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LAND CAPABILITY STUDIES IN PARTS OF THE
VALLEYS OF THE BROWNEY AND DEERNESS
RIVERS IN COUNTY DURHAM

by

Rev. David M. Smith

July, 1972

Thesis submitted for M.Sc. Degree



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ABSTRACT

The survey seeks to show the present actual land capability of part of the Browney-Deerness region. It does this by a review of the land use through historical time, with a description and analysis of present land use, for agriculture, forestry, settlement, mining and industry. This investigation, into actual land use, is followed by a study of the capability attributes of climate, geomorphology and soil which are the major influences on the actual utilisation of the land. Climate is shown to have a major influence on cropping and land use practice, and geomorphology on soil formation. The soils are divided into the types, which were discovered in the field and analysed in the laboratory. The characteristics of each soil type are diagrammatically represented with a verbal description of each type. A final chapter on land capability seeks to analyse farm practice, according to soil series, in response to all the above attributes. It also shows the deleterious effects of mining and settlement on the farming pattern. The land is then classified according to the U.S.D.A. grades, and final conclusions are made.

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INTRODUCTION

Land evaluation is an attempt to assess the suitability of the natural resource attributes for human use. As such it is a comprehensive study, covering such aspects as climate, geology, geomorphology, pedology as well as social and economic aspects including present land use and historical development of the area.

In order to evaluate the capability of land for a variety of purposes, it is essential to avoid subjectivity. To reduce this, measurable characteristics, or parameters, of each attribute are assessed with reference to particular forms of potential land use. For instance, soil characteristics of importance for agriculture include the drainage status, the soil depth and stoniness amongst other parameters and these have to be satisfactory before agriculture can be deemed to be feasible in terms of the correct use of a natural resource.

Land evaluation is not something that is carried out once and for all, but has to be reconsidered as human resources and technology change. According to Coppock (1962), changes in cropping can be of more importance in land reclassification than more stable characteristics. In the Browney-Deerness valleys, past economic activity has been chiefly influenced by coal mining, other forms of land use being subordinate to it. Now the coal is nearly exhausted and other native land uses must be considered.

Mackney (1962) and Cruickshank and Armstrong (1971) state two main objectives in land capability classification; firstly, by defining the quality of land, to provide a sound



basis for land planning and secondly, to enable the land use planner to allocate land among its various possible uses for the maximum satisfaction of the whole community. Fundamental to any such classification is a soil survey, for the land capability classification is basically an interpretation of soil survey. The soil has to be considered in terms of its wider environmental characteristics and restrictions imposed by any of the other attributes. For instance, some soils may be perfectly suitable for arable agriculture but climate and altitude may restrict land use to permanent pasture.

In the chapter on Capability, the different soil series described Esh, Ushaw, Broom, Browney, Deerness, Witton, Gilbert and Opencast have been physically quantified and assessed for crop yields and land use percentages.

To back up physical classification by an economic assessment is a major difficulty, mainly because an economical classification is necessarily based on standard net output. This involves measuring cash values, average output per acre based on production costs, labour costs, water rates, equipment, depreciation costs, clearing and levelling of land costs. Farm economics vary with farm and field size, farm layout, the enterprises and preferences of the individual farmer, as much as variations in land quality.

Such economic information is not within the scope of this survey. The approach adopted is to assess the soil series and analyse crop yields in relation to their physical parameters. Despite all the above mentioned economic considerations, "the effect of soil differences cannot be ignored" (Edwards 1967). Hence the environmental approach is necessary

in making a reasoned appraisal of land capability.

The aim of this survey is comprehensive, in that it tries to assess the physical capability of the land for a variety of uses. While the great emphasis on investigation is on the agricultural implications of soil survey and land use, the final analysis must include a consideration of industrial location, housing, recreation and communications. In the present survey, the legacy of mining, both deep and opencast are significant factors in physical land capability and have even had a considerable effect on the character of the soil profile itself.

The soil survey was carried out by means of a "free survey" - no fixed sampling points were determined prior to going out into the field. Some 150 pits were described in the field in an area of approximately 12,000 acres and 20 of these pits were sampled for routine laboratory analysis. As a result of this survey, the soils were classified in series - though the names of these series are different from those occurring on a reconnaissance map of the county (Unpublished information Soil Survey of England and Wales, 1946). At each profile site a wide range of environmental information was also obtained e.g. slope, aspect, terrain type, crops, "natural" vegetation etc. 45 farms were visited and a detailed questionnaire (Appendix VI) was completed for each.

The area chosen is "within the range of personnel and facilities available" (Hilton 1962) and is an area of special interest to the writer. The boundaries are neither council nor parish, nor even natural physical boundaries such as a watershed. They are simply chosen to reflect as much variety as possible of physical relief, soil type, climate type and farm type to be included.

A.1 THE EVOLUTION OF LAND USE

The historical land use of the area is of undoubted longevity, yet, unfortunately, in a survey of this type, one can only peruse through a limited number of sources. It is in ascertaining the chronological land use of the district that we can understand much of its present usage.

The Victoria Histories (1905) record the presence of pre-historic man in the area. A polished stone axe of Neolithic origin was discovered at Quebec. This is one of seventeen such finds in the North of England and probably indicates a sparse population of hunters. A flanged axe of Bronze Age origin has also been discovered at Esh wood near Flass Hall (207 425).

A series of earthworks and entrenchments possibly of Roman origin are to be found on Rowley (176 426) and Rowley Gillot (182 424) Farms. These farms lie along the Watling Street, (Dere Street), which passes through the western parts of the study area in a direct line from Vinovium (Binchester) to Longovicus (Lanchester). Much of these earthworks have been destroyed by subsequent farming. McLauchlan (1851), states that fields were certainly ploughed out in Roman times, but there is no record of what crops were grown. Today, the road remains as a discontinuous line, occupied by minor roads, or often by farm tracks, as at Heugh Farm (190 429).

While these early records and finds are sketchy, even less is known of the region during the Dark Ages. However, from the twelfth century onwards, there is ample evidence of farming activity in the area. In the Account Rolls of the Bursar of Durham, (Surtees Society 1898-1), we are told that a certain Gilbert de la Ley, gave to the almoner of

of St. Cuthbert, 60 acres of arable land in Witton Field, close to Witton Leper colony. (This colony is now Witton Hall Farm (235 455)). Unfortunately, there is again no evidence of what particular crops were being grown though it is probable that the land was mainly arable, to feed the people living in the colony.

In 1183, a survey of the possessions of the See of Durham was made, by order of Hugh Pudsey, the Bishop of Durham. These possessions are summarised in the Boldon Buke (1852), which became the Domesday Book of the Palatinate. In this account, "Arco, the steward, holds the Manor of Langley for his services to Henry II. Simm, the chamberlain holds Cornsay and Hedley, which render two marcs and carts wine with twelve oxen, as well as providing five ropes at the Bishops great hunt. Ivestan (site unknown), renders two marcs, one cow in milk and ploughs one and a half acres and attends the great chase with two greyhounds and carts wine with eight oxen."

During the abbacy of Prior Bartram II (1244-1258), the Benedictines of Durham Abbey constructed at Beaurepaire (Bearpark - 243 438) a summer palace. According to Wharton (1691) it was built for the use of the lordly priors of Durham "the site lies on a dry elevated plot within a rapid sweep of the Browney, whose sides are shagged with copse wood. A long level pasturage extends to the South, the distant view includes a wide range of upland, hill and moor, with scattered farmholds."

In the year 1283, Anthony Beke, Bishop of Durham, is quoted in the Papal Rescripts (1874), as writing of the church at Elsch (Esh). The actual letter is dated 8 Kal April 1283, "The dean of Lanchester, through the Prebend of

Esh, shall retain the whole alterage as well as the church of Esh, that is to say sheaves, grain, blades called thrush tithes, lambes, milk, calves, pulleyes, ~~kocks~~ and hennes, piggs, hemp and haye." Dugdale (1659) states that, to the Esh prebend was also assigned the farm fees of all Essch, Cornshowe (Cornsay), Hamsteles, (Hamsteels) and the lands of Matthew the Forester. The derivation of the names Cornsay and Hamsteels are recorded by the Surtees Society (1841), namely: Cornsay - Coenhere - Cornshare - Cornshohe - a projection of land, hill or spur where corn is grown. Hamsteels is derived from Ham - homestead plus steal - a stall or standing for cattle.

In 1306, according to Raine, the country between Esh and Lanchester was open moorland, hence the settlement and variety of farming practice recorded in the Papal Rescripts must have been very localised. It is evident that there was much more woodland in the early Middle Ages than at present. Esh is mentioned several times as 'Ash' in the Esh Parish Register (1897), the Esh Missal (14th century) and in Prynne (1697).

According to Wigger (1906/h) "amongst the forest trees indigenous to the soil of the vicinity, ash was abundant in the majority of three to one."

In 1306, according to Rymer (1869), the Manor of Langley reverted to the See of Durham, the transfer of charter being confirmed by Edward II in 1310. The Manor House site is described thus, "The site is elevated on the green southern slope of a hill by Langley Burn, which falls through oakwood to the Brune. The view over the Brune (Browney) is wild and varied and includes knoll, dell, stream and woods."

In 1311, according to Fordyce (1857), Bishop Kellawe

granted a licence to Prior Tanfield to enlarge his park at Beaurepaire and to enclose it with a stone wall to fence in the deer.

In 1315, Greystones (1864) records that during the Scottish invasions of Durham, 60 horses, 180 head of cattle and the young of the three preceding years were taken from Beaurepaire. It is not known how extensive was the farmland belonging to the Priory, but in view of the numbers of livestock and deer kept, it was probably over 200 acres and was mainly used for pastoral purposes.

The references quoted are the only evidence of the evolution of the land use pattern in the early Middle Ages. The only other reference, an isolated one of 1474, recorded by the Bursar of Durham Abbey (1898.2), mentions the fact that "Beaurepaire possesses 115 oxen and cows, worth at valuation of 6s.8d. each, £38.6s.8d. There is no further record of Beaurepaire, it presumably declined in importance and from the time of the Dissolution, it most certainly fell into disrepair. With the decline of the Priory, presumably, the pasture lands deteriorated.

An unpublished letter of George Smyth (dated .. xxjth (sic) day of July in the thirtenthe yeare.... of King Charles 1637) is the next chronological link available; it does show that farming in the district must still have been as localised as it was in the early Middle Ages. The letter refers to the wastes of the district, which must have been considerable. More specifically, this letter is the first evidence of coal mining in the area. "Sir Timothy Whittingham, Knight, hath given, graunted and assigned his interests in the Collyerey of the waistes of Lanchester parishe.... as also of all the collyereys of Hamstalls and

soe through all the waistes from thence Eastward into Bearpark upon the river of Brune on the North and upon the Lo(ands) uppes of Eshe and Ulshawe of the Southe...."

Another insight into land use since the sixteenth century can be gleaned from the parish registers of Esh Village. They show that sheep farming was of some importance. The Wray family worked a water woollen mill at Low Side, near the present site of Langley Park, from the early seventeenth century. This was a thriving business which occupied twelve workers in spinning wool, the making of blankets, rugs and coarse cloths, all based on the wool of local sheep. The Jackson family farmed High Finings, now demolished, (208 444) between 1586 and 1864 and developed it as a mixed pastoral and arable farm. The Grainger family began their long residence at Heugh Farm in 1700 (190 429); from Joseph Grainger, much valuable evidence of local farm practice in the late eighteenth century is obtained. The scattered references in the Registers are the only information available during the period (1600-1750).

Evidence for land use in the late eighteenth and early nineteenth century is much more plentiful. Smith of Brooms, who was the land agent of the Smyth family of Esh Hall (197 437), kept a diary during the later part of the eighteenth and the early years of the nineteenth century. (The Smyths farmed at Esh from the early sixteenth until the mid-nineteenth century). Smith records many points of information:-

1771 - The Hamsteels Common Enclosure Act divided
1000 acres of the Esh Parish.

August 19, 1781. - A very great crop of hay this year...
beginning to mow the first week in July and not

ending until now... the Watling High field produced 16 tons and the low field 10 tons. (The fields referred to are part of the Rowley or Rowley Gillot Farms, but as to the exact fields and acreages there is doubt).

June 1788 - "mowing mid June.... hay and corn crops middling...."

Oct.7. 1788 - the wheat of the district was sown this week....

(as to acreages and localities there is again no reference)

Oct.22. 1833 - a scheme of husbandry proposed for nine fields, giving the acreage, value, state of present cultivation and state of proposed cultivation for the ensuing seven years.... (There is no reference to which part of the Esh estate he is referring).

TABLE A1/1. SCHEME OF HUSBANDRY 1833-1840

<u>No.</u>	<u>Acres</u>	<u>Total Value</u>	<u>State of Cultivation</u>	<u>1834</u>	<u>1835</u>
1	6	£11.0.0.	wheat	fallow	wheat
2	3½	£7.0.0.	meadow	fallow	wheat
3	3	£4.10.0.	old sward	fallow	wheat
4	3½	£4.7.0.	old sward	fallow	wheat
5	2½	£1.6.0.	second grass	third grass	fourth grass
6	4	£4.4.0.	first grass	oats	fallow
7	3	£3.0.0.	oats	fallow	wheat
8	4	£4.8.0.	wheat	clover	second grass
9	3	£5.5.0.	fallow	wheat	oats

<u>No.</u>	<u>1836</u>	<u>1837</u>	<u>1838</u>	<u>1839</u>	<u>1840</u>
1	clover	second grass	third grass	fourth grass	fifth grass
2	clover	second grass	third grass	fourth grass	fifth grass
3	clover	second grass	third grass	fourth grass	fifth grass
4	clover	second grass	oats	fallow	wheat
5	fifth grass	oats	fallow	wheat	clover
6	wheat	clover	second grass	third grass	fourth grass
7	clover	second grass	third grass	fourth grass	oats
8	oats	fallow	wheat	oats	fallow
9	fallow	wheat	clover	second grass	third grass

The striking feature of the rotation is the complete lack of roots and the prominence of grassland. In fields 2 and 3, cereals occur only once in eight years. In fields 1, 4, 5 and 6 cereals occur only twice. In fields 6, 7, 8 cereals occur at least three times. Almost all the fields have a ley of at least five years and barley does not occur in the system.

In an entry for 1834, for the parish of Lanchester, Estate of Esh, a farm agreement for 212 acres is included:...

"the tenant shall dress and scour hedges and keep all the buildings and walls in good repair. The tenant shall not carry off or sell any hay, straw, corn or turnips, and shall cause one half of the dung produced to be spread upon the meadows, the rest to be put upon the tillage land. The tenant shall not plant nor sow more than three acres with potatoes and turnips in one year, nor shall be plough up nor have in tillage any of the lands now in grass, or that shall be laid to grass, without the landlords leave in writing, under penalty of £5 per acre per annum. The tenant shall yearly fallow the parts specified and spread upon every acre at least two fathoms (?) of well burnt lime and shall on no account sow more than two crops of corn or grain between such liming and fallowing. The tenant shall have the use of the threshing machine. The landlord shall cut and lay drains and cast new hedges. The tenant shall this year and every present year well and sufficiently sow with clover and other grass seeds all the lands that have been in fallow each preceding year....."

Whether this farm is an exception to the rule, whether it is the only farm well documented, or whether such husbandry

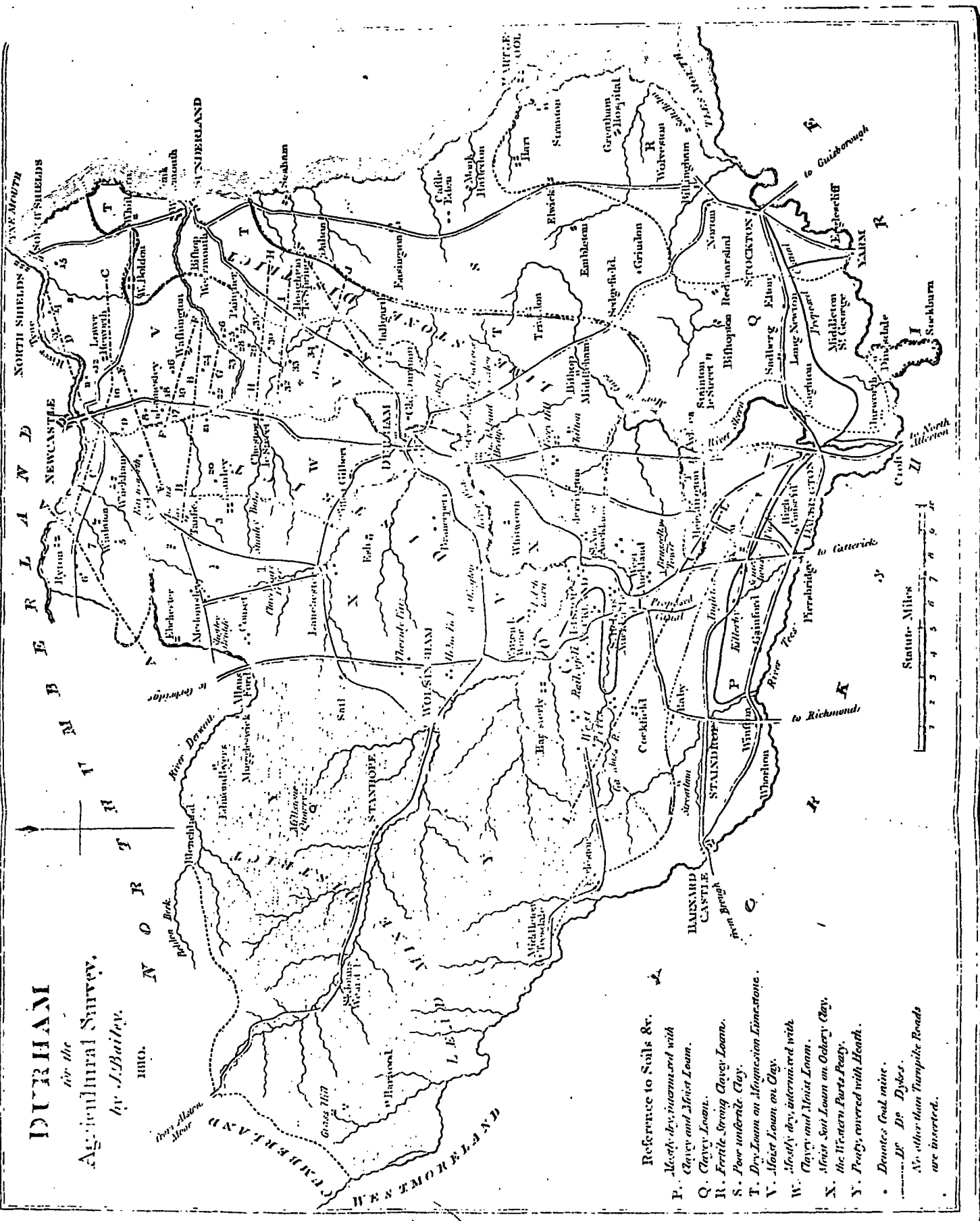
was common practice, it is difficult to say. What the document does reveal, is the strictness of the rotation pattern, the efforts to preserve fertility by strict sharing of dung, by strictly rotated liming, by an amazingly heavy fine for changing the rotation system and the fear of roots taking too much nutrition out of the soil. Grassland again appears to dominate the whole farming pattern.

Joseph Grainger, whose family commenced to farm at Heugh Farm in 1700, wrote his 'Agriculture of County Durham' in 1794. Writing of his own Heugh Farm and the area in general he stated that the chief grasses were rye and duffil grass, red, white and hop clover, rib and oat grasses. "... rib and oat grasses are falling into disrepute... because they are observed to be no favourite of the stock in the pasture and when made into hay, they shrivel so much that the grass slips through the rake and little of it reaches the stack, more especially when it is of slender growth from poor land.... another mischief from it is, that being productive of seed, it overruns the ground to the obstruction of better grasses. Oat grass too is losing favour, because it is only an annual and is found to impoverish the soil..... rye grass is much esteemed because of its earliest growth and because this continues late in the autumn.... it thrives in all soils and climates...."

"The present rotation of crops, usually found, is after summer fallow, wheat or oats, then a crop of broad clover.... in some spots of gravelly soil there are turnips and barley in perpetual succession, with now and then a crop of clover interposed. There are acres of meadowland, which sometimes produce two tons of hay per acre, but in general the produce is less than half a ton per acre. The modern price is about

Map 2

Bailey's Map of Durham 1810



DURHAM
for the
Agricultural Survey,
by J. Bailey.
1810.

- Reference to Soils &c.
- P. Moist, dry, intermixed with Clay and Moist Loam.
 - Q. Clayey Loam.
 - R. Fertile Strong Clayey Loam.
 - S. Poor underlie Clay.
 - T. Dry Loam on Magnesian Limestone.
 - V. Moist Loam on Clay.
 - W. Clayey dry, intermixed with Moist and Moist Loam.
 - X. Moist Soil Loam on Oatley Clay.
 - Y. Peaty, covered with Heath.
 - denotes Coal mine.
 - D^s Dykes.
 - other than Turnpike Roads are inserted.

London: Printed, Sold, by G. S. & P. Phillips, New-Burial Street.

£3 per ton.... Of wheat upon good land the yield may be estimated at between 20 and 30 bushels per acre upon the inferior land.... 10 to 20 bushels per acre the average price being 5/- per bushel.... The yields of barley vary from 30 to 40 bushels per acre.... the average price being 2/6d. per bushel of wheat straw, 12 thraves per acre.... average price 1/6d. per thrave.

The yields given are a useful guide, because they enable comparisons to be made with present yields, obtained by a heavy application of compound fertilisers. Perhaps, the rarity of barley in the district was caused by the low price obtainable in comparison to wheat.

Bailey (1810), writing on the state of farming in the county, records only 14 farms of over 400 acres, none in the area under survey. The area, then as now, was one of relatively small farms. Bailey further records that in 1762, 844 acres of Ushaw Common was enclosed by Act of Parliament, and the Bishop of Durham, being Lord of the Manor, received 6d. per acre in compensation. In 1801, 2400 acres of Witton Gilbert were enclosed, and by 1809, 800 acres at Cornsay remained open lands, because, as Bailey noted, they were still regions of poor heathland, although in many parts improvable.

Map 2 shows the land use and soil classification of Durham County in 1810. Bailey was one of the first agriculturalists to make a soil classification. His classification was based on the drainage status of the soil. For the region under study, he made only two divisions W and X.

In 1808, Ushaw College was built on part of the estate of the Smyths of Esh Hall. The College and surrounding parkland, taking some 24 acres out of agricultural usage. Ushaw

College Farm was built at the same time (214 447). Some 165 acres of land being used to feed the population of the new college. In 1813, according to Milburn (1964), on rising ground to the west of the College, a corn mill (215 448) was erected, its purpose being to make flour for the use of the students as well as feed meal for the livestock on the College farm.

"The mill was powerful and efficient in a steady West wind, which prevailed, but on New Year's Day, 1853, a violent wind swept the district and damaged the mill as well as the many stackyards. There being four times as many stackyards and cornstacks in the district as there are now." (Wiggen, 1906/2). The actual number of cornstacks was not revealed by Wiggen. It is clear in talking to those farmers whose families have farmed the same farm for 70 years or more (12 of the 45 farmers interviewed), that cornstacks today are as numerically great as they were at the beginning of the 20th century.

In 1835, when a new incumbent moved into the vicarage at Esh, much of the land around, which belonged to the living, was in poor condition, so the farmers of the district, in accord with local custom moved in to give a gratuitous ploughing day. "There being three times as many ploughs and ploughmen as there are now...." (Again it is difficult to estimate the number of ploughs. In 1971, there were 42 ploughs, in 1906, judging by oral tradition and verbal evidence of farmers there were certainly 50% more ploughs - but this figure again refers only to the twelve farmers whose families have worked the same farm throughout this century. It might not be too inaccurate to estimate that there were up to 200 ploughs and ploughmen in the area in the mid-nineteenth

century).

In 1801, according to the Census returns, the population of the parish of Esh was 276, living in a small village settlement with a few scattered homesteads. By 1881, the population was 6,305, three new mining villages having developed - Langley Park, Esh Winning and Ushaw Moor - as well as the mining hamlets of Waterhouses, Hamsteels, Esh, Bearpark and New Brancepeth. In 1911, the population had risen to 10,175. In these latter years of the 19th century there was an ever increasing competition for land, with the spread of urban settlement, mining settlement, colliery yards and spoil heaps impinging upon farmland. Some 3,000 acres, one quarter of all the farmland, was lost to non-agricultural purposes.

With this phenomenal industrialisation of the nineteenth century, agriculture dropped into a position of almost complete dependence upon mining. This relationship had two conflicting results which determined the progress of farming throughout the nineteenth century and explain the present utilisation of the land. The immediate reaction to the exploitation of the exposed coalfield was for capital to be invested in mining rather than in farming partly because mining gave higher returns, but also because of the danger of subsidence damage to land which made improvement a hazardous speculation. This caused the deterioration of agriculture in the coalfield. As mining spread, claims against subsidence and smoke damage became a serious burden to colliery owners and the practice of buying or leasing the land by colliery companies became widespread (hence the amount of land still owned by the N.C.B. in 1972). This completed the dependence of farming on the fortunes of coal mining.

As already indicated, the expanding mining industry saw

a rapid growth of population, including much immigration into the coalfield. To feed this population more land was converted to arable, 218,846 acres in 1871, or 36% of the total area of Durham County (Stamp 1941/1). This was a peak figure and has since declined steadily, so that in 1938, the land under arable cropping was 126,660 acres or 15% of the total area. (These percentages figures may be less for the Browney-Deerness region, though the trend is very similar). The supply of cereals and vegetable food crops were required for this increased population, in spite of the infertile soils overlying the Coal Measures.

Post 1870, the low price of grain made it unprofitable to cultivate much of the western area of Durham, which was already beginning to suffer widespread subsidence through mining. More recently, mechanised mining has limited demand for oats for pit ponies. Improved road transport has allowed potatoes to be brought in and has brought the local cultivation of roots into competition with the more fertile regions further afield. Thus, the initial advantage of a ready industrial market, which offset the disadvantage of relatively poor farmland, has been lost.

In the early twentieth century a good deal of land in the study area was laid back to grass, some to coniferous tree planting. Much of this return to grass was caused by increasing subsidence. As a result, "the grass lands tend to be neglected, but farmers are gradually being persuaded that periodic ploughing out and reseedling would result in heavier crops of hay and grazing for an increased number of stock. There is, however, a great predominance of smallholdings, a survival of the days of part-time mining and farming, where capital is severely limited. Even if the land were improved it is doubtful whether these small scale farmers could afford

to bring the number of stock up to the new carrying capacity of the land." (Stamp 1941/2).

The land use of the Browney-Deerness region during the 1930s is summarised by Stamp (1941/3). "The soils of the Lower Coal Measures are poor, the land has suffered considerably through subsidence whilst climatic conditions, though better than the Pennines, do not favour arable cultivation. Less than 15% is arable and even then rotation grass is the chief crop, followed by oats. More than half is under permanent grass, leaving a considerable residue in rough grazing and other utilisation, including much of the woodland of the county."

The Second World War meant a return to much more arable land, the growing of wheat and root crops especially; but this was only a temporary phase, because in the late 1940s the land resorted to pre-war usage. Much land had been ploughed out and was, therefore, reseeded. Stock was increased because of new government subsidies to farming. Many men who had been part-time farmers leased joint parcels of land from the new National Coal Board, and became full-time farmers, with much more viable holdings.

A.2 PRESENT LAND USE

Since the 1930s, there has been little change in land use and on the 17 farms that have kept records from before World War II only 335 acres have been converted from pasture to arable. There has been a tradition of stability in the area which may also explain this reluctance to change the land use, for only 15 farms have changed hands since 1935 and only 3 farms, out of 45 visited, have been farmed by the present occupier for less than 10 years.

Since World War II, the greatest decrease has occurred in oat production, which has declined from the 1947 figure of 1,000 acres to the 1971 figure of 381 acres. This has come about, because of the total disappearance from the farming scene of the working horse. Whereas, in 1950, all but two of the farms had working horses, by 1964, not one horse was left. Another crop to decline, with the working horse, is Coxfoot grass, a favourite horse pasture, but this grass is not so favoured in the sown grass system for cattle food.

Barley, in contrast, increased to become the major cereal crop, 900 acres were cultivated in 1951, while the 1971 acreage was 1,638. This crop has replaced the oats acreage since the new breeds of barley, with their greatly increased yields, provide an increased source of income. Fodder barley is dominant, for malting barley is grown on only one farm, and that under contract to the Newcastle breweries.

Figure A.2/1 shows that there are 14 farms of less than 100 acres, 16 of 100-200 acres, with a further five of 200-300 acres. 15 of the farms are owned by the occupier, while four more are part owned by the occupier, the remaining 26 being tenant farmers. The total amount of owner occupied

FARM SIZE IN THE BROWNEY AND DEERNESS REGION

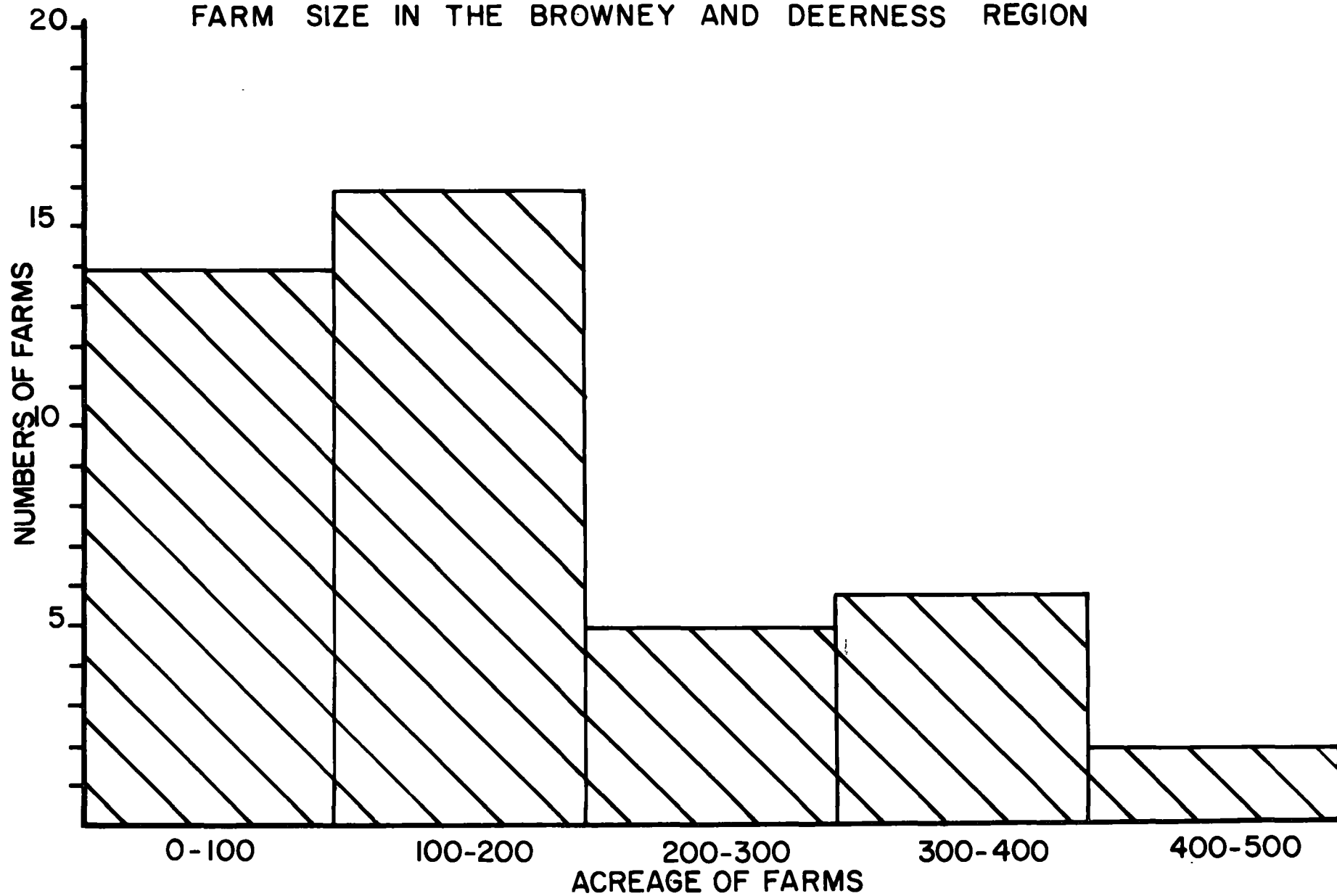


FIG. A2/1

land being 2,513 acres. The major land owners, who let their land, are the National Coal Board who own 3,217 acres (the historic reason for this has been already mentioned), the Earl of Durham, 2,134 acres and Ushaw College, 649 acres. The average size of the owner occupier farms is 166.8 acres, that of the tenanted farms 241.2 acres. The impression gained is that the buildings of the tenanted farms, with one or two exceptions, are always more adequate and better maintained than the private farmers. Most of the post-war building is on tenanted farmland.

There are 112 tractors in use on the 45 farms, while 20 farms also own combine harvesters, (14 of the harvesters are owned by tenant farmers). 17 farms have corn driers. On only three farms is there a serious lack of farm machinery; these are all farms of less than 50 acres.

The present labour force consists of 92 full-time male workers and 16 part-time workers of whom 7 are female. This contrasts with an agricultural working population in 1939 of 238 full-time and 36 part-time workers. Six farmers now have ~~part-time~~ jobs away from farming, because their farms cannot fully support them.

CHANGES IN FARMING PATTERN ACCORDING TO ALTITUDE

A farm at a greater elevation needs proportionately more land than a lowland or valley farm to be a successful economic unit. It is fact that of the farms situated at 500 feet or above, ~~ten~~ are over 170 acres. Only **five** farms above 500 feet are under 100 acres, and three of these cannot support full-time farming. The other, a ~~97~~ acre farm, is also distinctly marginal from the point of view of livelihood, though the farmer is full-time. Of the farms at 330 feet or below, only three are over 150 acres. However, three valley

farms are over 200 acres and these are the best farmed and most remunerative of all the area's farms.

There is also a distinct change in the character of farming which may be related to altitude, as illustrated in Figure A2/1a(i)-(iv). Permanent pasture increases in acreage with height. At heights of 650 feet 85% of the land is in permanent pasture. This is the only economic land use because of the harshness of the climate at higher elevations. Sown grass takes up an increasing proportion of the land between 300 feet and 500 feet, but above 600 feet the acreage of sown grass is replaced by the permanent pastures.

Wheat growing is absent above 550 feet, primarily because climatic conditions militate against its growth at these altitudes. Between 450 feet and 550 feet wheat occupies only a small fraction of the land acreage. Here the crop is distinctly marginal and yields are less than at lower elevations. The major areas of wheat growing are on the alluviums and the soils developed on fluvio glacial gravels. These soils are found at heights below 350 feet.

Barley, a hardier crop than wheat, is found at heights of 650 feet. However, beyond 500 feet, it forms less than 10% of the land acreage. The barley at this height is to be found primarily on the better drained soils, occupying nearly level ridge top sites. Again, the greatest area of barley cultivation is on the fluvio glacial deposits between 300 feet and 380 feet in altitude where approximately 20% of the area is used for barley growth. These soils are well suited to cereal growth, wheat and barley, being well drained, with gentle slopes and off the cold flood plain of the rivers.

