English Agrarian Labor Productivity Rates Before the Black Death: A Case Study

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by

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ABSTRACT

Historians debate whether or not population growth hindered or promoted development in the pre-industrial period. A crucial issue in this debate are the labor productivity rates of workers in the arable sector. It is often suggested that an agricultural revolution, currently defined as a rise in these rates, was a necessary precursor to industrialization and improved living standards. The first country to industrialize, England, therefore underwent such a revolution sometime in the seventeenth or eighteenth centuries. This paper provides the first direct measurement of arable workers’ average labor productivity for pre-industrial England. Rates are assessed for those production conditions which it is thought resulted in the lowest agrarian labor productivity rates in the pre-industrial period: c.1300-48. The agrarian labor productivity rates for English workers before the Black Death either surpassed or met the literature’s best estimates for English workers until 1800.

Introduction
Development economists’ debate over whether population growth hinders or promotes growth in poor countries is echoed among economic historians interested in pre-industrial European. ¹ A key issue is whether the productivity of agrarian labor is and was low, thus acting as a potential barrier to development. It is often suggested that the western European nations, who were the first to industrialize in the nineteenth century, overcame this barrier through an agricultural revolution, which dramatically raised output of food per worker. This freed product and producers for new sectors, permitting industrialization, fostered economic growth, and eventually raised living standards.

Solving this debate and the related question of pre-industrial global divergence is complicated by the lack of good aggregate data, which becomes available only in the mid-nineteenth century or later. The debate on the state of the pre-industrial western European economy and living standards hinges upon agrarian labor productivity rates but direct measurement of such rates are not feasible. For most of the pre-industrial period, researchers lack data on population numbers, employment numbers in different sectors and GNP. For example, estimates of England’s population c. 1300 range vary by as much as 3.6 million, from a low of 3.4 million to a high of 6 or 7 million.² Even more problematic are determining the numbers employed and the aggregate output of various sectors.

Researchers therefore employ indirect clues, such as real wages and urbanization rates, to shed light on labor productivity levels. Researchers with opposing views, however, dispute such indirect evidence and find that alternative frameworks lead to divergent perspectives on

¹ For an introduction to the debate between economic historians over the relationship of population growth and development, see, for instance, Livi-Bacci’s, *A Concise History*, pp. 80-111.

This paper focuses on pre-Black Death England. The schools of thought here on the impact of population growth are representative of those for other countries and/or periods. Michael Postan argued that population growth led, in a Malthusian/Ricardian framework, to diminishing returns to land and labor productivity over the course of the thirteenth century. By the early fourteenth century, labor rates fell to the point that Malthusian crisis ensued. In contrast to this mainstream perspective, advocates of the potential gains in labor productivity resulting from technological progress cause scholars such as Karl Gunnar Persson and H. E. Hallam to argue that the output of food per worker was growing until 1300 and until 1348, respectively. Population pressure drove up productivity by encouraging innovations; in addition, more people meant more brains and ideas. Yet another school maintains that a growing population means a larger market. Increasing commercialization would promote the specialization and division of labor—driving up labor productivity. Along these lines, Richard Britnell argues that English economy and living standards improved over the thirteenth century. Labor productivity rose mostly in the industrial sector; the agricultural sector captured the static and dynamic gains of growth from other sectors. But by 1300, population pressures were such

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3 Smith, “Demographic Developments,” pp. 25-78.

For example, E. A. Wrigley and Phillip Schofield contend that the later sixteenth century experienced a decline in labor productivity. They argue that this decline is suggested by a fall in the real wages of construction workers; they correlate this change and its causation to a rise in population. Robert Allen has recently produced a new real wage series which often differs from that if Phelps-Brown and Hopkins, the real wage series employed by Wrigley and Schofield. Allen argues that labor productivity rose in the late sixteenth century, as illustrated by the slight improvement in the real wages. See, Wrigley and Schofield, The Population History; Allen, “Real Wages”; for criticisms of the statistical analyses of Wrigley and Schofield, see Lindert, “English Living Standards.”


that the tiny industrial sector could not compensate for the low and declining rates found in the huge agricultural sector.  

Adding fuel to this debate are the pioneering research findings of Bruce Campbell and Mark Overton on pre-industrial English land productivity. It was thought that medieval land productivity was significantly lower than that found in later centuries; in earlier research, the agricultural revolution was defined as a significant improvement in land and labor productivity rates. Although yields fluctuated, Campbell and Overton find that the high yields per acre in English open fields before the Black Death, surprisingly, were not surpassed until the late seventeenth or c.1700. Campbell argues that pre-Black Death England, despite its high population, clearly was not experiencing Ricardian declines to land productivity, an important component in the argument that diminishing returns to labor emerged as a response to population growth. Campbell lacks data on labor and capital inputs but he speculates, in a Boserupian fashion, that good yields per acre before 1348 were achieved with massive inputs of hand labor, similar to the situation often found in less developed nations today. Thus, while land productivity is discounted as a barrier to growth, presumably agrarian labor productivity should have declined and it remained a dilemma in pre-industrial England.  

This paper sheds light on this question by providing the first direct measurement of average agrarian labor productivity at the disaggregate level for medieval England—indeed,

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6 Britnell, “Commercialization.” He has recently qualified his optimistic view of the pre-1300 period based on the belief that agrarian labor productivity was low. See, “Surveys,” pp. 1-16. For a critique of these perspectives, see Hatcher and Bailey, Modelling, pp. 21-65 and 121-74.

7 For example, Campbell and Overton, “A New Perspective on Medieval and Early Modern Agriculture,” pp. 38-105.

these are the first such rates produced for any pre-industrialized European country. Because of England’s success story, her development path has served as a yardstick against which the experiences of other countries and periods are measured. Historians often argue that she experienced the first agricultural revolution in labor productivity sometime in the seventeenth or eighteenth century. Explanations for this revolution vary and include enclosures of open fields (efficiency gains garnered by a shift to private property or economies of scale with bigger farms), improvement in the quality of labor inputs (elimination of serf labor and an improvement in wage labor), changes in the agrarian social structure (the elimination of serfdom and the emergence of capitalist tenant-landlord relations), and technological improvements.

Labor productivity rates are therefore assessed here for the period between c. 1300 and 1348 when researchers predict that the output per arable worker would be at its lowest level. Although there is some debate over a possible population decline during the half century before the Black Death reached England in 1348, it is still thought that the early thirteenth century population was not achieved again until the early modern period, perhaps as late as the eighteenth century. Population strain on food resources was therefore at its peak, and the mainstream view is that a Malthusian crisis was either in progress or threatened and so the average output of a farm worker did not suffice or scarcely sufficed to feed him or herself. The production took place in open fields, and on the demesne, the landlord’s share of the open fields, much of the work was performed by serf labor. Farmers, obviously, employed medieval agricultural techniques.

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9. The exact century in which English population numbers for the first half of the fourteenth century were surpassed depends upon which estimate for this period is employed. See Wrigley and Schofield for estimates of English population numbers from the sixteenth to the eighteenth centuries, *The Population History*, especially, pp. 563-87.
The analysis, outlined in the methodology section below, employs disaggregate data (aggregate data are not available for this period). In any case, as discussed in the Findings section, aggregate sources, even centuries later, offer at best only rough approximations of output and inputs while medieval local farm records provide fairly precise information. The data here are drawn, for reasons given in the methodology section below, exclusively from records belonging to Ramsey Estates. The focus is on the arable sector since it is here that researchers predict a dramatic rise in the output of workers in the early modern period. Researchers agree that the labor productivity of pastoral workers was always high. Furthermore, grain and legumes were the major staples in the pre-industrial diet so the output of arable workers would profoundly effect living standards.

The volume and real value of the average labor productivity of workers in the open fields on the Ramsey manors before the Black Death (depending on how the comparison is made) either surpassed, met or was not much below the literature’s best estimates for free wage workers employed on enclosed farms in early nineteenth century England. These estimates indicate, at best, agrarian labor productivity in the arable sector rose above these pre-Black Death rates sometime after 1800, well after industrialization was under way.

