Varietal innovation and the competitiveness of the British cereals sector, 1760–1930*

John R. Walton

Abstract

Varietal innovation is a neglected aspect of British agricultural history. This paper traces the origins of the varietal proliferation which occurred during the nineteenth century to late-eighteenth century advances in breeding science and to the growth of international commerce in cereals for consumption. It has been generally assumed that, in technical terms, high farming served the needs of cereals and livestock production with equal effectiveness and without prejudice to their character. In fact, this system helped establish a drift from the cereal varieties most suitable for human consumption to those better adapted to livestock. The consequential changes, which varied from cereal to cereal, form the main subject of this paper. The paper concludes by identifying shortcomings in the standard view that British farmers in the late nineteenth century were the passive victims of cheap wheat imports.

For upwards of half a century before 1765, Britain was a net exporter of cereals.[1] By 1925, imports supplied some 80 per cent of domestic demand for wheat and flour, 42 per cent of barley, and 8 per cent of oats.[2] In general, historians have not thought rising levels of import penetration, in both cereals and livestock, incompatible with a positive gloss on the achievements of British agriculture in the eighteenth and nineteenth centuries. The concept of the agricultural revolution survives. Its most recent advocate attaches particular significance to the rising productivity curve of the century after 1750, which had several components, including increasing yields per acre of the major cereal crops.[3]

This paper examines one important feature of the home cereals sector, the innovation and diffusion of new cereal varieties. During the period under review, most varieties originated either as introductions from foreign sources, or as selections of individual plants growing in stands of indigenous crops. The first experimental use of hybridization in the breeding of cereals

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1 A. H. John, 'English agricultural improvement and grain exports, 1660–1765', in D. C. Coleman and A. H. John (eds), *Trade, government and economy in pre-industrial England. Essays presented to F. J. Fisher* (1976), pp. 48–9; D. Ormrod, *English grain exports and the structure of agrarian capitalism, 1700–1760* (1985).

2 Ministry of Agriculture and Fisheries, *The agricultural output and food supplies of Great Britain* (1929), pp. 19–25.

3 M. Overton, *Agricultural Revolution in England. The transformation of the agrarian economy, 1500–1850* (1996).

predates by some sixty years the rediscovery and republication of Mendel's work in 1901.[4] Plant breeders began to apply the technique with increasing frequency and considerable commercial success during the last quarter of the nineteenth century. But acceptance of hybridization as the standard source of commercially-attractive variation in cereals only came with the growth of government-funded research in pure and applied genetics during the twentieth century. This development has attracted a good deal of attention, including recent work on Britain by Clive Holmes and Paolo Palladino.[5] The same could not be said for the history of crop improvement in the preceding period, which remains substantially unexplored.[6] The first two sections of the paper examine the flow of new cereal varieties from 1760 and the factors which gave rise to it. The third and fourth sections explore the contrasting competitive consequences of varietal innovation for British oats, barley and wheat producers.

I

Introduction and selection in one form or another are as old as agriculture itself. But the regular introduction of unfamiliar varieties from overseas and the frequent selection, multiplication, and distribution of superior specimens from existing stocks, demand certain preconditions which seem not to have been extensively exploited in Britain much before the second half of the eighteenth century. So far as introductions are concerned, the evidence for negligible activity before the mid-eighteenth century is reasonably clear. Thirsk, Thick, and Ambrosoli have documented the flow of introduced species of fodder crops, industrial crops and vegetables during the seventeenth century, but say virtually nothing about the introduction of unfamiliar varieties of established cereal species.[7] It may be deduced either that such introductions did not

4 P. Shirreff, *Improvement of the cereals and an essay on the Wheat Fly* (Edinburgh, 1873), pp. 26–9; D. J. Browne, 'The production of new varieties by cross-fecundation', *Report of the Commissioner of Patents for 1855: agriculture* (Washington DC, 1856), p. 182; H. Evershed, 'Varieties of wheat and methods of improving them', *J. Royal Agricultural Society of England* (hereafter *JRASE*), 2nd ser., 25 (1889), p. 257; R. H. Biffen and F. Engledow, *Wheat-breeding investigations at the Plant Breeding Institute, Cambridge* (1926), pp. 10–11.

5 C. J. Holmes, 'Science and practice in English arable farming, 1910–1950', in D. J. Oddy and D. S. Miller (eds), *Diet and health in early modern Britain* (1985), pp. 5–31; P. Palladino, 'Between craft and science: plant breeding, Mendelian theory, and the universities in Britain, 1900–1920', *Technology and Culture* 34 (1993), pp. 300–323; *idem*, 'Wizards and devotees: on the Mendelian theory of inheritance and the professionalization of agricultural science in Great Britain and the United States, 1880–1930', *History of Science* 33 (1994), pp. 409–44; *idem*, 'Science, technology and the economy: plant breeding in Great Britain, 1920–1970', *Economic History Rev.* (hereafter *EcHR*), 2nd ser., 49 (1996), pp. 116–36. On the United States see J. A. Clark, 'Improvement in wheat', *USDA Yearbook 1936*, p. 211; J. R. Kloppenburg, *First the seed: the political economy of plant biotechnology, 1492–2000* (1988), pp. 12, 68.

6 The contribution of Paul Brassley, 'Crop varieties', to E. J. T. Collins (ed.), *Agrarian History of England and Wales, VII, 1850–1914* (forthcoming), ch. 8, is the main exception. See also Jonathan Brown and H. A. Beecham, 'Arable farming', in G. E. Mingay (ed.), *Agrarian History of England and Wales, VI, 1750–1850* (1989), pp. 292–3.

7 J. Thirsk, 'Agricultural innovations and their diffusion' in J. Thirsk (ed.), *Agrarian History of England and Wales, V, 1640–1750* (2 vols, 1985), II, pp. 533–89; M. Thick, 'Market gardening in England and Wales' in Thirsk (ed.), *Agrarian History* V (ii), pp. 503–32; M. Ambrosoli, *The wild and the sown. Botany and agriculture in Western Europe* (1997). Their one reference to an introduced cereal is to wheat grains brought by an Italian gentleman from Italy to Obadiah Walker of University College, Oxford: Thirsk, 'Agricultural innovations', p. 557.

occur, or that if they did occur, they failed to make their mark and were lost. From the mid-eighteenth century, the international diffusion of scientific curiosity encouraged the exchange of cereal seed in small quantities suitable for experimental sowing. During the late eighteenth century, Britain's agriculturalists were recipients of unfamiliar varieties of diverse provenance. Examples recorded in the periodical literature include a 'new sort of wheat' grown near Washington DC and presented to the York Agricultural Society for distribution to its members in 1802, and 'an Egyptian wheat' 'received from a friend' by Lord St. Leger in 1792.[8] Some landowners were able to make informal comparative trials of newly introduced varieties. In 1771, Sir Digby Legard of Ganton, Yorkshire drilled two pecks of Siberian spring wheat, which he found 'superior to the common spring wheat but greatly inferior to some wheat of Switzerland sent to me by the Society of Arts and sown on land contiguous.'[9] After one or two harvests, the seed of varieties which seemed successful might be distributed throughout and beyond the locality which had first received it. One A. Hunter, place of residence unspecified, related how in May 1767 he had received 'a moderate wine-glassful' of Siberian barley from a member of the Society of Arts 'with the information that a foreign nobleman had presented it to the Society'. By 1769, the glassful had been turned into a harvest of 36 bushels, 20 of which were, it was claimed, 'under skilful culture' in 'many parts of' the recipient's unnamed county, in the counties of Kent, Surrey, York and Durham, 'in two or three counties in Wales, six or seven in Ireland and some in Scotland'.[10]

The role of continental Europe as a source of new varieties received further support from the increasing flow of grain imported into Britain for consumption. Regular continental importations, beginning in 1765, established a recognized channel of varietal innovation.[11] Grain trade middlemen living on the continent sent samples of interesting looking grains to contacts in Britain. According to folk history, it was such an individual who at some unspecified date in the first half of the nineteenth century dispatched to Scotland a sample of a variety which had originated in Polish Galicia. From Glasgow, part of the sample found its way to Ontario, and was sown by one David Fife on the assumption that it was a winter wheat. One plant survived the winter, and from grains of that plant, Red Fife, the foundation of the north American hard spring wheat industry, was born.[12]

For those living in Britain, the markets trading in these imported grains were an important source of new material. Mark Lane, already the centre of the London seed trade in the seventeenth century,[13] attracted the curious or those looking to make a quick speculative profit from the exotic as an increasing diversity of imported grains began to be traded on the London corn exchange. Although we naturally assume that buyers in grain markets supply the consumer, a grain sample is of as much interest to the seedsman as to the miller, and in technical terms

8 *Agricultural Magazine* (hereafter *Agric. Mag.*), 7 (1802), p. 382; 9 (1803), p. 111.

9 *Agric. Mag.* 8 (1803), p. 423.

10 *Agric. Mag.* 8 (1803), pp. 359–364.

11 B. R. Mitchell, *Abstract of British historical statistics* (1962), pp. 94–5.

12 The folk histories of outstandingly successful varieties agree on the substantive issues though details vary from one account to another. This version of the history of Red Fife appears in Clark, 'Improvement in wheat', pp. 214–5. C. R. Ball, 'The history of American wheat improvement', *Agricultural History* (hereafter *Ag. Hist.*) 4 (1930), p. 68, and J. Percival, *Wheat in Great Britain* (Shinfield, 1934), p. 64 date the Ontario importation to 1842.

13 Thick, 'Market gardening', p. 528.

serves the seedsman's requirements every bit as well. In all likelihood, the London corn exchange was the source of the 'new Syrian wheat seed', which a London seedsman advertised for sale in the Oxford newspaper, *Jackson's Oxford Journal*, in October 1794, and of the Moldavian barley which another London dealer offered the Oxford reading public, with exaggerated claims regarding its yield and malting properties, in March 1797.[14] There is no evidence that either had the least impact on what was sown in the fields of the south Midlands in the late eighteenth century, and it is possible that the varieties may have been entirely valueless in that local context. However, they do remind us that when a country imports cereals for consumption, it also presents its cereal producers with what in effect are unfamiliar varieties of seed. The London corn exchange continued to channel new cereal varieties into British agriculture well into the nineteenth century. In 1852, the London market was specifically mentioned as the source of four wheat varieties in the collection of Edinburgh seedsman, Peter Lawson.[15]

As to the possibilities of selection, the situation before 1750 is less clear. Certainly, such evidence as there is could bear the interpretation of an emergent varietal cereal culture if one wished to impose such an interpretation upon it. But it is more plausibly interpreted otherwise. A true variety arises either from the multiplication of seed saved from a 'sport', a single plant mutation showing commercially attractive characteristics, or from the reservation and multiplication of seed selected from attractive plants growing in varied crops of a mixed, landrace character.[16] There is some seventeenth-century evidence of selection of this kind, most notably in four references in Robert Plot's *Natural History of Oxfordshire*.[17] However, in general, the observations of seventeenth-century writers are better interpreted as references to locally distinct landraces, which appeared unfamiliar both to travelling observers new to their districts and to locals when traded outside their districts of origin. The practice of regularly taking seed from a distance, noted and advocated by agricultural writers from classical times onwards, does not deserve to be represented as a scientifically well-founded practice, whatever its merits empirically and in specific instances.[18]

In selection as in introduction, the second half of the eighteenth century appears to have been a turning-point. A highly significant development took place on the farm of Robert Bakewell at Dishley, Leicestershire. The first systematic application to cereals of the principles of careful selection and close in-breeding which Bakewell used with greatest success on the New Leicester sheep dates to the 1830s.[19] But there was a developing awareness, towards the end of

[14] *Jackson's Oxford J.*, 8 Oct. 1794, 25 Mar. 1797.

[15] P. Lawson and Son, *Synopsis of the vegetable products of Scotland in the Royal Botanic Garden of Kew* (Edinburgh, 1852), pp. 29, 32, 46.

[16] According to F. N. Briggs and P. F. Knowles, *Introduction to plant breeding* (New York, 1967), p. 116, a landrace or land-variety has three principal attributes: 'it is endemic to an area, with its origins sometimes going back several hundred years; it is a mixtures of types; and it is well adapted to the environment'.

