An Ecological History of Agricultural Land Use in Two Massachusetts Towns

Nicholas Jones
Division III
Natural Sciences
Hampshire College
Amherst, Massachusetts
Larry Winship, Chair
May 1991

Acknowledgements:

I am indebted to David R. Foster, the Director of the Harvard Forest, Petersham, Ma., for his guidance and direction from the beginning to the end of this project. In addition, Gordon G. Whitney, researcher at the Harvard Forest, provided crucial direction in how to approach the subject and was invaluable for suggesting sources of information.

I would like to thank Larry J. Winship, my Hampshire College advisor and committee chairperson, for his assistance in navigating the requirements of Hampshire College and his enthusiastic support of this project.

Byrd L. Jones provided important technical assistance in preparing the manuscript.

Finally, I would like to thank Margaret M. Christie for her untiring editing of my writing and her overall encouragement for my work on this project.

Table of Contents

Introduction

There is a common belief in America that the yeoman farmers of the 18th and 19th century embodied the good qualities of the United States. The small freeholder lived an honest and admirable life. There may be something to admire in those early farmers, but the way they farmed was not necessarily exemplary. Examination of the farming practices of two towns in Western Massachusetts reveals that our agricultural predecessors were mining the nutrients in the soil and probably farming themselves out of business. Although ecological ramifications of farming practices varied with site quality and economic conditions, the general trend was towards declining fertility.

The two towns investigated in this study are Deerfield and Petersham, Massachusetts. Deerfield is set in the Connecticut River valley, at the confluence of the Deerfield and Connecticut Rivers, and contains many acres of prime agricultural soils as well as some steep and rocky hills. Petersham is situated on the central uplands, about 20 miles east of Deerfield. The soils of Petersham are sandy and stony and there is a limited amount of plowable land.

How was land used during the 18th and 19th centuries? Were the farming practices employed in Deerfield and Petersham ecologically sustainable? Could the land continue to be farmed the way they were farming indefinitely? What were the differences in farming practices and the implications of those practices between Deerfield and Petersham? These are the questions this paper seeks to answer.

This study covers the period from 1770 to 1885. The choice of period was partly dictated by the availability of data, but was also influenced by the timing of agricultural changes. There was a shift in agricultural practices at the end of the 18th century; beginning the study in 1770 allowed the inclusion of agricultural practices of the colonial period. I collected data from a number of sources, including tax valuations, state census reports, and federal census returns. The data includes the number of acres of pasture, hay, and tilled land-known as tillage-and the number of animals, such as cows, oxen, pigs, and horses, in each town. Most of the data are aggregate totals for the towns, but I chose two years at opposite ends of my time period, 1771 and 1850, to look at the land use and animal resources of individual farmers. It is through this data, as well as contemporary reports and modern agricultural histories, that I have evaluated the ecological sustainability of agriculture in the 18th and 19th centuries.

Background

Fifteen thousand years ago, New England was covered by a huge ice sheet nearly one mile thick. As the ice moved southward it scraped the land, removing vegetation, soil and bedrock. The ice carved the features of our present landscape, creating valleys and rounding the mountains. As the ice sheet retreated northward it left behind sand, gravel, and boulders that had been carried in the ice and scattered over the bedrock. In Western Massachusetts this glacial till varies in thickness from a few feet to over one hundred feet deep, with most areas covered by five to fifteen feet of till. Slowly, after the glacial retreat, plants crept northward to re-dominate the landscape of Massachusetts.

The soils of Massachusetts originate from eroded glacial till, sand, and decaying plant matter. Over the course of ten thousand years the plants which grew in New England extracted inorganic nutrients from rocks, gravel and sand and made them available to other plants when they rotted away and became a part of the soil. Slowly the topsoil was created and the nutrient resources of the soil increased. Through this process the soils of New England were enriched and became capable of supporting a greater diversity of plant life.

Native Americans lived in New England for centuries before the arrival of Europeans. In Southern New England they practiced a mobile sort of agriculture, raising corn, beans, and squash on a site until the soil fertility dropped too low, then moving to a new location. This cycle took between eight and ten years.[1] They did little, other than add the ash from the forest they burned to create a clearing, to enhance the fertility of their fields. As long as population densities remained at low enough levels, the forest was capable of re-building the fertility of these scattered farming clearings.

When Europeans arrived in America, their first task was to begin to clear the forest. Once the forest was cut, and not allowed to grow back as in the Native American system, it became difficult to maintain the fertility of the soil. In an undisturbed forest, trees and plants hold nutrients in both their living biomass and in the decaying plant matter on the forest floor, thus preventing them from leaching or volatilizing. Forests decrease soil erosion by slowing the movement of water over the land. Finally, forests increase top soil and organic matter in the soil by the continual addition of decayed plants.

---

[1] William Cronon, Changes in the Land, (New York: Hill and Wang, 1983), p. 48.

Farming sustainability became an issue when Europeans established permanent agricultural villages. The continual cropping of land created problems that the Native Americans did not have to confront. Initially, farmers could rely on the organic matter in the soil established by thousands of years of plant decay and microbial breakdown. But unless they returned nutrients to the soil, for example in manure, the fertility would decline. As the population of settlers increased through the 1700s, the way they used the land became increasingly significant. This study will examine the way land was used in two towns with widely varying soil and economic conditions.

Chapter I

Methods

In researching the agricultural history of Petersham and Deerfield I used a variety of tax valuations and census returns that portray the historical changes in agriculture and land use. From these sources I collected data on the acres of land used for different purposes and the number of animals in both Petersham and Deerfield. Although data as late as 1905 is included, most of my data falls between 1771 and 1875. Using different sources of data across a one-hundred year span has proven difficult; the specific items that were tallied changed, definitions of categories varied over time, and the information provided by farmers may have shown biases throughout the time period. Some sources, like the town tax valuations, provided information on an individual basis, while other sources, like the Massachusetts state census, contained aggregate data for an entire town. I combined the various sources to make my calculations, and dealt with the variation between sources as best as possible. The data I have collected provides a fascinating look at the agricultural practices in Deerfield and Petersham.

Data Sources:

Three major sources of data were used: town tax valuations, Massachusetts state census reports, and federal census returns for 1850 (See Table 1). In addition, I relied on a compilation of state census and town tax valuation data put together by researchers at Old Sturbridge Village.

Town tax valuations provided both individual and aggregate data for my study. Town tax valuations were conducted every year to assess local taxes.

In most years these valuations contained a list of polls (males over sixteen years) and the value of a landholder's real and personal estate. Approximately every ten years, the Massachusetts General Court required a more complete valuation including a detailed list of the property held by landowners in order to recalculate tax burdens for each town. While the state was only interested in the aggregate totals for the towns, the towns would retain a copy of the individual information.[1] These more complete tax valuations were extremely detailed, listing horses, oxen, cattle, acres of pasture, hay, and tillage, bushels of grain produced, and other items on each parcel of land or for each property holder in town. The earliest town tax valuation I used, 1771, also included an estimation by farmers of the number of cows that their pasture could support. These detailed valuations were made on a decadal basis and with a few exceptions the data I have are spaced evenly every ten years. For many years the individual information that was retained by the towns is lost and all that remains is the aggregate state data currently stored in the state library. These aggregate compilations are what I relied on for data for the years 1771 to 1850.

---

[1]Bettye Hobbs Pruitt, "Agriculture and Society in the Towns of Massachusetts, 1771: A Statistical Analysis," Diss. Boston University Graduate School, 1981, p. 1.

Table 1. Summary of Data

Source of Data	Periodicity	What I Used
Town Tax Valuation: Contains individual and aggregate data.	brief assessment of real and personal estates annually. Comprehensive valuation completed decadally; aggregate valuations reported to state.	Aggregate data from 1771-1850, individual data from 1771.
State Census Reports: Contains aggregate data only.	Reported decadally beginning in 1845.	Aggregate data from 1855-1885, a few categories included data up to 1905.
Federal Census Returns: Contains individual data only.	Decadal census	Individual data from 1850.

Massachusetts state census returns comprised the second major source of data. Published every ten years beginning in 1845 as either Statistics of the Condition and Products of Certain Branches of Industry in Massachusetts or as The Census of Massachusetts, these census reports included only aggregate data for each town. As the titles suggest, they were primarily concerned with what and how much farmers were producing, rather than with how much land they owned. The information provided by the state census reports is not as detailed or as useful as that found in the town tax valuations. For example, pasture was not noted specifically on these reports, though presumably it was included in the category of 'improved land' along with tillage and hay land. Beginning in 1885, the acres of hay lands and the acres of individual crops such as corn and rye were no longer reported; they only reported the bushels of grain and tons of hay produced. While these numbers provided information about the output of farming as an industry and economic activity, they reveal few details about how the land was used. On the other hand, state census reports included information omitted from town-based tax valuations. The state reports were responsive to changes in what crops were being grown and sold. For example, by 1825, the growing of broom corn for making brooms had become quite popular with Deerfield farmers; yet town tax valuations made no mention of broom corn, while the state census reported 111,357 pounds produced in 1845. Likewise, town reports ignored potatoes which were tallied in the aggregate output recorded by the state. Despite the differences between my two major sources, state census returns and town tax valuations, together they provided complementary information on Deerfield and Petersham over a century.

Federal census returns provided individual taxpayer information where no other sources were available. The Seventh U.S. Census of Massachusetts for the year 1850 described individual farms in Petersham and Deerfield as did town tax valuations in 1771. The federal census listed the property of individuals in each town considered to be farmers, unlike the town tax valuation which included all property owners. According to the U.S. Census instructions to census marshals, their list included:

> The returns of all farms and plantations, the produce of which amounts to one hundred dollars in value, are to be included in this schedule; but it is not intended to include the returns of small lots, owned or worked by persons following mechanical or other pursuits, where the productions are not one hundred dollars in value.[2]

These criteria exclude many part-time farmers with small individual holdings whose combined agricultural property could add significantly to the cows, horses, or acres of pasture in each town. The data from the U.S. Census was not used as the aggregate data in any of my calculations, but was only used to

[2]From the U.S. Census of 1850, Instructions to Marshal and Assistants. (Washington, DC: Robert Armstrong, 1853).

analyze on an individual basis the differences between farmers in Petersham and Deerfield in 1850 and to compare to the individual data collected from 1771 tax valuation. I could not find satisfactory individual data from tax valuations dating from the middle of the 19th century for both towns. The 1845 individual tax valuation was available for Deerfield, but Petersham, perhaps because of a misunderstanding by the town tax collector, did not specify the categories of land on farms. For example, the tax records would list sixty-nine acres of farmland without distinguishing between hay fields, woodland, pasture, and tillage. These distinctions were essential to my study, so I turned instead to the U.S. census returns.

Another important resource for my research has been the data compiled by Old Sturbridge Village (OSV) in Sturbridge, Massachusetts. They have computerized most of the available tax valuation data for every town in Worcester County. This saved me a great deal of time in locating each decadal tax valuation for Petersham. I provided the 1771 and the 1784 valuations and the rest of my Petersham data up to 1850 came from the OSV compilation. The OSV data, which covers over 50 years, is compressed onto one page, which makes it easy to see the variations in what information was recorded over time.

The data which makes up my study consists of numbers of animals, acres of land, and quantities of farm products produced. Regarding animals, I was specifically interested in the numbers of horses, oxen, cattle, sheep and pigs owned by farmers. Cattle were divided into various categories that changed over time, including 'cows four years and older,' 'cows and steers three years and older,' and 'other cattle.' Beginning in 1831 steers and cows one year plus were counted. Similarly, I collected data on the number of acres of pasture, upland mowing, fresh meadow, and tillage. Upland mowing, also known as English hay, consists of grasses and clovers imported from England that were planted on land that was cultivated or plowed. Fresh meadow was hay land containing native grasses that were usually not planted, often growing on swales and along streams or rivers. Land that was plowed, planted, and cultivated on a yearly basis was called tillage. This included land growing corn, wheat, oats, barley, peas, and rye and later potatoes. Tillage would not have included the ubiquitous home garden plot. Perhaps most crucial to my study of agricultural ecology is the data I collected on agricultural yields. This included data on tons of hay produced per acre and bushels of grain grown per acre.

Constraints of Data

In combining this data to describe the agriculture of Petersham and Deerfield I have encountered numerous obstacles. Some of the difficulties inherent in the data have been mentioned, but a number of specific problems should be addressed. The data concerning Deerfield may underrepresent Deerfield in both number of animals and acres of tillage. A common practice in Deerfield, well established by 1750, was to fatten beef cows during the winter for marketing in the spring.[3] The 1771 tax valuation was conducted in September, well before the large Deerfield farmers had purchased their winter fattening stock, so the valuation would substantially under count the livestock of Deerfield. In 1811, the Deerfield valuation was done in the

---

[3]Ritchie Garrison, "Farm Dynamics and Regional Exchange: The Connecticut Valley Beef Trade, 1670-1850," Agricultural History, 61, No. 3 (1987), p. 3.

middle of October; this may have included some of the winter stock. The only other known date is for the 1850 federal census which was conducted in July. In all likelihood, the census reports frequently underrepresented the animals of Deerfield. It is also likely that Petersham farmers frequently sold some of their livestock in the fall to limit the number of animals they had to overwinter. The timing of the tax valuation or census could have misrepresented the data of both Petersham and Deerfield.

In addition, tillage may have been undercounted in Deerfield as a result of the relatively unique crops grown in the Connecticut Valley towns. The tax valuation forms provided to towns apparently did not ask for information on the acres of broom corn, which was grown in significant quantities beginning in 1825. It is not until the Massachusetts census of 1845 that it appears and then only as number of bushels with no indication of the acres devoted to broom corn. The lack of data on broom corn means that it does not appear anywhere in my data. Clearly, the timing of the valuation assessment and the questions posed to property owners impacted the information recorded and thus the data available today.

There are numerous difficulties in assuming too much accuracy in any of the tax valuations or census returns. John D. Black, in his study <u>The Rural Economy of New England</u>, questions the accuracy of all of the data sources I have used, and points out the difficulty of comparing various sources. Although his analysis is primarily of early 20th century data, in many ways it applies to earlier time periods as well. He asserts that federal farm census' have never been complete because of inadequate counting, particularly in the Northeast where the number of part-time farms is high and many potentially qualifying farms were omitted. Changing definitions of a farm also caused fluctuations in U.S. census statistics, though this did not impact my research since I used only the 1850 U.S. census. Fortunately for my research, Black believes that Massachusetts had the best state census of any New England state. The Massachusetts state agricultural census was conducted every ten years from 1845 to 1905. Black confirms my discovery that they "did not always assemble the same information and they changed their definitions freely," but he goes on to say that the state census was more reliable than the federal census:

> Obviously the Massachusetts state census reported the agriculture of the state more fully than did the federal census. The difficulty is that it reported it with increasing completeness over the decades, with the result that Massachusetts agriculture appears to have increased.[4]

Black also has found problems with town tax valuations, which I would rate as the most accurate of the three sources. He states that there are substantial irregularities over time in the township data.[5] This variation I would attribute to varying vigilance and accuracy of data collection in the towns. In addition to Black, C.L. Flynt wrote during the 1860s about the varying degrees of accuracy of different data sources. He found that during the 1860 U.S. federal census the produce of farms was substantially underreported when compared with the figures collected by individual towns for the same year. The hay crop was underreported by 5% while the number of horses differed by 48%.[6] This distinction is due in part to the U.S. census only counting the property and produce of "farms" while the assessors included

---

[4]John D. Black, Rural Economy of New England (Cambridge: Harvard University Press, 1950), pp. 61, 63.

[5]Black, 1950, p. 60-61.

[6]C.L. Flynt. Agricultural Statistics of Massachusetts (Boston: Massachusetts Board of Agriculture, 1862) pp. 297-299.

everything in the town. This difference is particularly noticeable in the number of horses reported. In light of Black's and Flynt's research I think that the town tax valuations are the most accurate source of data and that the state census reports are the second most accurate data source. Appropriately, these are the resources I have relied on most.

Data Calculations

My sources and the information they provided and their limitations formed the parameters for the comparisons and calculations I have made with the data. The bulk of my research relies on data from the town tax valuations completed between 1771 and 1850. From 1855 through 1885 and beyond I used the Massachusetts census reports. These two sources provided all of the aggregate statistics for Deerfield and Petersham and gave me the opportunity to explore the changes that took place in these two towns over time. The 1771 tax valuations and the 1850 U.S. census supplied particularly detailed data from opposite ends of my time period. It was through these snapshots of Deerfield and Petersham that I analyzed the relationships between various parts of each individual farm.

An important component of my study is the farm animals and how they related to land management. To effectively look at animals and how they related to land use--for example, acres of hay or yields per acre of tillage--I needed to devise a common base or denominator for the animals on a farm. This common base I call an animal unit. I approached this problem in two different ways. There are two ways, though closely interconnected, in which animals relate to land use. One is through feed, or the amount of land that is necessary to support each animal unit. The other is through manure, and the amount of manure that is produced by the animals on a farm. Different animal unit calculations were necessary to resolve these two ways animals relate to the land. In the literature and through discussion, I discovered two animal unit calculations for feeding or animal units(f). I chose the animal unit(f) with more documentation: 1 cow = .75 horse = 7 sheep.[7] An equivalency calculation for manure production was not to be found in the literature so I developed my own calculation.

My goal in creating animal unit calculations for manure production--animal units(m)--was to establish the amount of manure available to farmers to spread on their fields. I did my calculations based on the nitrogen produced by farm animals, including cows, oxen, horses, sheep, and swine. I assumed that fifty percent of the year these animals would be grazing on pasture or foraging in the woods and voiding their manure where the farmer had no opportunity to redirect its fertility. The time spent on pasture or foraging decreased over my time period as farmers became more concerned with maximizing their labor and directing their efforts toward the marketplace by feeding high quality hay and feed in the barn.[8] I chose fifty percent spent on pasture as

---

[7]Brian Donahue, "'Skinning the land,'" Unpublished manuscript, Brandeis University, 1984, table 4, 1 cattle = .75 horse = 7 sheep. Jerran Flinders, "An Alternate Method of Calculating Animal-Unit Equivalents," Society of Range Management, Annual Meeting, 33, 1980, p. 54. uses 1 cattle = .8 horse = 5 sheep. The other commonly known equation is 1 cattle = .75 horse= 5 sheep. This third one was suggested orally by a number of people, including Amherst College Historian, Kevin Sweeney.

[8]Discussion with Jochen Welsh, staff at OSV. Feb. 1991. and Henry Colman, Fourth Report of the Agriculture of Massachusetts, (Boston: Dutton and Wentworth, 1841), pp.51-121. In fact, 5 months may be closer to the time animals are kept in the barn yard, but some farmers toward the later period cut green forage and fed their animals in the barn even during the warmer months in an effort to fatten their animals.

an approximate average, with more than six months spent grazing in 1771 and probably less than six months spent grazing in 1875. Getting the manure to the barnyard was only half the story. Much of the nitrogen in the manure that did end up in the barnyard was lost, primarily through volatilization, but also by run-off and leaching. A significant portion of the nitrogen in manure is in the urine and even the "solid" excrement is 55% to 80% liquid.[9] In a barnyard, manure, even piled, would be subject to substantial leaching by rainfall and without any hard surface to retain the urine, significant quantities of the nitrogen would be leached away. Despite this, the ecologist R.S. Loomis, in critiquing medieval agriculture, suggests that it is difficult to mismanage manure so badly as to lose more than 60% of the nitrogen.[10] Accordingly, I have estimated a 50% nitrogen loss through mishandling of the manure in the barn and barnyard. This means that 25% of the nitrogen produced by farm animals had a chance of making it on to cultivated land. Whether farmers actually made full use of the available manure will be addressed later.

I calculated the nitrogen produced by various farm animals in the following manner. First, I estimated the weight of the average animal in 1830 (approximately half-way between 1771 and 1875) with the assumption that animal weights were steadily climbing during this time period.[11] Then I calculated

---

[9]Robert Parnes, Fertile Soil (Davis, CA: agAccess, 1990), p. 133.

[10]R.S. Loomis, "Ecological Dimensions of Medieval Agrarian Systems: An Ecologist Responds," Agricultural History, Vol. 52, No 4 (October 1978) p. 480.

[11]Weights for cows, oxen, horses, and pigs were obtained orally from the OSV Interpretation Dept. The avg. weight for sheep was obtained from conversation with Jill Horton Lyons, farmer, Feb. 1991 and Henry Colman, 1841, pp. 98-129.

the pounds of manure produced by animals of that weight. Next I converted pounds of manure to pounds of nitrogen. Lastly, I divided by four based on the manure loss estimated in the preceding paragraph and arrived at a pounds of nitrogen produced per animal per year and potentially available for use by farmers (See Appendix A for numbers and calculations involved). I then used these numbers to compare the nitrogen produced by different farm animals. I chose oxen, with 60 lbs. of nitrogen, as one animal unit(m) and related the other animals to oxen: 1 oxen = .667 horse = .667 cow =.25 swine = .067 sheep. The total number of animal units on a farm is not an absolute number, but is useful in comparison with animal units on other farms or in other years.

The variation and limitations of the data affected the results of my animal unit estimates. Neither of my animal units calculations included young animals. Cows and steers younger than three years as well as colts were excluded. This is because neither were listed on tax valuations until 1831; even beyond that date, their inclusion was not consistent in Deerfield or Petersham. While I include swine in the animal units(m) calculation, this number for the most part does not include pigs which were raised for slaughter. The tax valuations only counted swine, defined as pigs older than six months and considered breeding stock. Similarly, lambs were not included in the accounting of sheep, and goats, while an insignificant population except when America was first being settled by Europeans, are included with sheep in 1771 and not counted at all from then on. The exclusion of all these young animals should be considered when viewing my animal unit data. Due to variation in data over the years I discarded valuable data concerning young animals.

As a counterpart to nitrogen produced by animals I have estimated the amount of nitrogen that corn grown in 1771 and 1850 would have removed from the soil. Corn was the dominant crop grown on tillage land and the nutrients removed in the grain and stalk comprised the majority of the nutrients lost from tillage land. I used data on pounds of nitrogen removed by corn located in Parnes and Hopkins.[12] [13] Their data was for corn with much higher yields than the corn grown in the 18th and 19th century. I divided their numbers to achieve a number relevant to the 10 bushel per acre average in 1771 and 20 bushel per acre average in 1850. These average yields were estimated from the 7.2 bushels per acre in Deerfield and 14 bushels per acre in Petersham in 1771 and the 17 and 24.4 bushels per acre in 1850 in Deerfield and Petersham respectively. At the 1850 yield of 20 bushels of corn per acre I calculated 51 lbs. of nitrogen removed per acre with the data in Parnes and 30 lbs. of nitrogen removed per acre using the data provided by Hopkins. The 1771 yield of 10 bushels per acre gave a 26 lb. loss of nitrogen using Parnes and a 15 lb. loss of nitrogen using Hopkins.

I decided to use the results calculated from the Hopkins data for two reasons. Hopkins did his analysis in the first decade of the 20th century and his corn plants were physiologically closer to the corn grown in both 1850 and 1771. In addition, the lower quantities of nitrogen calculated from the Hopkins data seemed to fit nitrogen producing capacity of the farms more accurately (see figs. 23-24).

---

[12]Parnes, 1990, p. 126.

[13]Cyril G Hopkins, Soil Fertility and Permanent Agriculture (Boston: Ginn and Co., 1910), p. 154.

My calculations did not end with animal units and nitrogen content of corn. I had to make a number of adjustments to the 1850 data on individual farms because it lacked information on acreage. Though the 1771 town tax valuation included data on both acres of grain or tillage and acres of hay, neither were included in the 1850 U.S. agricultural census. The U.S. census was primarily concerned with quantities produced and thus left out information on acres of grain or acres of hay and recorded only bushels and tons. To compare land use in 1850 with that in 1771 I needed acres of these crops in both times. I was able to extrapolate using the Massachusetts statistics of agriculture reports and assign average values of yields to each farmer. With estimates of bushels per acre I was able to estimate the number of acres of each crop grown.

The technique I used for estimating grain and hay yields in 1850 was a little different in Petersham than in Deerfield. In Petersham, I took the bushel per acre grain production data from the 1855, 1865, and 1875 Massachusetts agricultural censuses and averaged them. These numbers seemed erratic, not showing any upward or downward trend in yield so it made sense to average them together to smooth out the bumps. The Petersham yields I estimated to be 30 bu/acre of oats, 33 bu/acre of corn, 15 bu/acre rye, and 12.5 bu/acre of wheat. In Deerfield I found that there was a steady rise in grain yields in the Massachusetts census reports between 1855, 1865, and 1875, so I used the 1855 yields to get the best estimate for the 1850 U.S. census. The yields for Deerfield farmers were as follows: 28 bu/acre of oats, 35 bu/acre corn, 10 bu/acre rye, and 13 bu/acre of wheat. I then applied these numbers to each farmer in the census so that if one looked at my 1850 data all the farmers in Deerfield appear to have the same yields per acre and all the farmers in Petersham also have the same yields per acre. For potato yields I followed an identical procedure in both towns. I averaged the yield data from the 1855, 1865, and 1875 Massachusetts census reports and applied these yields to the individual farmers in the 1850 census. The yields were 118 bu/acre in Deerfield and 104 bu/acre in Petersham. With the above manipulations, I was able to roughly estimate the acres of tillage land on each farm.

The 1850 U.S. census contained no information on the acres of hay grown, only on tons of hay produced. In addition, fresh meadow hay was not distinguished from upland mowing hay even though the nutritive value was significantly greater in upland mowing. This problem was approached similarly to the way I handled the lack of information on acres of various grains, except that I used a different source. For Petersham, the yields recorded in the 1850 aggregate town tax valuation were the best source. I used the yield recorded for upland mowing 0.934 tons/acre rather than fresh meadow, 0.740 tons/acre because fresh meadow constituted only 15% of the hay crop in 1850. I applied the figure of 0.934 tons/acre to the individual data on tons of hay produced in the 1850 U.S. census to get figures for acres in hay. In Deerfield I also used the aggregate town tax valuation to obtain hay yield information which I could apply to the farmers listed in the 1850 federal census. Fresh meadow composed 50.2% of the hay crop in Deerfield in 1850, though this changed drastically within five years as upland meadow increased and fresh meadow decreased. I averaged the yields, 1.1 tons/acre of upland mowing and 1.43 tons/acre for fresh meadow, and obtained a yield of 1.26 tons/acre for Deerfield hay producers. This average yield was used to calculate the acres of hay grown by each farmer in Deerfield listed on the 1850 U.S. census.