Because these findings will surprise some researchers (initially, they surprised even me), this paper focuses on a detailed outline of the source and methodology employed to calculate medieval average labor productivity. Rates are then presented and discussed in reference to comparable estimates made in the literature. Additional data on average medieval labor productivity, and the implications of these findings for development, will be presented in another paper.
Manorial farm account rolls, employed in this study, supply more than enough information to measure agrarian labor productivity directly. The rolls document in great detail the inputs and outputs of land, labor and capital for the landlord’s share of the open fields on the manor, known as the demesne. They are truly, as noted by Postan, the best source on the English agricultural sector available to historians until nineteenth century records. P. D. A. Harvey points out that the information supplied in these English records is unique and permits the study of agricultural practices in a way not possible for any other country during this period. One could extend this observation to encompass the entire pre-industrial period.

The account rolls offer an almost unique opportunity to study the labor inputs in arable and pastoral sectors separately. The managerial practice was to hire full and part-time workers who were generally employed exclusively in one sector. Estimating inputs from an estate complex in which tenants’ labor was widely employed on its demesnes offers another significant advantage: each arable job performed by a tenant on Ramsey Estates’ manors could not exceed one day of labor but might well require less.

Thousands of manorial account rolls, dating mostly from the late thirteenth to early fifteenth centuries, survive. During the thirteenth and fourteenth centuries, many English landlords deviated from the normal practice of leasing their demesnes and instead directly

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10 Stated by Postan in a conversation with J. Ambrose Raftis.


12 At harvest time, certain tenancies in a few locales owed multiple works or workers per day.
cultivated some or all of their manors.  

13 E. A. Kosminsky estimated that in six English counties an average of about 32 percent of arable was demesne.  

14 The account rolls were drawn up for the yearly audit made of each landlord’s manor in his or her estates.  

15 The reeve, the local tenant who managed the demesne, presented an itemized list of all receipts and expenditures for the manor over the course of the year.  

16 The earliest surviving rolls date from 1208 and belong to the estates of the Bishop of Winchester.  Until the 1270s, with the exception of Winchester’s records, relatively few account rolls are extant. The earliest such records for the Ramsey Estates are the summary accounts from 1243. As on most manors, the rolls contain information on demesne inputs and outputs for the fiscal year from 29 September (the feast day of Michaelmas) to 28 September of the following calendar year.  

Complete accounts are available in large

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13 For some views as to why direct cultivation of the demesne became widespread in these centuries, see Harvey, “The English Inflation”; Miller, “Farming of the Manors,” and Raftis, Ramsey Estates, esp. pp. 76-91 and 96-128.  

14 The manors analyzed in this paper lay in four counties, three of which were employed by Koskminsky in his study: Bedford, Cambridge, and Huntingdon. He notes that this estimate is not necessarily representative for the rest of England. See, his Studies in the Agrarian History, pp. 89-94.  

15 On the development of manorial farm accounts, see Harvey, “Introduction.” On this matter and for a discussion of auditing procedures, also see Oschinsky, Walter of Henley, especially, pp. 213-60.  

16 The reeve received free rent and sometimes some perks for this job. The demesne might also be managed by a “baliff,” who worked for wages. As a rule, reeves managed the demesne on Ramsey Estates before the Black Death.  

17 Account rolls were drawn up at the end of the fiscal year. For example, a fiscal account roll year of 29 September,1323 to 28 September, 1324 was produced in September of 1324. A crop was harvested in the summer of 1324 but there was no possibility of processing the entire crop fast enough to record its output in the fiscal year of 1323/4. Instead, this crop was threshed and winnowed over the course of 1324/5 and appeared in the accounts for this fiscal year. On this medieval accounting practice, see, Titow, p. 35. The labor inputs, therefore, depended on the harvest recorded in the fiscal year of 1323/4, with the exception of threshing and winnowing, appeared in the fiscal accounting year of 1322/3. Interpolation of labor inputs can be safely employed. Farmers did not change their labor inputs per acre in the arable sector significantly from one year to the next; nor did sown acreage vary much from one year to the next year. Changes were made gradually, over time, and farmers did not change their practices dramatically within two years. Changes in labor inputs found in consecutive years, extant for the post-1350 period, were usually an insignificant 10 percent a year. Even for fiscal years spaced widely apart in the pre-1350 period, labor inputs, as shown in Table 6, are still fairly consistent between years. Of the 7 account rolls which differed in their labor inputs per acre by an amount over 10 percent, 4 were from the exceptionally poor harvest year of 1297/8. Unusually higher inputs per acre in this year resulted from many more tenants attending the reaping and plowing
numbers from the late 1290s until the early fifteenth century, when Ramsey Estates began to lease demesnes which had been directly cultivated.\textsuperscript{18}

Documenting all labor inputs on the demesne in the account rolls was a particular concern for the landlord, since he wanted to keep labor costs to a minimum. For example, a contemporary agricultural treatise on accounting methods for these rolls, the \textit{Husbandry}, advised that when full-time wage workers were occupied with jobs which were also performed by others, for example, threshing jobs, the work of such full-time employees was to be carefully distinguished in the accounts from that of the others (usually part-time pieceworkers and tenants) “because the lord ought not to pay anything for their [the full-time employees] threshing.”\textsuperscript{19} In fact, the \textit{Husbandry} even gave expected efficiency rates for the expensive labor of harvest workers, as an index for the auditors on such expenditures.\textsuperscript{20}

The careful accounting of all jobs (labor rents and boonworks) performed by tenants was of special concern to the landlord.\textsuperscript{21} The \textit{Seneschaucy}, another medieval agricultural treatise,

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\textsuperscript{18} The date at which these individual demesnes were leased varied from the late fourteenth to the early fifteenth centuries.

\textsuperscript{19} Oschinsky, p. 421. On the possible dating of the Husbandry to c.1300, see Ibid, p. 201. For instance, in Ramsey Estates’ account rolls, the grange section, which recorded the output and the yearly expenditures of crops, very carefully distinguished the amount of each cereal or legume type threshed by pieceworkers and tenants. Full-time demesne employees rarely threshed until after the Black Death.

\textsuperscript{20} Ibid, p. 445.

\textsuperscript{21} Loveboons or boonworks were works required in addition to the regular work week. They were usually performed at time of peak demand for labor, such as harvesting. Although strictly defined in number and type, they were theoretically performed only when requested by the landlord. That is, they were somewhat arbitrary in nature. On the Estates, such loveboons were standardized in number and type and incorporated into the regular labor rent system. On the standardization of loveboons, see also, Jones, “Harvest Customs and Labourers,” (1978), p. 106.
explained that the tenants’ labor rents must be carefully recorded, so the expenditures on wage labor were limited.\(^{22}\) Recording the precise number of tenants’ labor rents was important to ensure that the landlord received the entire amount of rent owed for each tenant holding, either in the form of labor or the cash value assigned to each labor rent.\(^{23}\)

Although it has been acknowledged that account rolls have the potential to supply accurate calculations of agrarian labor productivity, the complexity of this source has deterred their use. The rolls actually document a very flexible system of allocating inputs within a superficially rigid structure of accounting. In order to fully exploit the source, one must move beyond the surface to uncover the dynamic decision-making process in the day to day operations.\(^{24}\) The techniques devised for this project were possible because of the extraordinary number of extant relevant Ramsey Estates’ records and their richness of detail concerning daily operations on the demesne. In particular, they offer abundant information on labor practices for wage labor and tenants.

Ramsey Estates, held by the Benedictine order, was one of larger estates in medieval England. The Abbey was founded around 970 and remained active until the dissolution of the monasteries in 1539. At the time of the Domesday survey in 1086, the agrarian holdings of these Black Monks included 23 complete villages, substantial amounts of land in 23 rural

\(^{22}\) “Seneschaucy,” p. 269. Oschinsky dates this treatise to c.1276. See, Oschinsky, “Introduction to the Seneschaucy,” p. 75.

\(^{23}\) Ibid, pp. 279. See also the “Husbandry,” p. 435. “Customary tenancies” were those landholdings which owed a specified amount of labor on the demesne or the cash value of this work for their rent. Those leasing freehold property on the manor also often provided a slight amount of work on the demesne as part of their rent, usually in the form of boonwork (s).

