THE DISTRIBUTION OF PINK-FOOTED AND GREYLAG GEESE IN RELATION TO AGRICULTURE IN BRITAIN

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Report to the Joint Nature Conservation Committee

JANUARY 1994

ABSTRACT

The distribution of Greylag Geese (*Anser anser*) and Pink-footed Geese (*Anser brachyrhynchus*) during 1988/89 was analysed in relation to the agricultural activity of farmers in Britain in 1988. Results confirmed that Greylag Geese (excluding the feral population) are more widely dispersed and have a more northerly distribution than Pink-footed Geese. Nevertheless, there was a positive correlation between the numbers of Greylag and Pink-footed Geese at sites where both species occur, indicating that the characteristics of a site may be selected by both species. The distribution of both Pink-footed Geese and Greylag Geese throughout the winter was positively correlated with the distribution of fodder swedes/turnips and spring barley. Greylag Geese were more concentrated in areas associated with horticultural crops. A positive association of Pink-footed Geese with cattle farming and new grass, and of both species with the 'other land' category (mainly rough grazing) in both autumn and spring, may be due to the birds selecting pasture land upon arrival in autumn and immediately prior to spring migration. The association between the distribution of Pink-footed Geese and the agricultural variables considered was much less clear than for the Greylag Geese. This may be due to greater heterogeneity of habitat in areas used by Pink-footed Geese, to the importance of variables not included in the analysis (*e.g.* the location of secure roosts), or to greater variability in their selection of feeding sites. The study makes a 'broad-brush' assessment of the effect of agricultural variables upon the distribution of the geese in a single winter. More detailed observations are necessary to determine factors influencing site selection at the field level, and to explain any differences in distribution between years.

INTRODUCTION

The association between geese and agriculture has long been of interest, to conservationists and farmers alike, owing to the potential for the birds' foraging activities to cause crop damage and economic loss to the farmers concerned. In some instances, the feeding of geese on farmland is thought to be benign, such as when the birds feed on spilled grain in stubble fields, or on potatoes left after the harvest (Kear 1963a,b; Newton & Campbell 1973). Furthermore, prevention of the dispersion of Potato-root Eelworms *Heterodera rostochiensis* by birds eating waste potatoes after harvesting was considered positively beneficial (Newton & Campbell 1973). In more recent years, however, farm management has become increasingly intensive and, in some areas, more diversified, providing a greater range of cash crops on which the birds might feed, and greater scope for conflict with the farmers involved (Moser & Kalden 1991, Patterson 1991). At the same time, there has been a marked development in the size of goose populations in the Western Palaearctic. Of 22 populations for which a trend has been determined, 19 have expanded since the 1950s, with the overall number of geese wintering in Europe virtually doubling in the last 10 to 15 years (Madsen 1991a,b). Numerous studies have aimed to quantify crop damage and estimate loss of yield

(Teunissen 1991 gives a review). The wide range of results indicates that the subject is complex, owing to the difficulty of controlling for the many variables influencing the growth of vegetation, such as climatic conditions, irrigation, soil conditions, the type of damage inflicted by the birds (*e.g.* clipping, treading, up-rooting) and the stage of plant development at the time of grazing (Teunissen 1991). Nevertheless, the increase in goose numbers at the same time as (and perhaps attributable to) the intensification in farming practice, and the movement of geese on to arable crops from grasslands, makes the feeding ecology of the geese an important area for research in conservation.

Of the four species of grey geese that winter regularly in Britain only two, the Pink-footed Goose *Anser brachyrhynchus* and the Greylag Goose *Anser anser*, are both numerous and widespread in this country. Several thousand European White-fronted Geese *Anser albifrons*, and some 15,000 Greenland White-fronted Geese *Anser albifrons flavirostris* now winter in Britain each year (Cranswick *et al.* 1992), but *Anser albifrons* uses only a small number of highly traditional sites in this country (Owen *et al.* 1986). The Bean Goose *Anser fabalis* is a comparatively rare winter visitor with some 500 individuals recorded each year, mainly at the Yare Valley in Norfolk (Cranswick *et al.* 1992). Only the Greylag and Pink-footed Geese were considered, therefore, in the present analysis of the potential for conflict or co-existence between grey geese and agriculture in Britain.

Results of early ringing programmes indicated that Pink-footed Geese which winter in Britain migrate to Iceland and East Greenland to breed (Boyd & Scott 1955); indeed it is thought that Britain receives the whole of the Icelandic and Greenlandic breeding populations (Owen *et al.* 1986). Traditionally, Pink-footed Geese occurred mainly on coastal saltmarshes, but have moved inland to feed on arable land in increasing numbers during the second half of the twentieth century, using reservoirs and other freshwater bodies to roost. Numbers have risen substantially from about 30,000 birds in 1950, to 55-60,000 by the early 1960s (Boyd & Ogilvie 1969; Ogilvie & Boyd 1976), over 90,000 by the early 1980s (Owen *et al.* 1986) and reached some 233,000 in October 1991 (Cranswick *et al.* 1992). Regional changes in the distribution of the birds have been recorded both within and between seasons, perhaps attributable to changes in food supply, and distributional changes have occurred over longer periods at a national level (Owen *et al.* 1986). For instance, although most of the population has consistently wintered in Scotland, an increasing proportion of the population concentrated in east-central Scotland during the late 1950s and 1960s (at the expense of sites in both

northern Scotland and northern England, Boyd & Ogilvie 1969), which was attributed to the increase in barley growing in the region (Kear 1963a). This trend was reversed to some extent during the late 1970s but eastern England has not regained its former status (Owen *et al.* 1986, Pashby 1992).

The Greylag Geese that migrate to Britain also breed in Iceland, although a native population in north-west Scotland and feral populations established in parts of England, southern Scotland and northern Ireland remain throughout the year (Owen 1980). The number of birds in the Icelandic population has risen from 26,500 in 1960 to 65,000 in the 1970s and to 95,000 in 1981 (Owen *et al.* 1986). A count of some 115,000 birds during the 1990 census was thought to be an under-estimate of the true size of the population (Kirby *et al.* 1991), although only 100,000 birds were recorded in the 1992 census, suggesting that the population is no longer increasing (Mitchell & Cranswick 1993). The feral population now numbers some 19,000 birds (Delany 1992), fewer than the 26,000 predicted by Owen & Salmon (1988), and the non-migratory native population in the far north and west of Scotland has reached some 3,000 birds (Kirby *et al.* 1991, Mitchell 1993).

Like the Pink-footed Geese, the migratory Greylag Geese winter mainly in Scotland, perhaps selecting the first suitable habitat that they reach upon arrival from their Icelandic breeding grounds. An earlier study of Pink-footed and Greylag Geese found that the two species regularly use the same roost sites, but that they tend to be separate at the roost and to flight to different feeding areas (Newton *et al.* 1973). In this study, Pink-footed Geese were more particular in their choice of feeding areas than Greylag Geese (regularly flying more that 10 km from the roost to feeding sites, whereas Greylag Geese rarely flew more than 5 km to feed), which was attributed to the greater wariness of the Pink-footed Goose (Newton *et al.* 1973). Greylag Geese have been recorded feeding on *Scirpus* roots in the Netherlands in recent years (Zwarts 1972), and this may have been their traditional habitat in Britain (Owen 1976), but *Scirpus* beds are no longer common in British estuaries and the geese now feed almost exclusively on arable land and improved pastures in Britain.

The present study describes the distribution of Greylag Geese and Pink-footed Geese during the 1988/89 winter in relation to agricultural activity during 1988, with a view to determining some of the factors affecting site selection, and the potential for damage to arable crops. The extent to which Greylag and Pink-footed Geese use the same sites is considered, since habitat

variables suitable for one species may also be selected by the other, but behavioural differences between the species (Greylag Geese being less wary than Pink-footed Geese) and the possibility of inter-specific competition for the best feeding and roosting sites may also influence distribution. Changes in distribution from month to month are considered not only with respect to food availability but also in relation to distance from the Icelandic breeding grounds and to variation in the birds' nutrient requirements during the winter. There were no precise data available on the types of crops in fields visited by the birds, only on the main types of agriculture in the area. The association between agricultural activity in the region and the number of birds recorded was assessed at spatial scales ranging from individual sites to 100 km squares, however, thus giving a broad measure of food availability in areas thought likely to be supporting the goose flocks, and also indicating the size of catchment area needed to support flocks of different sizes, ranging from tens to thousands of birds.

METHODS

Goose data

Data on the distribution of Greylag and Pink-footed Geese were obtained from the National Waterfowl Counts (NWC) database for winter (October to March) 1988/89, the winter most relevant to agricultural land-use in 1988. These data are a mixture of counts of geese on the water at wetland sites and of those feeding on land away from wetlands (with perhaps more of the former for Pink-footed Geese and more of the latter for Greylag Geese). The wetland counts are also made by a mixture of methods - true roost counts and daytime counts, which are less likely to be reliable. In the absence of available information on the nature of counts, or a strategy for dealing with heterogeneity of count quality, counts from all months and all sites have been treated equally in the following analyses. The November data, from the Autumn Census, are likely to be the most reliable and complete.

There were 176 British sites at which Pink-footed Geese were counted during October to March 1988/89 and 459 sites at which Greylag Geese were counted (including feral

populations), with a total of 507 sites holding Greylag and/or Pink-footed Geese at some time during winter 1988/89. Thus, both species were recorded at 128 sites, and 379 sites held one species only. Of the 2,754 possible counts of Greylag Geese (= 6 months × 459 sites), and 1,056 possible counts of Pink-footed Geese (= 6 months × 176 sites) during winter 1988/89, 362 (16.1%) and 170 (13.1%) respectively were missing. In order to allow the same set of sites to be included in all months, a simple method of estimating missing values was used. Counts were assumed to follow the Underhill Index multiplicative model (Underhill 1989):

$$x_{ij} = s_i \, m_j$$

where the count x_{ij} at site i in month j can be modelled as a product of a site factor s_i for site i and a month factor m_j for month j; missing values may be imputed according to this model using an expectation-maximisation algorithm. The proportion of the total count estimated in this way was 27.5% for Greylag Geese and 25.2% for Pink-footed Geese. The model assumes that the relative distribution of birds between sites remains the same in all months; this is unlikely to be strictly true, but with only relatively small counts being imputed departures from this assumption are unlikely to cause significant biases.

Agricultural land-use data

An Agricultural and Horticultural Census is conducted annually by the Ministry of Agriculture, Fisheries and Food (MAFF) in England and Wales, and by the Department of Agriculture and Fisheries for Scotland (DAFS) in Scotland. Data on over 200 categories of agricultural activity are obtained from farmers, in a form differing slightly between the MAFF and DAFS surveys (see Appendices 1 and 2).

These data are summarised on the basis of individual parishes and held by Edinburgh University Computing Service (EUCS). EUCS use a sophisticated conversion algorithm to relate parish-level data to 1 km squares of the National Grid, in which form it is available from the Edinburgh University Data Library.

The analyses presented in this report are based on agricultural data for 1988, summarised at a 10 km square level, which had been supplied to the Joint Nature Conservation Committee.

Data were in the form of total area of land-use types (ha for most crops and grass, m^2 for some horticultural crops), total head of livestock of a given type and total tonnage of hay, straw and silage stocks within each 10 km square.

Data for England and Wales and Scotland were held separately in slightly different formats, placing some minor restrictions on the compilation of a consistent database for Britain. Some agricultural activities, such as poultry and pig-rearing and soft fruit growing, were considered *a priori* to be unimportant for grey geese. A database of 39 variables was compiled, considered to describe all relevant variability of agricultural land-use with relation to geese (Table 1).

Summarisation of spatial scale

In order to allow direct comparison of the agricultural and goose data, goose numbers were totalled for 10 km squares of the National Grid. Comparisons at spatial scales larger than 10 km squares were made by summing of data (both goose and agricultural) across 10 km squares, to give total numbers of geese, total crop areas, total head of livestock *etc.* within squares of size 20 km and larger. Grids of 20 km up to 100 km squares were constructed using 10 km grid reference SV0000 as the most south-westerly corner.

Comparison of distributions of the two species

Two approaches were adopted to compare the distributions of the species. Firstly, Pearson correlation coefficients were used to test the hypothesis that ln $(x+1)$ transformed Greylag and Pink-footed Goose numbers were linearly related. This hypothesis was tested for each month and for total goose-months (sum of monthly counts) at spatial scales ranging from individual sites up to 100 km squares. Comparisons were limited to sites/squares that held at least one individual of either species during winter 1988/89; in other words, the analysis was conditioned on suitability of sites/squares to hold Greylags and/or Pink-footed Geese.

The second approach considered more general possibilities of relationship between numbers of the two species: 2×2 contingency tables were constructed, testing association between

numbers of Greylag and Pink-footed Geese. Four different threshold levels were used for comparisons: 1, 10, 100 and 1,000 geese. The null hypothesis for each contingency table is that 'flock' sizes above and below the threshold level were distributed at random with respect to the two species - 'flock' in this case being defined as the total number of geese within a square or site. Likelihood ratio X^2 values were compared with tabulated values of χ^2 with 1 degree of freedom, to test departures from randomness; the nature of non-randomness was explored through examination of standardised residuals. As with the correlation analysis, comparisons were made within each month and at spatial scales from sites to 100 km squares. Overall tests for the whole winter were constructed by summing X^2 values across months and comparing with tabulated values of χ^2 with 6 degrees of freedom.

Comparison between goose numbers and agricultural land-use

All comparisons between goose and agricultural land-use variables were made using untransformed data. The rationale was that the most natural relationship between goose numbers and land areas (whether actual, as in ha of a crop type, or implicit, as represented by head of livestock) was linear, *i.e.* as geese per unit area. Whilst it is true that this assumption of linearity may well not hold when the carrying capacity of a land-use type for geese is approached, there is insufficient information on which to base a more realistic model of response. Log-transformation of goose numbers is certainly inappropriate; for example, a log-linear model in which 1 ha of land is predicted to support 10 geese might also predict that 2 ha would support 100 geese (the antilog of 2 × the log of 10), which is clearly unrealistic.

In the first instance, simple univariate comparisons were made between goose numbers and the 39 agricultural land-use variables listed in Table 1. Pearson correlation coefficients were used to test hypotheses of linear correspondence between goose numbers and areas of agricultural activity or head of livestock. Spatial scales from 10 to 100 km squares were considered separately for each month. Thus, each correlation analysis consisted of 39 (agricultural variables) × 10 (spatial scales) × 6 (months) = 2,340 separate correlation coefficients. This number of tests of significance allows much opportunity for type I errors (Sokal & Rohlf 1981); the results of these analyses were consequently interpreted according

to the pattern and consistency of apparently significant correlations, rather than according to the significance levels of individual correlations.