It has proved challenging to combine data from tax valuations which span seventy years and Massachusetts agricultural reports that cover thirty years as well as federal census returns. I have tried to manipulate the data to reveal the patterns of agriculture without compromising the validity of the data. Even without the additional complication of combining these various sources, no source is entirely accurate even used alone. The month or season when the census or tax valuation was conducted has an impact on what data appears. Animal units(m)(f) are a useful tool for analyzing the nutrient relationships on farms, but their shortcomings are numerous; probably the most significant is the absence of colts, heifers, and other young animals. Despite all these limitations, these sources provide critical insights and allow description of land-use practices spanning one hundred years beginning more than two centuries ago.

Chapter II

Physical and Cultural Setting

Before I discuss the differences between the types of agriculture in Deerfield and Petersham, I will investigate the forces that influenced the way agriculture practices developed in the two towns. There were many influences on the development of towns in 18th and 19th century Massachusetts: the settlement history and location, the local geography, the soils, and the economic opportunities available to residents. The different influences on Petersham and Deerfield had direct consequences for the ecological sustainability of their local agriculture.

Deerfield was established as a land grant to the town of Dedham from the Massachusetts General Court. After an extended dispute, Dedham donated two thousand acres to a Native American settlement in the neighboring town of Natick. The Deerfield site was compensation to the town of Dedham for their loss of two thousand acres. In 1665, the Pocumtuck Valley was chosen as the site of the land grant by a team of surveyors. In 1827, Erastus Worthington quoted one of them as commenting:

> It is the best land we have seen in this colony; we dug holes in the meadow, with the intent to find the depth of the soil, but could not find the bottom. At the foot of the little hill we stood on, is a plat of ground sufficiently large to build a village upon, and sufficiently high to be out of the reach of spring flooding.[1]

When first settled Deerfield had large open meadows that had apparently been farmed by Native Americans; it was these unique treeless expanses which attracted the land surveyors to Deerfield.[2] The Pocumtucks were the dominant

---

[1]Erastus Worthington, The History of Dedham (Dutton and Wentworth: Boston) 1827, p. 25.

[2]Worthington, p. 25.

tribe that cultivated the fertile meadows of Deerfield. In the winter of 1637-1638, Englishmen in Connecticut were saved from starving by William Pynchon, a fur trader and agricultural exporter who founded Springfield, when he bought 500 bushels of corn from the Pocumtucks.[3] Deerfield was purchased on the behalf of Dedham from the Native Americans by the wealthy merchant, John Pynchon, the son of William Pynchon.[4] The Pynchon family played a similar role in other Connecticut Valley towns established during the 17th century. Despite the Massachusetts General Court land grant, Deerfield still had to be bought from the native residents.

The settlement of Deerfield, then the northern most town in the Connecticut River Valley, began in 1671. Shortly after the first houses were built, the town suffered a serious Indian attack that forced the abandonment of the village. Deerfield was resettled permanently in 1682, but continued to come under periodic though lessening attack until the middle of the 18th century.[5] The population of Deerfield did not grow rapidly during its first 100 years. There were only 737 townspeople by 1765, but thirty-five years later, in 1800, there were 1531.[6] The settlers of Deerfield had emigrated from Dedham; this group settlement helped give the town resilience against

---

[3] Elizabeth Harding Roessel, "A Study of the Deerfield Landscape: 1660-1860," Historic Deerfield Summer Fellowship Program, 1979, p. 11.

[4] Stephen Innes, Labor in a New Land: Economy and Society in Seventeenth Century Springfield (Princeton, NJ: Princeton University Press, 1983), p. 26.

[5] Rodulphus Dickinson, View of the Town of Deerfield (Deerfield, MA: Graves and Wells, 1815), p.26-27.

[6] For more information on population, see Appendix C.

these repeated Indian attacks and the difficulties of being an outpost town in the newly settled country.[7]

The origins of Petersham were somewhat different than those of Deerfield. The town of Petersham, initially called Volunteers Town, then Nichewaug after a local Indian settlement, and finally Petersham, was granted to veterans of the French and Indian Wars by the General Court of Massachusetts.[8] Land was more available to the state than cash, so they paid their soldiers with land.

Petersham was almost entirely covered by a dense forest when the town was established in 1754. The few clearings that existed from fire or possibly from abandoned fields of Native Americans were the first lots taken by settlers.[9] Seventy-one proprietors held title to the land in Petersham. Most of these proprietors never moved to Petersham; they used the land purely as payment for their efforts in the war. Nancy Gordon points out that while many town residents had surnames matching those of the proprietors, only three of the original proprietors appeared to have lived in Petersham. They viewed their proprietor's rights as a capital asset, either to be sold or given to their children as inheritance.[10] Despite being settled later than Deerfield, the population of Petersham was nearly equal to Deerfield's by 1765 with 707 people, and by 1800 there were 1794 residents.

---

[7]Douglas R. McManis, Colonial New England: A Historical Geography (New York: Oxford University Press, 1975), p. 53.

[8]Hugh M. Raup and Reynold Carlson, The History of Land Use in the Harvard Forest, Bulletin No. 20, (Petersham, MA: Harvard Forest, 1941), p. 17.

[9]Raup and Carlson, 1941, p.23.

[10]Nancy Gordon, "The Harvard Forest Model: Is that the Way it Really Was?" MSS Thesis, University of Massachusetts, 1986, p. 2.

Another interesting comparison between the settlement patterns of these two towns is the format of the land divisions. Common to both towns was the institution of "proprietors" which gave certain families significant claim to land in the town. Only those families initially granted land were considered "proprietors" and entitled to subsequent division of outlying parcels of land.

The town of Deerfield was laid out in the manorial style of England. The houses of the village were clustered together and the fertile meadows were divided into narrow strips with a common fence surrounding the entire field. This division system represented the communal attitude of these early settlers. With the threat of Indian attacks and the scarcity of labor and tools, this system provided more efficiently for the safety and well-being of the townspeople.

Petersham, settled later than Deerfield, embodied a more individualistic form of land division. In Petersham the houses were not clustered together but rather laid out on a grid in which a farmer's fields and home were together.[11] Land was parceled out in a series of divisions. The first division produced home lots of fifty to one hundred acres upon which the nucleus of the farm would operate. Four subsequent divisions of outlying land were made, increasing the holdings of the original grantees. In Petersham most of the grantees became absentee owners who rented or leased their land, and when later divisions were made they were not available to show their interest in plots which were adjacent to their initial division. Many land owners ended up with holdings scattered about the town rather than an assemblage of contiguous pieces.[12]

---

[11] McManis, 1975, p. 65.

[12] Raup and Carlson, 1941, p.18.

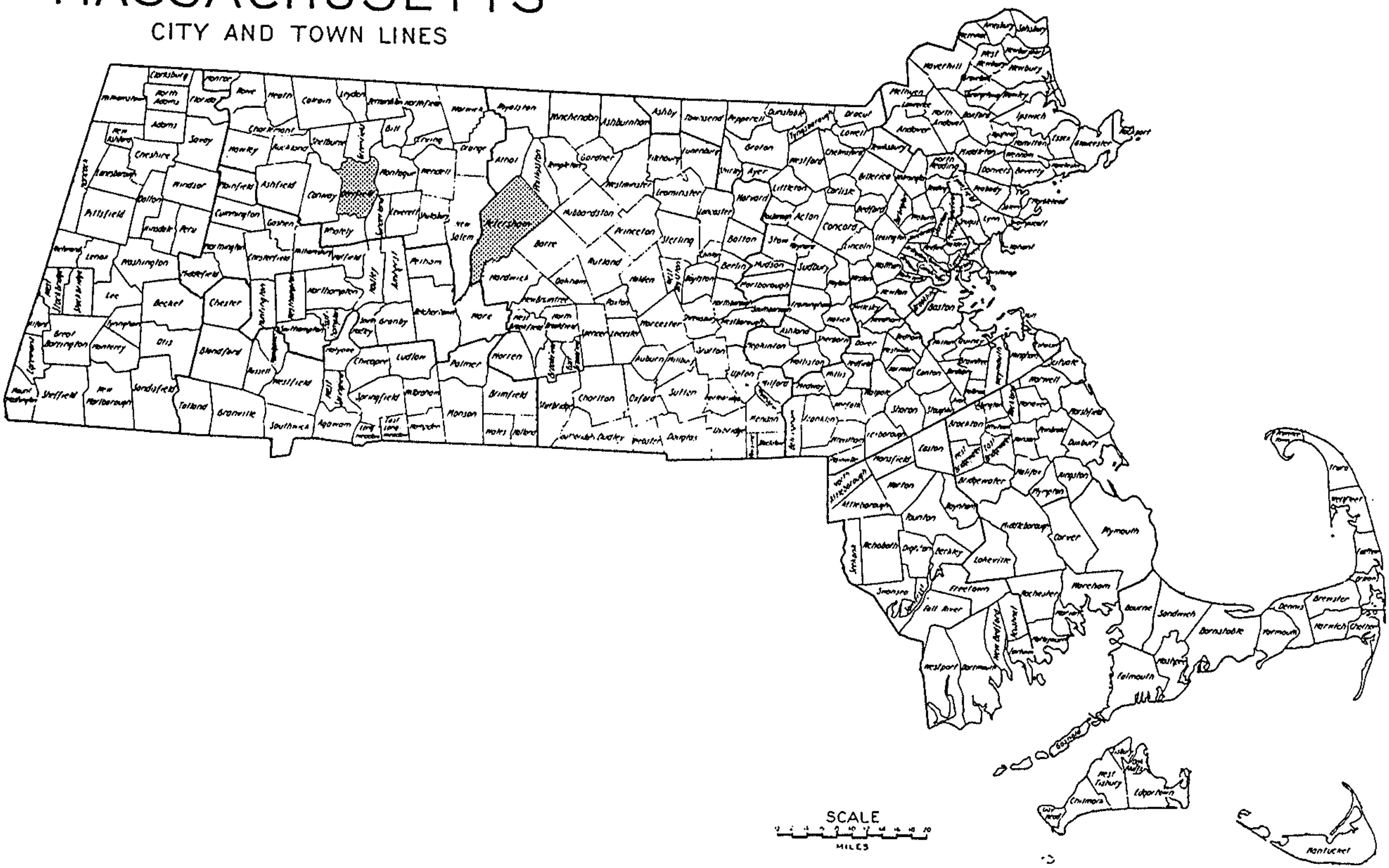
Geography

Located in the Connecticut River Valley, Deerfield included many soil types and great topographic variation. Initially in Hampshire County and later in Franklin County, Deerfield is bordered by the Connecticut River to the east and crossed by the meandering Deerfield River as it flows towards its confluence with the Connecticut (see map of Massachusetts). The town ranges in elevation from 150 feet on the meadows near the town center to over 950 feet at Arthurs Seat in the north-west corner of the town. The average yearly precipitation, measured at Turners Falls (slightly upriver on the Connecticut and at an elevation of 190 feet), is 43.6 inches and the average yearly temperature, also measured at Turners Falls, is 48.8° Fahrenheit.[13] The two most striking characteristics of Deerfield are its rich, flat farmland and the ridge of mountains, the Pocumtuck Range, running north-south through the town, culminating in South Sugarloaf Mountain. From the top of the red cliffs of Sugarloaf Mountain one can see across the whole Connecticut River Valley, from Amherst to Northampton south to the Holyoke Range and including most of Deerfield and the hill towns to the east and west. The foothills of the Berkshires rise on the west side of the town, making this section the rockiest and sandiest quarter of the town. The central village of Deerfield is in the northern part of town, near the Deerfield River and surrounded by natural meadow land to the north and south. South of the town center, in the valley formed by the Pocumtuck Range and the hills on the west, the land is level and

[13]U.S.D.A., Soil Survey: Franklin County Massachusetts, Soil Conservation Service in cooperation with Massachusetts Agricultural Experiment Station, (Washington, DC: GPO, 1967).

MASSACHUSETTS

CITY AND TOWN LINES



of good agricultural quality most of the way to the border with the next town, Whately.

Located in the central uplands of Worcester County, Massachusetts, Petersham is a town of rolling hills and rocky soil. The center of town is situated on the central ridge running north-south through the town. The town's average elevation is 920 feet, with no extreme heights or low points, though in the north the land reaches nearly 1300 feet. The average yearly temperature is 47° Fahrenheit and the average annual precipitation is 42 inches.[14] The east fork of the Swift River flows south-ward through most of the length of the town. In the 1920s, four entire towns to the south and west of Petersham were flooded to create the Quabbin Reservoir to provide water for Boston and its neighboring communities.

Though both Petersham and Deerfield have undergone significant changes in their physical size, both were relatively stable during the period 1770 to 1880. Before 1770, Deerfield lost parcels of land as Whately, Conway, Shelburne and Greenfield were carved out of Deerfield's initial land holdings. Petersham also lost land before 1770 to both Athol and Dana. Both Petersham and Deerfield experienced minor boundary changes during the 19th century. The specific number of acres lost in these changes could not be determined, but the larger land transactions occurred outside of the time period studied here.[15] In 1815, Deerfield's boundaries were eight miles by five miles or 25,600 acres and one can assume this to be representative of Deerfield's size

---

[14]John D. Black and Ayers Brinser, Planning One Town (Cambridge: Harvard University Press, 1952), p. 4.

[15]Conversations with Kevin Sweeney, Amherst College Professor and David R. Foster, Director of the Harvard Forest.

throughout the time studied.[16] Petersham's area hovered around 24,000 acres from 1781 until 1927 when the Quabbin was flooded and Petersham annexed an additional 10,000 acres from Dana, Greenwich and Prescott.[17] In conclusion, between 1770 and 1880 Deerfield and Petersham were similar in size and thus comparisons between them are appropriate.

Soils

The soils of both Petersham and Deerfield are brown podzols which have a thin organic layer over a narrow mineral layer. When cultivated these soils are easily leached of nutrients, particularly the neutralizing bases such as calcium and magnesium, resulting in an increase in soil acidity and a reduction in its agricultural productiveness. In addition, cultivation tends to volatilize the organic matter which is initially present in the soil, leaving just a mineral soil and reducing yields. The forest cover which predominated across New England before the Europeans arrived built and maintained the humus in the soil. Without this forest cover the soil tends towards lower and lower fertility.[18]

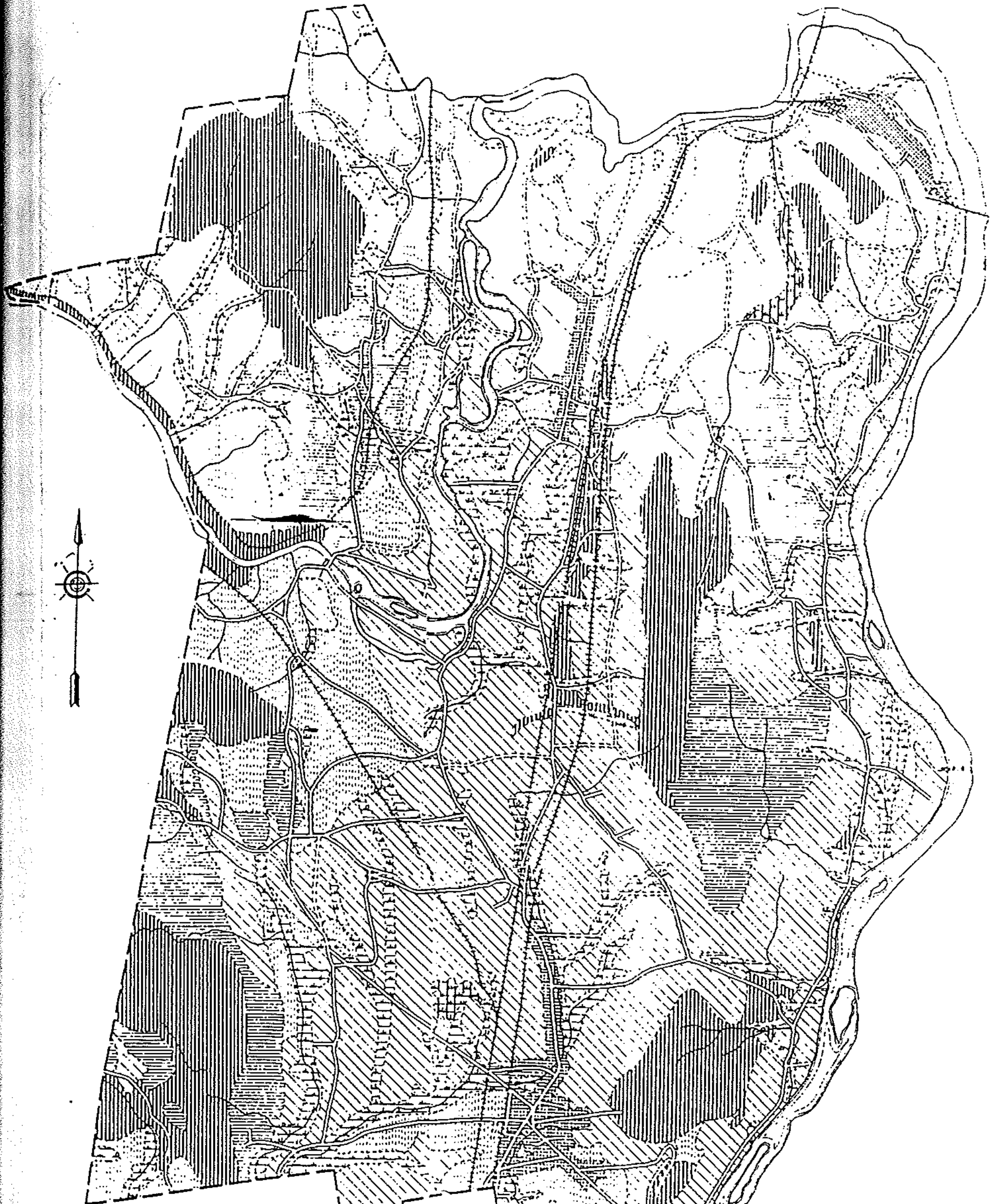
The differences between the soils of Deerfield and Petersham are striking (see soil maps, from "Experiment Station, Massachusetts Town Statistics"). Moist and good textured soils constitute nearly half the land in Deerfield. All of this land is considered good for agriculture. Petersham

---

[16] Dickinson, 1815, p. 1.

[17] Michael Joseph Connolly, Historical Data Relating to Counties, Cities, and Towns in Massachusetts 1975. and Black and Brinser, p. 8. 1952.

[18] Stephen Hopkins Spurr, "Stand Composition in the Harvard Forest as Influenced By Site and Forest Management," Diss. Yale University. 1950.



Soil Map of Deerfield

SYMBOLS FOR SOIL CLASSIFICATION MAP

GROUP I – VERY DROUGHTY SOILS
(PRINCIPALLY COASTAL AND DUNE SANDS)

GROUP II – DROUGHTY SOILS
(USUALLY SOILS OF THE SANDY LOAM AND LOAMY SAND SERIES)

GROUP III – SOILS BOTH MOIST AND OF GOOD TEXTURE
(WELL-WATERED LOAMS AND THE BETTER SOILS OF THE ABOVE TEXTURED GROUP)

GROUP IV – SOILS MOIST BUT SOMEWHAT ROUGH AND STONY (STONY SOILS OF VALLEYS AND LOWER FOOTHILLS)

GROUP V – ROUGH AND STONY SOILS
(ROUGH STONY AND OTHER OF THE VERY STONY AND STONY LOAM GROUP)

GROUP VI – WET SOILS
(ALL SOILS MORE OR LESS SATURATED YEAR ROUND, WITHOUT STONES)

GROUP VII – WET STONY SOILS

GROUP VIII – WATER BODIES

GROUP IX – THICKLY SETTLED AREAS

Soil Map of Petersham

has a narrow strip of these good agricultural soils along the main north-south ridge upon which the town is built and some in the western corner of the town, comprising about one fifth of the town. Thirty-four percent of Petersham's soil is moist, but rough and stony and difficult to plow. Over 40 percent of Petersham is considered unsuitable for agriculture because of the rough, stony and droughty nature of the soil. In Deerfield, the soils considered unsuitable for agriculture comprise only 23 percent of the land.[19] The differences between soil types will be explored more fully in this chapter.

Petersham's soils are primarily shallow sandy loams with considerable stoniness in nearly all soil types. These droughty soils require more manure to maintain their fertility than the rich soils of the Connecticut River Valley. The best soils of Petersham are located along the same north-south ridge as the center of town. Charlton loam, which has a good moisture holding capacity but some stones and boulders, comprises a strip of land running along the top of the north-south ridge. Flanking the Charlton loam to the west is Gloucester stony loam and on the east is Charlton stony loam. Gloucester stony loam is a dark brown sandy loam to about five inches whereupon it begins to change to a grey, coarse, sandy, un-weathered till.. This soil drains rapidly and because of the abundance of rocks is by modern standards considered useful only for forest and pasture land.[20] Gloucester loams are usually more susceptible to drought than Charlton loams and need greater

---

19"Experiment Station, Massachusetts Town Statistics, (RG 15/2.23," Deerfield, Franklin Co. and Petersham, Worcester Co., (University of Massachusetts, Amherst, MA: Archives, ND).

20U.S.D.A. and Massachusetts Dept. of Agriculture, Soil Survey of Worcester County, Massachusetts (Washington, DC: GPO, 1927).

fertilization, but are fine soils for hay and pasture. Charlton loams are considered good for agriculture, including tillage, if there are not too many rocks present.[21] The remainder of the town has pockets of these more productive soils, but large parts of Petersham are too steep, too stony or too droughty for agriculture.

The soils of Deerfield are rich and benefited greatly from the annual flooding of the Deerfield River and the occasional flooding of the Connecticut River. Underneath the subsoil there is a 100 to 120 foot thick layer of clay deposited by Lake Hitchcock, which covered the Connecticut Valley over ten thousand years ago. This clay layer has an aquifer trapped above it which aids in maintaining soil moisture.[22] The North Meadows, which includes the land to the west and north of the town center bounded by the Deerfield River, is nearly all part of the Hadley Soil series. Crossing onto the west side of the Deerfield River there is another piece of land within the Hadley Series. South of the town center is the South Meadows and another large stretch of Hadley Series. Other parts of the town consist of Winooski, Agawam, Ninigret, Belgrade, and the poorly drained Raynham and Muck soils. Hadley Series soils form in deep deposits of alluvial sediments and are some of the best agricultural soils in the world. They are well drained, yet have a high moisture holding capacity. They tend to be nutrient rich due to their formation process and have a high cation exchange capacity. Winooski Series soils are similar to Hadley soils, but are less well drained. The other soils on the flat lands of Deerfield are variously too well drained or too wet, but

---

[21]Black and Brinser, p. 17.

[22]Ali Crolius and Sarah Drew Reeves, Deerfield's Agricultural Lands (Conway, MA: Conway School of Landscape Design, 1989), p.29-35.

they are generally free of stones and are fine for many agricultural uses.[23] Deerfield's prime agricultural soils include over 4500 acres, out of approximately 25,000 acres, of which 3400 acres are located on flood plains. These acres have topsoil ranging from 9 to 12 inches in depth. The floodplains of the Deerfield River were flooded annually and often more than once a spring, depositing fresh and enriching sediment. Other Connecticut Valley towns did not have this advantage as the Connecticut River went years without flooding its banks.[24]

Deerfield also has its share of unimprovable land. The Pocumtuck range is primarily Merrimack Series with slopes ranging from 15-35% and many rocks. The hills rising on the western part of town contain the Westminister Series which is an extremely rocky and shallow loam.[25] These poor soils assured Deerfield farmers of a convenient wood supply since these lands were not suitable for anything else.

Markets and Transportation

While the soils and geography of Deerfield and Petersham played an important role in the settlement of these towns, other forces greatly influenced the economic possibilities available to town residents. Most of these forces were the result of variation in the accessibility of markets, including the quality of transportation available, the nearness of markets or

---

[23] Soil Survey: Franklin County Massachusetts, 1967.

[24] Henry Colman, 1841, p. 7.

[25] Soil Survey: Franklin County Massachusetts, 1967.

marketing forums, and the compatibility of crops that could be grown with the crops that were appropriate for the market.

There is a common perception that farmers in colonial America were self-sufficient, but Bettye Hobbs Pruitt has convincingly argued that virtually no farmers were able to provide entirely for their own basic needs.[26] Using the 1771 tax valuation returns for 131 towns in Massachusetts she has determined that the majority of farms did not possess the resources to be self-sufficient. Farms were lacking in pasture, orchard, oxen, or in many cases, tillage. "For these individuals the struggle for a living from the land must have meant integration into the larger agricultural community around them and even into the 'market'."[27] Larger farms may have been more likely to be self-sufficient since they had the means to produce the widest array of goods to meet their own needs, but they were also very likely to be engaged in the market, selling large quantities of goods that were often grown expressly for sale. The large farmer was "...less dependent on the sale of his produce than was his poorer neighbor, because what he sold was truly 'surplus'."[28]

From its inception, Deerfield was primed for exporting produce. Situated on the Connecticut and Deerfield rivers, Deerfield had relatively easy access to distant markets. However, there were a number of impediments to large ships making their way up the Connecticut to Deerfield, including the falls at South Hadley just south of Deerfield and the Enfield Falls and rapids in Connecticut. Goods could be carried on land around these falls and by 1794

---

[26]Bettye Hobbs Pruitt, "Self-Sufficiency and the Agricultural Economy of Eighteenth-Century Massachusetts," The William and Mary Quarterly, 41, No. 3, (1984), pp. 333-364.

[27]Pruitt, 1981, p.25.

[28]Pruitt, 1981, p. 26.

there was a canal--the first significant artificial waterway built in the U.S.--built around the South Hadley falls.[29] Barges of ten to fifteen tons could be pulled over the falls at Enfield enabling ships to travel from Deerfield straight to sea ports. Some inexpensive pine boats were built upriver, used to transport goods to a sea port, and then disassembled and sold for lumber.[30] Deerfield was also located near Springfield and Northampton, both of which were market centers. Through John Pynchon's ties to the West Indies--he owned half of the island of Antigua--there was substantial trade between Springfield and the Caribbean as early as the 1680s. Farmers from Deerfield regularly brought their surplus pork and grain to Pynchon's general store in Springfield because of his skill in merchandising their products.[31] Northampton, as well as Hadley and Hatfield, were meat packing centers by 1771 and provided a ready market for Deerfield's surplus beef and pork.[32] Deerfield's location in the Connecticut River Valley was central to its agricultural development.

Petersham, in contrast, was isolated from many marketing opportunities. It was not near to any waterway sufficient for transportation. Until the Brattleboro-Fitchburg railroad line was opened in 1849, farmers in Petersham relied exclusively on roads to market their products. Petersham's major market was Boston or the slaughterhouses in Brighton, though in the second

---

[29]Thelma Kistler, "The Rise of Railroads in the Connecticut River Valley", Smith College Studies in History, 23, No. 4. (Oct 1937- July 1938) p. 15.

