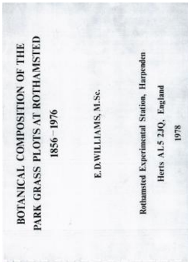
ROTHAMSTED RESEARCH

Botanical Composition of the Park Grass Plots at Rothamsted 1856-1976


BOTANICAL COMPOSITION OF THE PARK GRASS PLOTS AT ROTHAMSTED 1856–1976

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Default Title

Rothamsted Research

Rothamsted Research (1978) *Default Title ;* Botanical Composition Of The Park Grass Plots At Rothamsted 1856-1976, pp 1 - 62 **- DOI: https://doi.org/10.23637/ERADOC-1-156**

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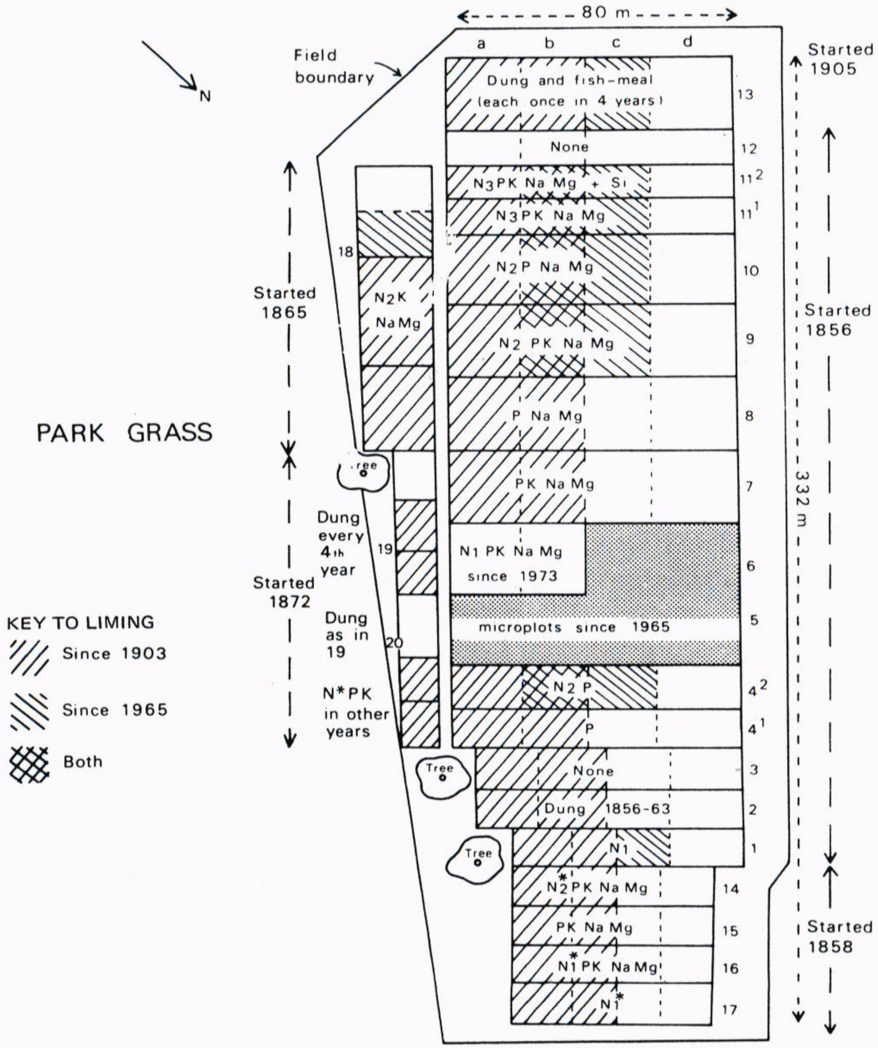
Fig. 1. Plan of the Park Grass Experiment



Plot size, number and area

Largest e.g.	7 to 10	0.2 ha = ½ acre
Half-plots e.g.	4^1, 11^1	0.1 ha = ¼ acre
Smaller	14 to 17	0.07 ha = ⅙ acre
Smallest	19 & 20	0.05 ha = ⅛ acre

For amounts and combinations of fertilisers applied to individual plots see Tables 1a and 1b, p. 18.

For details of liming schemes see Table 2, p. 19.

For pHs during 1974 to 1977 see Table 3, p. 19.

(Dung = farmyard manure = FYM)

INTRODUCTION

The Park Grass experiment was laid down by Lawes and Gilbert in 1856 to ascertain what were the optimum amounts and combinations of inorganic and organic fertilisers needed to obtain maximum yields of hay. When the experiment started "the Park had already been under grass for certainly more than a century" (Lawes & Gilbert, 1859). There is no record of any seeds having been sown, so the species present at the outset represented indigenous species and strains of plants. Prior to 1851 the land was manured with farm-yard dung, road scrapings and the like, and sometimes with guano or other purchased manure. One crop of hay (3-5 t ha^{-1}) was removed annually, and the second crop was always eaten off by sheep. In 1851 and 1852 sheep were fed with turnips on part of the field but during 1853-55 it received no manure.

The experiment was in effect an extension of the work previously started with arable crops on other fields; the lay-out resembled that on the Broadbalk winter wheat experiment where the fertiliser treatments were applied in strips running throughout the field. Although treatments on some plots were changed during the early years, a few plots were split to increase the number of treatments and some were added a little later than others, most plots have now received unchanged treatment for at least a century. Details of the amounts of fertilisers and individual plot treatments are given in Tables 1(a) and 1(b) respectively and a plan of the experiment (as in 1975) in Fig. 1

The treatments can be considered within four main groups: (1) no nitrogen; (2) nitrogen applied at three amounts as ammonium sulphate; (3) nitrogen applied at two amounts as sodium nitrate. Within the three groups there are comparisons of P and – with and without K Na Mg, applied as their sulphates, for some of the amounts of N. (4) Farmyard manure since 1905, either alone, alternating with fish meal, or with inorganic fertilisers.

Tentative applications of lime were made to different halves of the plots on two occasions, during 1883-84 and during 1887-88, but it was not until 1903 that a regular scheme of liming was introduced (Table 2). In 1920 more plots came into the liming scheme and another scheme was also introduced to test two laboratory methods for measuring the lime requirement of soils. In 1965 a new liming scheme (Warren, Johnston & Cooke, 1965) was introduced. In this scheme each half-plot is further divided into two, giving four sub-plots (*a, b, c* and *d*) for each fertiliser treatment and it is intended that eventually sub-plots of all plots should have soils with pHs of approximately 7.0, 6.0, 5.0 and 4.0 in water. A start was made during 1965-68 on the first phase of this scheme when lime was applied to previously unlimed sub-plots *c* in an attempt to increase their pH to 5 and also increased rates of lime were given to previously limed sub-plots *b* to increase their pH to 6. Only plots given ammonium sulphate were sufficiently acid then to require lime. In 1976 another phase of the same scheme, viz. the raising of the pH of sub-plots *a* to 7, where they are less than this, was begun. The amounts of lime so far given to those *b* and *c* sub-plots which have already come into the new scheme are given in Table 2 and the present pHs of all sub-plots in Table 3. The pHs on previous dates are given by Warren & Johnston (1964), Johnston (1972) and Thurston, Williams & Johnston (1976).

The management of the plots has remained fairly constant throughout; the plots have been cut for hay every year, usually in June, but occasionally in July. Before 1960 the yields of hay were recorded and dry matter yield often estimated on samples of hay. Since 1960 yield has been estimated from the weight of herbage taken in

1L

sample strips by forage harvester and the dry matter content of sub-samples taken immediately after cutting. Thus, dry matter yields since 1960 cannot be directly compared with those before 1960. The remainder of the herbage on each plot is then made into hay. During fifteen of the first twenty years of the experiment the aftermath was grazed by sheep. Since 1887 all of the second cut has been carted, weighed and yield given as hay, or since 1960, as herbage dry matter. In addition to work on the botanical composition of the plots, chemical analyses of soil and herbage have also been made at intervals (e.g. Lawes & Gilbert, 1900; Warren & Johnston, 1964) and recently the soil and surface fauna have been surveyed (Edwards & Lofty, 1975; Edwards, Butler & Lofty, 1976).

The full Latin names of species whose generic names only are given in the text appear in Table 4. These are as in Clapham, Tutin & Warburg (1962). Also in Table 4 are the common names recommended by the Botanical Society of the British Isles (Dony, Perring & Rob, 1974).

HISTORY OF WORK ON BOTANICAL COMPOSITION OF THE PLOTS AND THE NEED FOR FURTHER ANALYSES

The experiment soon showed how yield could be increased by fertilisers. For example, even in 1856 yield was trebled by P and K and the largest amount of N. Differences in yield have persisted and become accentuated since although yields declined on most plots they did so more on some than on others.

The treatments also soon began to change the botanical composition of the swards. In their report of results during 1856-58 Lawes & Gilbert (1859) wrote: "Perhaps the most remarkable and interesting of the effects of the different descriptions of manure upon the complex herbage of which the experimental meadow was composed was the very varying degree in which they respectively developed the different kinds of plants. In fact, the plots had each so distinctive a character in regard to the prevalence of different plants that the experimental ground looked almost as much as if it were devoted to trials with different seeds as with different manures. So striking and characteristic indeed were the effects produced in this respect that in 1857 and 1858 the subject was considered to be of sufficient interest to induce us to request the examination of the plots by Professor Henfrey, to which he kindly assented".

Lawes & Gilbert noted that the 'character of the herbage' was fairly uniform throughout the field at the start of the experiment but that unfortunately little evidence was obtained on the changes that occurred during the first seven years (Lawes, Gilbert & Masters, 1882). There is, however, some information for the early years. During the second year (1857) samples of herbage were taken for botanical analyses from many of the plots but the results were not published. In 1858 samples of herbage were taken from seven plots, sub-sampled and using specimen plants to aid identification a number of boys were set to pick from the weighed sample all they could find to correspond with the types. This left a large 'undetermined residue of detached foliage and undeveloped stems' which was then separated into four or five different lots. The separations were supervised by Dr. E. Pugh of Pennsylvania. The percentage contribution to the air dry (or hay) weight of the different fractions were then calculated (Lawes & Gilbert, 1859). About 20 species of plants were identified in these analyses; the main grasses were *Lolium* and *Holcus*. Further details are given when the botanical composition of individual plots is discussed. In 1862 a complete botanical analysis was made of all plots and this was repeated at five-year intervals until 1877. By this time the

https://doi.org/10.23637/ERADOC-1-156

method of analysis had improved. Small samples of plant material were taken from each swath and, after careful mixing of the total sample, a sub-sample was laid out to dry. Small handfuls were placed in front of each person and separated, as far as possible, into species; the separations were revised by a superintendent (W. Sutherland in 1862, R.L. Keenan in 1867, W.B. Hemsley in 1872 and W. Davis in 1877) assisted by J.J. Willis on each occasion. Part of the undetermined residue was sorted by the superintendent and the remainder "separated into portions of different character by sieves which facilitated identification of the remaining components. These later stages were, nevertheless, very tedious and laborious". The 1862-77 analyses were thus more exhaustive, and became increasingly so, than the 1858 analyses: this is reflected by the much larger number of species (c. 50) identified in these later analyses and by the smaller proportion of unsorted remainder. Some plots were analysed in this way in 1903, when the four-year liming scheme was introduced, and all plots were analysed in 1914 and in 1919 and during 1948-49. These were supervised by Dr. W.E. Brenchley, Miss Grace Bassil (Mrs. R.G. Warren) and Miss Heather Pellant respectively. The method of sampling in these years was similar to that described previously and is given in detail by Brenchley & Warington (1958). Many plots were also completely analysed in many years between 1920 and 1946, with some plots being analysed every year between 1921 and 1935. No analyses were done between 1949 and 1973; during 1973-76 selected plots, or sub-plots have again been analysed. In addition to the complete botanical analyses described, partial analyses have also frequently been done on samples from the plots, when only the three main groups of plants – grasses, legumes and 'other species' were separated. Except during 1895-1902, either complete or partial analyses were done in all years between 1874 and 1948 for plots 3 (unmanured), 7 (PKNaMg) and 9 (N_2PKNaMg).

Visual surveys of the plots also have been made throughout the course of the experiment. Until 1920 the copious notes frequently made of the vegetation were recorded in the 'White Books'. These are hand-written detailed records of all agricultural operations and observations made on the plots. Since 1920 visual surveys of the herbage have been made twice a year, before the hay is cut in June and in autumn, before the aftermath is cut. At survey, all species in inflorescence on a plot are noted and ascribed a score, on a five-point scale, for abundance. A record is also made of the species which are obvious in the vegetative state. This method of recording grassland is relatively quick and is useful to describe the larger differences between plots and major changes with time for some species. However, comparisons of the data for hay analyses in 1947, 1948 and 1949 with the corresponding visual surveys which preceded them show that the abundance score ascribed to a particular species is a poor indicator of the *amount* (or contribution to hay weight) of that species (Table 5) since there is a very poor correlation between the two. Visual surveys also, on average, detect many fewer species on the plots than do botanical analyses of hay samples (Table 6). Furthermore, species like *Agrostis* which may be abundant on some plots but do not flower until after the June survey are inevitably underestimated. Another difficulty is that small differences in time of survey may greatly affect the apparent relative abundance on plots dominated by two species which differ in time of heading, e.g. *Anthoxanthum* and *Holcus*, and *Alopecurus* and *Arrhenatherum*. Many plots are now dominated by one of these two pairs of species.

Botanical analyses of samples of hay from the Park Grass plots were discontinued after 1949 for several reasons. These included the fact that the plots appeared at that

https://doi.org/10.23637/ERADOC-1-156

time to have reached a relatively stable state, doubts about the relevance of the experiment to the practical problems of modern agriculture as well as the laborious nature of the work and the development and expansion of other interests within the Botany department. The experiment did, of course, continue to be of interest to a wide range of disciplines but the emphasis had shifted from the original agricultural aspects to more ecological ones.

During recent years there has been a resurgence of interest in the Park Grass plots over and above their continuing value as a demonstration of how botanical composition may be changed by fertilisers. The liming scheme introduced in 1965 (Warren, Johnston & Cooke, 1965) has added a new dimension to the experiment. Apart from plots 13, 18, 19 and 20, this was the first change of treatment since the original liming scheme was begun more than sixty years previously. As a result of recent lime, changes have occurred in the botanical composition of many sub-plots; hay analyses were therefore resumed to assess these changes in greater detail than could be done by visual survey (Williams, 1974). During these analyses it became clear that changes had also occurred on plots with unchanged treatment and it became desirable to extend the work to analyse some of those plots not yet in the new liming scheme. In the absence of any recent published data on the botanical composition of the Park Grass plots it is occasionally assumed by those not seeing the plots that this has not changed since the last analyses in 1949; less frequently the large difference in the present day composition of some plots compared to the 1948-49 data has been interpreted by those seeing the plots as a measure of the inaccuracy of those data. In recent years the realisation that old permanent pastures may often yield as much as sown leys and that bred varieties are not necessarily superior to locally-adapted indigenous species under all conditions has resulted in renewed interest and a reappraisal of the agricultural value and ecological requirements of 'native' species (e.g. Elliott, Oswald, Allen & Haggar, 1974; Haggar, 1976). There has also been increased interest in amenity grasslands and the maintenance of floristic diversity (Way, 1969; Duffey, Morris, Sheail, Ward, Wells & Wells, 1974; Lowday & Wells, 1977). The Park Grass plots provide information relevant to both interests.

Ideally, a thorough appraisal of the vegetation of all the plots would involve analysis of large duplicate or triplicate samples from all sub-plots for about three successive seasons. With the traditional method of hay analysis such a programme could occupy about ten people trained in hay analysis about three years. This was clearly not possible. The approach adopted during the current programme of work was, therefore, to ask specific questions at the outset.

(1) In 1973 analyses were done to assess the effects on botanical composition of applying lime between 1965 and 1968 to previously unlimed sub-plots *c* by comparing their composition with permanently unlimed sub-plots *d*.

(2) In 1974 analyses were done to quantify any changes brought about by giving increased rates of lime to previously limed sub-plots *b* by comparing them with sub-plots *a* (at that time being limed under the old scheme). Additionally, analysis of sub-plots *a* was intended to provide a base for the study of any future changes on these sub-plots when they were brought into the new scheme to raise their pH to 7. This phase was started in January 1976 but its effects are not investigated here.

(3) In 1975 analyses were made of those plots not yet in the new liming scheme, i.e. with unchanged treatment, to assess what changes had occurred since the previous analyses in 1948 and 1949. Additionally, comparisons of sub-plots *d* in 1973 and *a* in 1974 with the unlimed and limed halves respectively of the same plots in 1948-49 also

2R

give a measure of change during quarter of a century on the parts of the ammonium sulphate plots which had received unchanged treatment.

(4) To obtain a measure of seasonal variation the unlimed and limed half-plots of three of the plots sampled in 1975 were again sampled in 1976 together with two sub-plots sampled in 1974 and one sampled in 1973. It must be stressed, however, that the weather conditions preceding the 1975 and 1976 hay harvests differed greatly. The 1975 harvest followed an extremely wet period from autumn 1974 until May 1975 but the 1976 harvest was preceded by very dry weather from the summer of 1975 onwards. It is also likely that the sub-plots sampled in 1973 and 1974 would still be in a state of change induced by the new liming scheme when sampled in 1976.

Comparisons of the effects of the treatments on the botanical composition of the plots at particular dates have, as noted earlier, been made frequently in the past. These elucidated certain general principles but conclusions from many of the detailed comparisons of the percentage composition of the species may inevitably apply only to the specific conditions (e.g. nutrient status, pH) prevailing at a particular time and need not necessarily apply throughout the course of the experiment. Moreover, for many minor components it is not always possible to separate treatment effects, seasonal effects and sampling error. Too much emphasis cannot therefore be placed on comparisons of minor components in particular years nor indeed on the exact magnitude of difference of more abundant species. Comparisons over a number of years should give a better measure of differences due to treatment when effects due to season and sampling error are minimised. Since the major ecological 'truths' have been well established it is now equally important and interesting to ascertain the successional changes that are occurring on the plots. Less attention has been given to this, partly because of the difficulty of assembling the vast amount of accumulated data which extends over 120 years. During the present investigations, however, it became clear that a realistic interpretation of the present-day flora should take account of past changes and to this end all previous data have been put together. (See Tables 7 - 45.) Greater detail is of course available in the original publications; for reasons given earlier it is, however, doubtful whether these tell us much more about the herbage, except on the total number of species on a plot.

METHOD OF SAMPLING AND PLOTS AND SUB-PLOTS SAMPLED DURING 1973-76

Since 1960 tedding the herbage immediately after cutting has left it too fragmented to use for botanical analysis so the method of sampling used in the past could not be adopted. In 1973 and 1974 samples were cut by hand every 2-3 paces from the standing crop about 0.3m to each side of the forage harvester strips (which are cut before the rest of the crop to estimate yield), and also to each side of the centre strip cut for access for studies of the soil and surface fauna by the Entomology department in those years. Four strips are forage harvested on the larger and two on the smaller plots and this enabled sampling to be done along ten transects on the larger and along six on the smaller plots. No centre access strips were cut during 1975 and 1976 so that sampling was done along either eight or four transects. However, the fewer transects in those years, compared with 1973 and 1974, were partly offset by twice the area being sampled as half-plots were sampled in 1975 and 1976 but quarter-plots in 1973 and 1974. Samples were air-dried in a shaded glasshouse and then packed in polythene sheets in the laboratory and analysed during the winter. Approximately 600 g of hay was

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analysed from each sub- or half-plot.

The plots sampled in the four years were as follows:-

(1) 1973 – sub-plots *c* and *d* of plots 1 (N_1), 4^2 (N_2P), 9 ($N_2PKNaMg$), 10 (N_2PNaMg), 11^1 ($N_3PKNaMg$), 11^2 ($N_3PKNaMgSi$) and 18 (N_2KNaMg), i.e plots receiving N as ammonium sulphate.

(2) 1974 – sub-plots *a* and *b* of plots 4^2, 9, 10, 11^1 and 11^2 and also sub-plots 13*c* and 13*d* (FYM and fish meal).

(3) 1975 – unlimed (U) and limed (L) half-plots of plots 3 (unmanured), 7 (PKNaMg), 8 (PNaMG), 14 ($N_2^*PKNaMg$), 16 ($N_1^*PKNaMg$) and 17 (N_1^*).

(4) 1976 – unlimed (U) and limed (L) half-plots of 3, 7, 14 and sub-plots *a, b* and *c* of plot 9.

The dates of sampling in 1973, 1974, 1975 and 1976 were respectively 12, 20, 9 and 9 June.

As in 1948 and 1949 about 1-2% of the samples consisted of small detached fragments which were not sorted into species. Although it would have been technically possible to do so it would have taken too much time. To maintain continuity with past records the contribution of each species was expressed as a percentage of the total hay (air dry) weight of the sample. However, yields since 1960 have been based on dry weight before hay-making and it is possible that the contribution to dry weight may differ slightly from that to hay weight. Since yields of many plots differ greatly the % figures have nevertheless been used to calculate the weights of the different species per unit area to provide a measure of quantitative as well as qualitative difference between plots (see Tables 39, 41, 43 and 45).

The two main aims of this paper – to present recent data on the botanical composition of some of the main plots and at the same time to trace the major changes that have occurred on them with time and to report on the effects of the new liming scheme – are considered separately.

RESULTS

1. CHANGES WITH TIME

A. PLOTS NOT RECEIVING NITROGEN

1. **Unmanured plots** [3, 12 (since 1856) and 2 (since 1863)]

Although most treatments are neither randomised nor replicated two plots, 3 and 12, at different ends of the field have received no fertiliser from the start. However, Lawes, Gilbert & Masters (1882) considered plot 3 to be the true 'control' plot since they deduced that soil had in the past been brought in to plot 12 to level this part of the field. The soil of plot 12 has differed in chemical composition from plot 3 and yielded more hay for most of the duration of the experiment (Warren & Johnston, 1964). Plot 2 has received no manure since 1863 and so can now also be considered an unmanured plot.

The botanical composition of Plot 3 in 1858 (Lawes & Gilbert, 1859), is a reasonable indication of the flora of the whole field at the start of the experiment. About twenty species of higher plants were identified on the plot in 1858 but during 1862 about fifty species were found "a result no doubt due to the much greater amount of attention and labour bestowed upon the more recent separations" (Lawes & Gilbert, 1863). During 1877-1903 a decline in the number of species then occurred and between 1910 and 1948 the number of species identified averaged about 37. Thirty species were found in 1975 and 35 in the 1976 samples, but since the range of variation for

https://doi.org/10.23637/ERADOC-1-156

previous years was from 25 to 41 there is no evidence of any change in the number of species during the last 30 years.

The relative contributions of grasses, legumes and other species have changed during the duration of the experiment [Table 7(a)] as well as the composition of the three main groups themselves (Table 8). Grasses contributed 76% of the yield on plot 3 at the start and other species less than 20% and these proportions remained unchanged for about thirty years. Afterwards % grasses decreased, averaging 53%, and other species increased to about 40%, but seasonal variations have been large. At the same time yields declined by about 50% so that the net amount of grass greatly decreased but other species remained much the same. Legumes have ranged from 2 to 19% but usually 5 to 12% and averaged 7%; they have not changed systematically with time. The most plentiful grasses at the start were *Lolium* and *Holcus* which together contributed about a third of the herbage. *Arrhenatherum, Anthoxanthum, Agrostis* and *Festuca* all contributed at least 5%. *Lolium* and *Arrhenatherum* then declined and since 1877 have not made a significant contribution to yield. *Anthoxanthum* remained much the same but *Agrostis* increased as also did *Festuca rubra* and these have been the two main grass species throughout. *Festuca rubra* has increased markedly since the last hay analysis in 1949 and grasses now contribute more than 60% to the yield. Amongst the legumes, *Lotus* has usually been the main constituent; *Lathyrus* was not prevalent during 1975 and 1976 but similar results were obtained in 1938 and 1939. (Table 8). Although a large number of other species still persists the most significant change has been a tendency of three species to be dominant within this group. *Poterium*, present in small amount, and *Leontodon*, absent at the start, have been abundant from the beginning of the century. *Plantago* has also been plentiful throughout but has fluctuated systematically from only 3% between 1872 and 1914 to about 13% from then until 1939 and afterwards about 6%. *Ranunculus* species, 2-5% in the early years have been less conspicuous since then, but *Centaurea* increased from a small amount to 2-10% between 1903 and 1939 but afterwards declined. It is of interest to note that, although the weather preceding the 1976 harvest was much drier than that preceding the 1975 harvest, *Plantago* and *Poterium* were no more abundant in 1976 than in 1975. This contrasts with results in 1937 and 1938, with similar sequences of weather, when the % of both species was two-three times greater in 1938 than in 1937.

Plots 2 and 12, not analysed during 1973-76, have also been analysed much less frequently than plot 3 in the past; in general their botanical composition has been very similar to that of plot 3 (Tables 9 and 10). One of the main differences is that both have little *Poterium*.

Liming on plot 3 initially increased % grasses and decreased % other species, compared with the unlimed half-plot [Table 7(a)]. However, % grasses have declined and % other species increased with time so that there is now a greater percentage of grass but a smaller percentage of other species on the unlimed than on the limed half-plot. Percentage legumes was increased by lime and appeared to increase until about the mid-40's. The number of species has been little affected by lime; there has possibly been a slight increase. Lime soon increased *Helictotrichon* and *Briza* and decreased *Agrostis* (Table 11). Percentage *Briza*, although usually greater on the limed than on the unlimed half-plot, declined from about the mid-20's onwards and *Helictotrichon* has also declined more recently. *Festuca*, almost as plentiful on the limed as on the unlimed half-plot until about the mid-20's, declined more on the limed than on the unlimed half-plot and it has usually been more plentiful on the unlimed half-plot.

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Recently *Festuca* has also increased on the limed end. *Trifolium pratense* has increased since the mid-1930's. Amongst the other species the same three species have been abundant as on the unlimed end. However, lime decreased the percentage of all of them until around 1940. Afterwards % *Poterium* and *Plantago* have been greater on the limed than on the unlimed half-plot and during 1975 and 1976 % *Leontodon* was also larger on the limed than on the unlimed half.

Plot 4[1] (Table 12) which has received P alone since 1859 and has been only infrequently analysed was not included in these analyses. It has usually had a smaller % *Agrostis* and *Poterium*, but a larger % legumes and *Rumex* than the unmanured plots.

2. **PKNaMg** (Plot 7)

As on plot 3 (unmanured) % grass declined on this plot after the first 25 years or so and % other species increased slowly from the outset to reach about 30% by the mid-1940's [Table 7(a)]. The main difference between this and the unmanured plots in the three main groups of plants has been a much larger % legumes in most seasons. Even in the third year legumes, mainly *Trifolium pratense*, were 23%, but afterwards *Lathyrus* has been the main component of this group (Table 13). The 1975 and 1976 analyses show that, as on plot 3, % grasses have recently increased, % legumes and other species have decreased. This conclusion, although based on results from two contrasting seasons, must, nevertheless, remain a tentative one since the recent values are within the range of variation recorded in the past. Visual surveys, however, during the past ten years have also suggested a decline in the legumes on this plot.

Dactylis increased on this plot during the beginning of this century (Table 13), and made a much larger contribution to the yield of this than of the unmanured plot. The 1975 and 1976 analyses showed that it declined between 1948 and these dates but was still twice as plentiful as on plot 3. Percentage *Agrostis* and *Festuca* have usually been less on this plot than on plot 3 but both have increased tremendously since 1948 so that about half the herbage here, as on the unmanured plot, now consists of these two species. In contrast to the unmanured plot, where it has recently decreased, *Holcus* has increased on this plot.

The recent decline in legumes has been mainly in *Lathyrus; Trifolium pratense* has remained at the same level as in 1947-48. *Achillea* and *Heracleum* have usually been more prominent here than on the unmanured plot but both now contribute only 1% or less of the herbage. The large amount of *Achillea* recorded during 1947 and 1948 did not persist. *Poterium* and *Leontodon*, important constituents of the unmanured plot, are absent or infrequent on this plot but since 1947 *Plantago* has increased and it is now as abundant as on the unmanured plot 3. *Rumex* has been more conspicuous on this plot than on the unmanured plot, although it has declined greatly on both plots.

On the limed half of this plot grasses have contributed about 60% of the yield but have ranged from less than 40 to more than 80%, and during 1975 and 1976 were respectively 48 and 40% [Table 7(a)]. Legumes have also ranged widely, averaging about 25% and other species, about 12%. There have been no definite trends with time within the three main groups. However, within the grasses, *Arrhenatherum* has increased with time, especially during the last 30 years, and now makes up 30% of the herbage, but *Alopecurus* and *Dactylis* both prominent throughout have decreased during the same interval as also have *Helictotrichon* and *Trisetum* (Table 14). *Festuca rubra*, much decreased by lime, further decreased with time so that it now contributes less than 1% of the herbage. Both *Poa* species have maintained their contribution. *Lathyrus*

4R

although variable between seasons has also probably maintained its contribution and was abundant in 1976. *Trifolium pratense* increased from the mid-30's but *T. repens*, which was then conspicuous, is now infrequent. The most abundant other species are now *Taraxacum, Heracleum* and *Ranunculus* but their % contribution was much larger in 1975 than in 1976. *Heracleum* increased about fifteen years after liming but the increase in *Taraxacum* has been more recent. *Centaurea* and *Knautia* are now less abundant than in the past.