Fig.A2/1A (i)-(ii)

PERMANENT PASTURE AND SOWN GRASS
PERCENTAGE ACCORDING TO HEIGHT

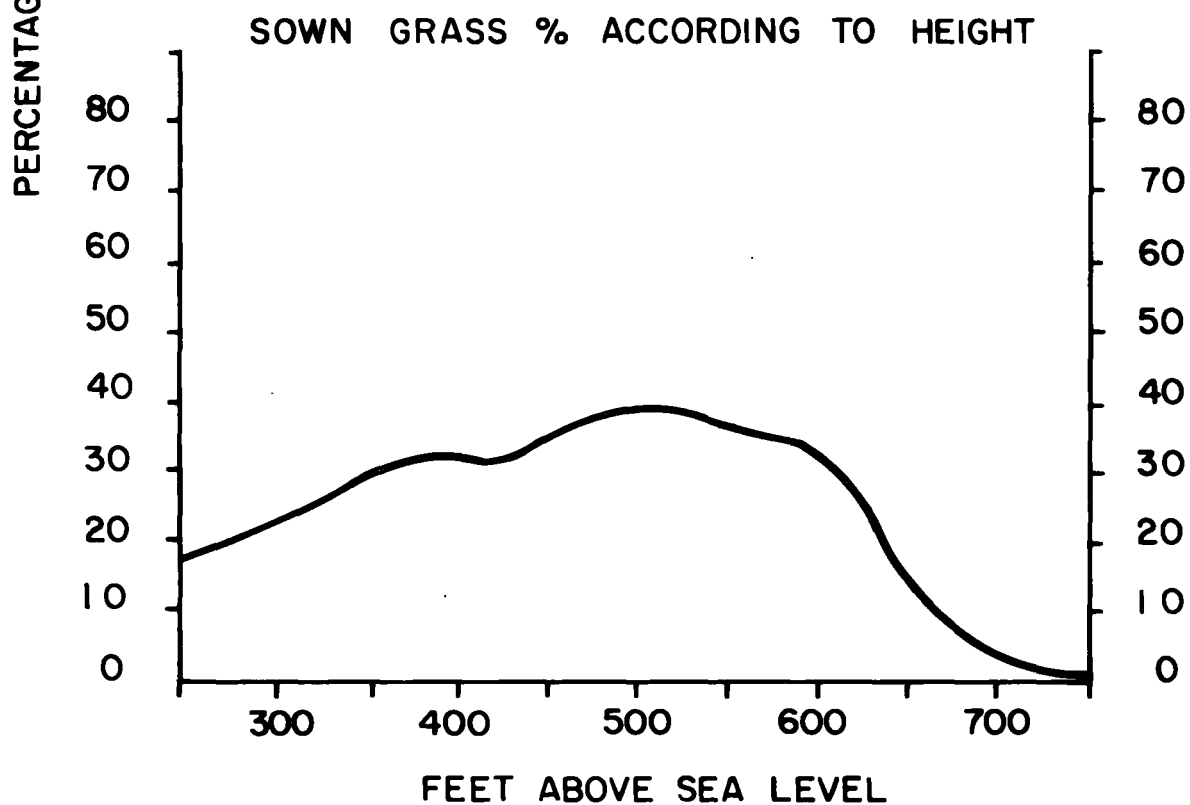
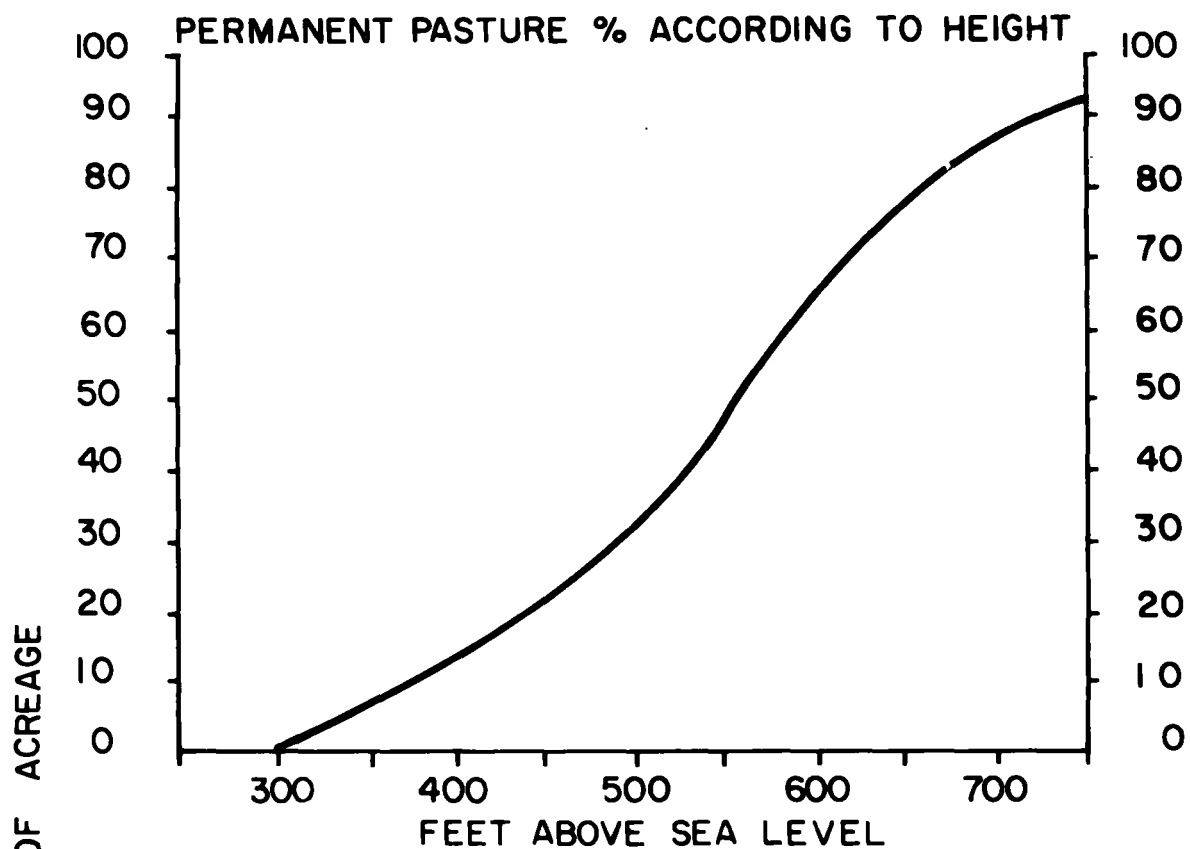
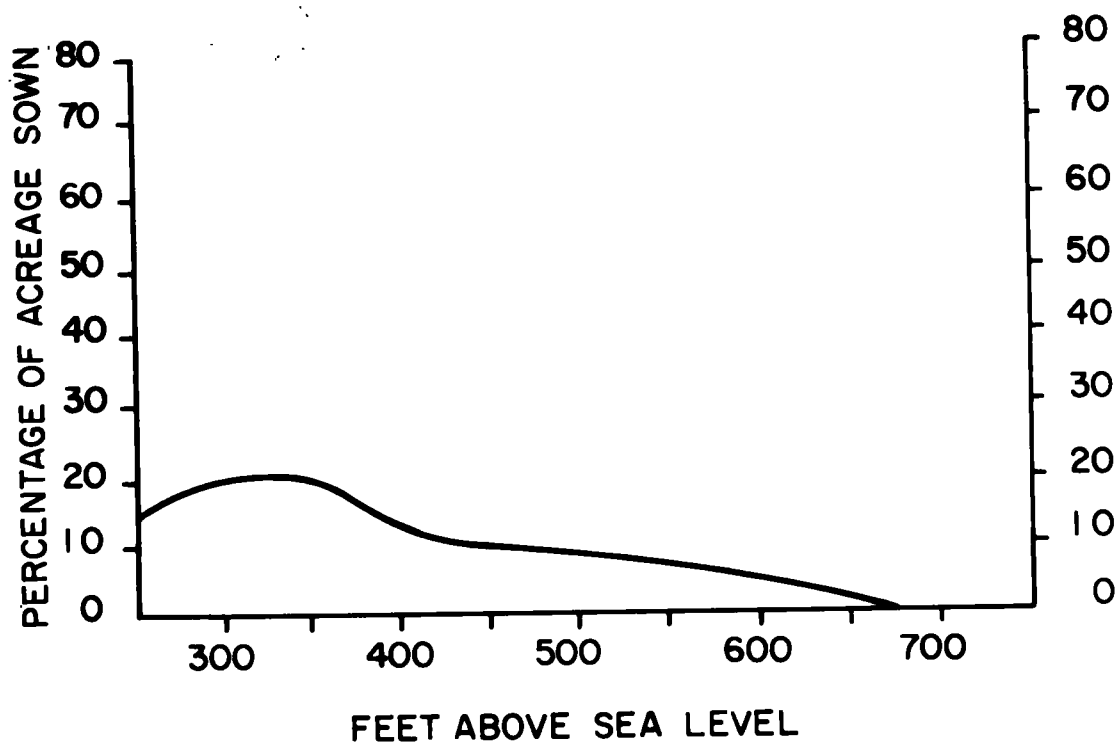
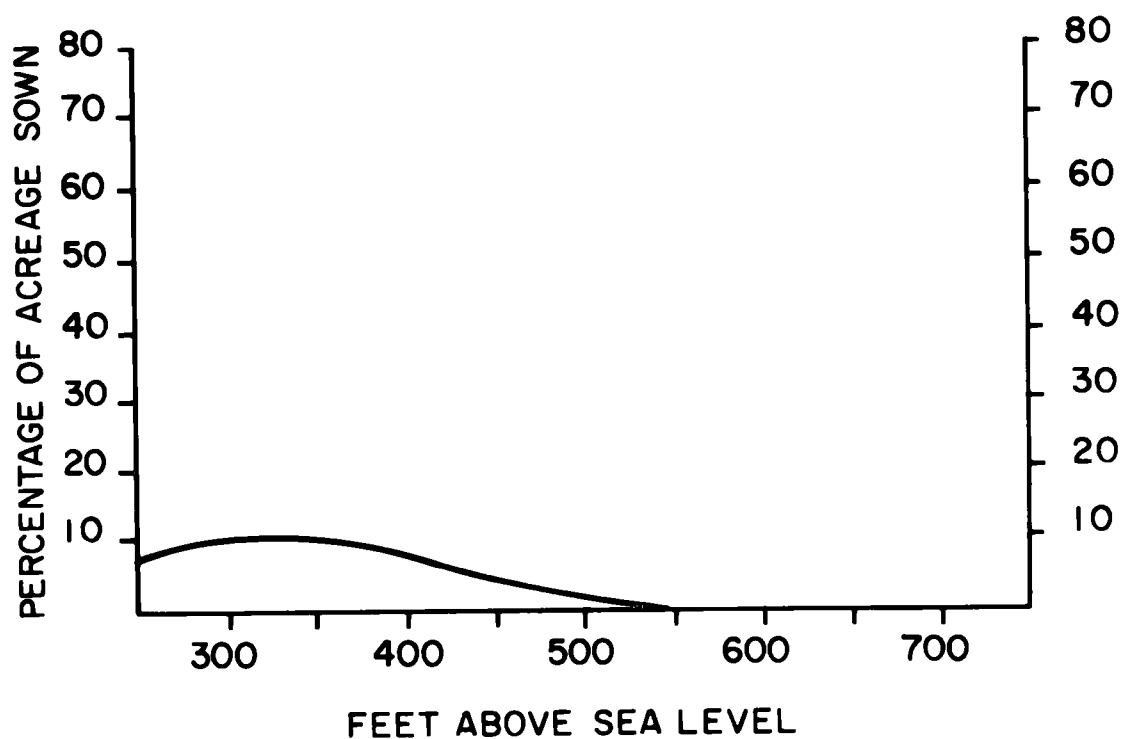


Fig.A2/1A (ii-(iv))

BARLEY ACREAGE ACCORDING TO HEIGHT



WHEAT ACREAGE ACCORDING TO HEIGHT



CROPPING PRACTICETABLE A2/2 AGRICULTURAL LAND USE -
JUNE, 1971

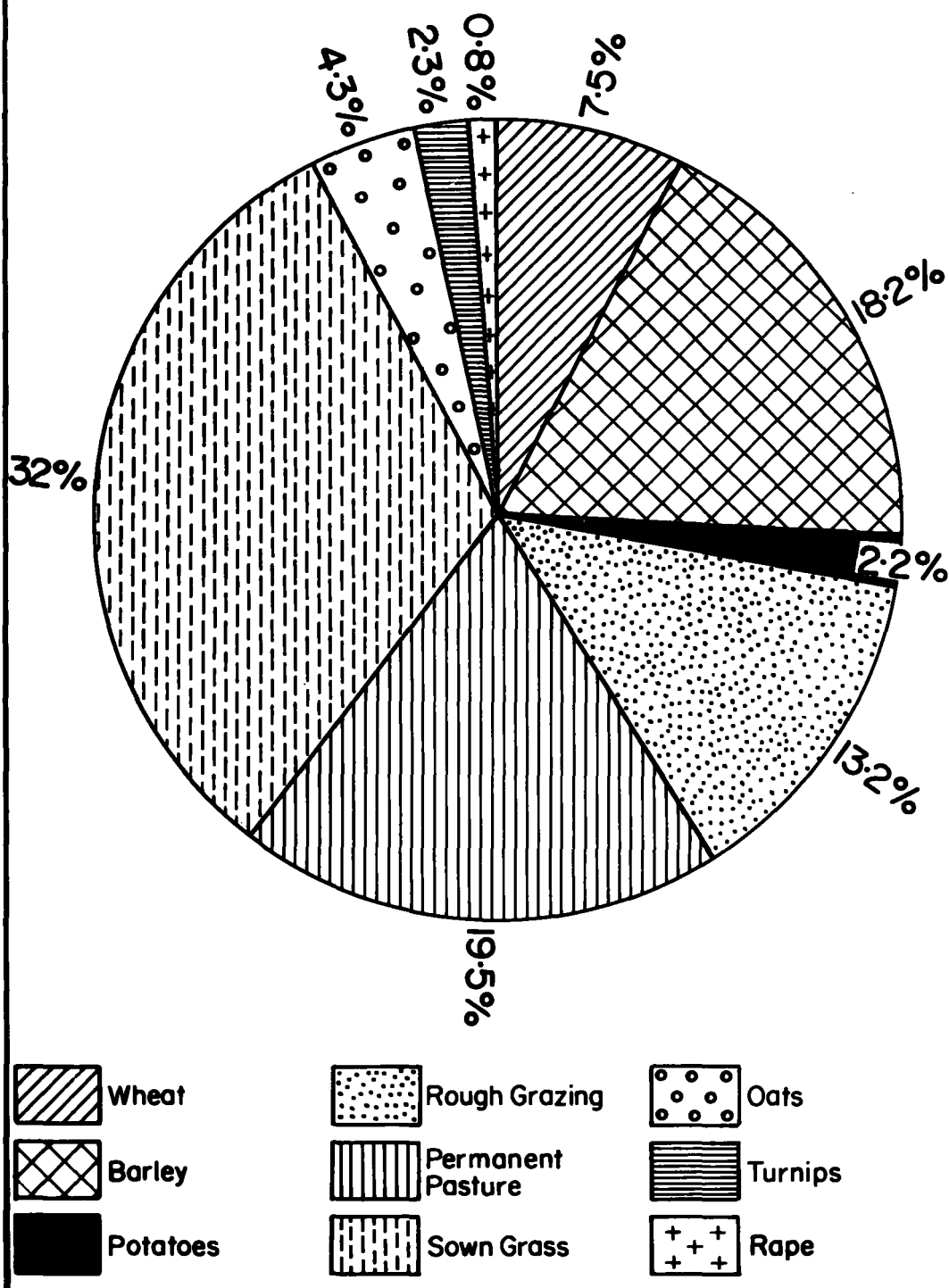
Sown grass -	2,804 acres
Permanent pasture - (that is, land not in the rotation system for at least 10 years)	1,729 acres
Barley -	1,638 acres
Wheat -	662 acres
Oats -	381 acres
Turnip -	202 acres
Potatoes	180 acres
Rape -	46 acres
Unploughed - (this includes approximately 50 acres of farm buildings)	1,151 acres
Total	<u>8,783 acres</u>

Figure A2/2 shows the percentage productive agricultural land use at June, 1971. Map 3, Land Utilisation (1971) is contained in the wallet.

Wheat is distinctly marginal in this area, but even so, 7.5% of the farm land is laid down yearly to this crop. It is always confined to the lower slopes or to the valley bottom. The acreage is, however, declining from year to year. In 1950, over 800 acres of wheat were grown. Today 19 farms still grow wheat, but varieties are reduced to three: Capelle, Jos Cambia and Manus Ranger, the first two are sound general purpose wheats, which will perform well even in marginal conditions and will respond to many different types of soil conditions. The yields were not unfavourable, in comparison with the North East of England, averaging around 30 cwts. per

Fig. A2/2

PERCENTAGE PRODUCTIVE AGRICULTURAL
LAND USE IN THE
BROWNEY-DEERNESS REGION JUNE 1971



acre. Manus Ranger, a new strain of hardier, more prolific yielding wheat is found on one farm. Yields of two tons per acre are claimed but this will have to be proved over a number of farms over several years.

Varieties of barley are more numerous than wheat varieties, Vards, Julian, Midas, Rika, Sultan, Proctor and Zephyr are frequently encountered. Farmers are, in general, hazy as to why certain varieties are used in preference to others. Very often, tradition keeps farmers to a known and trusted variety. Often, a new strain will be recommended by a merchant, or by a neighbouring farmer, who has met with greater success with the new breed.

Generally, yields do not vary greatly from variety to variety - the average yield on the 37 farms, where barley is grown is approximately 28 cwts. per acre. Varda is the most common variety, being used on 11 of the farms. Proctor, with its small grain and high malting quality, is an ideal crop for beer making, but is only grown on two farms, one for fodder and the other for malting. On the latter, the farmer has grown it for 14 successive years, because of his contract with the brewers, but the yield is declining, despite heavy applications of fertiliser.

Acreages of barley appear to vary proportionately with the size of the farm, except in the case of the largest farm, Broom House, 937 acres, where only 20 acres, or 2.2% of the farm area, is given over to barley growth. Generally, farms under 200 acres have 40% of their area in barley; farms 200 to 400 acres, approximately 20%; and farms of 400 acres or above, approximately 10%.

Three varieties of oats are used throughout the district: Blenda, Asta and Condor. Only 15 farms still produce oats in

the normal rotation. Blenda is most commonly grown, on over half of the oat growing farms, for it yields an early harvest, which is normally heavy; upwards of 30 cwts. per acre. It will also tolerate a very wide range of soil, physical and climatic conditions. Yields of oats vary from approximately 28 cwts.-35 cwts. per acre, depending on the amount of fertiliser used. Acreage of oats are in decline, and are kept by these farmers as a subsidiary; basically as an alternative to barley. In two-thirds of the oat growing farms acreages are less than 30. On only one farm is there over 10% of the area under oats; this is the occupancy of an elderly farmer, who still strongly believes in oats as a better all round fodder than barley.

The pie graph, Figure A2/2 shows the dominance of sown grass in the farming economy, almost one-third of the whole farming available area. In fact, 42 of the farms have sown grass as an integral part of the farm holding. The three farms that have no sown grass simply graze their stock on permanent grassland. They are the three farms, mentioned earlier, with insufficient basic machinery and an acreage too small to allow normal rotational practice.

Grass cropping practice varies quite substantially from farm to farm and from year to year. Ideally, two crops can be lifted, quite frequently, one of them for silage. The first harvest yields approximately 50 cwts., the second harvest 30 cwts. to 40 cwts. The first harvest being lifted around the period 25th June to 3rd July, and the second in late August or early September. The attainment of the ideal depends upon several factors; the amount of fertiliser used for a quick early bite, the available labour on the farm (often farmers can lift two crops but they have not the time

or the extra labour to do so), the necessary degree of mechanisation to handle two crops and a sufficient amount of storage facilities. The greatest doubt, however, concerns the weather, which may often prevent the first crop being quickly lifted, or may severely damage the second crop. 1971 was an average, unexceptional summer, but only three of the farmers managed to lift two crops. Twelve farmers have never taken a second crop since 1961, though all admitted that had factors worked for them, they could have lifted two. In 1971, one very efficient farmer, with plenty of labour, storage and machinery, took $4\frac{1}{2}$ tons per acre from his farm and was still able to graze sheep during the month of September on the cut fields.

The grass mixtures varied greatly, but amongst the more common types are rye, clover, timothy, with occasionally coxfoot. A favourite mix is the Cockle Park Mixture of 15 different grasses. This is considered advantageous to the stock in that it gives a wide variety of feedstuff, and a diversity, if one particular strain should fail. On Finings Farm, 205 448, immediately after opencasting in 1970, seed was laid down, with the intention of redraining and ploughing out in 1973.

The seed laid down in 1970 was as follows: (figures per acre).

S 22 rye grass	-	4 lbs. per acre.
S 24 rye grass	-	14 lbs. per acre.
S321 Coxfoot	-	4 lbs. per acre.
S123 Timothy English	-	1 lb. per acre
English Broad Red Clover	-	1 lb. per acre
Alsike Clover	-	1 lb. per acre.
New Zealand Wild White Clover	-	1 lb. per acre.
Total	-	26 lbs. per acre.

The first harvest was in 1971, the yields were above normal, as yet it is not clear whether this is a result of a good summer or the nature of the opencast replacement soil. The yield per acre was 40-45 cwts. and two crops were taken.

In 1973, the second batch of seed will be laid as follows (lbs. per acre).

S 22 rye grass	2 lbs. per acre
S 24 rye grass	4 lbs. per acre
S321 rye grass	4 lbs. per acre
S 23 perennial rye grass	5 lbs. per acre
S 48 Timothy English	4 lbs. per acre
S 26 Coxfoot	8 lbs. per acre
S123 Coxfoot	1½ lbs. per acre
New Zealand wild white Clover	1 lb. per acre
S184 Wild White Clover	½ lb. per acre

Total - 30 lbs. per acre of permanent seed mixture.

On Sleights Farm, 244 453, there has been a total transference from cereals to grass, because of lack of profitability from the former. Sown grass is to be the main form of livelihood and the aim is to keep 100 beef cattle on the 68 acres of grass. Here, lime is being applied at the rate of 30 cwts. per acre every three years; basic slag at the rate of 10 cwts. per acre per year, and compound fertiliser (20% Nitrogen, 10% Phosphate and 10% Potash) at a rate of 3 cwts. per acre. To date after two years of cropping, yields have averaged approximately 50 cwts. per acre, which is an increase of over 10 cwts. per acre on previous yields.

The lowest percentage of sown grass is found on Langley Farm, 199 458, where only 8 acres of a 430 acre farm is in sown grass. The present tenant is relatively new: there were over 300 acres in permanent pasture when he tenanted the farm

due to a combination of flooded riverside fields and the adverse effects of opencasting. On 16 of the farms, over 40% of the land is under grass. There is no pattern of percentage decrease of sown grass with farm size as is the case with barley.

Permanent pasture, or land which has not been ploughed for at least 10 years is to be found on all but two farms. The two remaining farms have recently been opencasted and ploughed out since 1968. The reasons for one-fifth of the farmland still being in permanent pasture are varied. Many farmers, literally do not like to disturb the "balance of nature" by ploughing up land which has served them well at a minimum of inconvenience over many years. Several farmers lacked the labour force, or time, or machinery, to plough, sow and harvest cereal land. Physical features, such as shallow depth of soil, or strong clay, ridge top position, amount and size of stones close to the surface, riverside land which is too heavy or too wet to plough out are also contributory factors. Man has also caused some areas to become permanent pasture, often of poor quality, through the effect of deep mining subsidence, damage to drains, pitfalls and the effects of opencasting, especially war time workings, when the soil was badly replaced and much compacting took place.

Only 15 of the farms still grow potatoes. On these farms Pentland Crown, Majestic, Morris, Piper and Dell are grown. The first named is the most popular type, being a general purpose potato providing moderate yields. The greatest acreage on any farm is 30 acres, but only four farms grow over 10 acres; the greatest area of land on any one farm under potatoes is 10%.

Turnips are more popular than potatoes being grown on 14

of the farms, but the acreage is decreasing. The two chief types are 'best of all' and Red Swede. The vast percentage, over 90%, is kept for fodder purposes, especially on those farms without silage making facilities. The greatest acreage is 21, and this on a farm of 502 acres. Only three farms grow more than 10 acres, the greatest percentage being 4%.

ROTATION PRACTICES

The main pattern of rotation which emerges from the survey is basically a six year one with variations on a theme. 13 of the farms keep to a system of three years ley, two years cereals (oats, barley or wheat), followed by one year in roots. This rotation is losing popularity; in 1961, 15 as opposed to 9 in 1971 used this particular rotation. Other variations of this system include two years ley, two years cereals, one year roots, one year cereal; or three years ley, one year cereals, one year roots, one year cereals. Two farms use a seven year system which involves two years ley, one year in wheat, one year in roots, two years in barley and one year in oats. Should economic conditions change some of the farmers are quite likely to alter the rotation system.

There are several major problems in keeping to a fixed rotation system in the region, qualifications which help to explain why a large proportion of farms at choice or through force of circumstances are not on a rotation system:-

(i) Opencasting has severely curtailed rotation.

At least 40% of the farms have lost land from agricultural use from time to time for this purpose. The land has been out of action for varying periods of from two to six years. 3,400 acres have been taken out of circulation in the years since 1944. 200 more acres are due for working in 1972 or 1973.

- (ii) Deleterious factors such as proximate settlement, roads, access, dogs, trespass necessitate that livestock be kept close to the farm buildings. Hence, very often, only that section of the farm away from the main farm buildings can be rotated.
- (iii) Loss of land to housing and schools has cut out major sections of four farms and dislocated a rotation system.
- (iv) Specialisation has often been found to be more profitable economically, and thus normal rotation systems are suspended. This has occurred on three farms which now concentrate on poultry or pig breeding.
- (v) The fear of ploughing good grazing land and "upsetting the balance of nature."
- (vi) Sheer inertia or tradition. Two farmers admitted that they had never thought of a system of rotation, because their present way of life gave them a reasonable standard of living.
- (vii) Some of the farms are not arable, (four in the area), or are in the process of changing to a more economic stock rearing policy.
- (viii) Physical factors, such as exposure to winds, wet riverside lands, stones, strong clays, shallow soils.
- (ix) The sheer size of farms, 17% under 70 acres, militate against any comprehensive rotation system.

- (x) The age of the farmer and whether he is part-time or full-time as well as the amount of machinery owned all limit a scientific approach to rotation. Nine of the farms fitted into this category.
- (xi) The great expansion in use of chemical fertilizer, especially the nitro-geneous variety, has enabled farms to grow cereals, for several years in succession, without any substantial decline in yields.

FERTILISERS AND CROP YIELDS

In the last 20 years, because of Government subsidies, fertilisers and lime have been much more liberally used on the land. As with rotation practices and cropping ratios, there are very many different variations on the theme of fertilising. Commercial firms are quick to give advice as to fertiliser need, based on regular soil tests, while with the service of the A.D.A.S. it is highly unlikely that any particular farm or field will be seriously deficient in plant food. Most farmers, however, do not keep fertiliser records and very often slavishly follow manufacturers recommendations. In fact, on only three farms are any records of fertiliser practice even kept.

Two of these farms have been recently opencasted. National Coal Board recommendations immediately post opencast (1970-1971) was as follows:-

On first year seed bed:	Compound fertiliser	9. 16.9.	- 5 cwts. per acre
On 2nd-4th year seed bed:	Compound fertiliser	18. 6.18.	- 3 cwts. per acre
On fifth year seed bed:	Compound fertiliser	9. 16.9.	- 3 cwts. per acre

Liming is most necessary on all the farms of the area. This is generally recognised by the farmers, in that liming applications are standard throughout the farming sample. All the

lime used is obtained from the Magnesium Limestone Plateau to the East of Durham, especially from the Coxhoe and Shadforth areas. The ex-opencast land is certainly more hungry for lime than the rest. Applications average four to five tons per acre per four years as against three to four tons per acre per four years. There is no danger of the land becoming too lime deficient, because the most common service of the commercial firms is pH testing. In fact, no less than five of the farms have reduced the amount of lime applied in the past few years, because too much has accumulated in the soil.

Basic slag is not universally used; just over half of the farmers spread this on the land. Amounts of application vary very widely, from 5 cwts. to 25 cwts. per acre according to deficiency, every third year. The farmers who use the least, tend to put slag on the grass or cereal stubble, post harvest, then allow the sheep to follow on with their droppings. The average application is in the region of 10 cwts. per acre, often on first year seed. The advantages of basic slag, according to the farmers who use it, are that: it lasts longer in its effects than compounds; it is cheaper, though now beginning to rise in price; it gives clover a better sward and a quicker start in growth. The rain gradually washes in the slag, thus preventing too quick a leaching of the slag chemicals, and the slag is rich in trace elements. Five of the farmers admit that they ought to use slag, but do not have the capital, the labour or the time to apply it. The 22 farmers who are against the use of slag state that it is too dirty, takes too long to act; it cannot be spread in winds, (winds are very frequent), and that it costs double money if compounds are applied as well. This seems to be false economy, because 20 of the 23 farmers who use the slag note that yields are

higher than when compound fertiliser alone is used.

Farmyard manure is a welcome addition to other forms of fertilisation and with most of the farms keeping cattle through the winter, there is no shortage. On seven farms, upwards of 300 tons of manure is available each year. It is found that if farmyard manure is concentrated on the opencast land, then the structure, organic matter and fauna of the soil are replaced more quickly than if compounds alone are applied. On the N.C.B. fertiliser list for Finings and North Farms, manure was not recommended for the precise reason that neither farm could supply sufficient manure. Sheep are also excellent manurers of grazing land. The leys themselves, are self fertilising in that the organic content of the soil is maintained in the well manured leys and the farmer can be very sparing in his use of fertiliser in the first year out of the three year ley. This is specially true of the 15 farms who keep to the three years in, three years out system.

The basic common fact arising from the farm survey is that no farmer can afford to apply all the fertiliser necessary. All agree that yields can be improved, if they can afford the initial outlay of more fertiliser. One farmer who spends £2,000 on fertilisers insists that he can spend as much again and that by so doing his yields will more than double. It is difficult to discern any regular pattern of fertiliser practice, there being many different ideas and practices.

The general pattern of fertilising barley varies from $2\frac{1}{2}$ -4 cwts. per acre of compound fertiliser (20% Nitrogen, 10% Phosphate and 10% Potash), the amount used depending upon the farmer's capital. A few farms use two cwts. per acre of 10% Nitrogen, 25% Phosphate, 25% Potash fertiliser, followed by an application of two cwts. per acre of Nitro-chalk, (34%

Nitrogen). This latter system, which is only slightly more expensive, yields a much greater return of barley.

Two fertilisers are used on wheat:- a 9% Nitrogen, 25% Phosphate, 25% Potash compound or no Nitrogen, 20% Phosphate, 20% Potash compound; both to be followed by two to three cwts. of Nitro-chalk, 21% to 34% Nitrogen, the stronger Nitro-chalk being placed after the 0:20:20 compound.

Chemicals, on roots, are generally of the 15:15:20 variety, applied at a rate of 8 to 10 cwts. per acre. A lesser application always needs an abundant use of farmyard manure.

The almost universal pattern on grassland is an application of 20%, 10%, 10% in varying amounts, between two cwts and four cwts. per acre. This is aided by 1½ cwts. to 2 cwts. per acre of Nitro-chalk, (21% to 34% Nitrogen). In the cases where Nitro-chalk is not applied, then the odds are very much against a second grass harvest being taken.

LIVESTOCK

Beef cattle are greatly superior in numbers to dairy cattle in the farms of the area; only 15 of the farms keep a dairy herd, 33 keep a beef herd. Beef cattle in June, 1971, numbered 2,741, but dairy cattle only 740. Of the 33 farms that keep beef cattle, there is a 60:40 ratio of storing to fattening. The distinction between fattening and storing depends on a number of factors; the amount of fodder crop that can be grown; the amount of shelter, (often the cattle cannot be leyd out during the winter and have to be sold off semi-fattened), the amount of fertiliser, lime and basic slag that can be put on the pasture, the amount of concentrate that is fed to the cattle, and whether the calves are single or multiple suckled.

The amount of live weight increase per acre varies

enormously from farm to farm. From birth to two years there can be a variation in weight added of from 8 cwts. to 12 cwts. In the former case, very few concentrates are bought, whilst the greater increase in weight is due to five tons of concentrates being used, together with minerals each month, plus 10 tons of sugar beet each year. In the former case, no nitro-chalk is added to the grass, but in the latter case three cwts. of Nitro-chalk per acre are added to increase the first flush of grass growth. Each herd is numerically similar, but the capital return per unit of expense has been much greater in the case of the heavier beasts.

In the instances where store cattle have been bought in for fattening, even wider variations in growth rate appear. In one instance, over a six month period, five cwts. were added to the live weight by the intensive feeding of concentrates, minerals and sugar beet. In another instance, where fodder crops and protein cake were fed, with very little added mineral, weight addition was in the order of three to four cwts. in a nine month period. In a third instance where minimal concentrates were given in addition to the basic fodder crops, over a 12 month period, the live weight gain was only 3 cwts. In the case of two farms which were converting from dairy to beef, for reasons of economy and time, the in-milk Friesians were suckling beef calves. Treble suckling was practised and each calf received approximately six pints of milk per day. In this way, some $5\frac{1}{2}$ cwts. to 6 cwts. were added in a nine month period, before the young beasts were sold off for stores.

The farming methods of producing cattle are evenly divided, between bulls and the artificial insemination service. The major bull breed is the Hereford, with Charolais becoming

increasingly popular.

There has been a move away from dairying to beef. This is for a variety of reasons, namely that:

- (i) There is a better economic return on beef in the form of subsidies, (in 1971, £10 per cow, £11.25 per calf).
- (ii) There is a better selling price per unit of beef than per unit of milk. Live weight beef can bring £12 per cwt.
- (iii) The great inconvenience of the twice daily milking system.
- (iv) The problem of obtaining the services of relief herdsmen during holiday times or during times of business away from the farm.
- (v) The problem of surplus disposal, during calving time.
- (vi) Rules of cleanliness, stalling, milking equipment cause greater expenses. This many farmers are not able to meet.
- (vii) Many dairy farms possess Friesian herds, which cannot always match the demands for milk total solids content, hence, such farms are penalised financially.

For these reasons, no fewer than a third of the farms which were in dairy production in 1959 have since converted to beef rearing. Of the farms that still retain a dairy herd, two-thirds are small farms of less than 100 acres, where dairying is the main occupation. Only three dairy farms are over 200 acres; in these cases dairying is a subsidiary occupation.

The Friesian is the most important and popular breed of dairy cow, because it gives higher yields of milk than the Ayrshire. Almost 85% of the dairy cattle kept are Friesians. Ayrshires are the only other milk breed used, and while they produce milk with a higher butterfat content, their beef calves are not as valuable as those of the Friesian. Ayrshires are normally to be found in farms with mixed herds. In only one case is there a pure pedigree Ayrshire herd, but pure bred Friesians are not uncommon.

The size of the dairy herd tends to vary with the size of the farm holding. Factors which have to be taken into account are that dairy cattle take up more space in housing facilities than the more remunerative beef cattle, and the numbers of sheep which are kept as followers of cattle on pasture. The sheep themselves represent an attempt to obtain optimum returns and hence a balance is sometimes struck in numbers, which reduces the numbers of dairy cattle. In addition, the amount of non-fodder crops which the farmer thinks economical to grow, will limit available space. A quarter of the farmers still do not apply strip grazing methods. This practice is a wasteful use of the early grown grass since the grass is not fully eaten. The amount of stock per acre varies widely - at one 502 acre farm, (420 acres of grassland), 220 milk cattle, 180 beef cattle and 440 sheep are kept whereas on a 265 acre farm, (120 acres of grassland), only 30 dairy cattle and 80 beef cattle are kept because of the emphasis on cash cropping. These features, in addition to the farmer's own knowledge and desires, (which often defy logic), lead to considerable differences in stocking intensity, especially in regard to dairy cattle.

Friesian and Friesian crossed with Angus or Hereford, form the major beef stock. The Hereford, Hereford Cross or Angus are also popular because they are quick maturing varieties. Only three of the farms possess Charolais, but six more farmers express intent or desire to change to this breed. The Charolais has the reputation of being the quickest of all the cattle for gaining weight. At the moment, demand for these cattle is greater than supply, thus, at Carlisle Auction Mart on March 2nd, 1972, Charolais bulls brought in excess of 1,000 guineas; consequently, only the very large farms can afford the necessary capital outlay. One of the major problems in changing from dairy to beef is the high initial financial investment with initially slow returns. The unit of size of beef rearing is everywhere greater than that of dairy producing. Only six are less than 100 acres, and on these beef rearing is a subsidiary occupation. In most of these cases, beef cattle are reared only to the store stage, which gives quicker, though smaller returns on capital. 12 of the beef rearing farms are over 250 acres.