[17] R. Plot, *A natural history of Oxfordshire* (1667), pp. 150–3; R. C. Allen, *Enclosure and the yeoman. The agricultural development of the south Midlands, 1450–1850* (1992), p. 207.

[18] J. Thirsk and J. P. Cooper (eds), *Seventeenth-century economic documents* (1972), pp. 150–4, 170–3; D. Woodward (ed.), *The farming and memorandum books of Henry Best of Elmswell* (1984), pp. 48, 104–6; Ambrosoli, *The wild and the sown*, p. 353.

[19] For a full discussion and contextualisation of Bakewell's activities, N. Russell, *Like engend'ring like. Heredity and animal breeding in early modern England* (1986), pp. 196–215.

Bakewell's career as a breeder, that frequent renewal of seed, hitherto promoted as best practice, imposed upon cereals producers an agenda entirely at odds with that which was creating the improved varieties of farm livestock. William Marshall was an early convert to the new line of thinking. A passage in his *Rural Economy of Yorkshire* of 1788 contrasted the former practice of crossing cattle with the work of modern breeders who 'pick out the fairest of the particular breed or variety they want to improve, and prosecute the improvement with these selected individuals'. The cereal farmer was advised to do likewise, and 'select such individual plants as excel in vigour and productiveness, under a moral certainty that such individuals are peculiarly adapted to his soil and situation'.[20] The theme was taken up in the 1807 encyclopedia, *The Complete Farmer*, whose anonymous author, commenting on the suggestion that seed should be changed every two to three years, observed: 'The practice is as little founded on propriety as a change of livestock once every two years would be, and will never be the means of advancing corn to a high pitch of excellence. On the contrary, when corn farmers become wise enough to apply Bakewell's method of improving cattle to the raising of seed grain, the advance will be rapid indeed.'[21]

It began to be recognized that the supposed advantages of seed changing were not absolute. Seed brought from one environment to another, and especially from a harsh to a less harsh area, generally performed impressively in its first season but a great deal less so thereafter as the negative consequences of its lack of adaptation to the new environment began to outweigh the positive, necessitating another change of seed. Some specialist seed producing areas, like Burwell in Cambridgeshire, were supported by a reputation for pure seed well selected.[22] The reputation of the chalk downlands of south central England probably owed something to the low susceptibility of those soils to seed-borne fungal disease. But sound husbandry practices applied to home-grown seed could be as effective. During the course of the nineteenth century, agricultural writers on both sides of the Atlantic advocated conscientious seed reservation for cereals. 'The practice of annual selection should be handed down by the farmer to his posterity as an inheritance more valuable than ... gold'.[23] The argument did not extend to the fodder grasses. If allowed to run to seed so that the seed might be saved for sowing a new grass crop, grass not only loses nutritive value but also exhausts soil fertility when one of its supposed functions is to restore it.[24]

The new emphasis on the selection and reservation of seed was associated with two significant developments in cereal breeding. First, the rate of identification of commercially-attractive 'sports' increased. The origins of the more successful and influential of these varieties became legendary. They include the Potato oat, allegedly first identified as a single plant in a Cumberland potato field in 1788, Spalding wheat discovered by a farm labourer at Barningham, Suffolk

[20] W. Marshall, *The rural economy of Yorkshire* (2 vols, 1788), I, p. 9. The point was reiterated in *idem*, *The review and abstract of the county reports of the Board of Agriculture* (5 vols, 1818), I, p. 74; II, p. 281; V, p. 133.

[21] Anon., *The complete farmer* (2 vols, 1807), I, n. p.

[22] Evershed, 'Varieties of wheat', p. 248; H. R. Haggard, *Rural England* (2 vols, 1906), II, pp. 17–19.

[23] W. M. King, 'Report of the chief of the seed division', *Report of the Commissioner of Agriculture* (Washington DC, 1885), p. 55.

[24] R. Brown, *General view of the agriculture of the West Riding of Yorkshire* (1799), p. 109; C. Cadle, 'The improvement of grasslands', *JRASE* 2nd ser., 5 (1869), p. 323; R. A. Oakley, 'The seed supply of the nation', *USDA Yearbook 1917*, pp. 509–10.

circa 1834, and the several varieties of wheat and oats selected by Patrick Shirreff in East Lothian and adjacent counties between 1819 and 1857.[25] Identification of the highly successful and influential Chevalier barley, at Debenham, Suffolk, is generally dated to 1819 or 1820, and the beginnings of its distribution to other areas to 1826 or 1827.[26]

The other development occurred as people began to act on the suggestion that individual plant selection could be applied constructively to the variability found in established landrace crops. The first successful pioneer of the approach was John (later Sir John) Le Couteur, of Belle Vue, Jersey (1794–1875), author of *On the Varieties, Properties and Classification of Wheat* (1836).[27] He wrote no parallel volume documenting his work as the leading improver of the Jersey breed of cattle, but it is clear that both breeding programmes date to the early 1830s and involved similar principles of selection.[28] Twenty-three different wheat varieties were identified in a single field, 14 of which were isolated and multiplied, each duly revealing distinctive morphological, growth and yield characteristics. A number enjoyed extended periods of popularity in mainland Britain.

II

From the mid-1830s onwards, new cereal varieties became available to the British farmer at a markedly increased rate. Fields of old-established heterogenous cereals began to give way to stands of single varieties, some introduced from overseas, others derived by combing established domestic crops for attractive variation and then multiplying these selections. The process was greatly assisted by the reproductive mechanisms of wheat, barley, and oats, which are almost entirely self-fertile crops. Within each floret, the anthers release pollen onto the female stigma, initiating the development of the grain, before the florets open sufficiently to allow pollen to be carried to neighbouring florets.[29] Precocious dehiscence of the anthers (the technical term for this process) ensures that cross-pollination in all three cereals is extremely rare, less than a fraction of 1 per cent according to an estimate reported in 1960.[30] Low levels of outcrossing over long periods of time create the variation on which selection acts to produce landraces

25 H. Hunter, *Oats: their varieties and characteristics* (1924), p. 14; Evershed, 'Varieties of wheat', p. 247; R. A. Peachey, *Cereal varieties in Great Britain* (1951), pp. 135, 187; J. C. Morton, *Cyclopedia of agriculture* (2 vols, Glasgow, 1855), I, p. 483; H. Raynbird, 'On the farming of Suffolk', *JRASE* 8 (1847), p. 301; Shirreff, *Improvement of cereals*, pp. 1–7; *idem*, 'On the Hopetoun wheat, and on comparative trials of wheat', *JRASE* 2 (1841), p. 344. For a fuller survey see Brassley, 'Crop varieties'.

26 E. S. Beaven, *Barley: fifty years of observation and experiment* (1947), pp. 90–2; H. Hunter, 'Developments in plant breeding', in [Anon., ed.], *Agriculture in the twentieth century: essays on research, practice and organization to be presented to Sir Daniel Hall* (1939), p. 224; P. Pusey, 'Some introductory remarks on the present state of agriculture as a science in England', *JRASE* 1 (1840), p. 11.

27 For a full biography see J. Stevens, *Victorian voices: an introduction to the papers of Sir John Le Couteur, QADC, FRS* (St Helier, 1969). An earlier instance, involving the identification of 11 apparently unenduring varieties by 'a gentleman of Great Bardfield', Essex, is referred to in Marshall, *Review and Abstract*, III, pp. 484–5.

28 E. P. Prentice, *American dairy cattle their past and future* (New York, 1942), pp. 340–9; J. Le Couteur, 'On the Jersey, misnamed Alderney cow', *JRASE* 5 (1845), pp. 43–50; Stevens, *Victorian voices*, pp. 199–212.

29 C. G. Hervey-Murray, *The identification of cereal varieties* (1980), pp. 20–1.

30 R. W. Allard, *Principles of plant breeding* (New York, 1960), p. 39.

attuned to their environments.[31] However in the shorter term, levels of outcrossing are sufficiently low not to threaten the integrity of varieties multiplied up from single-plant selections or introductions.

During the nineteenth century, this fact gradually registered with plant breeders, whose chequer-board trial plots would have been scenes of botanical mayhem had out-crossing been at all common. For Le Couteur, writing in 1840, one of the merits of Talavera wheat was that it was not 'at all likely to become intermixed by fecundation from other varieties, though sown about the same period, as it will, in such cases, flower a fortnight or three weeks before them'.[32] But by 1860, Patrick Shirreff had concluded that cross-fertilization was rare irrespective of flowering habit, albeit something he attempted to exploit by isolating promising-looking natural hybrids whenever he found them in his trial plots. He lamented that few corn growers were 'aware that the cereals possess both sexes in one blossom, through which alone they produce seeds'.[33] By the early twentieth century, plant breeders were convinced that under Britain's climatic regime outcrossing was virtually unknown. Biffen and Engledow reported that in 1924, the trial plots at the Plant Breeding Institute in Cambridge yielded a diverse harvest of hybrid and parental wheat cultivars totalling some 70,000 plants, only three of which showed evidence of natural hybridization.[34]

Self-fertilization brought the possibility of varietal proliferation. In the majority of cases, those aspects of a plant's appearance or phenotype which made it an attractive subject for selection were expressions of the plant's genotype.[35] Seed reservation over several seasons therefore enabled a varietal innovator to put into circulation limited quantities of seed of a new variety bearing the character of the plant originally selected. The initial years of seed multiplication were usually sufficient to bring to light any serious disparities between the message of the original phenotype and the medium of the genotype. These disparities were most likely to occur where a selection turned out to be a natural hybrid of recent origin. Probably for this reason, one of Le Couteur's original selections proved 'incorrigibly sportive' in Charles Darwin's words, and was rejected.[36] Genuine 'sports', that is single-plant mutations, and selections drawn from long-established landraces whose variability reflected an extended history of limited natural outcrossing were much less likely to be problematic.

In the last quarter of the century, as the possibilities of introduction and selection were gradually exhausted, breeders turned to hybridization as a source of new varieties. This

31 The selection might be both natural and artificial. If seed is reserved at random from and is representative of a mixed landrace crop (i.e. is as natural as the artificial act of seed-saving can be), then any plant which, as a consequence of natural hybridization, has a heavier than average yield or better disease resistance will contribute more to the seed supply than other plants. Its genotype will gain greater representation in the next crop. Artificial selection might further increase the contribution of such plants to the seed mix.

32 Le Couteur, 'On pure and improved varieties of wheat lately introduced into England', *JRASE* 1 (1840), p. 120.

33 Shirreff, *Improvement of cereals*, pp. 10, 34, 97.

34 Biffen and Engledow, *Wheat-breeding investigations*, p. 40.

35 R. N. Jones and A. Karp, *Introducing genetics* (1986), pp. 311, 315 define 'genotype' as 'the genetic constitution of an individual', and 'phenotype' as the 'appearance and function of an organism as a result of its genotype and its environment'.

36 C. Darwin, *The variation of animals and plants under domestication* (2 vols, 1905 edn,), I, pp. 386–7; J. Le Couteur, *On the varieties, properties and classification of wheat* (Jersey, 1836), pp. 64–5.

necessitated more elaborate, purposive breeding programmes, not least to ensure that the new variety was both breeding true and purveying the desired qualities. After 1901, increasing familiarity with Mendel's ratios and the associated concepts of dominance and recession assisted the creation of useful new hybrid varieties with stable characteristics.[37] By 1926, Biffen and Engledow could confidently attribute the 'rogues' appearing in field crops of the newer hybrids not to reversion, as farmers believed, but to cross-contamination of saved seed by threshing machines as they travelled from farm to farm. All but about 1 per cent of the so-called rogues were in fact commonly cultivated varieties.[38] The genotypes of the new hybrids were stable.