\(^{24}\) On the impact of economic epistemologies on accounting practices, see Poovey and Miller, “Accounting and Objectivity”; Hoskins and Maever, “Writing, examining, disciplining.”
communities, and small amounts of land (under 120 acres or so) in more than 13 locales. The Estates have an outstandingly high number of complete surviving manorial rolls and a great number of these contain tenants’ work sections (labeled as opera sections in the accounts). These sections list the types of jobs performed by tenants as their “works”, the number of such works and the season in which they were performed. The Estates’ extant surveys and extents, which often discuss tenant labor rent practices in copious detail, total about one hundred. In these records, a tenant’s arable “work” was carefully defined in piecework terms (specified amount of output or input) or according to the amount of time required for its completion (until noon, mid-afternoon, late afternoon, evening or dusk). Information in these extents as well as in the account rolls allowed the reconstruction and the analysis of the tenant labor rent system’s daily operation on each demesne and the Estates from the thirteenth to fifteenth centuries.

A deliberate decision was made to focus on a single estate complex in this study. The accurate measurement of agrarian labor productivity requires the examination of all account rolls for manors within an estate complex. A complex with a good series of extant rolls from most or

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25 For an outline of the Abbey’s foundation, see Raftis, pp. 1-6 and for its agrarian holdings in 1086 and subsequent purchases of land in the thirteenth century, Ibid, Table I, p. 20 and Table XX, p. 110.

26 Because opera sections were often attached on a separate membrane to the end of the roll before the Black Death, they could be easily detached and lost. The number of such sections which survive for Ramsey Estates, based on my comparative reading of three other large estates’ account rolls, again, seems to be exceptional. Without reading all extant account rolls in England, though, it is hard to say anything more definitive. See Appendix B.

27 By using manors located within one estate, it was also possible to distinguish between estate-wide managerial decisions and those carried out on a local level, on each manor, which seemed to reflect local farming practices. This issue is paramount in distinguishing which demesne productivity rates are applicable to the vast tenant farmers’ sector. Kathleen Biddick’s work (Biddick with Bijleveld, “Agrarian Productivity,” pp. 95-123.) has highlighted the import of approaching the question of land productivity within the framework of central estate management. The hypothesis that medieval English land productivity rates were low was predicated largely upon the evidence from Titow’s Winchester Yields. Biddick attributes low yields per acre on many Winchester manors to an orientation to pastoralism on these manors. Equally as important were the extraordinary low capitalization rates on these demesnes, which were caused by the periodic stripping of Winchester Estates’ working capital by the crown. J. Ambrose Raftis’ The Estates of Ramsey Abbey, which examined Ramsey Estates’ central management practices over the centuries in quantitative detail, has proven to be an invaluable aid in untangling the local and central decision-making process.
all of its manors is required. To do otherwise is to risk either understating or overstating labor inputs from wage workers and from tenants. A manor was simply an administrative unit. An open-field village could be divided into several manors, held by different estates; a manor could also consist of several villages.\(^{28}\) Demesnes on more than one manors, within a single estate, could be managed as a unit, sharing inputs and sometimes also sharing the responsibility for the demesnes’ output, which was delivered to the landlord in the form of food and/or cash. In such a unit, at times, some or all of the labor inputs of one manor are placed on the account rolls of another manor.\(^{29}\) To eliminate any possibility of error, the manors selected for this study consist of a single village held in its entirety by Ramsey Estates, where the performance of tenant labor works and wage labor could be easily tracked.

All extant account rolls for all manors in the Estates were examined, and nine manors selected as the focus of this study. These manors each possessed a good series of account rolls from before and after the Black Death.\(^{30}\) They also are characterized by a good number of extant opera accounts. The villages lay in Bedford, Cambridge, Huntingdon, and Suffolk, counties for which Robert Allen and Gregory Clark have produced estimates of early modern agrarian labor

\(^{28}\) See, Raftis, *The Estates*, throughout, on the nature of the farming system on Ramsey Estates’ manors.

\(^{29}\) This practice is found for both wage and tenant labor. Tenants who worked on a manor other than their own had their works entered on the opera section of their home manor to which they owed the labor rents; no notation that such “foreign” tenant work was performed was made on the account roll of the non-home manor. The reeve, the demesne manager, only needed to provide a report of those labor inputs for which he was financially responsible. So, the reeve on the home manor noted the payment of labor rents from customary tenants with holdings on his manor but the reeve on the manor where these “foreign” tenants paid their labor rent, did not need to report their inputs. As long as all account rolls and opera sections are extant for the same years for each manor in such an administrative unit, it is possible to accurately calculating labor inputs. Even when this is not the case, interpolation can still supply relatively precise estimates.

\(^{30}\) Because in all these cases, each manor consisted of a single village, the terms manor and village are used interchangeably, whenever referring to characteristics or activities which were likely common to both the seigniorial and tenant sector.
productivity. With the exception of Lawshall, they were typified by the clay soils of the Midlands, with some variation in quality and stiffness from locale to locale. Finally, although there was some variation in the orientation to arable or pastoral husbandry in these open field villages, cultivation of the open fields was a significant source of farmers’ profits. In villages oriented to a greater degree to pastoral or common production, this was not the case, and thus labor productivity in such villages can not be said to typify conditions in arable husbandry.

Methodology

The methodology employed to calculate labor productivity in the arable sector from account rolls is briefly outlined in Appendix B. Given space restraints, the appendix is only a cursory summary of the approach and source, which occupies 130 pages in the thesis; it focuses on the key points in the measurement of labor inputs and output. Ramsey Abbey’s medieval account rolls provide excellent information on labor inputs and permit a fairly precise calculation of the number of days expended in agricultural work. In constructing these estimates, in those instances in which there might be a range of higher and lower days worked, the choice was generally to add the highest possible number of days worked, resulting in a lower bound estimate

31. The villages of Abbots Ripton, Elton, Upwood, Warboys, and Wistow were located in Huntingdonshire. Gravely and Knapwell lay in Cambridgeshire. The village of Shillington was in Bedfordshire and Lawshall was found in Suffolk. For a map of these and the other manors of Ramsey Estates, see Rafts, The Estates, p. 20. For a description of these manors, see Ibid, throughout.

32. The negative qualities of clay soils have been a bit overstated in the literature. It should be borne in mind that although such soils required more work in some types of jobs, particularly to ensure adequate irrigation, they were far more fertile than the chalky and sandy soils found often in the eastern regions of England. The “bread basket” regions of both Canada and the United States are dominated by clay soils.

33. Appendix B is not included in the conference version of the paper.
of labor productivity. For example, I calculate 300 days of work per full-time demesne employee, even though it was unlikely that arable workers were employed this many days in one year. This approach drove the paper’s estimates of agrarian labor productivity downwards, potentially by about 20 percent or more. In this first case study, I wanted to produce conservative estimates of medieval agrarian labor productivity rates. This procedure was also followed in order to construct and test the accuracy of a general methodology that might be applied to the thousands of less detailed farm accounts, which constitute the bulk of available resources for researchers interested in measuring labor productivity. It can, additionally, be employed with some variations in the exploitation of early modern English farm accounts for the direct measurement of labor productivity.  

**Agrarian Labor Productivity in the Tenant farmers’ Sector**

Evidence in the account rolls for the demesne suggests that they might also offer insight into agrarian labor productivity rates in the vast tenant sector, who comprised some 75 to 90 percent of the population. Some specialists in estates studies have already suggested that account rolls might serve as an index to tenant practices, albeit in reference to seeding rates and crop mixes on demesnes. Mavis Mate and Bruce Campbell note the variation, often extreme, in seeding rates per acre and crop mixes from demesne to demesne (manor to manor), respectively, within one estate complex. They attribute this to a local decision making by the reeve, the local tenant who

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34 I have located only few early modern farm accounts that might permit a breakdown of days worked in the two sectors: arable and pastoral. Likely the most viable approach would be to estimate the output per worker for both sectors with these records. In using these accounts, some allowance must be made for labor inputs of the farmer and his family, since they are not recorded in the same fashion as that of wage labor. For a discussion of early modern farm accounts and their methodological issues, see Collins, E. J. T. “Historical Farm Records.”; and also Turner,
managed the landlord’s portion of the demesne, who simply employed the same seeding and crop geography practices carried out by tenants on their own land. In other words, the landlords were following tenants’ management practices.  