Plot 15 (Table 15) received 96 kg N ha^{-1} as sodium nitrate until 1875 but since then it has received the same treatment as Plot 7. Legumes, which were present in only small amounts when only nitrogen was given, quickly reappeared and were 10% by 1880, almost 20% during the next ten years and about 40% between 1891 and 1900. The level then decreased somewhat but with large seasonal variations. The reappearance of legumes on this plot was faster than where the same amount of nitrogen as ammonium sulphate was replaced by PKNaMg (original Plot 6). Plot 15 has had more *Alopecurus* and *Dactylis* than Plot 7 throughout most of the experiment. However, strict comparisons between the limed halves of the two plots cannot be made for particular years since liming started 17 years later on Plot 15 than on Plot 7. As on Plot 7 liming encouraged *Arrhenatherum* but *Dactylis* has usually been less plentiful on 15 than on 7. *Trifolium repens* has been more abundant on the limed half of 15 than on 7.

3. **PNaMg** (Plot 8)

This plot also received K and sawdust during 1856-61 and 1856-62 respectively. Omitting K had large effects on % legumes and on yield; in most years there has been 20-25% less legume on this plot than on Plot 7 (PKNaMg); the reduction was even larger in the early years. Recently, because of the decline on Plot 7, % legumes have been similar on the two plots. Percentage grass has usually been less and other species much more than on the PKNaMg plot [Table 7(a)] ; there have been more species on this than on the PK plot but slightly fewer than on the unmanured.

This plot has a smaller percentage of *Agrostis* than the unmanured and PKNaMg plot since c. 1930; as on those plots *Festuca rubra* has been plentiful throughout and although there was some evidence of decline in the late 40's it had also increased by the time of the recent analyses (Table 16). *Arrhenatherum*, although recently declined has been more prominent than on the unmanured or PK plot, but *Dactylis* has, except in 1947 and 1948, been less abundant than on the PK plot. A marked permanent decline in *Lathyrus* occurred during the 1920's and the legumes now consist mainly of *Trifolium* and *Lotus. Plantago* has contributed 10-30% since the beginning of the century and *Leontodon* is also prominent and possibly increasing, but *Achillea* was much less prominent in 1975 than in 1948.

The botanical composition of the limed half is qualitatively similar to that of the unlimed half (Table 17). The main difference is that *Helictotrichon* is much more abundant with than without lime. As on the unlimed half *Arrhenatherum* and *Dactylis* have recently decreased but *Anthoxanthum* and *Festuca rubra* increased and *Plantago* and *Leontodon* are the main other species.

B. PLOTS RECEIVING NITROGEN AS AMMONIUM SULPHATE

Some of the most spectacular treatment effects on Park Grass and some of the largest changes with time have been due to the acidifying effect of ammonium sul-

5L

phate. All the unlimed sub-plots of plots given ammonium sulphate are now dominated by acid-tolerant grasses.

Three plots in this group were omitted from the main experiment in 1964. One of them (original Plot 6) received N_2 and sawdust until 1868 and the other two (Plots 5^1 and 5^2) received N_2 alone until 1897. The nitrogen dressings, which were very damaging to the herbage, were replaced by PKNaMg on Plot 6 from 1869, PK on Plot 5^2 from 1898 but not replaced by anything on 5^1 from 1898, which remained an unmanured plot until 1964. Details of the botanical composition of these plots are given by Brenchley & Warington (1958).

1. **N_1** (Plot 1)

Plot 1 received farmyard manure during the first eight years; thus comparisons of its botanical composition in 1862 with that of Plot 2 (farmyard manure alone 1856-63) show the effect of a small amount of N in the presence of FYM: the main effect of the additional nitrogen was to increase *Dactylis* but slightly decrease *Lathyrus*.

This plot consisted of about 80% grass in the second year and grasses ranged from 78 to 95% during the next 60 years or so [Table 7(b)]. Legumes, which ranged seasonally from 0.2 to 3%, were absent from c. 1910 onwards although traces were present in the early 1940's. Most of the variation in % grasses was therefore counterbalanced by variations in other species. Nowadays, % grasses is about 98% and other species have seldom exceeded 5% during the last thirty years. During the first 20 years *Dactylis* and *Poa trivialis* declined and *Agrostis* and *Anthoxanthum* increased (Table 18). *Holcus*, after apparently declining between the second and sixth year, also increased. During the 1920's and 1930's *Anthoxanthum* and *Holcus* were reduced to very small amounts but *Agrostis* continued to increase as also did *Festuca*. The last two species were co-dominant in 1939 and in 1940 72% of the herbage consisted of *Festuca*. By the late 1940's, however, *Agrostis* was dominant and has remained so ever since. The recent analysis in 1973 showed a further decrease in *Festuca* but a substantial increase in *Anthoxanthum*.

Liming this plot increased *Helictotrichon* and *Dactylis*, and allowed a small amount of legume to flourish and also many other species, especially *Plantago* (Table 18).

2. **N_2KNaMg** (Plot 18)

This treatment has been applied to Plot 18 since 1905 following PKNaMgSi and an amount of N (16 kg) equal to that contained in 1.02 t hay. In the absence of P and with acid soil conditions *Agrostis* became dominant on this plot and possibly sooner than on Plot 1 although treatment on that plot started in 1863. *Dactylis* rapidly decreased and *Festuca* more slowly so that there was none of the former and little of the latter present in 1973 (Table 19). Both light and heavy liming greatly encouraged *Dactylis* and continue to do so, and *Alopecurus* was also increased initially but it declined during the 30's and early 40's. As *Alopecurus* declined *Arrhenatherum* increased with both light and heavy liming (Table 20).

3. **N_2P** (Plot 4^2)

Festuca rubra has been the most abundant grass on this plot for most of the duration of the experiment and it was co-dominant with *Agrostis* in 1949 (Table 21). *Agrostis* was abundant from the start and has maintained its contribution. *Anthoxanthum* became prominent from the beginning of the century and greatly increased during the 1950's and 1960's; it is now dominant (76%) on the unlimed quarter-plot but *Festuca*

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is infrequent. *Alopecurus* was the most plentiful grass for about 20 years following liming; it then decreased and *Festuca*, which now makes up about half the herbage, increased. *Poa pratensis* was also plentiful in 1974.

4. **N_2PNaMg** (Plot 10)

Like the other plots given nitrogen, this plot has also been dominated by grasses [Table 7(b)] except in the early years and during 1915-1920, when *Rumex* was abundant. *Dactylis, Helictotrichon, Poa pratensis* and *Poa trivialis* all declined during or shortly after the first twenty years. *Festuca rubra* increased during the same time, but except in 1948, did not make a very large contribution after 1920. The most important grasses on this plot during the last 40-50 years have been *Agrostis, Anthoxanthum* and *Holcus* and these have competed for dominance. *Holcus* became dominant probably sometime during the 1920's and remained so until 1938 but afterwards it declined greatly; *Anthoxanthum* and *Agrostis* together with *Holcus* made up 90% of the herbage in roughly equal proportions in 1940. Afterwards *Holcus* decreased, *Agrostis* remained plentiful and *Anthoxanthum* has been dominant for ten to fifteen years (Table 22).

Lime not only prevented *Alopecurus* declining but increased it so that it was dominant until c. 1940; afterwards its contribution was halved but *Festuca rubra* previously 20-30% increased to about 50% during the 1940's. Recently, *Alopecurus* has decreased further and *Arrhenatherum* and *Anthoxanthum* have increased (Table 23).

5. **N_2PKNaMg** (Plot 9)

This plot has been analysed more frequently than any other. By the third year *Holcus* and *Lolium* had doubled their contribution to a total of 69% (Table 24). Both subsequently decreased, *Holcus* temporarily, but *Lolium* was absent after 1903. *Dactylis* also declined from about 13% in the 1870's to less than 1% in the mid-20's and *Festuca rubra* which made a significant contribution until the mid-20's also later declined. *Arrhenatherum*, prominent between 1870 and the mid-20's was afterwards much reduced. Between 1900 and 1930 a struggle for dominance occurred between *Agrostis, Anthoxanthum* and *Holcus*; by 1921 they contributed 80% of the herbage in approximately equal proportions. However, by the mid-20's *Holcus* became increasingly ascendant and was dominant from 1930 probably until about 1962. Since then *Anthoxanthum* has been dominant on the unlimed sub-plot. Legumes have always been absent and after the first 60 years other species have rarely contributed much to the yield of this plot.

Alopecurus and *Arrhenatherum* have usually dominated the limed half of this plot, although several other grasses particularly *Dactylis, Festuca, Holcus* and *Poa pratensis* have also made significant contributions (Table 25). *Arrhenatherum* became prominent sooner and was twice as abundant as *Alopecurus* during the first four cycles of the liming scheme. From the late 1920's until 1940, except in 1932 and 1933 *Alopecurus* contributed about 50% of the hay yield and was usually much more abundant than *Arrhenatherum*; it continued to be so during 1947 and 1948 although both species were much reduced in those years. The evidence available in 1974 and 1976 suggests that whereas *Alopecurus* declined further, *Arrhenatherum* increased and there is now at least three times as much *Arrhenatherum* as *Alopecurus* on this plot. Recently, *Festuca* and *Poa pratensis* have decreased but *Holcus* increased.

Small amounts of *Lathyrus* were present on this plot in most years in the past and the amount increased during the late 1930's and 1940's; it is now abundant (Table 25). As on the limed half of Plot 7 (PKNaMg) the species was unusually abundant during 1976. Before 1940 other species rarely contributed more than 4% to the yield but since then they have ranged from 4 to 14%, the increase being mainly in *Heracleum* and *Taraxacum*.

6. $\mathbf{N_3}$**PKNaMg** (Plot 11^1) **and** $\mathbf{N_3}$**PKNaMgSi** (Plot 11^2)

On Plot 11^1 (with the largest amount of ammonium sulphate) *Alopecurus* and *Arrhenatherum* increased slowly to reach about 30% in 1903 and 1919 respectively. Both species then declined to very small amounts. Percentage *Dactylis* doubled during the first ten years, then decreased to its original level between 15 and 20 years and then virtually disappeared. Neither *Poa* species, both about 10% at the start, persisted. Neither *Lolium* nor *Holcus* were as much encouraged in the early years as on Plot 9, with a smaller amount of N. In fact, *Holcus* declined during the early years, but then increased greatly as *Alopecurus* and *Arrhenatherum* declined. It has been dominant on this plot since c. 1910 (Table 26). *Agrostis*, encouraged during the early years, has not persisted on this plot to the same extent as on the plots receiving N_2. *Anthoxanthum* has been present in only small amounts; in 1973 it made up 5% of the herbage and appears to be increasing. Except during the early years, or in exceptional seasons, only small amounts of other species have occurred on this plot. The botanical composition of Plot 11^2, which receives Si as well, has been similar to 11^1 except that *Holcus* probably became completely dominant later. *Alopecurus* contributed 30% to the yield of this plot in 1919 whereas it had declined to 1% on 11^1 by 1914. *Arrhenatherum* also persisted for longer on 11^2 than on 11^1 (Table 27).

As on the plot receiving N_2 (96 kg N ha^{-1}) and PKNaMg, *Alopecurus* and *Arrhenatherum* are the most abundant grasses on the limed end of these plots. Without silica (Plot 11^1) *Alopecurus* and *Arrhenatherum* were equally abundant in 1914, 11 years after the start of liming. *Alopecurus* then increased and *Arrhenatherum* decreased markedly. Afterwards *Alopecurus* decreased and *Arrhenatherum* increased so that they were again present in roughly equal proportions in 1974. On 11^2 *Alopecurus* was twice as abundant as *Arrhenatherum* in 1914 and a similar sequence of events occurred but on a different scale so that in 1964 there was almost twice as much *Arrhenatherum* as *Alopecurus*. There has, for most of the time, been more *Dactylis* on 11^2 than on 11^1. Although *Poa pratensis* has declined *Poa trivialis* has increased. A large increase in *Holcus* has occurred on both plots since the 1947 and 1949 analyses. *Taraxacum* established on these plots during the 1940's and since then *Anthriscus, Heracleum* and *Rumex* have increased slightly.

C. PLOTS RECEIVING NITROGEN AS SODIUM NITRATE

These plots were started in 1858. Plot 15 (already discussed) which has received PKNaMg since 1876, received 96 kg N ha^{-1} as sodium nitrate annually between 1858 and 1875.

1. N_1 (Plot 17)

The botanical composition of this plot contrasts strongly with that of Plot 1, which receives the same amount of nitrogen, but as ammonium sulphate. Grasses have usually contributed about 70% and other species 30% to the yield of plot 17 but legumes only

6R

a trace [Table 7(c)]. About 30 species of plants occur on this plot. There has, with the possible exception of *Anthoxanthum*, been no large or permanent increase in the acid-tolerant species: the plot now has less *Holcus* than in the past and there is less *Agrostis* than at the outset (Table 28). *Alopecurus* contributed almost a quarter of the yield at the start and also in 1976 but about 10% less than this in most of the intervening years. *Dactylis* increased during the first decade of the century and was abundant from 1925 to 1949 but declined sometime between that time and 1975, when it was 5%. *Festuca rubra* has been the other main grass. A small amount of *Lolium* has persisted on this plot. There have been few legumes. *Plantago* has been the main other species throughout. *Leontodon* increased at the beginning of the century and was 4% in 1975 as also was *Ranunculus.*

The vegetation on the limed half of this plot (Table 29) has been relatively stable although *Festuca* has decreased recently. A larger percentage of *Lolium* was recorded on this plot than on any other plot in recent years and more *Trifolium pratense* was also present than in the past. As on the unlimed half plot *Plantago* and *Leontodon* are the main other species.

2. **N_1PKNaMg** (Plot 16)

About 80-90% of this plot consists of grass. Legumes have been variable ranging from about 2 to more than 10% and other species about 10% [Table 7(c)]. The plot now has about 20 species. *Festuca, Helictotrichon, Holcus* and *Trisetum*, all prominent during the early years, afterwards declined. *Alopecurus* increased greatly during the first 60 years and was 51% in 1919; it then declined and was 29% in 1975. At the same time *Arrhenatherum* increased so that the two species are now co-dominant (Table 30).

On the limed half of this plot *Arrhenatherum* increased much as on the unlimed half. *Alopecurus* which was equally abundant on both half-plots in 1914 afterwards declined earlier and to a greater extent on the limed half so that it was only 4% in 1975 (Table 30). *Festuca* and *Helictotrichon* were much reduced in 1975 compared to 1949. The main recent change in other species on the limed half has been a very large increase in *Heracleum. Ranunculus* and *Taraxacum* have also increased.

3. **N_2PKNaMg** (Plot 14)

This plot has had a large percentage of grass and usually has less legume and other species than Plot 16 [Table 7(c)]. It has also had slightly fewer species.

As with the smaller amount of sodium nitrate *Alopecurus* quickly increased and as on that plot was 50% of the herbage in 1919. It remained at a high level (35-62%) during the next 20 years, declined to c. 30% during the late 1940's but had increased slightly again by 1975 and 1976. *Arrhenatherum* established sooner and had in fact reached 41% on this plot before starting to increase on Plot 16 (N_1PKNaMg); it has been co-dominant with *Alopecurus* especially since the late 1940's. The amounts of *Anthriscus* and *Taraxacum* have fluctuated throughout the course of the experiment (Table 31).

Liming this plot more than halved % *Alopecurus* from about the fourth year onwards but increased % *Arrhenatherum* from the fifth year onwards (Table 32). The amount of *Alopecurus* was further reduced in the 1940's. *Dactylis* has decreased as also has *Festuca rubra*, and *Anthriscus* and *Taraxacum* have fluctuated as on the unlimed half. Details of the differences between the botanical composition of parts of the plot in the sun and in the shade are outlined by Brenchley & Warington (1958) –

7L

in general *Dactylis* and *Arrhenatherum* were less but *Festuca rubra* much more abundant in the shade than in the sun.

D. PLOTS RECEIVING ORGANIC MANURES

None of the plots now receiving farmyard manure (FYM) have the treatment dating back beyond 1905. Plot 13 which has received FYM and fish meal alternately once every four years since 1905 received N_2 (as ammonium sulphate) and PKNaMg between 1856 and 1904 and straw until 1897. Plot 19 which has FYM once every four years received N_1 (as sodium nitrate) and PK between 1872 and 1904. Plot 20 which also received N_1 (N as potassium nitrate and PK) during the same period also now receives FYM every fourth year but also N (30 kg ha^{-1} as nitrate of soda), P (15 kg ha^{-1} as superphosphate) and K (45 kg ha^{-1} as sulphate of potash) in intervening years.

Plot 13 was included in the liming scheme of 1903 and is now in the new one. Plots 19 and 20 (like 18) were divided in 1920 into lightly, heavily and unlimed thirds to test two laboratory methods for measuring the lime requirement of soils. (Warren & Johnston, 1964). They are not included in the new liming scheme and were not analysed during 1973-76. They were, however, unlike the plots in the main liming scheme, analysed in the years immediately after liming and so provide evidence of the rate of change in different constituents after liming, not available from any other plots. For this reason past results for these two plots are also included (see also Brenchley, 1925 and 1930).

1. **FYM and fish meal** (Plot 13)

The main species on the unlimed end of this plot has for most of the time been *Alopecurus*. It increased until the mid-40's to c. 50%, then declined to 16% in 1974. *Agrostis* increased in the mid-40's and was twice as abundant as *Alopecurus* in 1973 and *Holcus* has increased markedly since 1949 (Table 33).

Alopecurus was increased by lime in 1919 but then declined to less than on the unlimed half. *Arrhenatherum* was also increased by lime in 1914 but then declined before increasing to become the most plentiful grass in 1948. Although lime had only small effects on *Dactylis* in the early years it greatly increased it during 1946-48 so that it contributed more than 20% in those years. With lime *Agrostis, Anthoxanthum* and *Festuca* are infrequent and *Holcus* now much reduced. Legumes, although variable between seasons were plentiful on the limed half. *Plantago* has been the main other species, although it was much reduced on the unlimed half in 1974 (Table 33).

2. **FYM every fourth year** (Plot 19)

Although *Alopecurus* was slightly more prominent than most other species it declined during the 30's and for most of the time there has been no single dominant. Legumes have been plentiful but variable, and although *Plantago* was the main other species during 1946-48 there was also much *Ranunculus* and *Achillea* (Table 34).

Lime had little effect on *Alopecurus* until the ninth year when low lime increased but high lime decreased it (Table 35). Afterwards during 1946-48 both amounts of lime increased *Alopecurus*. The effects of lime on *Dactylis* depended upon the season: in many years there was little effect but in others there were large (and similar) increases with both amounts of lime. *Festuca rubra*, little affected at the start, was usually decreased by lime although high lime increased it during the eighth and ninth years. High lime decreased *Agrostis* from the fifth year onwards but low lime had little

https://doi.org/10.23637/ERADOC-1-156

effect during the first 20 years.

Liming, especially the larger amount, decreased *Anthoxanthum* and *Holcus* but increased *Helictotrichon* and *Trisetum.* The amount of legume, although somewhat increased by lime, has been more dependent upon season than upon the liming treatment. The main other species have been *Plantago, Ranunculus* and *Achillea.* Neither % *Plantago* nor the time of its increase have been affected by lime, *Achillea* was little affected by low lime and decreased by high lime whereas *Ranunculus* was increased by low lime but decreased by high lime.

3. **FYM once every four years with NPK in other years** (Plot 20)

As on Plot 19 (FYM alone), *Alopecurus* has tended to be the main grass species on this plot but *Dactylis* and *Arrhenatherum* have also been prominent (Table 36). In contrast to Plot 19, where it declined during the 1940's *Alopecurus* remained at a high level on this plot. Although lime, especially the larger amount, increased % *Alopecurus* until 1925, it afterwards decreased it. In contrast, *Arrhenatherum* was decreased by both amounts of lime during the first three years; afterwards the smaller amount increased it but there was no increase with the larger amount until 1946-48. The effect of lime on *Dactylis* was small and somewhat erratic, and the larger amount tended to decrease it. *Poa pratensis* was decreased by the smaller but increased by the larger amount of lime though *Poa trivialis* was increased by both amounts. *Helictotrichon* has declined on all sub-plots of Plot 20; it was decreased by low lime at the start but then increased though high lime increased it throughout. In contrast *Trisetum*, decreased by both rates of lime at the start, was afterwards little affected. Both rates of lime decreased *Agrostis* but not *Holcus. Lathyrus* has varied greatly with season and has been increased by high lime throughout (Table 37).

Plantago, prominent in the late 40's was increased by both amounts of lime but *Achillea* little affected by low lime was increased by high lime. *Taraxacum* was also increased by lime.

2. CHANGES INDUCED BY THE NEW LIMING SCHEME

A. EFFECTS OF APPLICATIONS OF LIME BETWEEN 1965 AND 1968 ON THE BOTANICAL COMPOSITION OF PREVIOUSLY UNLIMED SUB-PLOTS *c* COMPARED WITH THAT OF SUB-PLOTS *d* (CONTINUOUSLY UNLIMED) OF PLOTS GIVEN AMMONIUM SULPHATE i.e. 1, 4², 9, 10, 11¹, 11² AND 18 AND OF 13 (FYM AND FISH MEAL)

To assess the effects of fresh applications of lime to previously unlimed sub-plots *c*, samples of herbage were taken for botanical analyses in 1973 from the relevant sub-plots and also from the corresponding permanently unlimed sub-plots *d* of the same plots. Although the plots were not sampled for botanical composition prior to the introduction of the new scheme in 1965, visual survey showed no changes in the flora of sub-plots *d* between 1965 and 1973. Since these sub-plots are dominated by single species, the botanical compositions of sub-plots *d* in 1973 may be taken as a measure of the composition of both *d* and *c* (i.e. the unlimed half-plot) at the start of the new liming scheme.

Since liming affected total dry matter yield at hay making as well as botanical composition, results are expressed not only qualitatively as % composition of hay but also quantitatively as amounts ha^{-1} as explained in the Introduction.

https://doi.org/10.23637/ERADOC-1-156

1. Plots 1 (N_1) and 18 (N_2KNaMg)

The unlimed sub-plots of both plots 1 and 18 were dominated by *Agrostis* at the start of the new liming scheme and sub-plot *d* of both plots had more than 80% *Agrostis* in 1973. By 1973, 12.5 and 10 t ha^{-1} of calcium carbonate had decreased this species from 84 to 20% on 1c and from 83 to 52% on 18c (Table 38). *Anthoxanthum*, which contributed c.10% on 1 and 20% on 18, was less affected. The most obvious changes were extremely large increases in % *Festuca rubra* on both plots (from 3 to 50% on 1 and from 0.1 to 14% on 18) and the introduction or increase of a large number of other species including *Cerastium, Plantago, Rumex* and *Taraxacum* on both plots. *Lathyrus* and *Trifolium* also established on both plots but in greater amount on 1 than on 18, *Lathyrus* having spread inwards from adjacent Plot 14.

Since liming increased the yield of *c* relative to *d* approximately threefold on both plots in 1973, the effects on the amount of species per unit area of land (Table 39) differed from those on percentage composition (Table 38). For example, the large reduction in % *Agrostis* on 1*c* compared to 1*d* was largely offset by the increase in yield and on 18*c* the relatively smaller decrease in % *Agrostis* was more than counterbalanced by the increased yield so that there was almost twice as much *Agrostis* on 18*c* as on 18*d*. On the other hand, increases in % composition of particular species e.g. *Festuca* were greatly accentuated by the yield increases.

2. Plots 4^2 (N_2P), 10 (N_2PNaMg) and 9 ($N_2PKNaMg$)

The unlimed half-plots of these three plots were dominated by *Anthoxanthum* at the start of the new liming scheme in 1965 and the unlimed sub-plots *d* continue to be so (Table 38). About 20 t ha^{-1} of chalk, applied to these sub-plots between 1965 and 1968, decreased % *Anthoxanthum* from more than 70% to between 5 and 11%. The yield of hay was at the same time increased by at least 50% but the reduction in the amount of *Anthoxanthum* was nevertheless at least 80% (Table 39). In contrast to *Anthoxanthum* and to *Agrostis* in the previously discussed plots, % *Agrostis* on these plots was less affected by liming. However, on Plot 10*c* the combined effect of a small increase in % *Agrostis* and the 50% increase in total yield resulted in a large increase in the amount of this species. Liming allowed a range of grasses to increase or to establish. On Plots 4^2c and 10*c*, in the absence of potash, *Festuca rubra* increased greatly to form about half and a quarter of the total yield respectively; on 9*c* which receives potash, *Festuca* increased much less and formed only 3% of the total yield. *Holcus* increased greatly on 9*c* and 10*c* and *Poa pratensis* increased on all three sub-plots.

There was some evidence that *Holcus* increased further between 1973 and 1976 on 9*c* as also did *Arrhenatherum* (Tables 44 and 45). Only on 9*c* did legumes and appreciable amounts of other species establish.

3. Plots 11^1 ($N_3PKNaMg$) and 11^2 ($N_3PKNaMgSi$)

The unlimed half plots of 11^1 and 11^2 were dominated by *Holcus* in 1965 and sub-plots *d*, permanently unlimed, continue to be so. Twenty t ha^{-1} of chalk, applied between 1965 and 1968 have resulted in very similar changes in the botanical composition of both sub-plots. Percentage *Holcus* was decreased from 96 to 34% (Table 38) and the weight was, on average, halved (Table 39).

In 1973 *Arrhenatherum* contributed about 30%, *Poa pratensis* 12%, *Alopecurus* 8%

8R

and *Dactylis* 6% on sub-plots *c* but were absent on sub-plots *d*. No legumes were present in the samples from either plot in 1973 although visual survey had indicated that a few plants of *Trifolium pratense* were present on 11^2c between 1966 and 1969. Liming allowed small amounts of *Anthriscus, Cerastium, Heracleum, Rumex* and *Taraxacum* to establish.

4. **Plot 13 (FYM and fish meal)**

The main effect of lime on this sub-plot has been to increase *Arrhenatherum* and the legumes, *Lathyrus* and *Trifolium pratense* and to decrease *Agrostis* and *Holcus*. Lime also appeared to have relatively large effects on some of the other species but since their individual contribution rarely exceeded 1% confirmation of the changes would be needed in other years. (Tables 38 and 39).

B. EFFECTS OF INCREASED APPLICATIONS OF LIME BETWEEN 1965 AND 1968 ON THE BOTANICAL COMPOSITION OF SUB-PLOTS *b* (WHOSE pH IS BEING RAISED TO 6) COMPARED WITH THAT OF SUB-PLOTS *a* (LIMED ONCE EVERY FOUR YEARS UNDER THE OLD SCHEME TO MAINTAIN pH AS IN 1965) OF PLOTS 4^2, 9, 10, 11^1 and 11^2.

As might be expected, increasing the rate of liming on previously limed sub-plots has effected fewer changes in botancial composition than liming sub-plots previously unlimed.

On plots 4^2b and 10*b* whose pH was previously more than 5.5, only 3.7 t ha^{-1} of calcium carbonate were needed to raise the pH to 6 and this caused few changes in botanical composition. The only significant change was a large increase in both percentage and weight of *Helictotrichon* on 4^2b. Both *Plantago* and *Rumex* appeared to be increased by increased lime on 4^2b but not on 10*b* (Tables 40 and 41).

Sub-plot 9*b* was slightly more acid than 4^2b and 10*b*and was given twice as much lime (7.5 t ha^{-1}) to increase the pH to 6. The main effects of this in 1974 were to halve the % (Table 40) and weight (Table 41) of *Alopecurus* and to increase the legumes, particularly *Lathyrus*. Sub-plots 9*a* and 9*b* were again analysed in 1976. It is likely, however, that sub-plot *b* would still be in a state of change and sub-plot 9*a* received 14 t ha^{-1} of chalk in 1976 under the second phase of the new scheme. It is, therefore, not possible to determine how much of the difference in the results between 1974 and 1976 is due to season or treatment. In general, total yield was less, grasses particularly *Arrhenatherum* contributed less but legumes and other species relatively more in 1976 than in 1974. The 1976 analyses like 1974 showed more *Anthoxanthum, Festuca rubra* legumes and *Taraxacum* but less *Poa trivialis* on sub-plot *b* than on *c*. On the other hand, results for *Dactylis, Poa pratensis* and *Anthriscus* were in 1976 opposite to those in 1974.

The largest effects of increased rates of lime were on 11^1b, which received 25 t ha^{-1} of chalk and whose pH was only 4.2 at the outset, and on 11^2b, which received 15 t ha^{-1} of chalk and whose pH was 4.7. The increased amounts of lime on these sub-plots almost halved *Alopecurus* but increased *Arrhenatherum*, particularly on 11^1. *Holcus*, however, which had become plentiful in recent years, especially on 11^1, was markedly decreased. Small amounts of *Lathyrus* were found in samples from both *a* and *b* sub-plots of plots 11^1 and 11^2 in 1974. *Anthriscus* and *Heracleum* were increased by the increased rates of liming.

9L

3. COMPARISON OF THE BOTANICAL COMPOSITION OF PLOTS 3, 7 AND 14 IN 1975 AND 1976

(Tables 42, 43, 44 and 45)

The present botanical composition of these plots has already been discussed when successional changes were presented and the very different weather conditions preceding the 1975 and 1976 harvests have also been emphasised.