In commercial terms, the supply of new varieties of seed corn to farmers presented some difficult paradoxes. Before hybridization became the standard route to varietal innovation, new varieties offering powerful commercial advantages could be identified with relative ease by individuals who knew what they were looking for. Four or five years of seed multiplication, again at no great expense to the innovator, culminated in the limited release of seed onto the market, at which point pricing became an important strategic issue. The breeder was confronted by the catch–22 of the agricultural seed trade before breeders' rights, namely that if a new variety did prove successful, then its originator soon ceased to be the sole supplier as the market began to receive seed from the crops of his early purchasers, and the price of seed began to fall. Some breeders responded to this paradox by pitching their initial seed releases at highly ambitious levels, courting the risk of choking off demand, especially if the breeder's aspirations were not matched by the true commercial qualities of the variety. Market failure was the fate of a six-rowed black barley, said to have been discovered as a single ear lying on the floor of a Cheltenham tobacconist's shop where it had fallen from a sailor's clothing. In 1847, the variety was mentioned in the *Farmer's Magazine* and advertised at high prices in the *Gardener's Chronicle*, but nothing was heard of it thereafter.[39] In other instances, ambitious initial prices appear to have helped publicize the new variety and did little to damage its marketability, largely because there appears to have been some truth in the claims which were made for its commercial prospects. Providence barley, multiplied from a sport found in a garden at Lytchett Heath, Dorset in 1835, was first offered to the public at 18d. per ounce or £528 per quarter.[40] Despite this outrageous initial price, the variety gained support from farmers in southern England, and was recorded in three Oxfordshire farm sales in 1843 and 1844 (figure 2).

However, most introducers of new varieties were motivated by considerations other than monetary gain, and the progress of the varieties was therefore not constrained by pricing policies designed to secure it. In a life of public service, like Le Couteur's, plant and animal breeding was seen as a means of supplying a public good. It is significant that Le Couteur's book on wheat concludes with an account of a visit to a farm school in Brittany, and a plea for agricultural

37 The significance of the Mendelian rediscovery was quickly recognized. See, for example, T. B. Wood and R. C. Punnett, 'Heredity in plants and animals: Mendel's principles and their bearing on agricultural problems', *Trans. Highland and Agricultural Society of Scotland* (hereafter *THASS*), 5th ser., 20 (1908), pp. 36–86. An extensive recent literature on the rediscovery includes Bert Theunissen, 'Knowledge is power: Hugo de Vries on science, heredity and social problems', *British J. History of Science* 27 (1994), pp. 291–311.

38 Biffen and Engledow, *Wheat-breeding investigations*, p. 41.

39 *Farmer's Magazine* (hereafter *FM*), 2nd ser., 16 (1847), pp. 546–7; *Gardener's Chronicle and Agricultural Gazette*, 23 Jan. 1847, p. 50; 27 Nov. 1847, p. 787.

40 *Mark Lane Express*, 24 Feb. 1840, p. 6; Lawson, *Vegetable products of Scotland*, p. 77.

education on similar lines in the United Kingdom. If the intangible rewards of public service were not thought adequate, then plant breeders enjoyed the prospect that their varieties, if successful, might carry their reputations and sometimes their names throughout the length and breadth of the land. Of the 179 varieties of wheat, 42 of barley and 53 of oats listed in the Lawson inventory, 17, 5, and 3 respectively (that is rather more than 9 per cent of all varieties) are identified by personal name, either that of the genuine introducer or of an adopter and promoter of the variety.[41]

Once put into circulation, there was nothing to prevent a new variety with attractive qualities passing rapidly from farm to farm. An impressive crop advertised its advantages to neighbours, who could then buy seed grain reserved from the same crop. Biffen and Engledow estimated that at least 70 per cent of purchased seed wheat, that is to say seed not reserved from crops grown on farm, was traded between farms.[42] In these circumstances, it is not surprising that the major garden seed houses, like Sutton, Webb or Carter, initially focused their agricultural activities on the supply of grass seeds and of turnip, swede and mangold seed. From the point of view of the commercial seed supplier, fodder crops offered two advantages. Not only was there a greater expectation that farmers would buy this seed every time they required it, but suppliers of grass seed, much in demand during the secular arable retreat of the late nineteenth century, were able to develop and promote complex proprietary mixtures over which they effectively asserted intellectual property rights. In 1869, the Gloucester firm of Wheeler was said to supply a different grass mixture for each of Britain's geological formations.[43] Towards the end of the century, these firms also increasingly offered cereal seed as their own branded product. In this context, their rights were more difficult to uphold because complex mixtures were not involved, and any purchaser could, after a season, sell seed in competition with the original supplier using the same brand identity. Advertising suggests that by 1890 each of the major seed suppliers had spawned up to half a dozen unofficial multipliers whose cereal varieties were warranted solely by the assurance that the seed on offer had been grown from seed bought from the stated source within the last couple of seasons. Occasionally, these claims were even endorsed by the original supplier.[44]

The major commercial seed houses therefore appear to have developed a niche role as informal guarantors of quality in agricultural seed supply. Some had joined the campaign for the 1869 Adulteration of Seeds Act, which finally outlawed the profiteering frauds devised by wholesalers of imported grass and turnip seeds, like dyeing inferior clover seed to give it the appearance of something better, and adulterating turnip seed with killed rape seed.[45] During the second half of the nineteenth century, a reputation for quality in existing seed lines, first

[41] Lawson, *Vegetable products of Scotland.*

[42] Biffen and Engledow, *Wheat-breeding investigations*, p. 61.

[43] Cadle, 'Grass lands', p. 333. A. N. McAlpine, 'The nature and construction of grass mixtures', *THASS*, 5th ser., 1 (1889), pp. 132–62 underlines the problems for farmers wishing to devise their own seed mixtures. The geography of British clover seed production in the early 1830s may be reconstructed from the evidence of witnesses to the SC on Agriculture (BPP, 1836, VIII). Ministry of Agriculture and Fisheries, *Report on the agricultural seed-growing industry in Great Britain* (1921), identifies the main British production zones for clover and grass seed in the early twentieth century.

[44] *Mark Lane Express*, 10 Mar. 1890, pp. 310–11; 6 Oct. 1890, p. 422; 24 Feb. 1890, p. 241.

[45] BPP, 1868–9, IX, Report of the SC on the Seeds Adulteration Bill, QQ 6, 9, 29, 335; Ambrosoli, *The wild and the sown*, pp. 380–4.

garden seed, then grass and turnip seed, was used as the basis for building a similar reputation in the new line of cereal seed. Quality was also the cornerstone of the business of the small group of commercial suppliers who had always specialized in cereal seed, even where, as in the notable case of Hallett of Brighton, the supplier believed quality a secondary attraction of his offerings. The basis of both Hallett's method and his sales pitch was a system of pedigree breeding, as he styled it, under which he applied to several existing improved varieties growing in his trial plots successive selections of the largest ear of the largest plant, each selection grown on at the generous spacing of one foot between plants.[46] In effect, this was a Lamarckian programme of selection based on nurture rather than nature, conducted under conditions highly unrepresentative of normal field culture.[47] That Hallett's business flourished throughout the entire second half of the nineteenth century owed less to his pedigree method itself, than to the level of seed purity it fortuitously guaranteed, and to the happy choice of some of the varieties to which it was applied. As late as 1890, Hallett's Pedigree Chevalier was the preferred barley of many brewers.[48]

It is clear, then, that in the nineteenth century there were few constraints on either the identification or the diffusion of new cereal varieties. The flow of varieties was facilitated both by the ease with which they could be identified and by the gains in standing, if not substance, that those responsible might expect in return for their efforts. Ease of varietal identification and introduction was matched by the free dissemination of varieties once in circulation. Cereal growers never had to look far for cereal seed. If dissatisfied with seed reserved from their own crops, then other seed could be bought from neighbours, or from corn exchanges, corn merchants or millers. Farmers acquiring seed in this way may well have made the transition from a mixed landrace to an unmixed single variety without knowing what the variety was. As late as 1926, Biffen and Engledow noted of seed wheat traded between farms that 'whatever the variety may be, it is often nameless so far as the contracting parties are concerned'.[49] Conversely, the same or very similar varieties might be known by a number of names. A further source of confusion was the tendency of some varieties to reveal their unsuitability to a new environment by a marked change of phenotype. For instance, some of the Scottish white wheats were said to turn red when grown in southern England.[50] The specialist seed suppliers were important in offering direction to the confused, the assurance of quality to those who sought it,[51] and seed grown at a distance to those who believed that frequent changes of seed were the essence of sound husbandry. Otherwise, they were tangential to the routine conduct of a cereal agriculture which adopted a variety-based mode of production during the nineteenth century largely through its customary habits of seed reservation and supply. By 1852, Peter Lawson was already speaking of the traditional wheat landraces of eastern Scotland

46 F. F. Hallett, 'On "pedigree" in wheat as a means of increasing the crop', *JRASE* 22 (1861), pp. 371–81.

47 Evershed, 'Varieties of wheat', pp. 251–3; Biffen and Engledow, *Wheat-breeding investigations*, pp. 7–8; Allard, *Principles of plant breeding*, p. 51.

48 *Mark Lane Express*, 3 Mar. 1890, p. 282.

49 Biffen and Engledow, *Wheat-breeding investigations*, p. 61.

50 Shirreff, *Improvement of cereals*, pp. 4–5.

51 This was the essential message conveyed by the advertising of the major British seed suppliers. Commercial sources of seed in Ireland appear to have been enduringly problematic. See J. P. Huttman, 'The impact of land reform on agricultural production in Ireland', *Ag. Hist.* 46 (1972), pp. 359–60.

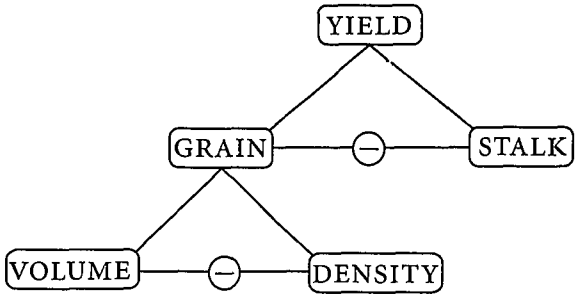


FIGURE 1. Components of yield in ninteenth-century cereal varieties.

as residuals. Common White Winter Wheat was 'the name given to whatever white wheat is generally cultivated in any district where its culture may not have been superseded by one or more of the superior and less mixed varieties: ... its cultivation is now giving place to varieties less mixed, which produce superior samples'.[52] Mixed landraces survived longest on the cultivable margins of cereal agriculture where their unique environmental adaptation scored over other considerations. Daniel Hall observed mixed, localized varieties of barley growing in mid Wales circa 1911.[53] The same area contributed a number of mixed landraces to John Percival's inventory of British wheats, published in 1934.[54]

III

The process of varietal change which was made possible by the developments outlined in the previous sections adds a new dimension to our understanding of the competitive difficulties of the British cereals sector during the nineteenth century. It is standard practice among agricultural historians to equate the productivity of cereals solely with the yield of the grain measured in volume per unit of area, typically bushels per acre. Yet, as figure 1 reminds us, a cereal plant produces both grain and stalk, and the latter may be as important to the grower as the former. Caird believed that the choice of one type of grain over another 'depends much on the local value of the different kinds of straw'.[55] Also, the 'yield' of the grain should be measured by both volume and density, for example pounds per bushel, if a plant's productivity in grain is to be expressed in both quantitative and qualitative terms. In general, varieties with the heaviest yields of stalk have the lightest grain yields and vice-versa. Increasing the 'harvest index' (the proportion of total shoot weight accounted for by the grain) has been one of the main objectives of breeders of new varieties in recent times, but was of dubious benefit when straw was in demand and before herbicides afforded effective control of the weed competition suffered by short-straw varieties.[56] Figure 1 also indicates that a similar inverse relationship exists between the volume and the density of the grain, at least in the context of pre-twentieth-century plant science. In

52 Lawson, *Vegetable products of Scotland*, p. 45.

53 A. D. Hall, *A pilgrimage of British farming, 1910–1912* (1913), pp. 328–9.

54 Percival, *Wheat*, pp. 95–7, 104–5.

55 J. Caird, *The landed interest and the supply of food* (1882), p. 36.

56 L. T. Evans, *Crop evolution, adaptation and yield* (1993), pp. 238–45, 28.

general, varieties with the highest volumetric yields had the lowest densities. As Edward Roberts put it in 1847, 'the most prolific are also very frequently of a coarse quality, and commonly lose in price what they gain in quantity'.[57]

The productivity of a cereal was as multi-faceted as its intended uses, which could not be equally well served by any single variety. Varietal choice was therefore partly determined by environmental suitability, partly by an estimation as to what was likely to produce the best overall return on the crop, given its intended uses. Compromise was an essential part of the decision. For example, there was no single variety of wheat capable of producing a heavy straw yield and a large volume of grain at the high bushel weights most desired by the baker. This fact is essential to a proper understanding of the implications for the British cereals sector of the high-input, high-output arable livestock fattening systems of nineteenth-century high farming.