Arable labor inputs per acre between manors in the Ramsey Estates, show striking differences. from demesne to demesne, similar to findings on seeding rates and crop mixes. This suggests the possibility that these labor inputs were devised in a similar fashion (see Table 1). That is, the reeve had the landlord’s arable lands plowed, harrowed, weeded and so forth in generally the same amounts and at the same times as did the tenants on their own holdings within each open field.

**Table 1** presents the average days per acre of all arable work (preparation as well as harvesting and processing the crops) on these nine demesnes (see Appendix B for a list of typical jobs). Since work was expended upon both the sown and fallow land, the total acreage is taken into account. Elton’s demesne had the highest arable inputs at around 13 days an acre. On three other demesnes, the workload was 9 to 11 days an acre. Four locales tended to use about 8 days an acre and the fewest days worked were 6 days per sown and fallow acre in the arable sector.

The literature’s estimates for non-mechanized pre-industrial western arable agriculture range from 3 to 17 days per acre. Three estimates of arable inputs exist for manors in pre-Black Death England. Bruce Campbell analysis of the Norfolk manor of Martham implies 10.3 days of

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Mate, “Medieval Agrarian Practices,” pp. 22-31. Campbell, like Mate, concludes that “the man who owned a demesne was probably less important that the man who ran...[according to]...prevailing local husbandry practices.” “Arable Productivity in Medieval England,” pp. 387, 397-8.
pastoral and arable work per sown acre between 1300 to 1324. Deducting pastoral inputs (thirty percent) and making a slight adjustment downwards of 10 percent to allow for a small fallow, places this manor in the lowest range of labor intensity found in Table 1. Harold Fox’s studies of two Devon manors yield 13.4 and 13.7 days (pastoral and arable work) per sown and fallow acre in the early fourteenth century. Allowing for 30 percent of these days to be expended in the pastoral sector, results in estimates of 9.38 and 9.59 days per arable acre. Christopher Thorton estimates a range of 14.57 to 20.38 days per sown acre in the arable sector on the Hampshire manor of Rimpton between 1209 and 1349 with an average of 18.25 days from 1300 to 1349. The fallow here occupied a third or more of the demesne acreage. Assuming the smallest fallow of 33 percent means that Rimpton demesne workers spent 9.7 to 13.6 days on sown and fallow acreage, with a mean 12.16 days in the first half of the fourteenth century.

The number of days worked on these medieval manors in Table 1 tend to be higher than Parker and Klein’s well-known estimates for total arable inputs per acre (sown acreage only) in pre-mechanized early nineteenth century United States. They found that farmers in the northeastern United States, who employed the most number of days worked per acre, hours spent per acre on the most labor intensive crop of wheat (with an estimated 14.5 bushels an acre, close to medieval yields) totaled 44.7 hours. Assuming either an 8 or 10 hour working day, days worked per sown acre were either 4.5 or 5.6. In the southern United States, days worked per

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36 Campbell includes only the inputs of full-time workers and payments made to part-time work on weeding, and implies that other part-time work was slight. I assumed that each weeder was paid one penny a day. See, “Arable Productivity: Eastern Norfolk,” Table 5, pp. 38-9. I reconfigured Martham’s demesne acreage to statute acres. For the size of the customary acre at Martham, see Campbell, “Arable Productivity: Norfolk,” p. 385.

37 Fox, “Exploitation,” 544-5.

38 Thorton, Table 7.7, pp.205 and on fallow see p. 186.
sown acre were either 3 or 3.74. In comparing these estimates to my own, it should be borne in mind that Parker and Klein include fewer types of jobs than I consider here. They do not add days spent fertilizing the soil and carting or work on the fallow; their estimates of time spent threshing per bushel average out inputs for the two contemporary techniques of flailing by hand and the faster treading technique.  

Implied in Robert Allen’s work are days worked per acre, circa 1800, for different sizes of enclosed arable oriented farms in England. On his large farms of 400 to 450 acres, laborers input a total of 9.25 days per acre (sown and fallow). On smaller farms of 100 to 150 acres, typical of the average farm, about 16.6 days per acre were needed. Allen’s estimates are based on a slightly different crop mix than that found in the medieval period and different crop mixes require different amounts of work. He includes the labor inputs for the early modern fodder crops of clover and turnips, which require much more labor inputs per acre than grain or legumes. Turnips, for instance, need anywhere from 8 to 17 days per acre, just on crop preparation.

George Grantham has calculated about 19 days of arable work per acre (sown) in early nineteenth century France before mechanization. With a fallow acreage of 25 percent, French farmers worked around 14 days per acre. Grantham assumes that each acre was plowed 5 or 6

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39 Parker and Klein estimate about 30 hours of work per sown acre on wheat crops in the southern United States. See, “Productivity Growth in Grain Production,” pp. 527, Table 1 on 532, 570.

40 Days per acre calculated from Allen’s estimates of percentage of work year per acre required on different size farms. Allen assumes 250 days of work a year per full-time worker. See, “The Growth of Labor Productivity,” Table 11, p.131.

41 See Timmer “The Turnip.”

42 Timmer argued that the greater labor inputs required in turnip production off-set any possible increase in land and thus labor productivity in c.1800 England. For this hypothesis, see “The Turnip.”
times. Multiple plowings were employed on light soils in medieval and early modern England but on clay soils, such as those found in these villages, usually the fallow was plowed twice and on the cropped acreage only once before sowing.

The divergence in arable inputs per acre from manor to manor shown in Table 1 could not have resulted from differences in the amount of tenant labor rents available to the reeve. The Abbey had a surplus of tenant labor rents in all its manors and a number of tenants paid off some or all of their labor rents in cash each year. For example, in Upwood, where the number of days on arable jobs per acre were amongst the lowest of the villages, only 58 percent (3379) of the labor rents were employed on the demesne and 42 percent (2446.5) of the works were sold to tenants in 1323. Even Elton, which employed the most arable labor inputs per acre, did not use all its labor dues. For example, in 1313, 15 virgates were ad censum (at money rent) and 992.25 additional labor rents were sold.43 Abbots Ripton sold 27 percent of tenants’ labor rents in 1307 and 29 percent in 1342.44 Evidence from after the Black Death, when tenants’ works declined in number or disappeared, confirms the conclusion that the reeve was setting demesne arable related labor inputs according to local tenant practices. Changes in the number of tenants’ labor rents per acre and shifts in the number of days worked per acre are uncorrelated. Again, days worked per acre varied, sometimes greatly, from manor to manor.45

How closely did rates of land and labor productivity on the demesne accord with those found on tenants’ farms? The strong contrast in arable labor inputs between manors suggests

43 Tenants ad opera (at labor rent) could pay some off their rent in cash rather than labor. Such payments are recorded in the account rolls as “sales” of each labor rent back to the tenant.

44 PRO 882/13, 882/9.

45 Karakacili, Tables 3.1 and 3.2, pp. 87-190.
that labor inputs on the demesne reflected, at least fairly closely, those used by local farmers in these same regions. It is sometimes contended that tenants’ land was of a poorer quality than that worked by the landlord, which might drive down land productivity, but demesne land here was scattered in strips and usually lay in furlongs intermingled with tenants’ strips. Tentative labor productivity for the tenant farmers’ sector therefore can be established by using labor inputs and land output found in the manorial account rolls as indices.

It is also possible that the land and labor rates on tenants’ own farms are somewhat higher than those found on the demesne. Labor inputs were potentially of better quality on farmers’ own land, following the reasoning of those who argue that serf labor rents were performed inefficiently and thus lowered labor productivity on the demesne—an important consideration given that much of the arable work was performed by tenants. In addition to tenant labor, manors used wage labor. Again, tenant farms, run largely with family labor, could have a comparative advantage, since it is frequently argued that family inputs tend to be more productive than wage workers, for incentive reasons.

