are in abundance, as in neutralized soils, other, highly soluble phosphate compounds are formed that present no problems for plants. Calcium itself is usually accorded an inconsequential

[39] Dodgshon, *op cit*, p 1.
[40] See, for example, Havinden, *op cit*, pp 105–6.
[41] The remarks here are based on a number of agricultural chemistry and soil-science texts. These will only be named individually when directly quoted.
[42] Brady, *op cit*, p 390.
[43] Emil Truog, 'Lime in Relation to Availability of Plant Nutrients', *Soil Science*, LXV, 1948, pp 2–3.

nutritional role, though some chemists argue that it can be useful for legumes.[44]

The other problem, that of toxicity, again has to do with soluble aluminium. Manganese has similar effects. Aluminium gathers in plant roots and interferes with nutrition. Manganese penetrates plant tissue and damages metabolism. Other possible offenders include sodium thiocynate, sodium chlorate, sodium borate, sodium arsenite, ammonium thiocynate, and ammonium sulphamate. Many fungi and other disease organisms also do well in acid conditions, causing, for example, finger-and-toe in turnips, swedes, and cabbages. Toxicity, however, only seems to be a major factor in conditions of pronounced acidity, combining with nutrition unavailability to inflict a potentially disastrous double blow on plants. Where the sourness is slight or moderate, the latter difficulty is usually the sole cause for concern.

Acidity itself is related less to underlying geological conditions than to climate and soil structure. The main cause is rain and its passage through the soil, meaning that it is perfectly possible to have acid soils on limestone and other calcaresous bedrocks. 'Soils', observes A R Midgely, 'are influenced by climate...to such an extent that they can be regarded as a product of it'.[45] Water assists the production of 'acid' hydrogen ions, and leaches away the 'alkaline' ions in solution. The most damaging loss is that of calcium carbonate. Relatively free-draining soils in damp climates, therefore, are most at risk – especially where cultivation has removed their former natural vegetal protection. An annual rainfall of twenty-five inches is usually enough to set the process in motion, with lower levels sufficing on thin soils.

Where, in Britain, was the need likely to be the greatest? The whole of the country lies within the twenty-inch isohyet, and large areas of the north and west record averages of at least double that level. Pedological circumstances are especially interesting, given the historiographical equation of marling with the needs of sandy soils. This reveals perhaps the largest of all the misunderstandings with which historians have been labouring. Calcareous marls may well have added body to thin soils, and they may have been applied for that purpose alone, with visible, tangible effect. But as these were likely to have been highly leached soils, with consequent acidity – for the reasons outlined – it is very likely that the main benefit was chemical rather than structural. Structural gains, in so far as these resulted from the use of a heavy marl, may *also* have been partly chemical in that they delayed further leaching. They would not prevent leaching altogether, though; and both the chemical and structural/chemical interpretations are consistent with the much-cited tendency to repeat marling after a number of years. An entirely structural exercise, successfully completed, would not have required such repetition. Light soils, moreover, were also the sorts where rotation farming was winning as a means of overcoming the forage deficit in drier parts of the country. They suited turnips by being open; but they only accommodated clovers, other legumes, and most grains, if their acidity was reduced or neutralized. The Holkham estate perhaps gives us the most precise example of the 'structural' misunderstanding. The thin, sandy soils of that part of Norfolk – as Arthur Young hinted, but could not understand – were the beneficiaries of acidity-reduction as well as simple soil-thickening. Had they remained acid, they could not have supported the celebrated rotations practised upon them.

[44] Frank Moser, 'Calcium Nutrition at Respective pH Levels', *Proceedings of the Soil Science Society of America*, VII, 1942, p 339; C B Harston and W A Albrecht, 'Plant Nutrition and Hydrogen Ion: IV. Soil Acidity for Improved Nutrient Delivery and Nitrogen Fixation', *Proceedings of the Soil Science Society of America*, VIII, 1943, p 247.

[45] A R Midgely, 'Lime – Its Importance and Efficient Use in Soils', *Proceedings of the Soil Science Society of America*, VIII, 1943, p 329.