[30]Ritchie Garrisson, "Surviving Strategies: The Commercialization of Life in Rural Massachusetts, 1790-1860," Diss, University of Pennsylvania, 1985, p. 283.

[31]Innes, p. 33.

[32]Pruitt, 1981, p.166.

half of the nineteenth century Athol and Worcester grew rapidly in population and became new marketing points. The quality of roads in Massachusetts was important to Petersham farmers. There was a flurry of turnpikes built at the end of the 18th century; most of these were privately financed and emphasized straightness rather than following the contours of the land. While new roads made it easier to get crops to market, straight roads had steeper inclines, as roads went straight over hills as opposed to along the contour. In her study of Massachusetts's farmers trading patterns from 1750-1855, Winifred Rothenberg points out that an increase of 5% in slope increases the weight of the load being pulled by 5%.[33] Public road building increased in the 1820s and 1830s, concentrating on improving road surfaces rather than building new roads. Macadam was introduced during the 1820s, but did not come into widespread use until after the invention of the mechanical stone crusher in 1858.[34] Despite the apparent increase in the number of roads and potential for their improvement, Petersham was still hindered by its lack of its lack of other forms of transportation. Fortunately, Petersham's biggest agricultural export crop during the 18th and much of the 19th century was beef which had the advantage of walking itself to market and did not require particularly good roads.[35]

The coming of the railroad was a mixed blessing for Petersham. During the 1840s Petersham had a considerable amount of industry for a town of its size. In 1849, the east-west railroad was laid through the center of Athol,

---

[33]Winifred Rothenberg, "The Market and Massachusetts Farmers, 1750-1855," Journal of Economic History, 41, No. 2 (1981), p. 300.

[34]Rothenberg, 1981, pp. 299-300.

[35]Black and Brinser, pp. 4-5.

the town directly north of Petersham.[36] Bypassed by the railroad and devastated by a series of fires in the local mills, Petersham's economy faltered and never recovered. The railroad did, however, provide the farmers of Petersham with a way to market their cash crop of the second half of the 19th century: upland hay.[37] The railroad also caused a population boom in the neighboring town of Athol, producing a local market for hay, meat, and cordwood.[38]

In both Petersham and Deerfield there was substantial neighborhood exchange, often between neighbors and relatives. Andrew Baker and Holly Patterson analyzed the trading patterns of an early 19th century farmer from Sturbridge, a town south of Petersham but of similar climate and terrain, and found that sixty percent of his marketing was done within a half mile of his home.[39] Presumably, Deerfield and Petersham farmers engaged in community-based exchange to compensate for the things which they did not themselves produce. As Pruitt asserted, few farms were self-sufficient. Yet, during the 18th and early 19th century, most trading entailed an exchange. Farmers traded their surpluses, particularly grain, for items they needed.[40]

---

[36]Kistler, p. 41.

[37]Donahue, 1984, pp. 31-32.

[38]Diary of Frank M. Wheeler, Petersham, 1881-1882, OSV. Members of the Wheeler family traveled to Athol frequently, often three or four times a week.

[39]Andrew H. Baker and Holly Izard Paterson, "Farmers' Adaptations to Markets in Early Nineteenth-Century Massachusetts", The Farm, 1986, p. 103.

[40]Christopher Clark, The Roots of Rural Capitalism (Ithaca, NY: Cornell University Press, 1990), p.67 and Margaret Pabst, "Agricultural Trends in the Connecticut Valley Region of Massachusetts," Smith College Studies in History, 26, No. 1-4, (Oct 1940- July 1941), pp. 11-12.

When compared with Deerfield, the transportation and marketing options available to Petersham farmers seem very constricted. Deerfield had access to regional and distant markets, while Petersham had only a few choices of what and where they could sell their produce. The differences in the marketing opportunities of Deerfield and Petersham, combined with distinctive differences in natural resources, soil and topography, tell a great deal about why different styles of farming developed in the two towns. These specific farming practices are explored in the next chapter.

Chapter III

Massachusetts Agriculture in the 18th and 19th Century

From 1770 to 1885, agriculture in the state of Massachusetts underwent significant transformations. Chief among these was the change from extensive to intensive farming practices, to be discussed in this chapter, which was closely linked to the changing farm economy. Competition from western grain and beef producers, brought on by the opening of the railroads, combined with expanding local markets to force farmers to change their practices. This chapter addresses both the changes in agricultural practices over time and the differences in agricultural practices between Petersham and Deerfield. Some farming techniques clearly changed during the 19th century, while others did not. By addressing specific land uses and farming practices I will illustrate both how farming was conducted and how it changed through time. I rely extensively on farm questionnaires published in 1815 which describe the agricultural practices of West Springfield and Shrewsbury. These two towns are similar in soil condition, climate and markets to Deerfield and Petersham respectively. This chapter will illuminate the overall trends in farming practices, while also noting those practices, such as crop rotations or manure management, where the trends are not entirely clear.

Despite the differences between towns, farming during the 18th and 19th century was in many ways similar throughout the agricultural regions of Massachusetts. Farmers worked long days throughout the year: planting, plowing and hauling manure in the spring; cultivating their crops and cutting hay in the summer; harvesting and threshing their grain and pressing cider in the fall; and cutting immense amounts of cordwood and cutting ice during the winter.

In the early 19th century, the typical breakdown of a farm in the Connecticut River Valley was one third tillage, one third mowing, one sixth pasture and the rest woodland. In the central uplands of Worcester County, farms had one third of their land in mowing, one third in pasture, one ninth in tillage and the remainder in woodland. Orchards were included in pasture or mowing because these fields served a double purpose.[1] Farms in Massachusetts often had several cows for meat and milk and a horse for transportation. Some had oxen, but it was common to hire a neighbor to plow for you, some had sheep, and most farms had pigs and chickens. An individual farmer might lack some components of a "typical" farm, but these animals and types of land use were all common on Massachusetts farms.

There were important changes in the character of farming between 1770 and 1880. One distinctive shift in New England agricultural practices can be described as the change from "extensive" farming to "intensive" farming. Extensive farming involves a long crop rotation and considerable acreage which makes use of a forest fallow. Newly cleared land would be tilled and planted to grain. After several years when yields began decreasing, English grasses were planted and hay would be cut for a number of years until those yields started dropping. These hay fields would then be used for pasture and eventually abandoned to grow up to forest. This process has been described as "land demotion".[2] The soil fertility would be rebuilt by the leaf litter and

---

[1] "Farm Inquiries", Massachusetts Agriculture Repository and Journal, (Boston: Ezra Tileston, 1815) Vol 3, p. 56 and p. 115.

[2] Brian Donahue, "The Forests and Fields of Concord: An Ecological History, 1750-1850," Concord: The Social History of a New England Town 1750-1850 ed. David Hackett Fischer, (Waltham: Brandeis University, 1983), p. 39.

decaying organic matter supplied by the forest.[3] Extensive farming also made use of woodland and unimproved land to graze cattle.[4] Farmers were forced to change this system by the increased commercialization of agriculture and the growing population pressures on the land at the end of the 18th century. It is not clear whether farmers ever re-cleared for cultivation land that had been abandoned a generation or two earlier, but it is clear that there were problems with this system of agriculture which precipitated the change to intensive cultivation.

The responses to this land degradation at the end of the 18th century and early 19th century were westward migration, population shifts from rural regions to the newly industrialized New England cities, and a switch to intensive farming. Intensive farming involved increasing the time and materials that went into cultivating land. More careful plowing, the addition of manures and soil amendments such as gypsum, ashes, salts, sulfuric acid, and peat to tillage lands, the increase in acres of upland mowing, and the feeding of higher quality forage to animals all contributed to increased or maintained yields while farming the same land.[5] Intensive farming meant getting away from the mixed cropping systems of the 18th century and an increased emphasis on specialization, focusing particularly on crops such as

---

[3]Raymond A. Young, ed. Introduction to Forest Science (New York: John Wiley & Sons, 1982), pp. 140-141.

[4]Clark, 1990, p. 80.

[5]Massachusetts Agricultural Repository and Journal, (Boston: Wells and Lilly) Vol. 6, 1820-21, pp. 349-360 and Brian Donahue, "'Skinning the Land'," (Chicago: Paper delivered at Annual Meeting of Social Science History Association, 1988), p.7 and Carolyn Merchant, Ecological Revolution: Nature, Gender, and Science in New England (Chapel Hill, NC: University of North Carolina, 1989), p. 189.

dairy, poultry, and vegetables.[6] These new crops were profitable because of improving transportation and expanding urban markets. The change to intensive farming was a response both to economic and to ecological demands being placed on farmers. A look at specific land use practices and types of agricultural endeavors will provide context for these changes.

Tillage

Tillage land absorbed most of a farmer's labor during the spring and fall. Although wheat was the grain of choice for most colonists of European descent, wheat rust, the Hessian wheat fly, and soil exhaustion made its cultivation difficult and wheat bread was considered a luxury. Often in newly settled areas land would be successfully planted to wheat for a few years until yields began dropping.[7] Despite the preference for wheat, corn dominated the tillage land of Massachusetts throughout the time period studied because it was well adapted to the climate and types of cultivation practices used. Corn was used for corn pone, corn bread, corn mush, and the staple rye and corn meal bread.[8] Corn was also used to some extent for animal feed. Rye was the second most important grain crop for New Englanders and was used both for bread and as an animal feed mixed with oats or peas and known as provender. Rye grows well in poor soil and, at least in Hadley,

---

[6] Percy Bidwell, "The Agricultural Revolution in New England," The American Historical Review, 26, (1921), p. 688.

[7] Clark, 1990, p. 42.

[8] James Kimenker, "The Concord Farmer: An Economic History," in Concord: The Social History of a New England Town 1750-1850 ed. David Hackett Fischer (Waltham, MA: Brandeis University, 1983), p. 148.

Massachusetts, was planted on land that was worn out from producing wheat.[9] Potatoes were not part of the repertoire of 17th century Massachusetts farmers, and though they were gaining in importance by the 1750s I have found no data on their production until the 1845 Massachusetts report on industry and agriculture.[10]

While techniques for raising crops varied from place to place and changed over time, many general practices remained the same between 1770 and 1880. One method of raising corn is as follows: the land was plowed either at the end of the fall or in early June. Farmers carried manure to the field in carts and laid it in the furrows. Then they plowed again to create hills and placed a shovel-full of manure was laid into each hill. Finally, five kernels of corn were laid on the hill about three inches apart. They hoed the corn two or three times during the summer. When thoroughly dried on the stalks, the corn was harvested and removed to the barn for shelling. In the 17th and 18th century livestock was often turned out to graze in the harvested fields to clean up the leftover stalks, but by the 19th century, with the transition to intensive farming practices, the stover was usually harvested to be fed to livestock during the winter.[11] Rye was usually planted in the fall, sometimes in combination with wheat to grow what was known as meslin. Oats were often sowed in combination with grass seed and clover and the oats

---

[9] Sylvester Judd, The History of Hadley, Massachusetts (Springfield, MA: H.R. Huntting, 1905), p. 355.

[10] Howard S. Russell, A Long Deep Furrow: Three Centuries of Farming in New England (Hanover, NH: University Press of New England, 1982), p. 72.

[11] Farm Inquiries, 1815, pp.117-118 and Russell, 1982, p. 24.

harvested during the year of transition to hay. Both rye and oats, which have lower fertilizer requirements than corn, were rarely manured.[12]

It is unclear whether farmers during the late 18th and early 19th century practiced crop rotations. Some historians feel fertility-building practices were uncommon: "Crop rotations were rarely used, and fertilizers were usually limited to the manure that collected on the fields after the harvest when livestock were allowed to graze on the stubble."[13] Some contemporary accounts, however, note that farmers used crop rotations to ensure that heavy feeding crops were grown in well fertilized fields, rather than to derive any benefit from the specific cycle of crops planted.

> A change of crops is generally practiced, not so much because any order or succession of crops is thought to be beneficial or injurious to the soil...as because there is not manure enough made to manure all the tillage land in each year.[14]

In 1841, Henry Colman reported a crop rotation consisting of corn the first year with manure, oats the second year without adding manure, and then grass for five years until the land was plowed and manured again for corn. He also reports on a number of crop rotations practiced in Deerfield, including a two year rotation of corn and then peas and oats.[15] Robert Gross suggests that the rotation of crops developed out of necessity during the transformation from extensive to intensive agriculture during the late colonial period. He

---

[12]Colman, 1841, pp.23-25.

[13]McManis, 1975, p. 90.

[14]Farm Inquiries, 1815, p.118.

[15]Colman, 1841, p. 136.

says farmers in Concord were incorporating clovers into a tillage rotation by the Revolutionary War.[16]

The extensive system of farming made use of an extremely long crop rotation which included a forest fallow; overused fields were turned to hay and then to pasture and finally abandoned to revert to forest. With the switch to intensive farming, farmers were pressured to devise ways to maintain the fertility of the land they had. They began to use short crop rotations of two to ten years. It is not clear how widely practiced these short crop rotations were, but certainly some farmers were making use of these techniques.

The differences in the amount of tillage land in Petersham and Deerfield is substantial. As noted earlier, these towns were of similar size throughout the time period studied, close to 25,000 acres. Yet Deerfield had nearly 2000 acres of tillage land in 1771, while Petersham had less than 500. By 1830, Deerfield farmers were tilling over 4000 acres and in Petersham there were fewer than 1000 acres being planted to grains or potatoes. Both towns grew mainly corn, but Deerfield farmers were growing a greater percentage of small grains during the 18th century.[17]

---

[16]Robert A. Gross, The Minutemen and Their World (New York: Hill and Wang, 1976), p.87.

[17]Mary Lynn Stevens, "No Complaints: Agriculture in Deerfield, 1760-1810," Historic Deerfield Summer Fellowship Paper, August, 1976, p. 27.

Hay

Hay lands consisted of fresh meadow or naturally occurring grass lands and upland mowing, which was composed of seeded herds grass, spear grass, red top, Cambridge grass, and red and white clover, known collectively as English grasses. Upland mowing hay was more nutritious than fresh meadow and was the favored feed. In West Springfield it was estimated in 1815 that fresh meadow hay had only two-thirds the value of upland mowing hay.[18] Upland mowing was often planted on land that had been tilled for years and whose fertility was declining. In this case, farmers nearly always planted grain with grass seed in order to profit from one last year of grain while providing a nurse crop for the newly established hay.[19] Fresh land was also cleared and put directly into English grasses. When planting upland mowing, farmers would plow or harrow the land and usually manure before seeding. First-year yields from upland mowing could be as high as two or three tons per acre, but within three years the yields would be as low as one ton per acre.[20]

Brush scythes and stubbing hoes found in farmers' inventories indicate that hay fields were carefully managed by some farmers.[21] Most hay fields were cut only once a year, usually during July and August, with the cutting, curing, and storing taking a month and a half of labor. The haying would not

---

[18]Farmer Inquiries, 1815, p. 59.

[19]Farm Inquiries, p. 59.

[20]Colman, 1841, p. 6.

[21]Stevens, p. 11.

begin until the first of July when the hay was mature and when one cutting would produce the greatest bulk of feed.[22]

The amount of hay fed to livestock increased throughout the time period 1770 to 1885, as farmers intensified their farming efforts. They cut back on the time cattle spent foraging in pastures and woods because they found the animals fattened much more efficiently on hay cut and fed by the farmer.[23]

Although farmers planted clover by the 19th century, it is doubtful that it thrived in the acidic soils of Deerfield and Petersham. The acidity of New England soils would have limited the successful cultivation of clover. Clover and other legumes, through a symbiotic relationship with bacteria on their roots, will make nitrogen from the atmosphere available in the soil for plant use. Clover is capable of fixing a significant amount of nitrogen in the soil so as to enrich the soil for future crops. Successful cultivation of clover, both in hay fields and pasture, would have been very useful in maintaining the overall fertility of 18th and 19th century farms. Clover needs soil with a pH of close to 7 to thrive and without significant liming, Massachusetts soils are naturally between pH 4.5-5.5. The sandier soils of Petersham would have responded more favorably to lime than the richer soils of Deerfield, but Petersham farmers would have to reapply lime more frequently because it would leach from their soil easily. In West Springfield, farmers sowed three quarts of clover seed with every quart of herds grass when planting upland mowing. Often the clover fields would be plowed in within a year or two with the

[22]Telephone Interview with Andrew Baker, Manager of Interpretation and Education, Lake FarmPark, Kirtland, Ohio. Feb. 4, 1991.

[23]Interview with Jochen Welsh, Feb. 1991.

purpose of providing the soil with a green manure.[24] West Springfield farmers applied gypsum to their clover crops, which supplied sulfur and calcium and probably improved the growth of their clover, but there is no evidence that they were applying lime.[25] In Deerfield there was little use of lime, but one farmer who applied it to their hay land found no positive results. The application rate of 25 bushels to the acre may not have been enough to substantially change the pH of the rich soil of Deerfield.[26] I suspect that clover planted in West Springfield was plowed under after one or two years because it would not survive any longer.

Pasture

Pasture accounted for the greatest acreage on most farms in Massachusetts during the 18th and 19th century. The exception to this was the fertile bottomlands of the Connecticut Valley where, as in Deerfield, tillage remained the heaviest use of land until 1800, at which point pasture became the largest land use category.

Usually, the hilliest rockiest land that was not able to be plowed was used for pasture. Often farmers converted the old worn out hay land to pasture. Pasture land increased dramatically across the state as farmers cleared new land for larger herds of cattle with the change to intensive farming.[27] In Petersham, for example, forest cover decreased from 9270 acres

---

[24]Farm Inquiries, 1815, p. 60.

[25]Farm Inquiries, 1815, p. 60.

[26]Colman, 1841, p. 127.

[27]Clark, 1990, p. 81.

in 1831 to 3385 acres--less than 15 percent of the town--in 1865.[28] A big boom in sheep raising during the first half of the 19th century also spurred considerable clearing of land to accommodate these profitable grazers.[29] Between 1820 and 1830, Petersham nearly doubled its acres of pasture. For farmers, pasture was a source of low labor feed for their animals during the warm months. Turning livestock onto pasture allowed farmers to concentrate on producing and storing food for themselves and their animals during the winter.

Woodland

The woodlot was an integral part of nearly every farm. Forests provided fuel for cooking and warmth, lumber for barns and houses, potash--used in making soap--for sale and occasionally home-use fertilizer, and maple sap for maple sugar. Woods were also an important part of the forest fallow system used by colonial farmers, and were extensively grazed throughout the 19th century. Woodlots provided winter work for farmers in cutting firewood and lumber and thus were an important part of the seasonal cycle of farm work. Potash, produced by refining wood ash, was often the first product sold off a new farm, and it continued to be an important farm export through the 19th century.[30] Its high value and low weight made it ideal for sale, but once sold, it could not be used to improve fertility at home.

---

[28]Russell, 1982, p. 229.

[29]Harold F. Wilson, "Sheep Industry in Northern New England," Agricultural History, 9, (1934), pp. 12-40.

[30]Merchant, p. 192.

Cordwood for fuel was cut at an enormous rate. William Cronon estimates that colonial families burned thirty to forty cords of wood a year.[31] The minister in Hadley, during the second half of the 18th century, was given fifty to sixty cords of wood a year, while the town of one hundred families burned more than three thousand cords per year.[32] Stoves in the 19th century were increasingly efficient, but the demands for cordwood from urban areas grew during the 1800s. Construction of ships and houses also used considerable forest resources. As a result of all of this wood use, "A local timber shortage was often the first ecological crisis to be visited upon a town; soil depletion came later."[33] In the census reports and tax valuations, wood lots were mostly listed as unimproved land and as such do not appear in most of my data.

Manure

Manure was the principal source of fertility for farmland during the 18th and most of the 19th century. Plaster of paris, gypsum, composted peat, wood ashes, clay, sand, soapy waste water, and a variety of salts were also used in varying degrees throughout the 1770-1880 time period. By the late 1800s, muriate of potash, sulphate of ammonia, nitrate of soda, phosphoric acid, and other chemical formulations were being used by farmers and

---

[31] Cronon, 1983, p.120.

[32] Judd, pp. 99-100.

[33] McManis, p. 114.

recommended by the Massachusetts Board of Agriculture.[34] Although manure was highly valued in the earliest European settlements, it is clear that farmers' awareness of the value of manure increased from the colonial period through the 19th century. The switch from extensive to intensive farming included an improvement in the way manure was managed.

The application of manure, especially to corn, was an integral part of spring planting. Corn was easy to grow, but it invariably needed manure.[35] Farmers records indicate the importance of manure. In 1654, John Pynchon contracted with Thomas Mirrick for thirty loads of high quality dung.[36] A Deerfield farmer, Jonathan Hoyt, entered into his diary five occasions, between April 4 and May 17 of 1800, on which he or someone in his family carted dung to his fields.[37] Emphasizing the importance of manure, a tenancy contract in Petersham in the year 1844 between Levi Knapp and John Howes gave explicit instructions for the tenant's management of the farm manure:

> And it is agreed that the manure made by the said Knapp's part of the hay, which shall be fed out on the place, shall remain for the use of the farm: and whatever shall remain at the close of the lease, may be sold by the said Knapp, unless said Howes will pay therefore as much as any other person will give for it, to be delivered on the premises. It is understood that the said Knapp is to take the care of the horse only when the cattle are kept at hay. The said Knapp is to carry out the manure as was done last year and to break up as much sward ground by ploughing as was done last year, if requested, and to cart fifteen loads of

---

[34] Thirty-sixth Annual Report of the Secretary of the Massachusetts Board of Agriculture: 1888 (Boston: Wright and Potter, 1889).

[35] Russell, 1982, p. 23.

[36] Innes, 1983, p. 74.

[37] Jonathan Hoyt Diary, 1800-1810, Pocumtuck Valley Memorial Association Manuscript Collection, P.V.M.A. Library, Deerfield, Massachusetts.

suitable materials into the barn yard for the purpose of making manure.[38]

The practice of hauling soil and other materials into the barnyard to mix with dung in the process of composting the manure and so increase the overall quantity of manure was much recommended by agricultural improvers of the 19th century.[39] Writing in 1816, an agricultural journalist expounds on the superiority of compost over simple barnyard manure:

> All dung before being used as manure should be mixed with other substances, and a large heap formed, which should be turned over once or twice before being used. The common way of spreading dung over the land . . . can by no means answer the end; for the fertilizing particles of dung being of a volatile nature, are readily exhausted by the action of the sun and air.[40]

This statement is a sophisticated and accurate view of manure management even in the late 20th century.

But in contrast to all the evidence of how well farmers used manure, there is considerable documentation that farmers of the 18th and 19th century were not taking advantage of their main source of fertilization. Timothy Dwight, writing in the early 1800s, found insufficient manuring as one of the liabilities of agriculture in New England.[41] In Hadley during a similar period, there was "much land . . . planted and sowed to which no manure had ever been applied."[42] Similarly, Jared Eliot stated that "the great want of

---

[38]Levi Knapp papers, Old Sturbridge Village, Contract for tenancy on a Petersham farm, 1844.

[39]Colman, 1841, pp. 131-133.

[40]Massachusetts Agricultural Repository and Journal (Boston: Tileston and Weld) 4, No. 1, 1816-1817. p. 88.

[41]Timothy Dwight, Travels in New-England and New York (London: Charles Wood, 1823), Vol. 1, p. 82.

[42]Judd, p. 357.

the country, which almost prevents their planting hemp in quantities, is the want of dung, and yet they will not take the only method of gaining it, which is the keeping of great stocks of cattle, not ranging through woods, but confined to houses or warm yards.[43] It is no coincidence that agricultural improvers spent so much time discussing manure management; they were addressing a real problem with the practices of their contemporaries. In discussing the practices of Berkshire County, the county to the west of Franklin County, Henry Colman finds "that little attention is paid to the subject of manures."[44] In Franklin County he stated that,

> [manure] is not appreciated by them as it should be. . . . I do not recollect an instance of a barn cellar on any farm in the county; nor any provision for covering the manure and keeping it excluded from the sun, and rain, and air; nor any attempt at forming a compost heap, and availing themselves of the various materials to be found on almost every farm and by the road-sides, for increasing the stock of manure.

Although farmer questionnaires from 1815 revealed that farmers in Shrewsbury mixed various farm materials with their manure and sought to protect it from excessive rain leaching,[45] farmers in West Springfield reported very little manure enrichment activity.[46] Eighteenth and nineteenth century farmers did not apply their manure to their fields during the winter, an unfortunate practice of farmers today. Nonetheless, they subjected their manure to significant nitrogen volatilization and leaching. Much of the nitrogen in manure is in the urine and even the excrement is 55 percent to 80

---

[43]Jared Eliot, American Husbandry, ed. H.C. Carman (Port Washington, N.Y.: Kennikat Press, 1939), p. 58.

[44]Henry Colman, Second Report on the Agriculture of Massachusetts (Boston: Dutton and Wentworth, 1838), p.76.

[45]Farm Inquiries, 1815, p. 124.

[46]Farm Inquiries, 1815, p. 64.

percent liquid. Without means to retain this liquid portion there is substantial nitrogen loss.[47] Henry Colman suggested a few methods for minimizing this loss, such as storing manure in an impermeable clay lined pit or barn cellar, adding farm materials and soil to absorb moisture, or protecting manure piles from the leaching effects of rainfall and the volatilizing effects of sunshine. Clearly many farmers were not handling their manure for optimal fertilizer impact.

Farm manure and other fertilizers were applied exclusively to tillage land and new plantings of upland mowing. In Worcester County, tillage was usually located on the best land on the farm and subsequently the best land would get better as manure was added. The practice of rotating crops was dictated by insufficient manure. Although there was not enough dung to fertilize all tillage land each year, through the rotation of crops each parcel of land would be manured when it was growing the more extractive crops like corn and flax.[48] By 1815, farmers in Shrewsbury and West Springfield were using plaster of paris, a combination of calcium, sulfuric acid, and water. In West Springfield, a teaspoon full of plaster of paris was added to each hill of corn and fields of clover optimally received a bushel per acre each year.[49] The plaster of paris or gypsum used by 19th century farmers on their fields does not have a liming effect, but it is known to improve the growth of clover. Gypsum may have been supplying sulfur which, due to excessive leaching, the acid soils of Massachusetts were probably deficient

---

[47] Parnes, p. 133.

[48] Farm Inquiries, 1815, pp. 118, 124.