High farming was an elaboration and intensification of the mixed farming tradition which had been the main foundation of agricultural progress in Britain since at least the seventeenth century.[58] It has been assumed that high farming shared with earlier mixed farming arrangements the ability to promote simultaneous increases in the output of livestock and cereals. Its 'expanding circle' is generally supposed to have applied to both livestock and cereals without prejudice to the character of either. As E. L. Jones puts it, 'the greater the scale of feeding farm-grown and bought-in fodder and the heavier the applications of farm-produced and purchased fertilizer, the more the saleable produce, and the more manure for the next round of cropping', resulting in both 'high yields of grain and of fodder crops for the stock'.[59] In fact, high fertilizer doses applied to nineteenth-century cereal varieties tended, while increasing the 'yield', either to reduce the harvest index (i.e. to increase the proportion of stalk to grain) or to increase the volume of the grain at the expense of its density, thereby shifting the character of the crop to something better suited to consumption by animals than by humans.[60] The trend, intensified by the choice of varieties known to respond positively to this treatment, would be particularly welcome in a mixed farming system focused more on livestock than on grain production. Jones suggests that this was a characteristic of high farming from the 1850s onwards. He does not take account of earlier evidence such as that more recently surveyed by Andrew Copus, who detects a transition in southern England as early as 1815.[61] The direct feeding of the

57 E. Roberts, 'On the management of wheat', *JRASE* 8 (1847), p. 71.

58 Overton, *Agricultural Revolution*; B. M. S. Campbell and M. Overton, 'A new perspective on medieval and early modern agriculture: six centuries of Norfolk farming, *c.* 1250–*c.* 1850', *Past and Present* 141 (1993), pp. 38–105.

59 E. L. Jones, 'The changing basis of English agricultural prosperity, 1853–73', *AgHR* 10 (1962), p. 104.

60 For a general discussion of the impact of nitrogen on the harvest index, see Evans, *Crop evolution*, pp. 241–2. For recognition of this point in the nineteenth-century literature, see John Morton, *The nature and property of soils* (1842), pp. 164, 166. Morton argues that manure should be applied to green fodder not cereals: 'large quantities of manure produce an over-abundance of straw'. The proportionately greater increase of straw than grain is documented in John Hannam, 'Report of experiments on the actual and comparative effects of special manures', *FM* 2nd ser., 9 (1844), pp. 503–17.

61 Jones, 'Changing basis'; A. K. Copus, 'Changing markets and the response of agriculture in southern England, 1750–1900' (unpublished Ph.D., University of Wales, 1986), esp. chs 7 and 8. A. R. Wilkes, 'Adjustments in arable farming after the Napoleonic Wars', *AgHR* 28 (1980), pp. 90–103 treats the cereal agriculture of the period 1815–46 as something which existed in opposition to livestock farming, not recognizing the extent to which they were integrated.

grain of wheat and barley to livestock is well documented during the depression of the 1830s.[62] A witness to the 1847–8 Select Committee on Agricultural Customs noted a greater inclination to feed stock on corn than formerly with 'much progress in the last 10 to 15 years'.[63] It is also clear that by the late 1830s and 1840s, chopped straw was being widely used in yard- or stall-based livestock fattening systems, and that its various benefits were well understood: savings in fodder crop consumption especially of turnips and hay; provision of the roughage necessary for the successful digestion by ruminants of fodder crops, oil-cake and other purchased feeds; and a key role both as feed and litter in the creation and subsequent conservation of manure.[64] By the 1840s, chaff machines for cutting straw and hay figured in about a quarter of farm sales held in Oxfordshire and a rather greater proportion in Shropshire.[65] The 1830s and 1840s also saw rapid displacement of reaping by sickle by mowing by scythe, a change which was welcomed at the time as much for the consequent increase in the quantity of straw recovered in the harvest as for anything else.[66] Lease covenants generally prohibited the removal of straw from farms, except where a nearby town or city supplied an off-farm demand and the loss of this manurial ingredient could be rectified by the purchase of equivalent quantities of town manure. A straw market existed and straw had a defined monetary value only for farmers in these situations.[67] This may explain why straw is sometimes not explicitly itemized and often not costed in reports on feeding experiments where it was evidently used. Such omissions should not be taken as evidence that it had negligible or zero value.[68]

62 BPP, 1836, VIII, QQ 560, 822, 826, 939–40, 4185, 4188–9, 7804–5.

63 BPP, 1847–8, VII, SC on Agricultural Customs, witness Thomas Chandler, farmer, Warminster, QQ 5448–9.

64 For example, BPP, 1836, VIII, Q. 10207; BPP, 1847–8, VII, QQ 266–9, 420, 496, 1647, 2135; *FM* 3 (1835), p. 383 (report that sheep of Berkshire are 'already at straw'). *FM* 6 (1837), pp. 99–100 (on stall feeding as practised in Norfolk). C. Hillyard, 'Essay on stall feeding cattle', *FM* new ser., 3 (1839), p. 406 (in Norfolk the common practice is to give store beast in fold yard eating straw as much linseed oil as they will eat). *FM*, 2nd ser., 3 (1841), pp. 380–1 (South Wiltshire and Warminster Farmers' Club resolve that the 'saving of hay is great by permitting straw to be cut and used with it'). *FM*, 2nd ser., 6 (1842), p. 15 (Leominster Farmers' Club discusses the diets of farm horses and resolves that the best comprise wheat straw, hay or clover cut into chaff, and oats. 'It is also resolved that the animal is less likely to be affected by wind and that his general condition when kept on cut food is greatly improved'). *FM*, 2nd ser., 8 (1843), p. 436 (a speaker to Swansea Farmers' Club advises mixing clover hay with barley and oat straw). See also William Youatt, *The complete grazier* (9th edn, 1851, p. 78) for the role of straw in aiding the digestion of linseed cake and C. W. Johnson, *The modern dairy and cowkeeper* (1850), p. 32 on the value of straw in the digestive process.

65 J. R. Walton, 'Mechanization in agriculture: a study of the adoption process', in H. S. A. Fox and R. A. Butlin (eds), *Change in the countryside* (1979), p. 25.

66 *FM*, 2nd ser., 3 (1841), pp. 34, 133, 153, 259, 280; 4 (1841), p. 368; 6 (1842), p. 13; 10 (1844), pp. 545–6; 20 (1849), pp. 263–4. E. J. T. Collins, 'Harvest technology and labour supply in Britain, 1790–1870', *EcHR* 2nd ser., 22 (1969), pp. 453–73 emphasizes gains in labour productivity.

67 BPP, 1836, VIII, QQ 2455, 4064, 4240; *FM* 6 (1837), p. 318; Henry Stephens, *Book of the farm* (2 vols, 2nd edn, Edinburgh, 1851), I, p. 459; C. W. Johnson, 'On farm leases', *FM* 2nd ser., 14 (1846), pp. 108–110; 21 (1850), p. 57. On the volatility of the straw market and its impact on the farmers of south Lancashire during the late century depression, see Alistair Mutch, 'Farmers' organizations and agricultural depression in Lancashire, 1890–1900', *AgHR* 31 (1983), p. 28.

68 *FM*, 2nd ser., 3 (1841), p. 216, 'not knowing what to say for the barn chaff, I put nil'; 17 (1848), pp. 97–9, report on the feeding experiments of John Hutton, Sowber Hill, Thirsk. For a full statistical survey of published nineteenth-century feeding experiments on cattle, see H. Ingle,

The creeping subservience of cereals farming to the demands of livestock production proceeded so far as the crop's other requirements and the market mechanisms which expressed them allowed. This varied from one cereal to another as, consequently, did the extent and character of varietal change. Traditionally consumed on farm and by livestock to a much greater extent than barley and wheat, oats did not experience the kind of varietal changes associated with a fundamental shift in the function of the crop. A rash of new varieties appeared between the 1820s and the 1840s to give the 53 of Lawson's 1852 list.[69] But the newcomers did not alter the strong existing preference for established varieties supplying a straw with good feeding qualities. So far as farmers in Scotland and the north of England were concerned, this often meant continued cultivation of the old Potato oat, which, notwithstanding its modest bushel yield, gave both a quality grain (this variety was the premium grade in published nineteenth-century price quotations),[70] and a palatable straw. As late as 1910, James Hendrick could remark that 'it is a common opinion among practical men that the straw of the new varieties is of poorer quality than that of well-known old varieties like the Potato and the Sandy'.[71] The new varieties included successful hybrids such as Abundance.[72]

Barley and barley straw were extensively fed, but varietal choice was to a large extent determined by the requirements of the malting trade, at least in those areas where barley of good malting quality could be grown. Several new varieties selected for their malting properties were offered to and tried by farmers during the 1830s and 1840s. For example, Annat, which originated as three ears selected at Annat Gardens, Perthshire in the harvest of 1830, was available in field quantities of seed by 1837.[73] In February 1840 a member of the Isle of Thanet Farmers' Club in Kent was able to report to the club on his experience of the variety.[74] As in similar gatherings elsewhere, but especially up and down the eastern side of Britain, opinion favoured Chevalier, which became the dominant barley variety of nineteenth-century Britain.

The diffusion of Chevalier from its Suffolk place of origin appears to have been rapid during the mid-1830s. In 1834, the *Farmer's Magazine* harvest report for Kent spoke of the 'lately introduced' Chevalier having been 'sown this year to a very great extent', while east of Scotland reports from Brechin and Kirkcaldy in the same year noted that the Chevalier had lived up to expectations but that little would come to market as the bulk of the crop was to be retained for seed.[75] In the following year, Chevalier was mentioned in published harvest reports from Oxfordshire, Berkshire, Tyneside and Glamorgan as if it were no longer a trial growth in those areas. In the Carse of Gowrie it was said to have had a fair trial 'with results such as to ensure an extended culture'.[76] In 1837, classes for Chevalier were included in seed competitions

'Cattle-feeding experiments in Britain: a review of over 200 trials made in the years 1833–1908', *THASS*, 5th ser., 21 (1909), pp. 196–254, and on sheep, *idem*, 'Sheep-feeding experiments in Britain: a review of over 190 trials made in the years 1844–1909', *THASS*, 5th ser., 22 (1910), pp. 178–257.

69 Lawson, *Vegetable products of Scotland*. For an account of varieties recently introduced to and cultivated in Perthshire, see *FM* 3 (1835), p. 501.

70 See London prices as given in the *Mark Lane Express* from the first issue in 1832, also London prices in *Exley and Dimsdale's Corn Exchange Circular* from 1825, and in *Blackwood's Edinburgh Magazine* from 1817.

71 James Hendrick, 'The composition of oats and its variations', *THASS*, 5th ser., 22 (1910), pp. 16–27.

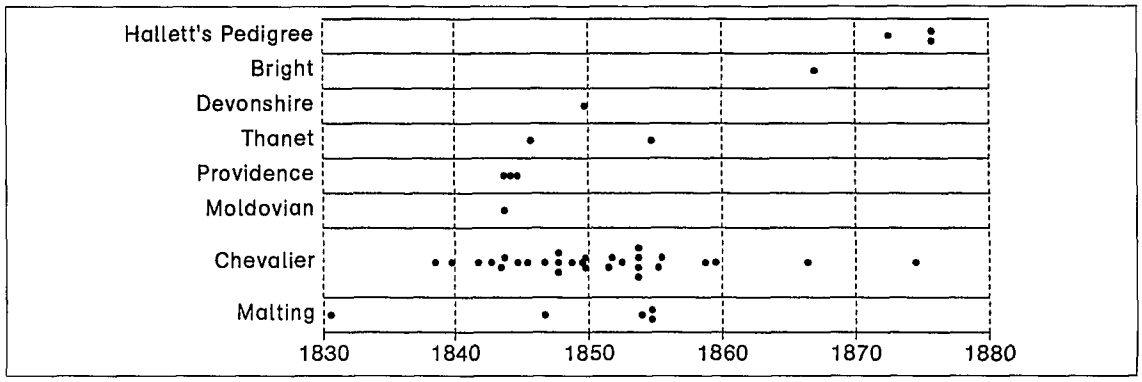
72 J. G. Stewart, 'Lessons from recent crop experiments', *THASS*, 5th ser., 22 (1910), p. 64.