SHEEP

At June 1971, over half of the farms of the area are used at least partly, for sheep rearing; but in most cases, sheep rearing is subsidiary to cattle rearing. Numbers are as follows: 2,940 ewes, 5,100 lambs and 150 rams. Sheep are found mainly on the larger farms, (19 of the farms which keep sheep are over 150 acres). The smaller farms do not normally keep sheep, because of lack of space. Even though sheep take up only one quarter of the space of a year old beef cow, they are very much less remunerative. The small farms tend also to be closer to settlement, having lost farm acreage to build-

ing development. They suffer the deleterious effects of trespass, dogs and so forth, which militate against the keeping of sheep. No less than six of the farms in the area have lost at least 30 acres to building in the post-war years. All these farms once kept sheep but are no longer able to do so.

The major breed of sheep is the Mewle or Greyface, a cross between the Blackface and the Border Leicester, while the Scottish Half Bred, a cross between the Cheviot and Border Leicester, is only slightly less popular. The proportion of storing to fattening is approximately 3:1. One or two farms simply let out pastures for the sheep of a neighbouring farmer. The most common method of rearing, (26 of the farms), is to keep a permanent stock of sheep by replacing their ewe flock with selected bred lambs. About one-fifth of the ewes are replaced each year. The old ewes are normally sold off as mutton to the school meals service.

The normal practice is to fatten lambs and sell off at the end of August, because there is very little housing to keep lambs during the winter. A few lambs are kept back until October to eat off the roots. Lambs sold off in August, at 6 months old, will weigh between 50 lbs. and 60 lbs. dead weight. The October lambs will weigh between 65 lbs. and 70 lbs. dead weight. A few farms buy in 6 month old lambs in late August and September to fold out during the winter; these gain between 25 lbs. and 30 lbs. and are sold in February or March, as one year old lambs, at dead weights of approximately 90 lbs.

Flocks vary greatly in size, from 15 to 600 ewes. In the case of the smaller number storing is practised. Wool forms a useful source of income with approximately 7 lbs. per fleece being obtained. The wool can be taken three to four

times from each ewe. Approximately 30 tons are sent each year to the Wool Marketing Board.

PIGS

Pigs are kept on 14 of the farms, but on only 7 of these farms are sows kept and piglets bred. On the rest of the farms, pig storing is a ready cash sideline. Many of the farmers who keep pigs do so to diversify as much as possible. The number of sows kept in the whole district is small, (only 130), with one farm keeping 70 of these. Eleven of the farmers who keep pigs do not keep sheep; the farms which are too small for sheep rearing seem to find a ready remunerative alternative in keeping pigs. The two chief breeds are Large White and Pure Landrace, in a ratio of 6:1. Only two farms keep pigs as a major occupation. On one of these farms, four sows and 120 piglets are kept, some bred, some stored, in varying periods from 8 weeks to 20 weeks, generally being sold off at pork weight, $7\frac{1}{2}$ to 8 score. This farm is not a full-time occupation, and will not support a family. The other farm breeds pigs intensively, 70 sows, with some 500-600 piglets, being the normal holding. They are kept as pork cutters, being sold off at $6\frac{1}{2}$ score dead weight, at any time between 18 to 22 weeks. Selected females are kept to replace old stock. Three boars are kept, but the artificial insemination service is also used, because it is felt to give better results. (A.I. 10.5 piglets, boar 9.5 piglets). 280 tons of feedstuff are used per month, comprising mixed special barley, maize, wheat and concentrates, made up into the farm's own recipe. Much of the barley and wheat is bought from neighbouring farms. In exchange, and in part payment for this, approximately 10,000 gallons of pig slurry, per fortnight, is sold off to neighbouring farms. The piggeries and equipment

are modern, but there is little room to expand, the farm being only 33 acres, 20 of which are scattered, away from the farm, in a separate parcel of land. Labour costs are kept to a minimum by exclusive use of family labour. This is an example of a farm where much capital has been spent, but where the returns for a very small acreage are relatively high.

The rest of the pig farms buy in weaners, cheaply, at a few weeks old, and sell off at 5 to 6 score live weight, with a consequent swift, but small profit. Here, pigs are definitely a more profitable subsidiary than sheep, especially since all these farms lie close to settlement, deleterious for sheep rearing, but conveniently close for collecting swill for pig food.

POULTRY

All the farmers keep some poultry, but in the vast majority of cases, only a few hens are kept to supply the farmer and friends with a few eggs. Only nine of the farms keep poultry in any significant numbers, one-third of these keep less than 100 poultry. These are bought in as 'point of lay' pullets, and eggs sold off the farm, for a quick but small return. All the hens are hybrids, which eat little, relative to their egg production. At slaughter, their dressed weight is always lighter than pure bred hens. On only two farms are poultry kept in large numbers; in one case, about 330 hens are kept for egg sales from the door, the farm lying conveniently placed next to a main road for regular customers, yet far enough away from settlement to discourage hen thieves. (No farm close to settlement keeps poultry on any large scale). The other farm which keeps much poultry is dominantly a poultry farm: this is the only instance in the whole district. This

has come about by accident in that 90 of the farms 97 acres were opencast in 1968 and were not laid down to grass until May 1971. The farm will be out of use as a grass, cattle unit until 1974, hence, another livelihood had to be found. With the compensation cost, plus sponsorship from the contracting firm, a broiler unit was built. About 28,000 to 30,000 broiler chicks are kept in deep litter houses. They are fed up from day old chicks to table birds in eight weeks. The work is performed by two men, on a contract basis with a Bedale firm. In this way approximately six crops per year are reared. Over 120 tons of broiler food is used, starter, rearer and finisher, mixed with assorted grasses. So successful has this venture been financially, (relatively less work is also entailed), that it is doubtful whether the farm will return to its original use.

Only two farms reared turkeys, in both cases, upwards of 100 turkeys are kept, but only in the period from June to December, when they are sold at various weights from 14 lbs. to 18 lbs. In each case, about three tons of proprietary foods are purchased. Profit is sufficient to make both farmers increase their turkey holdings in late 1971. Both these farms are some way from village settlements.

A.3 PRESENT LAND USE - NON FARMING

NON AGRICULTURAL LAND USE

The main factor of land use in the Browney-Deerness region is the farming factor; even so, only 73%, 8,783 acres are in agricultural productivity. Some 3,211 acres are taken by woodland, settlement, mineworking, mineral lines, spoil heaps or derelict land. These do form an essential, if somewhat negative factor in land use studies and hence have a vital bearing on land capability. If these "man-made landscapes" could be restored and returned to agricultural usage, much more valuable farm land would be obtained. "Manifestations of mining are ubiquitous features of the scene, although they do not occupy the whole terrain. Farmland has been seriously encroached upon by mine workings and spoil heaps. Settlement, too, is related to the pits, proximity was paramount and often the only consideration. The mining colonists introduced the terrace form of housing which still predominates in the valleys. The scars of abandoned workings are widespread; abandoned wagonways have left their trace in the form of grimy tracks, in varying degrees overgrown with weeds. Some are used as footpaths, others as bridleways; much is wasted farmland." (Smailes 1960).

This description by Smailes, applies perfectly to the Browney and Deerness mining communities. The village settlement, with the exception of Esh village, is the result, solely and simply, of colliery development. These settlements, along with the legacy of mining, form the deleterious factors to the agricultural productivity of the land.

The aim of this chapter is simple, to delimit and outline the competing uses for land space, other than farming, in order

that a better overall land capability pattern can be established. "It must be the job of the land surveyor to make an assessment in an attempt to gauge the potential of land for a variety of uses. Land classification defines the value or the quality of the land for any type of use, because one prime aim, is to enable land use planners to allocate land amongst its various possible uses for the maximum satisfaction of the whole community." (Cruickshank & Armstrong 1971).

"The Browney-Deerness region is an area of competing land use, but not an area which is in great demand; it is an area of bye gone days, which has seen its fullest uses." (Command 2206, 1964). This overall assessment must mean that pressures on present land use are not great, hence, the present large amount of dereliction which is evident. There is no great urgency to rectify the many deleterious factors which are evident; much of the reclamation being delayed or put on the final year of each Durham County Five Year Plan. It will be convenient to delimit the present land uses under the headings of forestry, settlement and mining legacy.

Forestry

There are at the present time 864 acres of forest plantation in the area under survey, or 7.25% of the area surface. This represents a slight drop on the pre-war figures; but much of the woodland that was reclaimed for farming between the wars, was not of the present commercial variety. It is estimated that at least 600 acres of deciduous woodland were replaced by farmland between 1910 and 1939. Of the present forest, which is almost totally coniferous, 821 acres are commercial, 43 acres non-commercial. The commercial plantations are the property of the Earl of Durham and the National Coal Board. Of the 43 acres of non-commercial woodland, 16

acres were planted by Ushaw College during the 19th century to form a windbreak, to protect the College from the prevailing south-westerlies which blow across the ridge top. The other 27 acres are scattered over four or five small plantations, containing mixed deciduous and coniferous woodland. None of this land has been subject to systematic silviculture practice and as with the Ushaw College plants, much dead wood is evident. One of these plantations has been reduced by 14 acres, since 1959, by Lanchester R.D.C. e.g. Ridding Wood (187 420).

Of the N.C.B. woodland, 27 acres were planted before 1900.

Of the Earl of Durham's Estate, 35.5 acres were planted before 1900.

The growth of coniferous plantation is as follows:-

1900	-	62.5 acres
1920	-	112.0 acres
1939	-	288.1 acres
1960	-	485.1 acres
1970	-	821.0 acres

Two-thirds of the present commercial woodland has been planted in the post-war period and consequently very few plantations have reached maturity. The oldest and most mature woodland is the N.C.B. owned Esh Wood, 215 415, where only 5 acres have been planted since 1960. New Brancepeth Hillside (2142), Ragpath Wood (2042), and Hag Wood (1943), are totally post 1960. The greater part of the Earl of Durham's woodland, which is all situated north of the A.691, Durham to Consett Road, is 80% post 1945. The five-year County Reclamation Plan includes provisions for another 68 acres of woodland for the N.C.B. at Waterhouses, 180 410, and at the Ushaw Moor pit heap 220 426. The potential of forest land is much greater than

this, but will not be included in the County estimates or plans before 1975.

The Earl of Durham's Estates aims in forestry growth are as follows:-

- (i) In certain cases, shelter is a prime aim. This is especially the case in the forest planted on the middle slopes of the north side of the Browney valley.
- (ii) Especially on the highest slopes of the north Browney valley, around Broom House Farm, 215 475, the soil is unsuitable for any type of farming economy.
- (iii) The main aim of silviculture is, however, to obtain a sufficiently sound economic return and the plantations are managed on a purely commercial basis (Grey 1972).

These plantations, which occur on the strong clay of the northern slopes of the River Browney valley, are restricted basically to Scots or Corsican Pine, with the exception of 55 acres of larch, spruce (both Sitka and Norway), Abies Grandis, sycamore and beech. "Upland Britain, due to impoverishment of natural flors, is dominated in its woodland community by Pinus sylvestris" (Newbiggin 1935). It is not surprising, therefore, that there are 704 acres of Scots Pine in the forestry plantation. Its advantages are many - it grows to a height of approximately 100 feet; it abounds in resin and hence is very durable; it reaches full maturity more quickly than any other pine except the Pinus laricio; it is as lasting as oak; its wood is as well adapted to outdoor as to indoor work; it is ready for cutting at approximately 50 years, if disease is carefully controlled and the forest is

well managed. It also has a dense foliage, which renders it valuable as a shelter tree for protecting land from wind and it resists gales much better than any other coniferous tree. (Harrar & Wiggins 1961).

Corsican Pine (Pinus laricio) covers 60 acres of woodland; these acres were planted in the 1920's and are, therefore, almost ready for cutting. Pinus laricio is the tallest of all the pines; has the quickest growth, but still has a very durable wood. It does not withstand gales as well as Pinus sylvestris, hence, in the six section plantations where laricio occurs, sylvestris is also present as a means of protection.

The Earl of Durham's Estates have not yet reached full maturity, hence, the only income derived is by the sale of thinnings, (trees removed from the crop to leave room for the remainder to increase their size). Approximately 24,000 cubic feet of timber per year are sold off in this way. The uses of thinnings are mainly in the field of chipwood and wood wool, for fencing posts, rustic fencing and general poles.

The National Coal Board estates are under systematic management on a purely commercial basis, though they do have, as a secondary aim, the reclamation and improvement of old colliery and waste heap landscape. "The species chosen for each site is dependent upon soil conditions, drainage, aspect, exposure to prevailing winds and vehicular access. The criteria for management is size and shape." Hence, the N.C.B. use the following species: Scots Pine, Corsican Pine, Norwegian Spruce, Sitka Spruce, with a low percentage of beech and sycamore mixture. The latest plantings at New Brancepeth Colliery, 1969, are 54 acres of Pinus contorta (N.C.B. 1971). The N.C.B. estates, which are much more

mature than those of the Earl of Durham, offer sawmill wood for mining timber, fencing materials, building timber and constructional purposes. The immature wood is used for wood pulp, chipboard, for making particle boards, turnery and round fencing material. The aim of N.C.B. silviculture is to have: 33% young woodland, 1-20 years; the remaining 66% being of age 21 years to 80 years. The annual increment, which is aimed for and normally attained, is approximately 100 cubic feet per acre. Of this increment, 30% is removed annually, partly by felling and partly by thinning. In the Deerness region, where over 90% of the N.C.B.'s forest is to be found, approximately 15,000 cubic feet of wood, mature and thinnings, are sold off each year.

Settlement (excluding industrial use)

It is difficult to estimate accurately, in terms of acreage, the actual area of settlement. The village areas have been estimated as accurately as possible with the aid of a planimeter, by surveying and information from the relevant Rural District Councils. If farmhouses are excluded, there are over 8,000 dwellings in existence, in the region under study. This information is ascertained from a study of the available electoral rolls and from visits to the three Councils concerned, Durham Rural District Council, Brandon and Byshottles Urban District Council and Lanchester Rural District Council. (The name 'byshottles' is Scandinavian in origin, and means 'the surrounding hamlets').

The average garden size of a post war house was 1930 sq. ft.; of a pre-war house, 3,200 sq.ft. The Councils state that post war gardens are smaller in area because most tenants are basically not interested in gardening. The total acreage of settlements and roads is approximately 1,808 acres, or 18%

of the total area. Of the 8,049 dwellings, some 3,200 had gardens; the total acreage of gardens was approximately 205 acres, or 2% of the whole area. It was found that as many as 30% of the gardens on the larger estates were not cultivated in any way. It would be very difficult to delimit the actual acreages of gardens devoted to vegetables or to lawns and flowers. It would be true to state, however, that approximately 10% of the settlement area could be said to be productive land.

Of the 8,000+ dwellings, over 450 are uninhabited, awaiting demolition and eventual reclamation to farmland, as part of the Durham County plan. Since 1960, some 550 dwellings have been demolished, but the sites of 300 of them are still awaiting reclamation. It is hoped to put all these dwelling sites to farmland or pasture. This will add 117 acres, or 1% more to the agricultural land. Already 15 acres have been added from part of the old colliery settlement of New Brancepeth, where forest growth is covering the ground formerly occupied by terraces and streets.

There are also more than 100 acres of allotments, which have been used in times past, especially during the war years, to produce vegetables. The greater majority of these acres are now unproductive and are generally used as pigeon coots, or are derelict. Within the area of settlement are many small scattered sites, which could not be reclaimed for farming or forestry, but they could be used for more attractive grass plots, or could be tidied up to decrease the area of desolation and dereliction. There are some 28 acres of recreation grounds. The grounds of Ushaw College add another 45 acres; five acres of this are market garden, used to produce fruit and vegetables for the students of the College.

Mining and its legacy

The deleterious effect of mining is not only to be found on farmland as subsidence and broken drains, but also is evident in the two valleys as pitheaps and opencast scars. In 1900, coal mines existed at Esh Colliery, Hamsteels, Waterhouses, Brandon, Ushaw Moor, Bearpark, New Brancepeth and Langley Park. Of these collieries, only two, Bearpark and Langley Park are now being worked. The total acreage of modern pits, slag heaps, old workings and coke woks, in June 1971, amounted to 314 acres, including 40 acres of mineral lines. Much of this is awaiting reclamation, its capability will be discussed in Section C. Included in the productivity of the area is the coal still to be washed out from the heaps, in addition to the industrial slag to be obtained.

Industrial Development

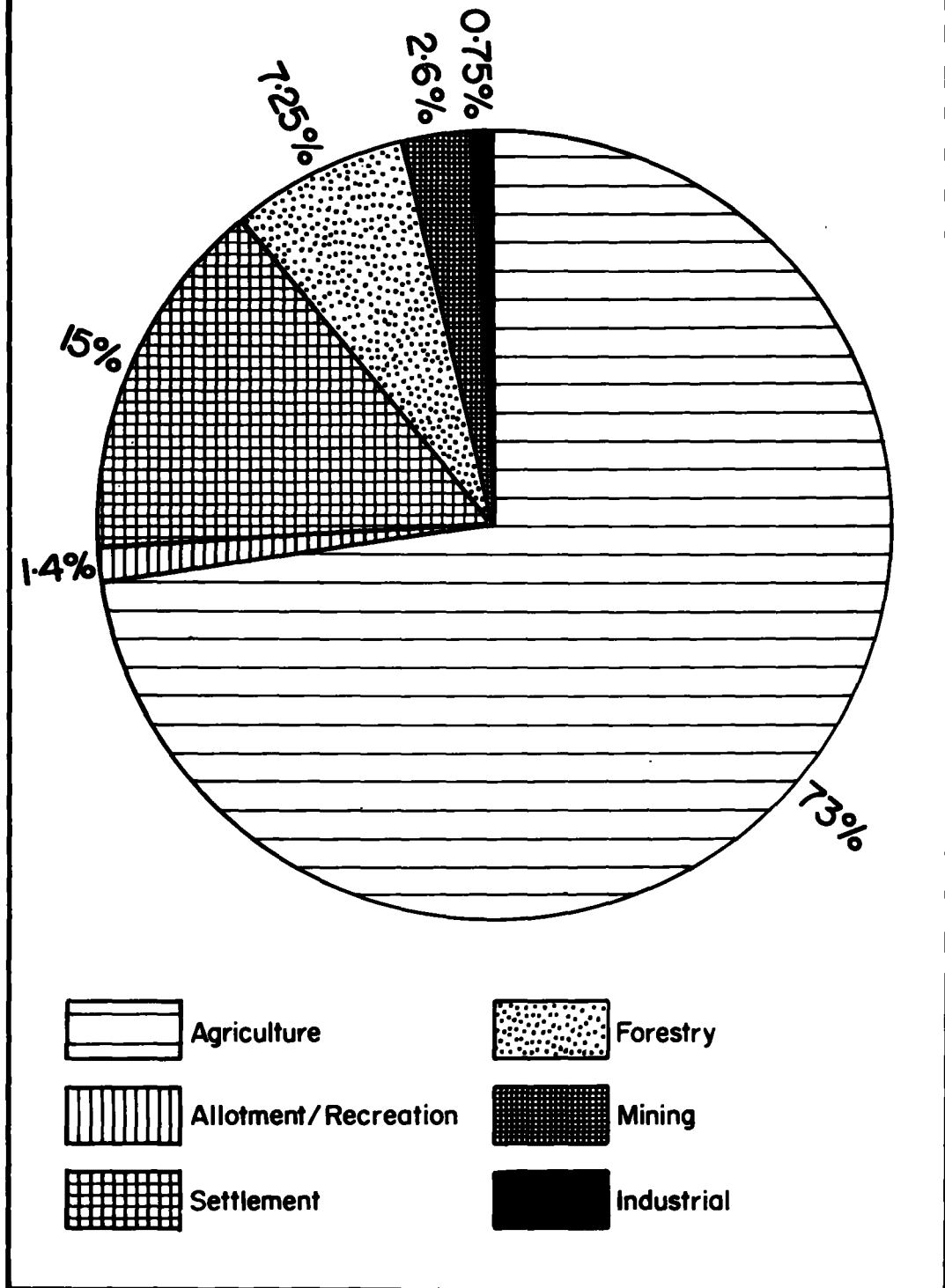
Industrial development in the region occupies only a very small acreage. There is a great reluctance on the part of any new concern to move into the locality, mainly because of the lack of transport and communications facilities, and because of a lack of trained and skilled labour. There are only four concerns of any size who, between them, occupy only 48 acres of land, (40 acres of these being occupied by the Cornsay Brick Works). Ten more acres are scheduled for light industrial development, but in four years of such designation, not one firm has applied for their usage; this would seem to be in accord with the findings of the White Paper on the North East.

TABLE A3/3. LAND USE ACREAGESJUNE 1971

Agriculture	8,783 acres
Forestry plantation	864 acres
Settlement (including roads)	1,808 acres
Allotments, recreation area	167 acres
Mining and its legacy	314 acres
Industrial and projected land	<u>58 acres</u>
Total	<u>11,994 acres</u>

Fig.A3/4

PERCENTAGE LAND USE IN THE BROWNEY-DEERNESS REGION 1971



B.4 CLIMATE

The attribute of climate in the field of land capability is basic to a fuller understanding of farming practice. It has been stated that "climate is the principal basic factor that influences the geographical distribution of crops as well as of livestock." (Bengston and Van Royan (1964)).

A study in great depth would require a micrometeorological approach because factors such as aspect, exposure, shelter, altitude cause many local variations. Such factors can vary considerably in distances of only a few yards.

In this thesis, no micrometeorological work has been considered but there are nonetheless marked differences in the records obtained from three stations, either in, or just outside, the study area. The three stations are Houghall Agricultural College, (284 413), height 125 feet, Durham University Observatory, (277 415), height 339 feet and Ushaw College, (218 437), height 594 feet. Records are taken twice daily at all the three stations.

It is realised that Houghall and Durham are outside the area of survey and that Houghall lies in a noted frost pocket, but it is felt valid to use their data, because their respective altitudinal positions fit well with the topography of the Browney-Deerness valley slopes and lowlands. The three stations form a climate traverse up the eastern foothills of the Pennines. Houghall occupies a valley floor hollow position, Durham Observatory, a hillside position and Ushaw College, a ridge position. Useful comparisons can therefore be drawn and applied to the relevant parts of the study area - approximately 25% of the area lies between the 300 and 400 foot contours, whilst 5% lies below 300 feet.

There are limitations to the interpretation of published climatic data in respect to crop growth. In particular, there is often too much emphasis on mean figures. This results from attempting to summarise an enormous quantity of available data, but it does lead to a danger of overlooking deviations from the mean. These deviations, recorded in some detail, may be of great importance in assessing land capability, for the amount of tolerance of plants to climatic factors varies not only according to the composition of the plant community, but also to the stage within the growth cycle of an individual plant.

At all stages, plants and crops must be adapted not only to average meteorological conditions, but to the probable oscillations around the mean at each period. Mean figures not only obscure the variations which occur from year to year and from season to season, but their apparent precision as cold stark figures stating scientific accuracy, can often cause incorrect notions to be formed. In Durham generally the average figures are so rarely achieved as to be almost meaningless. "The picture is rather one of substantial variations on either side of the average." (McKee 1965/1). "Mean annual rainfall is something of a fiction." (K. Smith 1970/1). In itself, rainfall has only limited importance to plants - what matters most is the amount of moisture available from the soil at any particular time. This depends partly on average total rainfall, the relationship between rainfall and temperature, and the degree of penetration into the soil. Frequent light showers may stimulate shallow rooted plants to activity, by bringing water within reach of their roots, but fail to have much effect on the deeper rooted ones, because much of the water does not reach the soil horizon occupied by their roots." (Newbigin, 1935/1).

Most of the farmers operations, such as mole and tile draining, open ditches, ploughing, surface cultivation, modify the moisture content of the soil and are in effect equivalent to modifying the actual rainfall. The farmer or the market gardener also has a number of possible ways of minimising exposure to low temperature or cold winds. At Ushaw College, for instance, a five acre market garden, on a ridge position, is surrounded by a high stone wall, varying in height from 12 to 30 feet. The author has observed a difference of 5^oF. on the exposed field to the south of the garden from that inside the garden itself. On the north side of the Browney valley, coniferous plantations have been established with the joint purpose of commercial forestry and windbreak function. Stone walls, hedges and copses, offer shelter for livestock rearing.

False springs, (a temperature in excess of 40^oF. for four or five days, followed by a period of four or five days when the temperature drops to 32^oF. or 35^oF.), are not infrequent between the months of February and May. In the years 1939-1968, at Ushaw College, such false springs occur on average twice per year. These false springs may lead to premature growth of crops and may be followed by damage from subsequent frosts.

Having drawn attention to these points of caution, the climate factors which do obviously affect farming and crop growth do need to be studied in some detail. "The geographers primary aim is to lay special stress upon mean annual range of temperature, on mean total and mean monthly rainfall. Actual average hours of sunshine are noted, the average length of days of frost free period and the reliability or otherwise of rainfall during certain critical periods." (Newbigin 1935/2).

Precipitation

"The Browney and Deerness valleys share with the remainder of north-eastern England the characteristics of low average rainfall with a dry spring and a heavy late summer rainfall." (Watson 1949/1). The latter is due to thundery conditions, the incidence of which increases during July and August. (Thunder is heard at Ushaw on average nine times per year, and of these, seven occurrences are recorded in July and August). Jackson (1969) has made a survey of 17 north-eastern weather stations and at all stations there is a spring minimum rainfall. A winter maximum occurs at the six most westerly stations and a summer maximum rainfall at the eastern stations. Late summer and early autumn are the second wettest seasons at Durham, Houghall and Ushaw.

Figure B4/4 shows the monthly average rainfall figures for Ushaw College, Durham University and Houghall. (It is to be noted that the years covered by these statistics are as

follows:	Ushaw College	1939-1968
	Durham University	1949-1968
	Houghall	1959-1968).

The figure shows that there is little difference in average yearly rainfall. All three stations show the relative dryness of the period March to June, (Ushaw 7.30", Durham 5.74", Houghall 7.21"), which is the main germination period, and the relative dampness of July to October (Ushaw 12.64", Durham 9.69", Houghall 10.10"), the harvest period.

Figure B.4/5 shows the annual rainfall figures for Ushaw College (1939-1968) and can be clearly set against Table B4/4 which is used to illustrate the importance of rainfall incidence. Deviation from the mean is clearly shown in column 4.

Table B.4/5 shows the fact that in over 33% of the years 1939-1968, there was a deviation from the mean of at least 20%.

MONTHLY AVERAGE RAINFALL

Ushaw (1939-68), Houghall (1959-68), Durham (1949-68)

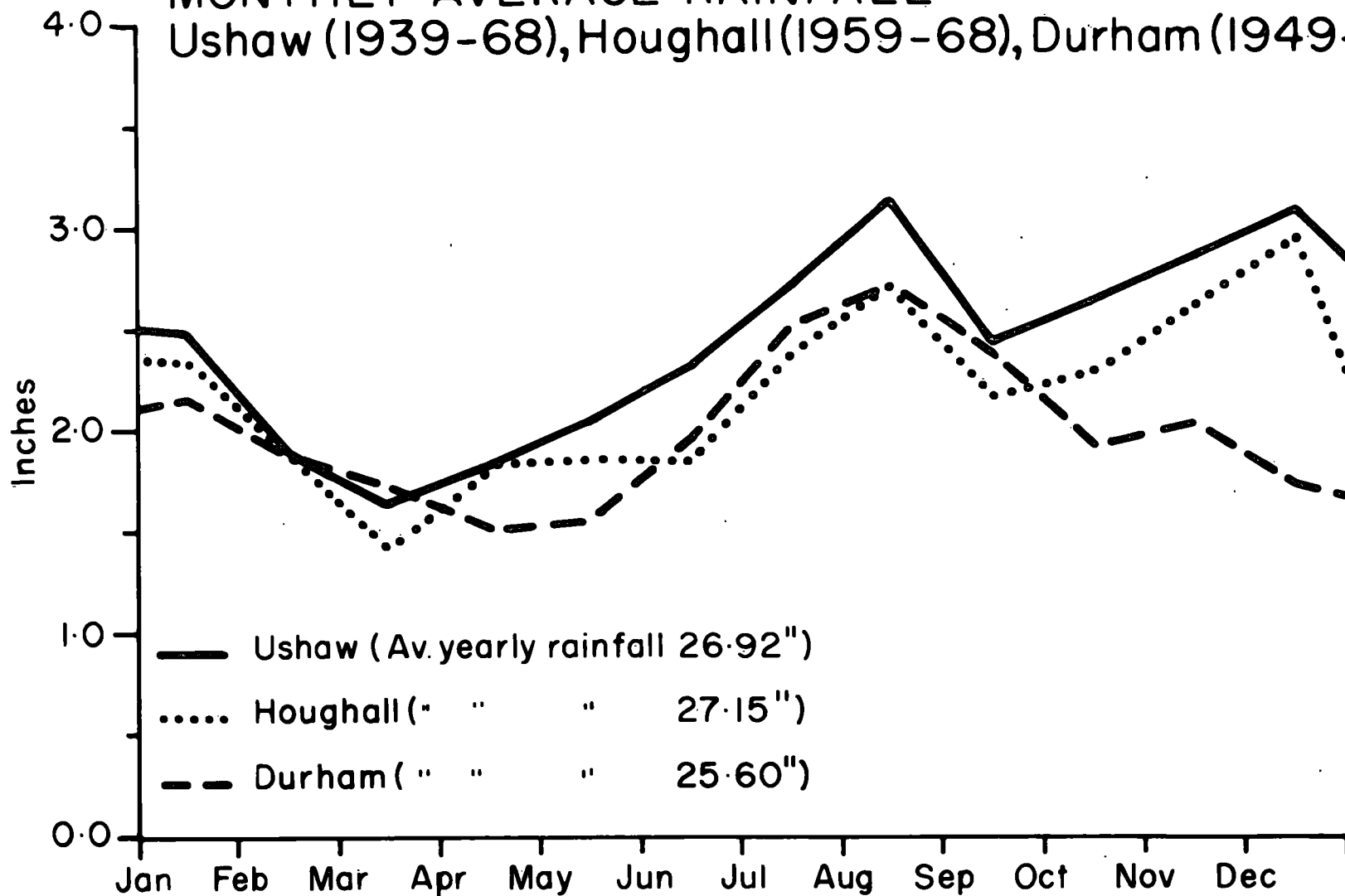


Fig. B4/4

Fig.B4/5

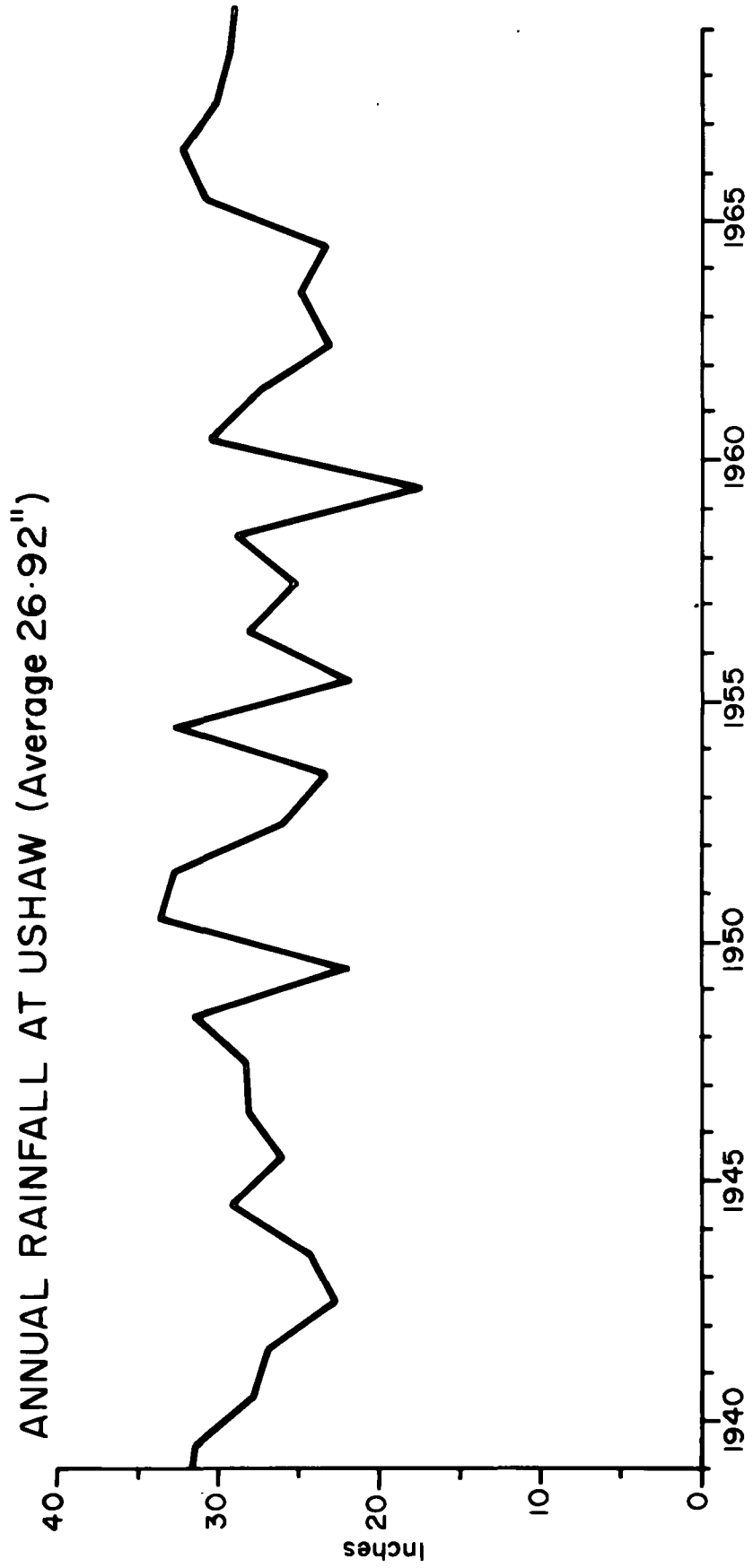


TABLE B4/4. DEVIATION FROM MEAN YEARLY RAINFALL
USHAW COLLEGE (1939-1968)

(1)	(2)	(3)	(4)
Year	Actual rainfall	Percentage of possible	Deviation from mean
1939	31.33	120.5	20.5
1940	27.90	102.5	2.5
1941	27.02	100.5	0.5
1942	22.73	84.0	16.0
1943	24.18	90.5	9.5
1944	29.30	109.0	9.0
1945	26.51	99.0	1.0
1946	27.88	103.8	3.8
1947	28.01	105.0	5.0
1948	32.74	122.0	22.0
1949	21.72	80.2	19.8
1950	34.30	127.0	27.0
1951	32.75	120.0	20.0
1952	25.85	86.10	13.9
1953	22.20	82.9	17.1
1954	33.89	126.0	26.0
1955	20.86	77.8	22.2
1956	28.17	106.2	6.2
1957	25.84	86.1	13.9
1958	30.07	114.4	14.4
1959	17.45	64.4	35.6
1960	32.78	120.1	20.1
1961	28.33	104.5	4.5
1962	23.36	87.0	13.0
1963	26.32	97.9	2.1
1964	23.31	86.9	13.1
1965	33.77	124.9	24.9
1966	34.32	127.7	27.7
1967	31.65	121.4	21.4
1968	29.15	108.2	8.2

TABLE B4/5. RAINFALL RELIABILITY
USHAW COLLEGE (1939-1968)

Maximum deviation	-	35.6% (1959)
Minimum deviation	-	1.0% (1925)
Deviation of $\pm 20\%$	-	11 of 30 years
Deviation of $\pm 15\%$	-	14 of 30 years
Deviation of $\pm 10\%$	-	19 of 30 years

If yearly deviations are of importance, so too are the deviations from the monthly means especially in the growing season. Table B4/6 shows the wettest and driest months as well as the average monthly rainfall, together with the percentage deviation month by month. This table shows that an average deviation of $\pm 50\%$ occurred in 10 of 30 years. It also shows that in the main growing months of April to August there was an average deviation of $\pm 25\%$, in 15 of 30 years and an average deviation of $\pm 50\%$ in 9 of 30 years. This is a considerable divergence from the mean and may well affect crop yields. It would have been informative to plot crop yields in the years of greatest deviation against the more normal rainfall years but, unfortunately, crop records were not available.