[49] Farm Inquiries, 1815, pp. 56, 65.

in. The addition of calcium may also have been beneficial to plant growth.[50]

Other Agricultural Products

For many farmers in Massachusetts, beef was a major source of cash and one of their few consistent exports. Drovers roamed the countryside during the fall, purchased cattle from farmers and drove them to the livestock market in Brighton, just outside of Boston. Cattle from as far away as Ohio, Kentucky, and New York were regularly driven to the Brighton market.[51] Towns like Petersham, with their extensive pastures, were well suited to raising cattle. According to tax valuations, Petersham farmers kept more cattle than Deerfield farmers. After keeping them on pasture all summer, farmers would sell their cattle to drovers who came before the cold weather set in. In this way farmers could trim down their herds to match the amount of fodder they had put up during the summer and the size of their barns. Drovers, though, were not the only ones to take advantage of the winter feed shortage of upland towns like Petersham.

Connecticut Valley towns, particularly Deerfield, were active in the winter fattening of beef as early as the 1670s. Farmers in Deerfield used their fertile river valley soil to grow huge quantities of grain which they then fed, along with their rich hay, to fatten cattle and oxen during the winter. Once upland towns around Deerfield were settled, after 1750, Deerfield farmers increased their volume of cattle fattening by buying the

---

[50]Parnes, p. 106.

[51]David C. Smith and Anne E. Bridges, "The Brighton Market: Feeding Nineteenth-Century Boston," Agricultural History, 56, No. 1, (January 1982), pp. 3-21.

surplus cows from the hill towns between October and December as well as renting pasture in the hills during the summer for their own animals.[52] In the 19th century, as the valley towns became the established cattle fattening region, hill towns began providing surplus hay to the valley towns rather than raising their own fat cattle.[53] With their large grain harvests, the valley towns were much more effective at raising cattle for the Brighton market. Given Petersham's distance from Deerfield it is unlikely that they were directly linked in this mutual dependency of hill and valley towns.

The fattening of cattle was an intensively practiced form of agriculture in Deerfield. By 1815, Deerfield farmers were buying as many as four hundred cattle and oxen a winter to fatten.[54] Most farmers fed cattle provender, along with hay, offering the animals as much as they would eat. The oxen were encouraged to do nothing but eat and sleep with the goal of putting on as much weight as possible by spring. "It was the cardinal doctrine of the feeders that the more comfortable and happy the animals were made the better the results...in this, humanity and profit are in full accord."[55] Most animals gained four hundred to six hundred pounds during the winter and were sold between March and May.[56] The prices farmers received for their fattened cattle fluctuated dramatically and farmers had to be savvy and lucky to make a

---

[52]Garrison, 1987, p. 3.

[53]Pabst, p. 36.

[54]Dickinson, 1815, p. 11.

[55]George Sheldon, 'Tis Sixty Years Since: The Passing of the Stall-fed Ox and the Farm Boy (Deerfield, MA: Proceedings of the Pocumtuck Valley Memorial Association, 1898).

[56]Garrison, 1987, p. 12 and Colman, 1841, pp. 74-75. In a careful analysis of stall-fed oxen winter weight gain, Colman cited numerous gains of over 500 pounds.

profit. It became increasingly difficult to make a profit on fat cattle during the 19th century, particularly once the railroads opened up competition from western ranchers, but some farmers continued to fatten cattle.[57] It should be noted that even in bad years, the farmers of Deerfield were left with mountains of manure and in that their efforts always had some value.

In addition to fattening cattle, there were a number of other agricultural products which were specifically produced in Deerfield and other Connecticut Valley towns. These included broom corn, tobacco, and onions. The heyday of broom corn was from approximately 1825 until 1875. For a brief period in Deerfield, broom corn was more profitable then raising stall-fed cattle. The corn would grow to ten or fifteen feet, but took a lot out of the soil and needed to be heavily manured.[58] Tobacco was another crop which demanded heavy fertilization; often farmers who specialized in fattening cattle also grew tobacco since they had a plentiful manure source. Tobacco cultivation began in the 1840s, but was not a major crop of the valley until the 1860s. Tobacco proved initially to be quite profitable and farmers were attracted to it, but then rejected it as the prices fluctuated. Tobacco production continued to wax and wane throughout the second half of the 19th century. Tobacco also stimulated Connecticut Valley farmers to begin purchasing fertilizers, such as guano and super-phosphate, as early as the 1860s. As a result, "these farmers were caught in a progressively complex dependence on outside markets" earlier than most of their contemporaries.[59] Onions also grew well in the rich soil of the Connecticut Valley. They were

[57]Garrison, 1987, pp. 12-16.

[58]Garrison, 1985, pp. 228-244.

[59]Clark, 1990, pp. 302, 294-298.

not a significant crop until the last decade of the 19th century, when their production increased dramatically.[60] These three crops all represented part of the unique agriculture of the Connecticut Valley and set the farming practices of Deerfield off as distinct from those of towns like Petersham.

There were many changes that took place in the farming practices of Deerfield and Petersham farmers between 1771 and 1880. The life of farmers, however, with its hard work and long hours remained constant throughout. "Historians have often noted that seasonality set farmers apart from industrial culture, but they are slower to recognize that nature was often as tyrannical a task master as the mill bell calling workers to their machinery."[61] The transformation from extensive to intensive agriculture occurred in both Petersham and Deerfield, though in the latter there is evidence of market-oriented, intensive farming from the outset of the settlement. Attention to tillage land intensified during this period as farmers began rotating crops and managing their manure resource more carefully. Pasture and hay land expanded, allowing farmers to keep more livestock with which to generate revenue and manure. The types of agriculture practiced dictated the ecological cycles on the farm, whether farmers raised livestock or broom corn. An examination of the farming practices employed during the 18th and 19th century reveal a great deal about the ecological sustainability of agriculture during this time period.

---

[60]Pabst, p. 57.

[61]Garrison, 1985, p. 42.

Chapter IV

The Ecology of Farming in Deerfield and Petersham

When left undisturbed, soils in temperate climates tend to increase in organic matter and nutrient content. Organic matter eventually reaches an equilibrium which is related to climate and vegetation. Disturbance, in particular wholesale removal of forest vegetation and intensive cropping, depletes the nutrients that have slowly accumulated.[1]

Did the farming practices of 18th and 19th century farmers in Deerfield and Petersham gradually deplete the fertility of their farms? Farmers in both towns concentrated their farm fertility, in the form of manure, on their tillage land, thus increasing its fertility. However, the overall nutrient resource of the farms deteriorated as nutrients were removed from the hay and pasture land more quickly than they could be replenished.

Although the overall fertility of farms declined in both Deerfield and Petersham, the different soil and geographic resources of the two towns influenced the long-term repercussions of this fertility decline. These resources, in connection with the given economic opportunities shaped the farming practices of the two towns. Deerfield's rich bottom-land and ready markets encouraged the raising of cash crops such as beef and broom corn. Petersham's hilly slopes and rocky land provided extensive range land, but little land for tillage. The natural resources and the way they were used dictated the sustainability of their farming systems. Sustainability, in this context, refers to the ability of the land to support this type of farming activity over time. Farmers needed to balance the flow of nutrients onto and

---

[1]Robert E. Ricklefs, The Economy of Nature (New York: Chiron Press, 1983), p. 168.

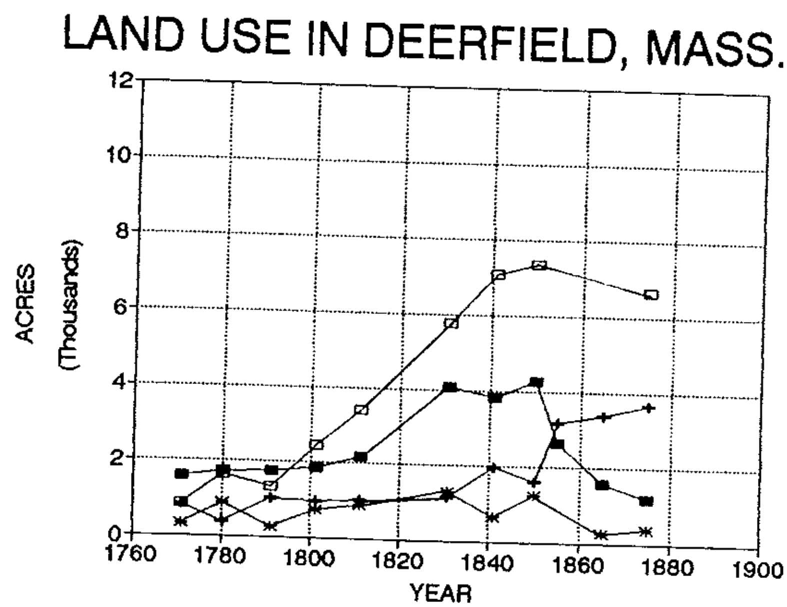
off of individual fields and the farm as a whole. This balance of nutrients determines the sustainability of the farming system.

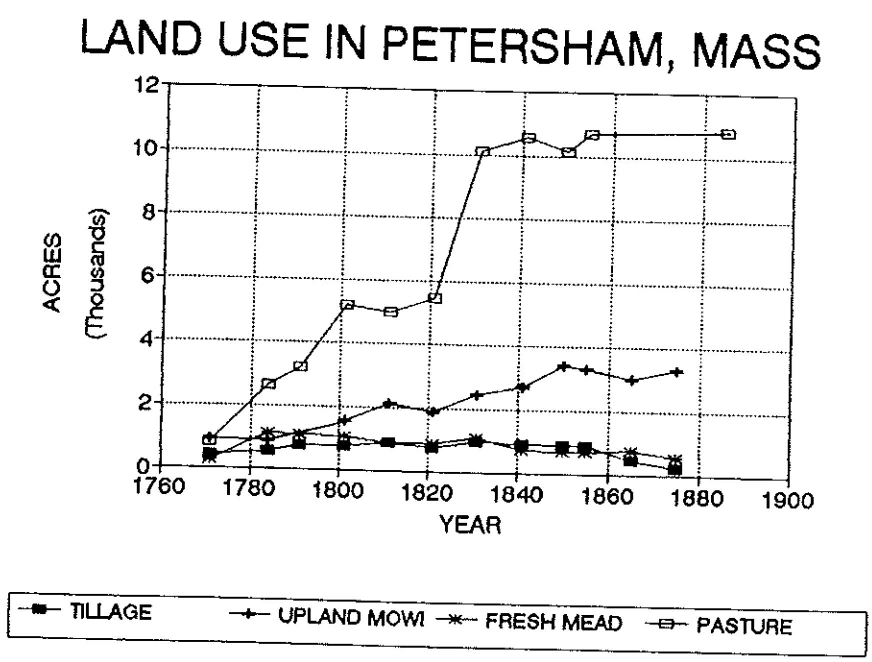
Tax valuation and census reports provide the data for viewing the differences between the farming systems of the two towns. They also reveal the overall decline of fertility on the farms of Deerfield and Petersham.

Farmers in Petersham and Deerfield used substantially different amounts of land for tillage (see figs. 1 and 2). Petersham farmers never planted more than 1000 acres of tillage land at any one time. Tillage in Petersham rose steadily from 437 acres in 1771 to peak in 1831 with 958 acres tilled and then declined to 243 acres by 1875. In Deerfield, farmers tilled 1611 acres by 1771. Their tillage increased to 4284 acres by 1850, and fell to 1217 acres by 1875. Interestingly, in Deerfield the acres tilled rose again in 1885 to 2585 acres, perhaps in response to a boom in the tobacco industry. Unfortunately, 1885 data is not available for Petersham's tillage land.

Tillage land lost more nutrients--through erosion, volatilization, and crop removal--than any other agricultural land. However, tillage land was also the only land on the farm which farmers worked to fertilize. Corn, wheat, potatoes, and tobacco all feed heavily on nutrients, particularly nitrogen. Tilled land often lay bare during the cold months at which time soil nutrients were subject to leaching down into the subsoil. In addition, plowed and subsequently cultivated land eroded more than land in hay, pasture or forest. Cultivated soil eroded both in the summer and winter, though during the growing season the crops helped to prevent erosion. In the winter nothing held the soil in place, except for snow cover. Fields in Petersham would have been particularly vulnerable to water erosion as rain carried the

Figures 1 and 2





sandy soil particles and organic matter off of sloped fields. Deerfield's tillage was on flat bottom-land and less prone to water erosion, but Deerfield farms would have been eroded by wind. Today airborne soil can be seen on windy days blowing off the cultivated fields of Deerfield.

There is no indication that winter cover crops were used in Deerfield or Petersham between 1770 and 1885. Winter cover crops are planted in the fall after the last crop is harvested and serve the purpose of physically holding the soil in place. Cover crops are then plowed into the soil in the spring before planting a new crop, thus adding organic matter. Cover crops also take up nutrients that might be leached down through the soil by rain, making them available again in the spring for the future crop. It should be noted, however, that crop rotations used by farmers often included hay and rye or wheat, which were planted in the fall. Thus fields were not always subject to severe nutrient leaching and erosion.

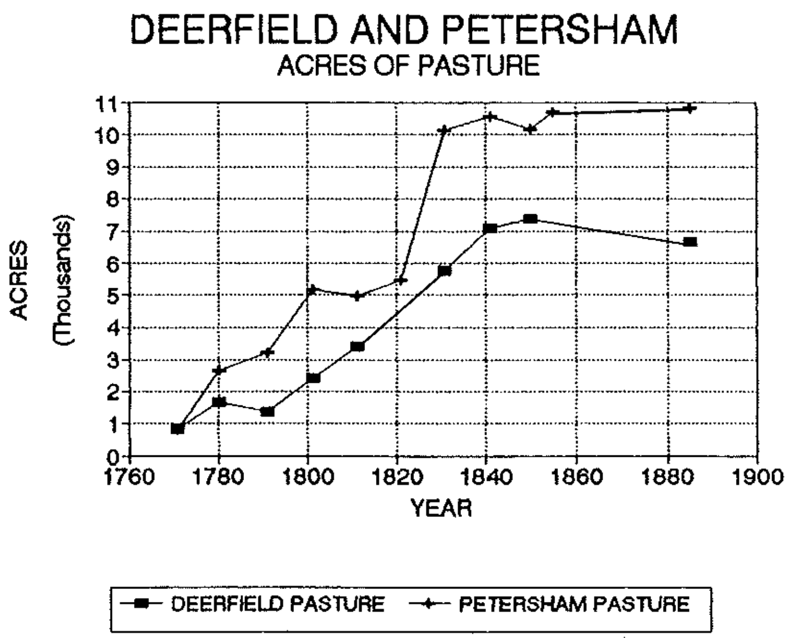
The ravages of soil depletion probably had a greater effect on Petersham's tilled fields than those of Deerfield. Petersham's fields were more vulnerable to water erosion because of the rolling land. Their sandy soil lost nutrients more easily through leaching. Perhaps more importantly, Petersham farmers did not have much topsoil to start with when compared to the thick silty loam planted by Deerfield growers. Soil erosion for Petersham farmers meant the loss of most of their soil organic matter while farmers in Deerfield had a deep resource to draw from. Deerfield farmers also benefited greatly from the annual floods of the Deerfield and occasionally the Connecticut which deposited rich soil and organic matter from farmers' fields and forests upstream.

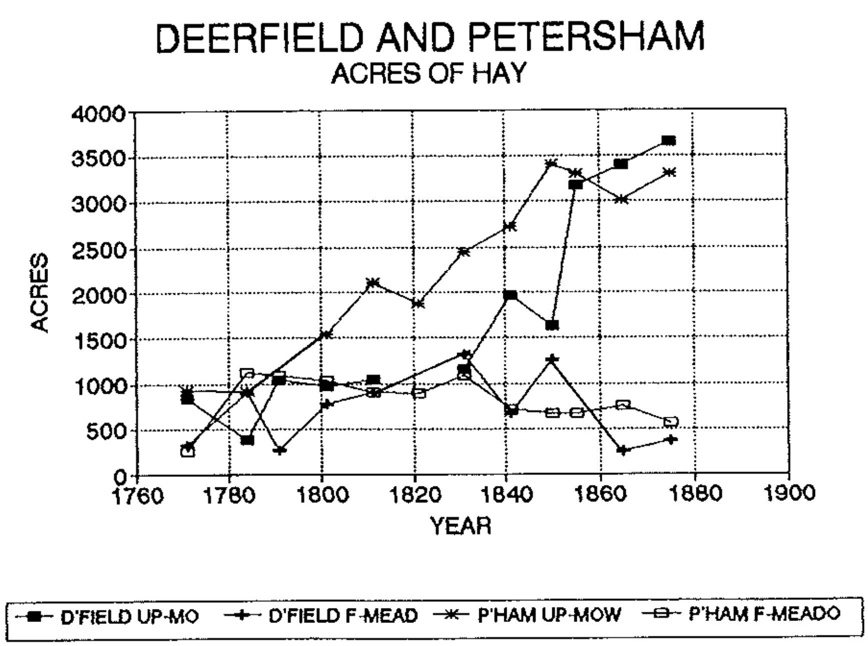
While tillage land was being depleted of nutrients at a quicker pace than land put to any other use, tillage land was also being fertilized. As noted above, tillage was the only land on the farm which received manure. The addition of manure to tilled land was needed to counteract the high nutrient demands of crops, like corn, and the effects of erosion and leaching. The nutrients of the grasslands of the farm were being redirected through farm animals to support the tillage land. In the final balance, the tillage land was staying even or gaining in fertility through time.

Deerfield and Petersham's pasture land increased dramatically between 1771 and 1885 (see figure 3). Petersham's land was well suited for pasture. In 1771, Deerfield and Petersham had roughly the same amount of pasture, 846 and 823 acres respectively. By 1801 Deerfield farmers had increased their pasture to 2447 acres and Petersham farmers had over 5000 acres of pasture. Between 1821 and 1831, Petersham's pasture land nearly doubled from 5468 to 10,134 acres. This increase coincides with the shift from extensive to intensive farming. It is likely that this new pasture land was made up of freshly cleared forest rather than deteriorating farmland. Meanwhile, Deerfield's pasture increased from 1790 until 1840 at a steady, constant pace. Deerfield's pasture peaked in 1850 with 7382 acres and Petersham reached a high point in 1885 with 10,814 acres of pasture. Presumably most of Deerfield's pasture was on the rocky, sandy hills surrounding the valley. The better land in Deerfield would have been saved for tillage and even hay.

Pasture is subject to slow but continual nutrient depletion unless properly managed. Grazing animals remove nitrogen, phosphorus, potassium, and

Figures 3 and 4





other nutrients and minerals from the soil in the form of the plants that they eat.

> Pastures can not be expected to maintain their yield permanently unless a portion of the plant foods removed by the growing crop is replaced occasionally, for the production and removal of flesh, bone, mild, and wool will sooner or later reduce the supply of plant food in the soil.[2]

Some of these nutrients are returned by manure voided by the animals, but even this is mitigated by volatilization of nitrogen and the leaching and runoff of other nutrients. When the animals are slaughtered they have accumulated in their bodies nutrients from the pasture that will never be returned. It is possible to maintain nitrogen levels in soil through the planting of legumes and careful pasture management such as rotational grazing. There is no indication that 18th and 19th century farmers were engaged in either of these practices.

In the absence of soil tests, it is difficult to know what specific nutrient deficiencies the fields of Deerfield and Petersham were suffering from, but there are some likely possibilities. The behavior of the elements phosphorus and potassium in soil is important to pasture fertility, and also to the fertility of hay and tillage land. Phosphorus would have been present in Deerfield and Petersham soils, in a rock or mineral form and in vegetation, but it is unlikely that there were sufficient quantities to replenish what was removed by livestock. The low pH of Deerfield and Petersham soils, caused by leaching and the lack of liming, would have rendered any phosphorus naturally in the soil unavailable. Phosphorus does not tend to leach from soil, but binds to other elements, particularly aluminum, calcium and iron, and becomes

---

[2]Arthur W. Sampson, Range and Pasture Management (Boston: Stanhope Press, 1923), pp. 98-99.

unavailable to plants.[3] Organic matter increases the availability of phosphorus, but it can be assumed that the hilly, rocky soils used for pasture in both Petersham and Deerfield were low in organic matter. In his treatise on permanent agriculture, Cyril G. Hopkins states that, "phosphorus is the only element that must be purchased and returned to the most common soil of the United States".[4] Farmers during this time period did not have any phosphorus-rich fertilizer, other than perhaps bones of which there is no evidence of use. Manure was the only available form of phosphorus.

Potassium is easily leached from the soil solution regardless of organic matter content. The main source of potassium is weathering of soil minerals, but it is also bound in organic residues. Potassium can be physically trapped in the soil by clay particles, unlikely in the sandy soils of Deerfield and Petersham's pastures, or held in the soil by cation exchange. The cation exchange capacity of pastures in Deerfield and Petersham would have been low because of the sandy, low humus soils that were commonly used for pasture land.[5] Farmers did have a convenient and potent source of potassium for their fields: wood ash, or potash. In addition, manure supplies potassium. I found no evidence, however, of any addition of these materials to pastures. They were used only on tillage land.

The general trend on Massachusetts pastures in the 18th and 19th century was for nutrients to be transferred from grass into animals and not returned to the pastures. This one-way nutrient flow had significant impacts on pasture quality. The return of manure from grazing animals no doubt

---

[3]Parnes, pp. 84-85.

[4]Hopkins, p. 183.

[5]Parnes, p. 92.

forestalled the decline of pasture fertility, but could not prevent it. With no effective way to maintain fertility, the desirable grasses were gradually replaced in pastures by junipers, cedars, and pines, and the pasture was abandoned.

Massachusetts farmers had two types of hay land during this period. Fields of unplanted, native grasses were known as fresh meadow and land that was seeded to English grasses was called either upland mowing or English mowing. Though the amount of land devoted to fresh meadow and upland mowing in Deerfield and Petersham fluctuated over time, there were no great disparities between the two towns in the total number of acres devoted to hay (see fig. 4). In 1771, Deerfield had 832 acres of upland mowing and 330 acres of fresh meadow, while Petersham farmers raised 930 acres of upland mowing and 258 acres of fresh meadow hay. By 1831, Deerfield farmers harvested 1155 acres and 1317 acres of upland mowing and fresh meadow respectively. Meanwhile, Petersham farmers had increased their hay fields to 2448 acres of upland mowing and 1085 acres of fresh meadow. By 1865 Deerfield was growing as much upland mowing as Petersham with 3391 acres to 3015 acres, but fresh meadow had dropped to 258 acres in Deerfield, while Petersham farmers still had 756 acres.

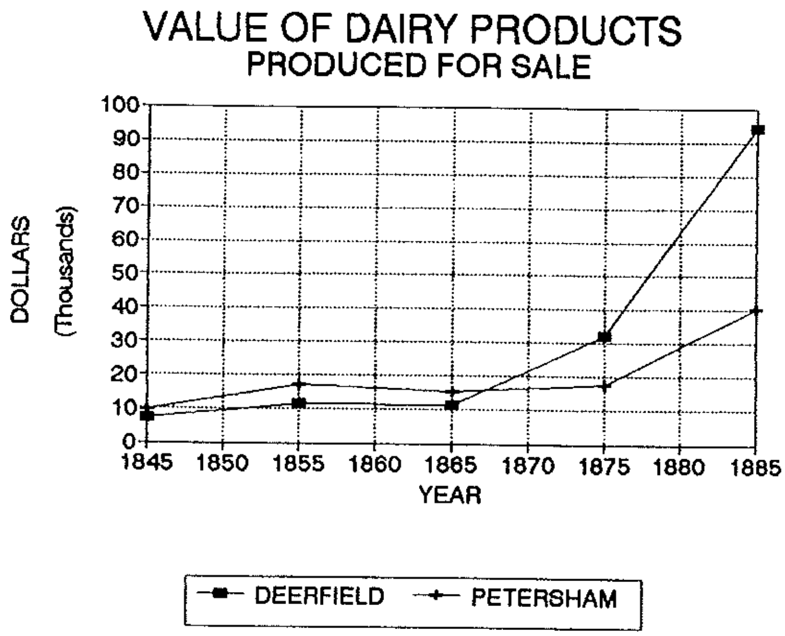
Farmers in Petersham expanded their English mowing lands in 1800, forty years before Deerfield farmers did. Petersham farmers relied on their hay to feed their livestock through the winter. Deerfield farmers were engaged in fattening their cattle over the winter, not merely sustaining them, so they concentrated on feeding grains to their cattle. The expansion of Petersham hay lands coincides with the switch to intensive farming. With this switch came more emphasis on feeding high quality forage rather than letting animals graze on poor pasture or in woodlands and an increase in the total number of animal units(f) (see fig. 8). The increase in Deerfield's upland mowing coincides with a decrease in tillage land and may be a foreshadowing of the boom in dairying which is first apparent in 1875 (see fig. 5). The increase in Deerfield's upland mowing may also be due to planting fresh meadow land to English grasses and thus changing their designation to upland mowing, as there is an increase in the one and a decrease in the other.

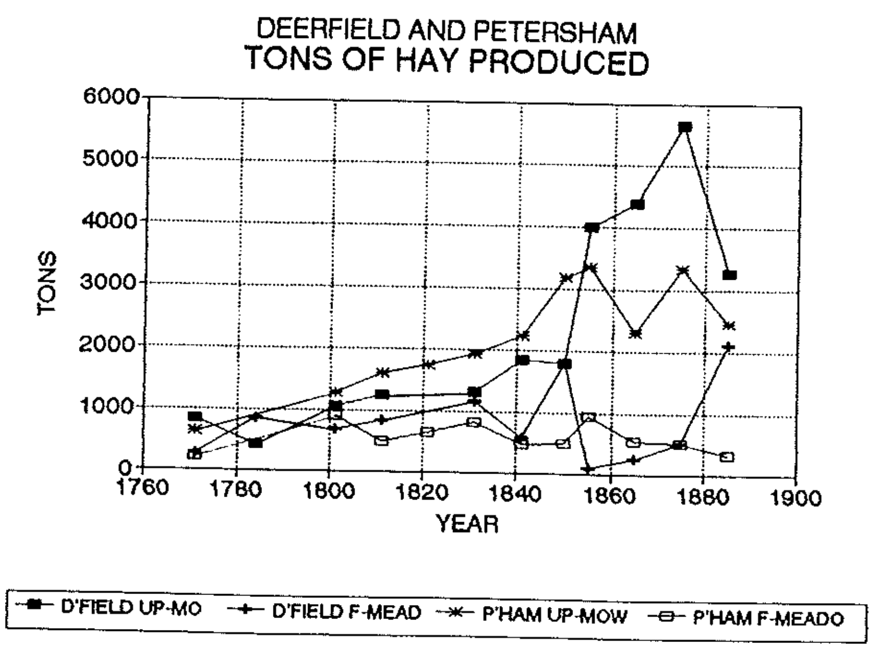
In addition, the introduction of the horse drawn mechanical mower and hay rake in the 1830s and 1840s may have encouraged farmers to expand their hay lands. Though Howard Russell suggests that in 1847 only one in ten farmers in Norfolk County south of Boston were using mechanical mowers,[6] it was probably the biggest farms that purchased mowers and they were the most able to greatly expand their hay production.