73 *FM* 2 (1835), p. 287.

74 *FM*, 2nd ser., 3 (1841), p. 34.

75 *FM* 1 (1834), pp. 70, 511, 512.

76 *FM* 3 (1835), pp. 220, 314, 385, 386, 502.



Source: *Jackson's Oxford Journal* 1753–1880 and *Reading Mercury* 1800–1880

FIGURE 2. Descriptors of barley in Oxfordshire farm sales notices to 1880

organized by local farmers' groups at Castle Douglas, Kircudbrightshire and Fortrose, Ross and Cromarty.[77] Chevalier was mentioned in Philip Pusey's survey of national agricultural progress in 1840, was reported to be cultivated on all but the inferior lands of Northumberland in 1841, and in 1849 was said to have 'spread over the whole country on the class of soils for which it is suitable'.[78] In 1841, members of the farmers' club at Stoke Ferry, Norfolk, agreed that its introduction had 'occasioned a complete revolution in some districts where no such thing as a malting barley was formerly thought of; it is one of the great improvements of modern times'.[79] The variety was first named in published Mark Lane price quotations in December 1833 where it represented the highest grade of malting barley, selling at 34 to 35 shillings per quarter compared with 30 to 32 shillings for other malting varieties, 27 to 30 shillings for distilling and 25 to 27 shillings for grinding grades.[80]

Auctioneers sometimes attached descriptors, mostly varietal, to standing crops or crops in store listed in farm sales advertising. Figure 2 shows these for barley in Oxfordshire sales notices up to 1880. The virtual disappearance of descriptors for barley after about 1860 suggests that Chevalier may have been so dominant in the county by that date that no useful purpose was served by mentioning it. Hallett's Pedigree was a Chevalier, and 'Bright' is probably a reference to brewing quality, not a variety. This interpretation of figure 2 is not at odds with E. S. Beaven's observation that 'before 1886, 80 to 90 per cent of the barley grown in England' was the progeny of a single plant of Chevalier.[81] Only where environmental conditions favoured other new varieties or, as at Holme Cultram, Cumberland, and Leominster, Herefordshire, local landraces of barley, were farmers inclined to mention that other barleys, at least in these locations, afforded better fodder.[82] Chevalier triumphed precisely because it was a premium barley perfectly attuned to the known and well-articulated demands of the brewing trade, irrespective of any considerations as to its fodder qualities. Yet it is some measure of the extent of the British farmers'

77 *FM* 6 (1837), pp. 310, 317.

78 Pusey, 'Agriculture as a science', p. 11; J. Grey, 'A view of the past and present state of agriculture in Northumberland', *JRASE* 2 (1841), p. 164; 'M. M. M.' [M. M. Milburn], 'On the means of improving the quality and increasing the quantity of the different varieties of barley', *FM*, 2nd ser., 20 (1849), p. 11.

79 *FM*, 2nd ser., 3 (1841), pp. 444–5.

80 *Mark Lane Express*, 9 Dec. 1833, p. 129.

81 Beaven, *Barley*, p. 90.

82 *FM*, 2nd ser., 6 (1842), pp. 12, 358; 11 (1845), pp. 156–161.

fixation with fodder that they campaigned long, hard and eventually successfully for an end to the taxation arrangements which secured the market for Chevalier and the other quality malting barleys of domestic growth, in large part because they believed, without correctly diagnosing the benefits of those arrangements, that they prevented British farmers exploiting to the full the fodder potential of the barley crop.

This is not the place to supply the (as yet) unwritten history of the long crusade for the repeal of the malt tax. Suffice it to say that the repeal campaign, vigorously prosecuted from the beginning of the nineteenth century, became particularly intense during the half century from 1830 to 1880 when beer itself was not dutied.[83] To an extent, the argument for repeal rested on a belief that to tax a raw material rather than the manufactured product must in principle disadvantage the producers of that raw material.[84] There was also an expectation, particularly among those who believed that they could only produce such grades, that the removal of the tax would encourage maltsters and brewers to use inferior domestic barleys.[85] However, the principal complaint against the tax was that it prevented farmers from making full and effective use of their own crops. Labourers could not be paid in farm-brewed beer nor, more importantly, could livestock be fed on malt derived from non-marketable barley grown on the farm.[86] In 1846, the Total Repeal Malt Tax Association argued the fundamental injustice of a situation where French, Belgian, Dutch or Danish barley growers could ship malt-fed cattle duty-free to Britain, while the British farmer 'could only stand by and see his own cattle superseded in his own market'.[87] The possibilities and limitations of malt feeding were explored in a succession of feeding tests, including some undertaken by J. B. Lawes at Rothamsted, and others ordered by the Board of Trade. In 1865, having reviewed all the evidence, Lawes concluded that malt had no advantage over the barley from which it was made as a staple food of healthy animals, although he acknowledged 'a certain amount of malt to be beneficial when given in admixture' either to young or weakly animals, or in 'finishing' or 'making up' for exhibition or sale.[88] However, these opinions were vigorously contested by farming witnesses to the malt tax select committee of 1867 and 1868, who argued that nothing short of repeal would meet their needs. The so-called 'Gladstone's mixture' of linseed and inferior malt, allowed by the Malt for Feeding Cattle Act of 1864, was dismissed as a worthless concession.[89] In their report the select committee concurred, considering it 'proven that excise restrictions, in preventing barley being sprouted for the feeding of horses and cattle, are injurious to the agriculturalist'.[90]

83 For a discussion of the fiscal situation, see S. Dowell, *A history of taxation and taxes in England from the earliest times to the present day* (4 vols, 1965 edn), IV, pp. 85–8; G. B. Wilson, *Alcohol and the nation* (1940), pp. 318–21.

84 *Hansard* (Commons), CCLIII, 24 Jun. 1880, cols 766–7.

85 BPP, 1867, XI, Report from the SC on the Malt Tax, QQ 2256, 2606.

86 BPP, 1836, VIII, QQ 341–5, 557, 560, 702–3, 797.

87 *FM*, 2nd ser., 14 (1846), p. 168.

88 *FM*, 2nd ser., 17 (1848), p. 256; BPP, 1865, L, Abstract report of experiments undertaken by order of the Board of Trade to determine the relative values of malted and unmalted barley as food for stock, p. 793; BPP, 1866, LXVI, Report of such experiments, pp. 397–478.

89 Especially BPP, 1867–8, IX, Report of the SC appointed to inquire into the operation of the malt tax, QQ 31–3, 87, 265–74, 373–5, 505–9, 577, 660–75, 4981–86. See also BPP, 1863, VII, Report from the SC appointed to consider whether the laws relating to the excise duty on malt can be amended; BPP, 1867, XI; BPP, 1864, III, Bill to allow the making of malt duty-free to be used in feeding cattle, pp. 1, 9; BPP, 1865, L, Number of malt houses entered to make malt to be used in feeding animals, p. 785.

90 BPP, 1867–8, IX, p. 238.

When the malt tax was finally repealed in 1880, the consequences were not at all that British farmers had anticipated. Any benefits from the freedom to use home-produced malt as fodder were effectively counteracted by the brewer's freedom to abandon premium British malting barleys for cheaper alternatives. The use in commercial brewing of imported barleys increased greatly, as did the use of maize, rice and other substitutes.[91] New British varieties of malting barley appeared and were adopted, notably Goldthorpe, a sport first identified in a south Yorkshire field in 1889, and the hybrids Standwell (introduced 1900), Plumage-Archer (1905), and Spratt-Archer (1920).[92] None gained a market penetration comparable with that previously achieved by Chevalier. In his authoritative text on malt and malting, published in 1885, H. Stopes estimated that because Chevalier yielded more extract than other varieties but paid no more tax, maltsters had been justified in paying four shillings per quarter more for it than it would have been worth had the tax not existed.[93] As the barley acreage, which had increased from 1867 to 1881, began to decline, farmers who had agitated for repeal had cause to reflect on the warning, made by the brewer and member of parliament for Staffordshire Michael Bass during the 1880 repeal debate, that the British farmer would have 'to compete with the whole world in beer-producing cereals as he (already) had ... to do in the production of food-producing ones'.[94] In 1894, Suffolk farming witnesses to Wilson Fox's enquiry lamented the effects of repeal no less passionately than their farming brethren had pleaded for repeal before the select committee on the malt tax in 1867 and 1868.[95]

IV

The needs of livestock did not have a transformative impact on varietal preference in oats because this was an important consideration in varietal choice from the eighteenth century. Farmers agitated for a taxation regime which would allow them more freedom to use barley as fodder, but met with little success before 1880. The national varietal mix before that date was therefore dominated by the quality malting varieties, especially Chevalier, which were grown wherever environmental conditions were suitable. Wheat offers the clearest evidence of a varietal shift influenced by the needs of livestock farming, a change all the more surprising as it occurred simultaneously with the nineteenth-century spread of wheaten bread consumption to all parts of Britain.[96]

91 Jonathan Brown, *Steeped in tradition. The malting industry in England since the railway age* (Reading, 1983), pp. 83–5; T. R. Gourvish and R. G. Wilson, *The British brewing industry, 1830–1950* (1994), pp. 183–5. The fiscal incentive to use home-grown barley in the distilling industry was effectively ended in 1855 and imported barley for distilling entered Britain in increasing quantities from the 1860s. See R. B. Weir, 'Distilling and agriculture, 1870–1939', *AgHR* 32 (1984), pp. 49–62.

92 Brown, *Steeped in tradition*, pp. 90–1; T. J. Riggs *et al.*, 'Comparison of spring barley varieties grown in England and Wales between 1880 and 1980', *J. Agricultural Science* (hereafter *JAgSc*) 97 (1981), pp. 599–610; H. Hunter, *Crop varieties* (1951), pp. 19, 34–6; Beaven, *Barley*, pp. 102–4; Brassley, 'Crop varieties'.

93 H. Stopes, *Malt and malting* (1885), pp. 610–1.

94 *Hansard* (Commons), CCLIII, 24 Jun. 1880, col. 760.

95 BPP, 1895, XVI, RC on Agriculture, pp. 438–9; BPP, 1867, XI; BPP, 1867–8, IX.

96 E. J. T. Collins, 'Dietary change and cereals consumption in Britain in the nineteenth century', *AgHR* 23 (1975), pp. 97–115.