The number of days on which rainfall actually occurs is also important. Figure B4/6 plots the number of days of rainfall over the year above 0.2 mm./0.01" and above 1mm./0.04". Figure B4/7 shows the number of days of rainfall, in the growing season, defined March 15th to August 31st.

However, the wide deviations observed in the mean monthly and mean yearly figures are not reflected in variations in numbers of rainy days which remain remarkably constant. Even during the growing season (April to August) a deviation of 25% in the number of rainy days occurred in only two of 30 years.

While there is no positive evidence for fluctuating crop yields, it would thus seem that the moisture left in the soil from the winter, mitigating the effects of a dry spring, in addition to a relatively constant number of days during which gentle rain falls, have the major effects on crop yields.

Snow cover is an element of some importance agriculturally but "it is not easy to make an exact statement on account of the many days on which exposed land is partly covered and

TABLE B4/6. DEVIATION FROM MONTHLY MEANS
USHAW COLLEGE (1939-1968)

Month	Average rainfall ins.	Wettest	Driest	Deviations (no. of times)		
				±10%	±25%	±50%
Jan.	2.50	8.62(1948)	0.60(1964)	27	17	10
Feb.	2.21	6.35(1941)	0.32(1946)	25	16	13
March	1.65	5.38(1947)	0.06(1953)	27	12	15
April	1.70	4.07(1966)	0.24(1957)	24	13	6
May	2.08	4.16(1954)	0.47(1959)	22	11	7
June	1.87	3.72(1956)	0.39(1960)	26	17	10
July	2.62	5.46(1940)	0.62(1952)	23	16	9
Aug.	3.13	6.76(1956)	0.34(1947)	25	18	14
Sept.	2.36	5.72(1944)	0.48(1941)	26	21	12
Oct.	2.53	8.60(1960)	0.58(1962)	29	20	10
Nov.	2.99	6.21(1965)	0.53(1956)	25	18	14
Dec.	2.57	3.64(1958)	0.35(1941)	22	16	3
Average deviation				25	16	10

DAYS OF RAINFALL AT USHAW COLLEGE (1939-1968)

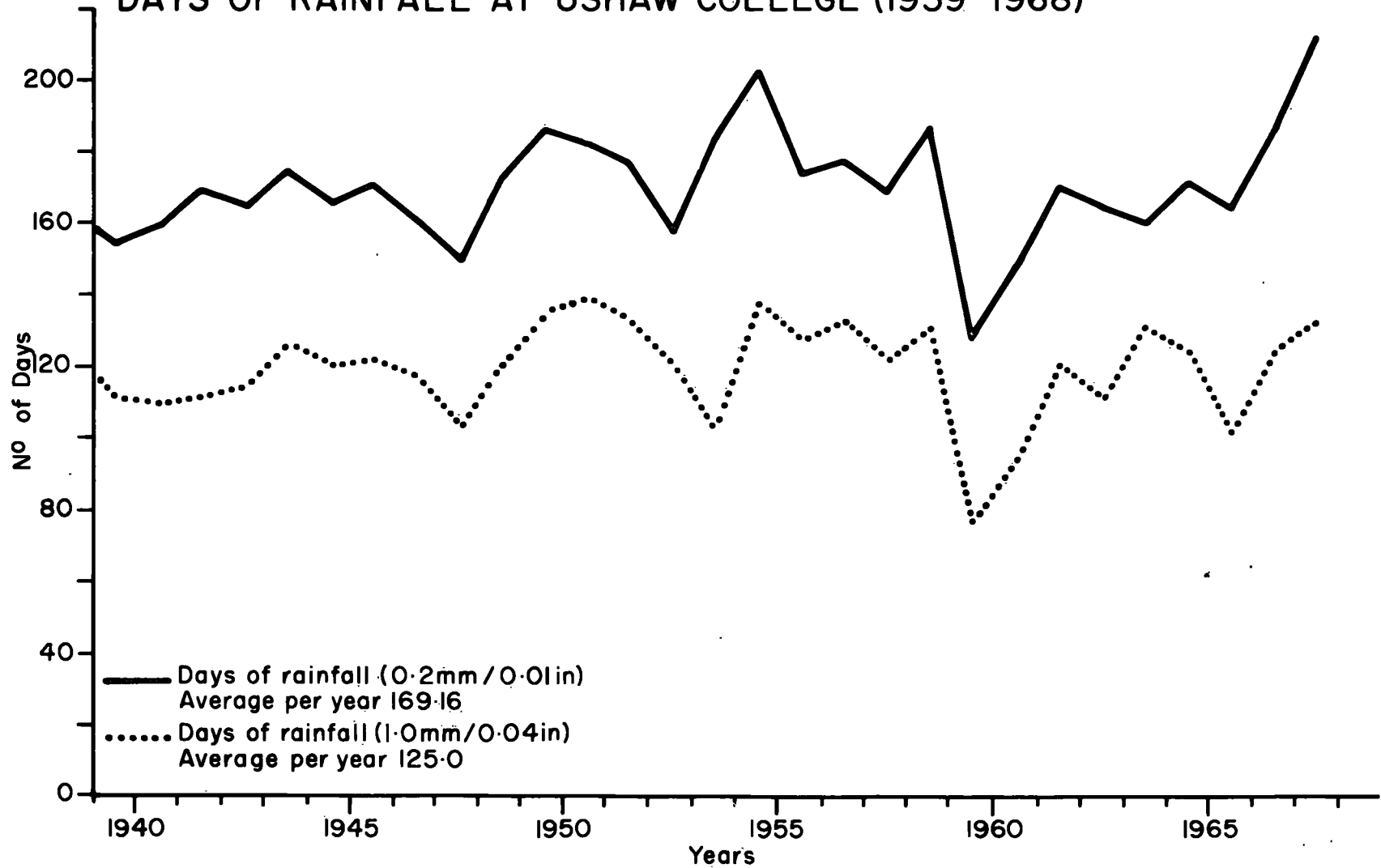


Fig. B4/6

DAYS OF RAINFALL IN THE GRAZING SEASON (March 15-August 31)
USHAW COLLEGE (1939-1968)

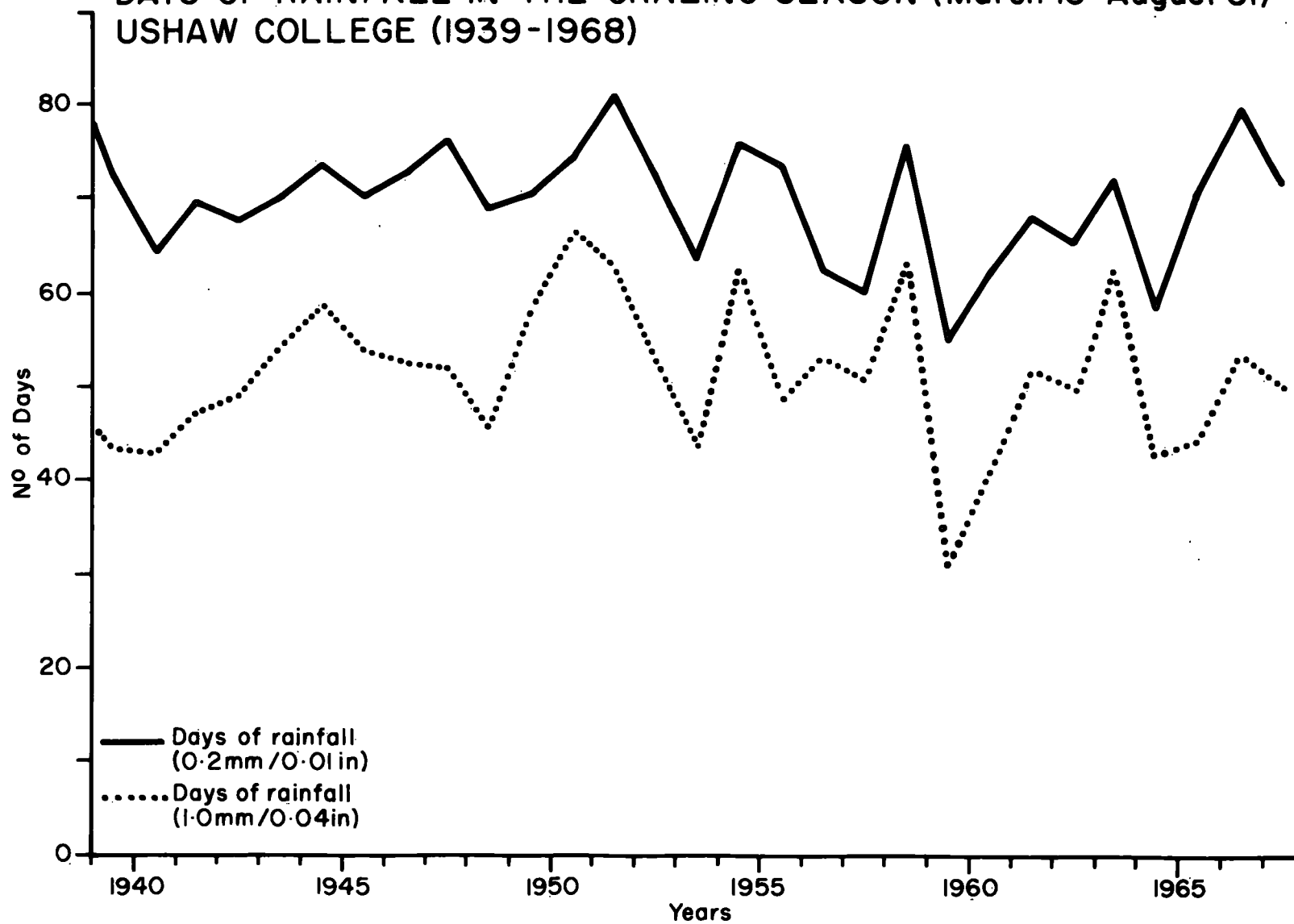


Fig. B4/7

partly bare owing to drifting" (Manley, 1943). Generally, the number of days on which snow lies increases with elevation:-

Houghall	1959-1968	21.3 days	In 1963, it lay for 67 days
Durham	"	22.0 days	" " " " " 67 "
Ushaw	"	27.0 days	" " " " " 69 "

The effects of snow cover on land capability are:-

- (1) Protection of young seedlings against late frosts.
- (2) An extensive period of snow cover, resulting in a late thaw, means that in the Browney/Deerness region the soil remains too moist to allow mechanical operations such as planting/seeding.
- (3) On the other hand, machinery can move on the snow surface, whereas it gets bogged down on the heavy textured soils, and manure and fertilizers are spread by some farmers when the snow is on the ground.
- (4) On the ridges and slopes, the snow tends to be deeper in places because of drifting and this makes difficult the winter feeding of sheep. In 1947 and 1963, grazing land was continually under snow cover for at least 2 months while in 1941, 1942, 1950, 1958, 1962, 1965 and 1966, snow covered the grazing lands for at least one month.

Temperature

The region as a whole has relatively low mean annual temperatures. This is a cumulative effect of northerly latitude, the coolness of the adjacent North Sea and the marked deterioration of climate that takes place with increasing altitude to the west. "Since 1841, at Durham Observatory, the average temperature has dropped below freezing in all months except July and August, whilst a maximum of 15°C. or over has been achieved in the three winter months of December,

January and February. In any one year, the maximum may occur between May and September, with an absolute minimum possible in any of the winter months from October to April." (Smith, 1970/2). The extreme maximum and minimum temperatures for Ushaw (1901-1968) are given in Table B4/7 to illustrate Smith's point on the deviation from the mean temperature.

It will be seen from Table B4/7 that for Ushaw, the highest maximum recorded occurred in September, the lowest minimum in February. In only the months of December and January was 15°C. not attained.

Deviation from the mean is not so great as in the case of rainfall and hence, temperature tends to be much more reliable. In the case of rainfall, deviations of more than 25% are quite common but in the case of temperature, deviations of more than 10% are uncommon. Hence, the mean maximum and mean minimum temperatures have most relevance in an assessment of climate as an attribute in land capability. Figure B4/8 shows these temperatures for Durham, Houghall and Ushaw.

The difference in temperature between Ushaw and Durham is explained, basically, by the difference in altitude. Although, as noted, Houghall is in a frost hollow, its temperature figures can be transferred without too much loss of value to the Browney and Deerness valley floors. "The Wear valley and its tributaries form in this region a basin with a rather narrow outlet to the north and so is subject to marked temperature inversion." (Manley 1941)

Kat. iabatic flow is an important influence in the region, and the upper slopes of the ridges appear remarkably free of frost when the mid-Wear valley is covered by white frost. The author, in 14 years residence at Ushaw College, has noted on countless occasions, in winter months, under anticyclonic

TABLE B4/7. EXTREME MAXIMUM AND EXTREME
MINIMUM TEMPERATURES
USHAW COLLEGE (1901-1968)

Month	Extreme Maximum	Extreme Minimum
January	13.3°C.	-12.2°C.
February	15.0°C.	-12.8°C.
March	22.2°C.	-10.0°C.
April	23.3°C.	-12.2°C.
May	27.2°C.	-2.2°C.
June	30.0°C.	1.1°C.
July	30.6°C.	2.2°C.
August	30.6°C.	2.8°C.
September	33.9°C.	-0.6°C.
October	25.0°C.	-3.9°C.
November	18.3°C.	-7.2°C.
December	14.4°C.	-9.4°C.

conditions, temperature inversions when looking out across the Browney valley from Ushaw College's ridge top site. For instance, during the winter months, November to March, 1970/1971, hoar frosts covered the fields in the valleys on 12 occasions when they did not occur on the ridge tops. From Figure B4/8 it will be seen that the mean minimum at Houghall in January is a rather remarkable 2.7°C . lower than Durham and 2.5°C . lower than that at Ushaw. In December, the figures for Houghall are 2.9°C . less than Durham and 2.4°C . less than those of Ushaw. The mean minimum in the summer months is also much less than Durham or Ushaw.

May	Durham	1.0°C .	Ushaw	0.6°C .
June	Durham	1.7°C .	Ushaw	1.2°C .
July	Durham	2.7°C .	Ushaw	2.2°C .

These figures are significant for farming in the 5% of the Browney-Deerness region which lies close to the Houghall Ordnance Datum.

From the point of view of farming, the incidence of frost and length of growing season remain as the most important temperature characteristics. Taking the usual threshold of mean monthly temperature of 6.1°C ., the normal growing season lasts from the beginning of April to mid-November in lowland Durham. At 1500 feet this has been reduced to $5\frac{1}{2}$ months. (Smith 1970/3).

Simpson (1964/1) states that, for the Tees Lowlands, "the growing season, the period during which the mean daily average temperature rises above 42°F ., is an excellent index of micro-climatic conditions. This season lasts on the average from late March to late November." Taking these two criteria, the mean monthly temperature and the mean daily average temperature, the growing season at Ushaw lasts on average, over the

MEAN TEMPERATURES (1939-1968)

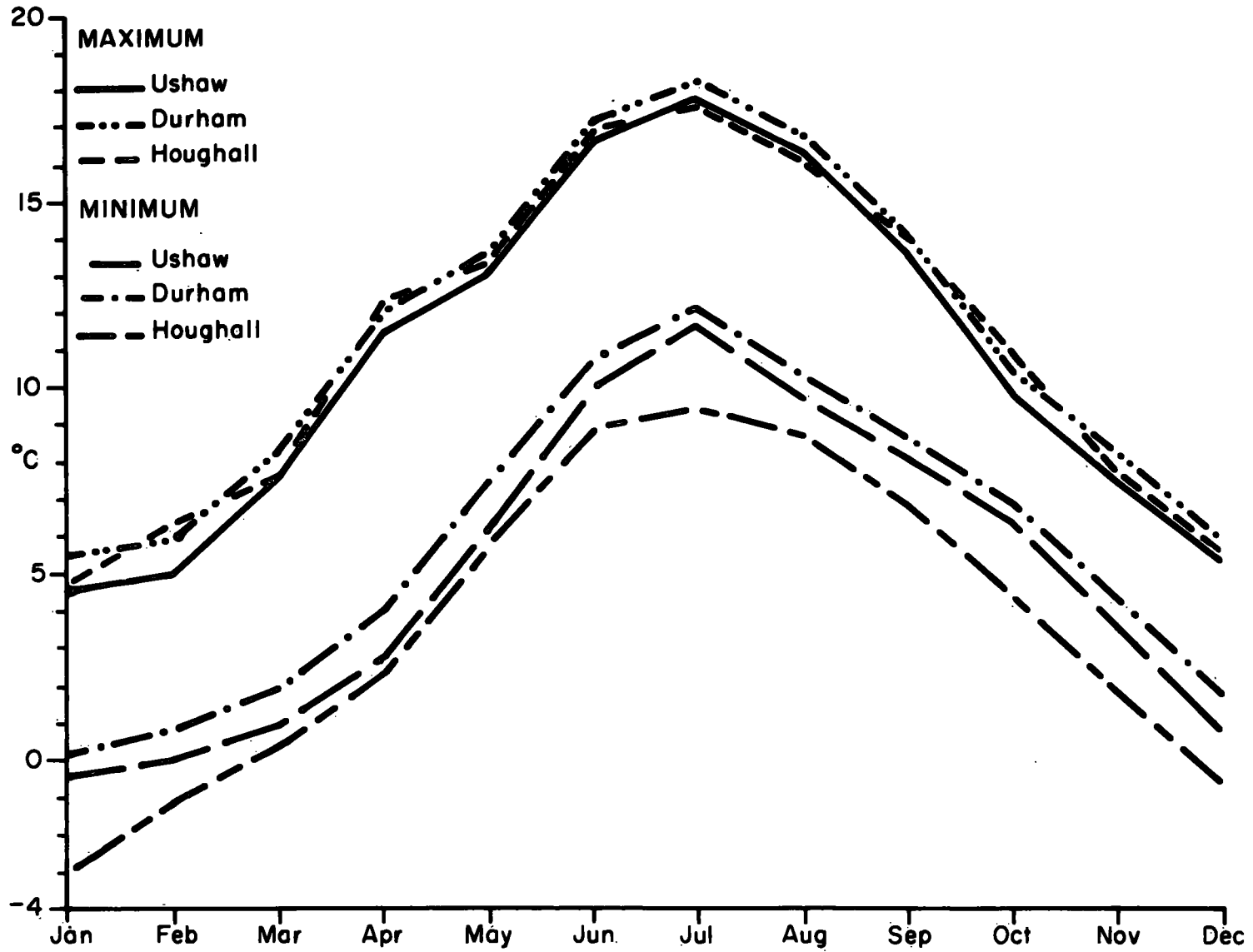


FIG. B4/8

30 year period (1939-1968), about 215 days.

Manley, taking a 30 year period 1913 to 1943, found the final air frost of the winter, at Durham Observatory, occurred on about May 10th, whilst the first winter frost occurred about October 5th. At Ushaw, in the period 1939-1968, the first air frost occurs on or about October 9th, and the last air frost on May 12th. The air frost figures for Ushaw are given in Figure B4/9 and compared with those of Houghall.

Figure B4/10 shows the ground frost conditions for the three stations. The figures reveal the increased occurrence of ground frost downslope, and accord with the author's own experience. The ground frost figures for the growing season are worthy of note; they reveal that Houghall can expect ground frost in all months of the year, whereas Durham City and Ushaw College are free in June, July and August. The Browney-Deerness valley floors experience a similar incidence to Houghall, the ridge tops, a similar experience to Ushaw, but this does not appear to cause any appreciable difference in crop growth patterns. It is said that spring is generally two to three weeks later than in the south of England, but that this slowness of growth has advantages. Plants are less likely to too early a flush and they are also less susceptible to late frosts (Smith 1970/4). The farmers of the area give the late spring as the chief reason for the absence of spring wheat.

The factor of accumulated temperature is of importance in relation to crop growth. Simpson (1964/2) gives several charts to instance this, and amongst them are ones for Houghall and Durham. (The accumulated temperature may be defined as the number of day degrees above the base of 42°F. , which is the minimum temperature for germination).

AVERAGE NUMBER OF DAYS PER MONTH OF AIR FROST (1959-1968)

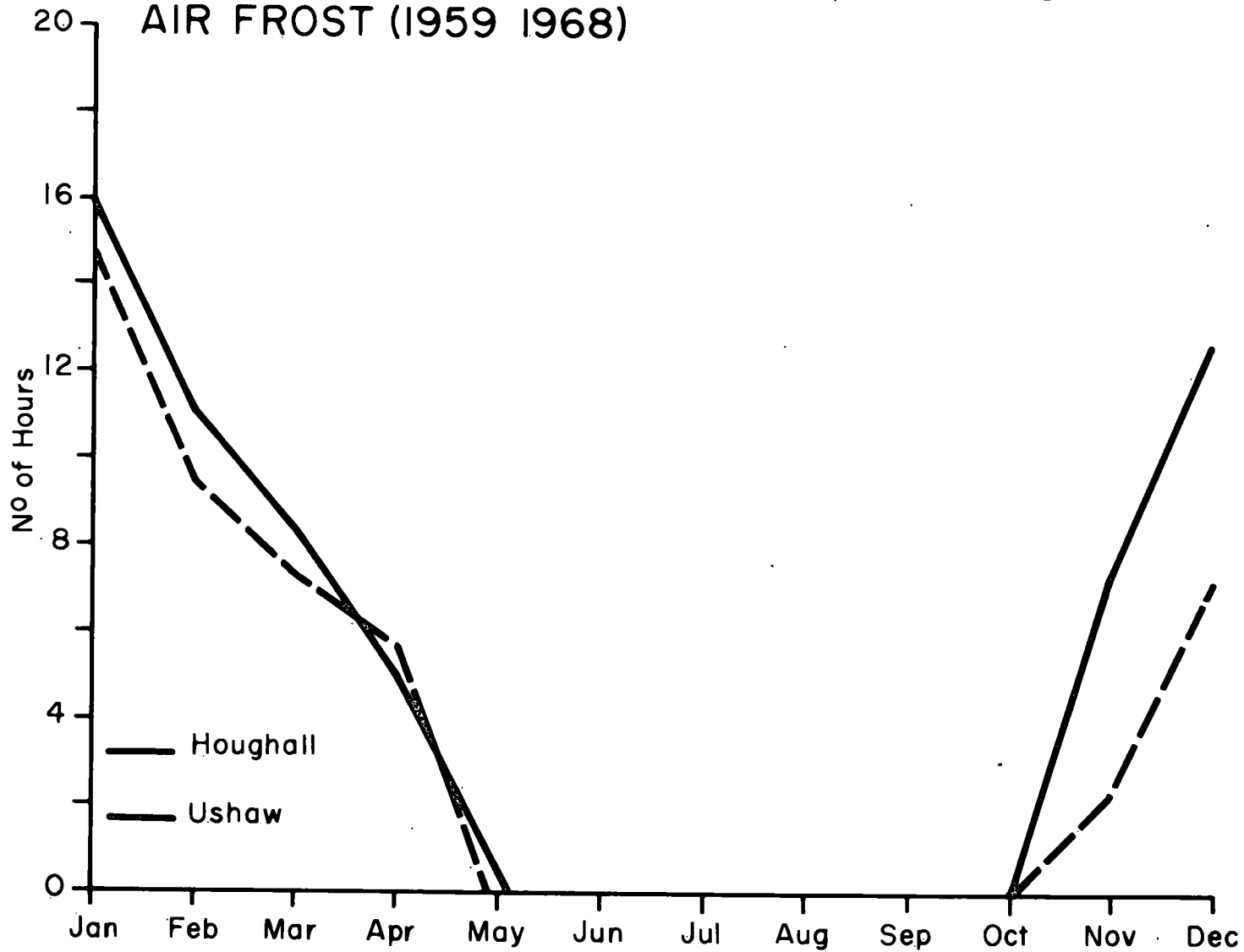


FIG. B4/9

AVERAGE NUMBER OF DAYS PER MONTH OF
GROUND FROST (1959-1968)

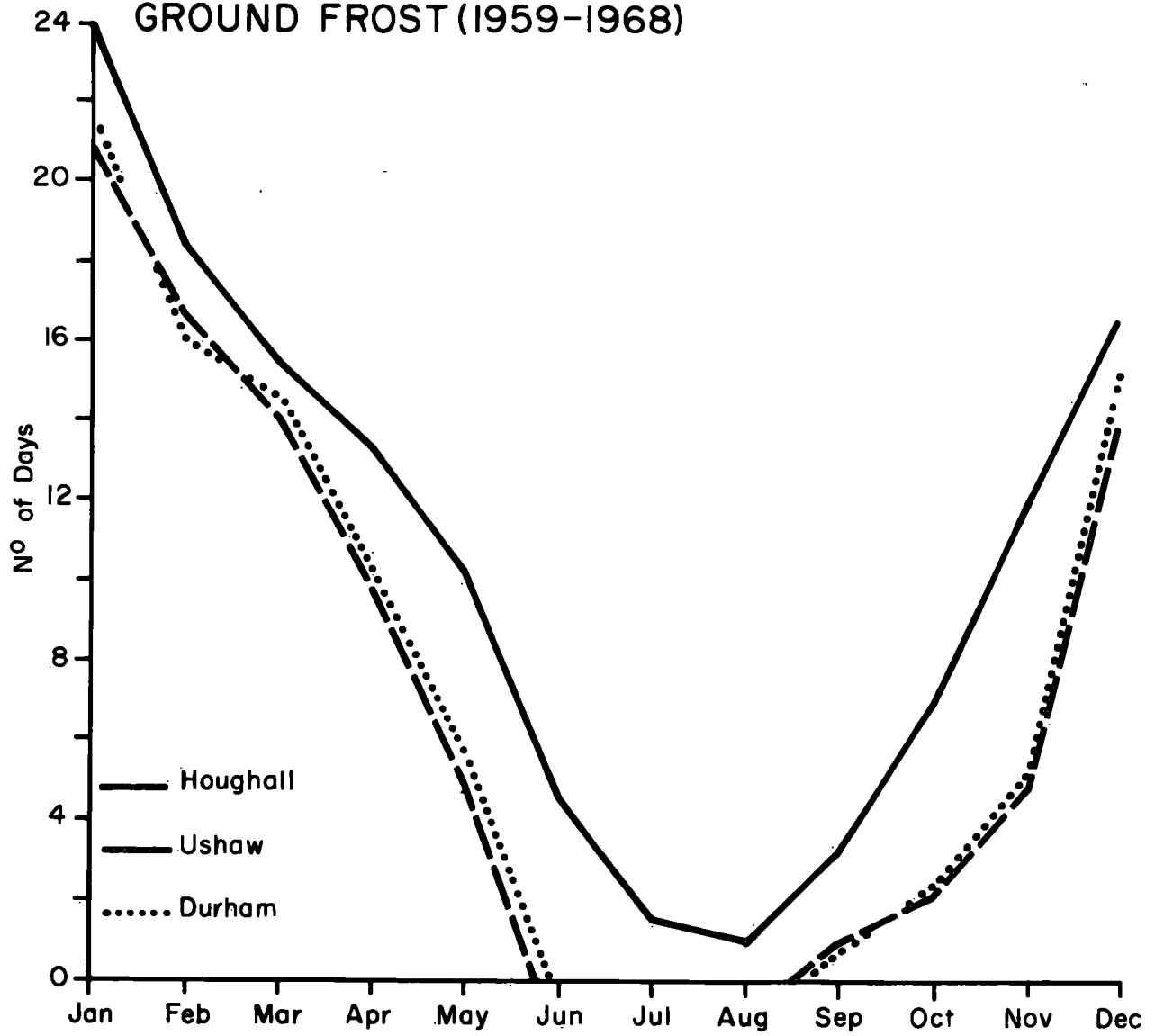


FIG. B4/10

The monthly figures for accumulated temperature at Houghall for the period 1952-1961 are:-

<u>Jan.</u>	<u>Feb.</u>	<u>Mar.</u>	<u>Apr.</u>	<u>May</u>	<u>June</u>	<u>July</u>	<u>Aug.</u>	<u>Sept.</u>	<u>Nov.</u>	<u>Dec.</u>	<u>Total</u>
0	0	32°F	99°F	269°F	403°F	514°F	494°F	377°F	24°F	1°F	2424°F

For Durham Observatory, during a similar period, 1952-1961, the average yearly total accumulated temperature was 2473°F. The difference in monthly distribution being negligible. (Unfortunately, the facilities at Ushaw do not enable the factor of accumulated temperature to be worked out and analysed). Simpson's analysis, based on readings at seven stations, showed that the further from the sea, the more concentrated into the growing season become the accumulated temperatures. Hence, for spring sown crops, the difference between inland and coastal localities is not appreciable great, (always allowing for the effect of altitude on temperature). Perennial crops, however, such as grass, do better in the coastal areas, than inland, and allow grazing, both earlier in the spring and later in the autumn.

Wilfred Smith (1961), basing his work on Rothamsted records, states that winter wheat requires a total accumulated temperature of 1961°F. "Winter wheat will tolerate a deviation of ±8%, but such areas will be distinctly marginal for wheat growth." Winter wheat, grown approximately between November 1st and August 31st, has a total accumulated temperature at Houghall of 1835°F, at Durham 1865°F. Both stations fall below the required figure but are within the marginal regions, within the 8% deviation range. Snodgrass (1932) however, shows that wheat can be grown in Scotland, where the accumulated temperatures reach only 1600°F, during the normally accepted growing season. The required temperature is

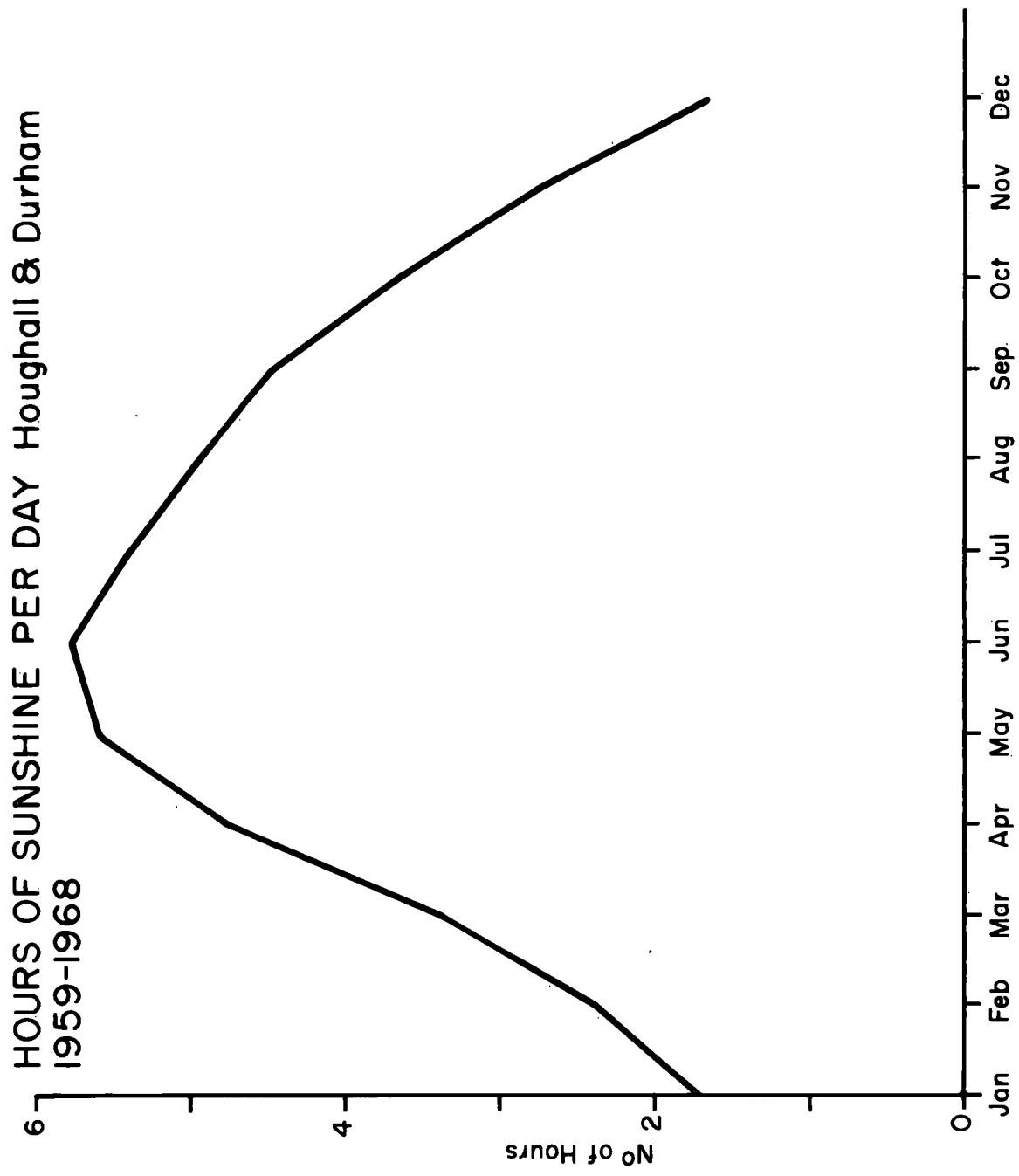
reached by delaying the wheat harvest to mid-September, which can add 200^oF. to the accumulation. Simpson has calculated that the East Durham Plateau at a height of 600 ft. records about 600 day degrees less than the lowlands, hence these uplands are at most distinctly marginal for wheat growth. In a survey of some 43 crop growing farms, in the area of Browney-Deerness, nowhere was wheat to be found growing on the ridges or upper slopes. Each farmer states that, for wheat at least, the weather is not suitable. The wheat harvesting is generally in early September and the acreage has declined slightly each year.

Sunshine

Sunshine records are not kept at Ushaw, hence the figures of Houghall and Durham are the only measurements that can be applied. So slight is the difference in average hours of sunshine that little is lost by reliance on these figures. Figure B4/11 gives these sunshine figures in hours per day.

The only significance of the figures is that they are perhaps lower than the farmer would desire. What is certain is that crops are harvested later than further south, but this is a combination of wetter ground, less sunshine and lower temperatures. What is perhaps most noteworthy is the rapid increase in insolation from February to May, which is of great importance to plant growth, while there is a prevalence of winds off the sea at this period which have a retarding effect on crop growth. Land with a southerly aspect can take the fullest benefit from the hours of sunshine. This can alleviate to a marked degree, the worst effects of cold polar air, brought by winds from the north-east quadrant. It is significant that farms having land with a southerly aspect do have greater yields, earlier harvests and more live

Fig.B4/11



weight percentage increase per beast. In the period February to May, the average number of days without sunshine amounts to only 26, contrasted with 38 in the period October to January (based on Houghall records 1959-1968). Hence, although sunshine amounts may not be high, sunshine is spread remarkably evenly. The early growing days are guaranteed 79% days with some sunshine. The days of ripening and harvesting, June to September, have only 13 days without sunshine, a 90% guarantee.

Fog

Fog occurs on an average of 45.5 days per year at 0900 hours. (Ushaw College records are based on the years 1939-1968). This exceeds the days noted by Simpson at West Hartlepool 29, Redcar 15.6, Middleton St. George 22.1, Durham 26. (All figures refer to the period 1952-1961). Much of the fog at Ushaw is hill fog. Its adverse effect on farming is the delay that is caused in morning ploughing during the autumn months. Both McKee and Simpson have noted the deleterious effects of fog on soils and crop growth in the East Durham area. "Considering the infrequency of dense fog, chemical pollution of soils in the region is surprisingly high. One of the reasons given for the lack of malting quality barley over the thin magnesian limestone soils is that the crops are too dirty." (McKee 1965/2).

At Durham Observatory, the mean daily concentration of smoke in suspension in the air was 5.46 mg. of solid per 100 cu. metres of air filtered (1961-1965).