Hay fields were managed in much the same way as pasturage. Hay was not afforded the luxury of manure that was given to tillage, nor did hay fields even receive the manure that pastures did from grazing animals. Hay fields were cut once a year and the nutrients in the grasses and occasional clover were removed to be stored and fed to livestock in the barn. This nutrient flow steadily depleted hay fields until their yields were so low that they were used as pasture. The exception to this was the low lying fresh meadow of Deerfield which was situated along the Deerfield river and whose fertility was replenished annually by flooding. The yields of these fertile meadows were often three times those of other hay fields, often exceeding three tons per

[6]Russell, p. 238.

Figures 5 and 6





acre.[7] As with pasture, hay fields did not suffer much nutrient or topsoil loss through erosion, either rain or wind, due to their constant cover of grasses. The nutrients from hay land were lost through the export of nutrients by the cutting of hay.

There was a flow of nutrients on the farms in both Deerfield and Petersham which slowly depleted the fertility of their hay and pasture land. Fertility from these fields was either exported off the farm or redirected as manure onto tillage land. Tillage land also lost nutrients, through natural processes, consumption by farmers, or sale off the farm. Nutrients went into streams through erosion, down into the subsoil through leaching, and to cities and other communities through the sale of meat, hay, and produce. Some of the nutrients from the tillage were fed to animals and partly recycled back on to the tillage as manure. Despite these losses, farmers tried to concentrate the fertility of their farms towards tillage, first by choosing the best land for cultivation and second by funneling animal and other manures to that land. The fertility of tillage land was improved as a result of this concentration of nutrients, as shown by the increase in yields. The grasslands, however, were declining in fertility, as shall be demonstrated shortly. The grasslands supported the farms of Deerfield and Petersham and as their fertility declined, the sustainability of the whole farm system was jeopardized. However, the differences between Deerfield and Petersham were crucial on this point.

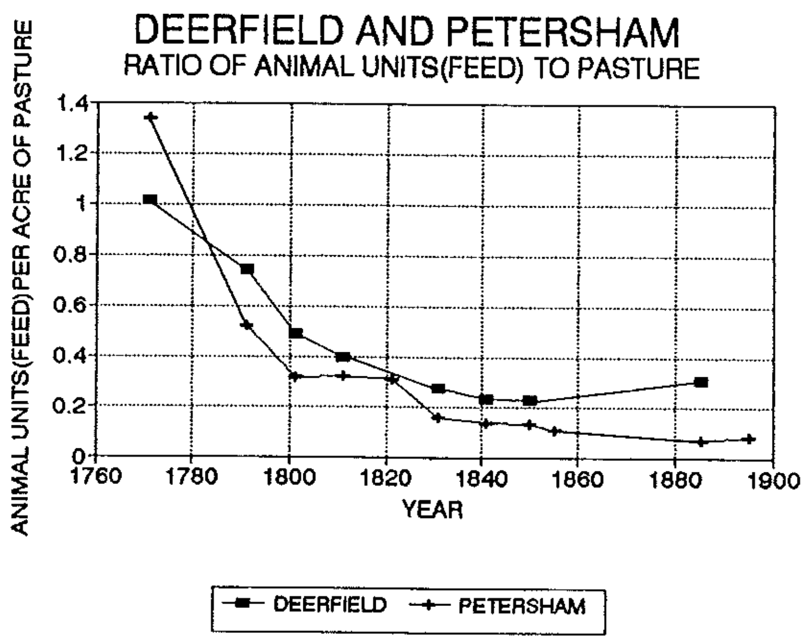
[7]Colman, 1841, p. 7.

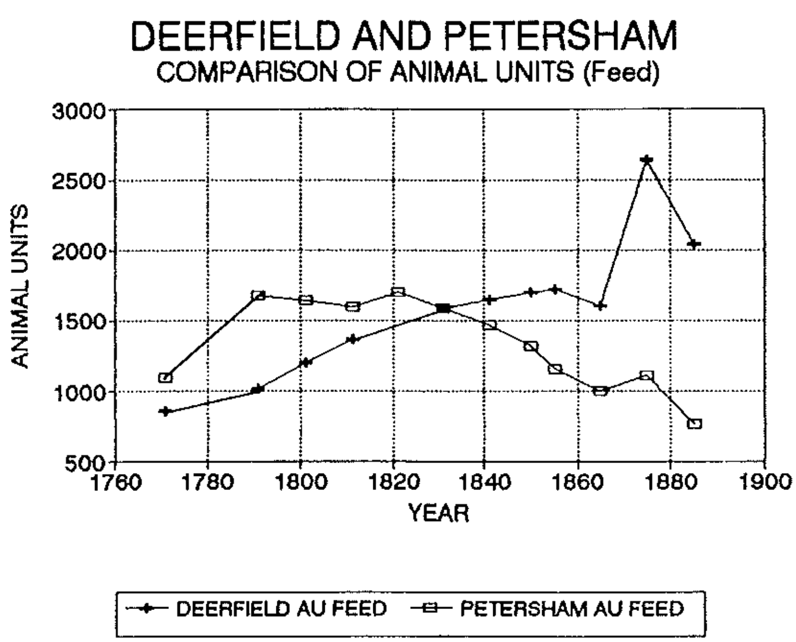
The Decline of Grasslands

The loss of fertility on pasture land in Deerfield and Petersham was an ongoing process which greatly affected the fertility and sustainability of the whole farm. Deerfield and Petersham farmers relied on pasture to feed their livestock during the summer. Some farmers in Deerfield rented pasture in nearby hill towns, but many had pastures within Deerfield. The acreage of pasture in both towns increased substantially and steadily throughout the time period studied. While the acres of pasture were increasing the stocking rates were decreasing (see fig. 7). In 1771, there were more than 1.3 animal units(f) for every acre of pasture in Petersham. Deerfield was supporting 1 AU(f) for every acre of pasture. Both of these stocking rates dropped dramatically to 0.5 AU(f) per acre of pasture in Petersham and 0.75 AU(f) per acre of pasture in Deerfield in 1791. By 1831, both towns were hovering around 0.3 AU(f) per acre of pasture. Deerfield did not drop much lower, but Petersham fell to less than 0.1 AU(f) per acre of pasture by 1895.

The reasons for this change in stocking rates should be explored more thoroughly. While the acres of pasture were climbing in both towns, the AU(f) trends in the towns were not alike (see fig. 8). The majority of animal units in both Petersham and Deerfield were cattle throughout the time period studied. Both towns had approximately 1000 AU(f) in 1771. By 1791, Petersham had 1678 AU(f), while Deerfield had just over 1000 AU(f). Petersham's AU(f) remained fairly stable until 1831 when the number of animals began dropping. Petersham's AU(f) dropped steadily until 1875, when the figure leveled off before dropping again in 1885 to 765 and 592 in 1895. Deerfield's AU(f) climbed after 1771 so that by 1831 there were 1588 AU(f) and by 1855 there

Figures 7 and 8





were 1724 AU(f) in Deerfield. Deerfield then experienced a slight drop in animal units before gaining 1000 AU(f) between 1865 and 1875 to 2638 AU(f). 1885 saw a drop in AU(f) to 2046 in Deerfield. In summary, Petersham had more animals early on and slowly their numbers declined, while Deerfield had fewer animals in the 18th century, but increased their numbers to peak in 1875.

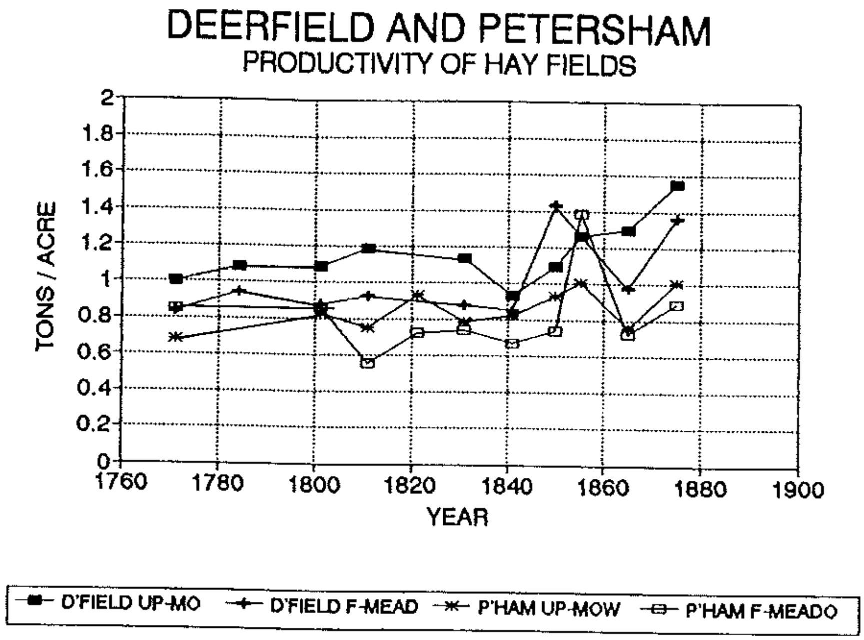
Since stocking rates describe a ratio it is important to look at how specific changes in one variable affect the changes in stocking rate. Petersham's AU(f) were stable at about 1600 from 1791 to 1821. During this time the stocking rate on their pastures dropped from 0.52 to 0.16. The change in stocking rate is due to an increase in pasture acreage from 1791 to 1800. From 1800 to 1821 the stocking rate leveled off because pasture did not increase and AU(f) remained stable. From 1821 to 1831 the acres of pasture in Petersham nearly doubled, while AU(f) dropped off resulting in a decrease in stocking rate from 0.31 to 0.16 AU(f) per acre. After this the stocking rate almost leveled off even though the number of animals continued to decline. In Deerfield there is a steady but gentle rise in animal units, but a steep rise in acres of pasture; this results in a constant decline in stocking rate until 1850. In 1875 there is a surge in animal units in Deerfield, but no corresponding data on acres of pasture so stocking rates cannot be determined. It can be concluded from this analysis that acres of pasture had an overriding influence over stocking rates, while changes in number of animals had a smaller influence.

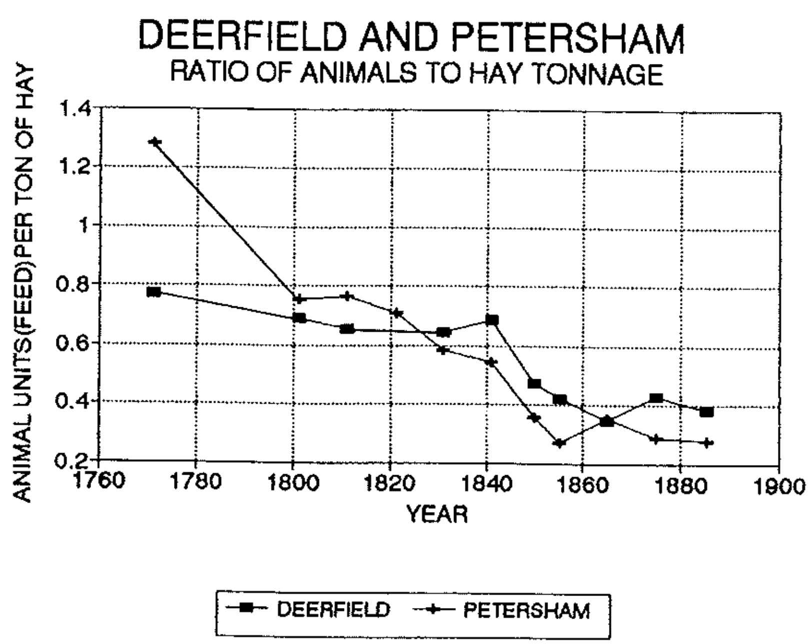
The fertility of pasture in both Deerfield and Petersham declined dramatically from 1771 until at least 1860, despite some indications that this should not have been the case. The reasons for this decline has been discussed in detail, but there are some interesting contradictions to note.

The dramatic rise of pasture acreage in Petersham in 1831 is not accompanied by an increase in animals. Presumably most of this land was being freshly cleared for pasture rather than converted from abandoned hay land, since the increase in pasture represents more land than was previously used for all hay and tillage. Thus it is odd that this new land was not reasonably fertile and capable of sustaining more cattle per acre. Deerfield was experiencing the same pattern: increasing pasture, at least some of it freshly cleared forest, yet fewer cattle being supported. It could have been that more of this new pasture was in fact nutrient-depleted, recently abandoned hay fields. Or perhaps their lack of lime, fertilizer, and clover made the pasture land nearly useless from the outset. Or, most likely of all, the newly cleared pasture land was sub-marginal land with poor soil and steep, rocky slopes that should never have been used for anything but growing trees. As already cleared land declined in fertility, farmers were forced to clear sub-marginal land to support the same size farms and the same number of animals. This last scenario seems most likely and demonstrates the ecological extremes farmers undertook to survive on their farms.

The hay crop management practices of farmers from 1770 to 1885 also indicates a decline in fertility of hay fields. Manure was never applied to hay fields except when sowing grass seed. Though hay was only cut once a year, this annual process slowly removed the nutrients from the soil and depleted the hay fields in much the same way as the pasture was degraded. In fact, the productivity of hay fields in Petersham and Deerfield remained fairly constant throughout my time period (see fig. 9). Deerfield's yields were consistently higher than Petersham's for both upland mowing and fresh

Figures 9 and 10





meadow; upland mowing was just above 1 ton per acre and fresh meadow was just below 1 ton per acre. Petersham's fresh meadow yields were consistently between 0.6 and 0.8 tons per acre and upland mowing was between 0.8 and 1 ton per acre. There were a few years in each of these categories when yields were exceptionally high or low, presumably because of unusually good weather or a well timed harvest, but the numbers stated above express general trends. By 1850 there is a noticeable increase in yields for upland mowing in both towns. In 1875, upland mowing was producing nearly 1.6 tons per acre in Deerfield and more than 1.3 tons per acre in Petersham.

The maintenance or even increase in hay yields could be interpreted to indicate steady or increasing fertility levels. I have found no evidence, however, of practices which could have maintained the fertility of the hay fields. These fields were not manured or limed; any leguminous crop planted probably fared poorly in the acidic soil. The following paragraphs explore some alternative explanations for the observed trends in hay yields.

One reason for the consistency in hay yields may have been the rotation of land from tillage to hay to pasture. Hay yields tended to be high the first few years after planting of grasses and clovers. The manure applied at planting and the pure stands of the first years provided high yields which dropped steadily from 2 tons per acre to 1 ton; finally, as yields approached half a ton per acre the hay fields were abandoned to pasture.[8] By continually bringing new land into hay, the average yields could have been maintained at around 1 ton per acre. In Deerfield, there is a sudden rise in acres of upland mowing in 1855 at the same time as there is a more than 1000 acre drop in tillage. Apparently, in this instance tillage land was being converted to

[8] Donahue, 1988, p. 8 and Colman, 1841, p. 6.

English grasses. Concurrent with the drop in tillage land is a decrease in fresh meadow so that perhaps the alluvial meadows of Deerfield were also being planted to upland meadow grasses. These fertile fields would have been capable of producing higher yields of hay. In Petersham, as well, there is an increase in upland mowing occurring alongside a decrease in fresh meadow. Additionally, in Petersham's case it is likely that fresh land was being cleared for hay fields and this may have helped maintain yields. However hay yields were maintained, through rotating tillage, fresh meadow or new land, it is reasonable to assume, given their hay field management practices, that land was being depleted of nutrients.

There is another factor which may have contributed to the rising hay yields that Deerfield experienced in the second half of the 19th century. The introduction of the horse drawn mechanical mower and hay rake would have allowed farmers to cut their hay fields twice a season. This would have increased annual yields, while simultaneously increasing the rate of nutrient depletion through crop removal.

The depletion of hay field fertility was particularly significant for farm nutrient cycles as hay became an increasingly marketable farm product during the 19th century. Brian Donahue suggests that during the 19th century hay became one of Massachusetts farmers' best cash crops. Many farmers were substituting corn fodder for hay on the farm so they could maximize the hay they had to sell.[9] According to Winifred Rothenberg, the percentage of the hay crop raised for sale rather than for on farm use in Massachusetts rose

---

[9]Donahue, 1984, p. 32.

between 1800 and 1850 from 23.2 to 51.6.[10] The ratio of animals to tons of hay produced dropped steadily beginning in 1811 in Petersham and 1841 in Deerfield (see fig 10). In 1800, both towns had approximately 0.7 AU(f) for every ton of hay and by 1865 this was down to 0.35 AU(f) for every ton of hay. This drop in the ratio of animals to hay can be partly explained by improved winter feeding regimes, but it was also due to selling hay.

Using the 1771 and 1850 individual farm data it is clear that hay production increased more than was needed to feed animals on farms (see figs. 11, 12, 13, 14). Using the base established by Winifred Rothenberg of one ton of hay per year for every cow or AU(f), these regressions clearly illustrate the change in farm economy and ecology. Each point on these graphs represents one farm. The farms within the shaded area of these graphs are producing at least one ton of hay for every AU(f) on the farm. In Deerfield, in 1771, the farms are split fairly equally, with slightly more farms below the "self-sufficient" line established by Rothenberg than above. By 1850 most Deerfield farms fall above the line, indicating that most were producing surplus hay, presumably for sale. In Petersham there is a similar pattern, but perhaps a more dramatic one. In 1771 the majority of the farmers are below the "self-sufficient" line and in 1850 nearly all Petersham farmers were producing excess hay.

The markets for hay improved greatly during the 19th century. The urban populations of New England were increasing during this time and the hay consumed by city livestock also increased. Farmers in Petersham and Deerfield took advantage of this situation. By 1850 Petersham farmers had increased

---

[10] Winifred Rothenberg, "A Price Index for Rural Massachusetts," Journal of Economic History, 39, No. 4, (1979), pp. 990-998.

Figure 11

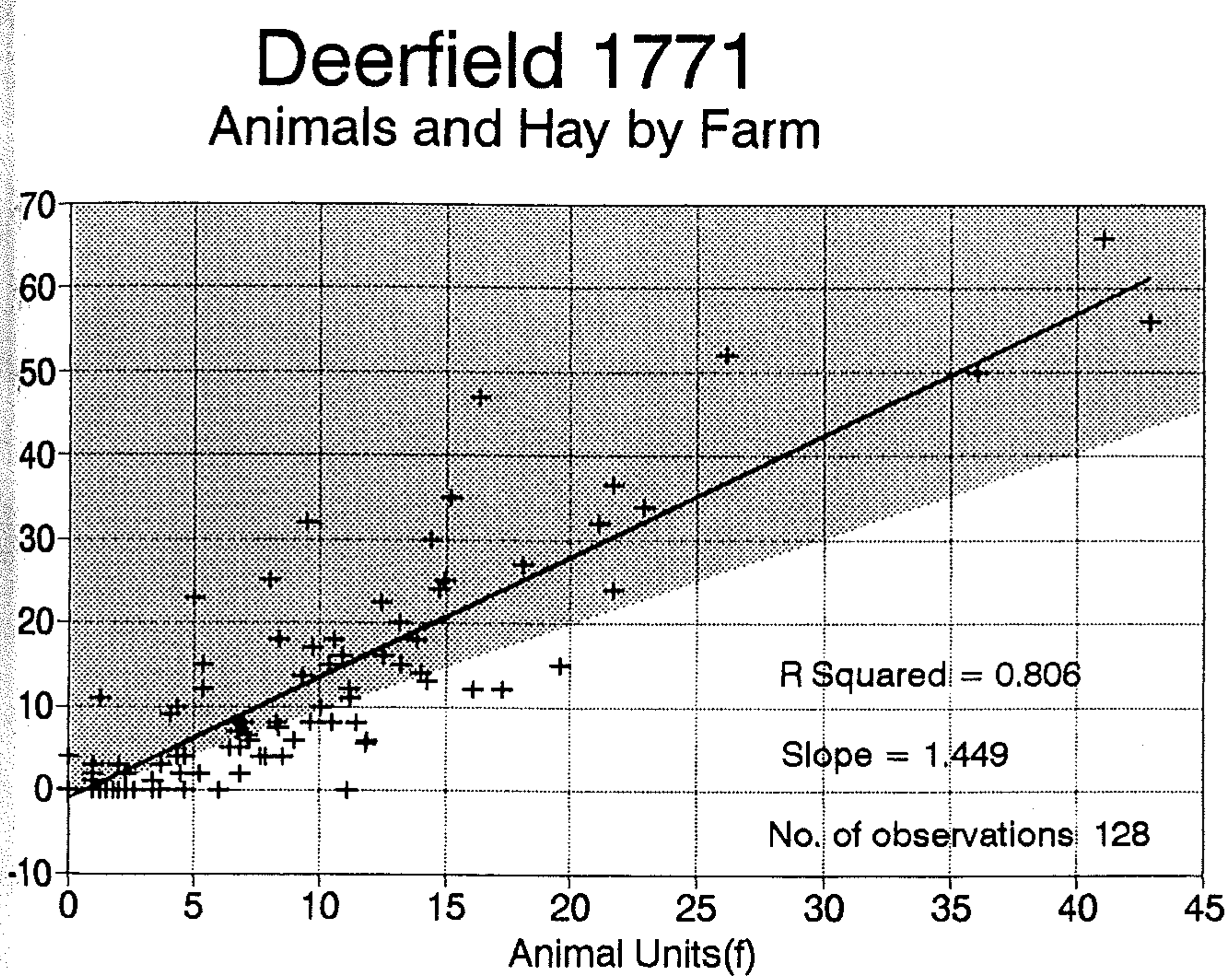
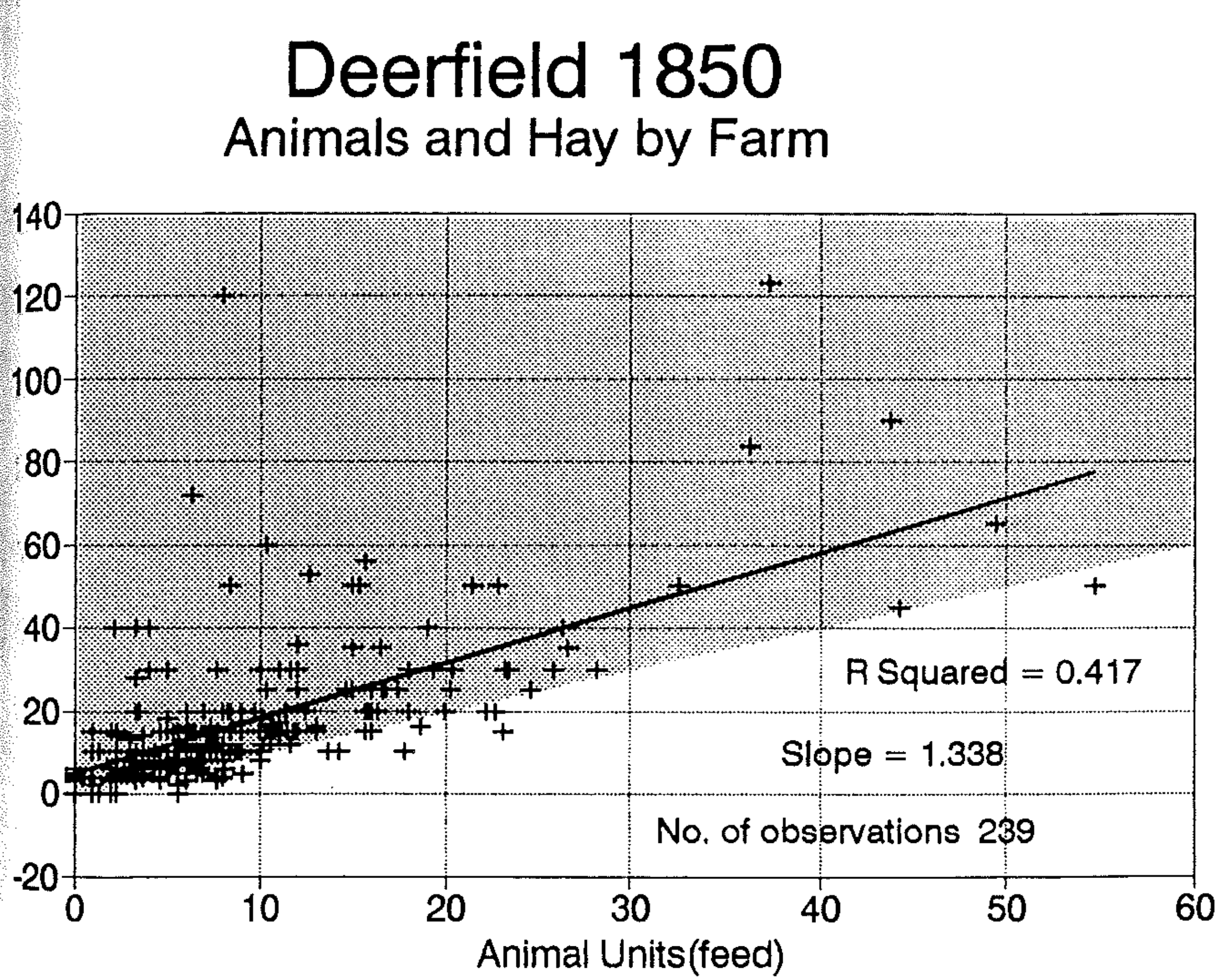

Deerfield 1771
Animals and Hay by Farm
70
60
50
40
30
20
10
0
-10
0
5
10
15
20
25
30
35
40
45
Animal Units(f)
R Squared = 0.806
Slope = 1.449
No. of observations 128

Figure 12



Deerfield 1850
Animals and Hay by Farm
140
120
100
80
60
40
20
0
-20
0
10
20
30
40
50
60
Animal Units(feed)
R Squared = 0.417
Slope = 1.338
No. of observations 239