The interpretation of these correlations differs according to the scope of sampling units (squares) considered. If all possible squares are considered, including the large number of those where no geese were ever counted, then the correlations mainly reflect a contrast in agricultural characteristics between geographical areas where geese are and are not found. If only squares which contain geese are considered then the interpretation is different: the question addressed is of how the agricultural characteristics of squares affects their capacity to support geese, given that the square is in a 'suitable' geographical area, where 'suitable' includes climatic, topographic and flyway considerations; these analyses, therefore, give a better indication of habitat selection, since there is some control for geographical distribution in influencing winter dispersal. In both cases, significant correlations persisting at higher spatial scales do not necessarily indicate a meaningful relationship between geese and agriculture at these levels - they may indicate incidental clumping in the distribution of both land-use type and geese.

Correlation analyses were initially performed using all squares, irrespective of holding geese; they were repeated with a reduced scope - using only those squares which at any time during winter 1988/89 supported geese of the species under consideration. In addition, the scope was further reduced for Greylag Geese to separate wintering Icelandic and native individuals from the feral (introduced) population: all records north of National Grid 10 km northing 53 were included (*i.e.* all of Scotland and a little of northern England), a line which effectively excludes most feral birds (see Figure 79 of Owen *et al.* 1986).

Thirty-nine agricultural land-use variables were available for the correlation analyses but there are unlikely to be 39 meaningful ways in which agricultural land-use varies. There is likely to be multi-collinearity within the data set. so that a significant correlation of goose numbers with an individual agricultural land-use variable does not necessarily reflect a causal relationship - instead, it may reflect the correspondence of that agricultural variable with some other (unidentified) land-use gradient. Two approaches were adopted to identify the fundamental dimensions of variability in agricultural land-use that best corresponded to abundance of geese.

Firstly, multiple regression models relating goose numbers to agricultural land-use variables were constructed. A best sub-sets regression procedure (BREG) was used to identify the optimum model among those nested within a 'global' (very general) model (Minitab 1991). The 'global' model contained 15 of the 39 agricultural variables selected for analysis (see below). The best model (maximum R^2) of each size was found, from 14 down to 1 agricultural variable, and the optimum model identified using Mallow's C_p model selection criterion (Burnham & Anderson 1992):

$$C_p = (\mathrm{RSS}_p/\hat{\sigma}^2) + 2p - n,$$

where RSS_p is the residual sum of squares from the fitted model with p parameters, n is the number of observations and $\hat{\sigma}^2$ is an unbiased estimator of the true residual variance (*i.e.* that of the global model). This statistic is analogous to the Akaike Information Criterion used in a maximum likelihood context: finding the smallest C_p among a family of models is equivalent to locating the most parsimonious model through a series of pairwise model comparisons.

Optimum models were found for the 10 km square data, with each month being treated separately. Only those squares which held geese of the given species at some time during winter 1988/89 were considered. The analysis for Greylag Geese was restricted to the wintering migratory stock, *i.e.* mainly Scottish birds. The list of 39 agricultural variables was reduced to exclude minor variables closely related to other variables (*e.g.* 'other' cows and 'other' sheep) and those variables which were functions of other variables (*e.g.* total grain and total crops and fallow). Fifteen variables were finally selected (Table 1), which was the maximum capacity of the BREG program. Ideally, a further three variables would have been included (see below); the variation in agricultural land-use described by the three omitted variables was considered to be adequately represented by the remaining 15.

The second approach also used a BREG procedure to identify optimum regression models. However, in this case principal axes of the agricultural data were used in place of the raw variables. Although there is a control for multi-collinearity in the regression models using the raw variables, there is still a danger of attributing the effects of a fundamental variable to which goose numbers respond to a different, but measured variable with which it correlates. Principal components analysis (PCA) (Digby & Kempton 1987) was used to

identify the main dimensions of variation in agricultural land-use in those 10 km squares used by geese, in an attempt to re-create fundamental variables which might have a bearing on goose distribution. Principal components analysis was performed on 18 agricultural land-use variables (Table 1), and those components with eigenvalues greater than 1 (*i.e.* linear combinations of the agricultural variables accounting for a greater than average proportion of the total variance) were used as predictor variables in regression models.

This analysis used the same scope of data as the previous one (except that more agricultural land-use variables were used since the number of variables in PCA was not limited by software constraints). The principal axes thus describe the variation in agricultural land-use in areas used by geese, rather than in the country as a whole. Separate BREG analyses were performed for each month.

RESULTS

Numbers and distribution of geese

Distribution maps for Greylag and Pink-footed Geese in each month of winter 1988/89 are given in Figures 1 and 2. The most important sites for Greylag Geese were in Scotland and Northumberland, notably Loch of Strathbeg (Grampian) with the most consistently large counts, peaking at 6,900 in February, Loch Spynie (Grampian) with 8,300 in November, the highest single count, Munlochy Bay (Highland) with 5,000 in November and Lindisfarne (Northumberland) with 4,000 in November. The most important sites for Pink-footed Geese were in south-east Scotland, notably Loch Leven (Tayside) with 9,000 counted in November, Lake of Menteith holding 6,000 in March and Cameron Reservoir (Fife) with 7,000 in November. Outside Scotland the most important sites for Pink-footed Geese were in Norfolk, centred around the Wash and Scolt Head Island (with 9,220 and 3,800 birds respectively in February), and in Lancashire, centred around Martin Mere (5,168 in November).

The overall winter phenology for both species was of peak counts in November and smallest counts in December, but at individual sites there was considerable variation about this pattern;

clearly, there was much exchange of geese between sites over the winter. Little systematic seasonal change in distribution was detected by examination of residuals from the index model, however, indicating that the movements of birds between sites may be due to a number of factors. It proved impossible to distinguish roost counts from feeding counts on the basis of count size alone, and there were no other data available (*e.g.* the timing of the count) to indicate whether a site was used for roosting, for feeding or for both activities. All the counts were included therefore in the following analyses assessing the distribution of grey geese in relation to agricultural variables.

Comparison of Greylag and Pink-footed Goose distributions

Log-transformed Greylag and Pink-footed Goose numbers correlate positively and significantly overall, in all months and at all spatial scales from site level to 100 km squares (Table 2). Given that out of 507 sites holding one or other species only 128 sites held both, it is clearly untrue to say that there is a close correspondence in distribution of the two species between sites. The conclusion from the significant site-level correlations is rather that the *importance* of sites for the two species is related, *i.e.* sites holding large numbers of one species are unlikely to hold very small numbers of the other, and *vice versa*. Correlations mostly increase in magnitude and statistical significance with increasing spatial scale, indicating that the coexistence of the two species is better represented at a broad geographical scale than at individual sites. Above the 20 km square level all correlations were significant at $P<0.001$.

There was little evidence of seasonal variation in the relative distribution of the two species; however, late winter correlations tend to be larger than those in early and mid-winter, perhaps indicating congregation of geese on the major sites prior to spring migration.

Results of the contingency table analyses are given in Tables 3 to 6. In every case of a significant X^2 statistic the pattern of residuals in the contingency table was the same: positive values on the leading diagonal, negative values off the diagonal, signifying positive association between Greylag and Pink-footed Goose 'flock' sizes.

The pattern of significant results in relation to month and spatial scale at each threshold level is interesting. In every case there was a tendency for significance to increase with increasing spatial scale. At the lowest threshold of 1 goose, *i.e.* testing for association between species in terms of presence/absence, the association was strongest in October and smallest in January, tending to increase towards the end of the winter (Table 3). At the highest threshold level of 1,000 geese, testing for association of major aggregations of geese, there is a quite different pattern of significance: the association was smallest in October and highest in March (Table 6). At threshold levels of 10 and 100 geese nearly all the X^2 values were significant.

These results reinforce the findings of the correlation analyses by confirming a positive association between the numbers of Greylags and Pink-footed Geese present at levels ranging from individual sites up to 100 km squares. The observation that nearly all the X^2 values were significant at threshold levels of 10 and 100 geese indicates that the most frequent associations are to be found for medium sized flocks. The association between Greylags and Pink-footed Geese at the 1 goose threshold level in autumn (October) and spring (February and March), compared with the lack of an association at this level in November and January, may perhaps be due to the mixing of flocks during autumn migration, and when congregating at pre-migratory sites in spring, and to segregation upon dispersal in mid-winter. Associations between the larger flocks (threshold of 1,000 geese) occurred mainly above the 40 km square level in mid-winter, indicating that a large catchment area is necessary to hold this number of birds, which may consist of one or several flocks. There was a significant association between Greylag and Pink-footed Goose flocks of at least 1,000 birds at most levels on the spatial scale in March, however, indicating that major aggregations of geese develop prior to spring migration.

In summary, it seems that Greylag and Pink-footed Geese have overlapping wintering grounds but there is some intra-specific variation in dispersal to the wintering sites. The two species do co-exist at sites, but the greatest similarities in distribution are at a spatial scale greater than the site level. There appears to be a seasonal change in the pattern of association, owing to aggregation of both species at the major sites towards the end of the winter.

Distribution of agricultural land-use

Maps of the distribution in 1988 of the major agricultural land-use types are given in Figures 3 to 8. Farmland (Figure 3) is distributed fairly evenly across Great Britain, except for the major conurbations (notably Greater London and Greater Manchester/Merseyside), Shetland, Orkney and the Outer Hebrides. Arable farming (total crops in Figure 3) is concentrated in the drier eastern side of Britain, especially the eastern counties of England to the south of the Humber. Sown grassland for mowing and grazing (total grass in Figure 3) makes up the third major component of total farmland, with a predominantly westerly distribution outside Scotland. 'Other' land (Figure 3), which mainly comprises rough grazing land in mountains, moors and deer forests, are in the remoter areas of the country such as Snowdonia, much of northern England (including the Pennines and the Lake District) and most of rural Scotland (excepting the arable east coast of the Grampian and Tayside regions).

The distribution of livestock farming (Figure 4) mirrors that of grassland. Sheep are rather more restricted in distribution than cattle, being concentrated in north and mid-Wales and north-west England. Dairy farming is distributed slightly differently to beef farming, with the latter being dominant in the livestock rearing areas of Scotland and in the Welsh borders. Livestock distributions can be compared with those of grass and fodder crops (Figure 5). Grass, both old (sown five or more years before the census) and new (less than five years old), has a similar distribution to cattle farming. Different fodder crops tend to have restricted distributions; for example, turnips and swedes are grown mainly in the north-east Grampian region of Scotland and fodder beet in south-east England (Figure 5).

Cereal crops, mainly wheat, barley and oats (Figure 6), are distributed throughout the arable areas (Figure 3), but the different grains show contrasting distributions. Wheat is the most widely distributed grain, although it is concentrated in the eastern counties of England. Oats is also widespread, but is mainly grown in eastern Scotland and in the English counties bordering Wales. Spring and winter barley show contrasting distributions, winter barley being grown more extensively outside Scotland and spring barley having a more northerly distribution, grown especially in the Grampian and Tayside coastal region. Some other arable crops, such as oilseed rape (Figure 7), appear to be grown in the same regions as cereals, especially wheat.

Horticultural crops (Figure 8) tend to have restricted distributions. Vegetable crops grown in the open (Horticulture in Figure 8) are notably prevalent in the Tayside, Fife and Lothian regions of Scotland; potatoes (Figure 7) are similarly distributed. Root crops, including carrots, and brassicas (Figure 8) are grown mostly in Cambridgeshire or Lincolnshire, and also in west Lancashire. Peas (Figure 7) are grown mainly in south-east England.

Univariate comparison of goose numbers with agricultural land-use

Patterns of correlation of Greylag and Pink-footed Goose numbers with selected agricultural land-use variables, summarised at spatial scales from 10 to 100 km squares, are shown in Tables 7 to 12. At the widest geographical scope there appear to be four main patterns of positive correlation of Greylag Goose numbers with agricultural land-use variables (Table 7):

(a) consistently significant correlations (*i.e.* in all months and at all spatial scales) were obtained with spring barley, oats, potatoes, horticulture and, most notably, fodder turnips/swedes;

(b) significant correlations, but tailing off at higher spatial scales, were found with beef cows and new grass;

(c) significant correlations at lower spatial scales (≤ 40 km squares), strongest in mid-winter, were exemplified by total grain, oilseed rape and brassicas;

(d) significant correlations at higher spatial scales (≥ 50 km squares), strongest at the start and, to a lesser extent, the end of the winter, exemplified by 'other' land.

Patterns (a) and (b) simply reflect the agricultural characteristics of the important areas for Greylag Geese; land-use types under (b) (Figures 4 and 5) are more widely distributed than those under (a), which are clumped particularly along the eastern side of Scotland (Figures 5 to 8), hence (a) correlations are more persistent at higher spatial scales. The negative correlations with dairy cows and old grass are related to this pattern, reflecting the predominantly westerly distribution of these land-use types (Figures 4 and 5). Patterns (c) and (d) both represent seasonal changes, but whilst pattern (c) might well characterise a real

seasonal change in land type preference since it was evident at lower spatial scales, (d) probably reflects a more gross shift in range during the winter season.

Similar patterns can be distinguished from positive correlations between Pink-footed Goose numbers and agricultural land-use variables recorded throughout Britain (Table 8):

(a) consistently significant correlations (*i.e.* in each month and at every spatial scale)were obtained with spring barley, potatoes, fodder turnips/swedes and horticulture;

(b) significant correlations, but tailing off at higher spatial scales, were found with oats;

(c) significant mid-winter correlations at widely differing spatial scales were exemplified by total grain, peas, fodder beet/mangolds, brassicas, carrots and total crops and fallow;

(d) significant correlations at the beginning and end of the winter at varying spatial scales, exemplified by beef cows and new grass;

(e) significant correlations at the beginning and end of the winter at higher spatial scales, exemplified by 'other' land.

Patterns (a) and (b) may be interpreted similarly to pattern (a) for Greylag Geese. The tailing off correlation with Oats at higher spatial scales may be due to the relatively small numbers of Pink-footed Geese in the northern part of the Grampian region (*c.f.* Figures 1 and 2), a major area for oats (Figure 6). Patterns (c) to (d) all represent seasonal effects; Pink-footed Geese were notably more changeable over the winter in their distribution in relation to agricultural land-use than are Greylags, despite occurring at fewer sites. Pattern (c) may be divided into effects at all but the smallest spatial scales (vegetable crops such as peas, brassicas and carrots), effects at higher spatial scales (fodder beet/mangolds) and effects at lower spatial scales (total grain). These differences are difficult and possibly futile to interpret, but presumably reflect differences in the clumping of land-uses in addition to seasonal changes in the agricultural preferences of Pink-footed Geese at different scales. In contrast, pattern (d) may well indicate more use of grazing land by Pink-footed Geese at the

beginning and end of the winter. Pattern (e) appears to be identical to pattern (d) for Greylag Geese.