There was nevertheless good agreement between the results for the two seasons especially for the major components on the plots. For example, on the unlimed half of Plot 3 (Unmanured), *Festuca rubra* contributed 32-33% in both seasons and *Agrostis* on the unlimed half of Plot 7 (PKNaMg) was 29 and 31% in 1975 and 1976 respectively. Also on the unlimed half of 14 (N_2*PKNaMg) *Arrhenatherum* and *Alopecurus* were co-dominant but on the limed half *Arrhenatherum* was dominant in both 1975 and 1976. The unlimed half of Plot 7 consisted of 30% *Arrhenatherum* in 1975 and although only partial analysis was done in 1976 (Table 44) about three-quarters of the grass fraction (40%) appeared to consist of *Arrhenatherum* in that year.

There were also some differences between seasons. The most significant of these was the increase in % other species on the limed half (L) of Plot 3 and the large increase in % legumes on the limed half of Plot 7 in 1976 compared with 1975. The increase in other species on 3L in 1976 was mainly at the expense of the grasses but the increase in legumes on 7L was accompanied by a decrease in other species so evidently the drought induced different reactions in different communities. Particular species e.g. *Hypochaeris* and *Leontodon* were much encouraged in 1976; *Dactylis* and *Lolium* also appeared more abundant than usual and *Arrhenatherum* was more plentiful on 14L in 1976 than in 1975.

DISCUSSION AND CONCLUSIONS

CHANGES WITH TIME

As pointed out in the Introduction the present analyses were initiated to quantify the changes in botanical composition on those sub-plots which had received new or increased rates of lime under the new liming scheme. The analyses were then extended to include plots with unchanged treatment to assess whether and how much they had changed since the previous hay analyses during 1948 and 1949. At the same time it became clear that a better appraisal of the present-day flora would be achieved by considering it not only in relation to changes in the immediate past but also in relation to the main changes on the plots throughout the duration of the experiment. The scope of the work was, therefore, widened from a presentation of the results of the 1973-1976 analyses to include also a review of past results. However, because of the large amount of accumulated data the results section dealt only with those changes which were deemed large enough or to have continued for long enough to be obviously 'significant'. It is likely that other changes have occurred especially in minor components which the method of analysis was not sensitive enough to detect. Plot yields have changed (usually decreased) slowly with time but except in the early (1862-77) and late (1973-76) analyses the amounts of species per unit area of land were not calculated; in view of the yield changes it is possible that over a period of time the changes in the amount of species might be somewhat greater or smaller than the percentage figures suggest. Although percentage composition can be compared throughout, because of the change

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in the method of estimating yield (hay before 1960 but dry weight since then) the absolute amount of species after 1960 cannot be compared with that before that date.

With the introduction of the four-year liming scheme in 1903 and the new liming scheme on some plots in 1965 the parts of the plots with unchanged treatment have become progressively smaller; thus for the ammonium sulphate plots the continuously unlimed section is now only a quarter of that during the first 47 years and on other plots half that at the outset. Nevertheless, despite the smaller area, because of the large differences between treatments and the length of time they have continued, it is possible to ascertain what successional changes are occurring.

Although many of the major differences between plots were established in the early years and have persisted throughout the duration of the experiment the dynamic nature of the vegetation on the plots has also long been recognised. Commenting on the 1858 results, particularly on the proportion of *Lolium* in the samples, Lawes and Gilbert (1859) stressed that "it must not be supposed that figures which represent the proportion of flowering and seeding stem of a certain plant at a given period of the season are at the same time accurate indications of the relative development of the total plant under all the conditions in question. It must be borne in mind that the numerous plants which constitute the complex herbage of our meadows have each their natural period of flowering and seeding. It must be remembered that by cutting time some plants are grown up and disappeared whilst others may escape the scythe. Plants may be present in diminished numbers or in such limited growth that they are not obvious at all times when observations are made and still less are they found in the samples. When circumstances become favourable again they re-appear". Brenchley (1937) also pointed out "that the botanical composition of the herbage of any particular area of grassland is by no means static, but is in a constant flux, varying not only from year to year, but also from one season of year to another. This is true even when the treatment of these plants is the same for many years". Apart from these short-term variations between and within seasons, the available evidence, including that from recent analyses, shows that long-term changes are also occurring on most plots. That is, botanical composition continues to change systematically despite unchanging treatment. The extent, rate and direction of the changes, however, vary between treatments. On some plots definite increases or decreases in certain components have occurred during the last 30 years, on others a complete change in dominant species has occurred, on others the changes have been cyclical such that the present-day botanical composition more closely resembles that sixty than thirty years ago and on yet others few changes have occurred in the dominant species although changes may have occurred in more minor components. The fact that groups of plots are behaving similarly confirms that the changes are genuine, and not haphazard.

The unlimed halves of the unmanured plot (3) and of those receiving PKNaMg (7) or PNaMg (8) had much more *Festuca rubra* during 1975 and 1976 than they had during 1948 and 1949. On the unmanured plot the 32% recorded was larger than any in the past although the species exceeded 20% during 1872-1903; on the other two plots similar or larger values were recorded in the past but not since 1935 on 7 (PKNaMg) and 1941 on 8 (PNaMg). On the limed halves of the unmanured and PNaMg plots there was also much more *Festuca* during 1975 and 1976 than during 1947 and 1948 but on the PKNaMg plot only small amounts were present, as previously. It is unlikely that these increases were merely seasonal since there was good agreement between the two contrasting seasons. On Plots 3 and 7, % grasses also appears to have increased

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recently. Some of these changes could be explained by the plots becoming more acid but this possibility is ruled out by the fact that recent analyses (Table 3) have shown the pH on these plots to be largely unchanged since 1959. *Dactylis* has also decreased generally in this group of plots except possibly on the PNaMg plot, where it has always been very infrequent and *Helictotrichon* and *Rumex* have also decreased. However, not all changes have been similar : whereas *Holcus* has decreased on the unmanured plot, especially on the unlimed half, it has increased greatly on the other two plots.

The unlimed halves (or quarter-plots since 1965) of all plots given the intermediate amount of ammonium sulphate, except the one not given phosphate, have become dominated by *Anthoxanthum* since the last analyses in 1948 and 1949. Visual survey suggests that they became so during the late 50's and early 60's. Even on the plots not given phosphate (Plot 1 (N_1) and Plot 18 (N_2KNaMg) the amount of *Anthoxanthum* has increased substantially. On these plots however, a similar precentage of *Anthoxanthum* has occurred in the past: on Plot 1 *Anthoxanthum* increased to about 15% and remained at that level until after 1919 and then declined, but on Plot 18 only in one other year (1920) was as much *Anthoxanthum* recorded as in 1973. However, since past records and present analyses show much seasonal variation in this species further analyses would be required to ascertain whether the increases on these two plots are transient or permanent. Also, although *Anthoxanthum* has evidently dominated the unlimed halves and later sub-plots *d* of Plots 4^2, 9 and 10 for the last 10-15 years, it is not clear whether the proportion (70%) now on the plots represents an equilibrium position with *Agrostis* or whether the species is still increasing to a completely dominant position as *Holcus* has done on Plots 11^1 and 11^2. Further analyses in 5-10 years time would be needed to assess this.

Most of the plots now dominated by *Arrhenatherum* and *Alopecurus* have shown systematic variations in these components in the past. On the limed halves of Plot 9 (N_2PKNaMg) and 11^1 (N_3PKNaMg) where *Arrhenatherum* is now dominant or co-dominant with *Alopecurus* respectively, the relative proportions of the two species in 1974 and 1976 more closely approximated to those in 1914 (ten years after the start of the main liming scheme) than they did in most of the intervening years, when *Alopecurus* was dominant. As on Plot 9, *Arrhenatherum* is also now dominant on 11^2. A decline in *Alopecurus* also occurred during the 1930s and 1940s on plots given FYM, especially on the unlimed and lightly limed sub-plots of Plot 19 which did not receive inorganic fertilisers. In contrast on Plot 20, which received NPK as well as FYM, there was less decline in *Alopecurus* and this did not occur on the unlimed sub-plot. On Plot 18 (N_2PNaMg), which lacks K, a very pronounced decline in *Alopecurus* occurred on both lightly and heavily limed sub-plots.

Amongst the half-plots that have shown little change during the last fifty years or so are those unlimed and given the largest amount of ammonium sulphate and PKNaMg (Plots 11^1 and 11^2) which are dominated by *Holcus*. The unlimed and limed half-plots of Plot 14 (N_2 as sodium nitrate) and 7 (PKNaMg), which are dominated by *Alopecurus* and *Arrhenatherum* respectively, have also been relatively stable although some decline in *Dactylis* has occurred recently compared to the level during the 1940s. It will be of great interest to see whether these plots remain stable in the future; in particular, whether *Anthoxanthum* which has appeared to increase on 11^1d since the 1973 analysis will continue to do so.

10R

CHANGES WITH LIME

Comparison of treatments and discussion of the effects of lime under the main schemes have, as mentioned earlier, been made several times in the past. The present analyses were not undertaken primarily to provide further evidence of these differences, and since only a limited number of plots were analysed in any one year, the results do not lend themselves readily to valid detailed comparisons of all treatments. It is, however, apparent in view of the many long-term changes already noted on some plots and relative stability on others, that differences between treatments will also be affected. However, such detailed comparisons would probably be applicable only to the particular site in question whereas a study of succession within particular types of communities would be expected to be more widely applicable. Except on the plots given sodium nitrate, the effects of lime are very pronounced but the differences between unlimed and limed half-plots are often not much greater than those which have occurred with time on the unlimed half-plots as they have become gradually more acid. For example, the botanical composition of the unlimed half of Plot 11^1 in 1903 was qualitiatively similar to that of the limed sub-plots *a* in 1974.

In so far as comparison is possible the effects of lime under the new scheme, particularly where it has been applied to previously unlimed sub-plots, have appeared in general larger than the effects in 1914 of lime applied under the old scheme in 1903 and 1907. The reason for this is that between that time and 1965, when the new scheme was started, the unlimed halves of the plots in question became progressively more acid; this was reflected in their botanical composition : whereas a wide range of species were present in 1903, in 1965 the unlimed sub-plots were dominated by single acid-tolerant grasses. The initial effect of lime applied in 1903 was to encourage or discourage differentially species already present but lime applied under the new scheme also allowed species which were absent at the time or present in extremely small amounts to be introduced or to increase on the newly-limed sub-plots. The increase in pH also at the same time caused a marked reduction in the dominant species. One of the effects of fresh lime during 1965-68 was to allow re-introduction of species previously present on the plots before they became so acid. For example, *Festuca*, much increased on 1*c*, was very abundant on Plot 1 unlimed during 1939 and 1940, the composition of 18*c* in 1973 resembled that of the unlimed sub-plot in 1923, 4^2c in 1973 probably resembled that of the unlimed half during the 1920s (it was not analysed between 1914 and 1949), 10*c* that of 10 unlimed in 1948, 9*c* that of 9 unlimed during 1926 and 1927, 11^1c that of 11^1 unlimed in 1903 and 11^2c that of 11^2 unlimed during the first ten years of the century. This provides further evidence that the effects of lime have not been much greater than changes which have occurred naturally with time. This was also so on sub-plots given increased rates of lime. The effect of lime on these plots was to accentuate the trends already occurring with time: the decline of *Alopecurus* already occurring since 1948 was increased by increased rates of lime. It is likely, however, that sub-plots which have received lime under the new scheme are still in a state of change, albeit a slower one than during the first seven years. Brenchley (1937), describing the effects of lime, states "that the initial effect may be accentuated with time until a certain position" (presumably of relative stability) "is reached as far as effect of liming is concerned, although seasonal conditions will still cause fluctuations in the normal way".

In general, lime in the new scheme has shown that under acid conditions relatively small changes in soil pH (Thurston, Williams & Johnston, 1976) in the uppermost soil

11 L

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layers may bring about fairly large changes in the botanical composition. For example, the changes in botanical composition on Plot 18*c* were associated with only 0.2 pH unit increase in the uppermost 7.5 cm of soil in 1971, although the pH of the 'mat' of partially decomposed organic matter was raised from 3.9 to 6.3 (Johnston, 1972). The effects of recent lime on the botanical composition of the swards has, in general, been more consistent than on yield since it has been less subject to seasonal variations. Also, although in 1973 recent lime on 11^1 increased yield of sub-plot *c* compared to *d* by only about 20%, but by as much as 70% on 11^2, changes in botanical composition were similar. The reduction in the acid-tolerant grasses and replacement by other species was accompanied by large increases in yield, especially at the first cut on sub-plot *c*. However, changes in the proportion of grasses already present e.g. on sub-plot 11^2b had little effect on yield, although pH was raised from 4.7 to c.6.0 in the uppermost 22.5 cm.

Although the unlimed sub-plots of plots 4^2, 9 and 10 were very similar, consisting of c.70% *Anthoxanthum*, and although this was decreased to 5-10% by lime, the species was replaced by different amounts of different species on the different sub-plots. On 4^2c *Anthoxanthum* was replaced mainly by *Festuca rubra* on 9*c* by *Holcus* and on 10*c* by both. It is clear therefore that a prediction of the effects of lime entails not only knowledge of the existing flora and extent of pH change but also previous fertiliser application or nutrient status of the soil as well as the proximity of other species. The presence of *Festuca rubra* on K-deficient soil in the pH range 4.7-5.5 on the Park Grass plots confirms this association on other soils and under other management conditions (*e.g.* Castle & Holmes, 1960; Murphy, 1960; Heddle, 1967; Smith, Elston & Bunting, 1975; Arnold, Hunter & Gonzalez-Fernandez, 1976). The relatively small effect of lime under the new scheme on % *Agrostis* on plots receiving N_2 is similar to the effects at the start of light lime on Plot 19, where there was also no reduction during the first 8 years although there were large reductions later. It is, however, not clear why lime should increase the amount of *Holcus* on sub-plots 9*c* and 10*c* whilst decreasing it on 11^1c and 11^2c.

It is now abundantly clear that, although some species are plentiful in very acid conditions whilst others are absent, great caution needs to be exercised in categorising species simply into those that are discouraged or encouraged by liming. The distribution of species is influenced by the relative preferences and tolerances of other species and also the influence of lime depends on the pH range and extent of change and on what other nutrients are applied. For example, although *Holcus* dominates the unlimed acid sub-plots of 11^1 and 11^2 this may not be because it prefers acid conditions *per se* but because it is better able to survive and is not subjected to competition from other species in such conditions. There have been some instances, as already noted, where the amount of *Holcus* has been increased by lime on Park Grass. Similarly, *Rumex*, which may appear to prefer acid conditions, also grows well on limed soils but is subject to increased competition there (Brenchley, 1935).

ASSOCIATION BETWEEN BOTANICAL COMPOSITION AND YIELD

Although the experiment was set up as an agricultural investigation and the treatments induced large changes in yield these were soon associated with conspicuous changes in botanical composition. However, the fact that complete fertilisers (N_3PK) increased yield three-fold even in the first year suggests that this was achieved by the response of species already present at the outset,

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since it is unlikely that large changes would have occurred in the botanical composition during the first year. As the unmanured plot became increasingly impoverished, *Lolium* and *Holcus* decreased to very minor components and *Agrostis* and *Festuca* became the main grasses; other species have been abundant. It is possible that through growing slowly the species may make small demands on the environment and/or that they may be very efficient in the use of mineral nutrients. The presence of large numbers of low-growing dicotyledonous species may also be a form of adaptation to the fertiliser and management regime – only a small part of this vegetation would be removed during harvest, perhaps enabling nutrients to be conserved and recycled within the community.

The larger yield on the plot given PKNaMg than on the unmanured plot has for most of the time been associated with more *Dactylis* and legumes and the still larger yield on the limed half of this plot, with even more vigorous growth of *Lathyrus* and also *Arrhenatherum* and *Alopecurus*. However, when yields of hay in individual years between 1900-1950 are plotted against % legumes in those years on both unlimed and limed half plots there appears to be no correlation between yield and legume content. Brenchley (1935), however, using data from four selected years postulated a correlation between the two parameters but it is clear that although high yields in particular years may be associated with much legume, there are many other years where large yields are associated with little legume and small yields with much legume. When potassium was omitted from this treatment, yield declined to about 50% of that with K, legumes became less frequent and latterly *Leontodon* and *Plantago* more frequent. On the plot given the smallest amount of ammonium sulphate without P and K, and where *Agrostis* has been dominant since c. 1940, yield has been smaller than on the unmanured plots. However, it cannot be deduced from this that *Agrostis* is a low-yielding species *per se* since its presence on this plot may merely reflect that it is better able to survive under these conditions than its competitors. The species was in fact, especially in the early years of the experiment, also associated with plots of higher fertility and is also frequent now on plots receiving N_2. The plot given N_2PKNaMg yielded about 4.0 t ha^{-1} of hay during the first 30 years but yield then declined progressively to about 2.8 t ha^{-1} during the 1950's. This decline was associated, at least during the first quarter of the century, with larger amounts of and subsequent dominance by *Holcus* for another thirty years before *Anthoxanthum* became dominant. The variations in yield on the limed half from the 1920's to the 1940's were not associated with any changes in botanical composition.

Omitting K from this treatment (i.e. N_2PNaMg) resulted in a sharp decline in yield which was associated with a decrease in *Poa trivialis* and *Dactylis* and increases in *Alopecurus, Arrhenatherum* and *Festuca* which continued until about 1920. Afterwards yield continued to decline while *Holcus* was dominant during the next 15 years or so and then while *Anthoxanthum* and *Agrostis* were the main constituents. Yield on the limed half-plot declined only very slowly and this was associated during the mid-40's to mid-50's with an increase in *Festuca* and a decrease in *Alopecurus*. On the N_3PKNaMg plots (11^1 and 11^2) Cashen's statistical analysis (1947) suggested that there was no significant falling off in yield during the first fifty years. Whilst this is probably true for the plot receiving N_3PKNaMgSi it is less likely to be so for Plot 11^1 (N_3PKNaMg). Examination of ten-year means for yields of this plot showed a gradual but consistent decrease from the outset: statistical analyses of the first fifty

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years were probably distorted by the abnormally high yields during the fifth decade. After the rapid increase and subsequent dominance of *Holcus* appreciable decreases in yield occurred. Although the larger yields on the limed halves were associated with *Alopecurus* and *Arrhenatherum*, changes in yield with time could not be correlated with changing botanical composition.

On plot 17, receiving sodium nitrate, yield has declined continuously although botanical composition has been relatively stable. However, on Plot 14, receiving the larger amount of sodium nitrate and PKNaMg, moderately stable yields have been associated with relatively stable botanical composition.

Although evidently it is possible to associate differences in yield on the Park Grass plots with differences in botanical composition and to outline changes in yield with time in relation to concurrent botanical changes it is clear that the relationship between yield and botanical composition is very complex and it is very difficult to establish causal relationships between the two. The complexity of the situation is due to the large number of species present, insufficient botanical data for some periods (e.g. 1877 to 1903), difficulties of estimating hay yield accurately on low-yielding plots and of satisfactorily eliminating the effects of variable and changing weather conditions. In addition, until 1960 estimates of yield were also affected by weather during hay-making. Another reason for the difficulty in correlating yield and botanical composition is that both are affected by a third factor, the fertiliser treatment and hence nutrient status of the soil. Yield is the indirect consequence of the effects of the fertiliser treatments on the responses and interactions or competition of the species present and depends on the fact that whereas some species may have very specific requirements and do not seemingly respond to increased fertility others may be less specific in their requirements and be able to respond to increased fertility.

Despite these difficulties it is nevertheless possible to characterise the extreme situations. In general, low-yielding plots, e.g. the unmanured and the PNaMg plots, have large numbers of low-growing dicotyledonous species together with unproductive grasses, or where conditions are acid and P and/or K are deficient, only acid-tolerant grasses are present, whereas the higher-yielding plots are now dominated by *Alopecurus* and *Arrhenatherum*. However, plots with roughly similar botanical composition may yield differently whilst others with similar total yields have very different botanical compositions.

RELATIONSHIP BETWEEN FERTILISER TREATMENT AND BOTANICAL COMPOSITION

The experiment is best known for the way in which the different fertiliser regimes have changed the presence and balance of species on the different plots. The subject has been comprehensively presented in many previous publications (Lawes, Gilbert & Masters, 1882; Brenchley, 1924; Brenchley & Warington, 1958) and need not be repeated here.

However, it must be emphasised that conclusions about the preferences of individual species and their response to various factors should take account of other factors involved and also of changes that have occurred with time. The distribution of species is not governed solely by the response to the presence or absence of one particular nutrient although data from Park Grass can be used to pinpoint some of the major determinants within a given situation. Additionally, the frequency of a given species may be determined as much by the response through competition of

12 R

other species, as by the preferences of the species itself. In such situations further experiment is needed to determine the relative importance of the two factors. As pointed out previously, although *Holcus* is dominant on the acid conditions of the N_3PK plots this may be a reflection of differential survival and tolerance under these conditions and cannot be interpreted as a reflection of the preferences of the species. *Holcus* is now infrequent where potassium is not given (Plot 10) but was so dominant during the 1920s and 1930s that Brenchley and Warington (1958) concluded that the species was encouraged by omission of potassium. However, in the absence of nitrogen the species continues to be more plentiful without than with potassium. Similarly, without nitrogen and under fairly acid conditions (pH approx 5) *Arrhenatherum* is more abundant where K is withheld but when the plots are limed the opposite is now true, though not in the past. Also, on the limed sections of Plot 10, given N_2PNaMg, omitting K decreases % *Arrhenatherum* but the species appears to be increasing on this treatment. *Alopecurus*, often described in the past as requiring complete fertilisers, was dominant for 30-40 years at the beginning of the century on two plots (4^2 and 10 limed) which had not received K for about fifty years previously. Evidently, the species is able to survive under fairly low levels of K; its replacement by *Festuca rubra* might be because *Festuca* can tolerate even lower levels of K or it is better favoured by the increase in pH which occurred between 1923 and 1959 on these plots (Warren & Johnston, 1964)

A further example of a different response at different time is shown by the colonisation of *Chamaenerion angustifolium* on the plots. Following much damage to the vegetation of the unlimed half-plots receiving ammonium sulphate during the severe winter of 1928/29, more *Chamaenerion* established on plot 4^2 than on 11^1 and Brenchley & Heintze (1933) attributed this to the greater competitive ability of the vegetation on 11^1 than on 4^2. However, botanical analyses of the plots following the very cold winter of 1946/47 showed that much more *Chamaenerion* then established on 11^1 than on 4^2.

EFFECT OF SEASON ON BOTANICAL COMPOSITION

Since almost all the major differences between plots are apparent every year it is clear that seasonal differences are small compared to those due to treatments and in only abnormal seasons is the influence of treatment out-weighed by weather. Nevertheless, large effects occur in some seasons, but these are usually reversible e.g. following the drought of 1871 there was a large amount of *Bromus* on Plot 14 but it soon decreased afterwards. Also, following the droughts of 1921 and 1976, *Alopecurus* was much increased on the unlimed half of Plot 14 during 1922 and 1977. On the unmanured and other plots in 1938 and 1976, % other species was larger than usual and the relative increase in this group in dry seasons has long been recognised. This effect is noted in the White Books for the 1872 season: "With regard to the weedy herbage these also have necessarily been retarded in growth but the ill effects of a dry season are less felt by many of them than by the graminaceous or leguminous plants on account of the faculty which some of them possess for retaining and storing in periods of plenty through the agency of their fleshy roots a sufficiency of moisture and nutrient to supply the parent plant in time of scarcity like that which prevailed during the present year". Temperature may, as well as rainfall, affect the proportion of the three main groups of plants. In 1921 the proportion of grasses was high on most plots despite low rainfall presumably because of high temperatures; low

13L

temperatures early in the season tend to reduce the proportion of grasses. Seasonal variations in yield, however, cannot easily be related to differences in botanical composition at least as far as the three main groups of plants are concerned (Brenchley, 1935).

The weather conditions preceding the 1937 and 1938 and the 1975 and 1976 harvests were similar in many respects, the spring of 1937 and 1975 being very wet but 1938 and 1976 very dry. In 1938, % other species was high on both limed and unlimed halves of the unmanured plot but in 1976 only on the limed half; *Poterium, Plantago* and *Leontodon* were all increased. In 1976 only *Leontodon* had a greater % on the unlimed half than in 1975. The relatively small increase in % other species on the unlimed half in 1976 compared with 1975 (35% as against 29%) contrasts strongly with the increase in 1938 compared to 1937 (67% as against 35%) but the reason for this is unclear. *Arrhenatherum* on Plot 14 (N_2*PKNaMg) limed increased in 1938 and 1976 compared to the levels in 1937 and 1975 but it decreased on Plot 9 with equivalent treatment where N is given as ammonium sulphate. Different depths of rooting of the same species on the two plots (Lawes & Gilbert, 1871) may possibly account for the different result. On both halves of the unmanured plot % legumes was about 2% less in 1976 than in 1975 but on the limed half of the PKNaMg plot there was very much more legume in 1976 than in 1975. Both these results are in accord with Cashen's conclusions (1947) from past data: these were that an extra 25 mm of rain increased % legumes by 0.5% on the unmanured plot and that a greater proportion of leguminous plants would be expected to occur on the plot receiving mineral manures *following* a dry year. (1975 was very dry from mid-May onwards).

Although seasonal effects are often in themselves not permanent they may precipitate developments and changes already occurring on the plots. It is possible for example that the large permanent decreases in *Holcus* on the unlimed halves of Plot 10 (N_2PNaMg) after 1938 and of Plot 9 (N_2PKNaMg) after 1962 and the increasing amount and eventual dominance of *Anthoxanthum* on these plots might, to a large degree, be associated with the extreme weather conditions in both years, the summer of 1938 being exceptionally dry and the 1962/63 winter exceptionally cold. It would be of great interest to know the mechanism of increase of *Anthoxanthum* on Plot 9– whether it was by rapid increase of the 'ecotypes' already present on it or whether there was incursion from nearby Plot 10.

GENERAL

There were large changes in yield and botanical composition of the plots during the early years; changes in yield were possible from the outset because of the presence of appreciable amounts of species like *Holcus* and *Lolium* which responded to the increased fertility and in botanical composition because of the large number of species present. Since the changes depended on both the range and type of species present initially, the potential for such rapid change might not exist in all vegetation types. For example, it is likely that if the experiment were now started on land whose botanical composition resembled the present day unmanured plot, changes in yield at least would be smaller since many of the species may have become adapted to the low nutrient status and so could not respond to increased supplies. Some evidence in support of this comes from results from the microplot experiment on Plot 5[1] (unmanured 1897-1963 following N_2 as ammonium sulphate) where increased supplies of nitrogen have resulted in only small increases in yield (Johnston, personal

https://doi.org/10.23637/ERADOC-1-156

communication). Although the unmanured plot can be regarded as a control plot and is the closest approximation to the state of the whole field at the outset, it is important to realise that it continues to change with time. Yield is now only half that at the start, the dominant grasses are different and there is a relatively much larger contribution of other species, three of which (*Leontodon, Plantago & Poterium*) are now abundant. It is also important to bear in mind that the botanical composition of the plots is not only a function of the fertiliser treatment but also of the management in general. Although this has remained fairly constant throughout, some changes have nevertheless occurred e.g. a change in method of cutting from scythe to mowing machine, and abandonment of grazing the aftermath after 1872. It is therefore possible that these changes in husbandry may have had some influence on changes in botanical composition with time.

Small differences in management e.g. slightly more frequent cutting, as on access strips for studies of the Entomology department in 1973 and 1974, may have profound influence on the botanical composition of the swards (Thurston, Williams and Johnston, 1976). This serves to emphasise the extreme plasticity of the grass sward with each new treatment imposed giving rise to a different species balance.

FUTURE WORK

Examination of the data from hay analysis over the duration of the experiment shows that although the rate of change has decelerated an end-point in botanical composition (plagioclimax) has not been, and possibly may not be, reached on most plots. Changes are also still occurring as a result of the new liming scheme and are likely to continue as new plots are brought into it. The scheme of differential liming was introduced to enable comparisons of the botanical and chemical compositions of the herbage to be made at several pH values for all manurial treatments (Warren, Johnston & Cooke, 1965). It is therefore desirable that assessments and/or surveys should continue to be done to provide some of the information for which the new liming scheme was designed and which it is now yielding. Such information is all the more valuable since the vegetation has been well documented in the past. At the same time a measure of long-term changes on plots not yet in the new scheme and a base line for future changes on the plots would be obtained.

It is clear, however, from comments made in the Introduction that the problem of how best to assess the changes in botanical composition is a very real one since although visual surveys give information on the relative amount of heading of different species at particular points of time they provide only limited information on the contribution of the species to the yield of the plots. Analyses of hay samples, on the other hand, whilst giving a better indication of contribution to yield at one particular point in time, are too laborious and time-consuming to be done regularly. Other methods e.g. point quadrat (Warren Wilson, 1960) would involve too much disturbance of the swards especially those of the taller-growing plots. However, despite these shortcomings it is clear that, when many changes are occurring, visual surveys may give a reasonable indication of them but are less successful at detecting changes in components already present. For example, visual surveys between 1965 and 1972 (Williams, 1974) gave a good indication of change on sub-plots *c* but not on sub-plots *b*. It is possible that botanical separations might be done more easily on fresh or frozen herbage than on air-dried material but this would require more people and much storage space, because such samples would be bulkier than hay samples. It would be desirable that if

https://doi.org/10.23637/ERADOC-1-156

and when a change be made in the method of analysing the vegetation, comparison be made with the traditional method of analysis if the results are to be compared with those in the past.