Figure 13

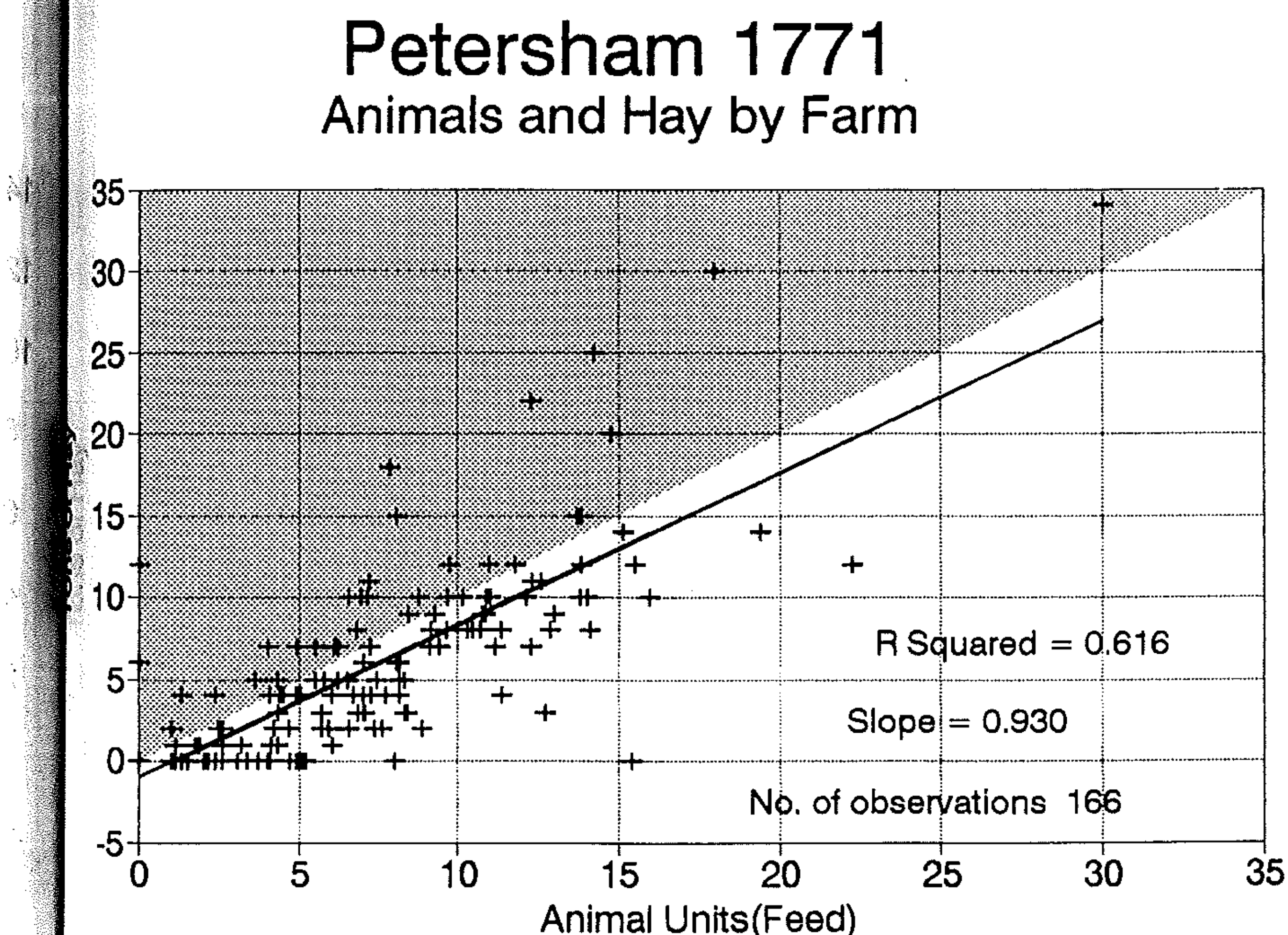
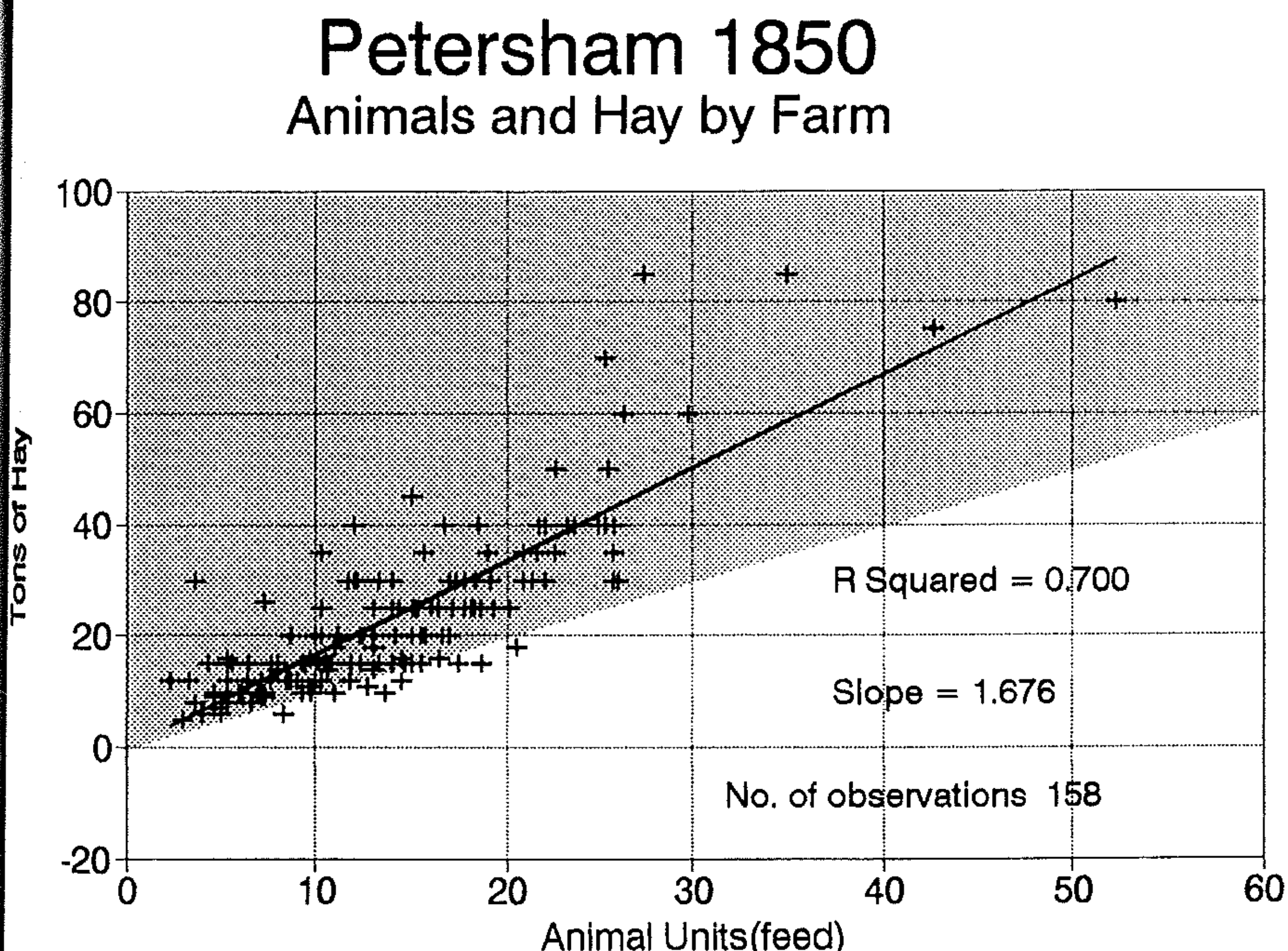

Petersham 1771
Animals and Hay by Farm
35
30
25
20
15
10
5
0
-5
0
5
10
15
20
25
30
35
Animal Units(Feed)
R Squared = 0.616
Slope = 0.930
No. of observations 166

Figure 14


Petersham 1850
Animals and Hay by Farm
Tons of Hay
Animal Units(feed)
R Squared = 0.700
Slope = 1.676
No. of observations 158
100
80
60
40
20
0
-20
0
10
20
30
40
50
60

access to markets in Boston via the railway in the neighboring town of Athol. Athol itself provided a market for some produce. Worcester, to the south and east of Petersham, boomed as a transportation center during the 19th century and would have provided a healthy market for surplus farm produce from Petersham. Northampton and Springfield would have provided markets for surplus hay from Deerfield farmers.

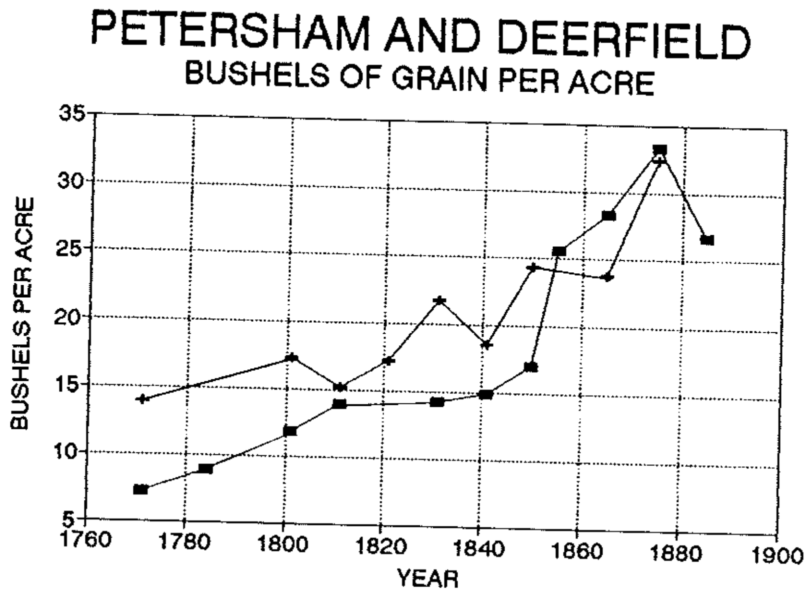
The impact that selling hay has on farm ecology is important. When hay is fed to animals on the farm, the animals leave behind a portion of the nutrients that were in the hay as manure. This manure can then be used to fertilize tillage land on the farm. All of the nutrients in hay are lost when hay is sold. Selling hay speeds up the process of nutrient decline on the farm as a whole.

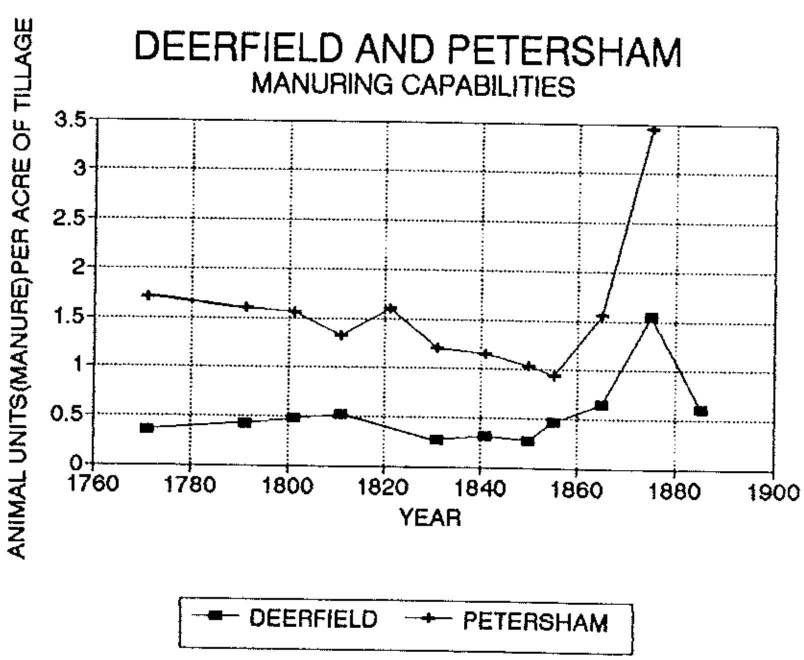
Tillage and Farm Fertility

As the fertility of the pasture and the hay land was being depleted, the tillage land on farms was receiving nutrients. Manure was applied to tillage land at regular intervals in both Deerfield and Petersham. Was enough manure applied to balance the nutrients being removed from the soil by crops? Or was the crop land slowly deteriorating, like the pasture, through harvested nutrient removal and erosion? The results indicate that the fertility was not declining on the tillage land of Petersham and Deerfield.

The maintenance, and in fact increase, in fertility of tillage land is demonstrated by the rising yields of grain that occurred in both Petersham and Deerfield over time (see fig. 15). Deerfield grain yields were 7.2 bushels per acre in 1771, 17 bushels per acre in 1850, and had climbed to 26.7 bushels

Figures 15 and 16





per acre by 1885. Petersham's yields were 14 bushels per acre in 1771, 24.4 bushels per acre in 1850, and by 1875 were up to 32.4. This dramatic increase could have been due in part to improved cultivars, but was primarily due to better manuring. Purchased fertilizers, such as phosphoric acid and nitrate of soda, may have been occasionally used on corn and other grains as early as 1850, but their use was not widespread.[11] There is another factor affecting the yields on tillage land. In 1855 the acres tilled in Deerfield dropped sharply, and Petersham's acres of tillage declined in 1865. The poorest soil was abandoned or turned to grassland leaving the choicest parcels of land in tillage. This process would have increased average yields. The soil of the tillage land was improving as the overall fertility of the farm was declining.

Curiously, yields from the rich fields of Deerfield were only half those of Petersham in 1771. Deerfield farmers had lower yields until 1865 when they produced 28.4 bushels to the acre compared with 23.8 in Petersham. The low yields of Deerfield can be explained in part by a lack of manure compared with Petersham (see fig. 16). In 1771, Petersham had 1.7 animal units(manure) for every acre of tillage, while Deerfield farmers had an average of only 0.3 AU(m) for every acre of tillage. Deerfield had less than half an AU(m) per acre until 1865, while Petersham had over one AU(m) per acre every year except for 1855. Petersham had slightly more AU(m) than Deerfield in 1771, but the significant difference between the towns is in the acres of tillage they had.[12] Deerfield farmers tilled nearly four times as many acres as farmers in Petersham (see Appendix E, Aggregate Town Data). Rising manuring capabilities

---

[11]Russell, pp. 232-233.

[12]As many as 400 cattle were purchased every fall by Deerfield farmers and these may well not be included in the tax valuations and census reports used to compile AU(m) figures.

in both Petersham and Deerfield were paralleled by an increase in yields during the second half of the 19th century.

Deerfield farmers were concerned with maximizing their bushels of grain harvested for the amount of labor invested. They had no shortage of flat, easily tilled land which was capable of growing corn. This led them to cultivate more acres with less attention paid to fertilizing.[13] Petersham farmers had limited land that was qualified for growing grain. Consequently, they concentrated on boosting the yields from the tillage land they had by spreading their manure more carefully. This extra care coupled with the much higher animal unit(m) to acre of tillage ratio enabled Petersham farmers to attain higher yields than those in Deerfield.

Another way I have analyzed the ability of farmers to fertilize their tillage land is by calculating the nitrogen requirements of the crops they grew and the amount of nitrogen they had available to apply to their crops. In the majority of agricultural systems nitrogen is the limiting nutrient and is the most important nutrient to add to fields.[14] Corn is probably the heaviest feeder of nitrogen of any of the crops grown by 18th and 19th century farmers, with the possible exception of tobacco. Corn predominated as the major crop in Petersham and Deerfield (see figs. 17 and 18). Removal of nutrients via crops is the most significant source of nutrient loss in soil.[15]

Farmers in Deerfield and Petersham were producing approximately 10 bushels of grain (primarily corn) per acre in 1771 and 20 bushels per acre in

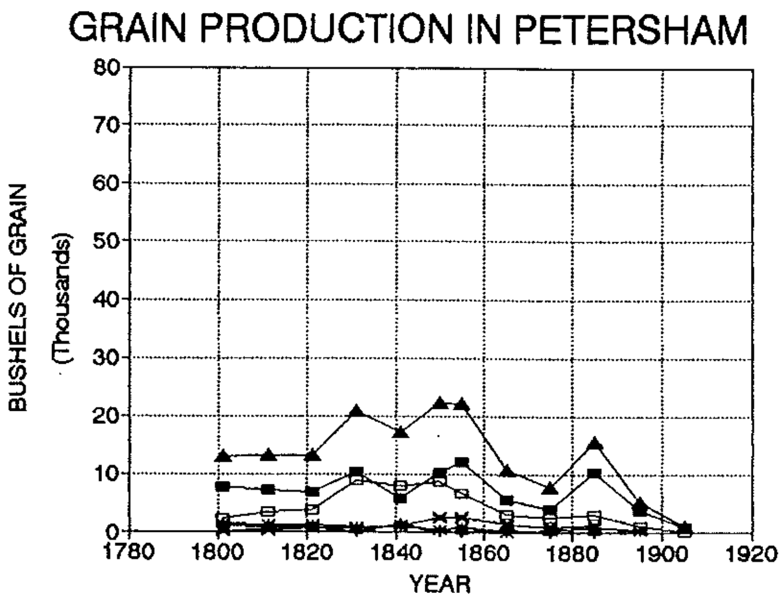
---

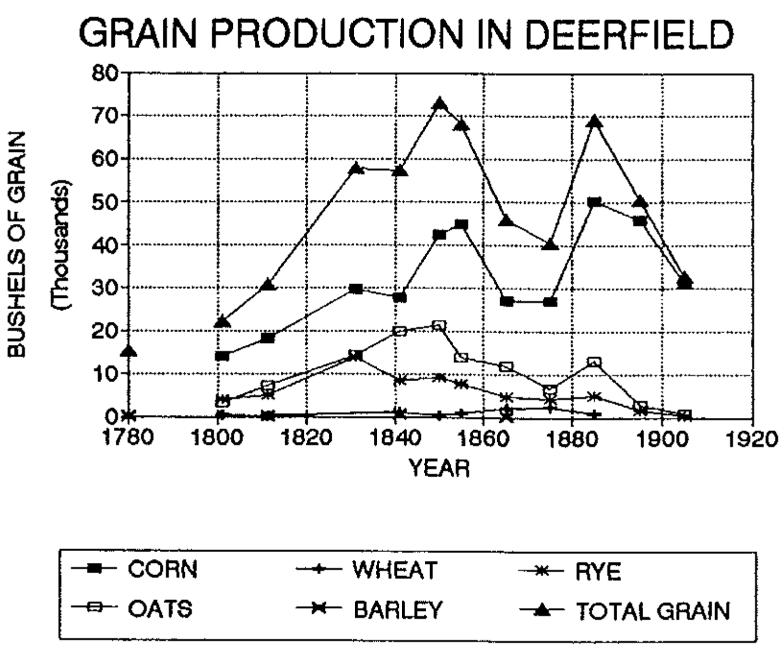
[13]Judd, p. 357. Judd examined Hadley, but comparisons with Deerfield are appropriate.

[14]Parnes, p.71.

[15]Nyle C. Brady, The Nature and Property of Soils (New York: Macmillan, 1984), p. 312.

Figures 17 and 18





1850. I have calculated that corn yielding 10 bushels per acre removes 15 lbs. of nitrogen in both the grain and the stalk from the soil (see Appendix B for an explanation of how estimation was made). Corn yielding 20 bushels to the acre would take up 30 lbs. of nitrogen from the soil each year in the stalk and the grain . From my animal unit(m) calculation I determined that 1 AU(m) produces 60 lbs. of nitrogen a year which the farmer could potentially spread on their fields. This 60 lbs. of nitrogen does not include the manure produced during six months each year spent on pasture and allows for a 50% loss of nitrogen from volatilization and leaching during storage and handling. Using these calculations, farmers in both Deerfield and Petersham in 1771 would need roughly 1 AU(m) for every 4 acres of tillage to supply the nitrogen needs of corn. Farmers in 1850 would require 1 AU(m) for every 2 acres of tillage to meet the demands of the corn crop which had doubled in yield.

Looking at individual farms in Deerfield and Petersham in both 1771 and 1850 it is clear that some farmers were producing enough manure to fertilize their tillage land (see figs. 19, 20, 21, 22). Each cross on the graphs represents one farm. The farms that are within the shaded section produced enough manure to replace the nutrients removed by the corn crop; those that are above the shaded area did not. In 1771 the line representing sufficient AU(m) for a given number of acres of tillage had a 4:1 slope and in 1850 it had a 2:1 slope based on the number of animal units needed to replace the nitrogen extracted by the corn. In Petersham, all but one or two farms were producing enough manure for their tillage in both 1771 and 1850. In 1771, over 20 farmers in Deerfield were not producing enough nitrogen to replace what their corn was extracting from the soil. In 1850 this number had increased so that nearly half of the farmers in Deerfield were not producing

Figure 19

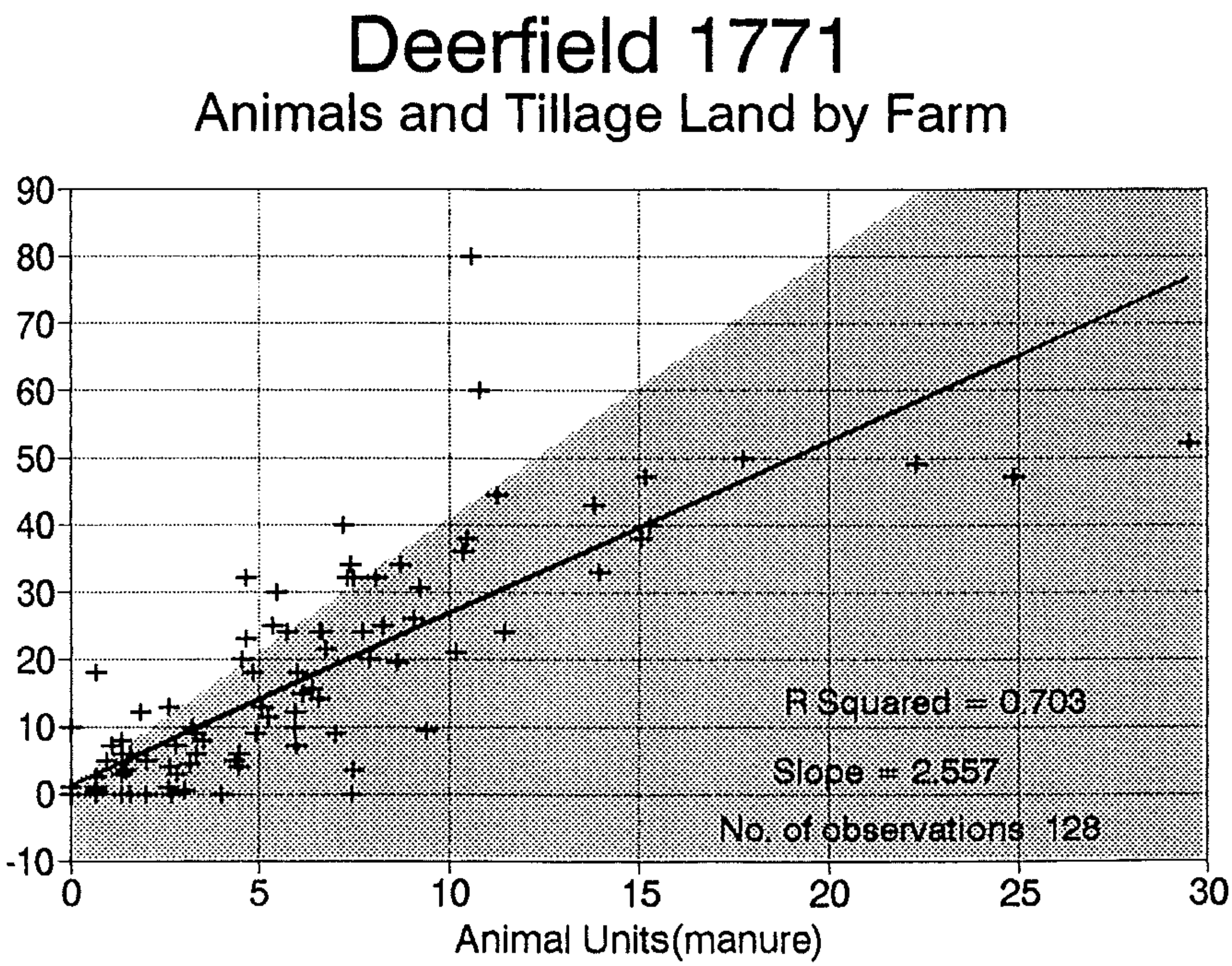

Deerfield 1771
Animals and Tillage Land by Farm
90
80
70
60
50
40
30
20
10
0
-10
0
5
10
15
20
25
30
Animal Units(manure)
R Squared = 0.703
Slope = 2.557
No. of observations 128

Figure 20

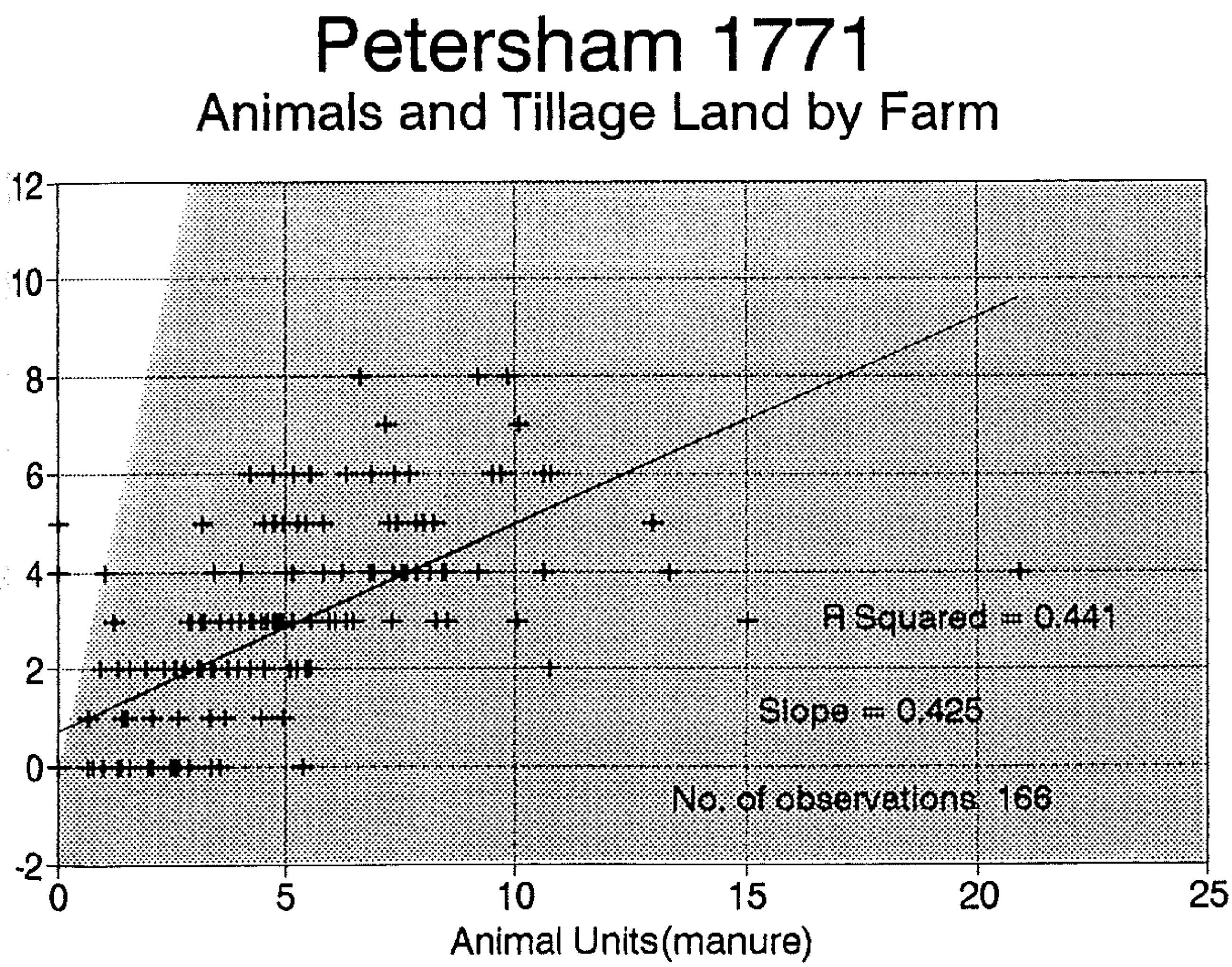

Petersham 1771
Animals and Tillage Land by Farm
12
10
8
6
4
2
0
-2
0
5
10
15
20
25
Animal Units(manure)
R Squared = 0.441
Slope = 0.425
No. of observations 166