On their own, these correlations do not provide conclusive evidence of the use of any single type of agricultural land by geese. Tables 9 and 10 restrict the geographical scope to squares in which geese of the given species were recorded during the winter. This provides a test of association of goose numbers with agriculture within the goose's range.

Patterns of correlation of Greylag Goose numbers are considered first (Table 9). The pattern (a) consistent correlations of spring barley, Oats, potatoes and fodder turnips/swedes remain largely the same, indicating, perhaps, a real association. Horticulture, however, loses the significance of its correlations at lower spatial scales, suggesting that the association may be an incidental geographical one, rather than a preference. The pattern (d) correlations with 'other' land remain, except that there were significant correlations at lower spatial scales, possibly because much of lowland Britain is now omitted from the analysis. The mid-winter pattern (c) correlations with total grain, oilseed rape and brassicas disappear.

Similar changes are noticeable in the results for Pink-footed Geese (Table 10). Of the pattern (a) consistent correlations, spring barley, potatoes and horticulture remain, although some of the mid-winter correlations at lower spatial scales disappear, perhaps suggesting some seasonality of use. Correlations with fodder turnips/swedes appear markedly seasonal at all spatial scales, the significance of all January and almost all December correlations having disappeared. Similarly, significant correlations with oats are restricted to the beginning and end of winter. The pattern (c) mid-winter correlations disappear, with the exception of total crops and fallow. The pattern (d) seasonal correlations with beef cows and new grass remain, but much reduced in significance. Pattern (e) correlations with 'other' land are changed in a similar way to the Greylag Geese.

It is likely that the use of agricultural land by feral Greylag Geese differs from that of migratory Icelandic-breeding Greylag Geese. Inclusion of feral birds might well bias or obscure the results of analysis. Tables 11 and 12 show the results of correlation analyses applied to squares north of grid northing 53, *i.e.* mostly Scottish Greylag Geese; Table 11 considers the distribution of Greylag Geese in relation to agricultural variables recorded

throughout Scotland, Table 12 includes data only from the 10 km squares in Scotland in which Greylag Geese were recorded.

At the widest geographical scope (Table 11), including all squares, many more agricultural variables are seen to correlate significantly with Greylag Goose numbers than was apparent when the whole of Britain was considered. Fourteen variables correlate positively and significantly in all months and at all spatial scales: beef cows, other male cattle, new grass, wheat, winter barley, spring barley, oats, total grain, oilseed rape, potatoes, peas, fodder turnips/swedes, brassicas and total farmland. Of these, wheat, winter barley, peas and total farmland were not seen previously to correlate significantly, total grain and oilseed rape were seen previously as mid-winter correlations and beef Cows and new grass previously did not correlate at higher spatial scales. Correlations with 'other' land almost disappear, becoming significantly negative at lower spatial scales. These changes may largely be due to less heterogeneity of agricultural land-use when the geographical scope of the analysis is reduced. Most of the agricultural variables were strong correlates of total farmland in Scotland, so that Table 11 reveals little more than that, in Scotland, wintering Greylag Geese are associated with agriculture rather than other types of land-use.

In Table 12 the geographical scope is limited to those squares in Scotland (or, more strictly, north of grid northing 53) which held Greylag Geese at some point during winter 1988/89. There are four consistent correlates of Greylag Goose numbers in all months and at all spatial scales: new grass, spring barley, oats and fodder turnips/swedes. Wheat, winter barley, total grain, oilseed rape, potatoes, peas and brassicas correlate more-or-less significantly at spatial scales above about 20-30 km squares. There was a scattering of significant correlations with other agricultural variables in various months and at various spatial scales, but little evidence of seasonal changes in the relationship with agricultural land-use. Given the strong relationships between the distributions of the different agricultural variables, it is difficult to interpret these results in terms of use of land by geese. The strongest and most consistent correlations were with fodder turnips/swedes.

Modelling goose numbers in relation to agriculture

The best regression models relating goose numbers to agricultural land-use, incorporating up to six agricultural variables (out of 15 included in the analysis) are summarised in Tables 13 and 14. Optimum models for Scottish Greylag Geese used from three to five agricultural variables, and accounted for from 15.1% to 26.4% (R^2 adjusted for degrees of freedom) of the variance in goose numbers (Table 13). Fodder turnips/swedes was the only variable selected in the models for all months, and was selected in 32 out of the 36 models presented in Table 13. Oilseed rape was included in five out of six optimum models, but there was a shift from negative coefficients in October and November to positive coefficients from December to February. Peas featured positively, and potatoes negatively, in four out of six optimum models. Wheat and winter barley featured twice, both negatively; no other variable featured more than once (oats, horticulture, total sheep).

The only safe conclusions from this analysis are that fodder turnips/swedes were important for Greylag Geese in Scotland throughout the winter, and that there was a relationship (possibly indirect) between Greylag Goose and oilseed rape distribution which changed during the winter. Interpretation of negative coefficients is difficult as they might indicate: (1) a geographical effect when the land-use type is variable geographically; (2) cross-correlation with another (unknown) variable which is directly related to goose numbers; (3) avoidance of land-use types. Thus, the mid- and late winter negative coefficients relating Greylag Goose numbers to the area of potatoes in Scotland might suggest that potatoes are grown in the areas least important for Greylag Geese, that the area of potatoes is related to an unknown gradient of land-use change important for Greylag Geese, or that Greylag Geese avoid potatoes, of which perhaps the second possibility is most likely.

Optimum models for Pink-footed Geese used from two to six agricultural variables, and accounted for from 5.2% to 19.0% of the variance in goose numbers (Table 14). The small R^2 values compared with those for Greylag Geese are, perhaps, inevitable considering the greater geographical scope of the analysis for Pink-footed Geese. No agricultural variable was included in the optimum model for every month, but horticulture (positive) was omitted from the February model only. There was some evidence of seasonality in the inclusion of agricultural variables: 'other' land (positive), beef cows (negative) and winter barley (negative) were included in models for the beginning and end of the winter; old grass and

wheat (both negative) were included in November to January models; potatoes and new grass (both positive) were included in February and March models. Fodder turnips/swedes was included in no optimal models; when introduced into models the coefficient was negative, as in sub-optimal models for December and March.

Thus, Pink-footed Geese depend on vegetable crops for most of the winter and that there was a mid-winter shift in the importance of other land-use types. Apart from the relative importance of different agricultural variables, there were several major differences between the Greylag and Pink-footed Goose models. The most obvious difference was in the signs of the coefficients for the major agricultural variables for each species: fodder turnips/swedes (positive for Greylag Geese and negative for Pink-footed Geese); horticulture (positive for Pink-footed Geese and negative for Greylag Geese); potatoes (negative for Greylag Geese and positive for Pink-footed Geese). 'Other' land was found to be of considerable importance to Pink-footed Geese, featuring positively in 16 out of the 36 best 1-6 variable models, but was not selected in any of the best 1-6 variable models for Greylag Geese. The agricultural variable most consistent between the species was winter barley, featuring negatively in two optimum models for each species.

Principal components analysis of agricultural variables

Table 15 gives the results of PCA of agricultural land-use in 10 km squares north of grid northing 53 in which Greylag Geese were counted at some point during winter 1988/89. Eigenvalues and eigenvectors are listed for the first five components, which are those for which the eigenvalue was greater than 1, together with correlations of these components with Greylag Goose numbers in each month. These five components together accounted for 77.4% of the variance of the 18 original variables. The five principal axes may be interpreted as follows:

PC 1. Describes a positive gradient of increasing intensity of agricultural land-use, especially arable crops. The only negative loading of even moderate size is 'other' land.

PC 2. Describes a negative gradient of increasing stock-rearing (of all kinds) and grass, and, to a lesser extent, fodder crops. Horticulture, vegetable crops (potatoes and peas) and wheat have moderate positive loadings.

PC 3. Contrasts dairy farming (positive) with sheep-rearing, some fodder crops and 'other' land; more-or-less a lowland (positive) *versus* upland (negative) stock-rearing gradient.

PC 4. Contrasts dairy cows, old grass, wheat and fodder beet/mangolds (positive) with other fodder crops, new grass, oats and 'other' land (negative); very roughly a south to north farming types gradient.

PC 5. Not easily interpretable but contrasts fallow, horticulture and fodder kale/cabbage (positive) with fodder beet/mangolds and oats.

There were significant correlations of three components with Greylag Goose numbers, but the order of size of correlation does not correspond with order of importance as defined by the PCA. The highest correlations were negatively with the fourth component, describing a largely geographical gradient of agricultural land-use. Intensity of agricultural land use, as represented by PC 1, shows a distinctly seasonal pattern of positive correlation with Greylag Goose numbers, with peak correlation in December and smallest coefficients in October and March. PC 3 correlates significantly with December to March Greylag Goose counts, suggesting an increasing tendency to move away from rough upland grazing and some fodder types towards lowland grassland.

Table 16 gives the results of PCA of agricultural land-use of 10 km squares in which Pink-footed Geese were counted at some point during winter 1988/89. Eigenvalues and eigenvectors are listed for the first five components, which, as for the Greylag Goose PCA, are those for which the eigenvalue was greater than 1, together with correlations of the components with Pink-footed Goose numbers in each month. These five axes together accounted for 76.9% of the variance of the original variables, almost exactly the same as in the Greylag Goose analysis. However, the principal axes extracted describe slightly different gradients of variation, which were rather more difficult to interpret:

PC 1. Describes a gradient from arable farming types (negative) to livestock rearing and grass (positive). There is also a contrast between fodder turnips/swedes (positive) and other fodder crop types.

PC 2. A negative gradient of increasing intensity of some arable farming types, notably spring barley, oats, fodder turnips/swedes and horticulture. Potatoes have the only large positive loading.

PC 3. A negative gradient of increasing intensity of livestock rearing, grass, wheat, winter barley, oilseed rape and fodder kale/cabbage. There are no large positive loadings.

PC 4. Contrasts dairy cows (positive) with beef cows, total sheep, 'other' land and fodder kale/cabbage (negative); somewhat of an upland to lowland livestock gradient.

PC 5. Contrasts fodder beet/mangolds, fallow and peas (positive) with oilseed rape and fodder kale/cabbage; this is an apparently meaningless gradient of variation.

There were significant correlations of Pink-footed Goose numbers with the first three components. The largest correlations were negative and with PC 2, significant in November and March, and indicated a tendency for higher counts associated with some arable types. Correlations with PC 1, the arable-livestock contrast, appear distinctly seasonal, highest at the beginning and end of the winter, suggesting increasing use of grazing land by geese at these times. The early winter significant positive correlations with PC 3 are rather hard to interpret, since there are no large positive loadings on this component.

Modelling goose numbers in relation to principal components of agricultural land-use

Optimum regression models were estimated, relating goose numbers to principal components of agricultural land-use rather than the original variables. This was an attempt to account for goose numbers in terms of a few fundamental gradients of agricultural land-use. Results of these analyses are given in Tables 17 and 18.

The best 1-5 variable models for Scottish Greylag Geese in each winter month are listed in Table 17. Optimum models involved three and, in February, four agricultural variables (principal axes), and accounted for from 7.4% to 14.4% of the variance in Greylag Goose numbers, about half that accounted for by the original variables. All five principal axes were included in at least two of the optimum models. PC 4 (north to south farming types) was included with a negative coefficient in the optimum model for every month; PC 1 (intensity of agricultural land-use) featured positively in November to March models; PC 3 (upland to lowland stock-rearing) featured positively in December to March models. Early winter models also included PC 2 (decreasing stock-rearing) and PC 5 (fallow, fodder kale/cabbage, horticulture *versus* fodder beet/mangolds, oats), both with negative coefficients; PC 2 also featured as the least important variable in the February model.

The order in which principal axes were entered into the model for each month suggests some seasonal changes in the relationship of Greylag Goose numbers with agriculture. PC 1 was unimportant in October, of peak importance during November and December and of declining importance during the rest of the winter. PC 3 was of increasing importance through the winter, being the second most important variable in March. PC 4 was of high importance throughout the winter, but to a slightly lesser degree in November and December.

The best 1-5 variable models for Pink-footed Geese in each winter month are listed in Table 18. Optimum models involved two or three agricultural variables, accounting for from 2.7% to 13.2% of the variance in goose numbers, about half that accounted for by the original variables. No variable was included in every optimum model. PC 1, 2 and 3 were of about equal importance, included in four, four and five optimum models respectively. The only optimum model to feature any but these three variables was that for February, which included PC 4. PC 1 (arable to stock-rearing gradient) was the most apparently seasonal effect, included with positive coefficients in models for the beginning and end of winter. PC 2 (potatoes *versus* other arable types) was important (negative coefficients) from November onwards, with the exception of February, when both this variable and the positive effects of PC 3 (decreasing livestock and some crops) were replaced by a negative coefficient for PC 4 (upland to lowland livestock gradient).

These regression models were generally less successful in explaining variation in goose numbers than those using the original agricultural variables. However, the interpretation of

their results gives additional insight into the nature of the association between geese and agriculture. From the original regression models it was concluded that Scottish Greylag Geese were dependent on fodder turnips/swedes throughout the winter and that there were seasonal changes in their dependence on other land-use types. From regression models using principal axes of the agricultural data it can be further concluded that there is a general association of Greylag Geese with more 'northerly' farming types (oats, 'other' land, fodder turnips/swedes, fodder kale/cabbage, new grass) as opposed to 'southerly' farming types (dairy cows, old grass, wheat, fodder beet/mangolds), strongest dependence on arable crops in early/mid-winter and a shift in the association with livestock-rearing land to increasing dependence on lowland stock types from early to late winter. Considering Pink-footed Geese, the original regression models indicated a dependence on vegetable crops, together with a mid-winter shift in the dependence on other land-use types. The regression models based on principal axes further suggest greater dependence on stock-rearing/grassland in early and late winter than in mid-winter when arable crops such as spring barley and oats were favoured.

The regression analyses based on principal axes tend to highlight different aspects of the variation in goose numbers in relation to agricultural practices than do regression analyses based on the original agricultural variables. The generally smaller amounts of variance accounted for by these models suggests that the major dimensions of variation in agricultural land-use are not necessarily those most important to geese.