Since the large number of sub-plots now precludes hay analysis being used routinely to monitor the vegetation, a more worthwhile approach, as previously explained, is to use the method to try to answer specific questions for a limited number of plots and treatments. In the early years of the experiment and again following the liming scheme of 1903 when major changes were occurring on the plots it was clearly of greatest interest to quantify the changes in species composition of the plots and this remains so for plots when new treatments are imposed. However, the emphasis has now changed: whereas this aspect was of paramount importance at the outset, data on the distribution and contributions of the different species may now serve as a background to more detailed studies of individual species and factors affecting the distribution of groups of species.

The Park Grass plots provide within a small area of relatively constant soil-type, a range of discrete types of vegetation which receive similar weather and management. They give ample opportunity for work to ascertain why some species are confined to particular habitats whilst others occur on a wide range of plots. Species may be confined to particular habitats either because of a direct preference for or adaptation to particular conditions or because they are less adversely affected than other species and so are at a competitive advantage under such conditions. The wide distribution of other species might be the result of a wide tolerance within the species as a whole or because morphologically and physiologically different populations have evolved on the plots. Such intraspecific variation for many heritable characteristics has been shown to occur in *Anthoxanthum* by Snaydon and Davies (Davies, 1975; Davies and Snaydon, 1973a, 1973b, 1974, 1976; Snaydon, 1970; Snaydon and Davies, 1972, 1976) in a significant lead on this type of work on species with a wide distribution on the Park Grass plots. The species has increased its contribution on many plots in recent years : the facts that it produces viable seed before the first cut and is cross-pollinated must contribute to the speed of differentiation within the species. Similar studies of other species e.g. *Festuca rubra* would not only help to explain their distribution on the Park Grass plots but also add to the understanding of the mechanisms of adaptation and differentiation within plant species. Populations of *Holcus* from the different plots are also now being used by the Unit of Comparative Plant Ecology (Natural Environment Research Council) at Sheffield University in a study of the variation of response within the species to different nitrogen sources.

Apart from the autecology and ecological genetics of individual species, studies of the comparative ecology and competition between pairs of species should also help to elucidate their distribution on the plots. Some species e.g. *Alopecurus* and *Arrhenatherum* usually occur together and appear to have roughly similar requirements but *Arrhenatherum* tends to become dominant at the higher pH values. However, on some plots e.g. 11^1 and 11^2 the relative amount of the two species has fluctuated with time despite unchanging pH. *Holcus* and *Anthoxanthum* also have very similar ecological requirements and at different times have dominated the same plots : *Holcus* was dominant for 30 years on Plot 9 and also for a shorter length of time on Plot 10 before being replaced by *Anthoxanthum*. The rapidity of transition suggests that the species have fairly similar requirements since it is unlikely that there would be any large differences in nutrient status of the soil during the time of change-over of species.

14 R

https://doi.org/10.23637/ERADOC-1-156

Studies of the comparative biology of related species which appear to have different ecological requirements would also be worthwhile. These would include comparisons of *Poa pratensis* with *Poa trivialis* and of *Taraxacum* with *Leontodon hispidus*. Lawes, Gilbert & Masters (1882) concluded that *Poa pratensis* benefitted from nitrogen in the form of ammonium sulphate but not as sodium nitrate, whereas *Poa trivialis* declined markedly on plots given ammonium sulphate, but remained prominent on plots given sodium nitrate. Although these differences have been generally true for much of the experiment, they are less clear-cut than in the past. For example, during 1947 and 1948 *Poa pratensis* was much more widespread on Plot 14 unlimed (nitrogen as sodium nitrate) than was *Poa trivialis* and during 1974 there was much more *Poa trivialis* than *Poa pratensis* on the limed half, especially the sub-plot receiving increased rates of lime, of plot 11^2 (nitrogen as ammonium sulphate). Fundamental studies of the response of the two species to different soil reactions and nitrogen sources should help in explaining their different distribution. Whilst *Taraxacum* and *Leontodon* are both absent from the most acid soils, *Taraxacum* is plentiful only on plots given potassium fertiliser whereas *Leontodon* is most abundant on plots lacking potassium. Experiments under controlled conditions should help explain to what extent differences in efficiency of uptake and utilisation of this cation can account for the different distribution of the two species and whether other factors such as competition with other species are also implicated.

It is possible that by now some of the changes that are occurring on the plots may be related to changes in supply and availability of minor elements. Since all the produce is removed every year and there is no replenishment, cumulative depletion of these elements must occur. Additionally, under the very acid conditions of plots given ammonium sulphate without lime, differential tolerance of species to such factors as aluminium toxicity (Hewitt, 1952; Rorison, 1975) must also be a factor in delineating the distribution of species and should be investigated.

The Park Grass plots now represent a range of sward types to be found in many areas of the British Isles. It would be of great interest to know what the likely outcome of ploughing and reseeding such areas would be in terms of regeneration from the previous vegetation. This would depend, in part, on the accumulation of seed of different species on the plots. Assessments of the number and type of viable seeds incorporated into the soil of the different plots would not only help in predicting this but would also contribute to an understanding of the role of buried seeds in regenerating and maintaining species under permanent pasture conditions. Only a very limited study of the buried weed seeds on Park Grass has previously been done (Brenchley, 1918).

In the early years of the experiment a measure of the value of the herbage on the different plots was obtained, at least of the aftermath, by the number of sheep the plots would support and the amount of liveweight gain made by them. Since then, although much work has been done on the botanical and chemical composition of the swards and yields have been estimated annually, no attempts have been made to determine the value of the vegetation, hay or individual species as animal feed although Brenchley (unpublished) applied the figures for individual species given by de Vries, Hart & Kruijne (1942) to estimate the quality of produce from the plots. This lack of information contrasts with the position for the Palace Leas field at Cockle Park at Newcastle (Elliott & Thomas, 1934; Thomas, Holmes & Clapperton, 1955a, 1955b), where less attention has been given to the botanical composition but more to the

15L

nutritive value of the herbage. Estimates of the nutritive value and digestibility of the material would greatly enhance the value of existing data. The value of a particular grassland species may, of course, depend upon where it is being grown and for what purpose and may also change with time. Although *Holcus* has been used in hill-land reclamation, it is nowadays considered undesirable in lowland pastures; Lawes & Gilbert (1859) state that "some consider it as almost a weed". Similarly, *Arrhenatherum* described by them as not growing abundantly except upon poor soil and being of "somewhat questionable value" is now abundant upon the high fertility plots of the experiment. It was, however, considered a useful hay grass by Smith (1924) and rated highly in de Vries' et al (1942) evaluation scores.

As far as can be foreseen it is likely that the botanical composition of many of the Park Grass plots will continue to change during the next 20-30 years, albeit at different rates for different plots, as a result of both natural succession and recent lime. If beyond that the flora became completely stable or the changes were of insufficient interest to continue recording, useful information would be obtained by changing the treatments on some plots, especially where there are two plots receiving almost the same treatment. For example, it would be of great interest to know what would be the effects on both yield and botanical composition of additions of nutrients to the now very impoverished Plot 2 (unmanured since 1863). This would not repeat the original investigation, because, as detailed previously, the vegetation at the outset differed in many respects from the present-day unmanured plots. Plots 3 and 12 (unmanured from the start) would continue as 'control' plots. As these plots are unique in not having any additions of nutrients for longer than 120 years, not only in the Park Grass but also in a wider context, it would seem desirable that they be maintained in such a state. The reverse situation where a plot given complete fertiliser e.g. N_3PK would be given no fertiliser would also be of interest. This could possibly be done on Plot 11^1 or 11^2 with the other plot continuing to receive N_3PK or alternatively by splitting Plot 9 ($N_2PKNaMg$) with one half continuing to receive the same fertiliser treatment as before and the other half none. However, soil acidity on the unlimed halves would be likely to limit the introduction of many species. Another possibility is that, where it is thought that a deficiency of a minor element is now influencing botanical composition and/or yield, judicious additions of such an element to a plot or part of it might reveal whether this is so. Plots 4^2 and 10 which receive similar treatment and have similar botanical compositions could also be used if any change of treatment were contemplated.

The fact that there are so many contrasting treatments in close proximity makes the experiment a rich source of plant material and this is likely to continue to be so.

Finally, it is clear that monitoring the botanical composition now serves a different purpose from that in the early years. In the past it provided new information of general application. However, as the experiment progressed, and with unchanged treatment, the contrasted processes of enrichment and depletion of nutrients on the different plots limited the applicability of much of the data to present-day agriculture. However, ecologically the data has become increasingly valuable and now serves as a source of information and ideas for more detailed studies of the behaviour of individual species. The usefulness of any future data on the botanical composition of the plots will be enhanced if steps are taken, as far as possible, to ensure that it not only describes the flora and changes in plant associations of a unique site but that it enables this data to be used to predict changes at other sites, and also attempts to describe the mechanisms of distribution and change within those associations.

https://doi.org/10.23637/ERADOC-1-156

Acknowledgments

I am deeply indebted to Mrs Hilary Harding for her patient and persevering help throughout the course of these investigations, to Miss Heather Pellant for help with the 1975 and 1976 analyses and for typing the manuscript and to Miss Joan Thurston for helpful discussions and editorial comments. I am also grateful to Mr A.E. Johnston for providing unpublished data for Table 3 and to Dr K. Warington for many helpful comments.

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16 R

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https://doi.org/10.23637/ERADOC-1-156

TABLE 1a

Amounts of fertilisers applied to the Park Grass plots

Nitrogen, applied in spring.

N_1, N_2 or N_3, ammonium sulphate supplying 48, 96 or 144 kg N ha^{-1}
N_1*, or N_2*, sodium nitrate supplying 48 or 96 kg N ha^{-1}

PKNaMgSi, applied in winter.

P	35kg P ha^{-1} as powdered (recently granular) superphosphate
K	225 kg K ha^{-1} as potassium sulphate (50% K_2O)
Na	15 kg Na ha^{-1} as sodium sulphate (14% Na)
Mg	11 kg Mg ha^{-1} as magnesium sulphate (10% Mg)
Si	450 kg ha^{-1} of water-soluble powdered sodium silicate to plot 11^2 only.

Plot 20 in years when FYM not applied
30 kg N, 15 kg P and 45 kg K ha^{-1}

Organic, applied every fourth year

FYM 35 t ha^{-1} farm yard manure (bullocks) (1973, 1977)
Fish meal (about 6.5% N) to supply 63 kg N ha^{-1} (1975, 1979) (about 950 kg meal ha^{-1})

https://doi.org/10.23637/ERADOC-1-156

TABLE 1b

Plot treatments, starting dates and early treatments for all the Park Grass Plots

Plot number	Present Treatment	Starting Date	Treatment in early years where different from present
	No nitrogen group		
2	Unmanured	1863	FYM 1856-62
3	Unmanured	1856	
12	Unmanured	1856	
4[1]	P	1859	Sawdust 1856-58
8	PNaMg	1863	PKNaMg, + sawdust 1856-61
7	PKNaMg	1856	
15	PKNaMg	1876	N_2* 1858-1875
	Ammonium N group		
1	N_1	1864	N_1 and FYM 1856-63
4[2]	N_2P	1859	Sawdust 1856-58
10	N_2PNaMg	1863	N_2PKNaMg 1856-61 Sawdust 1856-62
18	N_2KNaMg	1905	NPKNaMgSi 1865-1905
9	N_2PKNaMg	1856	
11[1]	N_3PKNaMg	1882	N_4PKNaMg 1856-81 except 1859-61 N_2PKNaMg
11[2]	N_3PKNaMgSi	1882	
	Nitrate - N group		
17	N_1*	1858	
16	N_1* PKNaMg	1858	P omitted 1866 and 1867
14	N_2* PKNaMg	1858	
	Organic		
13	FYM + fish meal	1905	N_2PKNaMg 1856-1904 and straw until 1897
19	FYM	1905	N_1PK 1872-1904
20	FYM + NPK	1905	N_1PK 1872-1904

18R

TABLE 2

Details of liming on Park Grass plots

(1) **Old (Main) liming scheme, started 1903**

Southern halves of all plots 1-13 (except 5/1, 5/2, 6 and 12) and 16 received 2.24 t CaO ha^{-1} as ground lime in 1903, 1907 and 1915 and every fourth year between 1920 and 1964. Plots 14, 15 and 17 came into this scheme in 1920.

(2) **Scheme to test two laboratory methods for estimating lime requirement of soils, started 1920**

Plots 18, 19 and 20 divided into 3 in 1920. One third received no lime, another third, light and the other heavy rate of liming every fourth year since then.

Rates in t CaO ha^{-1} are

Plot	Light	Heavy
18	4.43	7.61
19	0.64	3.53
20	0.64	3.11

(3) **New liming scheme, started 1965**

Eventual aim is to have pHs 7, 6, 5 and 4 for 4 sub plots (*a, b, c* and *d*) within each plot. Limed half-plot split into *a* and *b* and unlimed into *c* and *d*.

(a) *First phase 1965-1968*

Ground chalk applied to some of the *b* and *c* sub-plots receiving ammonium sulphate. Amounts in t ha^{-1} as follows.

Plot	sub-plot *b*	sub-plot *c*
1	–	12.4
4^2	3.7	22.4
9	7.5	17.6
10	3.7	20.0
11^1	24.9	20.0
11^2	15.1	20.0
13	–	3.7
18	–	10.0

pH of sub-plot *a* maintained at 1965 pH level by liming every fourth year; no lime applied to sub-plot *d*.

(b) *Second phase, starting 1976*

Lime applied to raise pH of all *a* sub-plots to 7 where they start less than thi

19L

TABLE 3

The pHs of all sub-plots on Park Grass during 1974-77 (supplied by A.E. Johnston)

Plot	a[1]	b	c	d[2]
1	6.6	5.9[3]	4.3[4]	4.1
2	7.1	6.7[3]	5.2[3]	5.2
3	7.1	6.5[3]	5.1[3]	5.3
4/1	6.9	6.6[3]	5.4[3]	5.3
4/2	5.8	5.9[4]	4.0[4]	3.9
6	6.3	6.5[3]		
7	6.6	6.3[3]	5.2[3]	4.8
8	6.9	6.8[3]	5.2[3]	5.2
9	5.0	5.6[4]	4.2[4]	3.9
10	5.5	5.8[4]	4.2[4]	3.9
11^{1}	4.3	4.4[4]	4.4[4]	3.7
11^{2}	5.1	5.5[4]	4.2[4]	3.8
12	5.3	6.0[3]	5.2[3]	5.2
13	6.9	6.2[3]	5.0[4]	4.9
14	7.0	6.7[3]	5.8[3]	5.8
15	6.3	6.5[3]	5.0[3]	4.7
16	6.8	6.5[3]	5.3[3]	5.2
17	7.2	7.0[3]	5.6[3]	5.9
18	6.8	6.7[3]	4.4[3]	3.9 18/2 7.6[3]

Plot	Unlimed	Low Lime	High Lime
19	5.3[3]	6.1[3]	6.7[3]
20	5.5[3]	6.0[3]	6.9[3]

(1) Sampled in 1975 (all *a* sub-plots) (2) Sampled in 1976 (all *d* sub-plots)
(3) Sampled in 1977 (4) Sampled in 1974

https://doi.org/10.23637/ERADOC-1-156

TABLE 4 Specific and Common names of species whose generic name only is given in the text and tables

Grasses		Other species	
Agrostis tenuis	Common Bent	Achillea millefolium	Yarrow
(A. vulgaris)		Anthriscus sylvestris	Cow Parsley
Alopecurus pratensis	Meadow Foxtail	(Chaerophyllum sylvestre)	
Anthoxanthum odoratum	Sweet Vernal-grass	Carex caryophyllea	Spring-sedge
Arrhenatherum elatius	False Oat-grass	(C. praecox)	
(A. avenaceum, Avena elatior)		Centaurea nigra	Common Knapweed
Briza media	Quaking-grass	Cerastium holosteoides	Common Mouse-ear
Bromus mollis	Soft-brome	(C. vulgatum)	
Cynosurus cristatus	Crested Dog's tail	Chamaenerion angustifolium	Rosebay Willowherb
Dactylis glomerata	Cock's-foot	(Epilobium angustifolium)	
Deschampsia caespitosa	Tufted Hair-grass	Conopodium majus	Pignut
(Aira caespitosa)		(C. denudatum)	
Festuca pratensis	Meadow Fescue	Galium verum	Lady's Bedstraw
Festuca rubra	Red Fescue	Heracleum sphondylium	Hogweed
(Festuca ovina)		Hieracium pilosella	Mouse-ear Hawkweed
Helictotrichon pubescens	Downy Oat-grass	Hypochaeris radicata	Cat's-ear
(Avena pubescens)		Knautia arvensis	Field Scabious
Holcus lanatus	Yorkshire-fog	(Scabiosa arvensis)	
Lolium perenne	Perennial Rye-grass	Leontodon hispidus	Rough Hawkbit
Poa pratensis	Smooth Meadow-grass	Linum catharticum	Fairy Flax
Poa trivialis	Rough Meadow-grass	Luzula campestris	Field Wood-rush
Trisetum flavescens	Yellow Oat-grass	Pimpinella saxifraga	Burnet-saxifrage
(Avena flavescens)		Plantago lanceolata	Ribwort Plantain
		Potentilla reptans	Creeping Cinquefoil
Legumes		Poterium sanguisorba	Salad Burnet
Lathyrus pratensis	Meadow Vetchling	Ranunculus acris	Meadow Buttercup
Lotus corniculatus	Common Bird's-foot-trefoil	Rumex acetosa	Common Sorrel
Ononis repens	Common Restharrow	Taraxacum officinale	Dandelion
(O. arvensis)		(T. vulgare)	
Trifolium pratense	Red Clover	Tragopogon pratensis	Goat's-beard
Trifolium repens	White Clover	Veronica chamaedrys	Germander Speedwell

Names in parenthesis are older Latin ones used in previous publications. *Festuca ovina*, of early publications, has now been more correctly identified as *Festuca rubra.*

https://doi.org/10.23637/ERADOC-1-156

TABLE 5 Relationship between abundance scores (F°-F^{++}) of visual surveys and the % contribution of species to yield estimated by botanical analysis of hay samples

	Abundance Score	1947 Range	1947 Mean	1948 Range	1948 Mean	1949 Range	1949 Mean
All species	F°	t - 69	6	t - 20	3	t - 22	5
	F	t - 81	8	t - 54	4	t - 82	4
	F^{+}	2 - 21	8	s - 45	9	t - 99	15
	F^{++}	s - 52	21	6 - 91	23	5 - 57	14
Grasses	F°	s - 69	11	t - 16	4	1 - 22	7
	F	s - 81	14	t - 54	6	t - 82	6
	F^{+}	4 - 21	9	s - 45	15	4 - 99	29
	F^{++}	14 - 52	33	6 - 91	32	57	57
Legumes	F°	t - t	t	t - 13	2	1 - 12	6
	F	s - 7	3	t - 16	3	2 - 10	5
	F^{+}	4 - 7	6	2 - 11	5	2 - 13	6
	F^{++}	6 - 11	8	6 - 6	6	5 - 5	5
Others	F°	1 - 6	2	t - 20	2	t - 8	2
	F	t - 13	3	t - 13	1	t - 10	1
	F^{+}	2 - 8	5	t - 13	5	t - 10	4
	F^{++}	s - 10	5	6 - 15	10	7 - 14	10

t = trace, 0.1% or less, s = small amount, 0.2-0.5%. In 1947 visual survey preceded the hay harvest by 3 days and in 1948 and 1949 by about 13 days.

TABLE 6 Comparison of number of species detected by visual surveys and hay analyses in 1947, 1948 and 1949. (mean of all plots analysed)

	Visual survey	Hay analyses	Hay analyses + O.S.
1947	13	21	25
1948	14	23	28
1949	14	21	27

O.S. = odd species whose presence was noted during analysis of hay but whose contribution was too small to be quantified.

21L

Notes on Tables 7-45

The following tables give details of the botanical composition of all Park Grass plots throughout the duration of the experiment. They have been compiled from data in Lawes & Gilbert (1859), Lawes, Gilbert & Masters (1882), Brenchley and Warington (1958), Rothamsted Annual Reports until 1939, Numerical Results of the Field Experiments at Rothamsted since then and the present (1973-76) analyses. However, to minimise errors in reproduction, reference has also been made to original papers where possible and the tables include results for some years not previously published.

The data are necessarily condensed both to reduce the bulk of the tables, and also since it is questionable whether the accuracy of the sampling method justifies presentation of minor components to many decimal places. The tables were assembled primarily to enable the major changes with time in botanical compositon within plots to be traced for the present paper but should also serve as a source of information for future reference. In the tables of complete analyses the species are listed in alphabetical order within three main groups, grasses, legumes (where they occur) and other species and the following abbreviations are used throughout: t = trace, 0.1% or less; s = small amount 0.2-0.5% inclusive. Care should be taken in interpreting differences between species which are evidently minor constituents of the herbage : little emphasis should be placed on a difference in one category in one season and it should be borne in mind that at this level the difference within a category may sometimes be larger than between categories. It is important therefore that comparisons of minor components should take account of the data for a number of years. Only species which have contributed at least 0.5% on at least one occasion are included in the tables so that the number of species listed should not be taken as an absolute measure of the number occurring on a plot.

Tables 38-45 give details of the botanical composition of plots analysed during 1973-76. To maintain continuity with the past records results are given to one decimal place but contributions of less than 0.05% are denoted by t. Because results were originally calculated to three decimal places, the totals shown may not agree exactly with the sums of individual species. Since the plots differ greatly in total yield the results are also presented as amounts of the different species per unit area of land.

https://doi.org/10.23637/ERADOC-1-156

TABLE 7a Percentage Grasses (G), Legumes (L) and Other Species (O) on the Park Grass Plots

Plots not receiving nitrogen

Plot	Treatment		1858	'62	'67	'71	'72	'74	'75	'76	'77	'78	'79	'80	'81	'82	'83	'84	'85	'86	'87	'88	'89	'90	'91	'92	'93	'94	'95	1902	'03	'04	'05	'06	'07	'08	'09	'10	'11	'12
		G	76	71	66	79	69	73	69	66	71	67	70	64	79	71	78	73	72	68	56	56	65	73	51	53	48	47	57	34	52	42	39	46	52	56	65	67	46	41
	U	L	5	8	5	5	9	10	12	12	9	15	10	4	3	8	4	10	12	20	15	13	12	3	9	3	3	9	6	7	8	13	9	8	6	13	6	3	4	5
		O	16	21	29	16	22	17	19	22	20	18	20	32	19	21	19	17	16	13	28	31	23	24	40	44	48	44	37	58	40	45	52	46	42	32	29	30	50	54
			'13	'14	'15	'16	'17	'18	'19	'20	'21	'22	'23	'24	'25	'26	'27	'28	'29	'30	'31	'32	'33	'34	'35	'36	'37	'38	'39	'40	'41	'42	'43	'44	'45	'46	'47	'48	'75	'76
		G	59	54	53	66	44	45	47	52	73	60	63	47	61	50	71	54	34	48	61	66	58	58	47	45	57	29	38	53	47	48	54	61	53	46	53	53	64	61
3 –	U	L	9	6	5	9	5	6	5	10	5	5	5	8	5	6	2	6	7	9	10	7	3	5	10	10	8	4	7	10	12	8	8	5	12	14	11	7	7	4
		O	32	36	42	25	50	49	48	38	22	35	31	40	34	44	26	40	59	43	29	27	39	37	43	45	35	67	55	37	41	44	37	34	35	40	36	40	29	35
			1904	'14				'18	'19	'20	'21	'22	'23	'24	'25	'26	'27	'28	'29	'30	'31	'32	'33	'34	'35	'36	'37	'38	'39	'40	'41	'42	'43	'44	'45	'46	'47	'48	'75	'76
		G	59	63				53	59	60	68	51	63	49	73	62	62	64	43	54	59	73	56	53	52	47	55	37	39	50	47	52	41	28	28	27	40	36	43	31
	L	L	8	8				11	5	12	10	8	11	14	5	8	4	7	19	17	12	7	14	6	11	16	15	10	18	23	18	11	13	17	21	21	15	16	12	10
		O	33	27				36	35	28	21	41	25	33	21	30	33	28	38	29	29	20	30	41	37	37	30	53	43	27	35	37	46	54	51	52	45	48	45	59
			1862		'67	'71	'72	'74	'75	'76	'77	'78	'79	'80	'81	'82	'83	'84	'85	'86	'87	'88	'89	'90	'91	'92	'93	'94	'95	1902	'03									
		G	72		63	80	72	74	81	83	81	84	87	76	82	80	78	68	69	66	64	64	73	72	60	61	65	65	76	29	43									
	U	L	19		9	3	8	7	5	5	4	5	3	2	1	5	2	7	7	6	10	11	3	3	5	4	6	8	5	22	19									
		O	9		28	17	20	21	14	11	15	11	11	22	17	15	20	24	24	27	26	25	23	25	35	35	29	28	18	49	38									
			'04		'05	'06	'07	'08	'09	'10	'11	'12	'13	'14	'15	'16	'17	'18	'19	'20	'35	'36	'37	'38	'39	'40	'41	'42	'43	'44	'45	'46	'47	'48	'75					
		G	50		35	35	45	44	45	50	51	30	30	63	53	69	48	38	46	49	56	44	57	34	46	42	47	40	47	35	32	27	51	53	56					
8 PNaMg	U	L	11		11	12	15	20	13	3	9	5	16	11	11	8	3	6	10	17	11	25	15	11	14	25	12	7	14	17	17	16	9	7	9					
		O	39		53	53	40	36	41	46	40	65	54	26	36	23	49	56	42	34	33	31	28	55	40	32	41	53	39	48	51	57	40	40	35					
			1904		'05	'06	'07	'08	'09	'10	'11	'12	'13	'14	'15	'16	'17	'18	'19	'20	'35	'36	'37	'38	'39	'40	'41	'42	'43	'44	'45	'46	'47	'48	'75					
		G	53		40	45	51	51	49	64	38	41	63	68	51	71	59	55	57	57	63	59	69	54	56	55	59	65	48	47	33	33	60	53	64					
	L	L	19		19	17	17	20	17	5	9	8	14	9	22	8	5	6	8	14	9	18	14	7	15	24	14	10	20	20	24	24	10	11	10					
		O	28		41	38	32	29	34	31	53	51	23	21	27	21	37	39	33	29	28	23	17	39	29	21	27	25	32	33	43	43	30	36	26					
			1858	'62	'67	'71	'72	'74	'75	'76	'77	'78	'79	'80	'81	'82	'83	'84	'85	'86	'87	'88	'89	'90	'91	'92	'93	'94	'95	1902	'03	'04	'05	'06	'07	'08	'09	'10	'11	'12
		G	72	65	59	72	46	74	83	81	74	75	80	72	86	69	76	61	52	53	64	59	54	58	52	56	45	37	71	20	42	62	49	48	53	56	52	71	65	46
	U	L	23	25	13	16	40	13	9	10	14	14	8	7	5	20	7	31	37	35	23	19	26	20	31	22	45	58	16	55	33	18	23	22	29	29	30	10	10	19
		O	2	11	28	12	11	13	8	9	12	11	11	20	9	10	17	8	10	11	13	21	20	22	17	21	10	6	12	24	25	20	28	30	17	15	18	19	24	35
																																'04	'05	'06	'07	'08	'09	'10	'11	'12
		G																												48	37	41	48	64	51	74	56	51
	L	L																												23	41	39	41	25	38	16	29	37
		O																												29	22	20	12	11	11	10	15	12
7 PKNaMg			'13	'14	'15	'16	'17	'18	'19	'20	'21	'22	'23	'24	'25	'26	'27	'28	'29	'30	'31	'32	'33	'34	'35	'36	'37	'38	'39	'40	'41	'42	'43	'44	'45	'46	'47	'48	'75	'76
		G	70	68	61	75	59	57	52	43	68	69	69	47	73	73	69	59	40	43	60	71	52	47	48	44	58	48	45	58	49	67	54	38	26	29	51	47	76	73
	U cont.	L	21	17	25	15	11	11	9	28	13	13	15	33	6	6	10	21	35	35	19	16	30	37	38	33	21	28	40	19	28	10	19	32	40	26	17	20	11	13
		O	8	15	14	10	30	32	39	28	18	17	16	20	21	20	21	20	25	21	21	13	18	16	15	23	21	24	15	23	23	23	27	30	34	45	31	33	13	14
			'13	'14	'15	'16	'17	'18	'19	'20	'21	'22	'23	'24	'25	'26	'27	'28	'29	'30	'31	'32	'33	'34	'35	'36	'37	'38	'39	'40	'41	'42	'43	'44	'45	'46	'47	'48	'75	'76
		G	71	72	54	70	71	71	59	43	66	61	53	37	75	82	63	57	33	51	77	69	44	42	59	51	74	56	69	74	63	64	71	52	61	65	71	57	48	40
	L cont.	L	21	20	37	26	18	16	20	44	22	30	40	52	1	5	25	34	57	43	9	14	44	41	31	31	10	21	22	14	26	11	17	34	20	15	9	25	22	47
		O	8	8	9	4	11	13	21	13	12	9	7	11	24	14	12	9	10	6	14	17	12	17	10	18	16	23	9	12	11	25	12	13	19	19	20	18	30	13

U = Unlimed: L = Limed

https://doi.org/10.23637/ERADOC-1-156

TABLE 7b Percentage Grasses (G), Legumes (L), and Other Species (O) on the Park Grass Plots