Figure 21

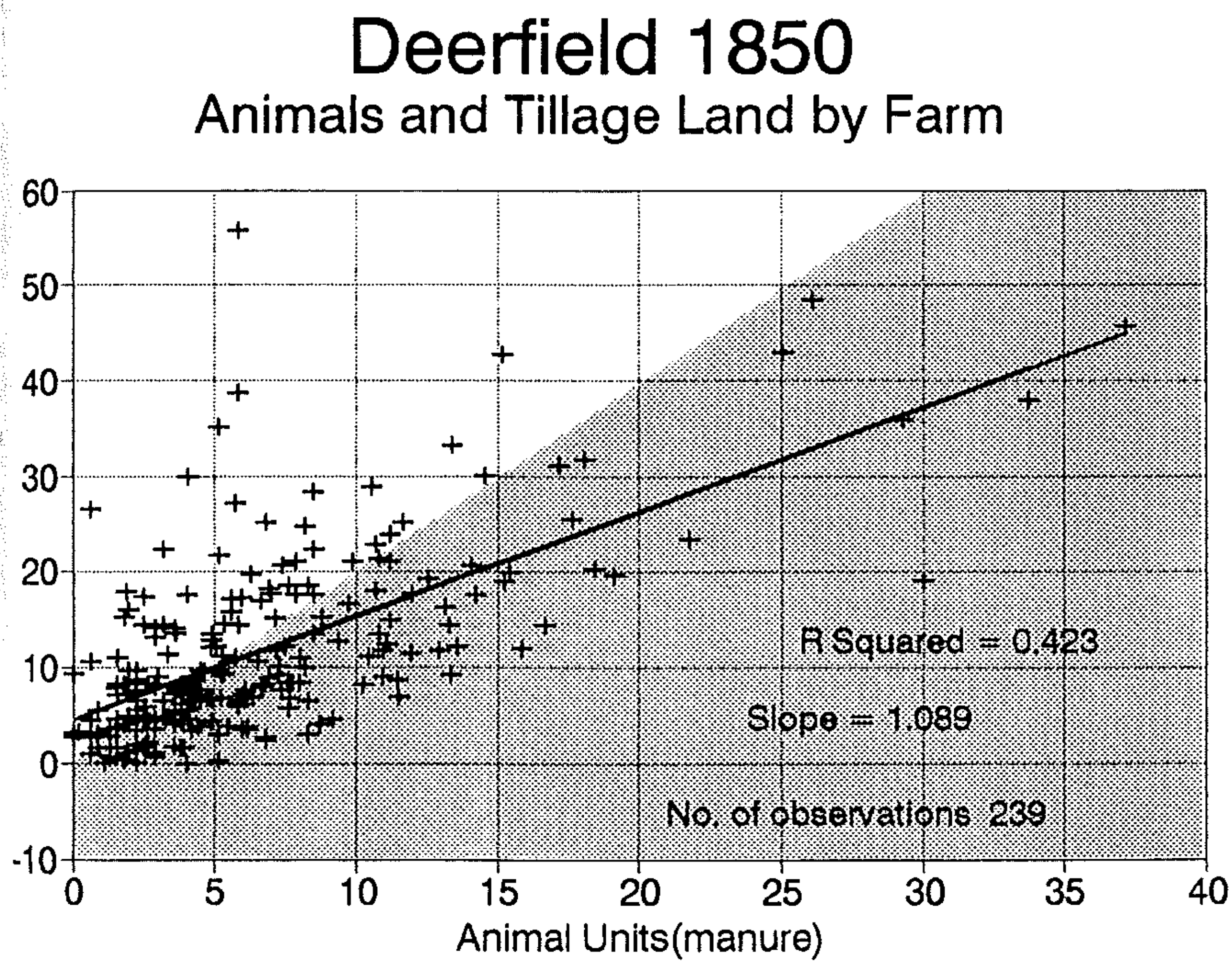
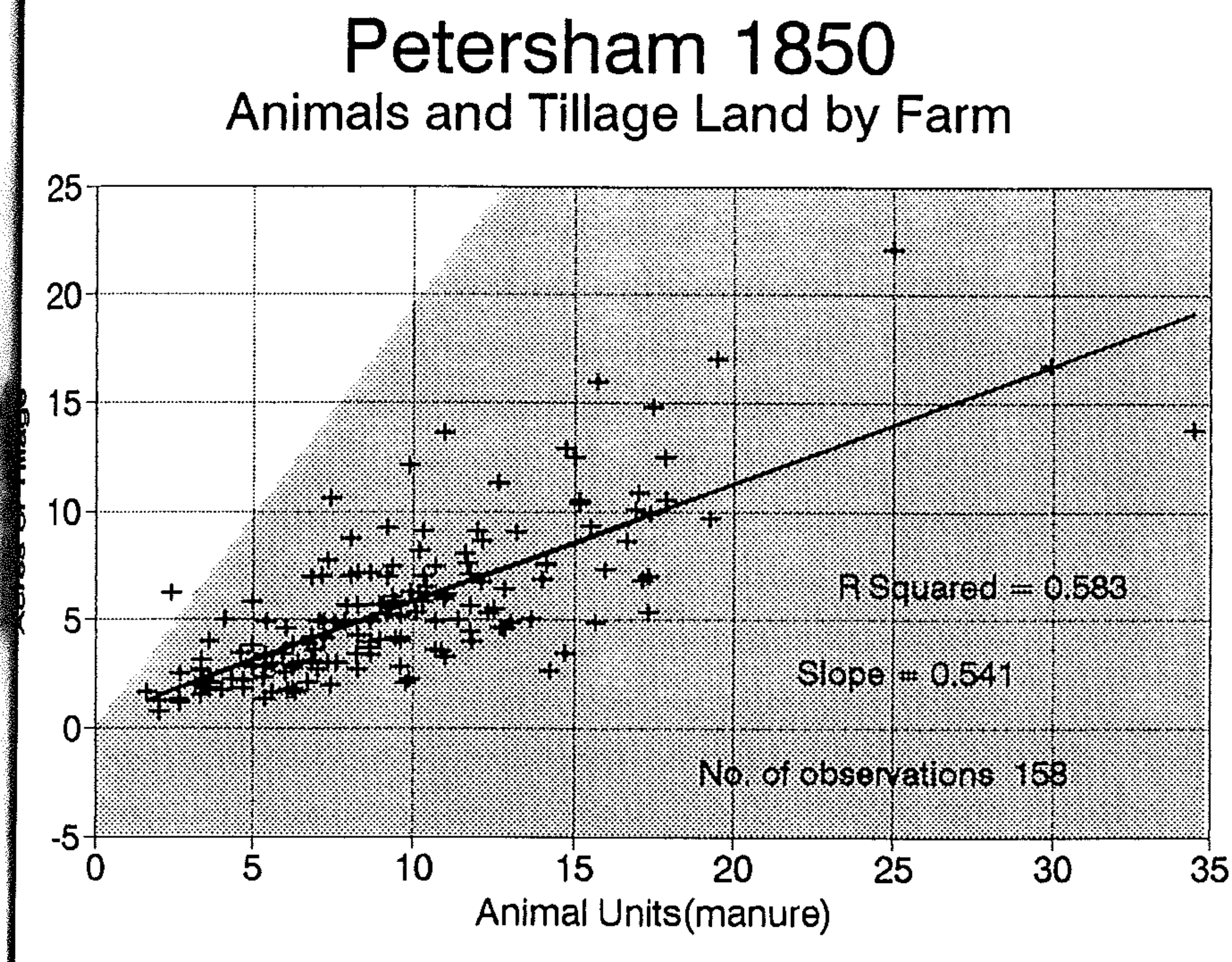

Deerfield 1850
Animals and Tillage Land by Farm
60
50
40
30
20
10
0
-10
0
5
10
15
20
25
30
35
40
Animal Units(manure)
R Squared = 0.423
Slope = 1.089
No. of observations 239

Figure 22



Petersham 1850
Animals and Tillage Land by Farm
25
20
15
10
5
0
-5
0
5
10
15
20
25
30
35
Animal Units(manure)
R Squared = 0.583
Slope = 0.541
No. of observations 158

enough nitrogen to replenish what their crops were removing. Deerfield farmers suffered lower losses from erosion and leaching than in Petersham because of the sandier soils and the steeper slopes of the tillage land in Petersham. Additionally, at least some Deerfield farmers had their tillage land within reach of the floods of the Deerfield river, which would have contributed to the nitrogen in the soil. Thus, replacing fertility through manure was less important to Deerfield farmers than it was to those in Petersham.

When all farms in each individual town are averaged, Petersham farmers had higher yields and greater manuring capability than those in Deerfield. However, within each town there is no indication that on a farm by farm basis, more manure meant higher yields (see figs. 23 and 24). Using regression analysis of manuring capabilities (AU(m) per acre of tillage) versus yields of individual farms in 1771 reveals that manuring capability and yields are independent of each other. The relationship, in both Petersham and Deerfield, is statistically insignificant. A number of factors may have contributed to this distinction between the general trend and the individual farms. Manure may not have always been used on the farm on which it was produced. This type of exchange between neighbors would have kept Petersham well manured, without directly linking high manure production on a given farm with high yields. Factors other than manure also influenced yields. With fewer acres to till, Petersham farmers spent more time per acre preparing the soil for planting, weeding, and harvesting their crops than farmers in Deerfield and this care could have produced higher yields. The lack of correlation between manure production per acre of tillage and yields on individual farms may have been due to manure exchange or may indicate that

Figure 23

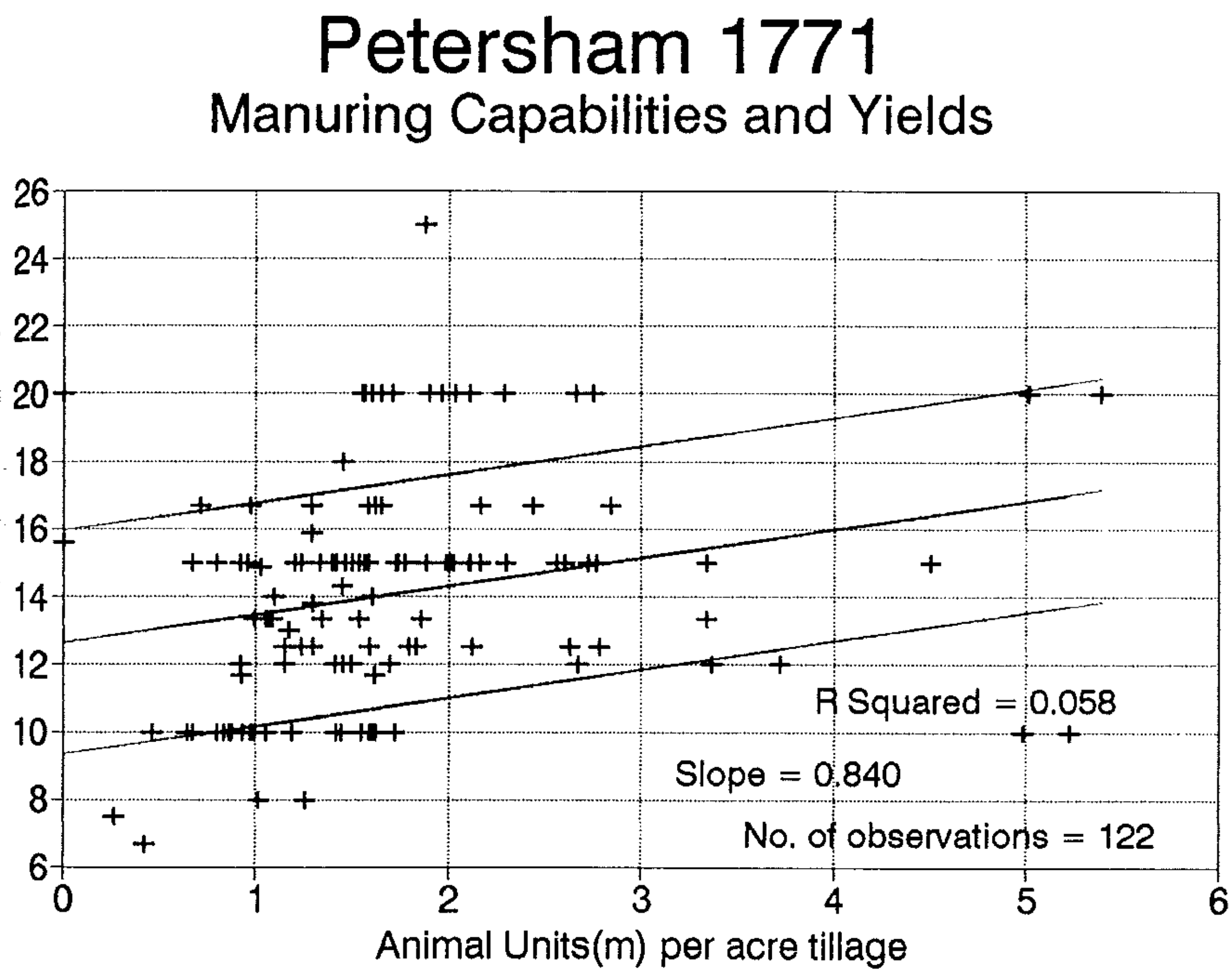
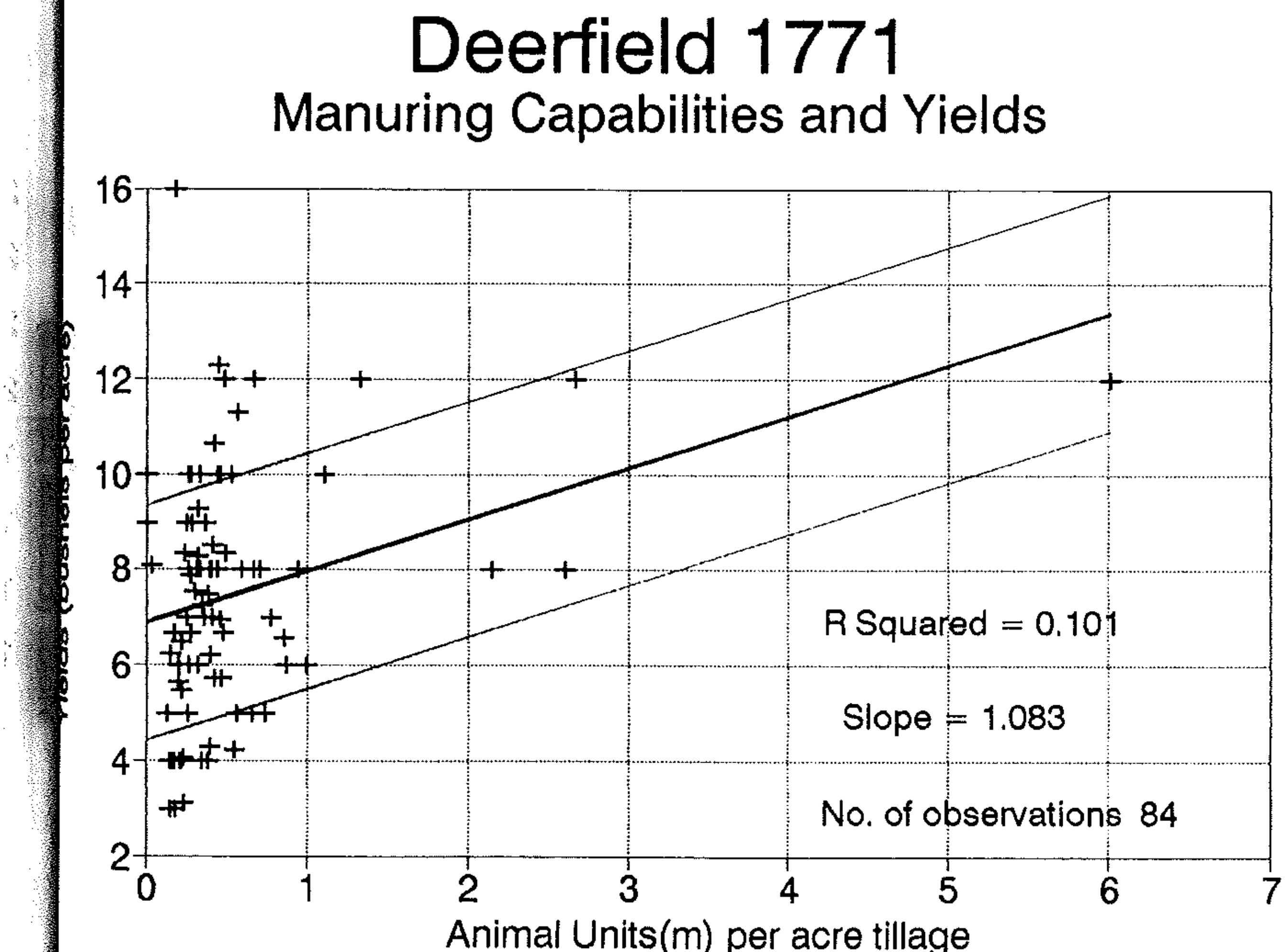

Petersham 1771
Manuring Capabilities and Yields
26
24
22
20
18
16
14
12
10
8
6
0
1
2
3
4
5
6
R Squared = 0.058
Slope = 0.840
No. of observations = 122
Animal Units(m) per acre tillage

Figure 24


Deerfield 1771
Manuring Capabilities and Yields
Yields (bushels per acre)
16
14
12
10
8
6
4
2
0
1
2
3
4
5
6
7
R Squared = 0.101
Slope = 1.083
No. of observations 84
Animal Units(m) per acre tillage

factors other than manure production were influencing yields.

Unsurprisingly, yields were higher in Petersham than in Deerfield until the middle of the 19th century. Deerfield farmers tilled many more acres than Petersham farmers, but they farmed less intensively. The ability of Petersham farmers to manure their tillage land was much greater. On an individual farm basis, there were numerous farms in Deerfield which could not have replaced the nitrogen removed by their corn crops. They may have overcome this by rotating corn with peas and oats, which require less nitrogen or by tilling fresh land and abandoning their tired tillage land. Deerfield farmers managed to increase their yields throughout the 19th century despite the apparent lack of sufficient manure on many farms for adequate manuring of tillage lands. Manure management practices must have improved over time, as yields increased in both towns (see fig. 15) regardless of upward or downward trends in manuring capabilities (see fig 16).

The shortcomings of the data should be considered in regard to the manuring capability of Deerfield and Petersham. Deerfield's AU(m) may be under-represented because of the winter stock that they bought in the fall after the valuations and census data was collected. The heavy feeding of these oxen during the winter would have produced copious piles of manure. Similarly, Petersham AU(m) may be over-represented as they may have sold stock in the fall and thus had fewer animals in the winter and less manure than the data indicates. In addition, the lack of young animals in any of my data has caused animal units to be under-counted in both towns. While these considerations do not trivialize the findings, they do add some uncertainty.

The overall trend on farms in Petersham and Deerfield was declining fertility. The soil nutrients of the farm were concentrated onto the tillage land and then lost by crop removal, leaching, volatilization, and erosion. These nutrients were carried off the farm in water, wind, and the sale of produce. The declining stocking rates on pasture in both towns indicate the loss of fertility on their pasture lands. However, hay yields were maintained at constant levels through the continual introduction of fresh and fertile land. The nutrients in the hay fields were slowly removed by the cutting of hay and no fertilizer was returned to hay fields to replace them. The fertility of tillage land was maintained in both Petersham and Deerfield. Petersham was able to return the necessary nutrients by manuring. Deerfield had to rely on the floods of the Deerfield river, their superior soil, and manure to maintain the fertility of their tillage land. Deerfield farmers also accepted lower yields because of their lack of ability or desire to properly manure their fields. The increasing yields on tillage land in both Deerfield and Petersham represents the draining of fertility from the rest of the farm. The farmers of these and other Massachusetts towns were slowly using up the soil resources that supported them.

Chapter V

Conclusion

Percy Bidwell commented in his classic 1921 review of New England agriculture in the 19th century:

> *There is an old French proverb which runs, "Tout comprendre c'est tout pardonner," [to understand is to forgive] and perhaps when we understand and fully appreciate the difficulties and discouragements which the New England farmers of this period had to face, and the doubts and fears which harassed them, we shall be inclined to judge that they did well, rather than poorly.*[1]

There is evidence that the overall fertility of the soil in the towns of Deerfield and Petersham was decreasing between 1771 to 1885. The balance of nutrients on farms was lopsided as more nutrients left the farm then were returned. This imbalance also occurred in on-farm nutrient flows, as nutrients were removed from pasture and hay land and redirected towards the tillage land. The fertility of the tillage land was slowly increasing, as demonstrated by increasing yields of grains. The practices of these farmers meant that the tillage land was constantly in need of fertilization because of nutrient loss from crop removal, volatilization, and erosion from the bare soil. The pasture and hay lands declined in fertility, as shown by the dramatic decline in pasture stocking rates and the lack of fertilization of hay fields. This nutrient flow meant that pasture and hay land fertility declined at the expense of the tillage land.

Despite the evidence and the interpretation presented in this paper and other ecological histories, there is still controversy over the management of fertility on 18th and 19th century New England farms. There are some clear reasons for viewing the overall fertility of farms as increasing. Hay yields remained constant and in fact increased between 1771 and 1885 and bushels of

---

[1]Bidwell, p. 699.

grain per acre more than doubled over this time period. However, the arguments for declining fertility are more persuasive. The data tells only half the story and needs to be interpreted in light of the available accounts of farming practices. For example, average hay yields may have remained constant, but Henry Colman reported in 1841, that yields on a given field decrease within a short period of time unless fertilized. There was no evidence of manuring hay fields and clover growing in fields would have been uncommon and short lived. Hay yields were probably maintained by rotating fresh land into hay and in later years by cutting twice a season with the mechanized mower.

The end of the 19th century heralded the decline of agriculture in Massachusetts. For many towns, like Petersham, the soil was exhausted and could no longer be farmed productively. Interestingly, Deerfield experienced no decline in agriculture during this same period. Many of the farmers across Massachusetts had switched to dairying by the 1900s because milk and cream were protected from mid-western competition by the lack of refrigeration. Looking at the number of cows in Deerfield and Petersham indicates the agricultural decline in Petersham and the absence of decline in Deerfield. In 1865 there were 700 cows in Petersham and 703 in Deerfield. By 1885 there were 602 cows in Petersham and 920 cows in Deerfield. By 1910 the dairy herd in Petersham was down to 389 while it had climbed to 982 in Deerfield.[2] In

---

[2]Experiment Station Massachusetts Town Statistics, RG 152.23,

1905, Deerfield produced $480,021 worth of agricultural products and Petersham only $162,391.[3]

Deerfield farmers used the same unsustainable practices as Petersham farmers, but were able to maintain their farms because of their deep, rich soil which was replenished by the flooding of the Deerfield river. The areas of poorer soil in Deerfield, which were used for pasture and some upland mowing, deteriorated at the same pace as the pasture and mowing of Petersham. Deerfield farmers tended to be wealthier than those in Petersham because of their successful agricultural specialty exports, including beef cattle, broom corn, tobacco, and onions, and their central location on the Connecticut River. The wealth of Deerfield farmers put them in a position to take advantage of new chemical and mined fertilizers in the late 1800s. With these fertilizers they were able to circumvent the need for manure, while increasing their yields. A combination of rich soil and economic advantage enabled Deerfield farmers to continue to farm their land, while Petersham's land was exhausted.

For Deerfield farmers, the use of imported fertilizers, both mined and synthetically derived, enabled them to balance the flow of nutrients onto and off of their tillage land. Deerfield farmers, because of their superior economic condition were able to take advantage of these purchased inputs.

Unfortunately, the use of synthetic fertilizers only allowed Deerfield farmers to ignore the fundamental problems with the ecology of the way they farmed. They were continuing to extract nutrients, but those nutrients were coming from off of their farms, rather than from their pasture and hay land.

---

[3] Census of the Commonwealth of Massachusetts: 1905, Vol 4, (Boston: Wright and Potter, 1909).

They had simply in expanded the boundaries of their extractive farming techniques in that they were drawing from a nutrient supply somewhere else. They spent money on these inputs rather than adjust their farming techniques.

Could the farmers of Deerfield and Petersham have avoided wearing out their soil? The addition of lime to their soils, planting winter cover crops, and relying on clovers for much of their nitrogen needs would have all made a big difference. Lime was the crucial missing ingredient from the agricultural practices of both towns. Without lime the soils of Deerfield and Petersham were quite acidic. Most agricultural crops grow best, because vital nutrients are most available, when the pH of the soil is close to neutral. Clover is particular sensitive to acidic soil and without lime could not be grown successfully in the soils of Deerfield and Petersham; without clover, farmers had to rely entirely on manure for nitrogen.

Some farmers applied lime, but its benefits were clearly not understood. That they were getting mixed results from its use, probably meant that they applied too little. Today, recommendations for liming range from two to six tons per acre in the acidic soils of the northern United States.[4] Local limestone was not readily available, so transportation costs may have made large additions of lime uneconomical.[5]

With their rich, loamy soil, Deerfield farmers and probably those of Petersham could have supplied all of their nutrient needs from the farm, with the exception of lime and other rock powders such as rock phosphate. They

---

[4]Dale Smith, Forage Management in the North (Dubuque, Iowa: Kendall/Hunt Publishing, 1975), p. 5.