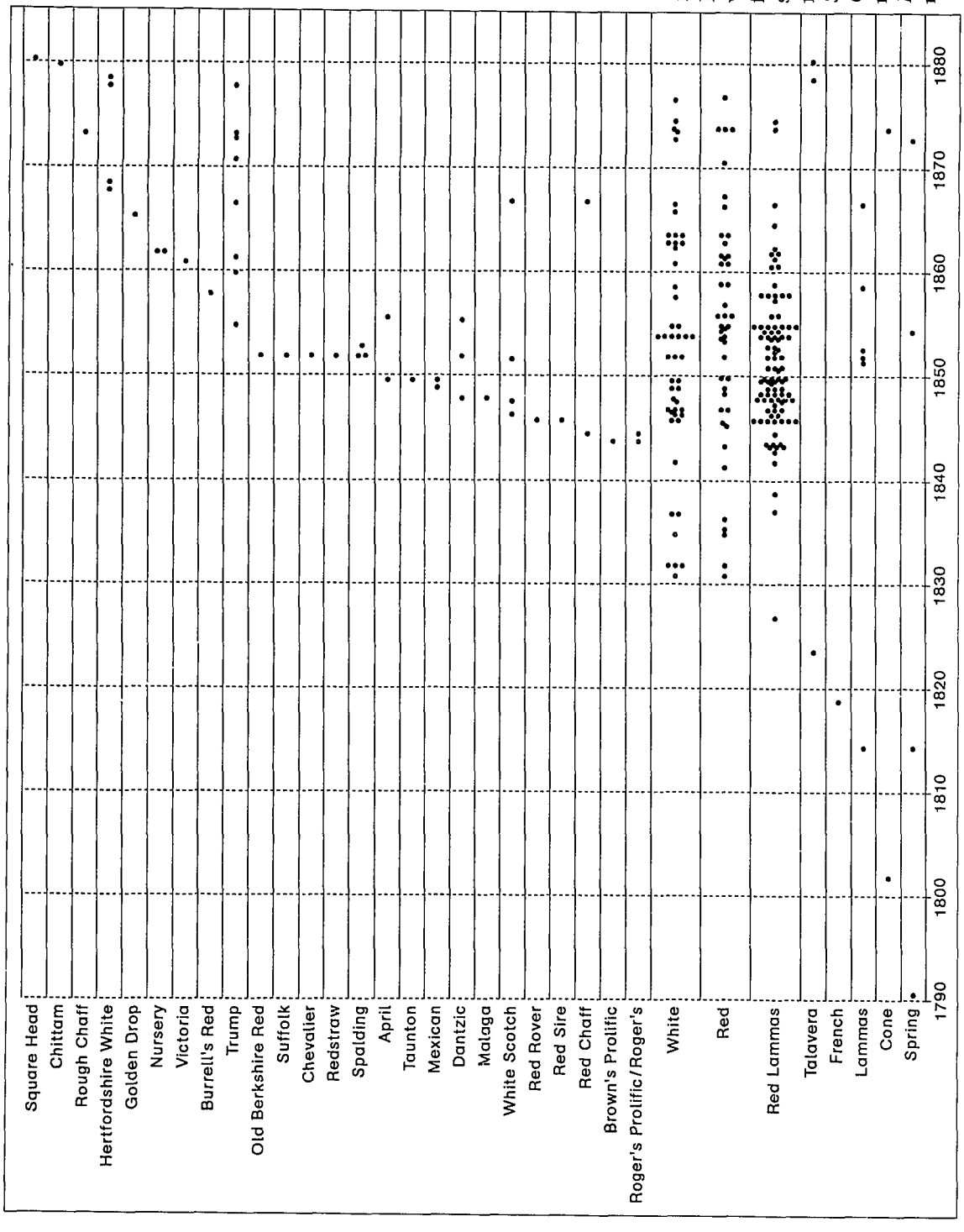


FIGURE 3. Descriptors of wheat in Oxfordshire farm sales notices to 1880
Source: Jackson's Oxford Journal 1753–1880 and *Reading Mercury* 1800–1880

By 1840 so many new wheat varieties were available that an East Lothian correspondent to the *Mark Lane Express* thought 'those in existence at the present time ... almost innumerable'. How does it happen', he rhetorically enquired, 'that not one individual variety possesses qualities capable of securing to it an undoubted pre-eminence over the rest?'[97] The answer, as was apparent from the deliberations of many of the newly-formed farmers' clubs during the years 1839 to 1845, was that no single variety could meet the twin requirements of environment and function when both were so diverse. The clubs' resolutions on wheat were consequently less prescriptive and certain than their resolutions on other matters: 'the results of the same variety of wheat upon different soils seemed so much at variance, that it was impossible to decide on the merits of any one kind for universal adoption', concluded the Hadleigh Farmers' Club in 1840.[98] Nevertheless, societies, clubs and interested individuals endeavoured both to monitor the flow of new varieties, and to assess their contrasting growth requirements and yield characteristics. These activities, which involved national organizations like the Royal Agricultural Society and the Highland, as well as local agricultural societies and farmers' clubs, have left their traces in the published literature. The Royal Agricultural Society's museum of wheat varieties appears to have been well established by 1845, thanks largely to the work of Le Couteur and sometime Cambridge botany professor J. S. Henslow.[99] By the same year, both the *Journal* of the Royal and the Highland *Transactions* had published the results of several inter-varietal wheat trials.[100] Local clubs and societies reported the results of trials relevant to local conditions, some of which they had also organized, and the reports were published in local newspapers or the *Farmer's Magazine*.[101]

Material of this kind assists us, as it doubtless assisted farmers at the time, to a better understanding of the distinctive and contrasting qualities of the new varieties. Before the nineteenth century, the most common wheats in Britain were various landraces of the autumn-sown Red Lammas type. These were wheats of relatively low yield but moderate hardness with sufficient strength to make bread of acceptable quality. The proliferation of varieties, which descriptors used in farm sale advertising suggest, became particularly marked in Oxfordshire during the 1840s and 1850s (figure 3), represented a search for higher productivity and profitability on a range of criteria. Some varieties equalled or even exceeded the strength of established types. They included the spring-sown Talavera, said to have been introduced from Spain during the Peninsular War. Talavera offered a high extraction percentage and flour of unusual strength.[102] In 1864, a market report in the *Farmer's Magazine* spoke with enthusiasm of the

97 *Mark Lane Express*, 24 Feb. 1840, p. 10.

98 *FM*, 2nd ser., 3 (1841), p. 134.

99 *FM*, 2nd ser., 2 (1840), p. 213; 6 (1842), p. 440; 21 (1850), p. 71.

100 J. Morton, 'An account of an experiment on the relative values of several varieties of wheat', *JRASE* 1 (1840), pp. 39–44; W. Miles, 'Report on the wheats selected for trial at Cambridge and on other wheats', *JRASE* 3 (1842), pp. 391–5; C. Hillyard, 'On wheat', *JRASE* 3 (1842), pp. 297–305; G. Kimberley, 'Report on prize wheats', *JRASE* 3 (1842), pp. 395–7; H. Handley, 'Report on prize wheats', *JRASE* 3 (1842), pp. 397–8; J. Waldie, 'Report of an experimental trial of six varieties of prize wheat', THASS, new ser., 9 (1843–5), pp. 124–7.

101 For example, Gloucester Farmers' Club, *FM*, 2nd ser., 3 (1841), pp. 211–2; Stoke Ferry Farmers' Club, *FM*, 2nd ser., 3 (1841), p. 442; Maidstone Farmers' Club, *FM*, 2nd ser., 4 (1841), pp. 293–4, 296–7; Beccles Farmers' Club, *FM*, 2nd ser., 11 (1845), p. 58.

102 'An Old Norfolk Farmer', *Wheat: its history, characteristics, chemical composition and nutritive properties* (1865), p. 171.

quality of the first of the new season's Talavera appearing at Mark Lane: 'strong, good coloured and heavy, some being up to 65 lbs per bushel'.[103] But the quality of the flour was insufficient compensation for the variety's low yield and its constitutional delicacy under British conditions. By 1865, Talavera had been abandoned by the farmers of Norfolk 'on account of the smallness of its yield and its disposition to sprout before harvest'.[104]

Although other varieties with reasonable bread-making qualities, like Rough Chaff, proved more durable, a general trend of declining hardness was detectable at an early date. Wheats which may not have been good in the quality of the grain but were 'better farmers' wheats' were increasingly preferred.[105] These included many of the heavier yielding reds, such as Spalding, Hickling and Brown's Prolific. Spalding, which returned one of the lower bushel weights but the highest volume yields in trials reported by the Beccles Farmers' Club in 1845, appears to have been quite extensively grown.[106] It was frequently reported from East Anglia during the 1840s, and in 1850 was said to be the only red wheat variety grown to any extent in East Lothian.[107] Spalding was also mentioned in the prize reports for Gloucestershire (1850), Northamptonshire (1852), Oxfordshire (1854) and Shropshire (1858), being described in the Oxfordshire report as 'more of a farmer's wheat than a miller's'.[108]

An essential feature of a 'farmer's wheat' was that it supplied straw and less often grain in the quantities and of the quality required for livestock fodder. These varieties were generally characterized by high average yields of grain of relatively low densities. The livestock producers' preference for such wheats was reinforced by agricultural writers and opinion formers who regarded high volumetric yield and the heavy applications of manure necessary to achieve it as self-evidently desirable, an answer to the wheat grower's competitive difficulties, irrespective of the quality of the resulting grain.[109] The characteristics of such varieties, which continued to appear through the second half of the century, may be gauged from data collected during the 1870s and 1880s. As part of his work as a scientific consultant to the baking industry, the chemist William Jago published an analysis of samples of British and foreign wheats from the harvests of 1883 and 1884. Table 1 presents summary descriptive statistics of the results for crude wet gluten percentage, probably the best single measure of strength provided in these

103 *FM*, 3rd ser., 3 (1864), p. 268. Also *Mark Lane Express*, 11 July 1842, p. 9.

104 'An Old Norfolk Farmer', *Wheat*, p. 171. In 1840 a report from East Lothian (*FM*, 2nd ser., 1 (1840), p. 154) noted that Talavera 'does not improve in this, to it, cold climate, and consequently an introduction of new seed is occasionally required'.

105 The first use of the expression 'farmer's wheat' I have been able to trace occurs in a report of the Norfolk and Suffolk Harleston Farmers' Club, *FM*, 2nd ser., 15 (1847), pp. 138–9. It is not entirely clear why a farmer's wheat was so called. As well as its qualities as animal fodder, suitability for grist milling for on-farm human consumption may have been a further consideration.

106 *FM*, 2nd ser., 11 (1845), p. 58.

107 *FM*, 2nd ser., 9 (1844), p. 439; 13 (1846), pp. 145–6; 15 (1847), pp. 138–9; B. Almack, 'On the agriculture of Norfolk', *JRASE* 5 (1845), p. 329; *FM*, 2nd ser., 22 (1850), p. 482.

108 J. Bravendar, 'Farming of Gloucestershire', *JRASE* 11 (1850), pp. 150–1; W. Bearn, 'On the farming of Northamptonshire', *JRASE* 13 (1852), p. 59; C. S. Read, 'On the farming of Oxfordshire', *JRASE* 15 (1854), p. 211; H. Tanner, 'The agriculture of Shropshire', *JRASE* 19 (1858), p. 16.

109 See, for example, Philip Pusey, 'On the source and supply of cubic saltpetre, salitre or nitrate of soda, and its use in small quantities as a restorative to corn crops', *JRASE* 13 (1852), pp. 349–367; Anon., 'An increase of manure the best source of our future supply of corn', *FM*, 3rd ser., 4 (1853), pp. 334–6.

TABLE 1. British and imported wheats: wet crude gluten (per cent)

British		*Imported*	
Low scoring		*Low scoring*	
Rivet	Trace	# 1 Calcutta	8.5
Rivet	Trace	Walla Walla (Oregon)	11.7
Fine Hertfordshire	14.5	# 2 Calcutta	13.0
Red Chaff	14.5	Hard White Karachi	14.7
Square Head	14.5	Persian	16.0
Rough Chaff	14.7	# 2 Club Calcutta	16.3
Red Nursery	14.8	Hard Calcutta	16.5
Square Head	16.6	# 1 Club Calcutta	16.8
Red Chaff	17.2	New Zealand	16.9
High Scoring		*High Scoring*	
Victoria	23.0	Red Königsburg	27.2
Red Chaff	23.2	# 1 Hard Canadian	28.0
Nursery	23.4	Saxonska	28.0
Kent Red	23.5	Kubanka	28.7
White Chaff	23.7	Australian	29.0
Red Lammas	23.9	Ghirka	29.5
Red Lammas	25.2	Persian	30.0
Essex Rough Chaff	26.0	Kubanka	30.3
Rough Chaff	27.6	Hard Fife	32.0
n = 37.0		*n = 43.0*	
Mean = 18.6		*Mean = 22.3*	
Median = 18.5		*Median = 23.4*	

Source: W. Jago, *The chemistry of wheat, flour and bread, and technology of bread making* (Brighton, 1886), pp. 238–9, 241–2.

data, and identifies high and low scoring varieties in the two samples. Under certain cultivation conditions, Rough Chaff could produce flours relatively low in gluten, but otherwise they were high. Red Lammas consistently registered relatively high gluten percentages. By contrast, the two Rivet samples showed no more than traces of gluten. The appearance of the two samples of Square Head among the lower gluten scores should also be noted. Table 2 shows annual means and coefficients of variation for the yields of 15 varieties of red wheat tested at Rothamsted between 1871 and 1881.[110] The highest mean yields were recorded for Rivet, although it also had the highest coefficient of variation. It was the third worst yielding of all 15 varieties during the disastrous harvest of 1879. By contrast, Old Red Lammas and Rough Chaff registered some of the lowest mean yields, but their coefficients of variation were also low, and they

[110] The white wheats in the trial have not been included in the table since they were not suited to the heavy soils of Rothamsted and performed indifferently.

recorded some reasonable yields in bad years. Red Lammas had the third highest yield of the sample in 1879, and Rough Chaff the highest in the almost equally disastrous year of 1880. The low yielding varieties offered good bread-making qualities and some prospect of a reasonable yield in poor years. The high yielding varieties offered a high average volumetric yield of grain of indifferent bread-making quality.

