THE MANAGEMENT OF FIELD MARGINS FOR THE CONSERVATION OF GAMEBIRDS

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ABSTRACT

The importance of hedgerows and other field boundaries as nesting habitat for gamebirds, and of cereal field headlands as foraging habitat for gamebird chicks is summarised. The various management options for hedgerows and headlands are described.

It is shown that hedges that are trimmed every other year (biennially) produce the best nesting cover for both grey and red-legged partridges. Annual trimming does not allow sufficient residual ground vegetation to build up, while hedges that are largely neglected become totally unsuitable nesting areas.

Cereal headlands left unsprayed with pesticides from 1 January produce significantly larger grey partridge and pheasant brood sizes. Headlands left unsprayed from 1 October had no additional beneficial effect.

The benefits to other farmland wildlife of field margin management for game are discussed.

INTRODUCTION

We have shown elsewhere (Rands 1982, 1985, 1986a, 1986b, in press, Sotherton and Rands 1986) the importance of hedgerows, other field boundary types and the field edge itself to gamebirds, both as nesting habitat and as a foraging area for chicks. In this paper we describe the ways in which field margins can be managed to enhance their value to game, firstly as nesting cover and secondly as a feeding habitat for young gamebirds.

MATERIALS AND METHODS

Hedgerows

In a detailed study of hedges and partridges (Rands 1982, 1986a), it was demonstrated that both the quantity and quality of hedge present within an area played an important role in the population dynamics of grey partridge (*Perdix perdix*) and red-legged partridge (*Alectoris rufa*). Four parameters connected with partridge nesting ecology were studied: (a) recruitment of first-year birds into subsequent breeding populations, (b) breeding density, (c) nest site selection, and (d) nest predation. Each of these was related to a series of habitat variables describing the physical and structural components of available nesting habitat (Table 1).

TABLE 1

The habitat variables recorded for each field boundary. The units of measurements are given in brackets.

Length	(per km^2)
Width	(metre)
Height	(metre)
Height of bank at base	(metre)
Amount of dead grass in ground vegetation	(%)
Amount of nettle (Urtica dioica) in ground vegetation	(%)
Amount of bramble (Rubus spp) in ground vegetation	(%)
Amount of cover provided by ground vegetation	(%)
Visibility through ground vegetation	(%)
Number of trees	(per km)
Number of gaps	(per km)
Presence of a wire fence	(presence/absence)
Presence of a ditch	(presence/absence)

Table 2 shows which of these habitat variables correlated significantly with each of the partridge population parameters.

TABLE 2

The habitat characteristics of nesting cover found to correlate with population parameters of grey and red-legged partridges.

Recruitment	Breeding Density	Nest-site Selection	Nest predation
		Grey Partridge	
Length of boundary	Length of boundary	Earth bank height	Hedge width
Amount of dead grass	Amount of dead grass	Amount of dead grass	Hedge height
Earth bank height		Amount of bramble	Amount of dead grass
		Amount of leaf litter	Number of gaps
		Red-legged Partridge	
Length of boundary	Length of boundary	Amount of dead grass	Ground vegetation height
Amount of nettle	Amount of nettle	Amount of nettle	
Number of gaps		Amount of bramble	
		Amount of leaf litter	

The effect of hedgerow management on these habitat characteristics was established during a field survey of 1,266 field boundaries spread over 17 different study farms. For each field boundary, the method of management was recorded and subsequent analysis revealed that all boundaries fell into one of seven management types (Table 3). The relationship between these different methods of hedgerow management and the habitat characteristics influencing partridges is discussed below.

TABLE 3

Methods of field boundary management.

Unmanaged field boundaries

Such boundaries had received no detectable management in the form of trimming, laying, coppicing or grazing, over the last ten years. This does not exclude the possibility that the edges of the field boundaries were sprayed to prevent weeds spreading into adjacent crops, but it implies that the bulk of both shrubby and ground vegetation was not systematically cut.

Occasionally managed boundaries

This included all types of boundary that showed evidence of previous cutting, laying, grazing and other forms of management within the last ten years but were apparently no longer managed.

Boundaries with the verges cut

This applied almost exclusively to roadside and trackside field boundaries, where only the grassy verges were cut and the central vegetation of the boundary was left largely undisturbed.