DISCUSSION

Analysis of the distribution of Pink-footed and Greylag Geese during the 1988/89 winter showed that, although there was an extensive overlap of their wintering ranges, Greylag Geese had a more northerly distribution. A high proportion of the Greylag population occurred in northern and eastern Scotland, whereas Pink-footed Geese were more concentrated in central and south-east Scotland. Large numbers of Pink-footed Geese also occur in north-west England and south-east England (Norfolk), with north-west England receiving the highest number of birds from October and south-east England in mid-winter. Resightings of marked birds have confirmed that at least some of the birds that alight in Lancashire in the autumn

move on to Norfolk in mid-winter (Fox *et al.* 1989a). These results are similar to the distributions described by an analysis of the National Wildfowl Counts from 1975 to the 1981/82 winter inclusive, which also indicated that Greylags had a more northerly distribution than Pink-footed Geese (Owen *et al.* 1986). It seems, therefore, that there has not been a major permanent change in the distribution of the two species during the 1980s comparable with the concentration of Pink-footed Geese in east-central Scotland during the 1960s (at the expense of more northern and southerly sites, Ogilvie & Boyd 1976), or with the shift of Greylag Geese away from east-central Scotland to north-east Scotland from the mid 1970s onwards (Owen *et al.* 1986).

Although large concentrations of birds were recorded for both species, Greylag Geese were more widespread than Pink-footed Geese, occurring at a larger number of sites. This may be because they are less wary than Pink-footed Geese, which perhaps would enable them to use a wider variety of sites or habitats owing to their ability to live closer to man. Further studies may indicate the extent to which roost sites and feeding areas selected by the two species are constrained by disturbance factors including proximity to human habitation. Despite inter-specific differences in the overall distribution of the birds in Scotland, and in the extent to which they concentrate at traditional sites, there was still a positive correlation between the number of Greylag and Pink-footed Geese using particular sites or regions, particularly at the higher spatial scales. This tendency for the birds to occupy the same areas could be due to them having similar food requirements (in which case there may be inter-specific competition for food if the food supply is limited), or to the similarity of their migratory routes, or to both of these factors. The extent to which Pink-footed and Greylag Geese are likely to compete for food, and whether one species is consequently displaced by the other, can only be addressed at a superficial level in the present study. Behavioural data, information on resource partitioning by Pink-footed and Greylag Geese when occupying the same site, and evidence of whether the presence of one species is detrimental to the other, are necessary for a more objective assessment of whether the two species compete or co-exist. The positive correlation between flock sizes, indicating that sites or regions holding very large numbers of one species are unlikely to hold small numbers of the other and *vice versa*, does however suggest that the movement of Greylags from east-central Scotland in the mid 1970s is not necessarily attributable to the increase of Pink-footed Geese in the area during the 1960s. Similarly, the positive correlation indicates that the more southerly distribution of Pink-footed Geese in comparison with the Greylags was not obviously due to Greylag Geese monopolising

sites in north-east Scotland, although more detailed observations at a regional level are needed to confirm this point.

Analysis of flock sizes recorded in areas where Greylag and Pink-footed Geese co-existed indicated that most associations (at all spatial scales) were of 'medium' sized flocks (consisting of 10s or 100s of geese). At the 1 goose threshold level (*i.e.* testing for associations between species in terms of the presence or absence of both species at a site, or within the area being considered) most associations occurred in autumn or spring, indicating a mixing of flocks upon arrival in the wintering range (perhaps owing to the accidental displacement of individuals during migration), species segregation in mid-winter, and some mixing again in spring as the birds move to more northerly sites in Britain before departing for the breeding grounds. Similarly, large flocks were recorded mainly at the 40-50 km square levels for most of the winter, indicating that an extensive catchment area is necessary to support large numbers of birds, but aggregation of large flocks at even the site level in March indicates that the birds group together prior to spring migration.

A range of tests were used to evaluate the distribution of the Greylag and Pink-footed Geese in relation to agricultural land-use variables, and these yielded a variety of results. Univariate analyses found positive correlations between goose numbers (for both species) and four of the agricultural variables: spring barley, potatoes, 'horticulture' (defined as a variety of vegetable crops grown on a small scale) and most notably fodder swedes/turnips, in all months and at all spatial scales when data for the whole of Britain were included. Consistently significant correlations (*i.e.* at all spatial levels and in all months) were also found between the number of Greylag Geese recorded and the number of hectares of oats grown in the region, but there was no association between oat-growing and Pink-footed Goose counts for areas above 50 km squares, perhaps because only a comparatively small proportion of the Pink-footed Goose population wintered in the north Grampian region, a major oat-growing area. When the association between goose counts and agricultural variables were reconsidered using data only from areas within the wintering range of the geese, the results were much the same except that the association between Greylag Geese and horticulture was no longer significant, indicating that the initial correlation was a feature of horticulture being prevalent in Scotland, rather than to the birds selecting horticultural sites. The distribution of Greylag Geese within their range in Scotland only (*i.e.* excluding sightings from England and agricultural data from parts of Scotland where Greylags were not recorded) was then assessed separately since the

inclusion of feral birds might have biased the results. This analysis again found consistent correlations for spring barley, oats, and particularly fodder swedes/turnips, with the number of Greylag Geese in the area. New grass also proved a relevant variable when most of the feral birds were excluded, but correlations with potato crops were only at spatial scales of 40 km squares or above.

In addition to the association with fodder swedes/turnips, spring barley, oats (in the case of Greylags) and horticulture (in the case of Pink-footed Geese) recorded throughout the winter, both species were also associated with other crops in mid winter when data from the whole of Britain was considered. Pink-footed Geese were associated with a wider range of crops than the Greylag Geese, despite occurring at fewer sites, indicating that should the correlation between goose numbers and agricultural practice in the area reflect feeding site selection, then the Pink-footed Geese may be more eclectic in their feeding habits. The use of additional crops in mid-winter by Greylag Geese was mainly at the lower spatial scales (≤40 km squares), however, so may reflect a real change in land-type preference, whereas the mid-winter correlations between Pink-footed Goose numbers and agricultural variables at widely differing scales show no consistency, and are perhaps due as much to regional bias in farming practice as to habitat selection by the geese. Restriction of the analyses to wintering areas used by the geese found no consistent evidence for mid-winter associations with additional crops, reinforcing the view that the earlier correlations were probably spurious. However, a positive association of Pink-footed Goose counts with beef cows and with new grass in both spring and autumn, together with the association found for both species with the 'other' land category at the start and end of the winter, were recorded both for the all-Britain data and when analyses were restricted to areas in which the birds were recorded. These results probably reflect a major change in distribution to pasture and away from arable land, both upon arrival in autumn and prior to spring migration.

The optimum model among a family of regression models, which tested the relationship between goose numbers and agricultural land-use, was ascertained both to support the results of the univariate analyses and to control for inter-correlations between the agricultural variables. The optimum models obtained for Greylag Geese in Scotland confirmed the association between the distribution of fodder swedes/turnips and goose numbers throughout the winter. Spring barley did not feature, however, and oats was a significant variable only

in October, suggesting that the distribution of these cereal crops may be similar to that of the fodder swedes/turnips, and that the latter correlated most closely with the Greylag Goose count data. A negative association with oilseed rape in October and November changed to a positive association thereafter, but more detailed observations would be necessary to confirm whether this indicated a genuine change in feeding site selection, particularly since the distribution of oilseed rape did not appear to be related to the numbers of Greylags when considered in isolation. Analysis of the Pink-footed Goose data found a positive association with horticulture, suggesting that the birds feed on vegetable crops farmed on a small scale for most of the winter, and a negative association with cereal crops (especially wheat). This result was a little surprising in view of earlier studies, which indicate that Pink-footed Geese select root crops in some areas (Owen *et al.* 1986), and the positive correlations between Pink-footed Geese numbers and fodder swede/turnip production noted by the univariate analyses in the current report. Perhaps a cross-correlation between horticulture and fodder swede/turnips has obscured the importance of the second of these two variables in influencing site selection by Pink-footed Geese. Again more detailed fieldwork is necessary to clarify this point. Only up to 24.9% of the variation in the Greylag count data, and 19.0% of the Pink-footed Goose count data, were accounted for by the distribution of the agricultural variables included in the optimum models, however, indicating that one or more other variables also have a major influence upon the distribution of the geese. Bearing in mind the importance of secure and disturbance free roosts for both species, it is suggested that the location of potential roost-sites is a major factor influencing dispersal. Unfortunately the 1988/89 count data did not indicate whether the birds were using a site for feeding, for roosting , or for both, so it was not possible to control for the distribution of roost sites in the present analysis. The low percentage of variation in the count data attributable to agricultural variables may also indicate that the general associations between agricultural land-use and goose distribution used in the present analyses are too broad to identify factors affecting site selection by the birds, although the agricultural land-use data do indicate the proportion of different crops present in areas used by the geese.

Principal components analysis was used to identify the broader patterns of agricultural land-use inherent in the data-set, and to determine whether these patterns in farming practice were associated with the distribution of the geese. Five main agricultural patterns were noted for the 10 km squares in which Greylag Geese thought to be from the Icelandic-breeding population were recorded, which could be summarised as: (1) intensity of agriculture; (2)

extent of stock-rearing; (3) lowland *versus* upland; (4) south to north gradient in farming practice; and (5) fallow/vegetable *versus* root/cereal crops. A positive correlation was obtained for Greylag Goose numbers in relation to the first component (agricultural intensity) in November to February inclusive, but not in October or March, reinforcing the view (expressed by Owen *et al.* 1986) that Greylags depend on agricultural land for most of the winter. The increased association with lowland grassland regions between December and March inclusive, compared with 'upland' sheep-rearing and some fodder crops in autumn, again confirms the tendency for geese to use grasslands towards the end of the winter, perhaps to increase the protein content of their diet in preparation for the energetic costs of migration and the breeding season. Perhaps the most interesting result was the significant negative correlation recorded in every month between the number of Greylags and the geographical gradient of land-use (from north, negative, to south, positive), confirming that the Greylags occur in greatest numbers at the northern end of their range, thus minimising dispersal from their Icelandic breeding grounds. Optimum regression models, relating Greylag Goose numbers to the principal components of agricultural land-use confirmed that the north to south farming gradient was selected as the first or second most important variable in every month, that the 'intensity of land-use' variable was selected in November to March inclusive, and that lowland grasslands (rather than upland sites) were selected from December until the end of the winter. Only 7.4% to 14.4% of the variance in Greylag numbers were explained by these variables, however, again perhaps owing to the omission of roost site distribution from the regressions, and the generally broad nature of the analyses.

Principal components analysis of agricultural land-use for the 10 km squares in which Pink-footed Geese were recorded found slightly different patterns of farming practice in these areas. Five main patterns were again identified, but only four were thought to be meaningful: (1) livestock *versus* arable farming; (2) intensity of arable farming; (3) intensity of livestock farming; and (4) upland *versus* lowland farming. A comparison of these patterns of land-use in relation to Pink-footed Goose counts again confirmed that Pink-footed Geese tend to use pasture (as indicated by livestock farming) in October, February and March, and to frequent areas of intensive arable farming in November and March, but unlike the Greylags no consistent pattern was found for the whole winter. A north to south gradient in farming practice was not apparent for areas used by the Pink-footed Geese, perhaps because their more southerly distribution resulted in their being less variation in the agricultural variables for areas used by Pink-footed Geese.

Overall, these results found a reasonably clear association between the distribution of Greylag Geese and agricultural variables. There was a consistent association with root crops (notably fodder swedes/turnips) throughout the winter and in various analyses, indicating that this may be an important food supply for the species in winter. Feeding on root crops may give rise to conflict with the farming community if the reason for growing the crop is to support livestock (and particularly sheep) on the land during the winter months, although this may be reduced by the presence of livestock deterring the geese from using the fields (Ridgill *et al.* 1994), which in turn may be due to an increase in disturbance levels as the farmer checks his livestock or to the stock reducing the amount of food available to the birds. Geographical location also seemed to have a significant effect on the distribution of Greylag Geese, which tended to occupy areas closest to their Icelandic breeding grounds. The general association between areas of intensive agriculture and high counts of Greylag Geese supports the view that these birds depend on arable crops, although there was no correlation with several of the agricultural variables tested individually (*e.g.* peas), indicating that these crops are not extensively used by the geese. The association between Pink-footed Geese and the agricultural variables considered was much less clear than for Greylags. This may be due to: (1) greater heterogeneity in the habitat used by the birds; (2) the greater importance of variables not included in the analyses, such as the distribution of roost sites, in influencing dispersal; and (3) greater variability in their selection of feeding sites, which could only be identified by more detailed studies of their distribution at a regional level. Although regional studies indicate that Pink-footed Geese feed on winter cereals and root crops (Newton & Campbell 1973, Patterson *et al.* 1989), the present analyses do not identify overall associations between Pink-footed Geese and the range of arable crops considered. It is not possible, therefore, to determine the associations between Pink-footed Geese and agriculture that are likely to give consistent problems to farmers at a national level. Although both species occur mainly in northern parts of Britain, any further increases in the size of the populations may result in them using new sites further south, although site fidelity, roost availability and feeding competition from other waterfowl species may reduce the rate at which they disperse to new areas. There is no evidence to suggest that density-dependent factors currently influence the growth of the population, although climatic variables influence reproductive success each year (Fox *et al.* 1989b).

The study considers the distribution of Pink-footed and Greylag Geese in relation to variation in agricultural activity in different parts of Britain, but a more comprehensive analysis is

needed for a more objective assessment of factors affecting distribution. Field observations are necessary, for instance, to verify the association described here between goose numbers and agricultural variables, and to identify other factors used by the geese in selecting feeding sites, such as disturbance levels and distance from the roost. Habitat variables other than the proportion of different types of crops available to the birds are also likely to be important and should be taken into account when analysing the distribution of birds at a national level, including climatic conditions, the timing of harvests and of sowing cereal crops (which in turn would influence the quantity of food in the field), the distribution of geese during the 1988/89 winter since information on farming practice referred to the 1988 season; further studies should aim to determine whether factors affecting the distribution of geese are consistent from year to year.

CONCLUSIONS

The main results of the study may be summarised as follows:

(1) Greylags were more widely dispersed and exhibited a more northerly distribution than Pink-footed Geese.

(2) Nevertheless, there was a positive correlation between the numbers of Greylags and Pink-footed Geese at sites where both species occur, indicating that characteristics of a site selected by one species may also be selected by the other. More research would be necessary to determine the extent of resource partitioning at sites where Greylags and Pink-footed Geese co-exist.

(3) There was no obvious major change in the distribution of Greylag and Pink-footed Geese in Britain between the late 1970s and the 1988/89 survey.

(4) Univariate analyses indicated that the distribution of both species throughout the winter was positively correlated with the distribution of fodder swedes/turnips and spring barley. Greylag Geese were more concentrated in areas associated with growing oats, and Pink-footed Geese with horticultural crops.

(5) There was no consistent evidence for mid-winter associations between goose counts and any of the other agricultural variables considered. A positive association of Pink-footed Geese with cattle and new grass, and of both species with the 'other' land category (mainly rough grazing), in both autumn and spring may be due to the birds selecting pasture both upon arrival in autumn and immediately prior to spring migration.