TABLE 2. Red Wheat varieties at Rothamsted, 1871–1881

	Mean yield per acre (bushels)	*Coefficient of variation (per cent)*
Rivet	45.8	35.5
White Chaff	44.2	26.5
Club	43.4	29.8
Hallett's Golden Drop	42.3	27.2
Bole's Prolific	41.3	19.2
Red Rostock	40.1	32.9
Red Langham	39.6	22.4
Bristol Red	39.6	24.3
Red Wonder	39.5	24.6
Browick	38.6	24.0
Red Nursery	37.9	18.2
Burwell (Old Red Lammas)	37.8	18.0
Golden Rough Chaff	37.3	24.5
Chubb	36.6	32.1
Hallett's Original Red	36.5	17.3

Sources: A. D. Hall, *The book of the Rothamsted experiments* (1917), p. 66.

Despite their status as 'farmers' wheats', high yielding but low density varieties like Spalding and Rivet would have been much less favoured had their grain been unmarketable. As data collected by the Richmond Commission shows, grain continued to constitute a significant component of gross farm receipts. For example, as late as the 1880s, wheat represented about 14 per cent of total receipts on a mixed farm in south Wiltshire.[111] For farmers growing the high-volume, low-density varieties, reasonable market returns were still necessary. In 1840, a contributor to a discussion on wheat varieties at the Watton Farmers' Club, Norfolk noted that 'there were many varieties that would produce more than others – Hickling for instance, but then it was not saleable'.[112] However, this does not appear to have been the general experience of those wishing to market inferior varieties. Samples of low bushel weight commanded lower prices, but not as low as was commensurate with their poor flour yields. Indeed, J. B. Lawes even thought it unusual for millers to pay more for better wheats.[113] The British marketing system appears to have been tolerant of inferior grades of wheat.

111 Copus, 'Changing markets', p. 337.
112 *FM*, 2nd ser., 3 (1841), p. 465.
113 *FM*, 2nd ser., 17 (1848), p. 107

Throughout the nineteenth century, sales in British markets were agreed on visual inspection of a sample, without formal grading, in contrast to north America's developing system of elevator-based marketing. Achievement of the economies associated with elevators required an agreed system of grading, since the produce of different farmers was pooled at that point, prior to sale. The essential basis of grading was the density of the consignment, measured by bushel weight.[114] It is true that such a system could only function with single varieties of wheat, as produced by the north American spring and winter wheat belts. Because of differences in the shape of the ear and hence in the volume of air a full bushel would contain, the British varieties with the highest specific gravities did not necessarily register the highest bushel weights.[115] The British wheat marketing system had to handle an intrinsically more problematic commodity. Britons not only failed to devise a solution, but seemed incapable of coming to terms with the problem. The sensible recommendations of the select committee of 1834 that sales should be by imperial bushel accompanied by a statement of weight per bushel were never carried into law, and subsequent parliamentary enquiries were distracted by issues other than grading: the standardization of measures, the accuracy of the published corn averages, and the injustice suffered by tithe payers who found their liability assessed in a translation of weight to measure at an arbitrarily-fixed conversion rate.[116] The problem does not appear to have been fully acknowledged until 1928 when a ministry report on grain marketing observed: 'in the trade in home-produced grain the conditions usually associated with systematic grading and standardization do not exist'.[117] In the meantime, a highly fractured and fragmented marketing system frequently failed to match buyer and seller in an appropriate fashion. Millers complained that they could no longer find suitable domestic wheats at the same time as the remaining growers of those wheats protested that no-one was prepared to pay the premiums they had once attracted.[118]

A system which encouraged British farmers to grow the kinds of wheats bakers least wanted to buy could only intensify the demand for import, a demand many in the corn trade were eager to satisfy. As early as 1835, the release of imported wheat in bond and its replacement by British flour or biscuit intended for export was being promoted as a solution to British supply problems consistent with the continued existence of the corn laws.[119] The issue most prominent in the deliberations of the Select Committees on Bonded Corn in 1840 and on the Grinding Act in 1842 was the need to recover overseas markets, including those in British colonies, lost to foreign suppliers of flour and biscuit.[120] The 1842 report recommended 'the enactment of

114 M. Rothstein, 'American wheat and the British market, 1860–1905' (Unpublished Ph.D. thesis, Cornell University, 1960), pp. 88–95; W. Cronon, *Nature's metropolis: Chicago and the Great West* (New York, 1991), pp. 97–147.

115 A. S. Wilson, *A bushel of corn* (Edinburgh, 1883), pp. 21–120; P. H. Frere, 'On M. J. Reisert's agricultural experiments', *JRASE* 24 (1863), pp. 436–54.

116 BPP, 1854, LXV; 1857–8, LIII; 1870, LXI; 1878–9, LXV, Returns of Measures and Weights; BPP, 1888, X, Report of SC on Corn Averages; BPP, 1890–1, XII, Report of SC on Corn Sales, QQ, 16, 17; C. R. Fay, 'The sale of corn in the nineteenth century: measure versus weight', *Economic J.*, 34 (1924), pp. 211–8.

117 Quotation from D. J. Britton, *Cereals in Britain* (1969), p. 170.

118 A. D. Hall, 'The question of quality in wheat', *J. Board of Agriculture* 11 (1904), p. 323; Hall, *Pilgrimage*, pp. 64–5; National Association of British and Irish Millers (hereafter NABIM), *12th annual report*, 1890, p. 69.

119 Report in *The Times* noted in *FM* 3 (1835), p. 398.

120 BPP, 1840, V, pp. 1–98; BPP, 1842, XIV, pp. 1–96.

some measure which would enable this country to participate ... in the fresh flour and biscuit trade ... framed so as not to infringe the law for regulating the duty on the importation of foreign grain'.[121] The problem was that any system which allowed biscuit or biscuit flour manufactured from inferior British wheats for export at some future date to release from bond an equivalent quantity of superior continental wheat, was likely merely to increase the importation of those wheats by an amount equivalent to the quantity of British flour or biscuit which could be found to place in bond. William Skipworth, a Lincolnshire farming witness to the 1842 committee, observed that if the consequence of the committee's proposals was 'to allow a speculator to grind up a quantity of our soft bad wheats here and introduce into our market a good wheat which has come from abroad and is in bond', then that would be objectionable in a bad harvest.[122] In fact, millers were already availing themselves of such freedom as they were allowed to mix hard continental wheats with the indifferent British wheats of wet harvests.[123] The consequence of the Grinding in Bond legislation, extended by repeal itself, was to allow British millers full participation in overseas wheat markets in good years and bad, without payment of the duty necessary to release imports from bond, thereby facilitating their acquisition of superior, more expensive, high-gluten wheats for mixing with inferior domestic varieties to produce flour of good bread-making quality.[124] In June 1846, the monthly corn trade report noted that wheat imported had been immediately released, 'not in the ordinary way by paying duty, but by substituting flour for the wheat required', a device 'much in use of late' by millers 'compelled' to take foreign wheat 'for mixing with the inferior qualities of English'.[125] In 1847, a Mark Lane report spoke of 'Essex and Kent stands so miserably supplied ... that many of the town millers were unable to secure a sufficient quantity for mixing with the foreign'.[126]

Britain's position as the emergent clearing house and marketing centre of the developing international wheat trade, which many witnesses to both the 1840 and 1842 select committees saw as the foundation of the country's future dominance of world trade in flour and biscuit, was both a partial outcome of its early preference for 'farmers' wheats' and a factor which allowed that preference to develop further. The marketability of indifferent bread wheats of domestic growth is explained not just by the failings of the marketing system but by the increasing proportion of premium grade bread flours which were mixes of low-gluten domestic and high-gluten imported wheats, a trend which gave many millers less reason to be demanding of quality in the domestic crop than they would otherwise have been.[127] These developments were to the advantage of the port millers who not only enjoyed the greatest discretion in the choice of domestic and Irish wheats and least-cost access to imports, but also the best opportunities on British soil to benefit by the economies associated with the large-scale purchase of imported

121 BPP, 1842, XIV, p. 3.

122 BPP, 1842, XIV, Q. 1042.

123 FM, 2nd ser., 4 (1841), pp. 303–6.

124 April 1845 corn trade review, *FM*, 2nd ser., 11 (1845), p. 477: 'favourite varieties of fine Danzig and Rostock have been taken in small quantities for mixing with the coarse kind of English'. Even before they gained the right to 'trade' domestic wheats and wheat in bond, merchants and millers were exploiting the bonded warehouse system to minimize duty payments: W. Vamplew, 'The protection of English cereals producers: the corn laws reassessed, *EcHR*, 2nd ser., 33 (1980), pp. 384–90.

125 *FM*, 2nd ser., 13 (1846), p. 577.

126 *FM*, 2nd ser., 16 (1847), p. 197.

127 On flour types at mid-century, see John Towers, 'On the nutritive qualities of the bread now in use', *FM*, 2nd ser., 16 (1847), pp. 65–7; Eliza Acton, *The English bread book* (1857, rep. 1990), pp. 66–7, 81–3.

grain of warranted quality handled mechanically and in bulk.[128] In due course, their dominance was reinforced by their adoption of long-system roller milling, and increasing consumer acceptance of white, characterless, nutritionally-deficient bread manufactured with low bran flours derived increasingly from imported hard wheats. These developments disadvantaged the inland millers, who not only enjoyed none of the same benefits but had a greater need of domestic wheats of reasonable strength. Small water and wind mills went out of business in large number, the survivors eking out a precarious existence grinding provender.[129] The competitive disadvantages were also increasingly felt by the larger inland concerns, even though many had converted first to steam and then to shorter roller systems.[130] To survive as producers of bread flours they needed to be able to mix costly imports with cheaper home-grown wheats available locally. Any reduction in the hardness of those wheats had to be matched by an increase in the proportion of imports in their flour mixes, and by a corresponding fall in the price they were prepared to pay for home-grown wheat.[131] They became deeply concerned about the declining hardness of the domestic crop and eventually attempted to devise a remedy.

In September 1890, millers who had gathered in London for the council meeting of the National Association of British and Irish Millers (NABIM) reflected with sadness on the British grower's preference for new wheats like San Salvator ('a long in straw, large yield, coarse kind of Rivet which when milled gives a poor, blue flour') and the disappearance of the likes of Talavera ('a finer wheat could scarcely be desired for a miller').[132] Under pressure from the inland millers among its members, NABIM made belated attempts to rectify matters. Gentle pressure on the railway companies for reductions in carriage rates on foreign wheats having produced no change, it was proposed that regional groupings of mills would be created, each with a central clearing house to allow the exchange of hard and soft flours between members, the intention being that all could then sell mixed flours of similar strength in their own market areas. The proposal foundered on the reservations of the port combines. Unwilling to concede any of the advantages of his formidable economies of scale, Joseph Rank advocated and obtained general assent for a policy of Darwinian survival of the fittest, albeit the industry then entered a period of price fixing by regional cartels, which gave a life-line to higher-cost concerns while increasing the already superior profit margins of the port millers.[133]

128 Rothstein, 'American wheat', pp. 158–172.

129 R. Perren, 'Structural change and market growth in the food industry: flour milling in Britain, Europe and America, 1850–1914', *EcHR*, 2nd ser., 43 (1990), pp. 420–37; H. Macrosty. 'The grain-milling industry: a study in organisation', *Economic J.*, 3 (1903), pp. 324–5; B. A. Holderness, 'Agriculture and industrialization in the Victorian economy', in G. E. Mingay (ed.), *The Victorian Countryside* (2 vols, 1981), I, pp. 188–90.