<u>Jan.</u>	<u>Feb.</u>	<u>Mar.</u>	<u>Apr.</u>	<u>May</u>	<u>June</u>	<u>July</u>	<u>Aug.</u>	<u>Sept.</u>	<u>Oct.</u>	<u>Nov.</u>	<u>Dec.</u>
9.2	6.2	6.9	4.8	3.0	2.5	2.2	2.2	3.9	5.0	11.3	11.9

The figures reveal the purer state of the atmosphere during the main period of crop growth. (The Durham figure compares favourable with the Central London average of 20 mg/100

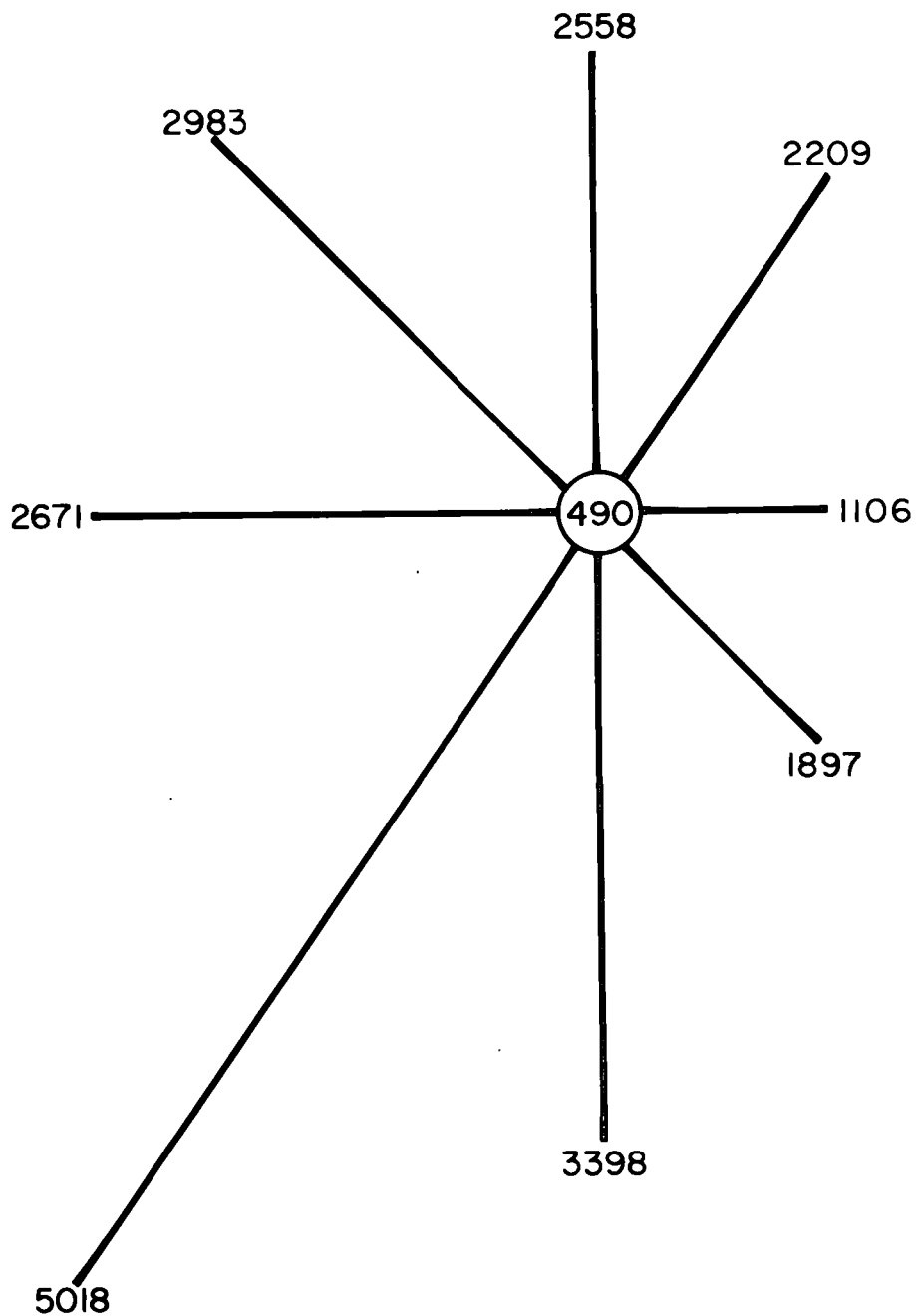
cu. metres, or Teesside 24 mg./100 cu. metres) (Durham University Weather Digest 1966). In 45 farm studies, the author did not in one instance hear any complaints of dirty crops. Two or three of the older farmers, on the contrary, noted that crops and grass were healthier today, when only two collieries were working, as against the days when eight collieries worked the seams of the Browney-Deerness. There are no Magnesian or Carboniferous limestone quarries in the district to spread dust freely as in east Durham or in higher western Durham. The fogs of the area, being hill fogs and though more frequent than in the east of the county, are not so deleterious to crop growth.

Wind

"Care has to be taken in interpreting statistics of wind speed and direction; because the influence of local topography and site is marked and there are many small differences in direction and speed from place to place."(Watson, 1949/2). Taking this consideration in mind, one expects to find fairly appreciable differences in wind speeds and directions especially between Ushaw and the two lowland stations. To give all the data and to analyse it would not be remunerative in terms of crop growth. The Durham figures are to be found in the booklet, 'Temperature, Rainfall, Sunshine and Wind Readings at Durham Observatory.' The wind rose for Ushaw is shown in Figure B4/12. This shows the composite wind rose, showing the great predominance of winds with a westerly component. The monthly wind roses for Ushaw, (1939-1968) are shown in Appendix 1. These show that winds from a north east quadrant blow more frequently in the months from March to June, on average **3.8** days per month, compared with an average of only **2.3** days per month in the rest of the year. Winds from the south west were

Fig. B4/12

**WIND DIRECTION—TOTAL NUMBER OF HALF-DAYS,
USHAW 1939-1968. (Readings taken at 0900 hrs & 1500hrs)**



1000 Days : 1inch

lowest in the months February to May, average 5.9 days per month, compared with 6.8 days in the remainder of the year. In only 3 months did wind from the east exceed 2 days per month. Monthly wind speeds are also contained in Appendix I.

Wind has an obviously greater effect upslope towards the Ushaw station. The major influence of the wind on farming practice in the Browney/Deerness area may be summarised as:-

- (i) A severe curtailment of annual cereal crops on the ridge tops.
- (ii) In the autumn, due to the prevalence of cold winds, the hill top cattle need to be housed some 10 to 14 days before the valley floor cattle.
- (iii) The minor problem of soil erosion, although minimal, is still to be considered. The spring ploughed fields are ripe for erosion - especially as a result of the light spring rainfall and the strong winds blowing from the north-east quadrant.
- (iv) At the height of Ushaw, few problems are met in coniferous planting, but upslope such plantations become less common.

While climate is the attribute which has the greatest general effect on agriculture in the area, other attributes, in particular, soil and geomorphology, influence the detail of the agricultural pattern.

B.5 GEOMORPHOLOGY

The solid geology of the study area is entirely composed of carboniferous rocks of the Coal Measures group. The working of this group of rocks entirely transformed the economy of West Durham during the nineteenth century and the legacy of this, and later activity, has caused the environmental problems evident today in the Browney and Deerness valleys.

Calvert (1884/1) states that the distinctive name of Coal Measures is applied to the whole of the rocks between the Millstone Grit deposits and the Permian rocks (Magnesian Limestone). Millstone Grit forms the surface rock of most of the hills to the west of the country; but dips under the Coal Measures in the Browney/Deerness region. The Coal Measures, which lie at the top of the Carboniferous strata, are divided into Lower, Middle and Upper divisions. The Lower Coal Measures are a sandy series, with mainly thin coal seams, forming a wide outcrop along the western margin of the Durham coalfield. Most of the thick productive seams, however, occur in the Middle Coal Measures, which occur in East Durham, while the Upper Coal Measures are shaly and contain very few coal seams. The latter do not outcrop anywhere in the Browney/Deerness area.

In the county of Durham, the Coal Measures attain a maximum thickness of 2,000 feet plus, but in the area under survey, the seams are much shallower and a total of 1,200 feet of strata is represented. The lower coal bearing deposits have been proved by mineshafts and the bore holes of the National Coal Board (Bramley 1971/1).

Appendix III shows in diagrammatic form the Lower and Middle Coal Measures which are represented in the Browney/

Deerness area.

It should be noted that coal seams seldom average more than 5% of the total volume of the Coal Measures, (British Regional Geology 1945). Seam thicknesses vary greatly in the region, from the six-inch Ruler to the 10 feet of the combined Five Quarter and Main seams. Any individual seam may also vary very greatly. This is due to the environment which prevailed during their deposition - distributaries within the carboniferous delta might change course, washing out peat in places or producing basins in which much thicker deposits were formed. Alternatively, emergence could cause a temporary break in deposition, whilst deeper submergence could cause pyrite rich mudstone bands to form. (Bramley 1971/2).

The Surtees Society (1884), give some nineteenth century information on the working of some of these seams including seam thickness, for example:-

"Broompark Colliery 1860 (246 416)

29 fathoms Hutton 3 ft. 6 ins. - prize gas coal

64 fathoms Harvey 2 ft. 0 ins.) excellent

75 fathoms Busty 6 ft. 6 ins.) coking

94 fathoms Brockwell 3 ft. 2 ins.) coal

Bearpark Colliery 1871 (243 435)

57 fathoms Hutton

66 fathoms Busty

"The coke here occupies 50 ovens, produces benzol oil and ammonia and coal tar and occupies 1,000 men and boys. At Ushaw Moor Colliery, (223 427), is being worked the Busty seam which contains a band which widens greatly to the west, the top coal is 1 ft. 10 inches thick, the bottom coal 3 ft. 6 inches. This colliery, sunk about 1865, employs 500 men. At Hill Top Colliery (207 443) the Hutton seam is worked to a

small extent and the drift is about 4 ft. thick."

In relating geology to topography, the most striking feature is the presence of sandstone scattered across the ridge tops. These carboniferous sandstones are to be found within 12 to 18 inches of the surface. It occurs frequently on the Browney-Deerness interfluvium, but less so on the northern slopes of the Browney and the southern slopes of the Deerness.

"The present landscape is only the current stage in a long continuum which began with the emergence of the area from the late Mesozoic seas in which Cretaceous sediment had been deposited. The Cenozoic in Durham has been dominated by erosion and it is this erosion that has been responsible for the larger elements of the present landscape. But, erosional processes have been complex and varied - marine, fluvial, and glacial features have all played important parts."

(Francis 1970/1).

The movement of elevation that began in early Tertiary times and culminated during the Miocene period, ushers in the most influential cycle of river development in north-east England. The elevation was greater in the west and, hence, the land sloped gently from the Pennines towards the east, corresponding roughly with the dip of the strata. Consequent streams with their sources in the Pennines, developed. An era of sub-aerial denudation held sway over Northumbria and continued without a break from the Miocene to the Glacial period. It was during this protracted epoch that the pre-glacial valleys of the Northern Counties were developed, the escarpments of Tynedale and Weardale gradually evolved, and the broader features of the present topography were formed. (Woolacott 1907).

The West Durham Plateau, of which the Browney and Deerness interfluves form extensions, comprise the mass of high ground which lies between the valley of the middle Wear and the approximate line of the 1250 ft. contour. The upper part consists of an undulating, little dissected, plateau which lies between 930 ft. and 1160 ft., but which is best developed between 1000 and 1050 ft. in the vicinity of Tow Law. The surface forms the even skyline of the Plateau throughout the whole of the western horizon. The Plateau surface is remarkably evenly preserved along the interfluves, in contrast to the steeply sided valleys of the eastward flowing Deerness and Browney, which drain the Plateau. The surface of this Plateau represents the eastward continuation of the 1000 ft. platform seen in the region of Tow Law and has a similar origin. According to Maling (1955/1) it may represent the structural dip slope of the Carboniferous strata; an exhumed sub-Permian surface, or it may be the summit surface of a later period. Alternatively, if the surface of the Plateau can be sub-divided into facets of similar altitude, these may represent marine surfaces of late Tertiary age. Maling then argues that the first of these speculations, representing the structural dip slope of the Carboniferous strata cannot be supported although it is clear that the regional dip of the Carboniferous strata approximates closely to the eastward gradient of the Plateau surface. In certain places, the dip of the rocks is slightly steeper, so that successively younger blocks are exposed towards the east. Along the interfluves, which are composed mainly of Upper Coal Measures and Middle Coal Measures, the dip of the individual seams is greater than the gradient of the Plateau. It also cannot be shown that the surface is disturbed along the

lines of the major faults, although a break in surface profile may be recognised where the Deerness fault crosses the Browney-Deerness interfluve. This is to be seen in the region of Low Esh (204 449). Similar faults do not, however, shift the surface configurations. If the base of the Permian is extrapolated westwards, assuming that the dip remains constant, and the Permian rocks are not disturbed by faulting, the level of unconformity rises more quickly than the surface of the Plateau. There are few significant faults with a north-south trend which could affect the Permian. For these reasons, Maling concludes that the surface of the West Durham Plateau and hence the three interfluves of the region, are either the remnant of a Tertiary peneplain, or a marine platform.

The glaciation of the North-East has left a marked imprint on the landscape in the form of till deposits. The National Coal Board has made some 30,000 drillings and borings over the Northumberland and Durham coalfield but the majority of these are not available to the public. However, 22 of these borings and drillings are shown on the Six-inch Geology sheets covering the Browney /Deerness area, and these give some indication of the variability of drift deposits resulting from glaciation (cf. Appendix IV).

The thickness of the drift cover differs even within relatively short distances. For instance, borings 18 and 19 at 198 454 and 190 452, a distance apart of some 550 yards, at almost the same heights above sea-level, have a drift cover of 135 feet and only 12 feet respectively. Numbers 2 and 4 are 230 yards apart but Number 2 is at a height of 520 feet (206 421) where the sandstone occurs at a depth of 4 feet. In contrast Number 4 is lower down the slope at a height of 360 feet (205 424) and here the drift cover is 85 feet.

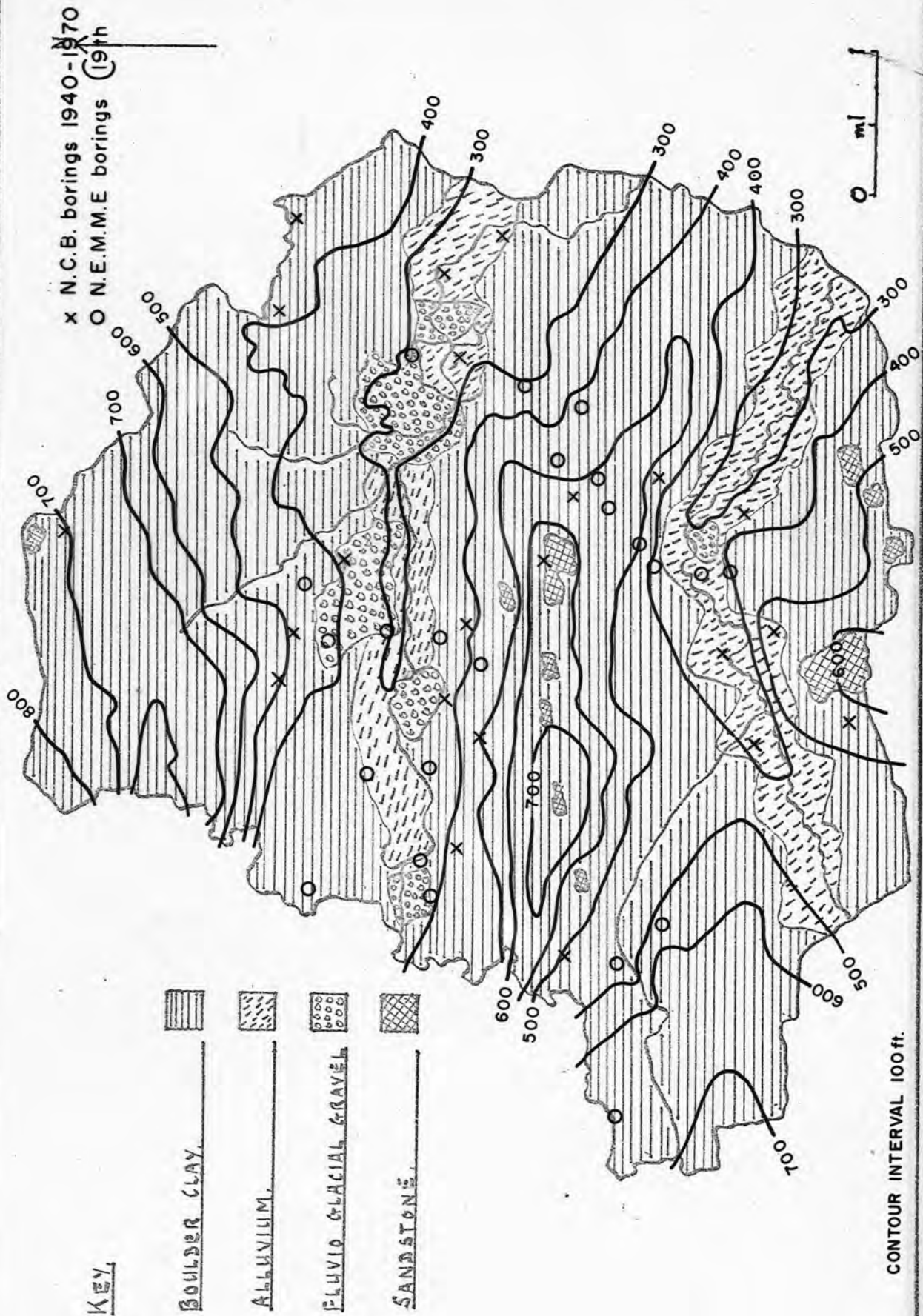
Appendix V gives more detailed information on the thickness of drift cover. It shows the work of the North of England Institute of Mining and Mechanical Engineers (1900). Many hundreds of borings were sunk during the 19th century in the Northumberland and Durham coalfield. Twenty-three of these borings were in the Browney-Deerness region. These borings are accurate to within approximately the nearest six inches and were sufficiently scientific to be still used by the National Coal Board. They were made over a period of many years and although the nomenclature varies slightly, they are a reliable source of evidence on the depths of the drift cover. The locations of the two sets of borings shown in Appendices IV and V are shown on the overlay on the geological map (Map 4).

The interfluves, which Trotter (1929) describes as "a tilted and dissected peneplain, originating from later Tertiary movements," do in general, lack the drift of the slopes or the valley floors. It can be assumed that over the area as a whole, the drift only becomes appreciable below a height of 500 feet.

Francis (1970/2) states that the drift cover on the ridges is generally thin and impersistent. He concluded that the principal drift deposits took place on the valley floor. In mapping the soils of the area, the sandstone was reached on occasions on the interfluves, but never in the valley floor itself.





Woolacott (1921/1) sounds a note of the caution "in my extensive study of drift in Northumberland and Durham, I am convinced of its complexity." Maling (1955/2) is able to point out discrepancies in the geological maps themselves, "the important facet upon which stands Ushaw College, rises gently to between 600 feet and 630 feet, but according to the

Map 4. Geology Map of Browney-Deerness



x N.C.B. borings 1940-1970
 o N.E.M.M.E. borings (19th)

KEY.

-  BOULDER CLAY.
-  ALLUVIUM.
-  FLUVIO GLACIAL GRAVEL.
-  SANDSTONE.

CONTOUR INTERVAL 100 ft.

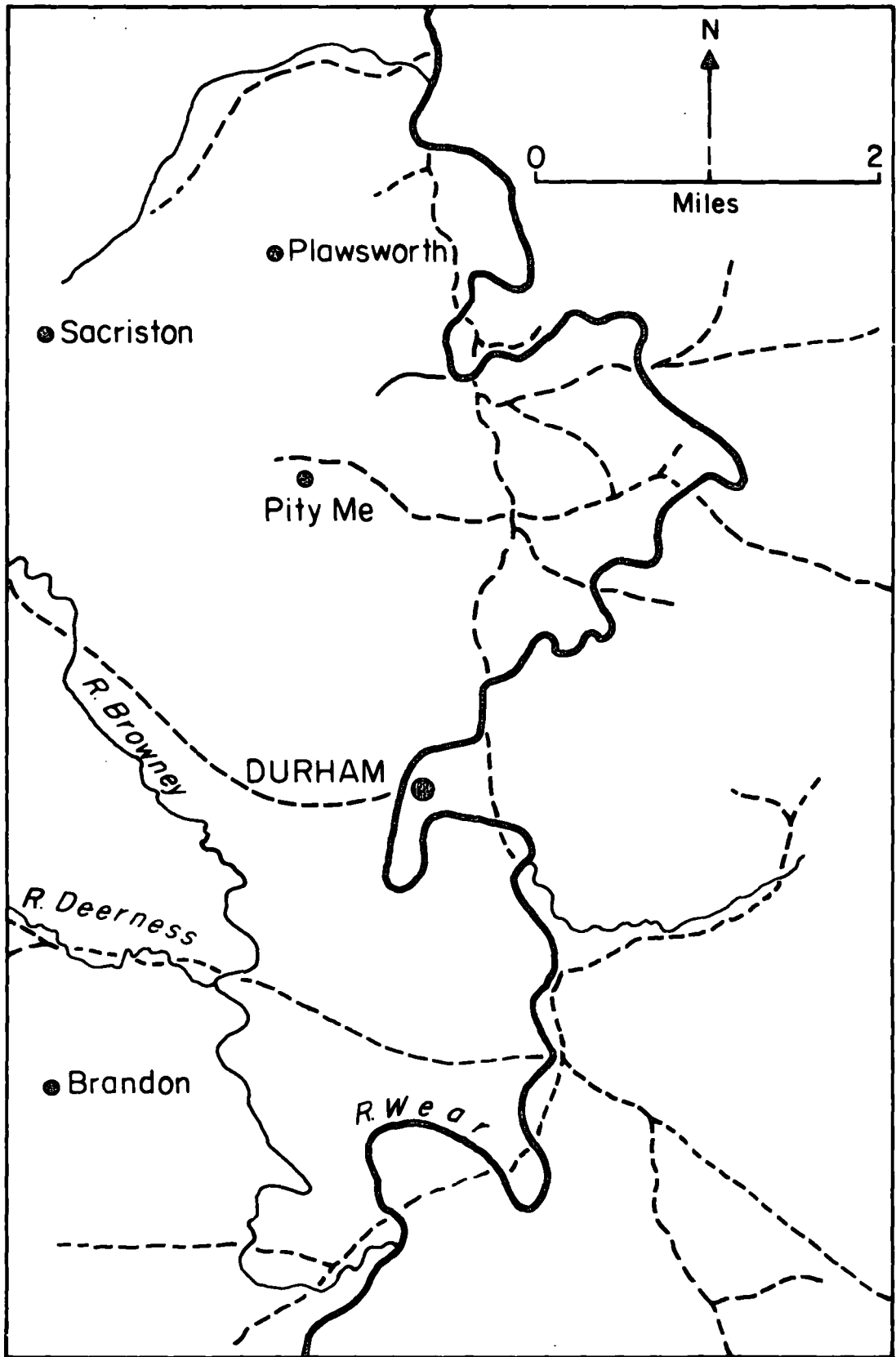
Geological Six Inch sheets, this part of the plateau is shown to be drift free, yet a recent opencast boring, close to the break in the 620 ft. contour line, proves no less than 19 ft. of drift." The opencast executive give the date of the boring as 1952, at O.S. reference, 213 438. The drift cover map, clearly shows the overlay of drift. From the numerous borings of the N.C.B. and the North of England Institute borings, it would be safe to draw the general conclusion, that the major drift deposits are to be found on the middle and lower slopes and the valley floors.

According to Woolacott (1921/2) the difficulties met with in working out the sequence of the drift deposits are due to several causes. Firstly, the irregular surface upon which it rests. Secondly, the possibility of the moraine profonde of one ice stream being overlain by that of another from a different region during one continuous period of glaciation. Thirdly, the possibility of some deposits being laid down by water without even an interval in the glaciation. Fourthly, the possibility of one moraine profonde of a particular ice age stream being entirely removed by another ice flow with an interglacial period between. Fifthly, the result of these, the complex manner in which the beds change from one point to another, so that it becomes increasingly difficult to correlate them.

One of the major features of the drainage patterns of the Wearlands is this system of buried valleys associated with the present rivers (cf. Map 5). This was first recognised by Wood and Boyd in the mid 19th century. Studies undertaken since that time show that the buried valleys systems were filled with great thicknesses of glacial deposits. All the major valleys have extensive glacial drift deposits as well as most

Map 5

BURIED VALLEYS OF CENTRAL DURHAM



(After Francis)

----- BURIED VALLEYS

of the small tributaries, including the Browney and the Deerness (Beaumont 1970). Woolacoot was able to use the findings of Boyd and Wood, together with the borings and sinkings of the Institute of Mining Engineers, to show that buried valleys existed between Durham and Bishop Auckland and that smaller buried valleys, corresponding to the Browney and Deerness, appeared to form tributaries of the Wash (Woolacott 1905). (The term 'Wash' is commonly used to define the buried Wear and its tributaries.) Holmes, (1933) indicates the probably confluence of the Browney buried valley with that of the Wear at Durham City. From the Geological Maps it is often possible to determine the middle lines of these valleys with great precision. Map 5 shows the positions of part of these buried valleys.

The most widespread of these drift deposits is Lower Boulder Clay (Beaumont 1970) which nearly always rests upon solid rock. The till is stiff dark grey or grey brown sandy clay, in the Wear and its tributaries it contains much Carboniferous material. These tills are in many places compact and tough, with large boulders, mainly of local origin. This deposit forms an almost continuous thick mantle over the lower Wear valley and its tributaries. The cover becomes more patchy as higher levels are reached. (Hickling and Robertson 1949/1).

These tills probably represent the basal tills of the major ice sheet moving in an east-east south east direction towards the present coastline. Beaumont (1970/2) considers them to be the product of maximum glaciation in the country. Outcrops of solid rock are very infrequent (in 150 soil pits in an area of 12,000 acres, solid rock was encountered only in the ridge top sandstones and basal glacial deposits are

poorly exposed.

Above this lower boulder clay is commonly found a more sandy brownish clay with small boulders and pebbles. It is thin, mostly less than 10 feet in thickness, and the included fragments commonly contain a notably high proportion of far carried material from Shap, the Lake District and the Southern Uplands. This is the so-called Upper Boulder Clay and is the most widespread of the glacial deposits (Hickling & Robertson 1970/2). Beaumont (1970/3) calls this "upper stony Clay," the Wear clay; it contains variable amounts of stones and shows considerable variation in texture and composition (cf. Appendix V on the Profiles and Borings of the Institute of Mining Engineers).

Hickling and Robertson (1949/3) state that the two clays are sometimes separated by sands and gravels, which have consequently been regarded as indicating an inter-glacial episode. In other cases, the lower clay appears to merge into the upper. In various areas, a similar upward grading of boulder clay into laminated silty clays is to be found; thence, into sand and gravels. All of these vary enormously in thickness.

The drift in the Wear tributaries is, according to Maling (1955/3), commonly distributed asymmetrically. He notes the contrast between the steep and generally straight slopes on the north side and the hummocky topography on the south side of the valleys. This is clearly to be seen in the Browney valley. On the north side, a long gentle slope (gradient 3° - 5°) stretches for two miles north of the Browney on Broom House Farmland, while south of the river below Ushaw College is a distinctly hummocky ridge (Square 2244). Here, fluvio glacial sands are developed on sandstones.

In the Browney valley, in the Witton Gilbert area (Square

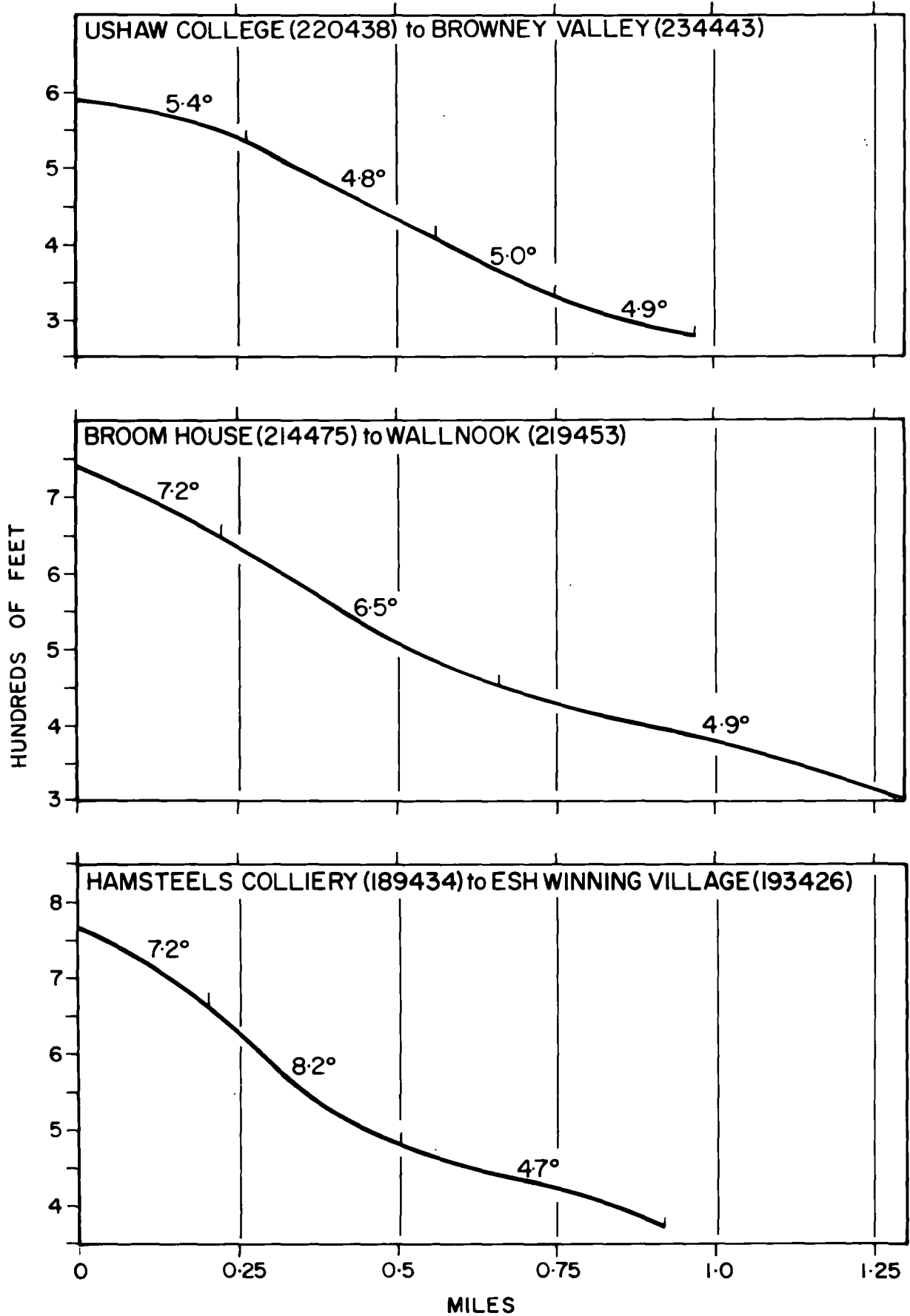
2345), a sequence of sands, gravels and clays is to be found. The surface of these deposits rises gently to a little over 325 feet. This height level is comparable with many other areas in central Durham in which fluvio-glacial deposits are to be found. (Frances 1970/3). These sands and gravels are of an outwash deltaic type. This thick spread of broad flat topped hills, which stretches through Witton Gilbert to the south of Durham to the north to Chester-le-Street, is banked against the rising ground to the west. The form of this deposit, the relative cleanness of the material and the strong current bedding suggest an origin as a true delta in a glacial lake. The near coincidence of their summit level with that of the great overflow channel at Ferryhill support this conclusion (Hickling and Robertson 1949/4). This fluvio-glacial sand and gravel is believed to represent the material swept into the late Pleistocene lake through an extensive series of overflow channels which swing round from the north-east foothills of the Pennines to Waldrige Fell (252 496) (Dunham and Hopkins 1958).

The essential physical features of the area are summed up by Calvert (1884/2), "The Browney rises on the moors near Burn Hill, (082 444, Sheet 84). The Deerness, its chief tributary, rises at Tow Law, (122 392, Sheet 84), and with the other tributaries, Rowley Burn, (rises at 166 413), and Hedley Hope Burn, (rises at 135 408), drains a very large area of rough countryside, (some 30 square miles would be an approximately accurate catchment), characterised by a succession of steep hills and deep valleys." Some indication of the topography of the area is given in Figure B5/13.

Much of the rainfall of the Pennine Moors is absorbed by the workings of the numerous collieries and the porous sand-

Fig.B5/13 (i)-(iii)

SLOPE TRANSECTS



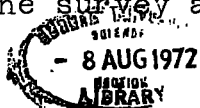
stones. This is shown by the fact that the separate streams, Deerness, Hedley Hope and Rowley are small in proportion to their length and even the united waters form a much smaller stream than might be expected from the large catchment area. For example the Deerness is 12.7 miles long, before the entry of the Hedley Hope and Rowley Burn at 202 421, and is rarely more than 6 feet wide. After the entry of the minor tributaries, the width increases to approximately 10 feet, but in only one or two places does the width exceed 12 feet. In addition, the soft strata tend to be deeply incised and denuded by many small streams e.g. Kaysburn, (225 451), Bleachgreen Burn (222 455), Redburn (226 419).

The interfluves are high and broad in proportion to the sizes of the streams. In fact, the distance between the 600 foot contours, on the northern and southern slopes of the Browney measured along the ground, is 2.4 miles. At the 22 **nd.** Easting, the Browney is only 12 feet wide. The distance between the 600 foot contour, on the northern and southern slopes of the Deerness, measured along the ground, is slightly under 2 miles and, again, the river Deerness at the 22 **nd.** Easting, is only slightly over 8 feet wide.

B.6 SOIL

Land capability classification is basically a form of soil survey interpretation. Soil conditions are "specific and local and permanent, thus a soil survey must be completed in sufficient detail to include all the factors affecting the use and management of the soils" (Kellog, 1951). In practice, the correct use or planning of land use involves so many criteria that, in order to classify and evaluate soils, "the only solution is a compromise one, to attempt to find visual key criteria, which correlate with most of the criteria, visual and analytical, which we deem necessary and important for most foreseeable purposes." (Gibbons, 1961). The soil must not be considered in isolation, but relevant environmental data must also be collected.

Hilton (1962/2) gives some principles which are applicable to all surveys. Objectivity must be a prime aim, though it becomes increasingly difficult as a balance is sought between many dissimilar factors. As a result, subjectivity is always present, though it can be valid if placed within the framework of a methodological approach. Furthermore, while there is some degree of generalisation within any classification, a detailed local study is still the basis of all levels of classification. This study of the Browney/Deerness area is a reflection of this latter principle, reflecting, as it does, the typical environment of the west Durham coalfield. In addition, it also falls within the limits set by Hilton's final principle, namely that the system chosen should be within the range of personnel and facilities that are available. Unfortunately, there was an absence of air photographs at the time of the survey and consequently this had to be



based on map work and visual interpretation of soil boundaries.

The method of survey employed was basically that of the free survey approach. The land surveyed covered some 25 square miles and a system had to be evolved that took cognisance of different altitudes, slopes and aspects. Some 150 sites were chosen, keeping in mind the various attributes which can affect land capability. Key criteria included depth of soil, drainage status, moisture holding capacity, stoniness, slope and climatic limitation.

The soil types that were recognised during the survey were developed on four parent materials; alluvium, fluvio-glacial deposits, sandstones, and overwhelmingly in this region, till derived from Carboniferous rocks. Much soil has been disturbed by man in his search for coal, though in recent years some has been reclaimed. It was felt necessary to separate this class from those formed by more natural pedogenesis. The nomenclature applied to each soil type seems to fit well into the pattern of the district and are used here for the first time. The soil survey of Englands reconnaissance Map of Durham, which was completed during World War II, classifies the soils of the district under three main series (R. Jarvis and J. H. Stevens 1969).

(1) Newburn Series

Type:- Sandy loam, loamy sand. Topography:- high ridges

Site drainage:- Seasonal drought Profile drainage:- excessive to free

Parent material:- Coal Measure Sandstone

Profile:-

1. 0-7" yellowish brown. Few stones, nutty structure, porous.
2. 7" bright yellowish brown micaceous sandy brash. Weathering rock.

This appears to be essentially similar to the Ushaw series described by the author (page 111). The justification for choosing a separate name from that of the Soil Survey of England and Wales is two-fold:-

- (i) It has not proved practical to correlate the soils in the Browney/Deerness area with the type area of the Newburn series.
- (ii) Apart from the sketchy profile described above, no further information about the Newburn series is recorded by the Soil Survey.