Tenants also enjoyed an advantage over the demesne in the vast labor supplies at their disposal. Such labor inputs might be employed to increase yields. For example, tenants could spend more time weeding or obtaining and applying fertilizers to their lands. Information on fines in manorial court records suggest that villagers were well aware of the potential benefits of applying marl and manure onto the soil and went to great lengths of obtain these for their holdings. Such work was not performed on every acre in every year—for example, the effects of one application of manure in temperate zones lasts three years and that of marl up to 30 years,

46 Campbell bases his recent estimates on levels of English medieval national grain production on the assumption that land productivity rates of the seigniorial and peasant sector were comparable. See, English Seigniorial, p. 396.
depending on the amount applied. But at which point would increased labor inputs fail to be offset by rising land productivity? Given the level of labor inputs and output of demesne labor, arable labor inputs on tenant farms would need to dramatically higher before a great fall in output per worker might emerge—post-Black Death evidence indicates that the point of diminishing returns to the average productivity of labor was not reached before 1348. Although this scenario of falling output might emerge should tenants switch their production focus to the relatively limited horticulture or industrial crop types available in this period, there is no evidence to date of widespread cultivation of such crops in the medieval open fields.

Finally, tenants in these villages had a considerable advantage over the demesne in draft animals. Their draft animal capital per acre was two to three times that of the landlord. E. A. Wrigley points out that the use of draft animals plays a critical role in increasing labor’s efficiency. The use of oxen in plowing can cut back human labor inputs by 66 percent. The use of faster horses rather than slower oxen in farm jobs results in even greater savings to labor. John Langdon found that the use of horses was much more widespread amongst tenants than landlords by the thirteenth century. He believes that the key consideration for the tenant farmer

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47 The estimates of tenants’ plow numbers are taken from the number of tenants’ plows recorded as present at the plowing boonworks in the account rolls. This number fluctuate widely from year to year or even in the same year. For example, in the village of Upwood in 1297/8, the first boonwork employed 26 plows and the second used only 18 tenant plows. See, PRO 885/11 and 885/14. Since food was given to all workers at these loveboons, as a cost saving measure, the reeve probably issued a request for the minimum number required to complete plowing needs. For this reason, the highest number of plows likely illustrates the minimum number of plow-teams held by tenants in each village; it is possible that tenants held an even greater number of plow-teams. So, tenants in Elton had one plow-team for every 43 or 52 acres but the landlord employed only one plow-team for every 105 acres. In Upwood, the demesne had one plow-team for every 110 acres but tenants could draw upon one for every 35 or 46 acres. The landlord was not undercapitalized in this area, though. A medieval agricultural treatise, the “Seneschaucy”, states that one plow-team should be able to plow about 180 acres in one year, p. 264. Two estimates were given for the ratio of tenants’ plow-teams to tenants’ acreage because of the occasional shift in the categorization of freehold and customary land. The first estimate deducts only freehold holdings of one hide, following the argument of Kosminsky that holdings of this size tended to operate as a sub-manor. On these issues, see Kosminsky, pp. 80-4, 78, 88.

in using horses was to save money by reducing the number of labor inputs or the size of the plow-team.  

Average Labor Productivity Rates Before the Black Death

Table 2 summarizes the average annual labor productivity rates for each of the nine villages in mixed bushels of grains and legumes (gross). A yearly breakdown of labor inputs and output is given in Appendix A. The gross output of mixed bushels is considered here in order to evaluate the physical capacity of these workers for production, given the emphasis placed in the literature on possible changes over time in the quality of labor inputs.

Although there was generally a relative consistency in the output per worker rather large differences in average labor productivity rates can be found not just between villages but also within the same place from year to year (see Table 2 and Appendix A). The causes that underlie these differences offer insight into the elements shaping medieval labor rates and the potential for change in later centuries. A discussion of these matters will be presented elsewhere. This paper will focus on establishing the actual amount of grain and legumes produced by medieval workers. How do these rates compare with the literature’s estimates?

50 It should be noted that output per worker in the village of Shillington was probably much higher than this amount would seem to indicate. The only usable account roll that survives before Black Death was a year characterized by a relatively poor harvest (1323) and therefore this estimate represents the lower levels of labor productivity here.
These estimates were usually produced in the context of studies of the British agricultural revolution and range between a 69 to a 300 percent rise in the labor productivity of arable workers between c. 1300 and c. 1851. Table 3 indicates that agricultural workers in these medieval villages before the Black Death were more efficient by 113 percent than their 1600 counterparts; again, medieval workers outstripped those labor rates found in 1700 by 43 percent to 135 percent. Arable labor productivity seems to become similar only by 1800, with medieval workers producing 15 percent more or 3 percent less than free wage workers on enclosed farms. And the difference between the output of arable workers before 1350 and those working in 1851, seems to be, at most, an upper bound 41 percent. This increase in the volume and real value of output emerges sometime after 1800, becoming apparent only in those estimates made for the mid-nineteenth century. Taking place over the course of six centuries, this rise in labor productivity can scarcely be defined as an agricultural revolution, and it emerges only after industrialization is well under way, sometime after 1800.

It is possible, given the problematic and imprecise nature of early modern and early nineteenth century data, that the productivity of early modern workers is either underestimated or overestimated in the literature. B. A. Holderness states that without agricultural censuses, researchers can only achieve a sense of overall output trends between 1750 and 1850. One can assume that this is also the case for earlier centuries. Researchers also experience difficulties with the construction of national agricultural labor force estimates. For example, even the relatively good 1851 census does not distinguish between full and part-time workers; there is

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51 Based on my direct measurement of arable workers’ output, using a few early modern farm accounts, it appears that output per worker likely rose, at least slightly, in later centuries.
52 Holderness, “Prices, Productivity, and Output,” p. 174.
also considerable debate over such issues as an underenumeration of women and children.\textsuperscript{53} Without knowing the precise volume of agricultural national output and the precise size of the full-time agricultural workforce, agrarian labor productivity estimates based on such incomplete aggregate data are ball-park numbers, at best.

Do the medieval agrarian labor productivity rates in these villages support a Ricardian/Malthusian perspective? Theoretically, increasing population pressure on scarce land resources should find expression in an increasing number of labor inputs per acre and a movement to cultivate less fertile lands, resulting in declining average and marginal productivity of land and labor. Campbell demonstrated that land productivity rates on medieval open fields do not decline in this period and are high in comparison to early modern rates. Similarly, labor productivity rates in these open fields do not decline and are high by any equitable standard.\textsuperscript{54}

Is Boserup’s model applicable to medieval England? She herself argued that pre-industrial western Europe experienced problems similar to those faced in mid-twentieth developing countries. In both scenarios, population pressure induced the adoption of more labor intensive techniques in the arable sector. Land productivity rose at the cost of labor productivity. Campbell’s evidence, though, shows no significant increase in land productivity at all before the Black Death, despite a rising population. Even after the Black Death, land productivity does not fall in accordance with the population decline.\textsuperscript{55} Similarly, farmers in these villages were not applying more and more labor to the arable in the first half of the fourteenth century in an attempt to increase a dwindling food supply. Arable inputs remained constant across the

\textsuperscript{53} For a summary of some of these issues, see Afton and Turner, “Agrarian Occupations,” pp. 1956-63.
\textsuperscript{54} It should be noted that since the bulk of data are post-1300, they cannot tell us whether rates rose or fell from their thirteenth century levels.
\textsuperscript{55} For instance, Norfolk yields, see Campbell’s “English Seignorial,” Table 6.8, p. 180.
decades, rarely shifting more than 10 percent (see Appendix A). Inputs could and would change when the economic climate changed—after the Black Death, farmers increased their labor inputs as a response to agricultural price changes, contradicting a Boserupian as well as a Malthusian scenario which would forecast a decline in labor inputs. Evidence from the post-1350 period indicates that the total output of food per worker could increase with the application of more labor—the point of diminishing returns to the average productivity of labor was not reached before the Black Death on these Ramsey Estate manors.