Plots receiving nitrogen as ammonium sulphate

Plot	Treatment		1858	'62	'67	'71	'72	'75	'77	'78	'79	'80	'81	'82	1902	'14	'19	'39	'40	'41	'42	'43	'44	'45	'46	'47	'48	'73
		G	80	89	86	91	82	87	84	89	95	85	94	92	78	78	86	95	98	96	97	99	97	95	98	93	95	98
	U	L	2	s	1	s	s	s	s	1	s	s	s	3	1	-	-	-	-	s	t	-	s	t	-	-	-	-
		O	16	11	13	9	17	13	15	10	5	15	6	5	21	21	14	5	2	4	3	1	3	5	2	7	5	2

Plot	Treatment		1914	'19	'39	'40	'41	'42	'43	'44	'45	'46	'47	'48
1	N_1													
		G	71	77	83	82	73	72	70	66	53	65	71	63
	L	L	1	1	2	3	4	4	3	2	7	6	4	5
		O	27	22	15	15	23	24	27	32	40	29	25	32

Plot	Treatment		1862	'67	'71	'77	1902	'03	'14	'15	'16	'17	'18	'19	'47	'49	'73
		G	80	86	89	95	96	94	99	94	99	92	99	92	98	100	100
	U	L	t	t	t	t	t	t	-	-	-	-	-	-	-	-	-
		O	20	14	11	5	8	6	1	6	s	8	11	8	2	s	-

Plot	Treatment		'14	'15	'16	'17	'18	'19	'47	'49	'73
4^2	N_2P										
		G	99	99	98	99	97	98	77	95	96
	L	L	-	-	-	-	-	-	-	-	-
		O	1	1	2	1	3	2	23	5	4

Plot	Treatment		1867	'72	'77	'78	1902	'14	'15	'19	'20	'21	'22	'23	'24	'25	'26	'27	'28	'29	'30	'31	'32	'33	'34	'35	'36	'37	'38	'39	'40	'41	'42	'43	'44	'45	'46	'47	'48	'73
		G	55	81	84	81	61	93	86	69	87	91	80	96	91	87	78	98	96		79	96	96	98	99	99	100	100	92	98	98	97	90	99	80	84	94	93	88	100
	U	L	5	3	2	3	8	t	s	-	t	-	-	t	t	-	-	-	-		-	-	-	-	-	-	-	-	t	t	t	t	-	t	s	-	-	-	-	-
		O	39	16	14	16	31	7	14	31	12	9	19	3	8	13	22	2	4		21	4	4	2	1	s	s	s	7	1	2	3	10	1	19	16	6	7	11	-

Plot	Treatment		1920	'21	'22	'23	'24	'25	'26	'27	'28	'29	'30	'31	'32	'33	'34	'35	'36	'37	'38	'39	'40	'41	'42	'43	'44	'45	'46	'47	'48
18	N_2KNaMg																														
		G	81	86	87	85	86	88	89	97	97	96	94	89	83	85	73	83	81	81	73	74	62	57	63	79	43	52	45	65	81
	LL	L	-	-	-	-	-	-	t	-	-	-	-	-	-	-	s	t	t	t	t	s	s	s	1	t	1	t	s	1	t
		O	19	14	12	14	14	11	10	3	3	4	6	11	16	15	27	16	19	19	26	26	38	43	36	21	56	47	55	34	19

Plot	Treatment		1920	'21	'22	'23	'24	'25	'26	'27	'28	'29	'30	'31	'32	'33	'34	'35	'36	'37	'38	'39	'40	'41	'42	'43	'44	'45	'46	'47	'48
		G	77	82	82	87	86	92	94	98	94	97	94	90	93	89	72	79	79	72	76	68	62	60	63	86	64	62	62	65	83
	HL	L	-	-	1	-	s	s	t	t	s	t	s	s	-	s	-	s	t	s	s	s	s	t	s	s	1	1	1	2	s
		O	22	17	16	13	13	8	6	2	5	3	6	10	7	11	28	20	20	28	24	31	38	40	37	14	35	36	37	34	16

U = unlimed, L = limed, LL = low lime, HL = high lime (see Table 2)

https://doi.org/10.23637/ERADOC-1-156

TABLE 7b (continued) Percentage Grasses (G), Legumes (L) and Other Species (O) on the Park Grass Plots

Plots receiving nitrogen as ammonium sulphate

Plot	Treatment		1862	'67	'72	'77	1902	'14	'15	'17	'18	'19	'20	'35	'36	'37	'38	'39	'40	'41	'42	'43	'44	'45	'46	'47	'48	'73
	U	G	85	83	95	93	98	98	98	93	88	92	99	100	100	100	100	100	100	100	99	100	100	100	100	99	100	100
		L	t	t	t	t	t	-	-	-	-	-	-	-	t	-	-	-	-	-	t	t	t	-	t	-	-	-
		O	14	17	5	7	2	1	2	7	12	7	1	t	t	t	-	-	-	-	s	t	t	-	s	1	s	t

Plot	Treatment		1914	'15	'17	'18	'19	'20	'35	'36	'37	'38	'39	'40	'41	'42	'43	'44	'45	'46	'47	'48	'74
10	N_2PNaMg																						
	L	G	98	100	100	100	100	100	99	99	97	95	98	96	99	91	99	94	98	93	89	94	94
		L	-	-	t	-	-	-	-	-	s	-	-	-	t	-	-	-	-	-	-	-	t
		O	s	s	-	s	s	s	1	1	3	5	2	4	1	9	1	6	2	7	11	6	6

Plot	Treatment		1858	'62	'67	'72	'77	1902	'03	'14	'15	'17	'18	'19	'20	'21	'22	'23	'24	'25	'26	'27	'28	'29	'30	'31*	'36	'37	'38	'39	'40	'41	'42	'43	'44	'45	'46	'47	'48	'75
	U	G	97	89	72	92	94	91	96	94	89	86	80	85	95	99	99	99	98	97	100	99	100		100	99	99	100	100	100	100	99	100	100	100	100	100	96	100	100
		L	-	t	s	t	s	1	t	-	-	t	-	-	-	-	t	-	s	-	-	t	-		-	-	-	-	-	-	-	t	-	-	-	-	-	-	-	-
		O	2	10	14	5	6	7	4	5	11	14	20	15	5	1	1	s	1	3	s	s	s		-	s	s	-	t	t	-	s	s	-	-	-	s	4	s	-

Plot	Treatment		1914	'15	'17	'18	'19	'20	'21	'22	'23	'24	'25	'26	'27	'28	'29	'30	'31*	'36	'37	'38	'39	'40	'41	'42	'43	'44	'45	'46	'47	'48	'75	'76
9	$N_2PKNaMg$																																	
	L	G	98	98	98	98	96	96	96	99	99	98	99	99	98	99	99	99	99	96	98	94	98	96	99	95	98	96	90	96	84	90	82	68
		L	-	t	-	-	t	1	-	s	-	t	t	s	-	t	t	t	-	t	-	2	1	1	s	t	t	-	3	s	6	3	11	18
		O	1	2	2	2	4	3	4	s	1	1	s	1	2	s	s	s	1	4	2	4	1	3	1	5	2	4	7	4	10	7	7	14

Plot	Treatment		1858	'62	'67	'72	'77	1902	'03	'14	'15	'18	'19	'47	'49	'73
	U	G	100	89	94	99	97	99	100	100	100	98	99	88	100	100
		L	-	t	1	t	-	-	-	-	-	-	-	s	-	-
		O	-	11	6	1	3	1	s	-	s	2	1	12	s	-

Plot	Treatment		'14	'15	'18	'19	'47	'49	'73
11[1]	$N_3PKNaMg$								
	L	G	99	100	100	100	98	99	100
		L	-	-	-	-	-	-	-
		O	s	-	s	s	1	1	-

Plot	Treatment		1858	'62	'67	'72	'77	1902	'14	'15	'16	'18	'19	'47	'49	'73
	U	G	100	94	95	99	98	99	100	100	100	98	100	99	99	100
		L	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		O	-	6	4	1	2	1	-	s	-	2	s	1	1	-

Plot	Treatment		1914	'15	'16	'18	'19	'47	'49	'75
11[2]	$N_3PKNaMgSi$									
	L	G	98	100	99	99	100	98	97	95
		L	-	-	-	t	-	t	-	t
		O	1	-	1	s	-	1	3	4

*Between 1932 and 1935 inclusive grasses made up almost 100% of the herbage

U = unlimed L = limed

https://doi.org/10.23637/ERADOC-1-156

TABLE 7c Percentage Grasses (G), Legumes (L) and Other Species (O) on the Park Grass Plots

Plots receiving nitrogen as sodium nitrate

Plot 17 N_1

Treatment		1862	'67	'72	'77	'78	1902	'03	'14	'15	'19	'20	'21	'23	'25	'27	'29	'31	'33	'47	'49	'75
U	G	81	76	73	76	76	44	56	68	51	58	62	65	65	75	76	61	80	71	70	71	63
	L	s	1	1	1	1	3	3	1	1	s	s	s	t	t	t	s	s	t	t	t	t
	O	18	24	25	23	23	53	41	30	48	41	37	34	34	25	24	39	19	28	30	29	36

Treatment		1920	'21	'23	'25	'27	'29	'31	'33	'47	'49	'75
L	G	67	73	73	78	82	71	78	76	76	83	72
	L	2	1	1	s	1	2	3	2	3	3	3
	O	31	25	24	21	16	27	18	22	21	14	24

Plot 16 N_1PKNaMg

Treatment		1862	'67	'72	'77	'78	'79	'80	'81	'82	1902	'14	'15	'19	'20	'47	'49	'75
U	G	78	84	82	83	81	92	89	91	87	62	74	83	86	83	68	75	87
	L	2	2	7	9	8	3	1	1	7	13	16	9	1	6	13	12	2
	O	20	14	11	8	11	5	10	8	6	26	8	8	13	11	19	13	11

Treatment		1914	'15	'19	'20	'47	'49	'75
L	G	90	89	92	92	72	76	60
	L	2	1	1	1	7	10	8
	O	7	9	6	6	20	14	33

Plot 14 N_2PKNaMg

Treatment		1862	'67	'72	'77	1902	'03	'10	'11	'12	'13	'14	'15	'16	'19	'20	'21	'22
U	G	89	94	93	88	89	85	92	88	82	90	91	88	84	93	97	97	96
	L	t	s	1	1	4	3	4	3	11	6	4	4	7	2	-	t	s
	O	10	5	6	11	7	11	3	9	6	4	4	7	10	5	2	2	3

Treatment		'23	'24	'25	'26	'27	'28	'29	'30	'31	'32	'33	'34	'35	'36	'37	'38	'39
U	G	93	90	86	98	97	99	98	97	99	95	99	97	93	95	93	94	96
	L	t	s	s	t	1	s	1	1	t	1	s	1	1	1	s	1	2
	O	6	9	14	2	2	s	1	2	1	4	1	2	6	5	7	5	2

Treatment		1920	'21	'22	'23	'24	'25	'26	'27	'28	'29	'30	'31	'32	'33	'34	'35	'36	'37	'38	'39
L	G	95	95	92	96	84	84	95	96	93	98	97	99	95	99	97	93	95	84	89	92
	L	1	3	1	1	6	t	1	2	4	1	1	t	1	s	1	1	1	s	2	6
	O	4	1	6	3	9	16	4	2	3	1	2	1	4	1	2	6	5	15	8	3

Treatment		'40	'41	'42	'43	'44	'45	'46	'47	'48	'75	'76
U contd	G	96	98	95	98	98	98	92	85	92	83	91
	L	1	s	s	s	1	2	2	3	2	1	2
	O	3	2	5	1	1	1	5	12	5	15	7

Treatment		'40	'41	'42	'43	'44	'45	'46	'47	'48	'75	'76
L contd	G	94	93	92	97	94	90	88	82	94	71	82
	L	1	4	1	1	4	7	9	13	3	9	8
	O	4	3	7	2	2	3	3	5	3	19	9

U = unlimed L = limed

https://doi.org/10.23637/ERADOC-1-156

TABLE 7d Percentage Grasses (G), Legumes (L) and Other Species (O) on the Park Grass Plots

Plots receiving organic manure

Plot	Treatment		1862	'67	'72	'77	1910	'11	'12	'13	'14	'15	'16	'19	'44	'45	'46	'47	'48	'73
13 FYM + fishmeal	U	G	90	86	94	93	91	85	82	91	96	95	96	80	86	74	76	76	74	91
		L	s	s	1	-	2	s	-	-	s	-	t	t	8	s	s	1	s	2
		O	10	14	5	6	7	14	18	9	4	5	3	20	14	26	24	23	26	7
	L	G									95			87	26	36	62	67	67	
		L									1			1	41	37	8	7	11	
		O									4			12	32	27	30	25	22	

Plot	Treatment		1872	'75	'76	'77	'78	'79	'80	'81	'82	'83	'84	'85	'86	'87	'88	'89	'90	'91	'92	'93	'94	'95	1902	'05	'06	'07	'08	'10	'11	'12	'13	'14	'15	'16	'17	'18	'19
19 FYM	U	G	89	84	77	81	83	85	85	92	80	91	91	81	74	81	84	77	87	83	81	81	74	89	52	64	60	69	60	81	76	78	80	79	69	74	69	73	75
		L	2	8	11	9	7	7	2	3	12	2	5	14	18	10	5	12	3	8	6	8	21	4	30	18	14	23	26	7	5	5	8	10	20	19	21	6	6
		O	8	8	12	10	10	7	12	5	8	7	4	5	7	10	11	11	9	8	13	10	4	7	18	18	26	9	13	12	18	16	12	11	11	6	10	21	19

Plot	Treatment		1920	'21	'22	'23	'24	'25	'26	'27	'28	'29	'30	'31	'32	'33	'34	'35	'36	'37	'38	'39	'40	'41	'42	'43	'44	'45	'46	'47	'48
19 FYM	U	G	76	89	86	78	67	83	85	90	90	84	87	89	88	87	84	81	84	84	68	65	81	82	76	75	62	52	56	51	50
		L	15	5	7	7	20	4	2	1	2	9	7	3	1	2	4	7	5	5	13	20	7	6	2	8	8	16	11	17	17
		O	8	6	7	14	13	13	13	8	8	7	6	8	11	11	12	11	11	10	18	14	12	12	20	17	30	31	33	32	32
	LL	G	71	92	88	79	66	76	84	88	89	84	87	89	88	87	84	81	84	84	68	65	81	82	78	75	62	52	56	51	50
		L	19	2	6	10	20	3	1	2	2	9	7	3	1	2	4	7	5	5	13	20	7	6	2	8	8	16	11	17	17
		O	10	5	6	11	13	21	14	10	9	7	6	8	11	11	12	11	11	10	18	14	12	12	20	17	30	31	33	32	32
	HL	G	85	92	86	72	69	85	90	88	90	77	80	88	91	92	91	88	89	85	76	73	87	90	95	79	77	70	54	60	67
		L	9	4	7	17	21	1	1	3	4	16	13	3	2	3	1	5	6	6	8	19	7	4	s	9	5	15	18	13	10
		O	6	4	7	11	9	14	8	9	6	6	7	9	7	5	8	6	5	9	17	8	6	5	5	12	18	15	28	26	23

Plot	Treatment		1872	'75	'76	'77	'78	'79	'80	'81	'82	'83	'84	'85	'86	'87	'88	'89	'90	'92	'93	'94	'95	1902	'05	'06	'07	'08	'10	'11	'12	'13	'14	'15	'16	'17	'18	'19
20 FYM NPK	U	G	87	80	74	86	81	89	76	89	88	86	83	82	78	73	73	80	81	79	80	85	95	65	63	69	72	64	79	80	63	76	84	77	82	66	78	82
		L	2	9	13	4	5	3	1	1	4	7	9	12	12	9	3	8	4	7	9	10	2	15	23	10	17	26	7	8	7	7	6	12	12	25	9	5
		O	11	10	12	10	4	8	22	10	8	7	8	6	10	17	23	12	15	14	10	5	3	20	14	21	11	11	14	12	30	16	9	11	6	9	12	13

Plot	Treatment		1920	'21	'22	'23	'24	'25	'26	'27	'28	'29	'30	'31	'32	'33	'34	'35	'36	'37	'38	'39	'40	'41	'42	'43	'44	'45	'46	'47	'48
20 FYM NPK	U	G	87	90	91	88	65	69	88	93	93	81	84	85	89	89	91	90	90		80	84	83	86	67	91	88	65	72	69	86
		L	4	4	1	2	23	10	4	2	3	12	10	4	2	2	2	4	3		6	9	6	6	3	2	3	18	6	8	5
		O	9	6	8	9	11	21	8	5	4	6	6	11	9	9	7	6	6		13	7	10	8	30	6	9	16	22	23	9

Plot	Treatment		'20	'21	'22	'23	'24	'25	'26	'27	'28	'29	'30	'31	'32	'33	'34	'35	'36	'37	'38	'39	'40	'41	'42	'43	'44	'45	'46	'47	'48
20 FYM NPK	LL	G	79	91	87	82	71	77	91	94	90	83	66	87	91	75	94	89	92	87	83	65	85	82	82	90	84	65	75	70	80
		L	15	5	8	11	17	2	1	1	3	9	24	4	2	10	1	5	2	2	7	23	5	4	s	1	1	12	5	4	5
		O	6	4	5	7	12	21	8	5	7	8	10	9	7	15	5	6	6	10	10	11	10	14	18	8	15	22	19	25	15

Plot	Treatment		20	'21	'22	'23	'24	'25	'26	'27	'28	'29	'30	'31	'32	'33	'34	'35	'36	'37	'38	'39	'40	'41	'42	'43	'44	'45	'46	'47	'48
20 FYM NPK	HL	G	86	90	86	83	58	63	88	89	87	72	73	81	82	86	80	80	70		63	68	79	90	87	84	78	57	61	52	74
		L	5	4	5	5	30	4	3	3	5	18	10	9	7	3	8	11	9		9	16	7	2	1	1	3	13	11	10	10
		O	9	6	10	12	12	32	9	8	7	9	17	10	12	10	12	9	20		27	16	14	7	12	15	19	29	27	37	16

U = unlimed L = limed LL = low lime HL = high lime (see Table 2)

https://doi.org/10.23637/ERADOC-1-156

TABLE 8 Botanical Composition (% contribution to hay weight) of PLOT 3, UNMANURED, UNLIMED

	Year																						
	1858	'62	'67	'72	'77	1903	'14	'19	'21	'22	'23	'24	'25	'26	'36	'37	'38	'39	'40	'47	'48	'75	'76
Agrostis	7	11	9	16	13	s	13	8	25	24	21	19	19	18	14	12	6	8	12	8	16	15	23
Alopecurus		4	6	s	s	1	s	s	1	3	s	5	1	2	1	2	1	2	3	2	8	2	s
Anthoxanthum	5	4	9	5	5	1	3	7	4	1	4	4	7	3	3	10	3	2	3	5	1	7	2
Arrhenatherum	6	t	s	t	t	t	t	s	s	s	t	t	s	t	t	s	t		1	1	t	s	t
Briza	2	2	1	6	7	20	4	2	1	1	5	s	2	1	3	3	1	3	1	5	s	1	1
Cynosurus	1	s	t	1	1	s	t	s	s	t			t	s		t		t	s				
Dactylis		2	2	1	1	1	4	8	12	8	4	4	7	5	3	5	3	3	3	12	4	2	1
Festuca rubra	8	13	15	22	22	17	25	7	13	13	20	11	11	7	13	14	8	11	19	10	17	33	32
Helictotrichon		10	3	3	3	5	4	4	3	3	4	4	6	4	5	4	5	5	6	3	3	s	s
Holcus	17	5	8	4	12	5	3	9	11	3	4	2	8	7	2	5	1	3	5	5	4	1	1
Lolium	17	6	4	2	4		t		t	t			t						t				
Poa trivialis		1	1	s	1	t									t				t				
Trisetum		2	2	3	1	1	1	1	1	2	1	s	s	1	1	s	s	s	s	1	s	t	t
Lathyrus	2	1	1	1	2	2	s	1	1	1	1	2	2	1	1	1	s	s	1	3	s	s	s
Lotus	2	2	2	6	4	4	3	2	3	3	3	4	2	3	7	5	2	4	6	3	4	2	1
Trifolium pratense	1	4	2	2	2	1	2	2	s	s	1	1	1	1	2	1	1	2	2	5	2	3	2
Achillea	1	1	1	2	2	3	1	2	1	1	1	2	1	1	2	1	1	1	2	1	1	1	1
Carex		s	1	1	s	1	1	s	1	s	2	2	1	1	s	1	s	s	2	1	t		1
Centaurea		s	1	2	1	4	9	6	4	7	2	10	3	3	3	2	4	3	1	1	1	1	1
Cerastium		s	s	1	1	1	s	1	t	s	s	s	s	t	s	t		s	t	1	s		t
Conopodium		1	3	3	2	1	s	5	s	2	2	2	3	5	2	2	1	2	2	6	2	s	s
Knautia									s	s	s	s	s	1	4	5	s	1	s	1	1	s	s
Leontodon		t	1	1	1	6	18	7	2	4	3	6	3	5	14	2	17	18	12	12	18	10	14
Luzula	t	2	4	3	2	s	s	t	s	s	3	s	s	t	1	1	t	s	1	s	t	1	1
Pimpinella		1	3	1	1	s	1		t	s	s	1	s	1	1	s	s	s	s		t	s	1
Plantago	11	7	11	3	3	2	3	19	8	11	11	11	15	17	6	9	24	12	6	4	6	6	7
Poterium			s	s	1	14	2	6	4	5	4	5	4	6	9	8	18	15	9	5	6	7	6
Ranunculus	s	5	2	3	3	2	s	s	t	t			t	t	t	s		t	t	1	t	1	s
Rumex	1	1	2	2	2	2	s	2	1	1	1	1	1	2	s	1	t	1	s	4	2		
Veronica		s	s	t	s	1	t	t	t	t	s	s	s	s	s	s	t	t	s		t		t

https://doi.org/10.23637/ERADOC-1-156

TABLE 9 Botanical Composition (%) of PLOT 2, UNMANURED

	Year									
	UNLIMED							LIMED		
	1862	'67	'72	'77	1914	'19	'49	1914	'19	'49
Agrostis	3	5	11	18	8	8	10	2	s	s
Alopecurus	3	2	6	3	2	1	10	2	1	4
Anthoxanthum	s	3	7	7	4	9	1	1	2	s
Arrhenatherum	2	s	s	t	s	1	s		s	s
Briza		t	s	1	6	3	2	3	2	4
Bromus	18	16	4	s						
Cynosurus	t	s	1	1	s	1		t	t	
Dactylis	4	6	3	3	4	11	8	5	15	7
Festuca rubra	s	5	10	11	26	5	15	24	5	7
Helictotrichon	3	4	10	8	5	5	3	18	20	22
Holcus	2	11	7	11	4	11	3	5	9	2
Lolium	1	4	3	5	s	s		t	s	t
Poa pratensis	2	4	2	1	s	s	t	1	2	1
Poa trivialis	28	16	3	2				t	s	s
Trisetum	6	6	12	3	1	1	s	2	4	1
Lathyrus	1	1	4	5	1	1	2	2	2	2
Lotus		t	s	s	4	3	9	2	2	10
Trifolium pratense	s	s	s	1	1	1	4	3	1	5
Trifolium repens	1	1	s	s	t		s	t	t	1
Achillea	2	1	3	2	1	1	2	1	1	1
Centaurea		t	1	1	7	5	1	8	4	2
Cerastium	t	t	1	s	s	1	s	1	1	s
Conopodium	3	3	1	1	s	4	3	t	1	s
Galium					s	s	2			
Knautia			t	t	s	t	s	t	s	2
Leontodon		t	t	t	16	3	12	8	2	9
Linum								t	s	1
Luzula	t	s	s	1	s	t	s	s	t	s
Pimpinella	s	s	s	s	1	t	t	1	s	s
Plantago	2	3	1	4	5	21	6	8	15	10
Ranunculus	3	1	1	4	s	s	1	1	4	3
Rumex	12	3	2	2	s	1	1	s	3	1
Veronica	s	2	1	1	t	t		t	s	t

This plot received farmyard manure during 1856-63

TABLE 10 Botanical Composition (%) of PLOT 12, UNMANURED, UNLIMED

	Year						
	1862	'67	'72	'77	1914	'19	'49
Agrostis	9	5	11	13	8	5	3
Alopecurus	3	3	3	1	1	2	8
Anthoxanthum	4	8	7	5	3	8	3
Arrhenatherum	1	1	2	1	1	4	1
Briza	1	2	4	4	10	2	6
Dactylis	3	3	2	3	4	14	9
Festuca pratensis	10	4	2	3			2
Festuca rubra	7	12	16	21	33	10	19
Helictotrichon	10	6	5	3	2	4	4
Holcus	5	6	4	10	3	5	3
Lolium	4	3	2	2	t	t	
Poa pratensis	1	1	1	s	s	s	s
Poa trivialis	3	2	1	1	t		
Trisetum	2	2	2	s	1	s	s
Lathyrus	2	2	2	2	1	2	1
Lotus	2	4	5	3	4	2	7
Trifolium pratense	2	3	2	2	2	2	5
Trifolium repens	s	2	1	t	t		s
Achillea	1	1	4	3	1	2	2
Carex	s	1	1	1	2	s	s
Centaurea	1	t	3	2	5	3	2
Cerastium	s	1	3	1	s	1	t
Conopodium	2	5	2	3	s	11	1
Knautia	t	t	t	t	s	1	2
Leontodon	t	t	t	t	6	3	10
Luzula	1	3	3	1	s	s	1
Plantago	8	8	s	1	5	15	7
Ranunculus	3	2	3	6	t	s	1
Rumex	3	4	3	2	s	3	1

This plot, unlike all others, was not split for liming

https://doi.org/10.23637/ERADOC-1-156

TABLE 11 Botanical Composition (%) of PLOT 3, UNMANURED, LIMED

	Year																
	1914	'19	'21	'22	'23	'24	'25	'26	'36	'37	'38	'39	'40	'47	'48	'75	'76
Agrostis	3	1	2	4	3	3	2	2	3	1	s	1	2	1	1	2	2
Alopecurus	1	1	5	3	7	9	4	3	2	5	1	3	7	3	6	1	1
Anthoxanthum	1	3	1	s	1	s	s	s	s	1	s	s	1	3	1	6	2
Arrhenatherum	s	s	s	1	t	t	s	s	s	s	1	s	1	t	t	s	s
Briza	10	9	8	5	7	2	10	11	5	5	2	5	1	4	1	2	2
Dactylis	3	7	8	8	3	4	6	8	3	4	4	3	4	3	3	2	2
Festuca rubra	23	5	13	10	18	9	8	6	7	8	2	5	8	3	4	14	12
Helictotrichon	14	19	18	11	18	17	32	19	12	16	20	16	18	13	13	8	5
Holcus	4	8	9	2	3	2	5	6	3	5	2	2	3	5	2	4	2
Poa pratensis	2	2	1	2	2	2	3	2	4	3	1	1	2	2	2	1	1
Poa trivialis	t	t	t		t	t	t	s	1	3	s	s	1	1	s	s	t
Trisetum	1	3	3	4	2	2	2	3	5	3	2	2	2	2	1	1	1
Lathyrus	3	1	2	3	2	6	2	2	1	1	1	2	2	2	2	2	1
Lotus	3	2	7	3	5	5	2	4	10	10	4	11	14	5	7	3	4
Trifolium pratense	2	2	1	1	3	3	1	1	5	4	4	5	7	7	6	7	5
Trifolium repens			t		s	s	t	t	s			s	s	s	1	s	t
Achillea	1	2	1	1	1	2	1	1	1	s	s	1	1	s	1	1	1
Carex	1	s	s	s	1	1	s	s	t	t	t	t	t	t		3	1
Centaurea	11	6	5	21	4	9	3	4	3	1	1	1	s	s	2	1	1
Cerastium	1	1	t	s	1	s	s	s	s	s	t	s	t	s	s	s	s
Conopodium	t	1	t	s	s	s	s	1	s	s	s	s	t	1	t	s	t
Knautia	1	2	1	2	1	6	2	3	10	7	3	4	4	2	2	s	1
Leontodon	4	1	1	1	2	1	s	2	4	2	12	9	7	9	12	12	19
Luzula	s	s	t	t	1	1	t	s	s	1	s	s	1	s	s	2	1
Pimpinella	1	t	s	s	1	1	s	1	1	s	s	1	1	s	s	s	1
Plantago	4	12	9	8	7	5	7	9	5	6	17	8	5	6	13	10	15
Poterium	3	3	2	4	3	4	2	4	9	5	13	13	4	13	12	12	17
Ranunculus	1	3	s	s	1	2	2	2	1	4	5	3	2	9	3	2	1
Rumex	1	4	1	1	s	1	1	4	1	s	2	1	s	2	1	t	t
Veronica	t	t	t	t	s	t	s	t	1	1	t	s	1	s	s	t	

https://doi.org/10.23637/ERADOC-1-156

TABLE 12 Botanical Composition (%) of PLOT 4[1], P

	Year										
	UNLIMED								LIMED		
	1862	'67	'72	'77	1903	'14	'19	'49	1914	'19	'49
Agrostis	7	6	14	10	t	1	1	2	2	s	s
Alopecurus	1	2	1	1	s	t	t	2	1	1	2
Anthoxanthum	4	7	5	5	2	4	3	3	1	2	1
Arrehenatherum	t	s	t	t	t	s	1	7	t	t	t
Briza	1	s	2	2	11	2	1	s	3	3	2
Dactylis	2	1	1	1	1	5	11	7	2	6	5
Festuca rubra	10	17	20	16	9	22	5	9	23	5	4
Helictotrichon	9	5	4	4	10	10	14	5	13	20	18
Holcus	12	9	5	19	5	9	10	7	7	7	4
Lolium	9	5	3	4	t	t	s	s			
Poa pratensis	1	s	s		1	1	1	1	1	2	2
Poa trivialis	5	6	4	5	1	1	1	s	s	1	2
Trisetum	4	4	6	2	3	2	3	1	2	4	3
Lathyrus	s	1	4	3	5	2	2	3	11	5	7
Lotus	s	1	4	1	7	1	1	4	2	4	8
Ononis			t	1		s	s	2			
Trifolium pratense	1	s	t	s	3	3	t	2	5	1	5
Trifolium repens	1	t	s	s	3	1	t	s	s		2
Achillea	1	2	5	3	2	2	2	4	1	2	3
Centaurea	s	s	1	1	5	9	8	2	8	6	3
Cerastium	s	1	1	1	1	1	1	s	1	s	
Conopodium	1	2	1	1	s		s	1		s	
Knautia			t		s	s		s	1	1	2
Leontodon	1	1	t	1	15	13		11	7	2	6
Luzula	1	2	4	1	1	s	s	1	1	s	s
Pimpinella	1	3	1	1	s			t	s	s	s
Plantago	6	10	3	4	2	7	18	8	4	11	10
Poterium	t	1	t	s	8	1	1	1	t	t	2
Ranunculus	6	1	4	6	1	s	2	4	1	5	2
Rumex	4	5	3	3	1	1	10	6	1	6	2