2. Improved Croxdale Series

Type:- loamy, sandy loam. Topography:- rolling slopes.

Site drainage:- Seasonally wet. Profile drainage:- Imperfect

Parent material:- Coal Measures Till.

Profile:-

1. 0-10" dark brown to brown, stony, crumb structure.
Porous and friable.
2. 10-21" bright yellowish-brown loam to sandy loam, very strong, fine cloddy structure, slightly compact, mottles; occasional MnO₂.
3. 21" yellow-brown true sandy clay loam with greyish tinge, numerous boulders, cloddy structure, compact MnO₂, mottling and grey coating on faces of structural elements.

3. Croxdale Series

Type:- sandy loam, loam. Topography:- undulating.

Site drainage:- seasonally wet. Profile drainage:- impeded.

Parent Material:- Coal Measures Till.

Profile:-

1. 0-8" dark grey-brown, stoneless, fine cloddy structure, compact, much rusty mottle.
2. 8-12" dark grey-brown loamy sand similar to 1.
3. 12-24" yellowish-brown coarse sandy clay loam with grey marbling, many stones. Prismatic structures, fissures and tenacious rust and MnO_2 mottling.
4. 24" dark brown sandy clay loam with blue-grey marbling. Many stones and occasional boulders. Similar to 3.

These two series appear to be similar to the Esh and Broom series (pages 114 and 118)respectively. However the textures as recorded by the Soil Survey of England and Wales is much lighter than that in the author's experience and consequently new series names were decided upon.

SOIL TYPESSoils developed on Alluvium (Browney/Deerness Series)

Of the 140 pits investigated, 16 were soils developed on alluvium - six in the Browney valley and the remainder in the Deerness valley. All profiles were located at elevations of 250-350 ft. and were located on level ground or ground that was only slightly undulating. All sites were on, or close to, the contemporary flood-plain. Three of the profiles were located on derelict land subject to annual flooding and/or surrounded by pit waste, one was being reclaimed, one was under permanent pasture and the remainder were located in arable fields in which there was an emphasis on root crops.

Profile development varies from site to site but depositional horizons of varying textures predominate. The soils developed on the higher, older terraces, resemble the soils

of the valley sides, e.g. at Unthank Farm (233 417). The soils provide the deepest rooting zone in the area, often over 40 inches, and are either freely or imperfectly drained, except where the profile was located on derelict land or on land subject to flooding, in which case mottles were frequently observed in the profile and some **gleying** was evident.

The soils are of a moderately coarse-coarse texture with sandy loams predominating. Structure is weakly developed, especially in the lower parts of the profile and consists mainly of medium crumbs, sub-angular blocks or single grains. A feature of these soils was that there was a virtual absence of stones and their soft or friable consistence resulted in their use for arable cultivation, especially root crops.

Soil: Browney/Deerness Location: 222 454 Parent material: Undifferentiated alluvium

Topography: Level ground Land use: Permanent pasture

Drainage: Free/imperfect above water table Height: 303'

- 1.5 - 0 ins. Partly decomposed grass roots: very dark brown.
- 0 - 3.5 ins. 7.5 YR 3/2 (dark brown): loamy sand; weak, large crumbs; friable, moist; abundant fine roots; no stones; abrupt change
- 3.5 - 7.5 ins. 10 YR 3/4 (dark yellowish brown); silty loam; small weakly indurated fragments; friable, drier; plentiful finer roots; no stones; merging gradually with
- 7.5 - 39.5 ins. 10 YR 3/4 (very slightly darker brown); loam; fine crumbs; friable; moist; roots, very few, fibrous; no stones; fairly distinct boundary with
- 39.5 - 64.5 ins. 10 YR 3/3 (dark brown); loam; fine crumb; friable; damp; no roots; no stones.
- 64.5 ins. gley waterlogged horizon - water table.

Laboratory Analysis

Sample depth	USDA limits			pH	O.M%	O.C%	N%	C/N ratio
	Sand %	Silt %	Clay %					
0.5-3.5"	67.7	21.4	10.9	4.70	4.69	2.72	0.22	12.4
4-7"	48.0	37.7	14.3	4.80	N/A	N/A	N/A	N/A
22-25"	64.7	22.3	13.0	5.10	N/A	N/A	N/A	N/A
52-55"	72.7	15.8	11.5	6.15	N/A	N/A	N/A	N/A
Sample depth	Available Phosphate mgms/100 gms.	CATION EXCHANGE CAPACITY me/100 gms.						
		Ca	Mg	K	Na	H	Total	
0.5-3.5"	0.75	2.70	0.50	0.04	0.52	25.20	28.96	
4-7"	N/A	2.00	0.23	0.03	0.85	20.60	23.71	
22-25"	N/A	0.50	0.33	0.03	0.42	18.55	19.83	
52-55"	N/A	3.70	1.53	0.03	0.58	17.60	23.04	

Soils developed on Fluvio-Glacial Gravels (Witton and Gilbert Series)

The soils based on this parent material are found chiefly around the settlement of Witton Gilbert. The surfaces of these gravel deposits rise generally to about 325 feet, forming a series of broad, flat topped hills. (Francis 1970). All the 10 profile sites examined were located on undulating ground. The predominant land use at the sites is root or wheat cultivation. Generally amounts of clay present in the profile are low, resulting in free drainage, but where the clay content is above about 25%, drainage is imperfect. In such profiles some mottling was evident. The Witton series includes the imperfectly drained soils while the freely drained soils are included in the Gilbert series.

There are several major observable differences between the two series Witton and Gilbert. The Gilbert series, freely drained, tends to have a thicker solum (48-72 inches, compared to above 25-40 inches in the case of the Witton series).

In the Witton series, more red and orange mottles are evident. There is a greater amount of clay present in the Witton series than in the Gilbert, averaging 25% in the Witton series and 15% to 16% in the Gilbert series.

The Gilbert series are much easier to work as farm land, being less waterlogged in the winter. Stones are present throughout the profile of the Witton but only in the lower horizons of the Gilbert, generally below about 36 inches. The texture of the Witton tends to be finer because of the increased clay content. The structure of the Witton series is also found to be much stronger, remaining blocky down the profile, while that of the Gilbert series become gradually single grain structure with depth. Consistency and constitution are everywhere much firmer in the less well drained series.

Soil: Freely drained fluvio glacial gravels, Gilbert Series

Location: 233 448 Parent Material: Fluvio-glacial gravels

Topography: Undulating - slope at profile site 3° - aspect - southerly.

Drainage: Free Land use: Wheat Height: 325'.

- 1.0-0 ins. partly decomposed cereal stubble, root molten abundant; very dark brown.
- 0-5 ins. 7.5 YR 4/2 (dark brown); silty loam; small weakly indurated fragments; very friable; abundant roots, no stones; merging gradually with
- 5-13 ins. 7.5 YR 6/4 (light brown); loam; large crumb; friable; dry; medium roots, no stones; abrupt change to
- 13-18 ins. 10 YR 7/8 (yellow); sandy loam; large crumb structure; very friable, fine root fibres, small stones evident, appreciable change to
- 18-48 ins. 10 YR 8/8 (yellow); sand; single grain structure, very friable; few fine roots; larger stones.
- 48 ins. gravelly parent material.

Laboratory Analysis

Sample depth	USDA Limits			pH	O.M%	O.C%	N%	C/N ratio	
	Sand %	Silt %	Clay %						
1-4"	46.5	38.3	15.2	6.05	5.42	3.20	0.26	12.3	
8-11"	66.3	22.5	11.2	6.25	N/A	N/A	N/A	N/A	
14-17"	61.0	21.0	18.0	6.00	N/A	N/A	N/A	N/A	
30-33"	91.7	2.0	6.1	5.95	N/A	N/A	N/A	N/A	
Sample depth	Available Phosphates mgms/100 gms.			CATION EXCHANGE CAPACITY me/100 gms.					
				Ca	Mg	K	Na	H	Total
1-4"	0.37			3.60	0.85	0.30	1.06	15.60	21.41
8-11"	N/A			3.00	1.08	0.03	1.58	21.60	27.29
14-17"	N/A			3.70	0.85	0.04	0.54	16.30	21.43
30-33"	N/A			3.55	1.08	0.06	0.68	14.30	19.67

Soil: Imperfectly drained fluvio glacial gravels, Witton series

Location: 221 457 Height: 320 feet. Parent material: Fluvio-glacial gravel

Topography: Undulating - slope 4%. Southerly aspect.

Drainage: Imperfect. Land use: root crops (turnips).

- 0-9 ins. 7.5 YR 4/2 (dark brown); silty loam: weakly indurated fragments; friable; abundant fleshy roots; stones up to 10% of mass of sample. Clear boundary with
- 9-17" 5 YR 4/4 (reddish brown); slight rust mottling; loam; large crumbly to blocky; moderate to firm; moister, roots abundant; stones up to 15% of mass of sample. Clear boundary with
- 17-21" 5 YR 6/4 (reddy orange brown); sandy, clay loam; sub angular blocky; damper (mottles increasing); firm but friable; medium, fine roots; stones 15% of sample mass. Clear boundary with
- 21-27" 5 YR 5/2 (reddish grey); sandy clay loam; angular blocky; mellow, friable, very moist (many rust mottles); roots fine, fibrous; stones up to 20% of mass.
- 27" + Gravel.

Laboratory Analysis

Sample depth	USDA Limits			pH	O.M%	O.C%	N%	C/N ratio
	sand %	Silt %	Clay %					
2-5"	49.80	29.80	20.40	6.00	6.14	3.54	0.32	11.1
12-15"	56.20	23.50	20.30	6.35	N/A	N/A	N/A	N/A
18-21"	57.40	16.30	26.30	6.05	N/A	N/A	N/A	N/A
22-25"	58.90	14.50	25.60	6.30	N/A	N/A	N/A	N/A
Sample depth	Available Phosphates mgms/100 gms.		CATION EXCHANGE CAPACITY me/100 gms.					
			Ca	Mg	K	Na	H	Total
2-5"	0.51		2.20	0.31	1.38	0.55	40.10	44.54
12-15"	N/A		1.20	0.31	0.98	0.55	40.10	43.14
18-21"	N/A		1.30	0.22	0.97	0.53	48.00	51.02
22-25"	N/A		1.20	0.21	1.00	0.38	47.60	50.39

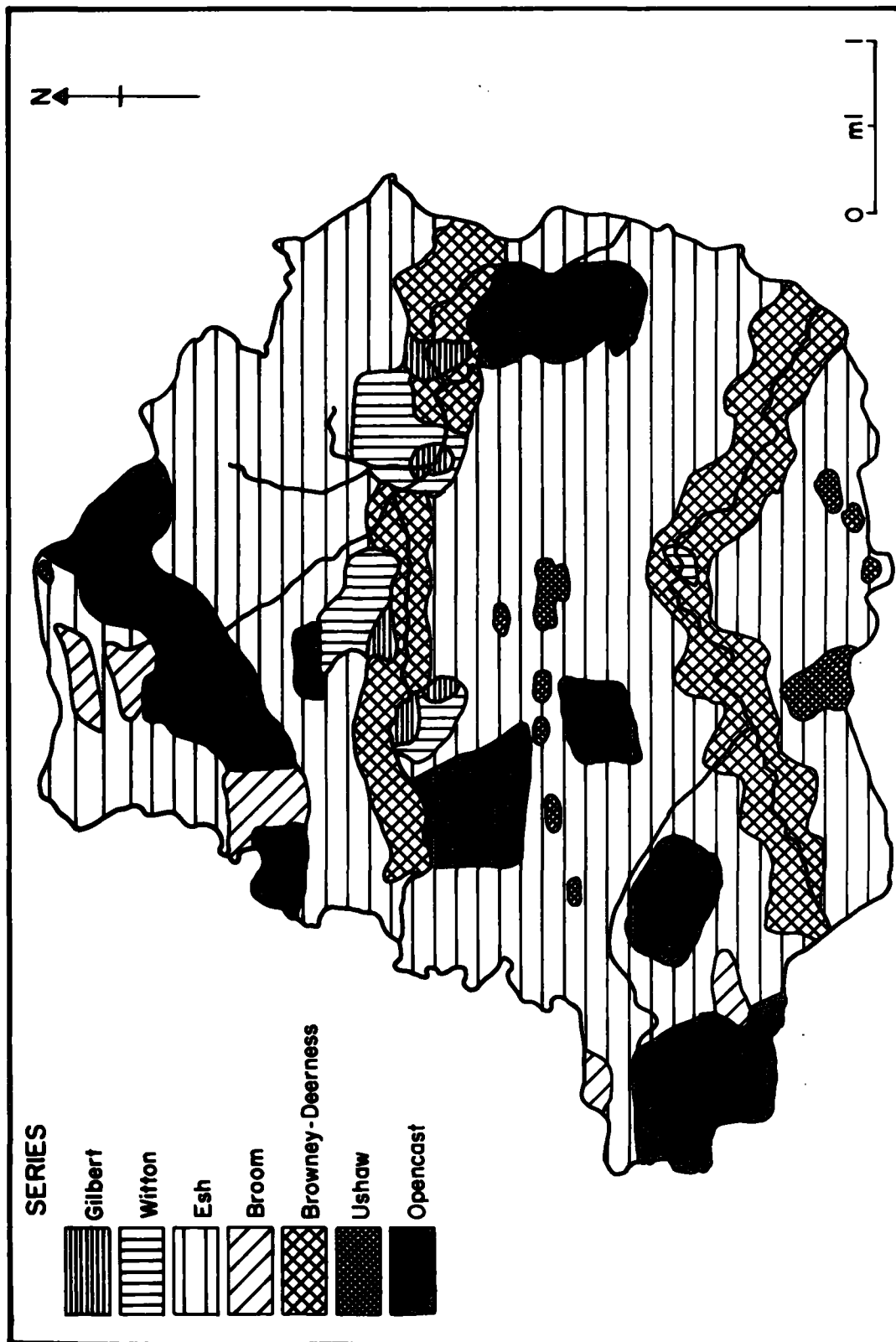
Moisture increases with depth in the Witton series but not in the Gilbert series.

Soils developed on sandstone (Ushaw series)

As the soil map, Map 6, reveals, this series tends to be confined to small patches along the inter-fluve ridges. This series has the smallest areal extent in the study area, being restricted to the limited outcrops of sandstone that occur on the ridge tops. The sites of the profiles are exposed, shelter being almost absent. Hence cropping practice is as much restricted by unfavourable climate as by the shallow depth of soil. All the sites were under grassland, generally of permanent rather than of the rotational variety.

In this series, the depth of the soil is inevitably restricted, often rarely in excess of 12 inches, though on one site a depth of 30 inches was recorded. The profile quoted is rather typical of the whole series. Land use at the sample site is in permanent pasture, with a liberal growth of thistles. The profiles are usually freely drained, although in two cases, slight rust mottles were noticeable, possibly due to weathering sandstone fragments in the profile. The soils tend to be well aerated. Structure is everywhere crumby to cloddy. Textures tend to be moderately coarse, usually sandy loam to sandy clay loam. Consistency is normally friable. Stoniness would be a major drawback to ploughing, with many of these soils often attaining 23% to 30% stone content within six inches of the surface.

Map 6. Soil Map of Browney-Deerness



Soil: Ushaw Sandstone Series Parent Material: Coal Measure sandstone

Location: 215 443 Height: 628 feet.

Topography: Undulating - slope 4° - 5° . northerly aspect.

Drainage: Free Land use: Rough grazing, nettles, thistles.

- 1-0 ins. vegetation matter; little decomposition of grass roots.
- 0-4 ins. 10 YR 4/3 (brown); sandy clay loam; large crumbly to sub angular blocky; firm; drainage - free; roots plentiful; stones 15% of mass sample; gradually merging to
- 4-12 ins. 10 YR 5/3 (lighter brown); sandy loam; large crumb structure; friable; plentiful roots; drainage - free; stones - 20% of mass sample.
- 12 ins. + weathered loose sandstone.

Laboratory Analysis

Sample depth	U.S.D.A. Limits			pH	O.M%	O.C%	N%	C/N ratio
	Sand %	Silt %	Clay %					
1-4"	46.0	28.0	26.0	5.90	6.30	3.21	0.26	12.3
7-10"	50.6	25.0	24.4	6.01	N/A	N/A	N/A	N/A
Sample depth	Available phosphate mgms/100 gms.	CATION EXCHANGE CAPACITY me/100 gms.						
		Ca	Mg	K	Na	H	Total	
1-4"	0.37	3.65	1.17	0.94	0.72	23.20	29.68	
7-10"	N/A	3.20	1.11	0.91	0.65	21.10	26.97	

Soils developed on Tillis derived from Carboniferous Rocks

Broom and Esh series

The soils having a clay parent material are the dominant soils of the whole area. These cover over 60% of the area under study. Two different series can be distinguished which are either poor or imperfectly drained. Soils which show the effect of gleying have developed over about 25% of the area covered by the heavy drift and these soils have been included in the Broom series, while the imperfectly drained soils form the Esh series.

1. Broom Series

The series is generally found at heights of 450 feet or above on gentle slopes, (usually less than 8°). Much of the area covered by the series, particularly north of the Consett-Durham road, are in permanent pasture or coniferous plantation. Only in limited areas, usually on the steeper slopes, is this soil included in the normal rotation practice. The depths of the profiles do not vary a great deal, rarely being in excess of 3 feet. Profile horizons are more easily distinguishable than in any other series, because of the amount of mottling and gleying. Boundaries between horizons were everywhere clearly distinguishable. The soils tend to be of medium to moderately fine texture, poorly aerated and hence, somewhat lacking in faunal activity.

Structure varies from large crumb in the cultivated horizon, to large angular blocky in the subsurface horizons. Consistency is very firm. Stones amount to 25% to 30%, in some cases in the B horizons, with small boulders measuring up to 9 inches to 12 inches in length being found in the parent material. Almost all the horizons are cold and stiff, very compact and firm.

These factors, together with boulders close to the

surface, has prevented much of the series being ploughed out. Natural grassland or coniferous trees are the most suitable land use. Natural grassland was the only land use on this series until about 1900, when the first conifers were planted as a diversification of farm practice. The effect of coniferous plantations has been to reduce the amount of moisture present in the soil and to cause the formation of a distinct litter layer. As a result, soils occurring under coniferous woodland have been separated into different phases. The woodland phase has a distinctly lower pH value than the soils under grassland. The latter have certainly been modified by liming and fertilizer application.

On the whole, however, it can be safely assumed that the physical soil factors are of more importance than the chemical factors in assessing the value of the land, hence the value of stressing the physical characteristics of the soil. The nutrient status of soils may be entirely artificial, i.e. it depends on the system of management adopted and the purpose for which the soil is used. If the more permanent characters of depth, texture, drainage are satisfactory, then the nutrient status of an inherently poor soil may be built up.

The Broom series, as stated, show the effects of gleying and have been differentiated from the Esh series, which is an imperfectly drained soil. The profile descriptions would indicate a true gley soil, but "hydromorphic soils can be found in association with all zonal soils, anywhere in fact where water can gather in sufficient volume and for sufficient time to produce the effect of gleying" (Bridges 1970). It may be that the coniferous phase is showing a reversal of the gley processes and the soil is becoming an imperfectly drained soil.

Soil: Broom Series (Woodland phase) Parent material: Till derived from carboniferous rocks

Location: 204 476 Height: 710 feet.

Topography: gentle uniform slope - 4°-5°. Aspect - southerly

Vegetation: Coniferous plantation.

Drainage: Poor

- 1-0 ins. discontinuous litter layer of pine needles - dark brown.
- 0-2½ ins. 10 YR 2/1 (almost black); silty loam; small crumb structure; friable; very moist, partly decomposed humus, needles, roots, very evident; no stones. Clear break to
- 2½-8½ ins. 10 YR 4/3 (dark brown); sandy clay loam; sub-angular blocky; friable; becoming short moist; (rust mottles very evident); heavy, dense roots; stones 10% of sample mass. Well defined boundary with
- 8½-12 ins. 5 YR 6/2 (orange grey brown); sandy clay; angular blocky structure; moister (very heavy grey mottling), firm roots, numerous, woody; stones 15% to 20% of mass of sample. Merging with
- 12-24" + 5 YR 6/1 (grey, with orange and white speckled mottles and streaks); clay; blocky; very compact; roots plentiful, woody, stones 15% to 20% of mass.

Laboratory analysis

Sample depth	U.S.D.A. Limits			pH	O.M%	O.C%	N%	C/N ratio	
	Sand %	Silt %	Clay %						
0-2"	43.0	37.0	19.0	4.0	2.93	1.70	0.13	13.1	
4-7"	41.7	26.3	32.0	3.7	N/A	N/A	N/A	N/A	
9-12"	40.3	13.3	46.1	4.3	N/A	N/A	N/A	N/A	
17-20"	40.8	19.2	40.0	4.8	N/A	N/A	N/A	N/A	
Sample depth	Available phosphates mgms/100 gms.			CATION EXCHANGE CAPACITY me/100 gms.					
				Ca	Mg	K	Na	H	Total
0-2"	0.67			2.20	0.77	0.34	0.32	22.80	26.39
4-7"	N/A			0.70	0.16	0.12	0.32	17.80	19.10
9-12"	N/A			1.00	0.36	0.11	0.31	14.80	15.96
17-20"	N/A			2.90	0.97	0.13	0.32	12.46	16.78

Soil: Broom Series (Grassland phase)

Parent Material: Till derived from carboniferous rock

Location: 196 473 Height: 760 feet.

Topography: Undulating - slope 3°-4° - aspect southerly.

Vegetation: Permanent pasture.

Drainage: Poor

- 1-0 ins. Grass mat - partly decomposed, dark brown.
- 0-6 ins. 7.5 YR 4/2 (dark brown); silty clay loam; fine, large crumb; compact; roots, fine and fibrous; stones less than 10%. Distinct boundary with
- 6-18 ins. 5 YR 6/4 (strong orange brown with grey streaks and mottles); clay loam; angular blocky; becoming wetter; very firm, roots fine and fibrous; stones 15% to 20%. Clear boundary with
- 18-30"+ 10 YR 7/1 (light grey with white and orange streaks and mottles - very brightly coloured); clay loam; large blocky structure; very compact, roots almost absent; heavy gleying and water logging (after snow); no faunal life; stones 20% - (boulders large up to one foot in length).

Laboratory Analysis

Sample depth	U S. D. A. Limits			pH	O. M%	O. C%	N%	C/N ratio	
	Sand %	Silt %	Clay %						
2-5"	45.5	20.1	24.4	6.30	7.48	4.28	0.36	11.9	
9-12"	50.1	19.9	27.9	6.40	N/A	N/A	N/A	N/A	
21-24"	45.0	22.6	32.4	6.75	N/A	N/A	N/A	N/A	
Sample depth	Available phosphates mgms/100 gms.			CATION EXCHANGE CAPACITY me/100 gms.					
				Ca	Mg	K	Na	H	Total
2-5"	0.75			3.10	0.78	0.32	0.47	30.00	34.67
9-12"	N/A			3.70	0.49	0.24	0.39	27.12	31.94
21-24"	N/A			2.70	1.06	0.59	0.45	23.00	27.80

Esh Series

This series, an imperfectly drained soil developed on the glacial till, is the most extensive soil found in the study area. 64 profiles have been examined in a variety of sites on slopes of varying steepness, on the interfluves and also in the valley bottoms. The depths of the profiles are again very varied, with the A horizon being as shallow as 4 inches, or as deep as 26 inches, the latter occurring in locations along the base of the valley slopes. Two-thirds of the profiles examined have, however, A horizons of less than 12 inches in thickness. (This measurement includes the Ap horizon). Generally, the depth of the soil solum is about 36 inches. Some soils are, however, too shallow to plough especially those occurring on the higher slopes or ridge tops where there may be only a thin skiff of till.

Over three-quarters of the area covered by this series is devoted to grassland, generally this is ley grassland, but permanent grass occurs where the solum is very shallow.

The series is characterised by heavy textured soils. Analysis in the field and mechanical analysis in the laboratory reveals that silty clay loam is the dominant texture, occurring in 40% of all the samples with clay loam and silty loam slightly less common. The clay fraction increases down each profile, reaching up to 50% in the parent material.

Structure tends to be large crumb and granules, which are well aerated, in the A horizons under grassland conditions, while large angular blocks dominate the B horizons. Consistency also becomes firmer with depth.

Cultivation of this series can be very difficult and can only take place at specific moisture conditions. Increasing moisture with depth is a common occurrence in the majority of

Soil: Esh series Parent material: Till derived from Carboniferous rocks

Location: 175 433 Height: 550 feet

Topography: Uniform slope - 6°-7° - aspect north-easterly.

Vegetation: Barley Drainage: Imperfect

- 1-0 ins. abundant, partly decomposed, thick barley roots; dark brown.
- 0-3 ins. 7.5 YR 4/4 (dark brown); silty clay loam; large crumbs; compact; drainage dry; roots frequent; free-growing, fleshy; stones - nil. Gradual merging with
- 3-9 ins. 7.5 YR 5/4 (lighter brown); clay loam; large crumbs; firm; roots less frequent; drainage slightly moist; stones 5% to 10%. Merging with
- 9-14 ins. 7.5 YR 6/4 (lighter brown); clay loam; sub-angular blocky; very firm; moistening; roots becoming fine and few; stones 10%. Clear boundary with
- 14-42" + 7.5 YR 5/8 (orange brown clay with a few rust and grey streaks); clay; angular blocky, very compact, moistening; drainage imperfect; roots finer, very few; stones 15%+. No evidence of fauna.

Laboratory Analysis

Sample depth	U.S.D.A. Limits			pH	O.M%	O.C%	N%	C/N ratio	
	Sand %	Silt %	Clay %						
1-3"	45.3	26.7	24.0	6.15	6.98	4.05	0.25	16.2	
5-8"	48.5	25.5	26.0	6.35	N/A	N/A	N/A	N/A	
11-14"	38.5	25.5	36.0	6.35	N/A	N/A	N/A	N/A	
21-24"	12.3	38.7	36.0	5.50	N/A	N/A	N/A	N/A	
Sample depth	Available phosphates mgms/100 gms.			CATION EXCHANGE CAPACITY me/100 gms.					
				Ca	Mg	K	Na	H	Total
1-3"	0.62			2.70	1.08	0.98	0.54	27.60	32.90
5-8"	N/A			6.20	1.16	0.78	0.42	24.60	33.16
11-14"	N/A			6.00	1.05	0.76	0.35	13.00	21.16
21-24"	N/A			5.20	0.80	0.59	0.42	12.80	19.81

profiles, though nowhere is any permanent waterlogging evident. Mottling is everywhere present in the B horizons, mainly of orange and rust colours. In many B₂ horizons, some grey gleying is evident, but not to the same degree as in the Broom series. Stones also affect cultivation, because in only 5% of the A horizons are stones absent. In most A horizons, stones average 10% of the mass and may be up to 6 ins. to 9 ins. in diameter. Generally, stones increase appreciably to as much as 25% to 30% in the lower B horizons, though these are generally below the plough layer. Freeze-thaw action in winter can bring them into the surface horizons. Faunal activity decreases rapidly with depth.

Opencast series

Opencasting is an important feature of the region, and the reclamation of these sites is sufficiently important to justify the separation of these disturbed soils into a distinct series. In fact, the natural parent material in all cases was glacial drift. The sites chosen for opencasting were away from the alluvium and fluvio-glacial gravels for obvious reasons. 15%, or 21 of the site profiles examined had been opencasted.

As opencast methods have become more scientific, so the efficiency and care in replacing the soil has also increased. In the earliest workings in the early 1940s, the prime aim was to obtain as much coal as quickly as possible, and as cheaply as possible. Replacement of the land to its former usage was a secondary consideration. The policy was short sighted, much land was permanently damaged and this is reflected in the present land usage, where permanent pasture or coniferous woodland are the only forms of land use feasible.

Since the 1950s, both aims, cheap coal and replacement

of farmland, have received equal attention. This means that modern reclaimed soils are now very much better for agriculture than the earlier ones. Nevertheless, in only a third of the cases studied, however, has opencasted land been returned to the previous rotational pattern and there has been heavy dependence upon grass as the major crop. Furthermore, over the area covered by the opencast series, there has been a change in land use away from rotation crops to permanent pasture, particularly where the land had been opencasted in the 1940s and the subsoils were indiscriminately mixed with the top soils.

Profile drainage varies, with the earlier sites being less well drained than the ones reclaimed more recently. Gleying is evident in some B₂ horizons, but nowhere are soils as poorly drained as the Broom series. Both early and recent opencasting has meant an alteration to the drainage system, often leading to a great improvement in the old system of drainage, due to the installation of the tile drains. There has often been, however, considerable compaction of soils by heavy vehicles and this is very evident in the older A horizons where the crumb structure has been destroyed. This compaction has often ruined the beneficial effects of the artificial drainage laid down by the opencasters. In the newer opencast sites, soil structure is essentially similar to that of the Esh series - crumbs and granules under the grass sward and angular blocks at depth.

Textures throughout the series are generally silty clay loam, silt loam, clay loam or clay. Profiles are everywhere shallow and rarely does a recognisable A horizon exceed 10 inches. In many cases, the depth of this horizon is three inches or less. Often, profiles might show one or two inches

Soil: Opencast series Parent material: Till derived from
Carboniferous rock

Location: 226 472 Height: 574 feet

Topography: Undulating - slope 5°-6° - Aspect south-westerly.

Vegetation: Permanent grass. Drainage: impeded

- 2-0 ins. Permanent grass roots - little decomposition - very dark brown.
- 0-4 ins. 7.5 YR 4/4 (dark brown); silty clay loam; angular blocky structure, compaction has taken place; pieces of reddy clay 2½ inches down: no true sorting of clay and soil; very compact; roots plentiful; moist - drainage imperfect; stones 15% to 20%. Fairly clear boundary with
- 4-12 ins. 7.5 YR 6/4 (light brown); sandy clay; large blocks; very compact and firm; drainage definitely impeded (mixed mottling, rust and greys); roots thin, old, fibrous, no evidence of fauna, stones 20%+. Well defined boundary with
- 12-30 ins. 7.5 YR 5/8 (orange brown with rust and grey mottles); clay; large blocky; drainage impeded: very compact; roots barely evident; no fauna; stones 20%+.

Laboratory Analysis

Sample depth	U.S.D.A. Limits			pH	(1)		N%	C/N ratio	
	Sand %	Silt %	Clay %		O.M%	O.C%			
1-4"	28.0	45.4	26.6	5.40	9.10*	5.51	0.27	20.4	
6-9"	47.0	12.0	41.0	5.95	N/A	N/A	N/A	N/A	
18-21"	30.0	21.0	49.0	6.50	N/A	N/A	N/A	N/A	
Sample depth	Available phosphates mgms/100 gms. (2)			CATION EXCHANGE CAPACITY me/100 gms.					
				Ca	Mg	K	Na	H	Total
1-4"	8.1*			5.20	1.11	0.28	0.32	40.00	46.91
6-9"	N/A			5.10	0.62	0.25	0.30	24.40	30.67
18-21"	N/A			3.20	1.17	0.24	0.37	24.60	29.58

(1) Organic matter uncommonly high - much higher than in any other opencast series.

(2) Available phosphates high - because the site had been recently basic slagged.

of compacted top soil, with below an undifferentiated clay and soil horizon where the colourings are intermixed. Root matter tends to be much less well developed than in the other series, presumably because the reclaimed soils have only been cultivated for a comparatively short period of time and compaction of the subsoil restricts root development.

Stones are less, both numerically and in size than in the Esh and Broom series, mainly because stones were removed during recent open-casting. Again, however, the earliest open-castings were not cleared of stones as carefully as in the later methods of reclamation. Fauna are everywhere less evident than in the other series - the most recent open-casting has not yet had sufficient time to develop faunal population, while the earlier, badly compacted sites, are unlikely to reach an optimum population. The most serious effect of open-casting on fauna, is that the worm population takes at least five years to return to normal.

SOILS AND TOPOGRAPHY

The differences in profile depth, irrespective of soil series, are shown in Figure B6/14. They are shown simply, in relation to physical relief, and hence can be best shown by a simple transect. The chief observations from this transect are that the deepest soils occur in the Browney-Deerness alluvium and the Witton and Gilbert fluvio-glacial gravels. These soils occupy valley floor, flood plain or lower slope positions. The Esh clays of the lower slopes are also amongst the deeper soil series.

Upslope, depth of soil decreases, degree of stoniness increases, and especially in the Broom series, drainage is increasingly impeded particularly on the shallower slopes. The shallowest soils, the most stony, and also the most freely

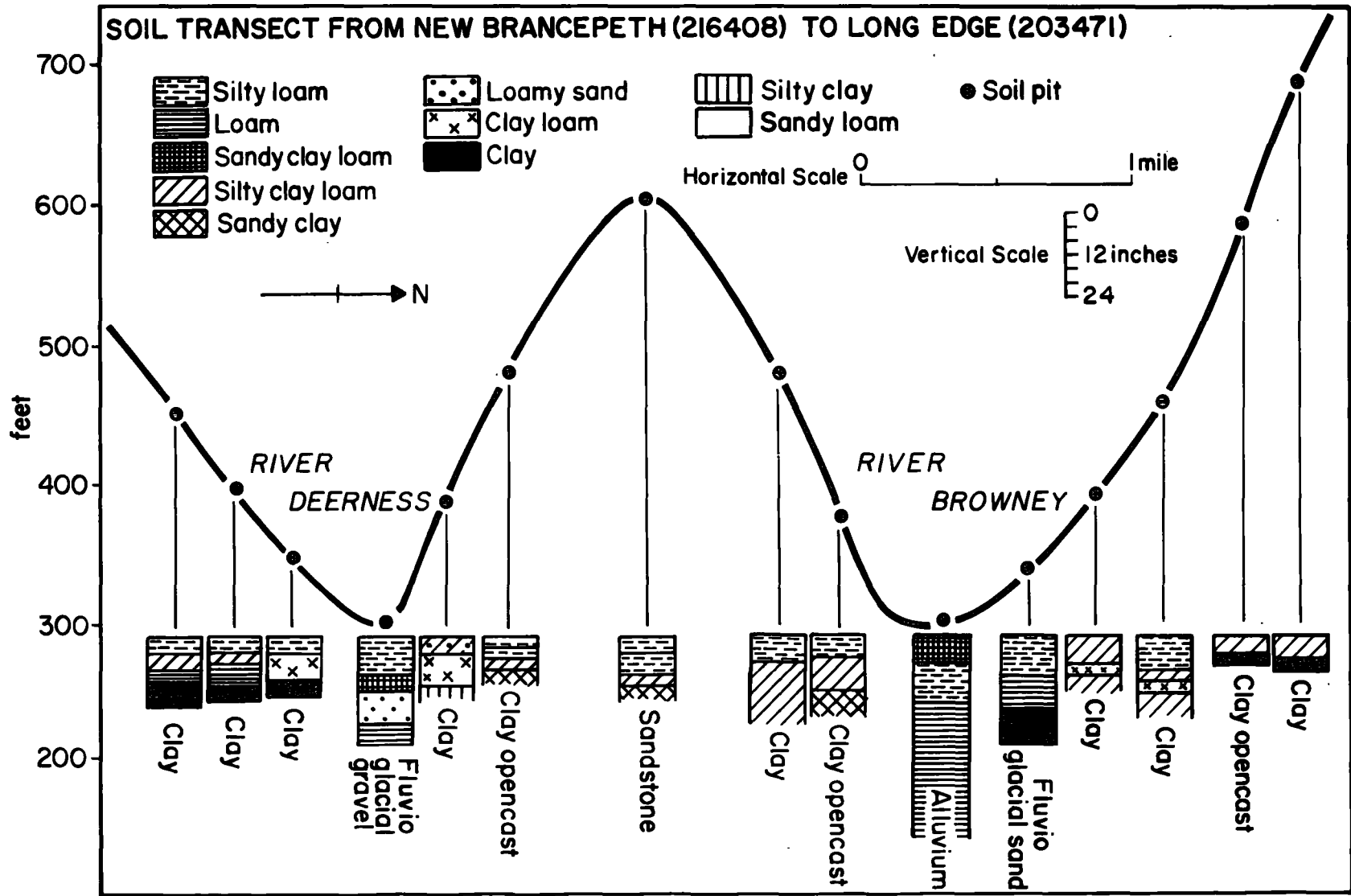


Fig. B6/14

drained are the Ushaw sandstone series which occupy the ridge top position. The shallowest soils of this series occur on the Browney-Deerness interfluvium to the west of Ushaw College.