It seems unlikely that the agricultural sector in medieval England, in terms of labor inputs, labor productivity, and population pressures, is comparable to those found in developing countries in the mid-twentieth century, from whence Boserup drew the bulk of her evidence. The following estimates should be viewed as crude approximations, constructed by myself. In Africa, an average of 45.5 days an acre in maize production resulted in a gross output of 148 wheat equivalent bushels per worker per year; farmers spent 58.9 days an acre on sweet potatoes and grossed 157 wheat bushels/worker/year; cassava production required 94.6 days per acre and resulted in an average output of 79.5 wheat bushels a worker a year. In Thailand, workers spent anywhere from 25.3 to 101.2 days an acre producing rough rice; a worker applying 68.36 days per acre produced 131.5 wheat bushels (gross) in one year. Guatemalan farmers spent 48 days

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56 Karakacili, pp. 176-241.
57 Decent aggregate data emerge by the mid-twentieth century on the factors of production employed in developing countries' agricultural sectors. I also use this early data to avoid the later green revolution, which increased land productivity dramatically in some regions.
58 Constructed using information in Colin Clark and Haswell, Table XVII, p. 82. To compare these numbers with the output of medieval workers, hours worked per acre were converted to days per acre, assuming 8 hours per work day and 300 days of work per full-time worker. If 10 hours a day are used rather than 8, labor productivity rises by 20 percent. The conversion to wheat bushels made using weights given by Clark, which are based on FAO data from 1960. See, Ibid, pp. 197-96.
59 Ibid, p. 90, with the assumption that the metric ton was employed. The long ton would mean that each worker produced 134 wheat equivalent bushels a year.
an acre on maize production, resulting in 158 wheat equivalent bushels per worker. Chinese farmers expending 67 days an acre on rough rice would produce 240 wheat equivalent bushels a worker in the early 1930s. Surprisingly, despite often very high inputs of days worked per acre in less developed countries, Colin Clark argues that the marginal productivity of labor was still often above 0. In Gambia, the marginal productivity of labor only began to fall rapidly after farmers input more than 35.4 days an acre in grain production. In India, the marginal product was higher than the average until 75.8 days an acre was spent on irrigated wheat production.

S. R. Sen argued against comparing the situation and problems found in less developed countries with the early stages of development in wealthier nations. He pointed out the density of population and their sheer numbers in less developed nations by the mid-twentieth century surpassed anything that was experienced in Europe’s past. For pre-1350 England to achieve the population density per arable acre (sown and fallow) experienced by India, her population would need to increase by 5 million above the highest estimate of 6 million, to reach 11.8 million in 1300 and to match China’s, an additional 14 million for a population of 20.6 million. In order to experience the same population pressure on land resources as Japan in the mid-twentieth century,

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61 Made using information found in Buck, Land Utilization, Table 14, p. 224 and Table 15, p. 304 and his Statistical Supplement, Table 9, p. 209. Buck gives man-days per acre but does not give the length of a working day. Conversion to wheat bushels as above.
62 Clark and Haswell, pp. 86 and 88.
63 Sen, “The Problem of Population,” pp. 533-45. Kuznets argued that mid-twentieth century agrarian labor productivity rates in less developed countries were only one-fourth to one-third the levels found in wealthier nations during their similar pre-industrialization stage. See his, “Underdeveloped Countries,” p. 179.
England’s population in the pre-Black Death period would need to reach an incredible 66.78 million.  

Gauging the Representative Nature of Ramsey Estates’ Manors

Since this is the first case study, it is not possible to quantify the representative nature of labor productivity rates found on these Ramsey Estates’ manors. The typicality of these rates might be gauged, though, to a degree by assessing key areas that might lead rates to diverge significantly from those found on other estates and locales. Bruce Campbell has compared management strategies of ecclesiastical and lay-owned estates in Norfolk and Suffolk and found no difference. Land productivity did not vary between manors held by the laity as opposed to ecclesiastical organizations. Tenant labor rents and free wage labor procedures on Ramsey Estates likewise do not seem to be greatly distinctive from manors of other estates. Indeed, given that manors held by one landlord existed side by side with those held by another, and a village could be divided between a number of landlords, it is not realistic to suppose that vastly different rental agreements would have been tolerated or that wages and employment conventions would vary greatly from one place to another.

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64 The estimates of population density requirements in early fourteenth century England were made with the assumption that arable land totaled 10 million acres in 1300. Campbell states that by 1315, English arable acreage was perhaps as high as 10.5 million acres (English Seigniorial Agriculture, pp. 386-90). Estimates of population numbers for 1950 and arable acreage for China (1947), India (1948), and Japan (1950) are in FAO, Yearbook, 1951, Table 1, p. 5 and Table 2, p. 2.

65 Campbell, “Arable Productivity,” pp. 397-98

66 E. A. Kosminsky argued that this was the norm as opposed to a village consisting of a single manor. Kosminsky, pp. 73-77.
Labor productivity is influenced by land productivity. To what degree are the land productivity rates of these Ramsey Estates’ manors typical of those found elsewhere in England? Unfortunately, a comprehensive data set does not exist for average medieval yields per county in the same year for all of England. However, such information is available from the nineteenth century and should still be indicative of soil quality and type found in these same areas in the past. The weighted average of wheat yields for the counties where these Ramsey villages were found using data from the c.1836 surveys and averages taken from the 1885 to 1894 studies, indicate that these lands were typical of the average output for England, being only 2 percent and 3 percent higher than the mean, respectively. 67

A forthcoming study of medieval lay taxes and Post Mortem Inquisitions by Campbell and S. Bartley finds that eight of these manors, excepting Lawshall, lie in a region of considerable individual wealth. They note that this wealth was not exclusive to landlords and was also clearly in the hands of the region’s customary tenants. 68 So, it is possible that agriculture here was more productive or at least more profitable than that found in some other regions in England.

It is difficult, however, to support a scenario in which these manors were substantially atypical. Specifically, it seems unlikely that farmers on these manors worked harder, or ran their open fields more efficiently, or employed a different technology than farmers in neighboring manors and counties. To conclude, the average labor productivity rates on these Ramsey Estates’ manors should provide some insight into medieval English rates in general--both for demesne and for the vast tenant farmer sector.

67 Data employed in these calculations taken from Table 2A.5, found in Collins, “Rural and Agricultural Change,” pp.132-3.
68 My thanks to Campbell for permitting me access to his book, Lay Lordship, Land and Wealth, forthcoming from
Conclusion

The volume and real value of the output per arable worker in these nine English open-field manors were surprisingly high. High output was achieved under those conditions which were thought would result in the lowest levels of agrarian labor productivity rates: much of the work was performed by serfs, in open fields, using medieval technology, during a time in which population pressures on land resources reached their peak. In fact, it was the heavy reliance upon labor rents within the Ramsey Estates that made this study feasible. The need for medieval estates to account carefully for all tenants’ jobs, and the widespread practice of hiring separate workers for the arable and pastoral sectors, provided the rare opportunity to accurately calculate the number of days worked in the arable sector and the output of these workers. A conservative approach to calculating labor inputs has produced a lower bound estimate of medieval labor productivity. Even so, these rates are still comparable to the literature’s best estimates of output per English worker, in non-mechanized agriculture, well into the nineteenth century.

Although the introduction acknowledged that many economic historians would find these results surprising, the relatively high levels of arable workers’ output in the pre-Black Death period should not, after all, come as a complete surprise. Recent research has challenged many of the hypotheses in which low medieval agrarian labor productivity seems a logical conclusion to barriers of one sort or another. Work by Carl Dahlman, Deirdre McCloskey and David Hall, reject gross inefficiency in open fields, significantly lowering returns to land, labor and capital. Instead, open fields are now viewed as an economically rationale response to environmental and
A positive reassessment of medieval as well as pre-industrial agricultural technology is also emerging, thanks in part to the revisionist work of Campbell and Overton. In fact, many of the techniques once derided by historians as inefficient, such as crop rotations, are now advocated as sustainable farming technology by agronomists for use in developing countries. The relative constancy in the technology widely employed by farmers in the pre-industrial period led George Grantham to argue that no significant improvement should have taken place in French agrarian labor productivity until mechanization emerged in the early nineteenth century. After all, if agricultural technology stays fairly constant, why should agrarian labor productivity change?

More studies that measure agrarian labor productivity directly, on a wider scale, are necessary to confirm the degree to which rates in these nine villages are representative of others elsewhere in England and on the continent. It is my hope that this paper, and its detailed discussion of source and methodology, will stimulate such studies. Still, the simple presentation of the relatively high volume and real value output of bushels per arable worker from these nine manors, under those conditions thought to produce the lowest levels in the pre-industrial period, casts some doubt on the traditional perspective concerning England’s path to economic greatness.

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69 Dahlman, *The Open Fields*; Hall, *The Open Fields of Northamptonshire*; and, for example, D. McCloskey, “The Prudent Peasant: New Findings of the Open Fields,” pp. 343-55. It is also possible that the open field system enhanced land and labor productivity. See, Karakacili, pp. 157-60, outlined also in the dissertation summary found in This Journal, pp. 540-1.