P has been applied since 1859, Sawdust between 1856-58

https://doi.org/10.23637/ERADOC-1-156

TABLE 13 Botanical Composition (%) of PLOT 7, PK Na Mg, UNLIMED

	Year																						
	1858	'62	'67	'72	'77	1903	'14	'19	'21	'22	'23	'24	'25	'35	'36	'37	'38	'39	'40	'47	'48	'75	'76
Agrostis	11	7	6	12	12	3	7	5	12	19	15	14	11	8	6	12	7	7	3	5	4	29	31
Alopecurus		s	1	1	s	4	2	2	1	1	2	2	1	3	1	1	5	1	6	4	8	7	3
Anthoxanthum	1	3	4	3	3	1	4	4	5	2	4	1	2	2	4	5	1	1	3	7	4	11	5
Arrhenatherum	9	2	t	s	1	1	1	3	1	1	1	2	5	s	2	3	5	1	3	4	2	s	1
Briza	1	t	t	t	t	t			t	t		t	t		t								
Bromus		1	1	t	t	1	2	t	t	t	t						t		s		s	t	
Dactylis		3	5	2	4	5	10	22	14	12	10	12	34	6	13	16	23	22	26	21	16	5	3
Festuca pratensis		s	1	t	1	s	s													s	s		
Festuca rubra	6	14	11	15	27	8	32	7	18	24	28	11	9	20	10	7	2	8	6	4	5	15	23
Helictotrichon		14	4	2	2	4	3	3	3	2	3	1	1	2	2	1	1	2	2	1	1	t	s
Holcus	12	5	12	3	13	3	3	4	12	4	2	1	6	3	4	10	3	1	6	2	3	7	6
Lolium	23	3	2	1	3	t	s			t	t	t			t								s
Poa pratensis		1	1	2	2	2	1	1	1	2	2	2	1	1	2	1	s	1	2	2	3	1	1
Poa trivialis		4	4	2	2	1	s	s	t	t	t	t	t	t	t	s	t		s	s	s	s	s
Trisetum		4	5	4	4	7	2	1	2	2	1	1	1	s	1	1	1	s	1	1	1		
Lathyrus	4	13	7	37	12	22	11	7	8	12	9	29	6	31	16	11	11	29	9	11	11	5	7
Lotus	s	1	1	s	t	s	1	s	1	1	1	1	t	3	5	2	2	2	3	s	s	t	1
Trifolium pratense	18	7	5	1	2	6	5	1	3	s	6	3	s	3	10	7	14	5	5	4	5	4	5
Trifolium repens		3	s	2	t	4	1	t	1	t	s	s	t	1	s	s	s	4	3	2	3	1	s
Achillea	s	2	3	5	1	9	2	6	4	2	1	3	2	2	3	1	2	3	1	8	14	1	1
Centaurea		t	1	s	t	1	7	2	3	6	1	s	2	5	8	2	8	4	3	7	4	2	1
Cerastium		t	t	t	t	s	s	t	3			t											
Conopodium		2	9	1	2	2	1	9	1	1	2	3	3	s	2	3	s	1	2	4	1	1	2
Heracleum			s	t	1	2	s	4	1	3	2	3	4	2	4	4	2	1	5	1	1	s	t
Luzula		1	1	2	s	s	s	s	s	s	1	s	s	1	s	s	t	s	1	t	s	1	1
Pimpinella		1	1	s	s	s				t	t												
Plantago		s	1	t	t	t	1	1	1	2	4	4	3	3	3	2	3	2	1	5	7	7	7
Ranunculus		1	s	s	s	3	1	2	s	t	1	1	1	s	s	1	1	1	1	1	1	s	t
Rumex	1	2	9	1	7	4	s	11		2	2	3	4	1	2	7	5	1	6	2	2	s	s
Spiraea						1	1	2	3	1	2	1	1	t	1		3	1	2				
Taraxacum		s	t							t					t		t		t	t	s	s	1
Veronica	s	s	s	1	s	1			t		t	t	t		t					t			

31.

TABLE 14 Botanical Composition (%) of PLOT 7, PK Na Mg, LIMED

	Year															
	1914	'19	'21	'22	'23	'24	'25	'35	'36	'37	'38	'39	'40	'47	'48	'75
Agrostis	4	2	5	5	5	1	2	1	s	s	t	t	s	t	s	s
Alopecurus	10	15	12	11	7	10	9	11	8	17	11	16	23	16	13	5
Anthoxanthum	1	s	1	t	1	s	t	1	s	t	t	t	t	s	s	1
Arrhenatherum	2	3	5	4	3	4	27	6	6	17	17	11	11	19	12	31
Bromus	16	1	3	5	8		t	3	1	t	s	2	7	s	2	1
Dactylis	12	19	12	10	5	10	23	11	11	17	22	19	14	21	13	3
Festuca rubra	13	5	10	13	10	2	3	5	3	2	1	3	1	1	1	s
Helictotrichon	4	9	12	5	6	5	8	9	4	3	2	6	3	4	5	s
Holcus	2	2	2	2	1	s	1	s	2	1	s	1	1	1	1	2
Poa pratensis	1	2	2	3	3	2	1	4	2	1	s	1	1	1	1	1
Poa trivialis	2	1	1	s	s	s	1	4	9	12	1	6	9	2	1	1
Trisetum	4	1	1	2	2	2	s	3	3	3	1	2	2	2	2	1
Lathyrus	16	20	21	29	37	51	1	24	16	2	8	13	6	5	16	14
Lotus	t	t	t	t	t	t	1	t				t			t	t
Trifolium pratense	3	t	t	s	1	t	t	2	4	4	8	1	2	t	s	8
Trifolium repens	1		1	t	3	t		6	11	4	4	8	6	4	6	s
Achillea	1	1	s	s	s	1	1	1	1	s	s	s	t	s	1	t
Anthriscus				s	s	1	1			t	s	s			s	1
Centaurea	3	1	1	1	1	1	1	1	4	t	3	1	t	1	s	
Conopodium	s	4	1	1	1	1	s	t	s	s	t	s	t	t	t	t
Heracleum	s	2	5	2	1	5	12	3	6	4	5	1	4	5	4	7
Knautia	1	1	1	s	s	s	t	t				1	2		s	
Plantago	s	s	1	1	s	s	s	1	1	s	1	1	s	2	5	3
Ranunculus	1	4	1	s	2	1	2	s	s	3	3	1	1	3	2	8
Rumex	s	7	s	t	s	1	5	1	1	4	3	1	1	3	s	2
Taraxacum	t	t		1	s	s	1	1	1	4	8	2	3	2	2	9
Tragopogon	s	2	1	2	s	s	t		2	t	1		t	3	3	

https://doi.org/10.23637/ERADOC-1-156

TABLE 15 Botanical Composition (%) of PLOT 15, P K Na Mg

	Year																						
	UNLIMED															LIMED							
	1862	'67	'72	'77	1903	'14	'19	'21	'23	'25	'27	'29	'31	'33	'49	1921	'23	'25	'27	'29	'31	'33	'49
Agrostis	8	7	8	13	3	12	11	15	13	17	12	12	20	17	3	9	14	8	6	2	2	4	s
Alopecurus	7	6	2	7	10	14	30	8	8	10	9	9	18	11	19	20	15	28	14	15	29	9	7
Anthoxanthum	22	2	4	4	2	3	3	5	4	3	4	1	5	8	2	2	s	1	1	s	1	1	s
Arrhenatherum	t				s	s	1	3	1	1	9	1	6	11	1	3	3	1	5	s	6	8	14
Bromus	2	6	4	2	3	3	t	t	1		t	t	s	1		1	2	t	1	t	s	s	1
Dactylis	2	s	t	s	s	2	5	5	3	10	16	6	7	12	8	2	2	6	5	3	7	7	4
Festuca rubra	14	12	35	21	15	14	7	22	21	8	8	17	11	9	7	20	24	10	8	8	13	13	4
Helictotrichon	3	1	2	3	4	2	2	3	2	2	3	3	3	4	1	3	3	6	11	8	13	12	13
Holcus	8	12	5	15	2	6	6	11	2	10	12	2	7	4	1	5	2	4	3	1	4	2	2
Poa pratensis	t	t	s	t	2	s	1	1	1	1	1	1	1	1	s	2	2	1	1	1	2	s	1
Poa trivialis	6	24	8	6	1	s	s	t	t	t		t	t	t		t	1	s	t	t	1	s	s
Lolium	7	3	4	7	t	s	t							s			1		s			s	
Trisetum	4	4	4	3	5	2	1	2	1	1	1	1	1	1	s	2	1	1	3	2	3	2	s
Lathyrus		t		1	16	28	5	8	15	4	5	16	5	8	22	18	11	14	26	27	4	14	13
Trifolium pratense	s	t	t	s	6	s	t	t	t	1	1	3	t	s	2	t	3	s	1	1	s	6	3
Trifolium repens	t	t	t	t	7	2	t	s	s	t	s	3	3	1	3		5	t	1	21	2	7	16
Achillea	2	1	3	1	10	4	5	3	2	7	6	16	8	1	10	2	1	2	3	4	3	1	1
Centaurea		s	3	1	1	1	1	1	s	1	s	1	t	s	8	t	1	s	s	t	1	1	1
Cerastium	1	4	9	1			t		t		t		1	t									
Conopodium	1	s	s	1	1	s	4	1	2	3	2	1	s	1	1	2	2	1	1	t	s	1	s
Galium		1	1	s					t	t	s	s	t	t	t								
Luzula	t	s	s	s	1	s	s	1	4	s	s	s	1	1	t								
Plantago	7	5	s	1	s	s	4	7	13	15	6	6	2	4	10	4	5	8	5	4	5	10	10
Ranunculus	2	s	s	s	6	1	3	s	1	3	1	1	t	s	s	1	1	4	1	1	s	s	2
Rumex	7	7	2	6	2	s	7	1	2	3	1	s	s	2	1	1	s	1	1	t	s	s	1
Taraxacum	1	t	t	t	t	s	1	t	1	s	1	s	s	s	t	1	2	1	1	t	s	s	2

This plot has received PK Na Mg since 1876, between 1858 and 1875 96 kg N ha^{-1} was applied as sodium nitrate annually

https://doi.org/10.23637/ERADOC-1-156

TABLE 16 Botanical Composition (%) of PLOT 8, P Na Mg, UNLIMED

	Year																
	1862	'67	'72	'77	1903	'14	'19	'35	'36	'37	'38	'39	'40	'41	'47	'48	'75
Agrostis	10	4	9	12	1	8	4	9	7	4	3	6	4	2	4	3	5
Alopecurus	s	1	s	1	s	s	1	1	s	s	s	s	1	s	1	4	3
Anthoxanthum	4	7	8	8	1	4	5	3	3	7	2	1	2	3	6	2	10
Arrhenatherum	4	3	4	3	4	3	8	7	8	10	15	11	5	5	12	14	2
Briza	t	t	1	1	6	1	s	s	s	s	s	s	t		s	t	t
Dactylis	3	1	1	1	1	4	4	3	3	1	3	4	4	3	11	13	2
Festuca rubra	7	18	24	20	9	25	7	18	12	10	3	9	12	24	5	5	16
Festuca pratensis	2	s	s	s	t						s		t			s	s
Helictotrichon	13	3	4	2	8	5	3	6	5	5	2	3	4	4	2	2	s
Holcus	4	10	5	18	6	8	11	6	3	15	2	6	8	4	6	7	17
Lolium	6	3	2	8	t	s	s		1	t	t	s	s		s	t	1
Poa pratensis	2	1	2	1	1	1	1	1	s	1	s	1	1	1	1	1	s
Poa trivialis	5	3	2	3	t	s	1		s	1	t	1	1	s	s	t	s
Trisetum	5	3	7	2	4	2	1	2	2	2	1	2	2	1	1	s	t
Lathyrus	9	7	4	2	4	3	4	s	s	s	t	2	s	1	s	1	s
Lotus	s	1	3	1	12	2	1	4	5	4	2	4	6	3	2	3	1
Trifolium pratense	8	1	s	s	1	5	5	6	19	10	9	8	18	6	6	3	7
Trifolium repens	3	t	s	t	1	t	t	t	s	s	t	s	1	2	s	1	1
Achillea	1	5	10	3	3	3	5	4	3	1	2	4	3	6	4	7	1
Centaurea	s	s	s	1	7	9	5	3	5	2	5	4	3	2	1	2	2
Cerastium	t	t	s	s	1	1	s	s	s	t	t	s	s	1	s	t	s
Conopodium	2	7	2	1	1	t	3	t	1	1	s	1	1	1	2	1	s
Galium	t	s	s	t	s	s	t	1	1	s	s	s	s	1	s	s	
Knautia	t	t	t	s	2	1	1	2	4	3	1	2	1	1	1	1	1
Leontodon					1	1	1	6	3	1	4	4	2	3	5	4	8
Luzula	1	2	3	s	s	s	s	1	1	1	t	s	3	2	s	s	3
Pimpinella	1	2	1	1	1	t	s	1	s	s	s	s	s	s		t	t
Plantago	1	1	s	s	6	9	18	13	9	10	33	13	11	19	10	15	16
Ranunculus	1	1	1	2	11	s	2	1	1	4	4	2	3	1	10	6	2
Rumex	2	8	2	6	2	s	7	1	1	3	3	7	4	2	6	3	t

Also received K 1856-61 and Sawdust 1856-62

34.

TABLE 17 Botanical Composition (%) of PLOT 8, P Na Mg, LIMED

	Year											
	1914	'19	'35	'36	'37	'38	'39	'40	'41	'47	'48	'75
Agrostis	5	2	2	2	1	1	1	1	1	1	1	4
Alopecurus	1	1	3	2	2	s	1	3	1	3	3	1
Anthoxanthum	3	1	s	1	1	s	1	1	1	6	1	13
Arrhenatherum	4	18	14	12	26	24	12	9	8	8	15	6
Briza	9	2	1	2	1	1	1	1	1	2	1	2
Dactylis	3	5	5	4	7	6	5	5	5	6	6	1
Festuca rubra	21	6	9	6	5	1	5	7	9	1	2	12
Festuca pratensis					1	3	4	2	2	6	7	4
Helictotrichon	9	12	15	16	11	12	16	15	20	17	11	12
Holcus	7	5	5	2	4	2	3	4	2	4	2	6
Lolium	t	t	t	1	1	s	s	s	t			
Poa pratensis	1	2	1	2	1	1	1	1	2	2	1	1
Poa trivialis	1	1	2	4	4	s	1	3	3	2	1	1
Trisetum	3	2	5	5	5	3	4	3	2	2	2	1
Lathyrus	2	5	1	s	s	t	1	s	1	1	1	t
Lotus	2	2	3	6	3	1	5	6	5	2	6	2
Trifolium pratense	5	1	5	12	11	5	9	17	8	7	3	8
Achillea	1	2	1	1	s	1	1	1	1	1	4	2
Centaurea	9	4	5	3	2	3	5	2	3	1	2	2
Cerastium	1	1	1	1	s	t	s	t	1	s	s	1
Knautia	1	4	6	8	3	3	3	5	6	5	4	s
Leontodon	s	s	4	1	t	3	3	2	1	3	6	6
Luzula	s	s	s	s	s	t	s	1	s	s	t	2
Pimpinella	s	t	1	s	s	s	1	s	s	s	s	s
Plantago	5	8	8	5	5	18	11	7	10	9	13	9
Ranunculus	1	5	s	1	3	2	1	1	1	4	2	2
Rumex	s	8	1	s	2	7	2	1	1	3	2	s

https://doi.org/10.23637/ERADOC-1-156

TABLE 18 Botanical Composition (%) of PLOT 1, N_1

	Year																	
	UNLIMED												LIMED					
	1858	'62	'67	'72	'77	1914	'19	'39	'40	'47	'48	'73	1914	'19	'39	'40	'47	'48
Agrostis	1	1	6	21	23	16	18	52	24	76	75	84	12	8	4	3	1	1
Alopecurus	s	s	2	3	2	2	1	s	s	s	t		4	6	4	4	1	2
Anthoxanthum	1	t	1	6	14	15	17	1	1	s	s	11	7	8	2	6	6	1
Arrhenatherum	17	1	1	2	2	t	s	t	t	s			s	1	2	1	4	3
Bromus		22	10	4	1													
Dactylis		16	6	3	4	9	11	1	s	2	3		7	23	13	12	16	18
Festuca rubra		1	6	6	11	28	14	41	72	14	16	3	26	11	15	19	6	15
Helictotrichon		s	2	3	2	t	s			s	s		5	8	35	28	27	12
Holcus	25	4	11	14	17	7	22		t				5	10	3	3	6	6
Lolium	15	1	3	2	2													
Poa pratensis	10	1	7	7	1	1	s	s	s				4	2	2	2	1	1
Poa trivialis		32	22	4	3													
Trisetum		4	7	6	1		t						1	1	2	2	1	2
Lathyrus	1	t	1	s	s								s	s	1	2	2	2
Lotus													s	s	s	1	1	2
Achillea	2	1	3	5	1	s	s						1	2	1	2	s	2
Centaurea			s	1	s	19	2	s	1	s	1		22	4	5	1	1	2
Cerastium													1	1	s	t	s	1
Conopodium		1	2	s	1	s	1			t			s	1	t	t	s	t
Galium						s		2										
Knautia															1		1	2
Leontodon															t	t	1	1
Luzula			t	t	t	s	s	s	s		t	1						
Plantago	8	s	s	t	s					1					3	7	11	20
Potentilla		t			t					s	2	1						
Ranunculus	2	1	s	1	1	t							1	2	1	1	1	1
Rumex	3	6	6	9	10	1	10	2	1	6	2		1	11	2	3	8	2
Taraxacum															s	s	s	1

This plot also received farmyard manure during 1856-63

https://doi.org/10.23637/ERADOC-1-156

TABLE 19 Botanical Composition (%) of PLOT 18, N_2 K Na Mg, UNLIMED

	Year													
	1914	'19	'20	'21	'22	'23	'24	'25	'26	'27	'28	'46	'48	'73
Agrostis	10	17	43	51	43	48	72	63	47	75	59	75	77	83
Alopecurus	3	5	6	3	10	5	5	4	6	4	5	2	t	
Anthoxanthum	4	3	6	8	3	20	4	3	4	3	7	4	1	17
Arrhenatherum	t	2	s	1	1	t	s	1	2	2	s		s	
Dactylis	37	34	16	12	12	3	4	7	11	9	9		1	
Festuca rubra	38	4	14	11	9	18	5	6	3	3	6	12	9	s
Holcus	1	2	1	4	1	s	s	1	3	2	8	s		t
Poa pratensis	s	s	1	1	1	2	1	s	1	1	1			
Centaurea	4	2	2	2	9		s	2		s	t			
Conopodium	1	4	s	s	2	s	1	s	s	t	s			
Heracleum			s	s	4	s	4	1	1	s	t			
Luzula		t	t	t		t	1	s		t	t			
Rumex	1	24	9	6	4	2	2	10	21	1	3	6	11	

Received NPK Na Mg Si 1865-1904

https://doi.org/10.23637/ERADOC-1-156

TABLE 20 **Botanical Composition (%) of PLOT 18, N_2 K Na Mg at two rates of lime**

	Year																					
	LIGHT LIMING											HEAVY LIMING										
	1920	'21	'22	'23	'24	'25	'26	'27	'28	'46	'48	1920	'21	'22	'23	'24	'25	'26	'27	'28	'46	'48
Agrostis	44	41	36	28	37	36	17	22	17	2	3	35	42	31	27	26	14	11	10	5	1	1
Alopecurus	4	5	25	10	23	14	25	22	46	3	3	6	5	17	8	22	14	25	19	23	3	4
Anthoxanthum	7	4	1	2	t	t	t	t	s	2	1	5	4	1	3	t	t	t	t		t	t
Arrhenatherum	1	2	2	2	2	7	9	10	3	10	25	s	2	3	3	10	1	11	19	18	10	25
Bromus			s							s	s			1							t	t
Dactylis	8	22	7	8	13	21	30	32	21	12	35	16	13	8	10	19	53	37	40	38	36	48
Festuca rubra	5	6	10	26	5	5	2	3	3	10	7	12	7	12	31	4	5	2	3	3	5	2
Helictotrichon	t	.	s	t		t	s	t	t	1	3			1	t	t	t	1	s	t	1	1
Holcus	8	3	2	1	s	s	1	3	1	s	s	2	5	1	1	t	s	2	2	2	s	
Poa pratensis	2	2	3	7	5	4	4	3	5	1	1	1	3	4	4	5	4	3	4	6	1	1
Poa trivialis							t	t	s	1	s	t		s					t	t	s	s
Trisetum	s		1					t	t					1	t	t				t		
Lathyrus							t			t		t		1	t	s	s	t	t	s	1	s
Achillea	s	t	s	t	s	t	s	1	t	t	s											
Centaurea	2	2	4	s	1	t	s	s	t	10	3	2	2	s	s	1	1	t		s	1	
Cerastium										1	t											
Conopodium	1	s	2	1	2	t	s	s	1	t	s	s	1	2	s	3	s	t	t	s		t
Galium												1	t	2		t		t	t		s	
Heracleum						s	t	t		1	1	t	s	2	t		1	s	1	3	2	2
Plantago						t	t	t		17	4			s			t				4	1
Rumex	15	1	6	13	10	11	9	1	2	s	s	18	14	8	12	9	5	5	1	1	1	s
Taraxacum						t	s		t	23	9			s		t		s		s	23	11
Tragopogon					t					1	1			t							3	3

Received NPK Na Mg Si 1865-1904

Ground lime applied every fourth year starting 1920
Light = 4.43 t CaO ha^{-1} and Heavy = 7.61 t CaO ha^{-1}

https://doi.org/10.23637/ERADOC-1-156

TABLE 21 Botanical Composition (%) of PLOT 4^2, N_2 P

	Year														
	UNLIMED										LIMED				
	1862	'67	'72	'77	1903	'14	'19	'47	'49	'73	1914	'19	'47	'49	'74
Agrostis	19	14	21	24	2	13	4	69	36	24	1	s	2	2	7
Alopecurus	1	15	4	2	5	2	1	s	1		42	76	32	24	6
Anthoxanthum	2	5	1	2	23	8	34	14	10	76	8	1	5	1	7
Arrhenatherum	2	s	2	1	1	s	3				t		2	2	s
Dactylis	2	s	s	2	t	1	1					t	t	s	
Festuca rubra	7	26	49	55	53	73	48	10	35		35	8	30	57	53
Helictotrichon	7	4	s	t		t								s	1
Holcus	16	10	2	6	1	t	s	5	17		s	t	1	t	2
Lolium	6	1	1	s											
Poa pratensis	1	4	5	2	8	1	s				13	13	5	6	19
Poa trivialis	8	2	2	s	s										
Achillea	2	1	2	s	t	t							s	1	s
Centaurea	t	s	1	1	1	t	t								
Conopodium	1	3	s	t											
Galium	t	s	1	1	4	s					s	s	1	s	s
Ranunculus	2	t	t										1	t	s
Rumex	13	8	7	3	s	s	8	1	s		s	1	21	4	2

N_2 P has been applied since 1859, Sawdust 1856-58

https://doi.org/10.23637/ERADOC-1-156

TABLE 22 Botanical Composition (%) of PLOT 10, N_2 P Na Mg, UNLIMED

	Year														
	1862	'67	'72	'77	1914	'19	'35	'36	'37	'38	'39	'40	'47	'48	'73
Agrostis	9	9	14	16	3	4	10	4	11	10	30	34	31	52	31
Alopecurus	2	3	10	16	19	21	s	t	1	s	t	t	s	s	t
Anthoxanthum	1	5	3	6	50	21	21	19	33	14	44	31	52	10	69
Arrhenatherum	t	12	13	10	5	26	1	1	2	3	1	1	5	5	t
Bromus	2	1	2	1											
Dactylis	12	5	3	5	1	2	t		t		t	t	t	s	
Festuca pratensis	1	s	t	t											
Festuca rubra	4	15	20	26	19	7	2	1	1	t	1	2	3	10	t
Helictotrichon	11	2	s	s											
Holcus	9	8	4	5	1	12	64	75	51	73	24	31	7	22	t
Lolium	3	2	1	s											
Poa pratensis	4	15	20	6	1	s		t					t		t
Poa trivialis	10	3	1	s			s								
Trisetum	10	2	1	s											
Achillea	1	2	1	t											
Conopodium	2	2	t	t											
Rumex	10	13	4	6	1	7	t	t	t				1	s	t

Also received K 1856-61 and Sawdust 1856-62

TABLE 23 Botanical Composition (%) of PLOT 10, N_2 P Na Mg, LIMED

	Year										
	1914	'19	'35	'36	'37	'38	'39	'40	'47	'48	'74
Agrostis	3	s	1	2	1	2	1	2	2	1	2
Alopecurus	47	77	55	49	62	51	64	50	25	29	8
Anthoxanthum	15	1	2	4	2	1	1	3	11	2	16
Arrhenatherum	9	8	2	2	6	6	3	8	3	4	20
Dactylis	1	2	t	t	s		s	t	1		
Festuca rubra	15	5	33	31	20	28	22	26	44	54	39
Holcus	1	t		t	t	1	s	s	1	s	4
Poa pratensis	4	6	6	12	5	5	6	6	3	3	6
Achillea									s	1	s
Galium									1		
Plantago							s		s	t	2
Rumex	s	s	s	1	3	5	2	4	8	5	1
Taraxacum			s				s		s	s	2

https://doi.org/10.23637/ERADOC-1-156

TABLE 24 Botanical Composition (%) of PLOT 9, N_2 PK Na Mg, UNLIMED

	Year																									
	1858	'62	'67	'72	'77	1903	'14	'19	'21	'22	'23	'24	'25	'26	'27	'28	'31	'36	'37	'38	'39	'40	'41	'47	'48	'73
Agrostis	6	13	13	15	12	4	18	12	27	16	23	31	17	25	14	8	12	t	s	2	2	5	6	24	8	15
Alopecurus		s	t	3	1	4	2	1	1	14	s	s	1	t	s	s	s	t	s		t	t		1		
Anthoxanthum	t	1	4	2	3	16	39	5	25	8	43	22	13	16	11	10	s	t	s	1	3	s	8	16	s	72
Arrhenatherum	5		2	11	13	43	9	47	4	11	8	22	20	6	3	4	2	t			t	1		4	1	
Bromus		4	t	t		t				t																
Dactylis	1	6	5	12	14	5	5	3	1	4	1	t	s	s	s	s	1							s		
Festuca pratensis		1	t	t																						
Festuca rubra	2	5	18	9	22	7	15	4	10	11	12	8	4	1	1	1	7				t	t		s	t	
Helictotrichon		10	1	s	t	t			t				t		t											
Holcus	37	12	10	8	10	4	4	12	30	32	12	14	40	51	69	76	76	99	99	97	94	93	85	51	91	13
Lolium	32	4	1	1	s	t																				
Poa pratensis		11	13	23	18	12	1	s	s	2	s	s	t	t	t	t								t		
Poa trivialis		9	2	1	t	t						t							t							
Trisetum		9	4	5	1	s	t		t	s																
Achillea	s	2	2	1	t	s	t								t		t									
Conopodium		3	9	1	1	s	t	t			t															
Epilobium																	s							2	s	
Heracleum					s	1	1		t	s		s	2	s	s											
Rumex	1	5	11	5	4	3	4	15	1	s	s	t	1		t	t					t			2		

In 1930, and 1932-1935 inclusive, *Holcus* made up 100% of the herbage

TABLE 25 Botanical Composition (%) of PLOT 9, N_2 PK Na Mg, LIMED

	Year																									
	1914	'19	'21	'22	'23	'24	'25	'26	'27	'28	'29	'30	'31	'32	'33	'34	'35	'36	'37	'38	'39	'40	'47	'48	'74	'76
Agrostis	3	2	4	4	2	3	2	3	3	3	5	3	2	5	3	5	1	2	s	2	1	3	3	4		
Alopecurus	18	26	22	28	28	45	42	24	38	54	40	57	47	35	26	50	62	58	50	49	69	55	32	38	15	11
Anthoxanthum	13	1	2	s	1	s	1	1	1	3	2	1	1	4	4	3	3	4	3	2	1	2	12	4	s	s
Arrhenatherum	39	47	43	31	36	32	45	50	39	18	18	21	34	39	51	23	15	16	30	24	14	22	13	15	53	41
Bromus	s			s								t	s	1	1	3	1	1			t	1	t	t	t	
Dactylis	7	7	5	8	2	2	4	8	6	2	7	2	4	4	2	6	4	3	9	12	4	4	12	12	2	7
Festuca rubra	9	6	8	5	13	3	2	3	3	8	15	7	2	1	5	3	2	3	1	1	2	5	3	4	t	t
Holcus	2	1	2	1	s	s	s	3	2	s	3	s	1	4	5	s	4	3	3	1	2	2	3	2	6	5
Poa pratensis	8	6	9	22	16	12	3	6	6	9	10	7	6	4	3	5	4	5		2	4	2	4	9	2	1
Poa trivialis														t		t			1	s	t	t		t	1	2
Lathyrus		t		s		t	t	t	s			t		s	s	1	t	t		2	1	1	6	3	11	18
Anthriscus									t										s		t	s	t		s	1
Heracleum	t	s	1	t	t				t	s		s	s	s	s	1	3	3	s	s	s	2	1	1	4	9
Rumex	1	3	2	t	s	s	s	1	s	s	t	t	s	1	2	s	s	s	1	2	t	s	2	1	s	1
Taraxacum			s			s	t	t	s				s	s	s	s	1	t	s	1	s	1	5	3	2	3

41.