The fact that the wettest, most leaching-prone areas were also the parts of the country best protected by grassy turf, and least in need of leguminous crops to provide nitrogen for wheat and food supplements for cattle, helped restrict the geographical extent of the acidity problem. But the west was not all pasture; natural grassland could also be damaged by sourness; and the centre and east were wet enough, and many of their lands free-draining enough, to experience the debilitating effects of acidity and the benefits of calcareous manuring.

V

Illustrative material apart, it is not our purpose here to give historical documentation of the pattern and fluctuation of marl consumption in Britain, nor shall we attempt direct, as distinct from circumstantial, analysis of its impact on agriculture. This has been mainly an exercise in preliminary identification. Careful regional studies are required to add to Dodgshon's work on Roxburgh and Berwick. These might follow some of the pointers suggested. They will, almost certainly, run up against awkward specificities concerning local soils, climatic conditions, and variations in crop tolerance of acidity. It might be useful for any such investigation if, by way of conclusion, some of the principal factors likely to explain the popularity and success of marling are briefly set out. Environmental and crop considerations have already been discussed. Beyond these, the important variables were costs of excavation and transport, difficulties of application, and competition from other ameliorative agents.

All costs were in major part a function of the quantities used, and these in turn largely depended on the constitution of the marl. Bulky clays, with a low calcareous content and high freight charges, were the most troublesome. Lighter, limier earths, such as shell marls were, value for value, cheaper to move.[46] Marling generally was always regarded as a costly undertaking. John Fitzherbert in the sixteenth century called it an 'exceeding chargeable' improvement;[47] M E Seebohm in the twentieth said it had been 'discontinued as too costly'.[48] To minimize outlay, pits and other sources were usually close by the areas of application[49], and the common landscape feature today is one of overgrown hollows in the middle of fields.[50] Henry Holland, estimating costs for Cheshire in 1813, supposed a maximum haulage distance of only a hundred to a hundred-and-fifty yards.[51] The processes, however, were fairly simple, with the labour heaviest for initial 'callow' clearance. Expenses – which in part have to be measured in 'opportunity' terms, related to diversions of existing farm labour forces – were modest. There are cost figures in virtually all the county reports cited above: disparate overall, and difficult to average.[52] Unit digging costs were probably lower in the larger commercial excavations, where there was specialization of labour, continuity of work, and perhaps a more common use of equipment. The severest expenses undoubtedly came from transport. Away from the rivers and the newer arteries, these could be hopelessly high, given the bulk of the commodity and the slowness of cart carriage along country tracks. William Marshall noted in Norfolk in the 1780s that marl selling at 1*s* a load at Norwich pits cost up to 3*s* 6*d* to carry six miles overland to Woodbastwick. Farmers there often preferred to have their supplies shipped by river and sea through

[46] For some comment, see Dodgshon, *op cit*, pp 4, 7.
[47] Quoted in Ernle, *op cit*, p 10.
[48] Seebohm, *op cit*, p 336.
[49] See Prince, 'Norfolk Pits', p 21.
[50] See, for example, photograph in Herbert L Edlin, *East Anglian Forests*, London, 1972, plate 20.
[51] Holland, *op cit*, p 223.
[52] In particular, works cited above of Batchelor, Boys, Kerr, Leslie, Pitt, Robertson, Singer, Smith (John), Smith (Samuel); also Arthur Young, *General View of the Agriculture of Herefordshire*, 1804.

Yarmouth – a journey of over forty miles.[53] The rough ton-mile cost was about 1*s* for the first, and 2*d* for the second. Dodgshon observes, from 1798 Scottish Borders estimates, that at distances of eight miles, 'transport costs per cart could be as much as twice the value of the marl'.[54] Water carriage was usually the only means by which extended exchanges could take place. The restricting difficulty, of course, was that the marl had to be exposed right by the waterways, so that cargoes could be loaded with minimal land transfer.

There were major practical problems as well concerning the application of marl. It had the inconveniences of claying at the structural extreme, through heavy labours of spreading and ploughing-in; and of liming at the chemical extreme, through dangers of quick soil exhaustion on land low in organic matter – nutrient availability being accelerated to a pace often greater than poor soils could tolerate. It was probably this latter chemical difficulty that led to the much-cited notion that marl was good for the first generation, but bad for the second. In Barnabe Googe's version of 1577, it could bring 'the ground to be starke nought, whereby the common people have a speache, that ground enriched with chalke makes a riche father and a beggarly sonne'.[55] There were also problems to do with the slowness of marl's effects, this producing the quite contrary saying that 'a man doth sande for himself, lyme for his sonne, and marle for his graunde child'.[56] It was very confusing for the farmer. Additionally, marl, as defined over different parts of the country, had a varying constitution, especially by bulk and by proportions of lime, thereby precluding clear, general advice on use. And the processes it set in motion were for the most part not understood.