(6) The association between Pink-footed Geese and the agricultural variables considered was much less clear than for Greylag Geese. This may be due to greater heterogeneity in the habitat used by the birds, to the greater importance of variables not included in the analyses (such as the distribution of roost sites) in influencing dispersal, or to greater variability in their selection of feeding sites.

(7) Although the results indicate the main types of farming activity in areas used by the geese, more detailed studies of their distribution at a regional level, together with data concerning the distribution of roost sites, are needed to confirm factors affecting site selection by the birds.

ACKNOWLEDGEMENTS

This analysis was undertaken under the WWT/JNCC "Services in Wildfowl Research" contract. The support of JNCC (on behalf of the Country Agencies: Scottish Natural Heritage, English Nature and Countryside Commission for Wales) is gratefully acknowledged. Agricultural land-use data was kindly supplied by Davy McCracken of JNCC, Paisley. Jeff Kirby and Carl Mitchell made helpful comments on a draft of the text.

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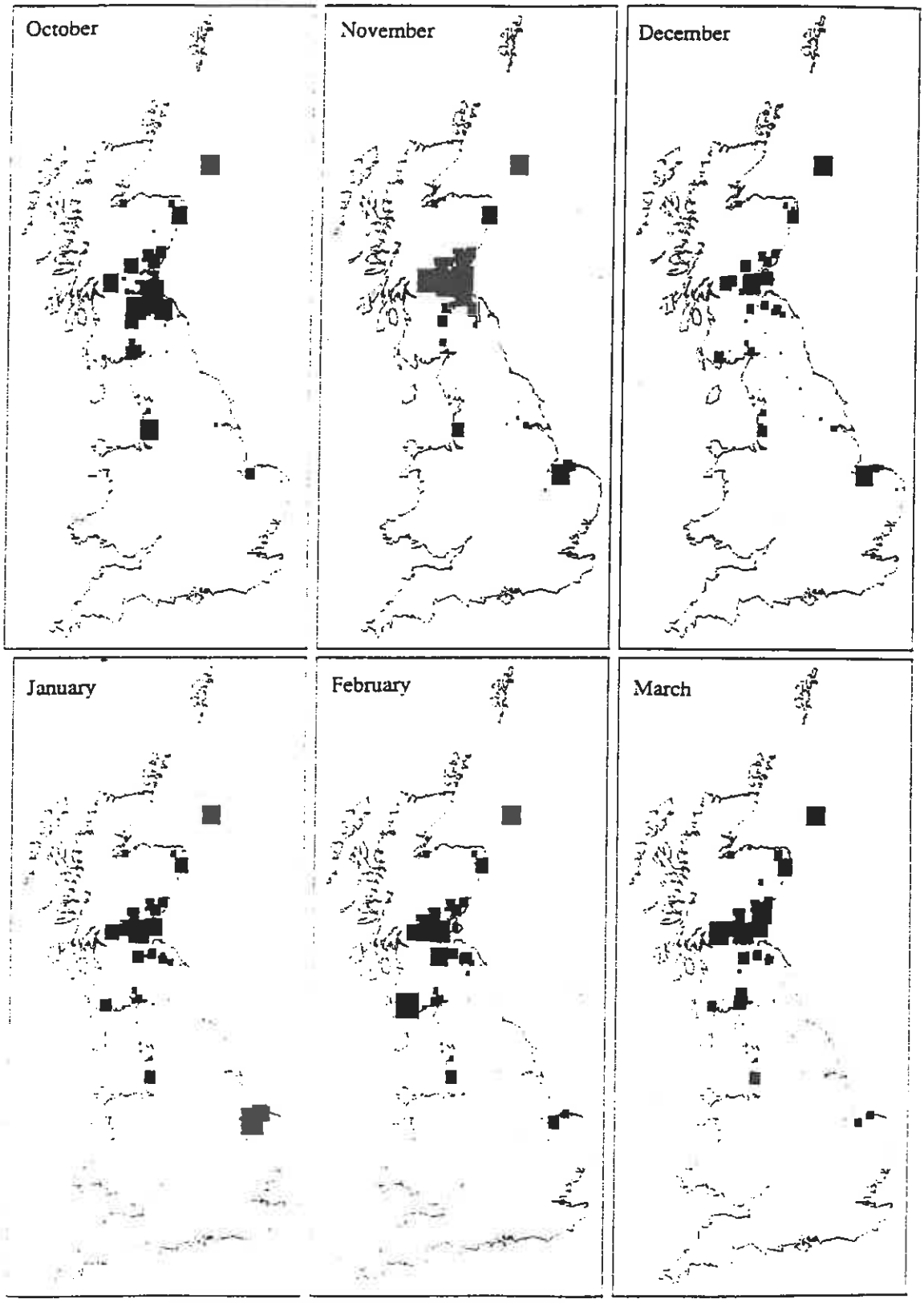
FIGURE 1. Distribution of Greylag Geese in Great Britain during winter 1988/89. Scale box represents 5,000 birds.

FIGURE 2. Distribution of Pink-footed Geese in Great Britain during winter 1988/89. Scale box represents 5,000 birds.



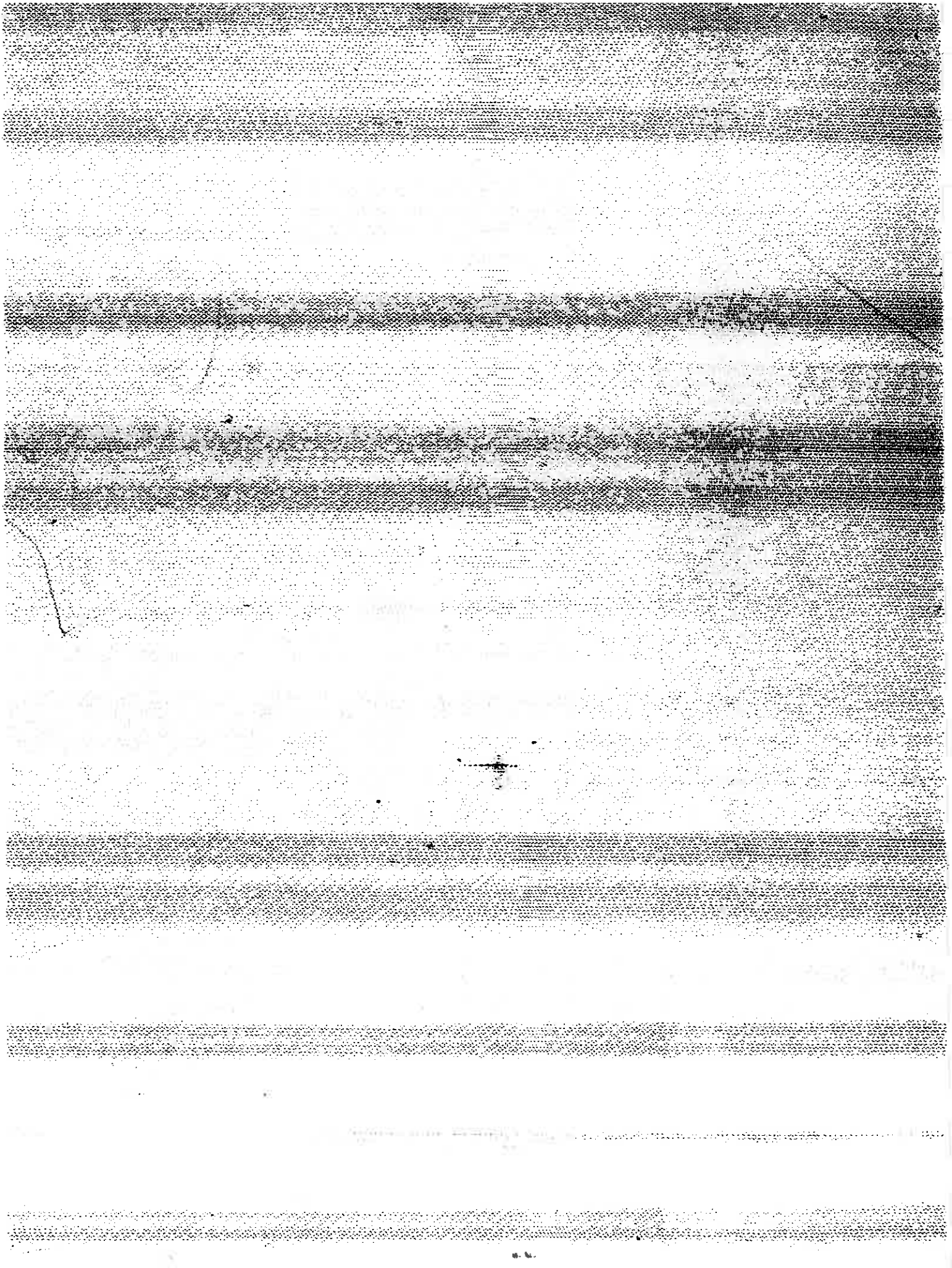


TABLE 14. Best sub-sets regression models relating 1988/89 Pink-footed Goose numbers to 1988 agricutural land-use variables summarised at a 10 km square level: best model of each size up to six predictor variables. Optimum model is italicised. R^2: coefficient of determination. C_p: Mallow's model selection criterion. +/– indicates sign of regression coefficient.

(a) October

	Number of Variables					
	1	2	3	*4*	5	6
Beef Cows			–	–	–	–
Total Sheep						+
New Grass					+	
'Other' Land	+	+	+	+	+	+
Winter Barley				–	–	–
Spring Barley						+
Horticulture		+	+	+	+	+
R^2 %	6.1	9.1	11.8	*12.6*	12.6	12.4
C_p	6.4	2.6	–0.6	*–0.7*	0.2	1.6

(b) November

	Number of Variables					
	1	2	*3*	4	5	6
Dairy Cows					+	+
Beef Cows						–
Total Sheep				+	+	+
Old Grass			–	–	–	–
Wheat		–	–	–	–	–
Horticulture	+	+	+	+	+	+
R^2 %	13.9	14.9	*16.1*	15.9	15.7	15.3
C_p	–2.3	–2.9	*–3.7*	–2.3	–1.0	0.7

[continued]

TABLE 14 (continued).

(c) December	Number of Variables					
	1	2	3	4	5	6
Old Grass			−	−	−	−
'Other' Land				+	+	
Wheat		−	−	−	−	−
Winter Barley						−
Oilseed Rape						+
Peas						+
Horticulture	+	+	+	+	+	+
Fodder Turnips/Swedes					−	
R^2 %	5.4	6.2	6.6	6.2	5.7	5.3
C_p	−4.8	−4.9	−4.4	−2.8	−1.0	0.6

(d) January	Number of Variables					
	1	2	3	4	5	6
Old Grass			−	−	−	−
'Other' Land						+
Wheat		−	−	−	−	−
Oilseed Rape					+	+
Peas				+	+	+
Horticulture	+	+	+	+	+	+
R^2 %	3.2	4.4	5.2	5.2	4.9	4.6
C_p	−3.5	−4.2	−4.3	−3.2	−1.8	−0.3

[continued]

TABLE 14 (continued)

(e) February	Number of Variables					
	1	2	3	4	5	6
New Grass					+	+
Old Grass						−
'Other' Land	+	+	+	+	+	+
Winter Barley			−	−	−	−
Spring Barley			+	+	+	+
Potatoes		+				
Fodder Turnips/Swedes				−	−	−
R^2 %	5.9	7.2	7.6	7.3	7.0	6.8
C_p	−5.3	−6.1	−5.5	−4.1	−2.6	−1.2

(f) March	Number of Variables					
	1	2	3	4	5	6
Beef Cows						−
New Grass				+	+	+
Old Grass					−	
'Other' Land						+
Winter Barley		−	−	−	−	−
Potatoes	+	+	+	+	+	+
Horticulture			+	+	+	+
R^2 %	14.0	16.4	17.1	17.6	18.1	19.0
C_p	10.0	6.8	6.6	6.6	6.9	6.3

TABLE 15. Principal components analysis of 1988 agricultural land use variables summarised on a 10 km square basis, for squares in Scotland containing Greylag Geese: components with eigenvalues greater than 1. Pearson coefficients of correlation with numbers of Greylag Geese in each winter month 1988/89: * $P<0.05$; ** $P<0.01$; *** $P<0.001$.

	Axis 1	Axis 2	Axis 3	Axis 4	Axis 5
Eigenvalue	6.748	3.148	1.590	1.401	1.044
Proportion of Variance	0.375	0.175	0.088	0.078	0.058
Cumulative Proportion	0.375	0.550	0.638	0.716	0.774
Eigenvectors:					
Dairy Cows	0.006	−0.330	0.315	0.448	0.161
Beef Cows	0.037	−0.442	0.016	−0.106	−0.078
Total Sheep	0.038	−0.426	−0.409	0.007	−0.049
New Grass	0.233	−0.368	0.220	−0.216	−0.060
Old Grass	−0.004	−0.497	0.130	0.287	0.043
Wheat	0.327	0.119	−0.131	0.225	−0.070
Winter Barley	0.351	0.026	−0.082	0.125	−0.115
Spring Barley	0.366	−0.01	0.047	−0.063	−0.019
Oats	0.271	−0.055	0.118	−0.309	−0.221
Oilseed Rape	0.340	0.098	0.069	0.024	−0.124
Potatoes	0.294	0.136	0.001	0.080	0.053
Peas	0.279	0.126	−0.140	0.110	0.043
Horticulture	0.254	0.111	−0.151	0.163	0.362
Fodder Turnips/Swedes	0.287	−0.109	−0.134	−0.418	−0.138
Fodder Kale/Cabbage	0.160	−0.168	−0.477	−0.030	0.305
Fodder Beet/Mangolds	0.064	−0.033	−0.254	0.432	−0.518
Fallow	0.164	−0.039	0.101	−0.046	0.601
'Other' Land	−0.149	−0.125	−0.510	−0.288	0.024
Correlations with Goose Numbers:					
October	0.101	−0.130	0.022	−0.242**	−0.143
November	0.228*	−0.088	0.063	−0.221*	−0.131
December	0.274**	−0.075	0.189*	−0.191*	−0.113
January	0.200*	−0.107	0.180*	−0.258**	−0.100
February	0.197*	−0.135	0.178*	−0.237**	−0.099
March	0.171	−0.056	0.223*	−0.293***	−0.097

TABLE 16. Principal components analysis of 1988 agricultural land use variables summarised on a 10 km square basis, for squares in Great Britain containing Pink–footed Geese: components with eigenvalues greater than 1. Pearson coefficients of correlation with numbers of Pink–footed Geese in each winter month 1988/89: * $P<0.05$; ** $P<0.01$; *** $P<0.001$.