130 On technical change to 1850, see J. Tann, 'Corn milling', in *Agrarian History*, VII, pp. 397–415. The term 'inland miller' is a necessary shorthand. The 'inland millers' included some in coastal locations where imported wheats were not received regularly or in bulk. These millers had no prospect of the scale economies available at the major ports.

131 Biffen and Engledow, *Wheat-breeding investigations*, p. 30; R. H. Biffen, 'Mendels's law of inheritance and wheat breeding', *JAgSci* 1 (1905), p. 5.

132 NABIM, *12th annual report, 1890*, pp. 68–9

133 T. W. Hibbard, 'Gradual reduction by roller milling applied to soft wheats', a paper delivered to the Dublin convention, 10 June 1886, reported in NABIM, *8th annual report, 1886*, p. 42; letter from Watson, Todd and Company, Birmingham, *NABIM 9th annual report, 1887*, p. 117; *Liverpool Corn Trade News*, 2 Feb. 1889, p. 3; Report on Buxton special convention, 14–15 Feb. 1901, NABIM *21st and 22nd annual reports, 1899–1901*, pp. 122–144; NABIM, *23rd annual report, 1902*,

The inland millers next brought forward less controversial proposals to encourage British farmers to greater care in the reservation of seed corn and in their initial choice of wheat varieties. Agricultural societies were to be assisted in organizing seed wheat exhibitions and competitions. W. R. Mallett of Exwick Roller Mills, Exeter, was the leading proponent of this policy and personally prevailed upon the Bath and West to take up the challenge.[134] He did not appear to appreciate that the competitive trials of seed wheat lately organized by the Royal Agricultural Society had proved either controversial or inconclusive.[135] Nor that Patrick Shirreff had devoted rather more than a third of the published account of his life's work to a sustained complaint about the agricultural societies' role in cereal breeding in general and their treatment of him in particular.[136] In 1907, Humphries and Biffen revealed that agricultural societies responded to NABIM's encouragement in this matter by persistently awarding prizes to wheats low in strength: 'the large berry, which is soft and obviously full of starch is still the judge's ideal'.[137] As they showed, high yielding wheats of the Rivet, Stand-Up and Square Head types, which had become increasingly popular since the 1870s, produced flour low in baking quality when compared with older varieties like Red Lammas. Experiments at Rothamsted between 1902 and 1904 demonstrated that the indifferent baking properties of Square-Head's Master deteriorated even further when yield was boosted by fertilizer.[138]

With the joint financial support of the Board of Agriculture and NABIM's Home Grown Wheat Committee, founded in 1901, Biffen, Humphries, Hall and their associates embarked on a programme of research which first demonstrated that the superior strength of some of the harder imported wheats, notably Red Fife, was heritable and not merely a function of climate.[139] They then set about breeding hybrids which combined the strength of the imports and the high yields of the popular domestic types. This resulted in the releases of Little Joss in 1911, Yeoman in 1916 and Yeoman II in 1924.[140] The hybrids proved popular in some quarters. As early as 1926 it was reported that 17 per cent of the seed samples forwarded by farmers to the government seed testing station for germination tests were Yeoman and about 8 per cent Little Joss.[141] But the Wheat Act of 1932 undermined home-grown bread wheat while ostensibly promoting it. The milling quota proposals of the abortive 1928 bill were watered down in the 1932 legislation, which authorized deficiency payments on all wheat of 'millable quality'. Some members of parliament were perceptive enough to suspect that this meant a subsidy on everything: 'taxed £6 million in order to provide an increased amount of chicken food', as one put it.[142] So it duly

p. 41; Perren, 'Structural change'; Macrosty, 'Grainmilling', pp. 330–334, 536–543.

134 NABIM, *21st and 22nd annual reports, 1899–1901*, pp. 63–5; NABIM, *23rd annual report, 1902*, pp. 52–3.

135 W. Carruthers, 'Report on the competition for seed-wheat, 1880', *JRASE*, 2nd ser., 17 (1881), pp. 75–86; *idem*, 'Report on the competition for seed-wheat, 1883', *JRASE*, 2nd ser., 20 (1884), pp. 300–9.

136 Shirreff, *Cereals*, pp. 64–97.

137 A. E. Humphries and R. H. Biffen, 'The improvement of English wheat', *JAgSci*, 2 (1907), pp. 2–3.

138 *Ibid.*, pp. 4–6; Hall, 'Quality in wheat', p. 335.

139 *NABIM, 25th annual report, 1904*, pp. 59–67; *NABIM, 26th annual report, 1905*, p. 22; Biffen and Engledow, *Wheat-breeding investigations*, pp. 91–3.

140 Clark, 'Improvement in wheat', p. 235; Biffen and Engledow, *Wheat-breeding investigations*, pp. 99–113; Percival, *Wheat*, p. 116; J. Long, *Making the most of the land* (nd., *c.* 1913), p. 73.

141 Biffen and Engledow, *Wheat-breeding investigations*, pp. 61–2.

142 *Hansard* (Commons), 262, 9 Mar. 1932, col. 1825.

proved. Since the subsidy, levied as a tax on flour, was effectively available on all marketed wheat, the markets were saturated with high-yielding, low-density wheats only suitable for fodder.[143] It took another world war, a more elaborate system of price support, and the invention of the Chorleywood bread process before British wheat was re-established as the main ingredient of British bread.[144]

The geography of wheat importation to Britain evolved in a stepwise fashion. Increasing demand and reducing transport costs brought in ever more distant zones of supply: the Baltic, the Black Sea, the Pacific slope, the Great Plains, India, Persia, the Plate, Chile, Australia, the prairies, to name only the most important. A maturing local, or at least less distant demand for food saw reduced exports to Britain from some supply areas. Increasing wheat flows from the Black Sea and north Africa between 1840 and 1860 precisely mirrored declining supplies from northern Europe, especially the western Baltic, as increasing food demand on the continent brought changes in farming systems and reductions in wheat available for export.[145] By the last decade of the nineteenth century, it was widely recognized that similar forces were at work in the United States, which, it was feared, would eventually lose its status as a net exporter of wheat.[146] The advent of new and the growth of old centres of metropolitan consumption served to accelerate the settlement of the remaining unoccupied parts of the globe suitable for wheat cultivation. As Table 1 shows, not all wheat varieties imported into Britain in the 1880s were hard. India and the Pacific northwest produced wheats rather softer than the British average. But the disappearance of some supply areas and the advent of others with more extreme climates had the net effect of increasing the overall hardness of the mix of wheats entering international trade. Such important late-settled areas as the northern Great Plains and the Canadian Prairies could only grow hard spring wheat.

The declining hardness of the domestic crop and the increasing hardness of wheat imports were complementary to a degree which does not always allow ready differentiation of cause and effect. Had the increasing softness of domestic wheat only occurred after 1870, then it could be explained without serious challenge to the orthodoxy that the British farmer post-repeal was a passive victim of events. The high yielding, low density varieties of the Stand Up, Square Head and Rivet types gained in popularity because, it could be argued, an autonomous increase in both the volume and the hardness of imports allowed a reduction in the hardness of the home grown crop at that time. Farmers who did not abandon wheat altogether favoured the high yielding, soft varieties because they no longer had a serious interest in supplying the market for bread flours. The further growth of a cake and biscuit industry able to take advantage of soft domestic wheats was one consequence.[147] Repeal created an open market in Britain. Countries with surpluses available for export competed to supply it, and after 1880 supplied it in such

143 'Bill to encourage the production of wheat by compulsory milling of certain proportions of home-grown wheat by millers', BPP, 1928, II, p. 429; J. A. Mollett, 'The Wheat Act of 1932: forerunner of modern farm price support programmes', *AgHR* 8 (1960), pp. 30–1.

144 A. Williams, 'The history of the Chorleywood bread process', in A. Williams (ed.), *Breadmaking. The modern revolution* (1975), pp. 25–39.

145 S. Fairlie, 'The nineteenth-century corn law reconsidered', *EcHR*, 2nd ser., 18 (1965), pp. 562–75; *FM*, Sept. 1853, p. 274.

146 J. W. Rush to 7th annual convention, NABIM, 30 July 1896, NABIM, *12th annual report, 1890*, p. 38.

147 T. A. B. Corley, *Quaker enterprise in biscuits. Huntley and Palmer of Reading, 1822–1972* (1972), pp. 78–9.

volume and with wheat of such quality as to place the survival of the domestic producer in peril. Events during the earlier high farming era play no part in the explanation.

However, evidence from the 1830s onwards, suggests that the orthodox view stands in need of revision. The adoption of arable-based livestock fattening, well under way before corn law repeal, created a demand for varieties of wheat which would both service the needs of livestock production and respond to the manure produced by it. Even before 1849, when repeal was fully implemented, 'farmers' wheats' were favoured to an extent which necessitated importation of relatively costly hard wheats. The trend was given further impetus by the preference of the powerful port millers for imported wheats, and by the informal and chaotic grading practices of British grain markets, which failed to deliver appropriate rewards to growers of the low-yielding wheats most suitable for bread making. While later events considered in isolation are not challenging to the view that the softening of the domestic crop was an effect of grain imports, it appears from earlier events actually to have been a cause. The late-century reduction in the hardness of British wheats was a late episode in a long-running saga.

V

Varietal innovation is a neglected theme in existing accounts of eighteenth- and nineteenth-century agricultural change. This paper has argued that the period after 1760 saw an increasing tempo of innovation in cereal varieties. Plant breeders gained a good empirical understanding of the possibilities of introduction and selection. Opportunity for significant financial reward was limited, but less tangible returns were possible and costs were low. Consequently, large numbers of new varieties became available to farmers during the nineteenth century. Seed and the principles of varietal selection were easily transported. The experience of varietal innovation was therefore shared by Britain's continental neighbours, though none opened its markets to importation over as extended a period as did Britain.[148] None therefore witnessed quite the same conflict between the forces of innovation and the forces of competition.

Varietal preferences in barley and oats were not significantly influenced by the rise of livestock farming, although many barley growers were unhappy that the effect of the malt tax was to restrict their use of the crop as feed. Further, while British oats and barley producers both had the advantage of growing some varieties which commanded a premium over imports, wheat growers did not. This served to worsen the effects of the wheat price decline of about one half between 1846 and the end of the century. Agricultural writers gave farmers every encouragement to adopt new high-yielding varieties, and they appear to have responded. The wheats so produced were acceptable as provender and bedding. Cheap soft flours stimulated the growth of the cake and biscuit industries. It is probable that the net return on a high yielding low gluten variety with a low unit price was better than the return on an equivalent acreage of any other domestic wheat. But this was in part a reflection of market failure. Samples of home-grown bread wheats entering British markets became too few to attract the premiums their quality

[148] For a discussion of Vilmorin's lists of French varieties see Evershed, 'Varieties of wheat', and on Dutch wheats, A. C. Zeven, *Landraces and improved cultivars of bread wheat and other wheat types grown in the Netherlands up to 1944* (Wageningen, 1990). On tariffs see BPP, 1913, LXVIII, Return showing average prices of wheat ..., p. 110.

warranted. Domestic markets had no formal system of quality grading, and strong prejudices against introducing one. Millers used ever larger quantities of imported hard wheats, a trend which reinforced the competitive advantages of the larger port concerns. The competitive position of the inland millers weakened further as British farmers abandoned the market for bread wheats. Comparison of London import prices for United States wheat and Gazette prices of English wheat shows that the American crop was more costly by 4.9 per cent in 1872–6, but that this difference had widened to 14.4 per cent by 1907–11.[149]

Analysts of British nineteenth-century agriculture, both at the time and subsequently, have persistently treated 'wheat' as a single undifferentiated commodity. The competitive problems of the British grower are therefore reduced to the single issue of comparative production and transport costs. This paper has suggested that varietal innovation by British wheat growers, mainly in response to the demands of livestock fattening, altered the available mix of British wheats in such a way as to stimulate the demand for hard wheat imports. To this extent, the pursuit of improvement through high farming was more a cause of than a constructive response to intensified international competition.

[149] Means of annual means given in A. J. H. Latham and L. Neal, 'The international market in rice and wheat, 1868–1914', *EcHR*, 2nd ser., 36 (1983), p. 276.