[5]Colman, 1841, pp. 127-128.

could have introduced legume fallow rotations into their crop cycles and managed their manure more effectively to increase the nitrogen in the soil. Wood ash could have supplied on-farm sources of potassium. These and other management improvements would have built soil fertility and decreased the extractive nature of their farming practices.

This study does not fully address the reasons for farmers' failure to adopt these more sustainable practices, but one can speculate that several factors may have contributed. One reason for their lack of adoption of these practices was the large land base of the United States. From the earliest European settlements it seemed to Americans as though there was a limitless amount of land and resources. Wild animals were hunted to extinction, forests were cut, and land was farmed out. As Americans moved westward, they continued to cut the forest at a non-renewable pace and mismanage the nutrients on their farms. Sustainability was not part of the American mentality. Another reason was the lack of money for off-farm inputs of any kind, including lime. And finally, while some sustainable agricultural practices were being advocated by 19th-century agricultural improvers, like caring for manure and adding lime, there was a lack of understanding of how to farm in a less extractive way. Even today, one hundred years later, there is no consensus among agricultural researchers or farmers on how to farm sustainably.

The sustainability of farming in the 18th and 19th century was essentially a problem of balancing the flow of nutrients on farms. Forests of Massachusetts will naturally increase the fertility of soil, by adding organic matter and aiding in the weathering of nutrients from glacial till and bedrock. When land is used for agriculture, it is difficult to prevent the loss of nutrients to erosion and volatilization. In addition, nutrients are lost through crop removal. Through careful management of manure, return of this manure and other organic matter to all parts of the farm, and the use of lime and clovers, it is perhaps possible to farm in way in which their is no net loss of nutrients from the farm. There may still have been a need for the addition of phosphate and potassium fertilizers. Farms in both Deerfield and Petersham experienced an ongoing net loss of fertility so that by the end of the 19th century the stony, sandy, slopes which comprise most of Petersham and some of Deerfield could support a marginal form of agriculture at best.

Appendix A

Animal Units Calculation for Manure Production

Average weight for animals in 1830[1]

Cows 1100 lbs.
Oxen 1600 lbs.
Horses 1500 lbs.
Swine 300 lbs.
Sheep 130 lbs.

Manure production per 1000 lbs. live weight[2]

Cow 27,000 lbs. Includes both urine and excrement
Horse 18,000 lbs.
Swine 30,500 lbs.
Sheep 12,500 lbs.

Average Lbs. nutrients/ton manure[3]

	N	P_2O_5	K_2O
Cow	11	3	9
Horse	12	4	10
Swine	13	8	7
Sheep	20	5	20

Cows
163.35 lbs N/year
44.55 lbs P_2O_5/year
133.65 lbs K_2O/year

Oxen
237.6 lbs N/year
64.8 lbs P_2O_5/year
194.4 lbs K_2O/year

Horses
162 lbs N/year
54 lbs P_2O_5/year
135 lbs K_2O/year

Swine
59.5 lbs N/year
36.6 lbs P_2O_5/year
32 lbs K_2O/year

---

[1]Weights for cows, oxen, horses, and pigs were obtained orally from the OSV Interpretation Dept., Feb. 1991. The weight for sheep was obtained from conversation with Jill Lyons, farmer, Feb. 1991 and Henry Colman, Fourth Report on Agriculture, 1841, pp. 98-120.

[2]Robert Parnes, Fertile Soil (Davis, Ca.: agAccess, 1990), p. 133.

[3]Parnes, p.135

Sheep

16.2 lbs N/year
4 lbs P_2O_5/year
16.2 lbs K_2O/year

Nitrogen available to apply to fields:

Total yearly nitrogen output is reduced by 50% for time spent on pasture and reduced again by 50% to account for volatilization and leaching during storage and handling.

Cows	163/4 = 41 N lbs
Oxen	238/4 = 60 N lbs
Horses	162/4 = 40 N lbs
Swine	59.5/4 = 15 N lbs
Sheep	16/4 = 4 N lbs

Conversions:

1 Animal Unit(manure) = 1 Oxen

1 Oxen = .667 Cow = .667 Horse = .25 Swine = .067 Sheep

1 Animal Unit(manure) = 60 lbs. N

1 Animal Unit(m) = 1 AU(m)

Appendix B

Average Corn Crop Removal of Nitrogen From Soil At Different Yields

Sources		20 Bushels per acre	10 Bushels per acre
Parnes[1]:	N loss in grain	34 lbs	17.2 lbs
	N loss in stalks	17 lbs	8.4 lbs
	Total N loss	51 lbs	25.6 lbs
Hopkins[2]:	N loss in grain	20 lbs	10 lbs
	N loss in stalks	10 lbs	5 lbs
	Total N loss	30 lbs	15 lbs

For this study, I have used the data obtained from Hopkins. The data from Hopkins is based on research conducted at the beginning of the 1900s, when cultivars were more similar to the ones grown in the late 18th and 19th century than the corn cultivars of today. In addition the Hopkins data seems to "fit" my data more closely than the data from Parnes.

I have included the results from both Parnes and Hopkins so the reader may evaluate the validity of my data.

[1] Parnes, p. 126.

[2] Hopkins, p. 154

Appendix C

Population

	Petersham	Deerfield
1765	707	737
1776	1235	836
1791	1560	1330
1801	1794	1531
1811	1490	1570
1821	1623	1868
1831	1696	1868
1841	1775	1912
1850	1527	2421
1855	1553	2766
1860	1465	3073
1865	1428	3038
1875	1203	3414
1885	1032	3042
1895	952	3007
1905	855	2112

Appendix D

Figure Sources

Figures 1-4:	Tax valuations, 1771-1850, and Massachusetts census reports, 1855-1885.
Figure 5:	Massachusetts census reports, 1845-1885.
Figure 6-10:	Tax valuations, 1771-1850, and Massachusetts census reports, 1855-1885.
Figure 11:	Deerfield 1771 individual tax valuation
Figure 12:	Deerfield, 1850 U.S. Census return.
Figure 13:	Petersham, 1771 individual tax valuation.
Figure 14:	Petersham, 1850 U.S. Census return.
Figure 15-18:	Tax valuation, 1771-1850, and Massachusetts census reports, 1855-1885.
Figure 19:	Deerfield, 1771 individual tax valuation.
Figure 20:	Petersham, 1771 individual tax valuation.
Figure 21:	Deerfield, 1850 U.S. Census return.
Figure 22:	Petersham, 1850 U.S. Census return.
Figure 23:	Petersham, 1771 individual tax valuation.
Figure 24:	Deerfield, 1771 individual tax valuation.

Appendix E

Petersham and Deerfield Tax Valuations and Census Reports

PETERSHAM: TAX VALUATIONS AND MASS. CENSUS REPORTS

	Population	polls rate	polls not-rate	acres tilled	grain bu	engl. mowing a	engl mow tons	fresh mead a
1771				437	6104	930	638	258
1784		322	31	577		915		1120
1791	1560	390		761				1087
1801	1794	317		753	13056	1543	1280	1036
1811	1490			865	13182	2111	1587	896
1821	1623			771	13270	1872	1742	894
1831	1696			958	20807	2448	1921	1085
1841	1775			935	17363	2718	2225	715
1850	1527			913	22261	3400	3175	670
1855	1465			884		3305	3344	671
1865	1428			454	10781	3015	2300	756
1875	1203			243	7880	3307	3340	570
1885	1032				15666		2447	
1895	952				5281			
1905	855							

	fresh mead tons	pasture a	cows keep	woodland a	unimproved a	unimprovable	horses 3+	horses 1+	oxen 4+
171	220	823	512				140		204
184		2647		3053	11549	1310	229		208
191		3220		14958			239		301
101	896	5186	1569	4736	6509	1749	291		306
111	498	4979	1609	3671	6195	2467	235		314
121	648	5468	1477	3988	5596	2715	198		343
131	806	10134	2049	3996	3927	1347		211	357
141	478	10566	1706	4445	2441	1677		291	360
150	496	10149	1896	3800	3056	1455		232	310
155	929	10713		3756	4239	387		262	234
165	545			3385	5518	410.5		250	202
175	508			4547	11320	178.5		216	141
185	321	10814		6391.5	11483	95.5		337	80
195		7206		10484	7267	199		273	34
105		6187		13151	6344	1		213	22

	cows 4+	cow/steer 3+	other cattle	steers/cows1+	sheep-goats	swine
171		481		[481]	1125	210
184	593		678		843	371
191		958		[958]		488
101		846		[846]		453
111		862		[862]		401
121		978		[978]		428
131		981		891	916	302
141		875		704	802	290
150		843		670	436	169
155		811		644	230	162
165		670		349	425	128
175		897		380	161	362
185		638		230	140	556
195		518		119	198	331
305		488		160	114	282

DEERFIELD: TAX VALUATIONS AND MASS. CENSUS RETURNS

	Population	polls rate	polls not-rate	acres tilled	grain bu	engl. mowing a	engl mow tons	fresh mead a
1771				1611.25	11684	831.8	835.5	330.3
1780		207	18	1719	15287	387	419	903
1791	1330			1753		1045		268
1801	1531			1864	22020	973	1057	771
1811	1570	359	44	2202	30697	1044	1236	902
1821								
1831	1868			4056	57780	1155	1312	1317
1841	1912			3838	57370	1971	1834	672
1850	2421	629	21	4284	73022	1633	1793	1264
1855	2766			2652	67899	3173	4000	
1865	3038			1613	45763	3391	4399	258
1875	3414			1217	40560	3648	5652	378
1885	3042			2585	69039		3268	
1895	3007				50614			
1905	2112				32643			

	fresh mead tons	pasture a	cows keep	woodland a	unimproved a	unimprovable	horses 3+	oxen 4+	cow 3+	steer/cow 3+
1771	276.5	846	436				166	169		309
1780	854	1659	386				319	270	378	
1791		1357		10305			196	225		448
1801	676	2447	775	9012	1803	1439	237	276		514
1811	837	3407	1169	6835	1876	1643	220	383		557
1821										
1831	1161	5775	1372	4884	1315	396	247	425	492	
1841	573	7081	1109	3893	1490	665	263	427	544	
1850	1808	7382	1322	3502	1748	97	313	365	701	
1855	98						337	351	695	
1865	253			2308	2125	238	351	228	651	
1875	514			2473	6936	946	374	178		1841
1885	2101	6662		3246	8155	124	457	40		1314
1895										
1905										

	st/cowl+	other cat	sheep	swine
1771	[309]		736	129
1780		682	1752	403
1791	[448]			364
1801	[514]			458
1811	[557]			972
1821				
1831	658		1403	385
1841	595		1299	542
1850	682		661	403
1855	[695]		784	502
1865	[651]		1300	209
1875	[1841]		426	789
1885	[1314]		490	1270
1895				
1905				

Appendix F

Tax Valuations and Census Reports: Calculated Values

PETERSHAM

	Bu/acre	AU(man)	AU(f)	AU(m)/acre till	AU(f)/tons of hay	AU(f)/acre pasture
1771	14	746	1100	1.71	1.28	1.34
1784	0					
1791	0	1221	1678	1.6		0.52
1801	17.3	1178	1642	1.56	0.75	0.32
1811	15.2	1146	1594	1.32	0.76	0.32
1821	17.2	4234	1699	1.6	0.71	0.31
1831	21.7	1148	1588	1.2	0.58	0.16
1841	18.6	1070	1469	1.14	0.54	0.14
1850	24.4	944	1318	1.03	0.36	0.13
1855	0	831	1156	0.94	0.27	0.11
1865	23.8	709	1000	1.56	0.35	
1875	32.4	841	1108	3.46	0.29	
1885	0	654	765		0.28	0.08
1895		475	592			0.08

DEERFIELD

	Bu/acre	AU(man)	AU(f)	AU(m)/acre till	AU(f)/tons of hay	AU(f)/acre pasture
1771	7.2	567	861	0.35	0.77	1.02
1784	8.9					
1791		745	1009	0.42		0.74
1801	11.8	891	1198	0.48	0.69	0.49
1811	14	1144	1361	0.52	0.66	0.4
1831	14.2	1108	1588	0.27	0.64	0.27
1841	15	1188	1649	0.31	0.68	0.23
1850	17	1186	1699	0.28	0.47	0.23
1855	25.6	1217	1724	0.46	0.42	
1865	28.4	1036	1608	0.64	0.34	
1875	33.3	1881	2638	1.54	0.43	
1885	26.7	1571	2046	0.61	0.38	0.31
1895						

Data Sources

Deerfield and Petersham aggregate and individual data, 1771. Pruitt, ed. The Massachusetts Tax Valuation List of 1771, Boston, 1978.

Deerfield town tax valuations, aggregate data, 1791, 1801, 1831, 1841, 1850. From the Massachusetts State Archives. Boston.

Deerfield town tax valuations, aggregate data, 1780 and 1811. From the Massachusetts State Library, Special Collections. Boston.

Petersham town tax valuation, aggregate data, 1783. From the Massachusetts State Library, Special Collections. Boston.

Petersham town tax valuations, aggregate data, 1790-1850. From the unpublished data collected by Old Sturbridge Village, Sturbridge, MA.

Deerfield and Petersham individual data, 1850. Seventh U.S. Census of Massachusetts. Massachusetts State Archives. Boston.

Deerfield and Petersham state census reports, aggregate data, 1855-1905, see Bibliography.

Deerfield and Petersham population data, "Experiment Station, Massachusetts Town Statistics, (RG 15/2.23). Deerfield, Franklin Co., and Petersham, Worcester Co., University of Massachusetts, Amherst, MA: Archives, ND.

Bibliography

Baker, Andrew H. Manager of Interpretation and Education, Lake FarmPark, Telephone Interview. 4 February 1991.

--------- and Holly Izard Paterson. "Farmers' Adaptations to Markets in Early Nineteenth-Century Massachusetts." The Farm. The Dublin Seminar for New England Folklife: Annual Proceedings, 1986. Ed. Peter Benes. Boston: Boston University, 1988.

Bidwell, Percy W. "The Agricultural Revolution in New England." The American Historical Review. 26, 1921.

Black, John D. and Ayers Brinser. Planning One Town. Cambridge: Harvard University Press, 1952.

---------. The Rural Economy of New England. Cambridge: Harvard University Press, 1950.

Brady, Nyle C. The Nature and Property of Soils. New York: Macmillan, 1984.

Barron, Hal S. Those Who Stayed Behind. Cambridge: Cambridge University Press, 1984.

Census of the Commonwealth of Massachusetts: 1895. Prep. by Horace G. Wadlin, Vol 4, Boston: Wright and Potter, 1899.

Census of the Commonwealth of Massachusetts: 1905. Vol 4, Boston: Wright and Potter, 1909.

The Census of Massachusetts: 1875. Prep. by Carroll D. Wright, Vol 3, Boston: Albert J. Wright, 1876.

The Census of Massachusetts: 1885. Prep. by Carroll D. Wright. Vol 3, Boston: Wright and Potter, 1887.

Clark, Christopher. "The Household Economy, Market Exchange and the Rise of Capitalism in the Connecticut Valley, 1800-1860." Journal of Social History, 13, No. 2 (1979), pp. 169-189.

---------. The Roots of Rural Capitalism. Ithaca, NY: Cornell University, 1990.

Coleman, Emma Lewis. A Historic and Present Day Guide to Old Deerfield. Boston: Plimpton Press, 1926.

Colman, Henry. Fourth Report of the Agriculture of Massachusetts. Boston: Dutton and Wentworth, 1841.

---------. Third Report of the Agriculture of Massachusetts on Wheat and Silk. Boston: Dutton and Wentworth, 1840.

Coolidge, Mabel Cook. The History of Petersham. Hudson, MA: Powell Press, 1948.

Cooter, William S. "Ecological Dimensions of Medieval Agrarian Systems." Agricultural History, 52, No. 4, (1978), pp. 458-479.

Cronon, William. Changes in the Land. New York: Hill and Wang, 1983,

Danhof, Clarence. Change in Agriculture: The Northern United States. Cambridge: Harvard University Press, 1969.

Deane, Silas. The New England Farmer: or Georgical Dictionary Rpt. (original published 1790), New York: Arno Press, 1972.

Dickinson, Rodulphus. Dickinson's View of Massachusetts Proper. Greenfield, MA: Denio Phelps, 1813.

----------. View of the Town of Deerfield. Deerfield, MA: Graves and Wells, 1815.

Doherty, Robert. Society and Power: Five New England Towns, 1800-1860. Amherst, MA: University of Massachusetts Press, 1977.

Donahue, Brian. "'Skinning the Land.'" Chicago: Paper delivered at the Annual Meeting of Social Science History Association. Nov. 1988.

----------. "'Skinning the Land': Economic Growth and the Ecology of Farming in 19th Century Massachusetts." Unpublished Manuscript, Brandeis University, 1984.

----------. "The Forests and Fields of Concord: An Ecological History, 1750-1850." In Concord: The Social History of a New England Town 1750-1850. Ed. David Hackett Fischer. Waltham, MA: Brandeis University, 1983, pp. 14-63.

Dwight, Timothy. Travels in New-England and New York. 4 vols. London: Charles Wood, 1823.

Eliot, Jared. Essays Upon Field Husbandry in New England and Other Papers 1748-1762. Eds. Harry J. Carman and Rexford G. Tugwell. New York: Columbia University Press, 1934.

Everts, Louis H. History of the Connecticut Valley in Massachusetts with Illustrations and Biographical Sketches. Philadelphia: J.B. Lippincott, 1879.

"Experiment Station, Massachusetts Town Statistics, (RG 15/2.23)." Deerfield, Franklin Co. and Petersham, Worcester Co., University of Massachusetts, Amherst, MA: Archives, ND.

Flinders, Jerran, T. "An Alternate Method of Calculating Animal-Unit Equivalents." Society of Range Management, Annual Meeting. 33. pp. 48-60.

Foster, David R. "Land-use and Vegetation Dynamics in Central Massachusetts: an Historical Perspective." Unpublished paper. Harvard Forest, Harvard University, Petersham, MA. 01366. ND.

Garrisson, Ritchie. "Farm Dynamics and Regional Exchange: The Connecticut Valley Beef Trade, 1670-1850." Agricultural History, 61, No. 3, (1987), pp. 1-17.

----------. "Surviving Strategies: The Commercialization of Life in Rural Massachusetts 1790-1860." Diss. 1985.

Gershuny, Grace. and Joseph Smillie. The Soul of Soil: A Guide to Ecological Soil Management. St. Johnsbury, Vt: Gaia Services, 1986.

Gordon, Nancy. "The Harvard Forest Models: Is That the Way it Really Was?" Masters Thesis, University of Massachusetts, 1986.

Grinell, James S. Massachusetts Agriculture. N.D., N.P.

Gross, Robert. "Culture and Cultivation: Agriculture and Society in Thoreau's Concord." The Journal of American History, 69, No. 1 (1982), pp. 42-61.

----------. The Minutemen and Their World. New York: Hill and Wang, 1976.

Henretta, James A. "Families and Farms: *Mentalité* in Pre-Industrial America." The William and Mary Quarterly, 35, No. 1, (1978), pp. 3-32.

Hirtle, Peter. "Agrarian Economy in Flux: The Agricultural History of Deerfield, 1670-1760." Historic Deerfield Summer Fellowship Program. August, 1973.

Historical Data Relating to Counties, Cities, and Towns in Massachusetts. Prep. by Kevin H. White, The Commonwealth of Massachusetts, 1966.

Historical Data Relating to Counties, Cities, and Towns in Massachusetts. Prep. by Michael Joseph Connolly. 1975.

Hopkins, Cyril G. Soil Fertility and Permanent Agriculture. Boston: Ginn, 1910.

Innes, Stephen. Labor in a New Land: Economy and Society in Seventeenth Century Springfield. Princeton, NJ: Princeton University Press, 1983.

Judd, Sylvester. History of Hadley. Springfield, MA: H.R. Hunting, 1905.

Kimenker, James. "The Concord Farmer: An Economic History." In Concord: The Social History of a New England Town 1750-1850. Ed. David Hackett Fischer. Waltham, MA: Brandeis University, 1983, pp. 139-197.

Kistler, Thelma M. "The Rise of Railroads in the Connecticut River Valley." Smith College Studies in History, 23, No. 1-4, (Oct. 1937-July 1938).

Loomis, R.S. "Ecological Dimensions of Medieval Agrarian Systems: An Ecologist Responds." Agricultural History, 52, No. 4, (1978), pp. 478-483.

Lyons, Jill Horton. Farmer, Personal Interview, Feb. 1990.

Massachusetts Agricultural Repository and Journal. Trustees of the Massachusetts Society for Promoting Agriculture. Boston: Ezra Tileston, Vol 3, 1815. pp. 55-67, 114-129, 264-269, and 342-345.

Massachusetts Agricultural Repository and Journal. Trustees of the Massachusetts Society for Promoting Agriculture. Boston: Tileston and Weld, Vol 4, 1816-1817. pp. 88-89, 340-361.

Merchant, Carolyn. Ecological Revolutions: Nature, Gender, and Science in New England. Chapel Hill, NC: University of North Carolina Press, 1989.

Mighell, Ronald L. and Marian Brown. "Type-of-Farming Areas in Massachusetts." Massachusetts Agricultural Experiment Station Bulletin, No. 244, (1928), pp. 255-268.

New England Farmer. Boston: Thomas W. Shepard, Vol 1, Feb. 22, 1823, p. 235.

New England Farmer and Horticultural Register. Boston: Joseph Breck, 24, No. 21, Wed. Evening, Nov. 19, 1845.

Pabst, Margaret Richards. "Agricultural Trends in the Connecticut Valley Region of Massachusetts, 1800-1900." Smith College Studies in History, 26, No. 1-4, (Oct. 1940-July 1941).

Parnes, Robert. Fertile Soil. Davis, CA: agAccess, 1990.

Pruitt, Bettye Hobbs. "Agriculture and Society in the Towns of Massachusetts, 1771: A Statistical Analysis." Diss. Boston University, 1981.

----------. The Massachusetts Tax Valuation List of 1771. Boston, 1978.

----------. "Self-Sufficiency and the Agricultural Economy of Eighteenth-Century Massachusetts." The William and Mary Quarterly, 41, No. 3, (1984), pp. 333-364.

Plantinga, M.P. "Agricultural Land Utilization in the Connecticut Valley in Massachusetts." MSS Thesis, Massachusetts State College Library. N.D.

Raup, Hugh M. and Reynold E. Carlson. The History of Land Use in the Harvard Forest. Bulletin No. 20. Petersham, MA: Harvard Forest, 1941.

Ricklefs, Robert E. The Economy of Nature. New York: Chiron Press, 1983.

Rothenberg, Winifred B. "The Market and Massachusetts Farmers." Journal of Economic History, 41, No. 2, (1981), pp. 283-314.

----------. "A Price Index for Rural Massachusetts, 1750-1855." Journal of Economic History, 39, No. 4, (1979), pp. 975-1002.

Russell, Howard S. A Long Deep Furrow: Three Centuries of Farming in New England. Hanover, NH: University Press of New England, 1982.

Sampson, Arthur W. Range and Pasture Management. New York: John Wiley and Sons, 1923.

Sauer, Carl. "Homestead and Community on the Middle Border." in Changing Rural Landscapes. Eds. Ervin H. and Margaret J. Zube, Amherst, MA: University of Massachusetts Press, 1977.

Shammas, Carole. "Consumer Behavior in Colonial America." Social Science History, 6, No. 1, (1982), pp. 67-86.

----------. "How Self-Sufficient Was Early America?" The Journal of Interdisciplinary History, 13, No. 2, (1982), pp. 247-272.

Sheldon, George. A History of Deerfield, Massachusetts. Vol. 1 and 2. Greenfield, MA: E.A. Hall, 1896.

Smith, Dale. Forage Management in the North. Dubuque, Iowa: Kendall/Hunt, 1981.

Smith, David C. and Anne E. Bridges. "The Brighton Market: Feeding Nineteenth Century Boston." Agricultural History, 56, No. 1, (1982), pp. 3-21.

Spurr, Steven H. "Stand Composition in the Harvard Forest as Influenced by Site and Forest Management." Diss. Yale University, 1950.

Statistical Information Relating to Certain Branches of Industry in Massachusetts, 1855. Prep. by Francis DeWitt, Boston: Dutton and Wentworth, 1856.

Statistical Information Relating to Certain Branches of Industry in Massachusetts, 1865. Prep. by Oliver Warner, Boston: Wright and Potter, 1866.

Statistics of the Condition and Products of Certain Branches of Industry in Massachusetts, 1845. Prep. by John G. Palfrey, Boston: Dutton and Wentworth, 1846.

Stevens, Mary Lynn. "No Complaints: Agriculture in Deerfield, 1760-1810." Historic Deerfield Summer Fellowship Program, August, 1976.

Sweeney, Kevin M. Amherst College Professor of American History, Personal Interview, Feb, 1990.

----------. "Gentlemen Farmers and Inland Merchants: The Williams Family and Commercial Agriculture in Pre-Revolutionary Western Massachusetts." The Farm. The Dublin Seminar for New England Folklife: Annual Proceedings. 1986. Ed. Peter Benes, Boston: Boston University, 1988.

U.S. Dept of Agriculture. Report and Recommendation on Organic Farming. prepared by USDA Study Team on Organic Farming, July 1980.

U.S. Census of 1850, Instructions to Marshal and Assistants. Washington, DC: Robert Armstrong, 1853.

Way, Winston A. The Manure Primer. The Extension Service, University of Vermont with the Dept. of Water Resources and Environmental Engineering. N.D.

Welch, Jochen, Staff at Old Sturbridge Village. Personal Interview. Feb, 1990.

Wheeler, Frank M. Diary of a 15-17 year old farm boy, 1881-1882. Located in library of Old Sturbridge Village, MA.

Willard, Max E. Bedrock Geology of the Greenfield Quadrangle. Dept. of Interior, U.S. Geologic Survey. Washington DC: U.S. Geologic Survey, 1952.

Wilson, Harold F. "The Rise and Decline of the Sheep Industry in Northern New England." Agricultural History, 9, (1935), pp. 12-40.

Young, Raymond A. Introduction to Forest Science. New York: John Wiley and Sons, 1982.

Hampshire College
Amherst, Massachusetts 01002

HAROLD F JOHNSON LIBRARY CENTER

COPYRIGHT RELEASE FOR DIVISION III EXAMS

Title of Paper: An Ecological History of Agricultural Land Use in Two Massachusetts Towns

Author's Name: Nicholas Jones

Year of Graduation: May 91

I hereby grant to the Hampshire College Library permission to reproduce this document for the purpose of filling inter-library loan requests. Reproduction for other purposes or by other persons than Hampshire College Library staff requires permission from the copyright holder.

Signature: Nicholas J. Jones

Date: 5/16/91