TABLE 26 Botanical Composition (%) of PLOT 11[1], N_3 P K Na Mg

	Year															
	UNLIMED											LIMED				
	1858	'62	'67	'72	'77	1903	'14	'19	'47	'49	'73	1914	'19	'47	'49	'74
Agrostis	4	13	19	14	29	1	s	2	4			2	1	1		
Alopecurus		3	13	12	10	28	1	1	1	t		27	64	79	82	30
Anthoxanthum		t	t	1	s	1	t	t	1		5	2	t	1		
Arrhenatherum	3	1	5	10	15	23	7	31	s			27	15	3	2	38
Bromus		1	t	t												
Dactylis	20	24	39	39	17	t	s	s				5	6	2	5	2
Festuca pratensis		2														
Festuca rubra		1	s	s	4	t	t	t	s			s	t	t	s	
Helictotrichon		2	t													
Holcus	26	10	3	10	20	46	91	65	81	100	95	32	12	8	3	22
Lolium	12	1	t		t											
Poa pratensis		9	13	10	1	s						3	2	4	5	2
Poa trivialis		13	t	t	s											1
Trisetum		5	s	t	t											
Achillea		1	t													
Anthriscus																1
Conopodium		2	2	t	t											
Epilobium									12	s						
Heracleum					s							s	t			1
Rumex		7	4	1	2	t		1				t	t	s	1	3
Taraxacum														2	s	1

This plot received N_4 (192 kg N ha^{-1}) between 1856 and 1881 except during 1859-61 when it received N_2 (96 kg N ha^{-1})

https://doi.org/10.23637/ERADOC-1-156

TABLE 27 Botanical Composition (%) of PLOT 11^2, N_3 P K Na Mg Si

	Year													
	UNLIMED									LIMED				
	1862	'67	'72	'77	1914	'19	'47	'49	'73	1914	'19	'47	'49	'74
Agrostis	19	24	10	17	s	1	44	5	2	s	t	s		
Alopecurus	1	6	23	20	18	30	1	s		49	76	70	57	29
Anthoxanthum	1	t	s	s	t	t	t		s			t		s
Arrhenatherum	6	5	13	21	21	46	13	1		25	16	11	17	50
Bromus	1	t	t											
Dactylis	23	38	27	13	s	3		t		11	7	8	10	1
Festuca pratensis	2	t												
Festuca rubra	1	2	s	3	t	t	s	t		t	t			t
Helictotrichon	1	t												
Holcus	7	5	11	19	59	20	41	93	98	6	t	2	2	11
Lolium	1	s	s											
Poa pratensis	5	10	12	4	1	t	t			3	s	6	11	1
Poa trivialis	17	1	1	t								t		3
Trisetum	3	2	s	t										
Anthriscus														1
Conopodium	1	1	t	t										
Heracleum				s						1		s	t	1
Rumex	4	4	1	1		s	1	1		s		t	1	2
Taraxacum												1	1	1

Plot 11 was split into 11^1 and 11^2 in 1862 after which 11^2 received Si.
Like 11^1 this plot received N_4 (192 kg N ha^{-1}) between 1856 and 1881 except during 1859-61 when it received N_2 (96 kg ha^{-1})

https://doi.org/10.23637/ERADOC-1-156

TABLE 28 Botanical Composition (%) of PLOT 17, N_1*, UNLIMED

	Year															
	1862	'67	'72	'77	1903	'14	'19	'21	'23	'25	'27	'29	'31	'33	'49	'75
Agrostis	11	7	11	18	2	12	6	6	9	3	5	3	4	5	1	6
Alopecurus	24	22	16	13	10	14	13	12	13	14	14	18	18	14	14	24
Anthoxanthum	2	2	4	5	11	5	7	9	7	7	10	3	5	10	9	14
Arrhenatherum	1	s	s	t		s	s	t	t	s	1	t	s	t		
Briza	t	t	s	1	2	1	s	s	s	t	s	t	s	s	1	
Bromus	s	2	1	s	s	t			t				1	t		
Dactylis	2	1	1	1	1	6	8	5	7	28	24	19	23	18	25	5
Festuca rubra	9	11	18	12	13	14	4	12	18	6	5	6	8	7	9	8
Helictotrichon	4	1	4	4	9	4	5	4	3	2	3	2	3	2	2	s
Holcus	8	8	6	11	5	7	11	16	3	10	12	9	15	14	9	3
Lolium	5	3	3	7	s	1	1	s	1	1	t	s	1	s	1	2
Poa pratensis	t	s	t	t	s	t	s	s	1	s	s	s	t	t		
Poa trivialis	5	12	3	2	1	t	s	s	1	1	t	t	s	1	1	s
Trisetum	1	3	5	2	2	1	1	1	1	s	s	s	s	s		
Lotus	t	t	1	1	2	s	s				t	t	s			
Achillea	2	1	3	1	3	1	1	t	s	s	s	s	1	1	1	s
Carex		t	t	t	1	t	s	s	1	t	s	s	s	1	2	t
Centaurea	4	4	10	3	11	8	9	2	1	2	2	8	6	5	5	1
Cerastium	s	1	3	s		s	s	s	s	s	s	1	s	s	t	t
Conopodium	1	2	1	1	1	1	1	t	s	1	s	t	t	s	s	t
Leontodon	t	t	t	s	4	4	3	1	2	1	2	4	2	1	4	4
Luzula	t	s	s	1	1	s	t	s	1	s	s	s	s	s		s
Plantago	4	5	2	8	11	14	24	29	27	17	16	23	8	16	14	24
Ranunculus	2	1	1	2	4	1	1	s	s	1	s	s	t	s	s	4
Rumex	4	7	2	3	2	s	1	t	s	1	1	1	s	2	s	1
Taraxacum	t	t	t	t	1	t	s	s	s	s	t	s	s	s	1	1

*nitrogen as sodium nitrate

https://doi.org/10.23637/ERADOC-1-156

TABLE 29 Botanical Composition (%) of PLOT 17, N_1*, LIMED†

	Year								
	1921	'23	'25	'27	'29	'31	'33	'49	'75
Agrostis	5	4	2	4	1	t	s	1	2
Alopecurus	10	10	13	14	12	12	9	7	8
Anthoxanthum	3	3	1	3	s	1	s	1	5
Arrhenatherum		s	t	2	t	1	2	2	1
Briza	1	s	s	s	1	1	1	1	4
Bromus		s		t		t	t	1	
Dactylis	11	4	15	7	8	10	11	21	11
Festuca rubra	22	35	22	21	27	28	29	22	13
Festuca pratensis								1	
Helictotrichon	7	10	16	17	18	16	10	20	17
Holcus	13	3	6	10	2	4	6	2	4
Lolium	1	t	s	1	1	1	2	2	7
Poa trivialis	s	1	1	1	s	1	2	1	t
Trisetum	2	1	1	2	1	2	3	1	s
Lotus	1	1	s	1	2	3	2	3	1
Trifolium pratense		t			t			t	2
Achillea	s	1	1	1	2	2	1	1	1
Carex	s	1	t	t	t			t	
Centaurea	4	1	2	2	3	2	s	1	1
Cerastium	t	1	s	1	1	2	s	t	s
Conopodium	s	1	1	s	s	t	t	t	t
Galium		t	t	1		t		s	
Heracleum	s	s	s		t	t		s	1
Leontodon	2	1	1	t	3	2	1	2	5
Pimpinella		t	t	t	t	t			1
Plantago	18	16	11	8	15	8	17	6	12
Ranunculus	s	s	2	s	s	s	s	2	s
Rumex	s	s	1	2	1	1	1	s	
Taraxacum	t	s	1	s	1	s	s	1	s

*Nitrogen as sodium nitrate
†Liming began in 1920

https://doi.org/10.23637/ERADOC-1-156

TABLE 30 Botanical Composition (%) of PLOT 16, N_1* P K Na Mg

	Year											
	UNLIMED								LIMED			
	1862	'67	'72	'77	1914	'19	'49	'75	1914	'19	'49	'75
Agrostis	12	14	12	15	5	1	2	1				
Alopecurus	1	8	15	12	26	51	22	29	26	36	11	4
Anthoxanthum	1	2	1	2	3	2	4	6	t	t	s	1
Arrhenatherum	t		s	t	3	3	22	38	1	3	19	42
Bromus	2	3	2	1	8		s		3	t	1	t
Dactylis	2	3	4	5	10	20	10	8	9	19	13	3
Festuca rubra	11	10	10	17	8	2	6	1	31	11	14	3
Helictotrichon	1	2	1	3	5	3	6	1	14	18	15	1
Holcus	10	12	5	13	1	2	1	3	1	s		s
Poa pratensis	t	t	s	s	1	1	s	t	s	s	s	t
Poa trivialis	7	9	6	5	t	s	t	1	2	s	s	3
Lolium	6	6	3	4			t	s				
Trisetum	18	15	19	7	4	1	1	t	3	1	1	t
Lathyrus	t	1	7	9	15	1	12	2	1	1	8	5
Trifolium pratense	2	1	s	t	1			s	s		1	2
Trifolium repens					s		s	t	1		s	1
Achillea	2	2	3	2	3	s	4	t	3	1	1	t
Anthriscus			t	t	t	1			1	3	1	3
Centaurea		t	1	s	1	t			1	s		
Conopodium	4	5	4	s	t	s	1	t		1	s	s
Heracleum								t		s	1	18
Plantago	1	1	t	s	3	2	6	3	s	1	5	2
Ranunculus	6	s	1	1	s	s	s	5	1	1	s	3
Rumex	5	6	1	2	t	1	s	1	s	1	s	1
Taraxacum	s	t			1	7	1	1			3	5
Tragopogon	t	t	t	t	t		1		s	t	1	

*N as sodium nitrate

https://doi.org/10.23637/ERADOC-1-156

TABLE 31 Botanical Composition (%) of PLOT 14, N_2* P K Na Mg, UNLIMED

	Year																							
	1862	'67	'72	'77	1903	'14	'19	'20	'21	'22	'23	'24	'25	'35	'36	'37	'38	'39	'40	'41	'47	'48	'75	'76
Agrostis	s	1	s	1	t	1	s	t		s	t	s	s	t	t				t	t	s	1		
Alopecurus	s	3	4	20	29	23	53	48	35	58	42	44	36	62	47	45	45	53	49	59	28	32	37	38
Anthoxanthum	s	t	t	t	t	s	s	t					t								s	1	s	t
Arrhenatherum	3			s	17	41	23	37	48	25	33	39	40	26	33	39	37	31	31	29	37	36	37	46
Bromus	18	18	42	8	23	5	s	s	1	5	4			2	4			t		t		s	1	t
Dactylis	10	7	3	12	1	6	3	5	5	3	5	3	7	2	5	3	6	6	6	7	14	14	3	2
Festuca rubra	1	2	s	s	3	6	5	t	t	s	s	t	t	s	t		t	s	t	t				
Helictotrichon	1	1	s	s	2	4	4	s	2	1	1	s	s	t	t	t		1	t	t	s	1		
Holcus	7	7	4	13	t	t	t	t				t	t		1	t		s			1		s	t
Lolium	14	9	5	3																				
Poa pratensis	1	1	3	4	9	2	1	s	1	1	1	1	s	1	2	s	s	1	s	1	4	5	s	1
Poa trivialis	22	33	25	22	1	1	1	7	5	3	8	2	2	1	3	5	5	3	10	1	s	2	5	2
Trisetum	5	7	6	3	s	2	1	t	s	s		t		1			t					s		s
Lathyrus	t	s	1	1	3	4	2		t	s	t	s	s	1	1	s	1	2	1	s	3	2	1	2
Achillea	s	s	s	1	t	t	t				t	t												t
Anthriscus		1	4	5	9	1	2		t	1	2	6	10	5	3	4	2	1	1	1	5	s	8	2
Conopodium	2	2	1	s	t							t	t											
Plantago	s										t	t						t			1	2		
Ranunculus	1	t	t		s	t	t				t	t											1	t
Rumex	7	1	1	4	1	s	1	1	1	s	2	1	2	1	1	3	2	1	1	s	2	s	1	1
Taraxacum	s	s	s	1	1	2	1	1	2	2	3	2	2	s	s	s	s	t	1	1	3	3	4	3

*Nitrogen as sodium nitrate

https://doi.org/10.23637/ERADOC-1-156

TABLE 32 Botanical Composition (%) of PLOT 14, N_2* P K Na Mg, LIMED†

	Year																	
	1920	'21	'22	'23	'24	'25	'26	'35	'36	'37	'38	'39	'40	'41	'47	'48	'75	'76
Agrostis	s	1	1	1	s		s	t					t		s	t		
Alopecurus	53	33	42	24	29	19	14	22	20	19	16	24	18	23	10	12	13	10
Anthoxanthum		1		t	t	t	t								s		t	s
Arrhenatherum	30	41	25	35	40	54	58	38	51	45	57	48	52	44	44	45	40	54
Bromus	s	1	6	15		t		s	s	t		s	t	s			2	s
Dactylis	3	2	2	1	1	3	6	4	5	3	3	4	6	7	11	14	1	2
Festuca rubra	2	5	5	9	7	t	3	9	3	2	4	5	5	11	9	13	3	5
Helictotrichon	1	4	2	5	3	t	1	1	1	s	s	1	1	1	4	5	4	1
Poa pratensis	2	2	5	3	2	1	1	5	4	1	1	2	1	1	3	3	2	5
Poa trivialis	4	3	3	3	2	7	11	2	7	13	6	7	10	4	s	1	6	4
Trisetum	s	1	s	1	s	t	s	s	t	s	1		t	s	t	s	s	s
Lathyrus	1	3	1	1	6	t	1	12	2	s	2	6	1	4	13	3	8	7
Trifolium pratense																	1	s
Anthriscus	1	t	s	t	2	12	1	4	6	14	6	1	2	t	1	1	5	3
Heracleum																t	1	1
Ranunculus															t		4	1
Rumex	1	s	t	1	s	1	1	1	s	1	1	1	1	1	t	1	1	t
Taraxacum	2	1	6	2	6	3	2	s	t	s	1	s	1	2	3	1	8	4

A separate analysis was often made of the parts of the plot in the sun or in the shade. Where this was done figures for 'Sun' only are given here.

*Nitrogen as sodium nitrate

†Liming began in 1920

https://doi.org/10.23637/ERADOC-1-156

TABLE 33 Botanical Composition (%) of **PLOT 13**, farmyard manure and fish meal alternating at 2-year intervals, since 1905

	Year														
	UNLIMED								LIMED						
	1914	'19	'44	'45	'46	'47	'48	'74	1914	'19	'44	'45	'46	'47	'48
Agrostis	12	11	8	6	8	11	16	32	2	3			t		t
Alopecurus	18	22	57	46	32	28	32	16	18	35	6	7	9	14	10
Anthoxanthum	4	5	5	5	15	14	6	9	1	2	s	s	1	1	s
Arrhenatherum	22	17	1	2	1	2	3	7	40	20	6	7	11	14	26
Dactylis	8	9	7	6	7	10	9	2	6	10	9	8	27	24	21
Festuca rubra	15	5	4	3	6	4	4	3	11	5	1	2	1	1	1
Helictotrichon		t				t				t		s	s	1	s
Holcus	15	7	3	4	6	6	2	20	14	6	2	2	5	5	4
Poa pratensis	1	2	1	1	t	1	1		1	4	1	2	1	2	2
Poa trivialis	t	s	s	t	t	s	t	s		s	1	8	6	5	1
Lathyrus	s	t	s	s	s	1	s	s	1	1	31	27	4	6	8
Trifolium pratense					t	t	t	2			7	6	2	1	2
Trifolium repens											3	4	1		s
Achillea	s	s	1	s	3	4	4	1	t	s	s	s	s	s	s
Anthriscus		s	s						1	2	2		s	s	1
Centaurea			s		1	1	t	s	s	s	4	s	s	2	1
Cerastium	t	s	s	t	t	t	t		s	1	s	s	t	t	t
Conopodium	s	3	1	2	1	2	1	1	1	2		s	t		t
Heracleum	s	1	s	1					1						
Leontodon				s	s	s	2				1	1	1	1	1
Plantago			6	12	14	10	15	2	t	t	16	14	19	11	11
Ranunculus					t	1	t	1			1	2	1	2	2
Rumex	2	15	4	6	2	3	2		1	6	s	1	1	2	1
Stellaria	t	t	s	1	1	s	t			s			t		
Taraxacum			s	1	1	1	1	1	t	s	6	4	4	5	3
Tragopogon							s			t	s	2	1	s	1
Veronica			s	s	1	1	s		t	t	1	1	s	t	t

This plot received N_2 P K Na Mg between 1856 and 1904 (and Straw until 1897)

TABLE 34 Botanical Composition (%) of PLOT 19, FYM (once every four years, since 1905) UNLIMED

	Year												
	1914	'19	'20	'21	'22	'23	'24	'25	'26	'27	'28	'46	'48
Agrostis	8	7	18	22	13	14	13	11	9	5	6	8	12
Alopecurus	13	22	16	13	22	16	17	16	29	26	33	13	6
Anthoxanthum	1	4	5	10	4	11	4	9	8	9	12	9	7
Arrhenatherum	4	8	1	8	11	8	11	18	12	18	8	10	6
Bromus	2	s	t	1	2	1	t						
Dactylis	12	16	11	5	5	5	7	9	14	17	10	4	3
Festuca pratensis												2	1
Festuca rubra	21	6	12	12	18	13	8	8	4	6	8	5	10
Helictotrichon	2	3	3	4	2	2	1	2	2	3	3	s	1
Holcus	3	2	2	5	1	3	1	6	4	3	5	3	1
Poa pratensis	1	s	1	s	1	1	s	s	s	s	s	s	1
Poa trivialis	2	1	1	2	s	s	s	1	2	s	2	s	s
Trisetum	9	3	5	5	7	2	4	1	1	2	3	1	2
Lathyrus	9	6	12	5	7	7	9	4	2	1	2	9	13
Lotus	1	t			t				t	t		t	1
Trifolium repens	t	t	3	s	t	t	s	t	t	t	s	1	3
Achillea	2	1	2	t	s	t	s	t	t	s	t	6	10
Anthriscus	3	s		s	t	2	1	1	s	1	t		
Centaurea	2	s	t	2	s	s	2		s	s	s		
Conopodium	s	2	s	s	1	1	2	1	1	1	1	s	s
Heracleum										t		t	1
Plantago	s	s	s	s	1	1	s	t	1	s	s	16	12
Ranunculus	1	5	3	s	1	4	4	5	2	1	2	6	6
Rumex	2	8	1	2	2	4	2	4	7	2	3	2	1
Taraxacum	t	t		s	1	s	1	s	t	t	t	1	s

This plot received N_1 (as sodium nitrate) and PK between 1872 and 1904

TABLE 35 Botanical Composition (%) of PLOT 19, FYM (once every four years since 1905)

	Year																					
	LIGHT LIMING*											HEAVY LIMING*										
	1920	'21	'22	'23	'24	'25	'26	'27	'28	'46	'48	1920	'21	'22	'23	'24	'25	'26	'27	'28	'46	'48
Agrostis	15	18	16	15	18	9	9	5	5	3	4	15	14	10	10	8	3	2	2	2	t	s
Alopecurus	15	20	20	16	16	22	30	28	43	18	25	22	16	19	24	27	24	27	17	21	20	17
Anthoxanthum	4	8	2	9	7	5	8	9	8	3	1	2	3	1	1	1	1	1	s	1	t	
Arrhenatherum	4	s	2	2	1	3	6	6	3	6	5	5	14	5	7	8	15	21	22	16	14	14
Bromus	s	s		1					t	s	s	t	1	1	2	t		t	t	s	t	s
Dactylis	9	16	15	6	4	21	15	26	11	4	11	9	9	12	4	5	18	16	17	9	4	14
Festuca pratensis																					4	6
Festuca rubra	12	10	15	15	10	5	3	3	4	2	5	15	15	15	16	13	7	4	11	14	3	4
Helictotrichon	4	2	1	3	2	3	3	4	3	2	2	5	5	3	4	6	7	7	11	12	3	5
Holcus	2	6	2	2	2	2	2	2	3	2	2	2	1	s	s	1	2	1	1	1	s	
Poa pratensis	s	1	2	2	1	1	1	1	1	1	1	2	1	2	2	3	2	2	1	1	1	2
Poa trivialis	s	2	1	1	1	3	6	1	5	1	2	2	2	s	1	1	3	6	5	6	1	1
Trisetum	4	8	10	7	4	1	1	3	3	s	3	5	10	18	9	7	2	2	4	6	2	3
Lathyrus	18	2	6	9	18	3	1	1	1	10	7	8	3	7	15	20	1	1	1	1	13	7
Lotus												s	t	s	s	s	s	t	1	1	3	2
Trifolium pratense	s								t	1	t								t		t	s
Trifolium repens	s	s	t	1	2	t	s	1	s	3	1	1	1	t	1	1	t	t	1	2	1	1
Achillea	1	s	t	t	s	t	s	s	t	5	5	1	s	s	t	s	t	t	s	s	2	2
Anthriscus		s	t	t	s	1	s	s	t	s		t	s	t	s	s	2	1	1	s	t	
Centaurea	3	t	s		1	t	t	t		1	1	t	s	t	t	t	s	s	s	t	2	1
Cerastium	1	t	t	s	1	t	s	t	s	s	t	s	t	t	s	t	t	t	t	s	t	
Conopodium	s	1	1	1	2	1	1	1	1	s	s	s	1	2	1	2	1	1	1	s	s	
Heracleum									t	1	s	t	s	s	s	s	t	s	2	s	2	1
Plantago	s	s	s	s	t	t	t	s	t	14	10	s	t	s	2	s	1	s	1	s	16	10
Ranunculus	2	1	1	5	7	11	4	3	2	10	8	1	1	1	5	3	5	2	2	1	2	4
Rumex	1	2	2	2	1	7	6	4	5	4	2	1	s	s	s	s	2	3	1	1	s	s
Taraxacum	s	t	s	s	s	t	t	t	t	2	1	1	s	s	s	2	2	s	s	s	2	1
Tragopogon												s	s	t	t	t	t	t		t	1	3
Veronica	s	s	t	s	s	t	s	s	s	2	1											

This plot received N_1 (as sodium nitrate) and PK between 1872 and 1904

*Ground Lime applied every fourth year, starting 1920
Light = 0.64 t CaO ha^{-1} and Heavy = 3.53 t CaO ha^{-1}

https://doi.org/10.23637/ERADOC-1-156

TABLE 36 Botanical Composition (%) of PLOT 20, FYM every fourth year since 1905 with NPK in other years, UNLIMED

	Year													
	1914	'19	'20	'21	'22	'23	'24	'25	'26	'27	'28	'29	'46	'48
Agrostis	4	6	11	13	10	10	15	14	9	4	4	5	3	4
Alopecurus	11	30	27	19	23	29	16	17	27	30	46	34	34	39
Anthoxanthum	1	1	1	1	s	s	1	1	1	1	2	1	1	1
Arrhenatherum	4	5	6	10	7	5	6	9	18	25	11	9	10	15
Bromus	5	s	s	s	2	2	t	t			t	t	t	s
Dactylis	10	12	10	6	9	6	6	10	11	15	7	9	10	15
Festuca rubra	22	4	10	9	16	14	8	4	3	3	5	6	5	4
Helictotrichon	6	10	11	12	8	8	5	6	6	5	7	8	3	1
Holcus	10	7	3	10	3	2	2	4	6	7	4	2	3	1
Lolium	s	s	s	s	s	1	s	t	t	t	s	s	t	
Poa pratensis	s	1	2	1	3	2	1	10	2	1	1	1	s	1
Poa trivialis	2	1	2	1	s	1	s	s	2	s	1	1	1	1
Trisetum	6	3	5	7	9	6	5	1	1	3	3	4	1	4
Lathyrus	6	5	4	3	1	2	12	10	3	2	3	7	5	4
Trifolium pratense						s	1			t		s		
Trifolium repens	t	t	1	s	t	s	1	t	s	t	s	5	t	1
Achillea	2	1	3	1	2	s	1	2	1	s	s	1	2	s
Anthriscus	3	2	1	s	1	3	1	5	1	1	s	s	1	s
Centaurea	3	1	2	1	1	s	2	6	s	t	s	s		
Conopodium	t	1	t	1	2	1	1	1	1	1	1	1	s	
Plantago	t	t		s	s	t		s	s	t	t	s	3	1
Ranunculus	s	2	1	1	1	2	3	4	2	s	1	1	5	1
Rumex	s	3	1	1	1	2	1	2	3	2	1	1	5	1
Taraxacum	t	t		t	t	s	s	s	s	t	t	s	1	1
Tragopogon		t			t	t	s	t	t		t		4	3
Veronica	s	s	t	t	t	t	t	t	t	t	s	s	1	t

Received P and N and K (as potassium nitrate) between 1872 and 1904

https://doi.org/10.23637/ERADOC-1-156

TABLE 37 Botanical Composition (%) of PLOT 20, FYM every fourth year with NPK in other years

	Year																					
	LIGHT LIMING*											HEAVY LIMING*										
	1920	'21	'22	'23	'24	'25	'26	'27	'28	'46	'48	1920	'21	'22	'23	'24	'25	'26	'27	'28	'46	'48
Agrostis	15	10	11	13	9	3	5	3	4	1	2	6	5	5	5	4	3	4	2	1	t	t
Alopecurus	22	22	24	17	27	15	21	19	31	18	22	30	31	33	25	21	19	26	23	24	13	18
Anthoxanthum	2	6	1	6	1	2	4	3	6	3	2	1	2	s	1	s	s	1	1	1	1	s
Arrhenatherum	2	9	5	12	10	33	24	31	19	27	22	2	4	3	2	s	4	8	7	4	15	17
Bromus	s	1	2	2	t	t	t	t	s	s	t	s	1	3	3	t	t	t	t	s	s	s
Dactylis	8	9	11	4	5	13	14	18	7	8	14	9	9	9	3	5	9	13	14	6	4	14
Festuca rubra	10	9	13	15	6	1	3	3	6	4	3	10	7	13	21	10	4	5	5	9	9	5
Helictotrichon	10	8	5	5	5	3	7	8	9	4	3	14	19	7	12	10	16	16	24	29	9	7
Holcus	5	10	4	2	2	4	6	7	8	3	6	7	8	3	2	1	5	8	7	5	1	2
Poa pratensis	s	s	1	1	1	s	1	s	1	s	s	1	1	3	2	2	1	2	2	3	1	3
Poa trivialis	2	2	s	2	1	1	4	1	3	4	4	1	1	s	1	s	1	4	1	3	4	4
Trisetum	3	3	7	3	3	1	1	2	4	2	2	4	5	7	5	3	1	1	3	3	3	3
Lathyrus	15	5	8	10	17	2	1	s	2	5	2	5	4	4	5	30	4	3	3	5	7	9
Trifolium repens	s	t	t	1	t	t	t	t	1	1	3	t	t		t	t	t	t	t	s	3	3
Achillea	1	t	s	s	1	s	s	1	1	2	2	1	s	s	s	s	s	1	1	s	4	3
Anthriscus	t	t	s	1	1	6	1	s	s	3	t	1	1	2	3	2	8	1	1	s	1	s
Centaurea	1		t	t		t	t	1	t	2	1	3	s	s	1	s	2	1	1	s	3	s
Conopodium	s	s	1	1	1	1	s	1	1	1	t	s	1	2	1	2	1	s	1	s	t	
Plantago	t	s	s	t	t	1	s	s	s	7	6	t		t	s	t	s	s	s	s	6	4
Ranunculus	s	1	1	3	4	3	2	s	1	1	2	1	1	1	2	2	9	2	1	1	2	1
Rumex	1	1	1	1	1	5	3	s	2	2	1	1	1	1	s	1	2	1	s	s	2	s
Taraxacum	t	s	s	1	2	3	1	s	1	3	1	t	1	1	1	2	6	1	1	3	3	2
Tragopogon	1	s	s	s	1	1	1	t	t	s	1	s	s	s	1	1	3	1	1	s	3	4
Veronica	t	t	t	t	t	t	s	s	s	s	s	t	t	t	t	t	t	t	t	s	3	s