70 Grantham, “Divisions of Labour: Agricultural Productivity,” pp. 478-502. Grantham notes out that a single constant technology is capable of generating quite different levels of productivity depending on how intensively it is exploited. There was considerable productivity elasticity in the old pre-industrial technology. My thanks to Grantham for this point. More recently, making a similar point, see Campbell’s, “Uses.”

82 Clark and Haswell, p.86.
Historians had thought to explain the timing of industrialization by some sudden change in the output per worker, a later “agricultural revolution,” in England. It appears that any “agricultural revolution” that freed up product and producers from agriculture did not occur relative to the conditions on these fourteenth century farms, unless that later revolution was a recovery from some still-uncharted early modern slump. This is not to say that agrarian labor rates could not change—indeed they could as the post-1350 period indicates (more on this at a later date)—but that there was no barrier, institutional, tenurial, or technological in nature, that necessarily held rates in check until the seventeenth or eighteenth century.

Appendix A

**Average Labor Productivity Rates, 1279 - 1347** (Output in gross mixed bushels of wheat, rye, barley, dredge, oats and legumes. Estimate 1 counts all threshing inputs as half-days. Estimate 2 is based on the likely efficiency of labor in threshing.)

<table>
<thead>
<tr>
<th>Village</th>
<th>Year</th>
<th>Estimate 1. gross bushels/worker per year</th>
<th>Estimate 2. gross bushels/worker per year</th>
<th>Total arable days worked per acre (sown and fallow) based on estimate 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abbots</td>
<td>1307/8</td>
<td>354 bu.</td>
<td>389 bu.</td>
<td>11.2 days</td>
</tr>
<tr>
<td>Ripton</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>“ ”</td>
<td>1323/4*</td>
<td>303 bu.</td>
<td>323 bu.</td>
<td>9.87 days</td>
</tr>
<tr>
<td>“ ”</td>
<td>1342/3*</td>
<td>270 bu.</td>
<td>286 bu.</td>
<td>11.3 days</td>
</tr>
<tr>
<td>Elton</td>
<td>1297/8*</td>
<td>219 bu.</td>
<td>234 bu.</td>
<td>12.75 days</td>
</tr>
<tr>
<td>“ ”</td>
<td>1311/12</td>
<td>323 bu.</td>
<td>336 bu.</td>
<td>12.7 days</td>
</tr>
<tr>
<td>“ ”</td>
<td>1313/14</td>
<td>333 bu.</td>
<td>351 bu.</td>
<td>12.5 days</td>
</tr>
<tr>
<td>Village</td>
<td>Year</td>
<td>Estimate 1. gross bushels/worker per year</td>
<td>Estimate 2. gross bushels/worker per year</td>
<td>Total arable days worked per acre (sown and fallow) based on estimate 2</td>
</tr>
<tr>
<td>-----------</td>
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<td>------------------------------------------</td>
<td>------------------------------------------</td>
<td>---------------------------------------------------------------------</td>
</tr>
<tr>
<td>“        ”</td>
<td>1323/4*</td>
<td>314 bu.</td>
<td>342 bu.</td>
<td>13.36 days</td>
</tr>
<tr>
<td>Gravely</td>
<td>1307/8</td>
<td>299 bu.</td>
<td>321 bu.</td>
<td>8.6 days</td>
</tr>
<tr>
<td>“        ”</td>
<td>1314/15</td>
<td>335 bu.</td>
<td>362 bu.</td>
<td>7.6 days</td>
</tr>
<tr>
<td>“        ”</td>
<td>1323/4*</td>
<td>263 bu.</td>
<td>276 bu.</td>
<td>9.2 days</td>
</tr>
<tr>
<td>“        ”</td>
<td>1346/7*</td>
<td>318 bu.</td>
<td>358 bu.</td>
<td>7.3 days</td>
</tr>
<tr>
<td>Knapwell</td>
<td>1323/4*</td>
<td>211 bu.</td>
<td>228 bu.</td>
<td>8.8 days</td>
</tr>
<tr>
<td>“        ”</td>
<td>1325/6*</td>
<td>153 bu.</td>
<td>165 bu.</td>
<td>8.5 days</td>
</tr>
<tr>
<td>“        ”</td>
<td>1329/30*</td>
<td>256 bu.</td>
<td>272 bu.</td>
<td>9.23 days</td>
</tr>
<tr>
<td>“        ”</td>
<td>1347/8*</td>
<td>183 bu.</td>
<td>200 bu.</td>
<td>9.5 days</td>
</tr>
<tr>
<td>Lawshall</td>
<td>1279/80*</td>
<td>242 bu.</td>
<td>254 bu.</td>
<td>6.2 days</td>
</tr>
<tr>
<td>“        ”</td>
<td>1280/1*</td>
<td>250 bu.</td>
<td>261 bu.</td>
<td>6.7 days</td>
</tr>
<tr>
<td>“        ”</td>
<td>1346/7*</td>
<td>234 bu.</td>
<td>251 bu.</td>
<td>5.33 days</td>
</tr>
<tr>
<td>Shillington</td>
<td>1323/4*</td>
<td>190 bu.</td>
<td>219 bu.</td>
<td>9.77 days</td>
</tr>
<tr>
<td>Upwood</td>
<td>1297/8*</td>
<td>161 bu.</td>
<td>174 bu.</td>
<td>11.38 days</td>
</tr>
<tr>
<td>“        ”</td>
<td>1306/7</td>
<td>376 bu</td>
<td>419 bu.</td>
<td>7.26 days</td>
</tr>
<tr>
<td>Village</td>
<td>Year</td>
<td>Estimate 1. gross bushels/worker per year</td>
<td>Estimate 2. gross bushels/worker per year</td>
<td>Total arable days worked per acre (sown and fallow) based on estimate 2</td>
</tr>
<tr>
<td>---------</td>
<td>--------</td>
<td>------------------------------------------</td>
<td>------------------------------------------</td>
<td>-----------------------------------------------------------------------</td>
</tr>
<tr>
<td>“</td>
<td>1323/4*</td>
<td>243 bu.</td>
<td>258 bu.</td>
<td>8.1 days</td>
</tr>
<tr>
<td>“</td>
<td>1342/3*</td>
<td>295 bu.</td>
<td>313 bu.</td>
<td>8 days</td>
</tr>
<tr>
<td>Warboys</td>
<td>1297/8*</td>
<td>119 bu.</td>
<td>124 bu.</td>
<td>10.7 days</td>
</tr>
<tr>
<td>“</td>
<td>1318/9</td>
<td>374 bu.</td>
<td>410 bu.</td>
<td>8.23 days</td>
</tr>
<tr>
<td>“</td>
<td>1323/4</td>
<td>267 bu.</td>
<td>286 bu.</td>
<td>9.28 days</td>
</tr>
<tr>
<td>“</td>
<td>1342/3*</td>
<td>297 bu.</td>
<td>318 bu.</td>
<td>8.2 days</td>
</tr>
<tr>
<td>“</td>
<td>1344/5*</td>
<td>375 bu.</td>
<td>398 bu.</td>
<td>7.8 days</td>
</tr>
<tr>
<td>“</td>
<td>1347/8*</td>
<td>408 bu.</td>
<td>441 bu.</td>
<td>8.9 days</td>
</tr>
<tr>
<td>Wistow</td>
<td>1297/8*</td>
<td>156 bu.</td>
<td>162 bu.</td>
<td>11.2 days</td>
</tr>
<tr>
<td>“</td>
<td>1316/7</td>
<td>224 bu.</td>
<td>240 bu.</td>
<td>8 days</td>
</tr>
<tr>
<td>“</td>
<td>1323/4*</td>
<td>274 bu.</td>
<td>292 bu.</td>
<td>7.8 days</td>
</tr>
<tr>
<td>“</td>
<td>1335/6*</td>
<td>399 bu.</td>
<td>451 bu.</td>
<td>7.2 days</td>
</tr>
</tbody>
</table>

Sources: PRO 882/13; 882/18; 882/19; 874/5; 874/6; 874/7; 878/14; 884/4; 767/12; 767/13;
Asterisk indicates that an opera section is extant for this year. In Elton’s 1297-8 account roll, only the winter fiscal season of the opera section survives.