	Axis 1	Axis 2	Axis 3	Axis 4	Axis 5
Eigenvalue	4.921	4.138	2.034	1.495	1.251
Proportion of Variance	0.273	0.230	0.113	0.083	0.069
Cumulative Proportion	0.273	0.503	0.616	0.699	0.769
Eigenvectors:					
Dairy Cows	0.106	0.173	–0.448	0.434	0.130
Beef Cows	0.313	–0.074	–0.213	–0.364	0.100
Total Sheep	0.280	0.098	–0.310	–0.359	0.028
New Grass	0.287	–0.238	–0.250	0.042	0.099
Old Grass	0.203	0.198	–0.506	0.121	0.140
Wheat	–0.365	–0.146	–0.241	–0.154	–0.142
Winter Barley	–0.274	–0.190	–0.319	0.038	–0.093
Spring Barley	0.059	–0.447	–0.007	0.058	0.176
Oats	0.110	–0.370	–0.041	0.019	–0.031
Oilseed Rape	–0.246	–0.273	–0.263	–0.070	–0.325
Potatoes	0.113	0.379	0.091	0.155	0.059
Peas	–0.272	–0.022	0.031	–0.119	0.417
Horticulture	0.066	–0.337	0.062	0.143	0.064
Fodder Turnips/Swedes	0.203	–0.350	0.073	–0.095	0.125
Fodder Kale/Cabbage	–0.316	–0.068	–0.245	–0.265	–0.229
Fodder Beet/Mangolds	–0.249	0.046	0.042	–0.190	0.532
Fallow	–0.227	–0.042	–0.137	–0.121	0.483
'Other' Land	0.242	0.045	0.091	–0.558	–0.107
Correlations with Goose Numbers:					
October	0.167*	–0.079	0.193*	–0.088	–0.039
November	0.132	–0.251**	0.171*	0.039	–0.022
December	0.109	–0.154	0.142	0.013	0.003
January	0.100	–0.124	0.159	–0.002	0.009
February	0.217**	–0.080	0.083	–0.137	–0.020
March	0.228**	–0.275***	0.151	0.028	0.013

TABLE 17. Best sub-sets regression models relating 1988/89 Scottish Greylag Goose numbers to principal component scores 1988 agricultural land-use variables summarised at a 10 km square level. Optimum model is italicised. R^2: coefficient of determination. C_p: Mallow's model selection criterion. +/– indicates sign of regression coefficient.

(a) October	Number of Variables				
	1	2	*3*	4	5
PC1				+	+
PC2			–	–	–
PC3					+
PC4	–	–	–	–	–
PC5		–	–	–	–
R^2 %	5.1	6.4	*7.4*	7.6	6.9
C_p	4.4	3.7	*3.4*	4.1	6.0

(b) November	Number of Variables				
	1	2	*3*	4	5
PC1	+	+	+	+	+
PC2				–	–
PC3					+
PC4		–	–	–	–
PC5			–	–	–
R^2 %	4.4	8.6	*9.6*	9.6	9.3
C_p	8.6	4.0	*3.6*	4.5	6.0

(c) December	Number of Variables				
	1	2	*3*	4	5
PC1	+	+	+	+	+
PC2					–
PC3			+	+	+
PC4		–	–	–	–
PC5				–	–
R^2 %	6.7	9.7	*12.6*	13.2	13.1
C_p	10.9	7.7	*4.6*	4.8	6.0

[continued]

TABLE 17 (continued).

(d) January	Number of Variables				
	1	2	*3*	4	5
PC1		+	+	+	+
PC2				−	−
PC3			+	+	+
PC4	−	−	−	−	−
PC5					−
R^2 %	5.9	9.2	*11.8*	12.2	12.5
C_p	11.3	7.6	*5.0*	5.4	6.0

(e) February	Number of Variables				
	1	2	3	*4*	5
PC1		+	+	+	+
PC2				−	−
PC3			+	+	+
PC4	−	−	−	−	−
PC5					−
R^2 %	4.9	8.0	10.5	*11.7*	11.9
C_p	11.9	8.4	5.9	*5.4*	6.0

(f) March	Number of Variables				
	1	2	*3*	4	5
PC1			+	+	+
PC2					−
PC3		+	+	+	+
PC4	−	−	−	−	−
PC5				−	−
R^2 %	7.8	12.1	*14.4*	14.7	14.3
C_p	11.2	6.0	*3.8*	4.4	6.0

TABLE 18. Best sub-sets regression models relating 1988/89 Pink-footed Goose numbers to principal component scores 1988 agricutural land-use variables summarised at a 10 km square level. Optimum model is italicised. R^2: coefficient of determination. C_p: Mallow's model selection criterion. +/– indicates sign of regression coefficient.

(a) October	Number of Variables				
	1	*2*	3	4	5
PC1		+	+	+	+
PC2				–	–
PC3	+	+	+	+	+
PC4			–	–	–
PC5					–
R^2 %	3.0	*5.2*	5.3	5.3	4.8
C_p	4.6	*2.3*	3.2	4.2	6.0

(b) November	Number of Variables				
	1	2	*3*	4	5
PC1			+	+	+
PC2	–	–	–	–	–
PC3		+	+	+	+
PC4				+	+
PC5					–
R^2 %	5.7	8.0	*9.1*	8.6	8.0
C_p	5.7	3.1	*2.3*	4.1	6.0

(c) December	Number of Variables				
	1	*2*	3	4	5
PC1			+	+	+
PC2	–	–	–	–	–
PC3		+	+	+	+
PC4				+	+
PC5					–
R^2 %	1.7	*3.1*	3.6	2.9	2.2
C_p	2.8	*1.8*	2.0	4.0	6.0

[continued]

TABLE 18 (continued).

(d) January	Number of Variables				
	1	2	3	4	5
PC1			+	+	+
PC2		−	−	−	−
PC3	+	+	+	+	+
PC4					−
PC5				+	+
R^2 %	1.8	2.7	3.1	2.4	1.7
C_p	1.8	1.5	2.0	4.0	6.0

(e) February	Number of Variables				
	1	2	3	4	5
PC1	+	+	+	+	+
PC2				−	−
PC3			+	+	+
PC4		−	−	−	−
PC5					−
R^2 %	4.0	5.3	5.3	5.3	4.7
C_p	2.9	2.1	3.0	4.1	6.0

(f) March	Number of Variables				
	1	2	3	4	5
PC1		+	+	+	+
PC2	−	−	−	−	−
PC3			+	+	+
PC4				+	+
PC5					+
R^2 %	6.9	11.6	13.2	12.7	12.1
C_p	10.5	3.9	2.2	4.0	6.0

APPENDIX 1. Agricultural census form for England and Wales.

1 June, 1987: Notes for guidance in completing the return

LAND

Item 1 — **Total Area** Enter the total area of all pieces of land which make up your holding — see note on seasonal letting (items 1-35).

Items 2 and 3 — **Land Rented and/or Owner Occupied** include the total area of land, as entered at item 1, showing the area rented or owned as follows:-

Item 2 — **Rented** include land let or leased to you for any term not exceeding 30 years in return for rent in money or kind. Also include land which is let to you or used by you rent free, but not common grazing land.

Item 3 — **Owned** include land of which you are the sole legal owner or which you own jointly with others. Also include land in which, although you are not the legal owner, you have a beneficial interest, or hold on trust for others whether in your sole name or jointly with co-trustees. Such land must be returned by only one trustee. Include also land leased to you for more than 30 years.

Items 1-35 — **Seasonal Letting** include details at items 1 to 35 of land on your holding used by another farmer for seasonal grazing or cropping but not and on another holding used by you for this purpose — see also note on return of stock.

Item 7 — **Rough Grazing** include mountain, heath, moor, down or other rough land used for grazing, whether enclosed by boundary fences or not, on which you have sole grazing rights. Do not include common rough grazings.

Item 8 — **Woodland** Give the total area of woodland (other than orchards) forming part of the holding, including woodland used for commercial or amenity purposes.

CROPS

Items 11-31 and 170-243 — **Crops** include under the appropriate crop any area of headland and ditches. Land (other than bare fallow) being prepared for sowing, together with land already sown on 1 June, and crops grown for seed, include the area of crops undersown in the area covered by the appropriate nurse or cover crop.

Item 15 — **Mixed Corn** include mixtures of any grain crops or any of these with beans, peas, etc., sown together and intended for threshing. Enter any not intended for threshing at item 28.

Items 28 and 31 — **Other Crops** include the total area of crops not named separately and also the total of any crops grown on less than 500 square metres. Any cereal crops not intended for threshing should be entered at item 28.

FARMERS, PARTNERS AND DIRECTORS AND THEIR WIVES OR HUSBANDS

Items 50-65 — Include only farmers, partners and directors, and their wives or husbands working on the holding (including managerial and office work) but omit those who have only a financial interest in it. Whole-time implies a person whose main occupation is farming and who devotes about 40 hours per week to running the holding.

Enter each person once only and on only one form. In the case of married couples, both working on the holding, enter only one of them as a farmer, partner or director, the other should be entered at item 62 or 65 as appropriate.

Farms run by Individuals or Partners

There can be only one principal farmer or partner who, if working on the holding, should be entered at item 50 or 51. The wife or husband of the principal farmer, if working on the holding, should be entered at item 62.

Other Partners who work on the holding, should be entered at item 63 or 64. In the case of married couples, if both are partners and both work on the holding, enter one at item 63 or 64 and the other at item 65.

Farms run by Limited Companies or other Corporate Bodies

No entries should be made at items 50, 51 or 62.

Directors working on the holding should be entered at item 63 or 64. In the case of married couples, if both are directors and do farm work on the holding, enter one at item 63 or 64 and the other at item 65.

WORKERS

Items 56-66 — Include each person once only and on only one form. Include all persons doing agricultural work on the holding on 1 June (this includes drainage, hedging and ditching, maintenance and repair work and the marketing of produce grown together with managerial, supervisory and office staff.

Do not include workmen engaged in building or installing plant, gardeners, groundsmen, gamekeepers, grooms or similar estate workers, domestic staff employed in the farmhouse, schoolchildren or young workers engaged by you as trainees under the Youth Training Scheme.

Item 56 — **Salaried Managers** are those with contracts of employment as managers who are normally paid monthly and may have profit-sharing agreements as well.

Items 57-64 — **Regular Workers** are workers, whole-time and part-time, normally employed on the holding for some part of each month throughout the year.

Family Workers are relatives of farmers, partners and directors or of their wives or husbands, who work regularly on the holding and do not have a contract of employment.

Hired Workers are all workers who have a contract of employment including relatives with contracts: salaried managers should be returned at item 56.

Items 65 and 66 — **Seasonal or Casual Workers** are workers, family and hired, who are not regular workers but are working on the holding on 1 June including those supplied temporarily by agricultural contractors or gangmasters.

LIVESTOCK

Return of stock on your holding on 1 June, include (i) any stock, i.e. cattle, sheep, pigs or poultry you are grazing or housing for someone else under contract or to whom you may have sold the grass keep; (ii) any stock sent for sale on 1 June or the previous day; (iii) any stock you are grazing on common land. Do not include any of your stock being grazed or managed for you on another holding or on marshes. Such animals should be returned by the occupier of the other holding or by the marshman representing the occupier of the land.

Barren Cows for fattening include at item 81 and not at items 70-72.

Items 97 and 98 — **Calvings** include the number of calvings that occurred on the holding during the previous six months even though the cows or heifers are no longer on the holding. Do not include calvings of cows and heifers bought during the six months as newly calved, or any other calvings from another holding.

HORTICULTURE

See general note above under crops.

Item 174 — Cauliflower [illegible] harvested [illegible] for spring harvest; include winter cauliflowers at item 220

Item 175 — Calabrese [illegible]

LIVESTOCK — see notes

JUNE 1987

CATTLE

				Number
Cows and heifers in milk	Mainly for producing milk or rearing calves for the dairy herd		70	
	Mainly for rearing calves for beef		71	
Cows in calf but not in milk	Intended mainly for producing milk or rearing calves for the dairy herd		72	
	Intended mainly for rearing calves for beef		73	
Heifers in calf (first calf)	Intended mainly for producing milk or rearing calves for the dairy herd	2 years & over	74	
		Under 2 years	75	
	Intended mainly for rearing calves for beef	2 years & over	76	
		Under 2 years	77	
Bulls for service	2 years old and over		78	
	1 year old and under 2		79	
All other cattle and calves	2 years old and over	Male (excluding bulls for service)	80	
		Female — Intended for slaughter	81	
		Female — For dairy or beef herd replacements	82	
	1 year old and under 2	Male (excluding bulls for service)	83	
		Female — Intended for slaughter	84	
		Female — For dairy herd replacements	85	
		Female — For beef herd replacements	86	
	6 months old and under 1 year	Male (including bull calves for service)	87	
		Female	88	
	Under 6 months old	Intended for slaughter as calves	89	
		Others — Male (including bull calves for service)	90	
		Others — Female	91	
TOTAL CATTLE AND CALVES			92	

	Tick
Please tick this box if all the cattle entered at 92 above belong to someone else, and you are only providing grazing	93

CALVINGS on the holding during the 6 months December 1986 to May 1987

	Number
Heifers that calved for the first time during the period December 1986 to May 1987	97
All other cows that calved during the period December 1986 to May 1987	98

GOATS

	Number
Milch goats	142
Other goats (including kids)	143

PIGS

			Number
Breeding pigs	Sows in pig	100	
	Gilts in pig	101	
	Other sows (either being suckled or dry sows being kept for further breeding)	102	
	Boars being used for service	103	
	Gilts 50 kg (110lb) and over liveweight not yet in pig but expected to be used for breeding	104	
Barren sows for fattening		105	
All other pigs (not entered above)	110kg (240lb) and over liveweight	106	
	80kg (175lb) and under 110kg (240lb) liveweight	107	
	50kg (110lb) and under 80kg (175lb) liveweight	108	
	20kg (45lb) and under 50kg (110lb) liveweight	109	
	Under 20kg (45lb) liveweight	110	
TOTAL PIGS		111	

SHEEP AND LAMBS

	Number
Ewes kept for breeding (do not include two-tooth ewes, item 114, or draft and cast ewes, item 116)	113
Two-tooth ewes (shearling ewes or gimmers) out, or to be out, to the ram in 1987	114
Rams for service	115
Draft and cast ewes (do not include at item 113)	116
Wethers and other sheep	117
Lambs under 1 year old	118
TOTAL SHEEP AND LAMBS	119

FOWLS Do not include the same birds under more than one heading and do not include game birds

			Number
Hens and pullets kept mainly for producing eggs for eating	Growing pullets (from day old to point of lay)		121
	Birds that have been in the laying flock for:	Less than 12 months	122
		12 months but less than 18 months	123
		18 months or more	124
Fowls for breeding	Hens and pullets of all ages kept mainly for producing eggs for hatching	Layers	133
		Growers	134
	Cocks and cockerels of all ages kept for breeding		126
Growers (for killing up to 10 weeks of age)			127
Poussins and other table fowl (not turkeys or guinea fowl)			128
TOTAL FOWLS			137