Received P and N and K (as potassium nitrate) between 1872 and 1904

*Ground lime applied every fourth year, starting 1920

Light = 0.64 t CaO ha^{-1} and Heavy = 3.11 t CaO ha^{-1}

https://doi.org/10.23637/ERADOC-1-156

TABLE 38 Effects of Lime applied between 1965 and 1968 on the Botanical Composition (% Contribution to Hay Weight) in June 1973 of Sub-plots *c* (pH being raised to 5) compared to that of Sub-plots *d* (permanently Unlimed, pH 4)

	1 (N_1)		18 (N_2KNaMg)		4^2 (N_2P)		9 (N_2PKNaMg)		10 (N_2PNaMg)		11^1 (N_3PKNaMg)		11^2 (N_3PKNaMgSi)		13 (FYM + fish meal)*	
	d	*c*	*d*	*c*	*d*	*c*	*d*	*c*	*d*	*c*	*d*	*c*	*d*	*c*	*d*	*c*
Agrostis	84.4	19.6	82.7	51.8	23.9	21.0	14.7	11.3	30.7	36.0		t	1.6	1.6	32.3	18.8
Alopecurus							0.1	0.8	t	0.1		9.1		7.4	16.1	15.3
Anthoxanthum	11.1	9.5	17.2	23.0	76.1	4.9	71.7	11.1	69.0	7.8	5.1	t	0.3	t	9.4	5.7
Arrhenatherum				1.6				2.7	t	0.1		30.0		27.5	7.0	27.8
Bromus				t				0.1								
Dactylis				0.5						1.4		6.3		5.7	2.2	2.7
Deschampsia										0.2						
Festuca rubra	2.9	48.7	0.1	14.1	t	55.9		3.6	0.1	24.1		2.0		4.1	3.2	0.7
Helictotrichon						0.2										
Holcus		1.3	t	0.8		2.7	13.5	44.3	0.1	21.2	94.9	36.7	98.1	30.9	20.3	13.8
Poa pratensis		2.5		1.5		12.2		16.1	0.1	7.4		11.7		13.4		0.1
Poa trivialis		0.1				2.9		0.6		0.2		3.4		7.8	0.3	1.3
Lolium															0.2	
Trisetum																t
Total	**98.4**	**81.7**	**100.0**	**93.3**	**100.0**	**99.8**	**100.0**	**90.6**	**99.9**	**98.5**	**100.0**	**99.3**	**100.0**	**98.4**	**91.1**	**86.1**
Lathyrus		0.5		t				3.5							0.2	5.4
Trifolium pratense		1.2		0.2				t							1.9	3.7
Total		**1.6**		**0.3**				**3.5**							**2.1**	**9.1**
Achillea		0.2		0.3						0.3					1.2	0.3
Anthriscus								0.6				0.3		0.8		0.3
Centaurea		1.5		0.4											0.2	0.1
Cerastium		2.4		0.9								t		0.2		t
Conopodium				0.1											0.9	0.9
Heracleum				0.7				2.7						0.3	1.1	0.1
Hypochaeris		0.9														
Leontodon		0.1		t												
Linum		0.2														
Luzula	1.0	1.1		t											0.1	t
Pimpinella		0.7														
Plantago		4.8		0.2		t									1.8	0.9
Potentilla	0.6	0.1														
Poterium		0.3														
Ranunculus		1.0								0.1					0.7	1.8
Rumex		2.7		2.5		t		0.6	t			t		0.2		
Taraxacum		0.7		0.9		0.2		2.1		1.0		0.4		0.1	0.7	0.2
Tragopogon				0.4												
Total	**1.6**	**16.7**		**6.5**		**0.2**		**5.9**	**t**	**1.4**		**0.7**		**1.6**	**6.7**	**4.7**

*Analysed in 1974, t = <0.05%

https://doi.org/10.23637/ERADOC-1-156

Table 39 Effects of Lime applied between 1965 and 1968 on the amounts (t ha^{-1}) of different species in June 1973 on Sub-plots *c* (pH being raised to 5) compared to that on Sub-plots *d* (permanently Unlimed, pH approximately 4)

	1 (N_1)		18 (N_2KNaMg)		4^2 (N_2P)		9 ($N_2PKNaMg$)		10 (N_2PNaMg)		11^1 ($N_3PKNaMg$)		11^2 ($N_3PKNaMgSi$)		13 (FYM + fish meal)*	
	d	*c*	*d*	*c*	*d*	*c*	*d*	*c*	*d*	*c*	*d*	*c*	*d*	*c*	*d*	*c*
Agrostis	0.51	0.41	0.94	1.68	0.62	0.80	0.66	0.83	0.96	1.67			0.11	0.14	1.18	0.80
Alopecurus							t	0.06	t	0.01		0.73		0.64	0.59	0.66
Anthoxanthum	0.06	0.20	0.20	0.75	1.96	0.19	3.21	0.82	2.15	0.36	0.24		0.02	t	0.34	0.24
Arrhenatherum				0.05				0.20	t	0.01		2.41		2.36	0.26	1.19
Bromus				t				0.01								
Dactylis				0.01						0.07		0.50		0.50	0.08	0.12
Deschampsia										0.01						
Festuca rubra	0.01	1.02	t	0.46	t	2.14		0.26	t	1.12		0.16		0.35	0.12	0.03
Helictotrichon						0.01										
Holcus		0.03	t	0.03		0.10	0.60	3.25	t	0.98	4.41	2.94	6.91	2.66	0.74	0.59
Lolium															0.01	
Poa pratensis		0.05		0.05		0.47		1.18	t	0.34		0.94		1.15		0.03
Poa trivialis		t				0.11		0.05		0.01		0.27		0.68	0.01	
Trisetum																t
Total	**0.58**	**1.71**	**1.14**	**3.03**	**2.58**	**3.82**	**4.47**	**6.66**	**3.11**	**4.58**	**4.65**	**7.95**	**7.04**	**8.48**	**3.34**	**3.66**
Lathyrus		0.01		t				0.26							0.01	0.23
Trifolium pratense		0.02		0.01											0.07	0.16
Total		**0.03**		**0.01**				**0.26**							**0.08**	**0.39**
Achillea		0.01		0.01						0.01					0.04	0.01
Anthriscus								0.05				0.02		0.07		0.01
Centaurea		0.03		0.01											0.01	t
Cerastium		0.05		0.03								t		0.02		t
Conopodium				t											0.03	0.04
Heracleum				0.02				0.20						0.03	0.04	t
Hypochaeris		0.02														
Leontodon		t		t												
Linum		t														
Luzula	t	0.02		t											t	t
Pimpinella		0.01														
Plantago		0.10		0.01		t									0.07	0.04
Potentilla	t	t														
Poterium		0.01														
Ranunculus		0.02								t					0.03	0.08
Rumex		0.06		0.08		t		0.04	t			t		0.02		
Taraxacum		0.02		0.03		0.01		0.15		0.05		0.03		0.01	0.03	t
Tragopogon				0.01												
Total	t	0.35		0.20		0.01		0.44	t	0.06		0.05		0.15	0.25	0.18
Total yield	0.59	2.09	1.14	3.25	2.58	3.83	4.48	7.36	3.11	4.64	4.65	8.00	7.04	8.63	3.67	4.23

*Based on 1974 analysis, t = < 0.005 t ha^{-1}

https://doi.org/10.23637/ERADOC-1-156

TABLE 40 Effects of Lime applied between 1965 and 1968 on the Botanical Composition (%) in June 1974 of Sub-plots *b* (pH being raised to 6) compared to that of Sub-plots *a* (Limed once every Four Years under the old Liming Scheme)

	4^2 (N_2P)		9 ($N_2PKNaMg$)		10 (N_2PNaMg)		11^1 ($N_3PKNaMg$)		11^2 ($N_3PKNaMgSi$)	
	a	*b*	*a*	*b*	*a*	*b*	*a*	*b*	*a*	*b*
Agrostis	6.9	6.9			2.2	3.4				0.2
Alopecurus	5.7	7.0	15.3	8.1	7.6	6.9	29.6	17.0	28.7	15.2
Anthoxanthum	7.0	9.6	0.2	1.5	16.3	17.9			0.2	
Arrhenatherum	0.5		53.4	50.7	19.6	22.3	38.3	63.9	50.3	60.8
Bromus			t							
Dactylis	t		1.9	4.3			2.3	2.0	1.3	4.8
Festuca rubra	53.1	40.9	0.1	1.5	38.9	36.6		0.1	0.1	
Helictotrichon	0.8	11.7	0.7	1.5		0.7				
Holcus	2.2	1.5	6.5	5.6	3.9	6.8	21.8	7.1	10.6	2.8
Poa pratensis	19.5	15.8	2.4	1.3	5.8	2.5	2.0	2.9	1.2	1.8
Poa trivialis			1.5	t			0.9	0.6	3.0	10.1
Trisetum				0.5						
Total	**95.8**	**93.3**	**82.1**	**75.0**	**94.3**	**97.1**	**94.9**	**93.6**	**95.4**	**95.8**
Lathyrus			11.0	15.6	0.2		0.1	t	0.2	t
Trifolium pratense				0.4						
Total			**11.0**	**16.0**	**0.2**		**0.1**	**t**	**0.2**	**t**
Achillea	0.3	0.5	t		0.2	0.2			0.6	2.0
Anthriscus			0.5	2.8		t	0.5	0.5		
Cerastium			t			t				
Conopodium				t		t				
Galium	0.3	0.5			0.1	0.2				
Heracleum			4.0	3.3			0.9	1.1	1.4	1.7
Hypochaeris	0.5									
Pimpinella	t	0.4								
Plantago	0.3	1.2			1.9	0.4				
Poterium	t									
Ranunculus	0.2				0.1	0.1				
Rumex	2.2	4.0	0.5	0.4	0.9	0.4	2.6	2.9	1.8	0.3
Taraxacum	0.3	0.1	1.9	2.4	2.3	1.5	1.0	1.9	0.6	0.2
Total	**4.2**	**6.7**	**6.9**	**9.0**	**5.5**	**2.9**	**5.0**	**6.4**	**4.4**	**4.2**

t = < 0.05%

https://doi.org/10.23637/ERADOC-1-156

TABLE 41 Effects of Lime applied between 1965 and 1968 on the amounts (t ha^{-1}) of different species in June 1974 on sub-plots *b* (pH being raised to 6) compared to that on sub-plots *a* (Limed once every Four Years under the old Liming Scheme)

	4^2 (N_2P)		9 ($N_2PKNaMg$)		10 (N_2PNaMg)		11^1 ($N_3PKNaMg$)		11^2 ($N_3PKNaMgSi$)	
	a	*b*	*a*	*b*	*a*	*b*	*a*	*b*	*a*	*b*
Agrostis	0.19	0.19			0.08	0.12				0.01
Alopecurus	0.16	0.20	1.01	0.51	0.28	0.23	1.98	1.02	2.09	1.19
Anthoxanthum	0.19	0.28	0.01	0.10	0.60	0.61			0.01	
Arrhenatherum	0.01		3.52	3.21	0.73	0.76	2.56	3.85	3.67	4.75
Bromus			t							
Dactylis	t		0.12	0.27			0.16	0.12	0.09	0.37
Festuca rubra	1.48	1.17	0.01	0.09	1.45	1.24		t	0.01	
Helictotrichon	0.02	0.33	0.05	0.10		0.02				
Holcus	0.06	0.04	0.43	0.36	0.14	0.23	1.46	0.43	0.77	0.22
Poa pratensis	0.54	0.45	0.16	0.08	0.22	0.09	0.14	0.17	0.09	0.14
Poa trivialis			0.10	t			0.06	0.04	0.22	0.79
Trisetum				0.03						
Total	**2.67**	**2.68**	**5.41**	**4.75**	**3.51**	**3.30**	**6.34**	**5.64**	**6.95**	**7.48**
Lathyrus			0.73	0.99	0.01		t	t	0.01	t
Trifolium pratense				0.02						
Total	-	-	**0.73**	**1.01**	**0.01**	-	t	t	**0.01**	t
Achillea	0.01	0.02	t		0.01	0.01				
Anthriscus			0.03	0.18		t	0.03	0.03	0.04	0.16
Cerastium			t			t				
Conopodium				t		t				
Galium	0.01	0.01			t	0.01				
Heracleum			0.26	0.21			0.06	0.07	0.10	0.14
Hypochaeris	0.01									
Pimpinella	t	0.01								
Plantago	0.01	0.03			0.07	0.01				
Poterium	t									
Ranunculus	0.01				t	t				
Rumex	0.06	0.12	0.03	0.03	0.03	0.01	0.18	0.18	0.13	0.02
Taraxacum	0.01	t	0.13	0.15	0.09	0.05	0.06	0.12	0.04	0.01
Total	**0.12**	**0.19**	**0.45**	**0.57**	**0.21**	**0.10**	**0.33**	**0.39**	**0.32**	**0.33**
Total yield	2.79	2.87	6.59	6.33	3.72	3.40	6.68	6.03	7.29	7.81

t = < 0.005 t/ha

https://doi.org/10.23637/ERADOC-1-156

TABLE 42 Botanical Composition (%) of Unlimed (U) and Limed (L) halves of Plots 3, 7, 8, 14, 16 and 17 in June 1975

	3 (Unmanured)		7 (PKNaMg)		8 (PNaMg)		17 (N_1*)		16 (N_1*PKNaMg)		14 (N_2*PKNaMg)	
	U	L	U	L	U	L	U	L	U	L	U	L
Agrostis	15.5	2.3	29.0	0.4	4.6	4.0	6.1	1.9	1.0			
Alopecurus	2.5	1.0	7.3	5.2	2.8	1.0	24.4	7.9	28.8	4.3	36.8	13.4
Anthoxanthum	7.2	6.5	11.3	1.1	9.6	13.1	14.2	5.3	6.1	1.1	0.3	t
Arrhenatherum	0.2	0.2	0.4	30.8	2.0	6.1	0.3	0.8	37.6	42.4	37.0	39.8
Briza	1.0	2.0			0.1	1.6	0.2	3.9				
Bromus			t	0.9						0.1	1.3	2.4
Cynosurus		0.1						t				
Dactylis	2.2	2.2	5.0	3.0	1.9	1.5	5.0	11.0	7.8	3.1	2.7	1.4
Festuca rubra	33.2	13.6	14.7	0.3	15.6	11.7	7.8	13.4	1.0	3.4		2.7
Festuca pratensis				0.5	0.3	3.6	0.3			0.2		2.0
Helictotrichon	0.3	8.5	0.1	0.3	0.3	12.0	0.4	16.7	0.6	1.5		4.2
Holcus	1.5	4.3	6.5	2.5	16.7	5.6	2.7	3.8	3.0	0.4	0.4	
Poa pratensis	0.2	0.9	1.3	0.6	0.2	0.9		t	0.1	t	0.4	
Poa trivialis		0.4	0.2	1.1	0.4	1.2	0.2	0.1	0.8	3.1	4.6	5.6
Lolium				0.1	1.0		2.0	7.4	0.2			0.2
Trisetum	0.1	1.0		0.8	0.1	1.4	t	0.2	t	t		0.2
Total	**64.0**	**43.0**	**75.9**	**47.8**	**55.6**	**63.8**	**63.5**	**72.4**	**87.1**	**59.7**	**83.5**	**71.8**
Lathyrus	0.5	1.7	5.4	14.0	0.3	0.1	0.1		1.8	4.9	1.5	8.4
Lotus	2.5	3.0	0.1		1.1	2.0		1.0				
Trifolium pratense	3.3	7.2	3.9	7.7	7.2	7.6	0.1	2.0	0.2	2.1		0.9
Trifolium repens	0.2	0.3	1.2	0.5	0.8	0.4		0.1	t	0.6		
Total	**6.6**	**12.2**	**10.6**	**22.2**	**9.4**	**10.1**	**0.1**	**3.1**	**2.0**	**7.6**	**1.5**	**9.3**
Achillea	1.3	1.3	0.7	t	0.9	1.6	0.4	1.1	0.1	0.1		
Anthriscus				0.6						3.1	8.3	4.7
Ajuga	0.1						0.1					
Carex		2.7				t	0.1					
Centaurea	1.5	1.2	2.5		2.3	1.7	1.5	1.2				
Cerastium		0.2		0.3	0.2	0.8	0.1	0.4				0.1
Conopodium	0.3	0.2	1.1	0.1	0.5	0.2	t	t	0.1	0.5		t
Galium	0.2					t						
Heracleum			0.3	7.2			0.1	0.7	0.1	18.1	0.1	1.5
Hypochaeris	0.1											
Knautia	0.4	0.3			1.0	0.4						
Leontodon	10.0	12.2			8.3	6.2	4.4	5.4				
Linum		t										
Luzula	1.4	2.2	1.2		2.9	2.2	0.3	0.7				
Pimpinella	0.3	0.4			t	0.3	t	0.9				
Plantago	6.1	10.3	6.7	3.3	16.2	9.5	23.9	12.4	2.9	1.6		t
Poterium	6.9	11.7						0.4				
Ranunculus	0.7	1.6	0.2	7.7	1.9	2.5	3.7	0.3	5.3	3.2	0.7	4.0
Rumex		0.1	0.2	1.9	0.1	0.3	0.9		1.0	1.4	1.5	0.8
Taraxacum	0.1	0.3	0.4	8.8	0.6	0.4	0.9	0.4	1.4	4.8	4.5	7.9
Tragopogon		0.1						0.3				
Veronica		t				t						
Total	**29.3**	**44.8**	**13.5**	**30.0**	**35.0**	**26.1**	**36.4**	**24.5**	**10.9**	**32.7**	**15.0**	**18.9**

* = N as sodium nitrate   t = < 0.05%

https://doi.org/10.23637/ERADOC-1-156

TABLE 43 The amounts ($t\ ha^{-1}$) of different species in the Unlimed (U) and Limed (L) halves of Plots 3, 7, 8, 14, 16 and 17 in June 1975

	3 (Unmanured)		7 (PKNaMg)		8 (PNaMg)		17 (N_1*)		16 (N_1*PKNaMg)		14 (N_2*PKNaMg)	
	U	L	U	L	U	L	U	L	U	L	U	L
Agrostis	0.13	0.04	0.94	0.02	0.13	0.09	0.13	0.04	0.04			
Alopecurus	0.02	0.02	0.24	0.25	0.08	0.02	0.52	0.19	1.26	0.20	1.77	0.58
Anthoxanthum	0.06	0.11	0.36	0.05	0.27	0.30	0.30	0.12	0.27	0.05	0.01	t
Arrhenatherum	t	t	0.01	1.51	0.06	0.14	0.01	0.02	1.64	1.95	1.77	1.74
Briza	0.01	0.03			t	0 04	t	0.09				
Bromus	0.01	0.03	t	0.04						t	0.06	0.11
Cynosurus		t						t				
Dactylis	0.02	0.03	0.16	0.15	0.05	0.04	0.10	0.26	0.34	0.14	0.13	0.06
Festuca rubra	0.27	0.21	0.48	0.02	0.44	0.27	0.17	0.31	0.04	0.16		0.12
Festuca pratensis				0.03	0.01	0.08	0.01			0.01		0.09
Helictotrichon	t	0.14	t	0.02	0.01	0.27	0.01	0.39	0.03	0.07		0.18
Holcus	0.01	0.07	0.21	0.12	0.47	0.13	0.06	0.09	0.13	0.02	0.02	
Lolium				0.01	0.03		0.04	0.17	0.01			0.01
Poa pratensis	t	0.01	0.04	0.03	0.01	0.02		t	t	t	0.02	
Poa trivialis		0.01	0.01	0.05	0.01	0.03	t	t	0.03	0.14	0.22	0.24
Trisetum	t	0.02		0.04	t	0.03	t	t	t	t		0.01
Total	**0.52**	**0.70**	**2.46**	**2.34**	**1.55**	**1.46**	**1.34**	**1.70**	**3.81**	**2.75**	**4.00**	**3.13**
Lathyrus	t	0.03	0.17	0.68	0.01	t	t		0.08	0.22	0.07	0.37
Lotus	0.02	0.05	t		0.03	0.05		0.02				
Trifolium pratense	0.03	0.12	0.13	0.38	0.20	0.17	t	0.05	0.01	0.10		0.04
Trifolium repens	t	t	0.04	0.02	0.02	0.01		t	t	0.03		
Total	**0.05**	**0.20**	**0.34**	**1.09**	**0.26**	**0.23**	**t**	**0.07**	**0.09**	**0.35**	**0.07**	**0.41**
Achillea	0.01	0.02	0.02	t	0.02	0.04	0.01	0.03	0.01	t		
Anthriscus				0.03						0.14	0.40	0.20
Ajuga	t						t					
Carex		0.04				t	t					
Centaurea	0.01	0.02	0.08		0.06	0.04	0.03	0.03				
Cerastium		t		0.02	0.01	0.02	t	0.01				0.01
Conopodium	t	t	0.04	0.01	0.02	t	t	t	t	0.02		t
Galium	t					t						
Heracleum			0.01	0.35			t	0.02	0.01	0.83	t	0.06
Hypochaeris	t											
Knautia	t	t				t						
Leontodon	0.08	0.20			0.23	0.14	0.09	0.13				
Linum		t										
Luzula	0.01	0.03	0.04		0.08	0.05	0.01	0.02				
Pimpinella	t	0.01			t	0.01	t	0.02				
Plantago	0.05	0.17	0.22	0.16	0.45	0.22	0.51	0.29	0.13	0.07		t
Poterium	0.06	0.20						0.01				
Ranunculus	t	0.02	0.01	0.38	0.05	0.06	0.08	0.01	0.23	0.15	0.03	0.17
Rumex		t	0.01	0.09	t	0.01	0.02		0.04	0.06	0.07	0.03
Taraxacum	t	t	0.01	0.43	0.02	0.01	0.02	0.01	0.06	0.22	0.21	0.34
Tragopogon		t			0.03	0.01		0.01				
Veronica		t										
Total	**0.24**	**0.73**	**0.44**	**1.47**	**0.98**	**0.60**	**0.77**	**0.58**	**0.48**	**1.50**	**0.72**	**0.82**
Total yield	0.81	1.63	3.24	4.90	2.79	2.28	2.12	2.35	4.38	4.60	4.80	4.36

* = N as sodium nitrate t = $< 0.005\ t\ ha^{-1}$

https://doi.org/10.23637/ERADOC-1-156

TABLE 44 Botanical Composition (%) of Unlimed (U) and Limed (L) Halves of Plots 3, 7 and 14 and of Sub-Plots *a*, *b* and *c* of Plot 9 in June 1976

	3 (Unmanured)		7 (PKNaMg)		14 (N_2*PKNaMg)		9 (N_2PKNaMg)		
	U	L	U	L[P]	U	L	a^+	b	c
Agrostis	23.3	1.6	31.1					t	3.5
Alopecurus	0.3	0.9	2.7	E	38.5	9.8	11.2	11.1	2.1
Anthoxanthum	2.0	2.5	4.7	J	0.1	0.5	0.2	2.6	2.3
Arrhenatherum	t	0.3	0.7	A	46.5	53.6	41.3	33.9	9.6
Briza	0.6	2.2			0.1				
Bromus				I		0.5		t	0.1
Cynosurus		t							
Dactylis	0.9	1.6	3.2	B	2.5	2.3	6.8	4.7	0.1
Festuca rubra	32.3	12.0	22.7			5.4	0.1	1.1	2.1
Helictotrichon	0.4	4.6	0.2	G		1.2	t	0.9	
Holcus	0.9	1.8	6.4	H	0.1	0.1	4.8	6.2	60.6
Lolium		0.7	0.2			0.2			
Poa pratensis	0.2	0.9	1.5	F	0.9	4.8	1.3	5.9	11.9
Poa trivialis	t	0.1	0.2	C	2.3	3.8	1.9	0.2	0.9
Trisetum	t	1.1	t	D	0.2	0.3	0.1		
Total	**61.1**	**30.6**	**73.6**	**40.0**	**91.3**	**82.5**	**67.8**	**66.7**	**93.2**
Lathyrus	0.4	1.3	6.9	A	2.0	7.4	17.9	21.1	3.9
Lotus	1.4	3.9	1.0						
Trifolium pratense	2.1	4.9	4.6	B		0.2		0.6	0.4
Trifolium repens	0.2	t	0.3	C		0.4			
Total	**4.1**	**10.1**	**12.7**	**47.1**	**2.0**	**8.0**	**17.9**	**21.8**	**4.3**
Achillea	0.8	1.2	1.2	H	0.1	t	t		t
Anthriscus					2.5	2.9	1.1	0.6	t
Carex	1.1	1.3							
Centaurea	1.3	1.4	0.7						
Cerastium	t	0.5	t	F			t	t	
Conopodium	0.4	0.1	2.2	G		0.1	t	0.3	t
Galium	0.1								
Heracleum			0.1	B	t	1.2	9.3	4.9	0.2
Hieracium	0.1	t							
Hypochaeris	1.6		0.3						
Knautia	0.2	0.9							
Leontodon	14.3	18.7	0.3						
Linum		t							
Luzula	1.1	0.8	0.6						
Pimpinella	0.8	0.9							
Plantago	6.7	14.6	6.8	D		0.1			
Poterium	5.6	16.7							
Ranunculus	0.5	1.2	0.1	C	0.1	1.1			
Rumex	t	0.1	0.2	E	0.6	0.1	0.8	1.5	0.2
Taraxacum	0.2	0.2	0.6	A	3.3	3.9	2.9	4.1	1.9
Tragopogon	0.1	0.5							
Veronica	t								
Total	**34.8**	**59.3**	**13.7**	**12.9**	**6.7**	**9.4**	**14.3**	**11.5**	**2.4**

* = N as sodium nitrate

P = Plot 7L was only partially analysed and species within the tree main groups were ranked for relative abundance, A being the most abundant in each group.

+ = Under the new liming scheme the pH of sub-plots *a* will be raised to 7, 9*a* received 14 t ground chalk ha^{-1} in January 1976.

t = < 0.05%

https://doi.org/10.23637/ERADOC-1-156

TABLE 45 The amounts ($t\ ha^{-1}$) of different species on the Unlimed (U) and Limed (L) halves of Plots 3, 7 and 14 and of Sub-plots *a*, *b* and *c* of Plot 9 in June 1976

	3 (Unmanured)		7 (PKNaMg)		14 (N_2*PKNaMg)		9 (N_2PKNaMg)		
	U	L	U	L[P]	U	L	*a*	*b*	*c*
Agrostis	0.23	0.02	0.76					t	0.16
Alopecurus	t	0.01	0.06		1.87	0.41	0.65	0.62	0.09
Anthoxanthum	0.02	0.03	0.11		t	0.02	0.01	0.14	0.10
Arrhenatherum	t	t	0.02		2.26	2.25	2.41	1.88	0.43
Briza	0.01	0.03							
Bromus					t	0.02		t	t
Cynosurus		t							
Dactylis	0.01	0.02	0.08		0.12	0.10	0.39	0.26	t
Festuca rubra	0.32	0.16	0.56			0.23	t	0.06	0.09
Helictotrichon	t	0.06	t			0.05	t	0.05	
Holcus	0.01	0.02	0.16		0.01	t	0.28	0.34	2.72
Lolium		0.01	t			0.01			
Poa pratensis	t	0.01	0.04		0.04	0.20	0.08	0.33	0.53
Poa trivialis	t	t	t		0.11	0.16	0.11	0.01	0.04
Trisetum	t	0.01	t		0.01	0.01	0.01		
Total	**0.61**	**0.42**	**1.80**	**2.03**	**4.44**	**3.47**	**3.95**	**3.71**	**4.18**
Lathyrus	t	0.02	0.17		0.10	0.31	1.04	1.17	0.18
Lotus	0.01	0.05	0.02						
Trifolium pratense	0.02	0.07	0.11			0.01		0.03	0.02
Trifolium repens	t	t	0.01			0.02			
Total	**0.04**	**0.14**	**0.31**	**2.39**	**0.10**	**0.34**	**1.04**	**1.21**	**0.20**
Achillea		0.02	0.03		t	t	t		t
Anthriscus					0.12	0.12	0.06	0.03	t
Carex	0.01	0.02							
Centaurea	0.01	0.02	0.02						
Cerastium	t	0.01	t				t	t	
Conopodium	t	t	0.05			t	t	0.02	t
Galium	t								
Heracleum			t		t	0.05	0.54	0.27	0.01
Hieracium	t	t							
Hypochaeris	0.02		0.01						
Knautia	t	0.01							
Leontodon	0.14	0.25	t						
Linum		t							
Luzula	0.01	0.01	0.01						
Pimpinella	0.01	0.01							
Plantago	0.07	0.20	0.17			t			
Poterium	0.06	0.23							
Ranunculus	t	0.02	t		0.01	0.05			
Rumex	t	t	t		0.03	t	0.05	0.08	0.01
Taraxacum	t	t	0.01		0.16	0.17	0.17	0.23	0.08
Tragopogon	t	0.01							
Veronica	t								
Total	**0.35**	**0.80**	**0.32**	**0.65**	**0.32**	**0.40**	**0.83**	**0.64**	**0.11**
Total yield	1.00	1.36	2.43	5.07	4.86	4.21	5.82	5.56	4.49

*N as sodium nitrate, [P] = partial analysis only, grasses, legumes and other species separated

61.