As for competition, the main challenge came from lime – and not from fertilizers generally. Good marlers, working on thin soils, had to be good manurers as well. Ameliorators and manurers were complementary, as our case of John Hudson of Castleacre shows. Historians who document marl's local losses of popularity usually connect this with the increased use of lime (itself, as suggested, sometimes made from marl). This, being lighter in its processed 'quick' form, was cheaper to transport, and it was also of more precise chemical identity. In the words of J Home, writing of Berwickshire in 1797: 'Lime, portable to all distances, quick and instant in its action, unlocked at once on all soils the dormant powers of reproduction'. According to another 1790s observer in the same county, 'marl was deadstock after the general introduction of lime'.[57] Industrialization and increased domestic, factory, and public building stimulated a wide, if uncharted, growth of lime manufacture – first in rough kilns in rural areas and, as Havinden documents for Devon,[58] along the coasts and waterways at points of limestone importation; and then, increasingly, in larger-scale quarry and urban enterprises, sometimes as an industrial by-product. Norfolk farmers got much of their lime earlier this century from the refuse of sugar-refining at Cantley in the south of the county.[59] And the relative ease and cheapness of its transport meant that the consumer could draw on a wide range of distant supplies. Dodgshon's Borders farmers were purchasing from Midlothian, East Lothian, and Northumberland in the last decades of the eighteenth century.[60]

[53] Marshall, *op cit*, p 99.
[54] Dodgshon, *op cit*, p 7.
[55] Quoted in Ernle, *op cit*, p 99.
[56] Quoted in H E Hallam, ed, *The Agrarian History of England and Wales, II, 1042–1350*, Cambridge etc, 1988, p 440.
[57] Both quoted in Dodgshon, *op cit*, pp 2, 10.
[58] Havinden, *op cit*, pp 107–8, 113–25.
[59] L Dudley Stamp, *The Land of Britain. The Report of the Land Utilisation Survey of Britain. Part 70. Norfolk*, 1938, p 96.
[60] Dodgshon, *op cit*, p 7.

Among the principal areas for the application of marl and related bulky calcareous materials in the eighteenth and nineteenth centuries were – as the various examples above indicate – the Thames estuary, Norfolk and Suffolk, Staffordshire and the neighbouring Cheshire-Lancashire plain, the coasts around the Solway Firth, and the border counties of southeast Scotland. Other parts at all extremities of the country used it as well,[61] though it would be premature, in the present state of knowledge, to draw clear, period-by-period distribution maps. Suffice to say that a practice that had begun more than two thousand years ago was still vigorously pursued into modern times. It was, by William Marshall's designation, Norfolk's 'grand fossil manure'. John Holt in 1795 saw it as 'the foundation of all improvements in the agriculture' of Lancashire. The Rev Samuel Smith declared in 1815 that the 'most material change' that had taken place in Galloway 'since the inclosing of farms, has risen from the introduction of *calcareous manure*. In Argyll, around the same time, the Rev John Smith insisted: 'marl...excels all other manures'. The last diggings at Little Switzerland on the Bure in Norfolk were not closed until the 1870s.[62]

If marling was indeed as popular as these and other comments suggest, and if its main consequence – however misunderstood by farmers – was the alleviation of soil acidity, it must be given its place as both a major and a modern agricultural improvement, bearing on the whole spectrum of advanced mixed farming. When it faded, the reason was not that its calcareous functions had become redundant but that they were more easily and cheaply performed by other agents.

[61] For England, see Prince in Darby, *op cit*, p 416.

[62] Marshall, *op cit*, I, p 16; John Holt, *General View of the Agriculture of the County of Lancaster*, 1795 (1969 reprint), p 120; Smith (Samuel), *op cit*, p 45; Smith (John), *op cit*, p 211; Maltster, *op cit*, p 73.