	Yes/No
Do you intend to keep any turkeys on your holding in the next 12 months? Please answer "YES" or "NO"	135

OTHER POULTRY

	Number
Ducks of all ages	129
Geese of all ages	130

AREA OF HOLDING AND MAIN LAND USES

JUNE 1987

Enter all areas to the nearest 0.1 hectare

		Item	Hectares
TOTAL AREA OF YOUR HOLDING (to agree with total of items 4-9 below)		1	•
OF THE ABOVE AREA	How much is rented by you?	2	•
	How much is owned by you?	3	•

		Item	Hectares
CROPS AND FALLOW (to agree with item 35 below)		4	•
GRASSLAND (include clover, sainfoin and lucerne)	Put down in 1983 or later	5	•
	All other grassland excluding rough grazing	6	•
ROUGH GRAZING on which you have sole grazing rights (see notes)		7	•
WOODLAND on the holding (see notes)		8	•
ALL OTHER LAND not included above, e.g. farm roads, yards, buildings, gardens, ponds, derelict land, etc.		9	•

CROPS AND FALLOW (see notes)

			Item	Hectares
Cereals for threshing	Wheat		11	•
	Barley	Winter	12	•
		Spring	13	•
	Oats		14	•
	Mixed corn		15	•
	Rye		16	•
Maize for threshing or stockfeeding			17	•
Potatoes (early and maincrop)			19	•
Sugar beet not for stockfeeding			20	•
Hops			21	•
Horticultural crops (excluding mushrooms) (to agree with item 249 on page 4)			22	•
Field beans			23	•
Peas for harvesting dry (human consumption or stockfeed)			27	•
Other crops for stockfeeding	Turnips and swedes		24	•
	Fodder beet and mangolds		25	•
	Kale, cabbage, savoy, kohl rabi and rape		26	•
	Other crops (not grass) Show triticale for stockfeeding here. Please specify:		28	•
Rape grown for oilseed			29	•
Other crops not for stockfeeding (see notes) Show triticale for threshing here. Please specify:			31	•
Bare fallow			32	•
TOTAL CROPS AND FALLOW (to agree with item 4 above)			35	•

	Item	Hectares
How much of the wheat at item 11 is DURUM WHEAT? (the type used for pasta and semolina manufacture etc.)	302	•

GRASS GROWN FOR SEED

	Item	Hectares
Area of grass (including sainfoin and clover) expected to be harvested for seed this year	40	•

SEASONAL USE OF LAND

	Item	Hectares
Area of land let seasonally, this year, to another person for cropping, hay-making or grazing. This land should be included in items 1-35	41	•
Area of land rented seasonally, this year, from another person for cropping, hay-making or grazing. This land should NOT be included in items 1-35	42	•

IRRIGATION

	Item	Yes/No
Do you irrigate outdoor crops (except watercress)? Please answer "YES" or "NO"	43	

LABOUR FORCE — FARMERS AND WORKERS (see notes)

Include each person once only. Include Youth Training Scheme employees employed by you at Agricultural Wages Board rates or more but exclude YTS trainees (see foot of column)

			Item	Number
Principal farmer or partner (if working on the holding)	Whole-time		50	
	Part-time		51	
Wife or husband of principal farmer or partner (if working on the holding)			52	
Other partners and directors (if working on the holding)	Whole-time		53	
	Part-time		54	
Wives or husbands of other partners and directors (if working on the holding)			55	
Salaried managers			56	
Other family workers (see notes)	Regular whole-time	Male	57	
		Female	58	
	Regular part-time	Male	59	
		Female	60	
Hired workers (see notes)	Regular whole-time	Male	61	
		Female	62	
	Regular part-time	Male	63	
		Female	64	
Seasonal or casual workers (hired or family)		Male	65	
		Female	66	
TOTAL FARMERS AND WORKERS			659	

YOUTH TRAINING SCHEME TRAINEES

	Item	Number
Persons engaged by you as trainees and not paid AWB rates or more	68	

HORTICULTURE

Enter all areas to the nearest 0.1 hectare

VEGETABLES GROWN IN THE OPEN — for human consumption (see notes)

INCLUDE land rented out to processors etc. for the season

			Hectares
Brussels sprouts	For fresh market	170	•
	For processing e.g. freezing	171	•
Cabbage (summer and autumn)		172	•
All other cabbage including spring cabbage		173	•
Cauliflower (summer and autumn maturing only)		174	•
Calabrese (green sprouting broccoli)		175	•
Carrots		178	•
Parsnips		181	•
Beetroot (red beet — not sugar beet or fodder beet)	For sale on fresh market	183	•
	For processing e.g. bottling	184	•
Onions	For salad	185	•
	Dry bulb — include previous autumn plantings	186	•
Broad beans		187	•
Runner beans (stringless)		189	•
Runner beans (stringy)		190	•
French beans		192	•
Peas for harvesting dry			Enter in item 27
Green peas	For fresh market	195	•
	For processing e.g. freezing, canning etc.	196	•
Field celery self blanching excluding wide row main crop)		197	•
Lettuce (not under glass)		198	•
Sweet corn		199	•
All other vegetables include watercress and mustard here, also include mixed areas (see notes)		200	•
Please specify			
TOTAL VEGETABLES GROWN IN THE OPEN		201	•

GLASSHOUSE AREA

(1,000 sq. metres = 0.1 hectare)

		Hectares
Total area under glass or plastic structures excluding lights, cloches and low plastic tunnels — see note A on page 5	205	•

BULBS AND FLOWERS GROWN IN THE OPEN

		Hectares
Bulbs, corms, tubers (except dahlias) and rhizomes for cut flowers or bulbs	240	•
Dahlias	241	•
Chrysanthemums	242	•
All other flowers for cutting	243	•
TOTAL BULBS AND FLOWERS GROWN IN THE OPEN	244	•

ORCHARDS — NON COMMERCIAL

		Hectares
Orchards, not grown commercially	207	•

ORCHARDS — COMMERCIAL

				Hectares
Orchards grown commercially (include area of young non bearing orchards but not fruit stock) (item 230)	Dessert apples	Cox's Orange Pippin	208	•
		All other varieties	209	•
	Cooking apples	Bramley's Seedling	210	•
		All other varieties	211	•
	Cider apples and perry pears		212	•
	Pears		213	•
	Plums		214	•
	Cherries		215	•
	Other top fruit (including nuts)		216	•

SMALL FRUIT

(include all items 218-225 (but not all 225) any area of small fruit grown under orchard trees)

		Hectares
Strawberries	Open grown only	218	•
	Under cloches or low tunnels	219	•
Raspberries		220	•
Blackcurrants	For market	221	•
	For processing	222	•
Gooseberries		223	•
Other small fruit (including grapes)		225	•
TOTAL ORCHARDS AND SMALL FRUIT (items 207-225 above less any area of small fruit grown under orchard trees)		226	•

HARDY NURSERY STOCK

			Hectares
Fruit trees, bushes and canes, strawberries for runner production and other fruit stock for transplanting		230	•
Field grown	Roses (including stock for budding)	231	•
	Shrubs, conifers, hedging plants and Christmas trees (not roses)	232	•
	Ornamental trees	233	•
	Perennial herbaceous plants (not for cut flowers)	234	•
Other hardy nursery stock and mixed areas (including the area of land used for container-grown plants)		235	•
TOTAL HARDY NURSERY STOCK		236	•

CONTAINER GROWN NURSERY STOCK

			Number
In the last 12 months, how many plants were produced	For sale in retail pots of	1.9 litres or less	237
		2 - 3 litres	238
		3.1 - 4.0 litres	239
		More than 4 litres	245
	For growing on as liners		246
TOTAL CONTAINER GROWN NURSERY STOCK			247

		Hectares
TOTAL HORTICULTURAL CROPS (include all items 170 to 225, 230 to 235 and 240 to 244)	249	•

GLASSHOUSE AND PROTECTED CROPS

GLASSHOUSES AND PLASTIC COVERED STRUCTURES

'000 SQ. FT. = 93.0 SQ. METRES

Square metres

TOTAL AREA (whether in use or not – see note A)			
Area covered by glass	With heating equipment	250	
	Without heating equipment	251	
Area covered by plastics or other glass substitutes	With heating equipment	252	
	Without heating equipment	253	
TOTAL AREA OF GLASSHOUSES AND PLASTIC COVERED STRUCTURES (to agree with item 274 below)		254	

Note A – "Glasshouse" includes any fixed or mobile structure of a height sufficient to allow persons to enter in an upright position and which is glazed or clad with glass, rigid plastic, film plastic or other glass substitutes. In the case of mobile structures return only the area covered by the structures themselves and not the total area of the sites that could be covered by moving the structures.

Do not include lights and cloches or low plastic tunnels.

Note B – Items 258 and 264–266 give the total area of glasshouse floor space, not the total area of benches or beds.
Include vegetables for commercial production at item 256.

Note C – Enter strawberries grown in the open under cloches or low tunnels at items 218 or 219.

Note D – Bedding plants. The number of boxes or trays recorded should be in terms of the standard 14" x 9" box or its metric equivalent 350mm x 215mm.

Note E – Basic bed area is the area of shelves, tray, boxes or bags excluding that of peak heat or [illegible]

AREA OF CROPS AT 1 JUNE (do not include crops under lights or cloches)

Square metres

Vegetables (exclude plants in propagation see item 266)	Tomatoes: heated crop	Planted on 28 February 1987	255
		Planted after 28 February 1987	256
	Unheated crop		257
	Cucumbers		258
	Sweet peppers		259
	Lettuce		267
	Other vegetables and herbs		260
Flowers and foliage for cutting	Pinks		248
	Carnations (excluding pinks)		261
	Alstroemeria		269
	Roses		262
	Chrysanthemums (excluding pots – see item 268)		263
	Other flowers and foliage (excluding plants for sale or in propagation)		270
Plants see note B)	For sale as pot plants:	Chrysanthemums	268
		Other flowering plants	264
		Foliage plants	265
	Plants in propagation for growing on or for sale to growers and gardeners		266
Fruit	Strawberries and any other fruit (see note C)		271
Remaining glasshouse area at 1 June	Area which you expect to crop in 1987		272
	Area which you do not expect to crop in 1987		273
TOTAL CROPS AND REMAINING GLASSHOUSE AREA (to agree with total at 254 above)			1274

SELF-BLANCHING CELERY (grown as a protected crop)

Square metres

Self-blanching celery (area grown this season – include crops harvested since October 1986)	275

BEDDING PLANTS IN POTS OR BOXES IN GLASSHOUSES – see note D

			Number of pots/boxes
Bedding plants grown in pots or boxes. Numbers grown this season including spring and summer sales. (exclude plant raising for commercial production)	Vegetables	In pots	276
		In boxes	277
	Ornamental bedding plants	In pots	279
		In boxes	280

MUSHROOMS (grown as a protected crop)

Square metres

Total basic bed area used for production (see note E)	281

NB: The year in which the areas of buildings stand should be returned at item 5 on page [illegible]

CONTINUED ON NEXT PAGE

CROPS

Enter the area, including headlands and ditches, of each crop at 1st June, 1987. Land being prepared for a crop should be returned as under that crop.

			hectares (nearest 0.1)
Wheat		14	•
Triticale		15	•
Barley	Winter	16	•
	Spring (including bere)	19	•
Oats		20	•
Mixed grain for threshing (only mixtures of wheat, barley, and oats or any two of these)		22	•
Rape for oilseed		23	•
Potatoes intended mainly for **SEED**		24	•
Potatoes intended mainly for **WARE**	Earlies intended for harvesting on or **by 31st July**	25	•
	Main crop intended for harvesting **after 31st July**	26	•
Peas for Combining		28	•
Turnips and swedes for stock feeding (**Not** for human consumption)		29	•
Kale and Cabbage for stock feeding (**Not** for human consumption)		30	•
Rape for Stockfeeding (**Not** oilseed rape)		31	•
Fodder Beet		32	•
Other Crops for Stock Feeding (**Not** grass)		34	•
Vegetables for Human Consumption grown in the open (must agree with item 68)		35	•
Orchard Fruit-apples, plums, etc., for sale or manufacture. Include land planted with maiden trees but exclude fruit stocks (see item 80).		36	•
Soft Fruit. (must agree with item 76)		37	•
Other Crops not included above (**Not** Grass) Include here **Glasshouse Crops**, item 84, and areas of unspecified crops, including mixed crops (other than vegetables or soft fruit at 67 and 75), which are too small to be shown separately. (see also foot of column).		38	•
Bare Fallow—land left uncropped for the season.		39	•
TOTAL CROPS AND FALLOW		40	•

Item 38 (Other Crops). If crops other than glasshouse crops, bulbs, flowers and nursery stock are included, please enter the **total** area in the box below

	hectares (nearest 0.1)
Unspecified Crops—(total area	41 •

Please name any major unspecified crops, e.g., max. 5 hectares, in the space below.

GRASSLAND

Land should be shown as "Grassland" where productive grasses, clovers, etc., are dominant. Land which cannot normally be cultivated or is dominated by poor quality grasses, heather, bracken, etc., should be returned as "Rough Grazings".

		hectares (nearest 0.1)
FOR MOWING this season	**Under 5 years old** (including grass sown this year without a nurse crop)	42 •
	5th year grass and older (i.e. sown in 1982 or earlier)	43 •
FOR GRAZING this season	**Under 5 years old** (including grass sown this year without a nurse crop)	44 •
	5th year grass and older (i.e. sown in 1982 or earlier)	45 •
TOTAL CROPS AND GRASS (total of item 40 and items 42 to 45)		46 •
Rough Grazings—Mountain, hill, Moor, Deer Forest situated within the farming unit, whether enclosed or not. Do not include woods, roads, etc., a share in common grazing or any land taken by you for the season.		47 •
Woodlands—(other than commercial orchards)—situated within the farming unit for shelter belts, fencing materials, other farm uses and for commercial or amenity purposes.		48 •
Other Land (i.e. roads, yards, buildings (excluding glasshouses), ponds, derelict land, etc.		49 •
TOTAL AREA OF ALL LAND to which this form relates (total of items 46 and 47 to 49; must also agree with item 12).		50 •

VEGETABLES FOR HUMAN CONSUMPTION GROWN IN THE OPEN

Do not give number of rows or plants. Include under the appropriate crop land prepared for it but **not yet planted.**

		hectares (nearest 0.1)
Peas for canning, freezing or drying (**Not** green peas for market or peas for stock feed).		52 •
Beans for canning, freezing or drying (**Not** fresh beans for market or beans for stock feed)		53 •
Leeks (include land prepared for the crop)		55 •
Turnips and Swedes for human consumption		56 •
Cabbages and Savoys for human consumption (include land prepared for the crop)	Summer/Autumn	57 •
	All other	58 •
Brussels Sprouts (include land prepared for the crop)		59 •
Calabrese		60 •
Cauliflower and Broccoli-Heading Varieties (include land prepared for the crop)		61 •
Carrots		63 •
Lettuce		64 •
Rhubarb		65 •
Other Vegetables grown in the open (**Not** tomatoes or other glasshouse crops)		66 •
Mixed Vegetables—areas which as individual crops are too small to be shown separately		67 •
TOTAL VEGETABLES (must agree with item 35)		68 •

Please see over →

SOFT FRUIT

Exclude spawn beds, runner beds and young plants intended for sale. (These should be entered at item 80).