The Esh till series show the greatest variations in depth of profile, degree of stoniness and drainage capacity. This is because Esh series occupies a wide range of altitudes, slopes, ridge tops, valley slopes and valley sites.

C.7 LAND CAPABILITY

The environmental background, in the form of historical land use, climate, geomorphology, geology and the soil, each to varying degrees, present limitations to either actual or potential land use, and, whilst it is not the aim or the intent of this study to make specific recommendations, it is an aim to judge whether or not, against the background of these limiting factors, the land is being used as fully and as efficiently as possible.

Since the efficiency of land use, to a great extent, depends on competition for that land, and since this area, in the terms of the White Paper on the North-East, "is not an area in which there is much competition for the use of the land," then both the term "efficiency" and the judgement of "efficient" or "inefficient" land use, must be to a certain extent, subjective. The amount of dereliction, the delays in implementing the County Plan, the delays in reclamation, the empty property, the unwashed and unused spoil heaps, the lack of industrial expansion, all point to the fact that the Browney-Deerness region is not an area where there is any great urgency of efficient land use, except in the case of the individual farmer. Each farmer, each forester, each reclaimer, each builder, must economically use his parcel of land to best advantage to himself, balancing the unit cost of the land against financial, social or environmental gain. Hence, the value of the survey lies in the study of the present land economy, so that an analysis might show whether farming could be made more viable economically, whether more land could be forested remuneratively, (rather than marginally farmed), whether the cost of reclamation of dereliction is

financially justifiable or environmentally and socially necessary in an area which is partly Category D* and hence designated as a dying area, whether the prospects of the farming community in this particular area are likely to decline in view of the Mansholt Plan and the future working of the Common Agricultural Policy within the British framework. Already one farmer has taken the offer of a fair price for his marginal farmland, for building purposes, with the major influence on his decision being the imminence of entry into Europe.

Farming is the dominant land use in the district, though per unit acre, certainly not the most remunerative. "The principal factor in determining agricultural land use and classification will remain for the foreseeable future, the quality of soil itself." (Ede 1962). "The soil factor most affecting land quality within the county is the soil drainage status" (Stevens and Atkinson 1970). Other soil factors in addition to drainage status, affecting agricultural use in this particular area, would seem to be the depth of the soil, the degree of stoniness, and, to a lesser extent, the natural nutrient deficiency.

Factors limiting capability

Soil depths are partially illustrated in the transect of Figure B6/14. While alluvium and the series developed on the fluvio-glacial deposits are sufficiently deep to present no hindrance to cultivation, the factor of limited soil depth is most evident in the Ushaw series, where the solum is often less than 12 inches. This series covers approximately 7% of the study area. (It must be noted, in connection with this particular series, that soil depth is only one of the limiting

* Category D - refers to an area where any future development is not permitted: no settlement, no new industry may be established there. No property may be sold and no new inhabitants may settle.

factors to agriculture, exposure and winds being prominent on these interfluvial sites, where this soil occurs).

The Broom series also tends in the majority of cases, to be too shallow for ploughing, because tractors get bogged down in the heavy gley horizons. Even in the case of the Esh series, which cover about 45% of the area, some profiles examined are too shallow for ploughing, or at best are marginally thin, particularly on the upper slopes. When considering the reclaimed areas, about two-thirds of the open cast series are unploughable because the soil was badly replaced, top-soil, sub-soil and fragmented sandstones being haphazardly replaced. The poor internal drainage causes tractors to bog down unless the soil is at a low moisture content.

The alluvium series are generally satisfactorily drained, though low-lying riverine sites are subject to seasonal flooding. These low-lying sites may have slight impedance when not waterlogged. Rotation practice on such soils is impracticable and they can only be used as summer rough grazing. Approximately 25% of the alluvial series are poorly drained.

The fluvio-glacial sands and gravels vary considerably in their drainage. The Witton series occur where there is only a comparatively shallow veneer of sand/gravel over the glacial till and consequently there can be local impedance especially in depressions. However, this deposit of till mitigates the danger of sands and gravels being excessively drained of moisture during drought periods. Consequently, farming practice on this damp Witton series is less restricted than on the Gilbert. Hence, when classifying the soils the damp, moisture retentive Witton series is generally regarded as having a higher capability than the Gilbert series.

The Ushaw series are everywhere well aerated and well-drained, with the texture being less coarse than the Gilbert gravels and consequently has a greater water holding capacity.

Soils developed on the heavy glacial tills are everywhere poor or imperfectly drained. Some improvement of the drainage status of the Esh series can be made by the use of tile drains, but it is generally not worth while to consider similar improvements to the Broom series on account of the very slow movement of moisture within the soil profile. When improvements have been made, they are only marginal in terms of economic return to the farmer.

The Opencast series, again, are very varied in terms of their drainage status. In general, pre-1960 reclamation is characterised by strong compaction, bad aeration and poor drainage, while sites reclaimed post-1960 are better drained and cannot be further improved. The former offer little scope for improvement.

It is possible to measure the degree of stoniness of the profile by means of a metal frame, consisting of 100 wire intersections; inside the frame. The frame is then placed in the profile, against the soil face, and a percentage stoniness is measured. The alluvium series are almost completely devoid of stones. The general tendency in the fluvio-glacial gravels is for stoniness to increase in percentage, but not in size, down the profile. Stones in the plough layer are generally less than 10%. While this is only a slight handicap to ploughing, at any one time, there is a tendency for them to accumulate on the surface due to aeolian erosion of the finer particles and they need to be picked from the fields from time to time to avoid plough damage. Generally, the stones in the fluvio-glacial gravels are less than two inches in diameter.

Stoniness is the greatest impedance to ploughing in the Ushaw series. The amount often reaching 25% to 30% in the lower horizons which in most cases come to within six inches of the surface, while fragmented sandstone is a common feature at 12 inches.

The Broom series have an average degree of stoniness of between 15% and 20% in the surface horizons. Quite often, large boulders measuring 12 inches or more in diameter are to be found within the plough layer. This stoniness, when taken in conjunction with the cold, stiff clays and shallow depth of profile is a severe drawback to ploughing.

The Esh clays show the greatest variation in degrees of stoniness, the normal profile showing anywhere between 0% and 30% stoniness. The normal incidence is for percentage stoniness and size of actual stone to increase with depth through the profile.

The early opencast series show a great divergence of stoniness normally there are 15% to 20% stones in the plough layer, though in odd cases, as much as 30% is measured. In the later opencastings, the stones and boulders were much more carefully picked off; hence the degree of stoniness is much less than the earlier opencasts.

As a result of natural sorting processes - wind and water erosion, freeze-thaw action, faunal activity etc. - there is a tendency, over a period of time, for stones to accumulate in the plough horizon. The impact of stones on the plough results in excessive wear on the share, while too many stones make for a bad seed bed. In some of the stonier areas a collection of stones from the surface of the fields has to be made every few years.

It is extremely difficult to correlate natural nutrient

deficiency with the different soil series since all the land is cultivated and improved. Soils developed on the tills appear to have a higher natural fertility than those developed on fluvio glacial gravels, because they are heavier and more retentive of chemicals. However, the fluvio glacial sand and gravel soils which one might expect to be nutrient and lime deficient, have been so improved that they have acquired fertility which is maintained by regular application of lime and fertilizer. Improvement of the fertility status of all soils in the study area is chiefly a matter of economics, as low fertility can be remedied with sufficient capital. The major consideration is whether the capital spent on heavy fertilisation is commensurate with the financial return from the crop obtained. The early opencast series which were not systematically fertilized after reclamation are certainly of a lower fertility status than the areas reclaimed more recently, but it is not economically worth while to expend large sums on fertilizers when the return to the farmer will be very small.

The nature of the slopes varies tremendously, convex or concave being indiscriminately mixed across the series. Although the nature of the slope can affect the drainage, it is still difficult to make any firm correlation between slope nature and soil series. Nowhere is soil creep or erosion a problem, but if any series were susceptible to erosion it would be the ploughed sector of the Ushaw series. One such farmer did notice a small movement to the bottom of a field, but this does not constitute a major problem: one or two ridge top farmers noted that soil tended to blow off the newly sown barley seed in spring, which is a detriment to early sowing, when the soil is likely to be dry.

Slope degree and shape is of little consequence in affect-

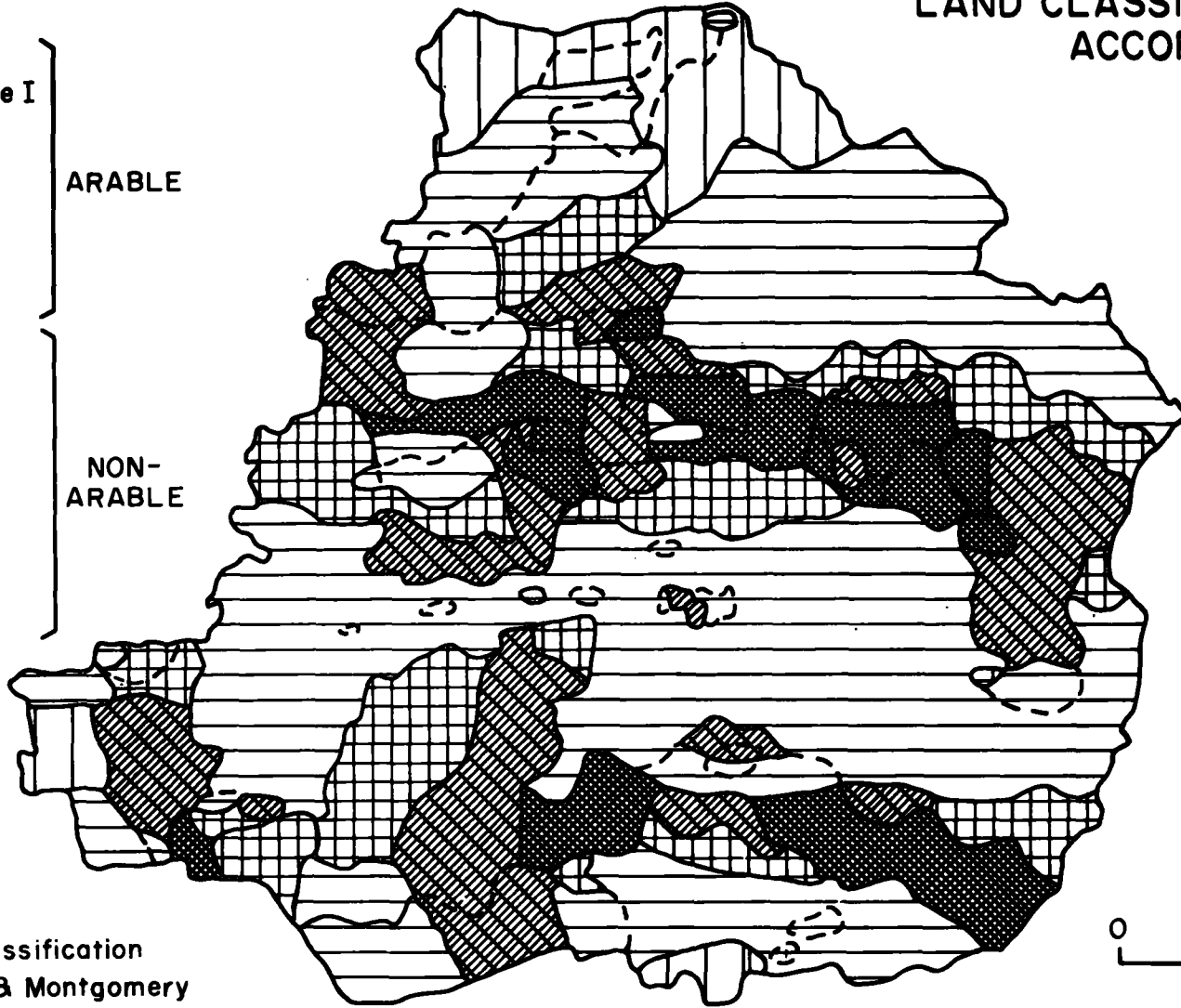
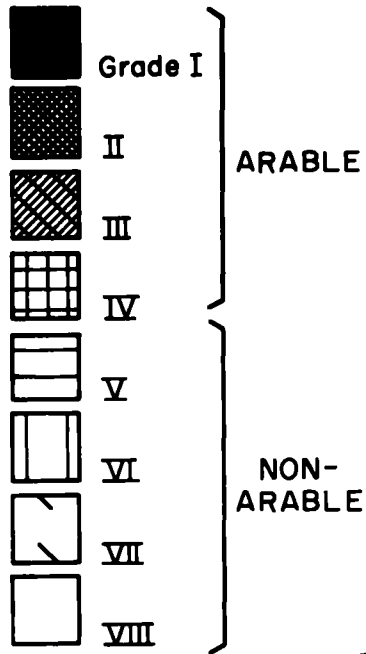
ing the capability of soils on alluvium and fluvió glacial gravels, being nowhere greater than 8%, whilst the Ushaw series normally occupying ridge top sites, tends to be almost level. Most of the Broom soil series occupy areas having only gentle slopes, rarely exceeding 8% and frequently are found in level localities. The Esh series, mainly found on the valley sides have very variable slopes, in some instances exceeding 15%. In the opencast series, the sites worked since 1960 have been systematically graded and recontoured so that none of the slopes can be classed as more than gentle. The earlier sites were not regraded and hence have a divergence of from gentle to moderately steep slopes (5% to 15%).

The study area has been classified according to the Land Capability Classification of the U.S. Department of Agriculture (Klingebiel and Montgomery, 1961) and the criteria used are shown in Table C7/8. It is important to realise that no class I land is present in the area because of the adverse climatic conditions, (e.g. the relatively short growing season), which restricts both the range of crops that can be grown and cause limitations during the growth period. A Map of Land Capability classes in the study area is shown in Map 7, while Table C7/9 shows the proportion of each soil series in each capability class. In Table C7/9 a greater proportion of the Witton series is in class II than in Gilbert series because of the greater moisture holding capacity of the former. One-fifth of the alluvium is in Class V because of the water-logged nature of some riverside pastures. The Ushaw is dominantly Class V, because of ridge top climatic factors, shallowness of soil and degree of stoniness. The Broom is dominantly Class V, because of the impeded nature of the drainage. The Esh series displays the widest Class range because of the

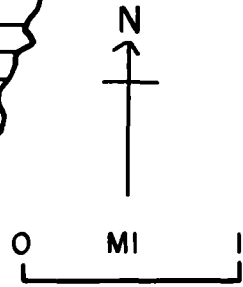
TABLE C7/8. U.S.D.A. LAND CLASSIFICATION
(modified-after Klingebiel and Montgomery, 1961)

	1-4 ARABLE				5-8 NON-ARABLE			
Item	I	II	III	IV	V	VI	VII	VIII
Slope	Nearly level less than 3%	Gentle 1%-8%	Moderate 5%-16%	Moderately steep 10%-30%	Nearly level less than 3%	Steep 20%-65%	Very steep + 45%	Very steep + 45%
Depth	Deep 24"+	Less than ideal 12-24"	Shallow 12"	Shallow Less than 12"	Variable 12"-36"	Shallow 12"	Shallow Less than 12"	Shallow Less than 12"
Drainage	Good	Correctable	Wetness	Excessive wetness	Poor	Poor	Wet soils	Wet soils
Moisture holding capacity	Good	Fair	Low	Low	Not relevant	Low	Low	Low
Climatic limitations	None	Slight	Moderate	Moderately adverse	Short growing season	Severe	Unfavourable	Severe
Stones	None	Few 5%	Few 5%-10%	Few 10%+	May be present 0%-10%	Present 10%-20%	Severe limitation 25% +	Severe limitation 25% +

LAND CLASSIFICATION ACCORDING TO SERIES



U.S.D.A. classification
Klingebier & Montgomery



Map 7

TABLE C7/9. PROPORTION OF EACH SOIL
SERIES IN CAPABILITY CLASSES
ACCORDING TO U.S.D.A. CLASSIFICATION (TABLE C7/8)

Soil Series	I	II	III	IV	V	VI	VII	VIII
Alluvium	0	45%	35%	0	20%	0	0	0
Gilbert	0	40%	45%	0	15%	0	0	0
Witton	0	60%	30%	0	10%	0	0	0
Ushaw	0	0	15%	20%	55%	10%	0	0
Esh	0	5%	25%	15%	35%	10%	0	0
Broom	0	0	3%	17%	65%	15%	0	0
Opencast	0	10%	25%	20%	25%	20%	0	0

widespread and differing topographical positions of the series. The high percentage of Class V and VI in the opencast is the legacy of the earlier workings. The more recent workings are now dominantly Class III land. No series is sufficiently poor to be placed in Classes VII or VIII.

Limiting factors in order of importance for each soil series may be summarised:-

Alluvium: Restricted areas of flooding

Witton series: Stoniness

Gilbert series: Stoniness, low moisture retention

Ushaw series: Climate (local), soil depth, stoniness

Broom series: Excessive moisture, restricted rooting depth, stoniness

Esh series: Restricted rooting depth, stoniness, slope, drainage

Opencast series: Stoniness, drainage, nutrient deficiencies, slopes - on the older reclaimed

CROP PRODUCTIVITY RELATED TO THE SOIL SERIES AND LAND CAPABILITY (cf. Table C7/10)

"The yield of crops is the touchstone of agricultural research" (Van der Pauw 1950), and according to Mackney (1962) "Soil surveys mainly yield information on the physical character of the soil, yet the object of land classification cannot be attained through the production of the soil map alone." It is necessary to study the effects of the limitations of the various soil series on actual crop productivity as far as this is possible, without adequately kept, sufficiently scientific, information. Cruickshank and Armstrong state that "information needs to be collected from farms which have a definite level of management over a period of not less than 5 years before the relationship between soil analysis and crop growth

TABLE C7/10. CROP YIELDS PER ACRE ACCORDING
TO SOIL SERIES 1971

Alluvial	wheat 35 cwts. barley 32-34 cwts. sown grass 3 tons potatoes 10-11 tons	<u>Not sown</u> oats turnips
Fluvio-glacial	barley 33-35 cwts. wheat 32 cwts. oats 30 cwts. sown grass 2½ tons	potatoes turnips - Witton only 35-40 tons
Sandstone	barley 35 cwts. oats 30 cwts. sown grass 2-2½ tons potatoes 9-10 tons	wheat turnips
Esh series	barley 28-32 cwts. wheat 30 cwts. oats 30 cwts. sown grass 2-3 tons potatoes 9-10 tons	turnips
Broom series	barley 30 cwts. oats 30 cwts. sown grass 2 tons potatoes 8-9 tons	wheat turnips
Opencast* series	barley 32 cwts. wheat 30 cwts. oats 30 cwts. sown grass 2-3 tons potatoes 8-10 tons	turnips

*Crop yields refer only to newer opencast workings, the older workings are used principally for permanent pasture.

can be analysed." (Cruickshank and Armstrong 1971/2). Here lies the difficulty; how does one measure standards of management? What is the measuring stick of farming practice? Each farmer is his own independent manager - some are obviously efficient, some are manifestly inefficient, some are part-time farmers only, some have sufficient capital, others have not, some have sufficient equipment, others have not. Some farm only one soil series while others farm a variety. Moreover, a classification of farm types in the study area would cover five types of the Newcastle University, Department of Agriculture Economics classification (cf. Appendix VII).

No farmers were encountered who had kept statistics for a period of five years. Hence, one is thrown back upon considered generalities. Conclusions can be drawn to state that the Broom series is non-arable, the Browney-Deerness alluvium is generally arable, the Witton series make better turnip land than do the Gilbert soils, that wheat does better and gives higher yields on the lower slopes of the Esh series than on the upper slopes, etc.

The effect of physical factors on the capability are very great, without even taking account of human factors such as labour intensity, storage facilities, fertilizer application, capital, etc. All these human, social and economic factors are bound to partly offset even the best soil potential. A field on Esh soil can show better yields than a field on the Witton series, (which has a better physical rating), due to human factors.

Subjectivity and generalisations are inevitably disruptive of a scientific approach and it is with great caution that one must allow actual yield to be the touchstone of the potential of soil series. So many distortions are evident

after a study of the soil series and after a fairly intensive questioning, that one is left with the knowledge that certain series are being underused in regard to their potential, whilst other series which have severe physical soil limitations, can with intensive effort and high fertilizer application, produce higher than their expected potential. The most objective approach that can be made is to try to analyse each series over a one or two year period, in regard to yield, stock rearing, fertilizer application and rotation. The 45 farms were spread proportionately, over the various soil series, so that an even spread of results can be reasonably and objectively analysed.

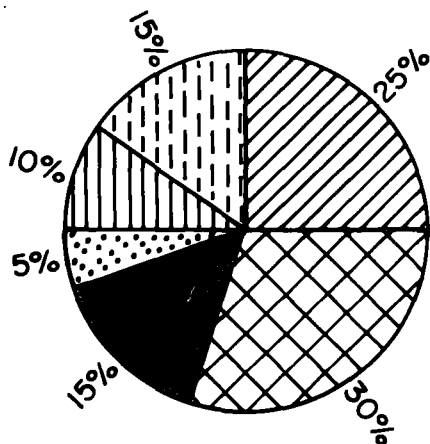
Figures C7/15(i)-(vi) show the percentage cropping use according to series. They reveal the dominance of grassland, in the form of long ley permanent pasture and rough grazing, on the Esh (90%), Ushaw (85%), Broom (87%) and on the Opencast (77%) series. Cereal cropping is highest in the Witton and Gilbert series (61%), and lowest in the Esh series (9%). Root cropping is the least important agricultural use throughout the area, only being important on the Witton and Gilbert series (14%), and the Alluvium (15%). Over the rest of the area, root cropping takes less than 3% of any single soil series. If the cash crops, namely wheat and potatoes, are considered, then the alluvium (40%) and Witton and Gilbert (24%) series are far more dominant than the other series.

The stock carrying capacity and growth rate of stock is a difficult factor to quantify for a variety of reasons. While the alluvium, the Witton and Gilbert series only have a small percentage of their area under grassland and, hence, a low quantity of stock, the Ushaw series, 90% of which is under grassland is not fully stocked due to economic reasons.

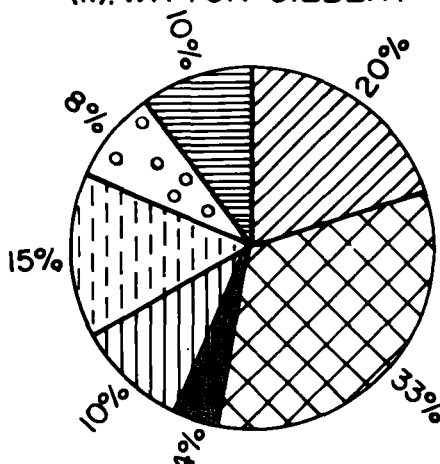
Fig.C7/15 (i)-(vi)

PERCENTAGE AGRICULTURAL USE BY SERIES

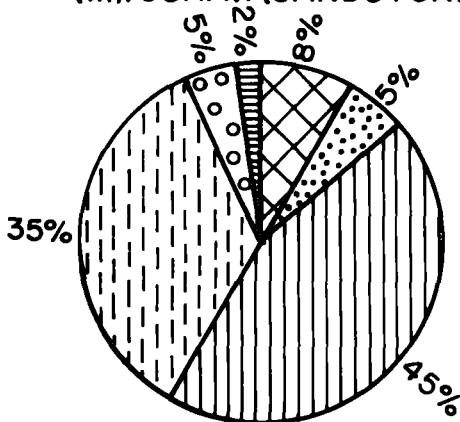
(I). ALLUVIUM



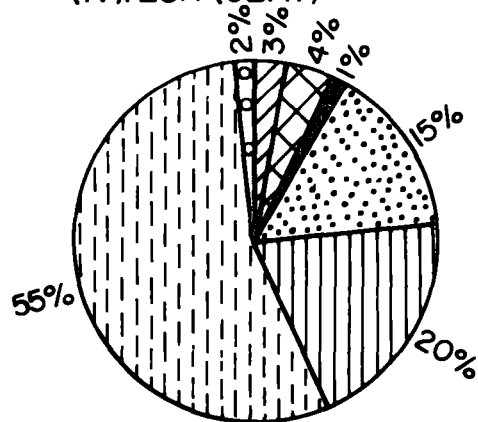
(II). WITTON-GILBERT



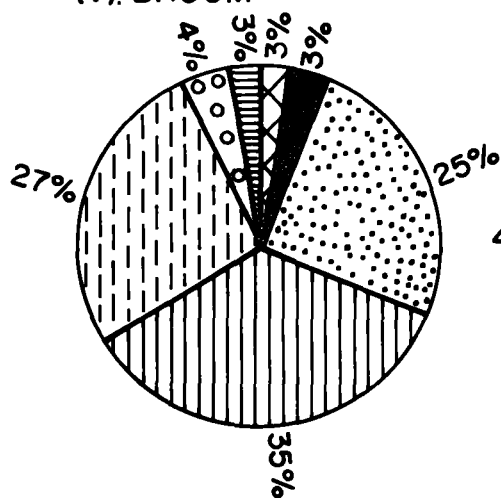
(III). USHAW (SANDSTONE)



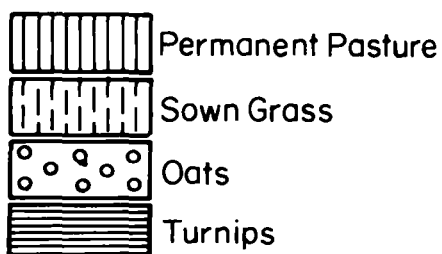
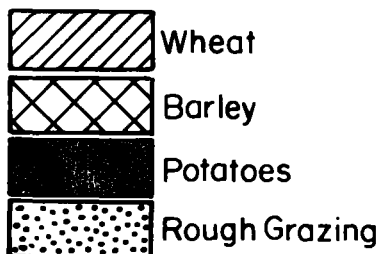
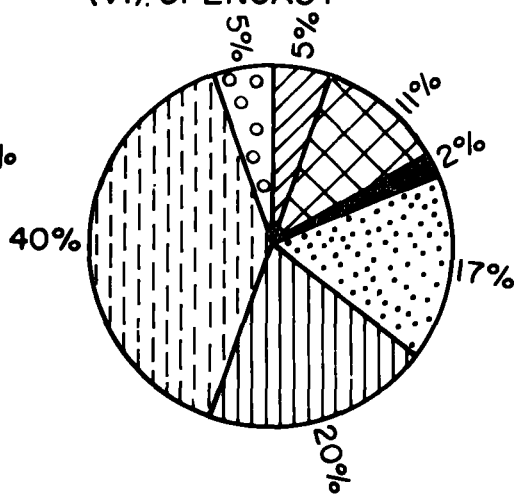
(IV). ESH (CLAY)



(V). BROOM



(VI). OPENCAST



Much of the newer opencast is not yet fit for cattle rearing, because of danger of compaction. A 56 acre farm (228 433) dominantly on Esh series, had only 18 cattle on 50 acres of grassland because the farmer is struggling financially while a farm (215 476) mainly on the Broom series had an average of 0.6 cattle and 1.8 sheep per acre and is possibly overstocked. A 430 acre farm (199 458) predominantly on the Esh series carried effectively 0.5 cattle and 4.2 sheep per grassland acre, but because of feeding high protein cake and rapid turnover of cattle achieved not only a quick growth rate per capita, but also a good economic return.

Allowing for all the above variations, the Esh series carried the most stock per acre, (average approximately 0.6 cattle and 2.2 sheep per acre), as against the 0.5 cattle and 1.6 sheep of the Broom series and the 0.5 cattle and 1.5 sheep of the Ushaw series. The alluvium series averages only 0.2 cattle and 0.8 sheep per acre of grassland.

The average growth rate of stock of grassland of each of the soil series reveals a similar pattern - the greatest live weight gain per capita is recorded on the Esh series. A note of caution must be sounded, however, because this deduction can only be based on the study of the growth rate of all the stock on each farm and then estimating how much of a particular farm's stock is kept on one soil series rather than another. This problem of growth rate is particularly difficult to estimate when stock are scattered indiscriminately across a farm on different series. Deductions can only be made scientifically on farms of predominantly one soil series. Moreover, the same standard of farm management in regard to stocking practice is rarely found.

Rotation practices also differ according to soil series.

On only three series, the Witton, the Gilbert and the alluvium are full crop rotations practised. In contrast, rotations are only practised on 10% of the area of the Ushaw series. While it has been seen that two-thirds of the farms do follow a rotation, this is severely modified according to soil series and is increasingly becoming a simple variation of cereal, ley, cereal and ley.

On the basis of all the above factors, and taking into account the climate and socio-economic limitations to farming, the conclusion must be that the alluvium and the Witton series of the fluvio-glacial gravels must be the optimum series for arable farming while pastoral farming is best on the Esh series.

NON-AGRICULTURAL DEMAND FOR LAND

The non-agricultural land use accounts for 27% of the available land. The basic difference between the agricultural land use and the non-agricultural land use is that the farmer is in the hands of individuals while the latter is publicly owned. Certainly, much of the forest, over half the settlement, and all the mining with its legacy, is in the hands of public bodies who do not weigh profit and convenience as the outstanding factors, as do the farming communities. Hence, availability of public funds and social criteria are greater determinants of non-agricultural land use than in the case of farming which relies heavily on the economic climate. *Ceteris paribus*, there is a greater urgency in using farmland as remuneratively as possible. While profit is the major factor in the case of mining, opencasting and industry; housing and road access arise from social necessity. Forestry has evolved because it appears to be the most suitable form of land usage on certain soil series. Other forms of land use

are wasteful, uneconomic and socially undesirable e.g. the derelict property and the sites awaiting reclamation. Such areas might only form a small percentage of the land and while there might be a lack of competing demand, a speeding up of the County Plan in regard to improvement of these sites is urgently required. Furthermore, the advent of the European Economic Community, the Common Agricultural Policy and the implementation of the Mansholt Plan, must mean that more marginal farmers will be driven from the land, either leaving more areas of dereliction, or a chance for the efficient farmer, with sufficient capital, to increase the size of his holding. The proposed amalgamation of the area, under the Local Government Act with the Durham City Council and the Consett Urban Authority, must inevitably lead to some delays in the proposed schemes for reclamation.

Forestry in the region, as noted, is basically a commercial land user, rather than for recreational purposes. Profit is not the only aim, however, for improving the old waste heaps, diversifying cropping and adding more variety to the landscape, are some of the aims of the National Coal Board who own much of the woodland. The profit obtained is certainly very much less, per unit of expenditure, than for farming, although if land is laid down to forestry, there must be some prospect of economic return. Nationally, more money is spent in planting forests than the actual return. Forests costing £107m. to establish in 1969, will only have a realisation value of £75m. at 1969 prices (Forestry Commission 1971). The Yates Committee, 1966, reporting on the relative economics of forestry and farming, stated that the forests employ more capital for considerably longer periods and give a lower return per acre. In the case of private foresters, this loss

is partially offset by Government grants and tax incentives which tends to make forestry more attractive, especially in view of the fact that the alternatives, on the gley soils in the area are dereliction or distinctly marginal farming.

Forests have expanded greatly over the post-war years but their future and immediate expansion depends on the reclamation of spoil heaps. At April, 1972, there were some 83 acres occupied by spoil heaps awaiting reclamation under the present County Five Year Plan. Approximately two-thirds of this land will eventually be placed under forest use. Any further extension of the forest lands, probably very restricted in extent, will come on the gley Broom or the old opencast series, where farming is at its most marginal. The question which has to be asked is whether or not it is correct, economically or ecologically, to give farming precedence over forestry or vice-versa. In the case of the marginal returns from agriculture on the Broom and Opencast series it is probably best to turn the land over to forestry to avoid further despoilation and deterioration of the environment.

Settlement in the present context refers to habitable properties covering, with ancillary road networks, some 1,808 acres. However, 450 acres of this total are currently uninhabited and/or derelict. New dwellings are in great demand, even in an area with little local employment and with a coal industry in rapid decline. This demand in the Browney-Deerness region arises because of the willingness to travel to work to places such as Durham or Crook, especially by private vehicle. Hence, the statement that there is little competition for land use, has to be qualified, in regard to housing development. From facts ascertained from the District Councils concerned, some 345 houses, both council and private,

are scheduled for completion in the financial year 1972/1973. 300 more private houses have been recently completed at Ushaw Moor. Approximately 144 acres are scheduled to be taken out of agricultural production over the period 1971-1974 alone, and 1,300 more people will be added to the population of 16,500. Thus, in addition to the farmland lost, must be added the extra deleterious factors brought about by a sizeable increase in population - litter, transport and dumping of household waste. These are important hazards to farms closest to settlement. The problems of farmers close to settlement are enhanced by the fact that their farms tend to be smaller than the average, since they have already lost parcels of land to previous housing developments. Any additional building, therefore, assumes grave proportions, in that these farms become increasingly non-viable. As the farms move closer to the margin of productivity, either farming must become part-time, which basically means that more land is used to less than its full potential, or the land goes out of agriculture. The problem is made worse by the fact that most of the existing building and proposed extensions to built-up areas are located on the lower slopes and hence on the better quality land.

The settlement pattern occupies six times the area of mining and its legacy, yet its effects on the land and its capability cannot be said to be proportionately greater. The legacy of mining has already been discussed and its effects have been seen over a period of 100 years or more. The immediate problem for the area is that mining is in decline, the two pits which are still working are facing a very uncertain and probably a very limited future. The effect of open-casting on farmland has been noted, but also the effects of

subsidence are very important. The area is riddled by underground workings, either in use or long since abandoned, but work on sealing off these workings, and thus putting an end to subsidence, cannot be undertaken until the present mines have ceased production. Water migrates through the old mine-workings which honeycomb these eastward dipping slopes.

There are pumping stations at Kaysburn, Ushaw Moor, Langley Park, Pithouse and Bearpark Colliery which, together, pump out 2,370 gallons of water per minute. Much of this water is sold to the Sunderland and South Shields Water Board.

(Deery 1972). The subsidence related to the old workings causes field drains to be broken and in some instances, fields become reduced to wet permanent pastures.

The National Coal Board is the chief land owner in the district and in the years since the Second World War, it has improved farm buildings, drainage and sewerage, tracks, fencing and hedging, as well as being involved in land clearance and improvement. This work is far from complete, because there has been little co-operation between the Board and the independent farmers. Drainage of individual fields is insufficient especially if no work is performed upslope or downslope. To instance one recent case near Langley Park, a new reclamation scheme on an opencast site was severely impeded by obstructions downslope, close to the river, where mattresses, waste paper and general household waste from a local council estate were blocking the drains. An overall plan of regional drainage, which takes account of mining subsidence and its effects, is imperative, but there is little sign of any movement towards such a scheme. The major problem, in this piecemeal approach, is the amount of capital, labour and machinery which the individual farmer possesses. The present

conditions are a combination of partially working 19th century drains, which are not fully integrated with the new and efficient drainage systems. On another opencast site, a new drainage scheme upslope is completely useless because old mine workings have caused severe subsidence and drain breakage in the fields immediately below.

Opencasting does mean landscaping, with new fences, new roads, removal of derelict buildings, removal of stones from the soil surface and superior drainage. There are disadvantages during working, noise and dust, (harmful to stock in neighbouring fields), loss of farmland and loss of rural amenities. After reclamation, the landscape needs time to readjust itself and there may be problems during this period.

The basic principle of reclaiming old, deep mines, pit houses, winding shafts, waste yards and spoil heaps, is that they can only be touched if they are in fact derelict. Hence, any opencasting, any washing out of spoil heaps, any leading of shale, any deep mining work, any smouldering of waste heaps, must mean delay to reclamation. In the case of washing and shale leading from heaps, this may mean a delay of 3 to 10 years while, in the case of smouldering pit heaps, any time up to 50 years. Nevertheless, the National Coal Board are anxious to remove waste heaps as quickly as possible.

Reclamation projects are described below, based on information from the County Planning Office, the District Councils and the National Coal Board. One of the major difficulties in planning reclamation is the number of public bodies concerned with each scheme. Paper work, committees and discussions can add three years on to a scheme of reclamation work. Before most projects can be commenced, the following bodies are involved in the discussions:- National Coal Board, British

Rail, The Ministry of the Environment, Ministry of Agriculture and Fisheries, (for grants), County Council, District Councils and the District Valuer. This does not take into account the public inquiry which is usually needed. Clearly, some speedier method is required, with a great deal more streamlining.