CITATIONS

Primary Sources

Account Rolls

Public Records Office: 882/13; 882/18; 882/19; 874/5874/6; 874/7; 878/14; 884/4; 767/12; 767/13; 767/17; 767/19; 768/30; 768/31; 768/32; 785/35; 1001/8; 1001/9; 1001/10; 741/20; 885/11; 885/14/18; BM 34881; 34870; 34884; 39798; 39803; 39805; 39809; 39891; 39892; 34914; 39894; 39895.

British Museum: 34881; 34870; 34884; 39798; 39803; 39805; 39809; 39891; 39892; 34914; 39894; 39895.

Printed Editions


Secondary Sources


---------. “Arable Productivity in Medieval England: Some Evidence From Eastern Norfolk.”


Table 1: Average Labor Inputs Per Demesne Acre (Sown and Fallow) for Nine Ramsey Estate Manors Before the Black Death

<table>
<thead>
<tr>
<th>Village</th>
<th>Days/acre in total arable works (prep. &amp; harvesting &amp; processing)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elton</td>
<td>12.8</td>
</tr>
<tr>
<td>Abbots Ripton</td>
<td>10.8</td>
</tr>
<tr>
<td>Shillington</td>
<td>9.8</td>
</tr>
<tr>
<td>Knapwell</td>
<td>9.0</td>
</tr>
<tr>
<td>Warboys</td>
<td>8.4</td>
</tr>
<tr>
<td>Gravely</td>
<td>8.2</td>
</tr>
<tr>
<td>Upwood</td>
<td>7.8</td>
</tr>
<tr>
<td>Wistow</td>
<td>7.7</td>
</tr>
<tr>
<td>Lawshall</td>
<td>6.0</td>
</tr>
</tbody>
</table>

*See Appendix B for description of job types in the three categories of arable preparation, harvesting, and processing the crops. Total inputs per acre takes into account all days worked in the arable sector on sown and fallow land. Only account rolls with extant opera sections employed, excluding the year of 1297/8. The latter year was not used in constructing mean since labor inputs were unusually high that year. See, note 17 on this point. Sources: Public Records Office 882/18; 882/19; 874/7; 767/17; 767/19; 768/30; 768/31; 768/32; 785/35; 1001/8; 1001/9; 1001/10; 741/20; 885/11; 885/14; 885/15; British Museum 34884; 39803; 39805; 39809; 39894; 39895.
Table 2: Gross Average Labor Productivity Rates (bu./full-time worker) in Nine Ramsey Estates Villages, 1279-1347 (mixed bushels of grains and legumes)

<table>
<thead>
<tr>
<th>Village (number of account rolls used)</th>
<th>Average bu./worker in one year</th>
<th>Lowest amount of bu./ worker</th>
<th>Highest amount of bu./worker</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abbots Ripton (3)</td>
<td>333 bu.</td>
<td>286 bu.</td>
<td>389 bu.</td>
</tr>
<tr>
<td>Elton (3)</td>
<td>343 bu.</td>
<td>336 bu.</td>
<td>351 bu.</td>
</tr>
<tr>
<td>Gravely (4)</td>
<td>329 bu.</td>
<td>276 bu.</td>
<td>362 bu.</td>
</tr>
<tr>
<td>Knapwell (4)</td>
<td>222 bu.</td>
<td>165 bu.</td>
<td>272 bu.</td>
</tr>
<tr>
<td>Lawshall (3)</td>
<td>255 bu.</td>
<td>251 bu.</td>
<td>261 bu.</td>
</tr>
<tr>
<td>Shillington (1)</td>
<td>219 bu.</td>
<td>----</td>
<td>----</td>
</tr>
<tr>
<td>Upwood (3)</td>
<td>330 bu.</td>
<td>313 bu.</td>
<td>419 bu.</td>
</tr>
<tr>
<td>Warboys (5)</td>
<td>371 bu.</td>
<td>286 bu.</td>
<td>441 bu.</td>
</tr>
<tr>
<td>Wistow (3)</td>
<td>328 bu.</td>
<td>240 bu.</td>
<td>451 bu.</td>
</tr>
</tbody>
</table>

*Because of the relatively small sample size, the averages in this table does not include the very bad harvest year of 1297. Sources: PRO 882/13;882/18;882/19;874/5;874/6;874/7; 884/4; 767/12;767/17;767/19;768/31;768/32;785/35;1001/8;1001/10;741/20;885/18; BM 34881;34881; 348770;34884;39803;39805;39891;39892;34894;39895.
Table 3: A Comparison of Average Gross and Net Output of Medieval Arable Workers in Nine Ramsey Estate Manors to the Literature’s Estimates (all in wheat bushel equivalents)

<table>
<thead>
<tr>
<th>Year</th>
<th>Gross Output per Worker</th>
<th>% Dif w/ Average Med. of 224 bu/worker</th>
<th>Net Output per Worker (aggregate for pastoral &amp; arable)</th>
<th>% Dif w/ Average Med. of 154 bu/worker</th>
</tr>
</thead>
<tbody>
<tr>
<td>pre-1350</td>
<td>77 bu (Allen)</td>
<td>+ 191 %</td>
<td>56 bu (Clark)</td>
<td>+ 173 %</td>
</tr>
<tr>
<td>1600</td>
<td>105 bu (Allen)</td>
<td>+ 113 %</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1700</td>
<td>157 bu (Allen)</td>
<td>+ 43 %</td>
<td>65 bu (Allen)</td>
<td>+ 135 %</td>
</tr>
<tr>
<td>1800</td>
<td>195 bu (Allen)</td>
<td>+ 15 %</td>
<td>157 % (Allen)</td>
<td>- 3 %</td>
</tr>
<tr>
<td>c. 1800</td>
<td>246 bu (Allen)</td>
<td>- 14 %</td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. 1850</td>
<td></td>
<td></td>
<td>223 bu (Allen)</td>
<td>- 31 %</td>
</tr>
</tbody>
</table>

72 A conversion of the mixed bushels of wheat was made to wheat equivalent bushels so that a comparison of caloric and real value might be made. Wheat had the most calories per pound of the grains and was the most valuable crop—prices moved in conjunction with those of wheat in these periods. For years used in constructing average and sources, see notes to Table 2.

73 Estimates made using aggregate data for the output of a full-time worker employed in both arable and pastoral sectors. Many historians argue that labor productivity in pastoral work was much higher than that in arable; Clark states that output was 80 percent higher. See his “Labour Productivity,” p. 231. These estimates might be upper bound and the output of a worker employed just in the arable sector could be lower.


75 This estimate and that for c.1850 given in Clark’s “Labour Productivity,” pp. 211-35.

76 Estimates in this column are made using Allen’s “Agriculture,” Tables 5.1 and 5.3, pp. 105 and 107.

77 Many thanks to Timmer for supplying me with his unpublished data for “The Turnip,” which permitted this calculation. In mixed bushels of wheat and barley, each worker produced 346 bushels a year.
<table>
<thead>
<tr>
<th>Year</th>
<th>Value</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>c. 1850</td>
<td>246 bu (Clark)</td>
<td>-38%</td>
</tr>
<tr>
<td>c. 1850</td>
<td>258 bu (Karakacili/McCulloch)</td>
<td>-41%</td>
</tr>
</tbody>
</table>

Made by myself using B. A. Holderness’ correction of McCulloch’s estimate of 1846 agricultural output in England and Wales. I used Holderness’ lower bound estimate of 118 million pounds, and then deducted revenues from wood, gardens, and eggs, since Allen and Clark do not include such output in their own estimates. For workforce numbers, the average of four different estimates for 1851 England and Wales was employed. Workers who were not employed in the arable or pastoral sectors, such as gardeners, florists, and woodsmen, were not included. For a discussion of McCulloch’s estimate, see Holderness, pp. 175-76. McCulloch’s estimate can be found in Ibid, Table III.2(b), p. 1046. For workforce estimates see, \textit{Agrarian History}; Vol. VII, Part II, Tables 41.3a, 41.4b, 41.4d, 41.4e, pp. 1970, 1972, 1974-75.