Hectares (nearest 0.1)

Strawberries	70	
Raspberries	71	
Blackcurrants	72	
Mixed and Other Kinds of soft fruit including the areas of soft fruits named above which as individual crops are too small to be shown separately	75	
TOTAL SOFT FRUIT (must agree with item 37)	76	

BULBS, FLOWERS AND NURSERY STOCK GROWN IN THE OPEN

Do not give number of plants.

Hectares (nearest 0.1)

Bulbs grown for the production of dry bulbs and/or cut flowers **in the open**		77	
Other flowers for cutting **in the open** not from bulbs including land prepared for the crop		78	
Hardy Nursery Stock	**Fruit Stocks**—spawn beds, runner beds and stool beds and young plants intended for sale	80	
	Roses and Rose Stocks	81	
	Ornamental trees and shrubs (not forest trees)	82	
	Other nursery stock (herbaceous plants, alpines, etc.)	83	
TOTAL (include also in item 38)		84	

GLASSHOUSES AND TOMATOES

See metric conversion tables.

sq. metres

GLASSHOUSES in use	"Walk-in" Plastic Structures	85	
	Glass clad structures	86	
	Tomatoes	87	

Include total area of glasshouse crops in item 38.

HAY, STRAW AND SILAGE STOCKS

Include stocks left over from previous seasons and any which have been bought in.

Tonnes (nearest tonne)

Hay, on holding at 1st June, 1987 (Tonnes)	91	
Straw, on holding at 1st June, 1987 (Tonnes)	92	
Silage, on holding at 1st June, 1987 (Tonnes)	93	

LIVESTOCK

Enter livestock belonging or hired to you (or to your workers or family, unless these persons make an agricultural return in their own right), **whether on your farm or elsewhere. Include livestock** you are keeping and managing **on contract** for someone else. Enter livestock sent for sale on 29th May or 1st June.

Exclude any of your **livestock kept on contract for you** by another farmer **or on hire to another farmer** and any **livestock** owned by another farmer which are **temporarily on your farm** but which you are not managing on contract.

FARMED DEER

Exclude wild or park deer which cannot be gathered, identified, recorded and handled.

Number

Deer of all ages and types	94	

HORSES

Number

Horses used for agricultural or horticultural purposes	95	
All other Horses and Ponies	96	

GOATS

Number

Female goats which have kidded	97	
All other goats	98	

CATTLE

Number

Cows and Heifers in milk		**Dairy**	100	
		Beef	101	
Cows in Calf but not in milk		**Dairy**	102	
		Beef	103	
Heifers in Calf for the first time	2 years old and over	**Dairy**	104	
		Beef	105	
	Under 2 years old	**Dairy**	106	
		Beef	107	
Bulls for Service	2 years old and over		108	
	1 year old and under 2		109	
All Other Cattle	2 years old and over — **Female** — **Breeding**	**Male**	110	
		for **Dairy**	111	
		for **Beef**	112	
		Not for breeding	113	
	1 year old and under 2 — **Female** — **Breeding**	**Male**	114	
		for **Dairy**	115	
		for **Beef**	116	
		Not for breeding	117	
	6 months old and under 1 year	**Male**	118	
		Female	119	
	Under 6 months old	**Male**	120	
		Female	121	
TOTAL CATTLE			122	

CALVES SOLD AND BOUGHT DURING THE LAST YEAR

Enter the **number** of calves (i.e. under 1 year old) **sold** and **bought** during the last year.

Number

Calves Sold between 2nd June 1986 and 1st June 1987.	**Under 6 months** including calves for immediate slaughter	133	
	6 months old and under 1 year	134	
Calves Bought between 2nd June 1986 and 1st June 1987	**Under 6 months** at time of purchase	135	
	6 months old and under 1 year at time of purchase	136	

IRISH CATTLE BOUGHT

Number

Cattle you bought directly or almost directly from the Irish Republic or Northern Ireland during the year from 2nd June 1986 to 1st June 1987	for **Breeding**	137
	for **Feeding**	138

CHANGE IN AREA OF HOLDING

JUNE 1987

- Check that the total area shown above box 166 on the front of the form agrees with the current total area of your holding.
- If it does not agree:
  a) enter the correct total area in box 169 (on page 1)
  b) account for the difference by entering the changes below.
  Note that **seasonally let land** should not be recorded as being given up or taken over.

LAND GIVEN UP

1. Date of change .....

2. Area of land given up and (if known) now it will be used:

		Hectares
(a) farmed by another person	291	•
(b) for urban, industrial or recreational development	294	•
(c) for mineral working	295	•
(d) for forestry or private woods	297	•
(e) for Ministry of Defence purposes	298	•
(f) Other reasons for decrease in area (include here where new use is not known)		•
.....		•
.....		

3. If any of the above land given up is officially designated as Less Favoured show the area in the following categories:

Area of seriously disadvantaged land (old LFA)	•
Area of disadvantaged land (old marginal land)	•

4. New Occupier of land
Name and address .....
.....
.....

LAND TAKEN OVER

5. Date of change .....

6. Area of land taken over and (if known) its previous use:

		Hectares
(a) farmed by another person	281	•
(b) from urban, industrial or recreational use	284	•
(c) from mineral working	285	•
(d) from forestry or private woods	287	•
(e) from Ministry of Defence	288	•
(f) Other reasons for increase in area (include here where old use is not known)		•
.....		•
.....		

7. If any of the above land taken over is officially designated as Less Favoured show the area in the following categories:

Area of seriously disadvantaged land (old LFA)	•
Area of disadvantaged land (old marginal land)	•

8. Previous Occupier of land
Name and address .....
.....
.....

9. CHANGE OF ADDRESS

Please give any necessary correction to name and address shown on page 1 BLOCK LETTERS .....
.....
.....
..... Postcode

10. OTHER HOLDINGS IN THE SAME OCCUPANCY

Please list here any other holding reference numbers under which you make agricultural census returns .....
.....
.....

DO NOT SEND BACK THIS COPY OF THE FORM. SEND BACK THE ONE WITH YOUR NAME AND ADDRESS ON THE FRONT. YOU MAY FIND IT USEFUL TO USE THIS FORM TO KEEP A COPY OF THE INFORMATION THAT YOU PROVIDED AND TO RECORD THE DATE ON WHICH YOU DESPATCHED THE FORM

CPH No .....

Date 1987

APPENDIX 2. Agricultural census form for Scotland.

Department of Agriculture and Fisheries for Scotland.

Agricultural and Horticultural Census 1st June, 1987

NOTICE REQUIRING INFORMATION BY 15th June, 1987

The Department of Agriculture and Fisheries for Scotland
Economics and Statistics Unit
Chesser House, 500 Gorgie Road, Edinburgh EH11 3AW

May, 1987

AGRICULTURE ACT 1947, SECTION 78 (AS AMENDED)

As the occupier of the land to which this form relates you must complete the form. The information you give should be as at 1st June, 1987 except where otherwise stated. **The completed form must be returned to the department as soon as possible after 1st June 1987 and not later than 15th June, 1987.**

The information you give on the return is strictly confidential and cannot be disclosed without your written consent except as specified in Section 80 of the above Act and Section 12 of the European Communities Act, 1972.

Section 31 of the Agriculture Act 1947 (as amended) provides that anyone who fails to fill in and return the form shall be liable on summary conviction to a fine not exceeding four hundred pounds. Penalties are also prescribed for knowingly or recklessly furnishing false information.

Secretary

The area figures below are those previously received and include woods, roads, buildings, etc.

AGRICULTURAL AND HORTICULTURAL RETURN AS AT 1st JUNE, 1987

PLEASE SEE THE ENCLOSED METRIC CONVERSION TABLES

FOR OFFICIAL USE

C.O. 3.

A.

Total Area

Owned Area

OR PRESENT OCCUPIER

CHANGE OF ADDRESS/POST CODE

If your postal address is different from that above please give the correct address here:

.....

.....

..... Post Code.....

CHANGES IN AREA OF HOLDING

If the total area of your holding differs from that above the address, please give details. Exclude land rented for 364 days or less. Use a separate piece of paper if you need more space.

Land you have taken over

Name of land..... Code No .....

Parish ..... Area Acquired ..... Hect.

Name and Address of Previous Occupier .....

Land you have given up

Name of land..... Code No .....

Parish ..... Area Given Up ..... Hect.

Name and Address of Present Occupier .....

SEASONAL USE OF LAND

If so many months of grazing for so many head of stock are taken let, rather than a set area, please estimate the area used to graze that land is taken or let.

	Hectares (nearest)
Area of land on this farm let seasonally (364 days or less), as at 1st June, 1987 to another person for cropping or grazing. (This land should be measured elsewhere on the form as arable, grass or rough grazings).	.
Area of land rented seasonally, as at 1st June, 1987 from another person for cropping or grazing. (This land should NOT appear elsewhere on this form).	.

LAND RENTED AND/OR OWNED

Enter the total area of land to which this form relates (including woods, roads and farm buildings), showing what area is rented by you on a full agricultural tenancy and what area is owned by you. If you rent land from a near relative, a trust or any business or concern in which you have an interest, enter the area in item 10. Starters should normally return their land as rented. The Total (item 12) must agree with item 50. The total area and owned area should agree with the figures above the address, unless you have taken over or given up land (accounted for in the box below left).

	Hectares (nearest)
Rented by the occupier from an outside concern	.
Rented from a near relative or from a concern in which the occupier has an interest	.
Owned by the occupier	.
TOTAL AREA OF LAND	.

SHEEP

Do not enter your share in a Sheep Stock Club as the Club Secretary will return these sheep.

Enter at question 139 only those **Ewes and Gimmers which have survived** until 1st June and still belong to you.

		Number
Ewes used for breeding in 1986/87 season (**Actual Number at 1st June, 1987.**)		139
Rams to be used for service in 1987		140
Other Sheep 1 year old and over	For breeding	141
	Other	143
Lambs (Please estimate if not yet counted)		144
TOTAL SHEEP		145

PIGS

Enter pigs being kept **under contract** on your farm.

		Number
Sows in Pig		146
Gilts in Pig		147
Other Sows for breeding		148
Barren Sows for fattening		149
Gilts 50Kg (110 lb) and over, not yet in pig, but expected to be used for breeding		150
Boars being used for service		151
All Other Pigs (not entered above)	110Kg (240lb) liveweight and over	152
	80Kg (175lb) and under 110Kg (240lb) liveweight	153
	50Kg (110lb) and under 80Kg (175lb) liveweight	154
	20Kg (45lb) and under 50Kg (110lb) liveweight	155
	under 20Kg (45lb) liveweight	156
TOTAL PIGS		157

POULTRY

Exclude game birds.

Enter poultry being kept **under contract** on your farm.

			Number
Fowls for producing eggs for eating	**Pullets** and **Hens** in the laying flock	Pullets—Fowls in first laying season	158
		Hens—other fowls including those in moult	159
	Growing pullets—day old to point of lay		161
Fowls for breeding	Pullets and Hens of all ages kept for being reared mainly for producing hatching eggs		162
	Cocks of all ages kept for being reared for breeding		163
Fowls being reared for the table—broilers and other table birds including table cockerels			164
Other Poultry (ducks, geese, guinea fowl)			167
Turkeys of all ages—including breeding stock			169
TOTAL POULTRY			170

OTHER HOLDINGS IN THE SAME OCCUPANCY

	172
Please give the Code No.s under which you, your Company or Partnership make agricultural census returns for other holdings.	173
	174
	175
	176

If Code Nos. not known enter addresses here:

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P.T.O.

LABOUR
OCCUPIER AND WIFE OR HUSBAND

If you are doing farm work (including office work) enter yourself in this section, also your wife/husband if she/he is doing farm work.

Enter yourself as part-time if you work less than about 40 hours per week on the farm, even if you have no other job. If you have more than one farm, do not enter yourself and your spouse on more than one return.

When the farm is run by a partnership or company, enter only the principal or senior working partner or director as the occupier, enter also the spouse, if doing farm work.

Include other working partners or directors in the "All Other Labour" section.

			Number
Occupier—if doing farm work (one person only)	Full-time		177
	Part-time	½ time or more	178
		less than ½ time	179
Wife/Husband of occupier (if doing farm work)			181

ALL OTHER LABOUR EXCLUDING OCCUPIER, WIFE OR HUSBAND ENTERED ABOVE

This section relates only to persons working for you on 1st June, including those that were sick or on holiday on that day.

Exclude anyone working under THE YOUTH TRAINING SCHEME.

Leave out school children, non-farm workers working on buildings, installing plant or carrying out contract work, and gardeners or estate workers who do no farm work.

Enter once only, and on only one return, all persons doing farm work including drainage, ditching, maintenance and repair work and transport of farm goods.

Part-time workers are those who do farm work each week but for less than the full working week.

Casual and seasonal workers are those actually working on 1st June doing work of a temporary or seasonal nature; include labour supplied by gangmasters.

			Number
FULL-TIME REGULAR STAFF employed on 1st June	**Males**—20 years old and over	Hired	188
		Members of Occupier's family	189
	Males—under 20 years old	Hired	190
		Members of Occupier's family	191
	Women and Girls	Hired	192
		Members of Occupier's family	193
PART-TIME REGULAR STAFF employed on 1st June	**Males**	Hired	194
		Members of Occupier's family	195
	Women and Girls	Hired	196
		Members of Occupier's family	197
Casual and Seasonal Workers Employed on 1st June	**Males**		198
	Women and Girls		199
TOTAL REGULAR AND CASUAL STAFF (excluding entries of occupier and spouse)			200

I declare the information I have given on this form to be correct to the best of my knowledge and belief.

SIGNATURE OF OCCUPIER.....

Date.....Telephone No .....

If signature is not that of the addressee, please say why, e.g., "manager", "new owner", "occupier abroad" etc.

Please use the enclosed pre-paid envelope. No stamps required.

FOR OFFICIAL USE

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