Lanchester Rural District Council

- (i) Cornsay Colliery 171 432 - derelict rows, old ballast heaps of Cornsay brick works to be levelled - to add 22 acres of grassland.
- (ii) Esh Colliery 194 425 - levelling of derelict houses, pit heap and old colliery workings, to be laid to grassland and forestry - 56 acres.
- (iii) Hamsteels Colliery 183 432 - levelling of houses and old pit workings - 48 acres - to be used for grassland and forestry.
- (iv) Quebec village 180 438 - derelict houses, 7 acres of grassland.

The total cost of the above reclamation schemes is about £130,000 at 1971 prices. The whole campaign is destined to be started and completed by the year 1975-1976; but there is a real danger of delay because of the amalgamation of local councils during 1973 and 1974.

- (v) The Durham-Consett railway is due for converting to bridle paths and woodscaping at a cost of £40,000. As yet no date has been set for this work.
- (vi) Esh Hill Top 208 443 - 8 acres was blended, restored and recontoured in 1971 at a cost of £30,000. It will be in agricultural use for pasture in 1973.
- (vii) Esh Winning 197 422. 3 acres of abandoned workings have already been levelled, but 11 acres of spoil heap are designated for washing. The total weight

of the heap is approximately 1.3 million tons, but no date has been set for washing to commence. (The recovery rate of coal from washing must be between 12% and 15% to be viable).

- (viii) Langley Park Colliery 211 455. At present there are 13 acres of slag heap, (1.7 million tons in weight), and 18 acres of pit workings which are still in production; 22 acres of land which were used for the old coke works, (which closed in 1967), have been levelled and are scheduled for light industry, but as yet are totally unoccupied. In future years, the 31 acres currently in use will be reclaimed and added to the 22 acres designated for light industry.

Durham Rural District Council

- (i) Bearpark Colliery 246 433. At present there are 30 acres of pit workings still in productivity, plus 40 acres of pit heap, (5.5 million tons), designated for washing. At the moment, no plans can be formulated, because of the uncertain future of the colliery. Eventual reclamation of these 70 acres will include approximately 30 acres of alluvium and 20 acres of soil developed on fluvio-glacial sands and hence could well be used for agriculture.
- (ii) Witton Dene 235 456. A 5½ acre derelict site is to be reclaimed as parkland.

Brandon and Byshottles Urban District Council

- (i) Brandon Colliery 216 403. The pit heap, 14 acres in extent, (weight two million tons), is being washed and will be landscaped for leisure use or

forestry during 1973. This site is located on the Ushaw series.

- (ii) Ushaw Moor Colliery 220 428. A nine acre pit heap has been almost washed and cleared of shale and is due for recontouring and forestry planting during 1973. This will blend with the New Brancepeth Colliery clearance, already completed, which is adjacent to the Ushaw Moor site. The valley here is very narrow and approximately four acres is of alluvium subject to flooding. To date, no plans have been formulated to drain the land or channel the river.
- (iii) Waterhouses 185 412. A 75 acre reclamation scheme is currently being implemented at a cost of £85,000. It involves the clearance of derelict houses, derelict pit workings, a straightening of roads, recontouring of slopes, the removal of slag heaps and the building of a bridle path along the old Deerness Valley railway. The whole scheme is due for completion in 1973, giving a further 75 acres for agriculture, approximately 20 acres of alluvium and the rest, Esh clay.

Hence, in the foreseeable future, some 362 acres are due to be returned to farmland or forestry, while in addition, 136 acres of present workings are destined for future reclamation. (The relative costs are high, £1,500 to £2,000 per acre to re-contour and reclaim as farmland, £500 to £1,000 to plant forests on old spoil heaps). Schemes for ski-slopes are projected on two of the opencast sitings, but as yet are not at the planning stage.

It is important to continue this work of reclamation,

especially in view of the amount of farmland which is taken out for settlement. Moreover, 150 acres of the 362 acres affected are alluvium based, with the highest fertility yields.

To estimate future prospects for the region is complex due to the effects of the Common Agricultural Policy, the amalgamation of councils, the uncertainty of mining, the lack of industrial development, the steady growth of population and the piecemeal approach to environmental problems.

C.8 CONCLUSION

What is clear from all the available evidence, is that at the current time a proportion of the land is being used incorrectly. Many reasons for the land capability classification have been given, (cf. summary of limiting factors for each soil series p.137). This classification led to the general conclusion (p.143), that the alluvium and Witton series of the fluvio glacial gravels are the optimum series for arable farming while pastoral farming is best on the Esh series. This is in fact only a general conclusion, because exceptions can be shown. Some of the Ushaw series is being used for barley growth whilst some of the alluvium series for permanent pasture. Here, financial reasons are the major influence on land use. The alluvium series fields which are subject to flooding ought to be drained and put down to cereal, whilst the Ushaw series which produces poor yields of barley could be more profitably used for permanent pasture. Hundreds of acres of earlier opencast land have been needlessly allowed to deteriorate, because of intermixing of soils and clays and compaction of the surface soil. To strip and correctly replace, to recontour in the modern manner would be expensive but would yield much more improved arable and pastoral land.

The discrepancies in stock carrying capacity, rotation practice, fertilizer application, individual approaches to farming methods, have all been shown. Each one of these discrepancies makes more difficult and more subjective, classification of land capability. "So many distortions are evident after a study of the soil series and after a fairly

intensive questioning, that one is left with the knowledge that certain series are being underused in regard to their potential, whilst other series which have severe physical soil limitations, can with intensive effort and high fertilizer application produce higher than their expected potential." (p.140). Examples of this can be easily cited e.g. the farmer on the Witton series, who is outmoded in his whole farming approach and whose yields are inferior to a modern farmer on the same series. The former has little capital, the latter, much capital. One farmer on a predominantly Ushaw and Esh series farm has better yields of barley than a farmer on the alluvium series, because of differing rotational practice.

The whole of farming practice is also affected by the incidence of mining and its legacy, by subsidence drainage problems, interruption to farming practice by opencasting, by council house estates and their detrimental effects, all of which can cause a soil series to be misused or underused. Whereas poorer soil series, not affected by the deleterious factors mentioned, can be fully utilised.

As mentioned (p.144), the County Plan, the re-organisation of local Council boundaries and their effect on new building and reclamation and the Common Agricultural Policy cause anxieties for the future and make farmers reluctant to spend time and money on either improving or fully using their productive potential.

In this complexity of circumstances pedological, climatic, agricultural, industrial, economic and social, any specific conclusions are quite impractical. For every conclusion that can be made about underuse then mitigating reasons can be drawn to show how or why a particular soil type, or a particular farm is not being utilised to full capability.

Table C7/9 shows the proportion of each soil series in capability classes. Such a classification ignores all factors except those mentioned in Table C7/8, a modified U.S.D.A. Land Classification. It is still not practicable to state that too much alluvium is graded Class V or too much of the Broom is graded Class V, or too much of the Opencast is graded Class VI. Such classifications are, de facto, based on the soil itself, and whilst allowance is made for all the non-agricultural factors mentioned above, it would be immensely complex to correlate two opposites.

It must be re-stated that whilst general conclusions can be misleading, they are of more relevance and value than specific conclusions, which although made objectively, are capable of so much change and transformation at the human level, as to be rendered worthless.



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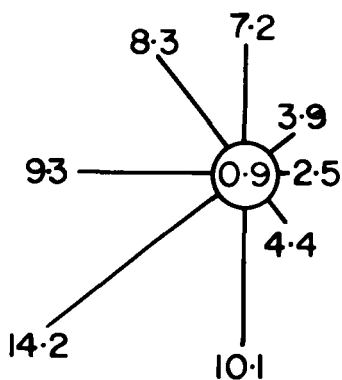
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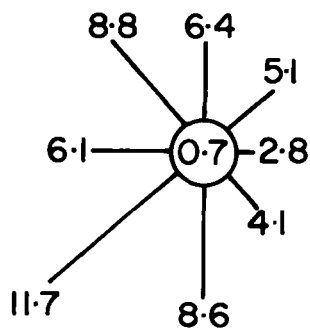
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**APPENDIX(I). MONTHLY WIND DIRECTION—
AVERAGE NUMBER OF HALF DAYS PER MONTH,
USHAW (1939-1968)**

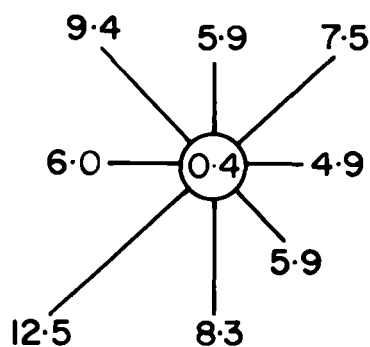
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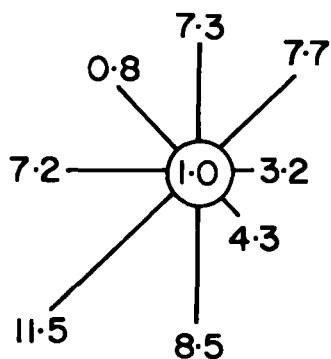
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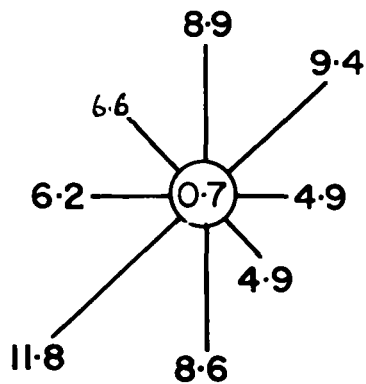
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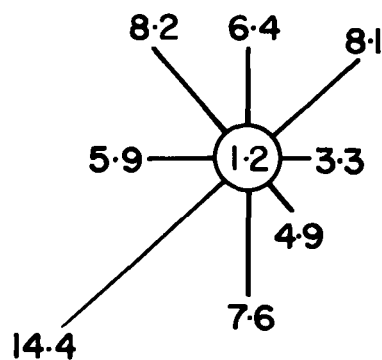
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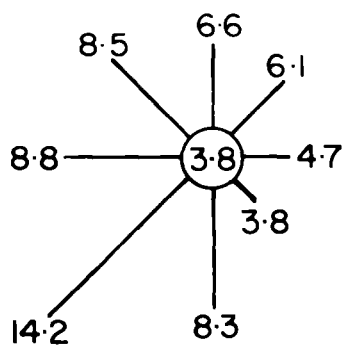
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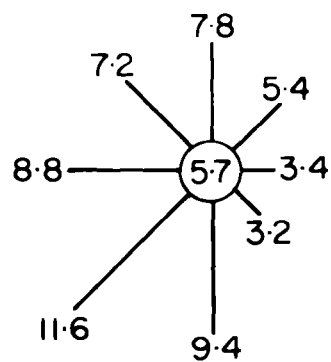
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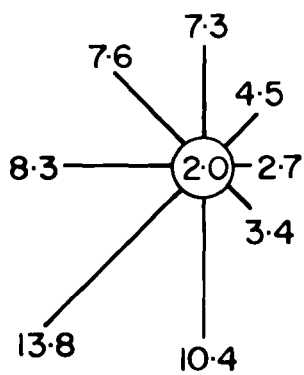
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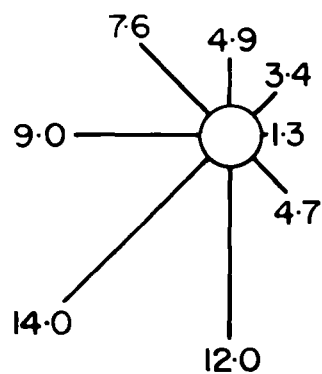
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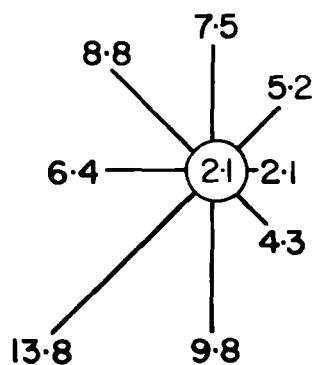
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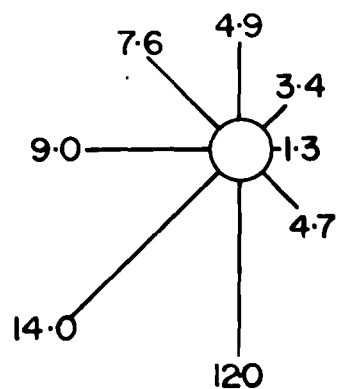
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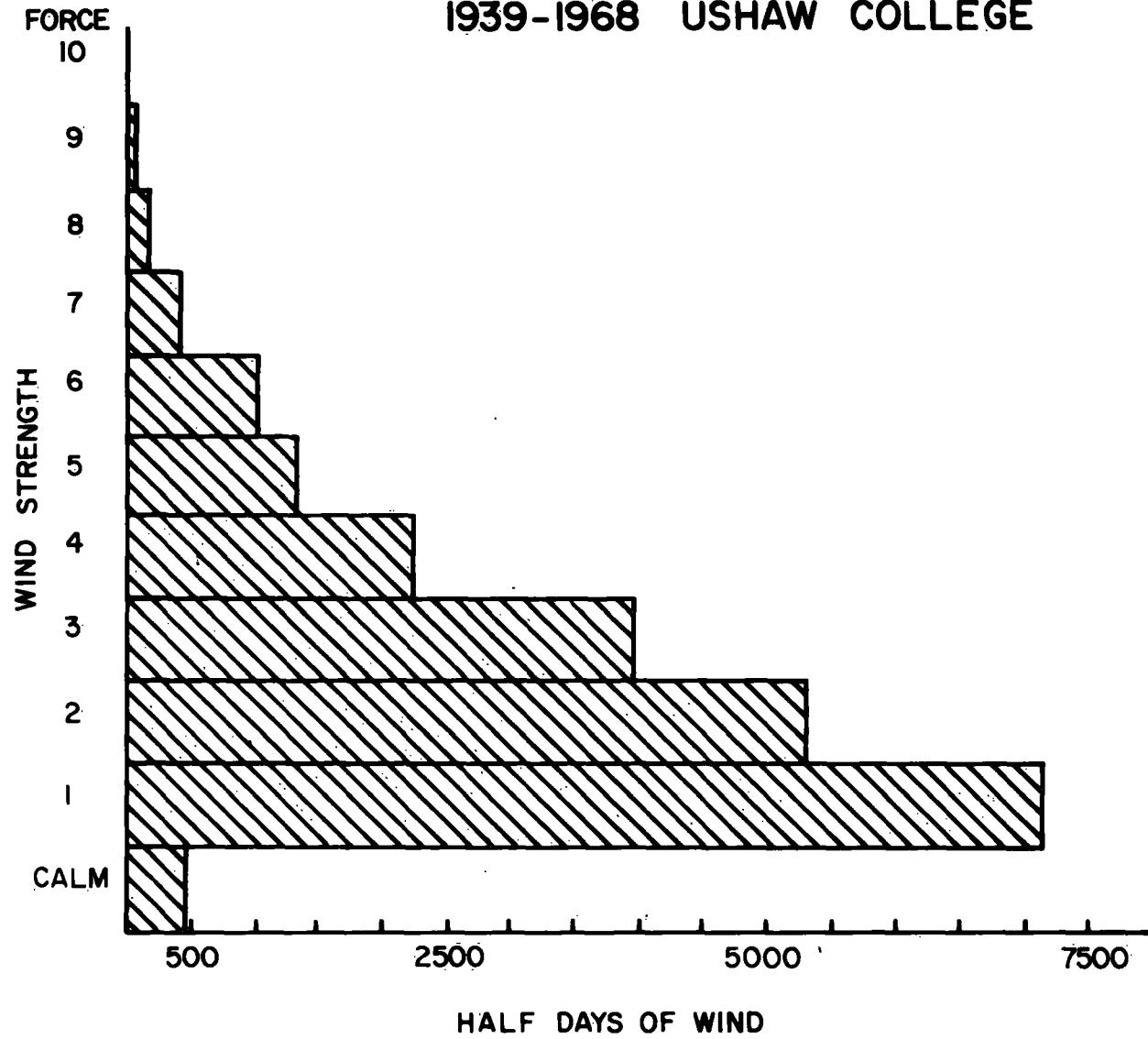


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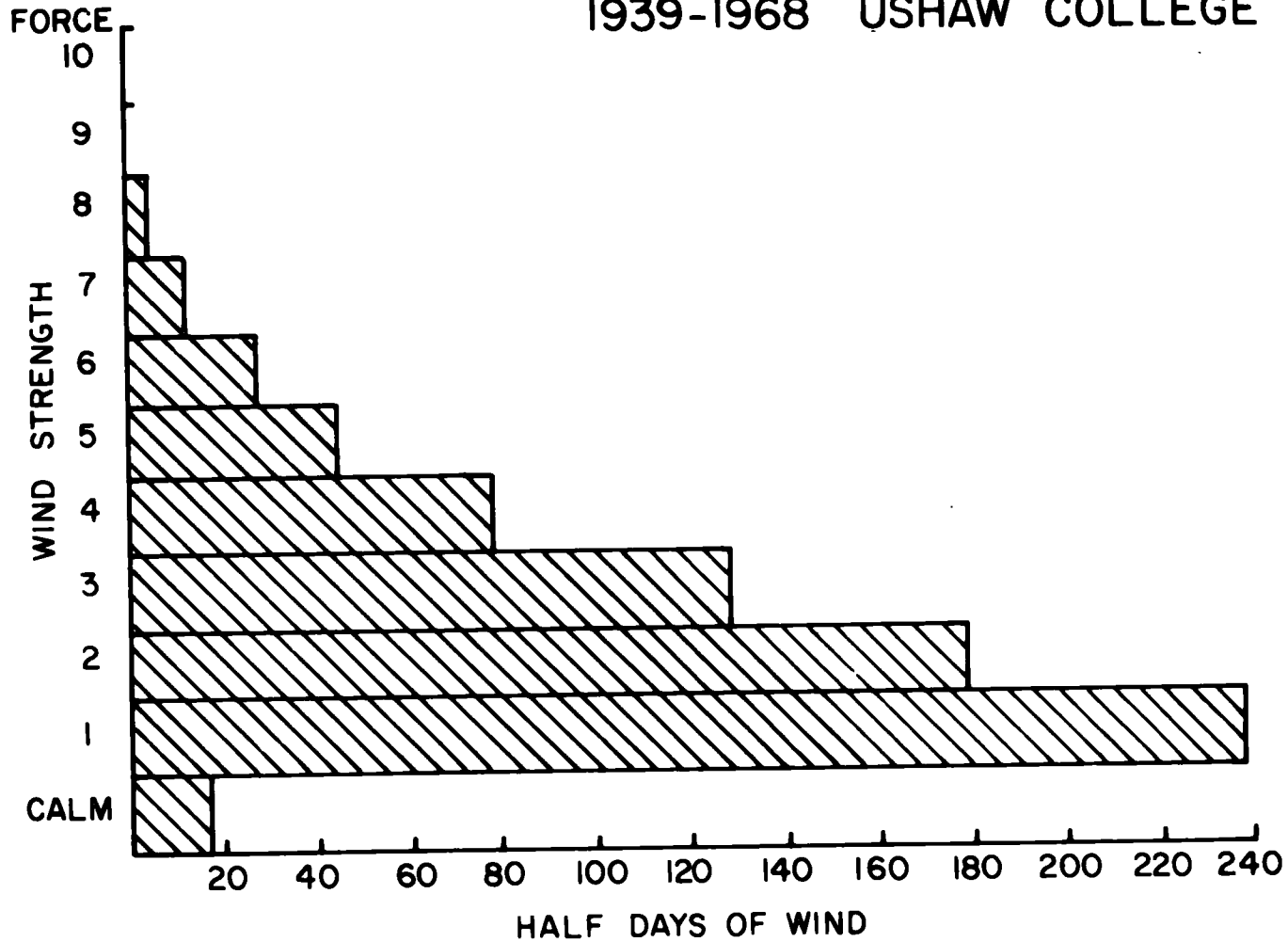
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TOTAL NUMBER OF HALF DAYS (0900-1500hrs) WIND SPEEDS
1939-1968 USHAW COLLEGE



APPENDIX II

AVERAGE NUMBER OF HALF DAYS (0900-1500hrs) YEARLY WIND SPEEDS
1939-1968 USHAW COLLEGE



APPENDIX IIIUpper Carboniferous Coal Seams

	<u>Name</u>	<u>Thickness</u>	<u>Workable extent</u>
	Hebburn Fell	4 ft.	
	Usworth	Up to 5 ft.	Restricted to coast.
	Ryhope Five-Quarter	2½-3 ft.	Restricted to Eastern areas.
	Ryhope Little	3 ft.	Little worked, due to erosion.
	High Main	1-8 ft.	Mid-East Durham - dirty.
	Five Quarter	1-6 ft.	East of Durham City.
	Main	2½-7 ft.	One of the principal seams.
	Maudlin	Up to 6 ft.	Worked in North Durham.
	Durham Low Main	2-6 ft.	Important over most of Durham.
	Brass Thill	2½-3 ft.	Predominant in Central Durham.
	Hutton	Up to 7 ft.	One of thickest seams.
	Ruler	Up to 2½ ft.	Worked in north west.
	Harvey	1-5 ft.	Good widespread seam.
	Tilley	3-5 ft.	Worked in the west.
	Busty	1-5 ft.	Bottom Busty worked in west.
	Three-Quarter	Up to 3 ft.	Impersistent. Improves offshore.
	Brockwell	2-6 ft.	Very important in south-west.
	Victoria	2 ft.	Important in the north-west.
	Marshal Green	1-2 ft.	Opencasted in West Durham
	Ganister Clay	Up to 1½ ft.	Thin and of no economic value.
	Gubeon	Up to 1½ ft.	Persistent but uneconomic.

Adapted and slightly modified from Geology of Durham, p.51

MIDDLE COAL MEASURES

LOWER COAL MEASURES

WESTPHALIAN

APPENDIX IVNational Coal Board Opencast Borings

1. O.S. Ref. 204 412 Ht. 670'
Soil to 2 ft.
Durham low Main 66 ft.
Brass Thill 98 ft.
2. O.S. Ref. 206 421. Ht. 520 ft.
Soil to 2 ft.
4 ft. Hard Sandstone.
4 ft. 9 ins. Thin bedded sandstone.
3. O.S. Ref. 222 418 Ht. 327 ft.
Drift to 73 ft.
Harvey 194 ft. 20 ins. thick.
Tilley 237 ft. 28 ins. thick.
4. O.S. Ref. 205 424. Ht. 360 ft.
Drift to 85 ft.
Three Quarter at 137 ft. 21 ins. thick.
Drilled to 142 ft.
5. O.S. Ref. 222 426. Ht. 377 ft.
Drift to 115 ft.
Harvey at 156 ft. 27 ins. thick.
Tilley at 198 ft. 27 ins. thick.
6. O.S. Ref. 213 443. Ht. 572 ft.
Low Main at 44 ft. 24 ins. thick.
Brass Thill at 70 ft. 24 ins. thick.
7. O.S. Ref. 220 441. Ht. 557 ft.
Soil and head 9 ft.
Durham Low Main 103 ft. 10 ins. thick.
8. O.S. Ref. 227 449. Ht. 265 ft.
Drift 116 ft.
9. O.S. Ref. 208 448. Ht. 342 ft.
Drift to 83 ft.
Durham Low Main at 115 ft. 11 ins. thick.
Top Brass Thill 155 ft. 22 ins. thick.
10. O.S. Ref. 242 433. Ht. 346 ft.
Soil and Head 12 ft.
Durham Low Main at 45 ft. 24 ins. thick.
11. O.S. Ref. 238 451. Ht. 410 ft.
Drift to 13 ft.
Durham Low Main at 81 ft. 24 ins. thick.
Brass Thill at 114 ft. 24 ins. thick.

Appendix IV (Contd.)

12. O.S. Ref. 212 456. Ht. 372 ft.
Drift to 65 ft.
Tilley at 89 ft. 14 ins. thick.
Busty at 166 ft. 56 ins. thick.
13. O.S. Ref. 207 465. Ht. 589 ft.
Drift to 8 ft.
Top Brass Thill 45 ft. 53 ins. thick.
Bottom Brass Thill 53 ft. 13 ins. thick.
Hutton Workings 83 ft.
14. O.S. Ref. 231 466. Ht. 439 ft.
Drift to 17 ft.
Main at 58 ft. 39 ins. thick.
Brass Thill at 247 ft. 24 ins. thick.
15. O.S. Ref. 242 465. Ht. 585 ft.
Drift to 8 ft.
Bottom Ryhope Little at 11 ft. 33 ins. thick.
Top High Main at 43 ft. 24 ins. thick.
16. O.S. Ref. 205 468. Ht. 727 ft.
Without drift.
Five Quarter 14 ft. 46 ins. thick.
Main 67 ft. 31 ins. thick.
Durham Low Main 198 ft. 28 ins. thick.
17. O.S. Ref. 218 480. Ht. 519 ft.
Drift to 26 ft.
Five Quarter Working 50 ft.
Main 103 ft. 72 ins. thick.
18. O.S. Ref. 198 454. Ht. 330 ft.
Drift to 135 ft.
Victoria 174 ft. 14 ins. thick.
19. O.S. Ref. 190 452. Ht. 383 ft.
Drift to 12 ft.
Three Quarters at 31 ft. 3 ins. thick.
20. O.S. Ref. 198 438. Ht. 679 ft.
Top Brass Thill 35 ft.
Hutton Workings 100 ft.
Harvey Marine Band 241 ft.
21. O.S. Ref. 196 424. Ht. 411 ft.
Drift to 90 ft.
Brockwell at 145 ft. 35 ins. thick.
22. O.S. Ref. 184 438. Ht. 630 ft.
Harvey Workings 78 ft.
Tilley Workings 120 ft.
Top Busty Workings 153 ft.

APPENDIX VNorth of England Institute of Mining and
Mechanical EngineersBorings and Sinkings, Durham and Northumberland

1. Cornsay Fell. Victoria Pit. O.S. 158 434. Dug 1853.
Soil 0 ft. 6 ins.
Blue Clay 2 ft. 2 ins.
Yellow loam 3 ft. 0 ins.
2. Esh Colliery. 195 425. Dug 1866.
Soil and yellow clay 5 ft.
Stony bluish clay 2 ft.
3. Standagainst All. 194 471. 1903.
Soil 6 ins.
Yellow stony clay 3 ft. 6 ins.
Boulder clay 16 ft.
4. Hill Top. 216 445. 1903.
Soil 4 ins.
Yellow clay with stones 4 ft.
Stony clay 37 ft.
5. Kaysburn Pumping Shaft. 221 462. 1895.
Soil 1 ft. 6 ins.
Yellow clay 6 ft. 10 ins.
Gravelly sand
6. West of Bearpark Hall. Banks of R. Browney. 243 440. 1843.
Soil 1 ft.
Brown clay 14 ft.
7. East of White House. 233 433. 1886.
Soil 1 ft.
Brown clay 20 ft.
Dark grey metal 10 ft.
Coal 8 ins.
8. New Brancepeth Pit. 221 420. 1874.
Soil 0 ft. 9 ins.
Gravel 2 ft. 9 ins.
Clay with stones 4 ft. 3 ins.
Sand 4 ft. 6 ins.
Strong stony clay 16 ft. 6 ins.
9. South east of Heugh Farm. 193 428. 1854.
Soil 1 ft.
Clay 1 ft. 1 in.
Freestone 7 ft. 11 ins.
Grey metal/post girdles 6 ft. 1 in.
Blue metal 4 ft. 7 ins.
Coal.

APPENDIX V (Contd.)

10. Four Lane Ends, Ushaw. 228 426. 1867.
 Clay 5 ft. 6 ins.
 Post 20 ft.
 Coal 2 ft. 5 ins.
11. Sleights House. 244 453. 1838.
 Soil 1 ft. 6 ins.
 Yellow clay 1 ft. 6 ins.
 Brown stony
 clay 8 ft. 6 ins.
12. Blackburn Cottages. 196 453. 1867.
 Soil 10 ins.
 Yellow clay 2 ft.
 Brown clay 5 ft. 8 ins.
 Brown/white
 post mixed 1 ft.
13. No.1 Borehole Langley Park. 1873
 Soil 10 ins.
 Light clay 1 ft. 6 ins.
 Brown clay/
 sand 5 ft. 0 ins.
14. No.2 Borehole Langley Park. 1893
 Soil 10 ins.
 Yellow clay 1 ft. 6 ins.
 Brown clay
 gravel 6 ft. 9 ins.
15. No.4 Borehole Langley Park. 1873.
 Soil 2 ft. 0 ins.
 Soft yellow
 clay 4 ft. 3 ins.
 Coal 6 ins.
16. No.5 Borehole Langley Park 1873
 Yellow clay and freestone (sandstone) 4 ft. 10 ins.
 Loamy sand 1 ft. 2 ins.
17. South of Clifford House. 1867.
 Soil 6 ins.
 Yellow clay 4 ft. 0 ins.
 Blue clay 15 ft. 0 ins.
18. Southwest of Clifford House. 1867
 Yellow clay 4 ft. 6 ins.
 Blue clay 23 ft. 3 ins.
19. Blackburn Farm. 1868.
 Sand 3 ins.
 Yellow clay 1 ft. 11 ins.
 Brownish
 sandy clay 21 ft. 4 ins.
20. No.2 Pit. New Brancepeth 1872.
 Soil 1 ft.
 Strong brown
 stony clay 6 ft.
 Loam and sand 12 ft.

APPENDIX V (Contd.)

- | | | |
|--|--------|-----------|
| 21. Langley Paper Mill. | | pre-1840. |
| Soil | 3 ft. | |
| Sand | 3 ft. | |
| Clay | 18 ft. | |
| 22. New Brancepeth Colliery, No.2 Pit. | | 1873. |
| Sand and gravel | 10 ft. | |
| Clay | 14 ft. | |
| 23. Bearpark Low Farm House. | | 1843. |
| Soil | 2 ft. | |
| Dry sand | 2 ft. | |
| Brown soft clay | 4 ft. | |

APPENDIX VI
FARM QUESTIONNAIRE

Name of farm

Size in acres.

Are you the owner or the tenant?

If tenant, who owns the farm?

How long has the farm been in your family?

How long was the farm held by the previous owner?

Can you give me any historical details of the farm and the changes which have been made, especially in the 20th century?

How many full or part-time workers are employed?

Is there much turnover of labour?

Are there any great difficulties in obtaining labour?

How many machines do you possess?

Have you sufficient?

Do you hire in machinery, (e.g. combine harvesters)?

What significant changes have occurred since 1939?

In land use?

Crops?

Machinery?

Livestock?

Labour?

Buildings?

Drainage?

Fertilizers?

Crop rotation and yield?

When was the last horse worked?

Acreage of land ploughed since 1939?

Crops

Acreage of each?

Yield?

APPENDIX VI (Contd.)

Strain or variety of each?

Why particular type chosen?

Which crops are kept?

Which sold?

Purpose in growing?

Which are processed?

Do you make sileage?

What rotation system is used?

Why?

Is it rigid or changed? Do you easily change it?

Have you never thought of changing it?

What fertilizer is used?

On which crops are they used?

How much per acre?

What particular compounds?

How much lime?

How often?

Do you use basic slag?

Advantages or disadvantages?

Has there been any significant yield differences?

Any chemical samples taken?

Any pH values?

Any specific means of preserving fertility or crop yields?

Is strip grazing practiced?

LivestockCattle

Numbers?

Breeds?

Purpose, milk or beef or store?

How much buying and selling of beef?

How much milk sold?

Do you raise your own cattle?

How many bulls do you possess?

Do you use the A.I. service?

How long are cattle kept?

What housing facilities are there?

How much cattle food bought?

How long are cattle stall fed?

How long outdoor pastured?

Sheep

Numbers?

Breeds?

Purpose? Mutton or wool or store?

How much buying and selling of sheep?

How many do you breed?

How many rams?

How long are ewes, rams kept?

What are their foodstuffs?

Pigs

Numbers?

Breeds?

Purpose pork or bacon or store?

Do you breed your own?

Is there much buying and selling?

What type of foodstuffs?

How much?

Poultry

Numbers?

Breeds?

Purpose?

How long kept?

Much buying and selling?

APPENDIX VI (Contd.)

Do you co-operate with any other farmer?

In harvesting?

Machinery sharing?

Seed buying?

Consultation and advice?

Effects of opencasting on structure?

Land use change?

Fertility change?

Drainage change?

Stoniness change?

Fauna population change?

Which areas have been opencasted?

Crop yields?

How long before ploughed out and first crop taken?

Climatic effects?

Wind?

Frost?

Snow?

Effects of climate on machinery on land?

On crop yield?

Stock feeding?

Time of harvesting?

Future prospects and plans?

Effect of E.E.C.?

Deleterious effects?

How do you see the farm in five years time?

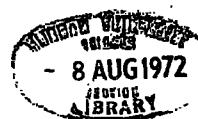
APPENDIX VII

Newcastle University
Department of Agricultural Economics
Classification of Farm Types (Modified)

- A 30% or less output from crops
Livestock fattening with cash cropping
- B 30% or more output from crops
Cash cropping with livestock fattening.
- C Milk twice times gross output of any other single enterprise
Milk with subsidiary enterprises
- D At least three enterprises including milk contributing 15% or more to the gross output
- E Grazing without crops
- F Specialised. 75% of output from a single enterprise.

APPENDIX VIIIDivisions of Farms according to Appendix VII

A	Broom	937 acres	(730 feet)
	Ushaw College	265 acres	(575 feet)
	Red House	56 acres	(525 feet)
	Langley House	430 acres	(400 feet)
	Hill House	198 acres	(612 feet)
	Ivesley	333 acres	(660 feet)
	West Broom	60 acres	(360 feet)
	Glebe	127 acres	(690 feet)
	Broom Hall	180 acres	(420 feet)
	Low Esh	106 acres	(575 feet)
	East Flass	192 acres	(378 feet)
	Hare Holme	221 acres	(430 feet)
	New Ivesley	201 acres	(691 feet)
	Witton Hall	375 acres	(320 feet)
	Greenland	128 acres	(570 feet)
	Hag House	173 acres	(496 feet)
	Fulforth	277 acres	(450 feet)
	Clifford House	184 acres	(595 feet)
	Pringle House	107 acres	(595 feet)
B	Unthank	106 acres	(350 feet)
C	Hill Top	330 acres	(530 feet)
	Wallnook	108 acres	(295 feet)
	Cockhouse	82 acres	(424 feet)
	Blackburn	189 acres	(325 feet)
	Heugh	323 acres	(650 feet)
	Scout House	98 acres	(365 feet)
	Bearpark Hall	172 acres	(305 feet)
	Langley West House	430 acres	(600 feet)
	Biggin	163 acres	(460 feet)
	Biggin House	156 acres	(464 feet)
	Biggin	388 acres	(467 feet)
	Red House	75 acres	(508 feet)
	Finings	93 acres	(340 feet)
	Whitehouse	150 acres	(510 feet)
	Rowley	383 acres	(550 feet)
	Esh Hall	502 acres	(706 feet)
	Witton Farm	98 acres	(350 feet)
	Bearpark Lodge	208 acres	(340 feet)
E	Sleights	68 acres	(400 feet)
	Rowley Gillot	43 acres	(456 feet)
	Broadgate	26 acres	(326 feet)
	Hill Top	51 acres	(525 feet)
F	North Farm	97 acres	(525 feet)
	Snoek Acres	39 acres	(350 feet)
	Cotehill Cottages	32 acres	(556 feet)



MAP ONE
ORDNANCE SURVEY (1:25,000) OF SURVEY AREA.

■ = FARMS SURVEYED D = CLASSIFICATION ACCORDING TO APPENDIX VII.
• = PITS EXAMINED IN THE FIELD X = PITS SAMPLED IN THE LABORATORY



Land Utilisation Map 1971, Browney & Deerness Valleys.

Scale: 2 1/2 inches to 1 mile.

Key.

- Forest/Plantation.
- Permanent Pasture (rough grazing)
- Sown Grass.
- Cereals.
- Roots.
- Built-up area/waste/collieries.