Boundaries cut annually

This included all types of field boundary that were mechanically cut every year. The vast majority of boundaries in this category were hedges that had their sides and top mechanically trimmed. It was the second most frequent method of management recorded on the study estates.

Biennially trimmed field boundaries

This applied largely to hedgerows which were mechanically trimmed along the top and sides every other year.

Boundaries with annually cut sides

A common practice on estates where shooting takes place is to allow the tops of some hedges to grow up unrestricted to make partridges and pheasants fly higher when they are flushed. The sides of such hedges are trimmed annually, while the top is rarely cut.

Boundaries grazed regularly

A boundary was only placed in this category when grazing dominated all other forms of management. It was most commonly applied to grassy fence lines but included some hedges.

Headlands

Experiments with unsprayed headlands have been carried out for three years on an 11 km^2 mixed farm in north-east Hampshire. A further eight arable farms in the eastern counties were used for experiments in 1984 and 1985. On each farm a six-metre strip around the edge of a sample of cereal fields was left unsprayed with herbicides, fungicides and insecticides from 1 January onwards. A similar number of cereal fields was fully sprayed to act as a control. The study areas and experimental design have been described in greater detail elsewhere (Rands 1985, 1986b, Sotherton et al 1985).

The effects of not spraying headlands on weed abundance, insect density, gamebird chick production and the number of butterflies was measured by sampling the populations of each group in sprayed and unsprayed headlands (see Rands 1986b, Sotherton et al 1985).

RESULTS

Hedgerows

The mean values for each type of management of the individual habitat characteristics influencing partridges are given in Table 4, from which it is clear that certain characteristics were associated with particular methods of management. The significant habitat differences between management regimes are summarised below.

Unmanaged field boundaries. Such boundaries were significantly wider than all others, significantly taller than all except those where only the sides were cut, and earth banks at the base were low or absent. The amount of dead grass present at the base was significantly less than for all other management regimes except grazing.

Occasionally managed boundaries. Although wider than all but unmanaged boundaries, these boundaries had low earth banks and significantly less dead grass, nettle and bramble than most other methods of management. They were significantly less gappy than more regularly managed field boundaries.

Boundaries with the verges cut. These resembled field boundaries cut every other year in most habitat characteristics but had significantly lower earth banks, less nettle and fewer gaps.

Boundaries cut annually. These were the narrowest and shortest of all field boundary types. Bank height was significantly higher than in less frequently managed boundaries. Dead grass was more abundant than in unmanaged or grazed boundaries but significantly less frequent than in boundaries cut every other year (biennially).

Biennially trimmed field boundaries. These boundaries contained the highest earth banks (significantly higher than in any other method of management), and dead grass and nettle were significantly more abundant than in other boundary types. They contained more gaps than any less frequently managed boundary.

TABLE 4

Mean values (and standard errors) of the habitat characteristics recorded at field boundaries under seven different methods of management. Only those characteristics shown to influence partridges are included.

	Method of field boundary management							
Habitat	Unmanaged		Occasionally managed		Only verges cut		Top and sides cut annually	
Variable	Mean	SE *	Mean	SE *	Mean	SE *	Mean	SE *
Width	25.0	± 2.47	10.3	± 2.74	5.2	± 0.66	3.8	± 0.32
Height	4.3	± 0.05	2.6	± 0.59	1.7	± 0.48	1.7	± 0.12
Bank height	0.05	± 0.00	0.12	± 0.03	0.13	± 0.03	0.23	± 0.02
Dead grass	10.0	± 1.21	15.5	± 2.64	20.1	± 2.76	15.5	± 1.00
Nettle	10.1	± 0.76	7.6	± 1.46	5.9	± 1.45	8.0	± 0.67
Bramble	4.4	± 0.72	2.3	± 0.59	2.5	± 0.87	3.3	± 0.35
No of gaps	0.31	± 0.05	0.49	± 0.15	0.18	± 0.06	1.49	± 0.12

* = standard error

TABLE 4 continued

	Method of field boundary management					
	Top and sides cut biennially		Only sides cut annually		Regularly grazed	
Variable	Mean	SE *	Mean	SE *	Mean	SE *
Width	3.6	± 0.17	4.4	± 0.37	6.1	± 2.37
Height	3.0	± 0.14	5.2	± 0.28	1.9	± 0.49
Bank height	0.34	± 0.02	0.25	± 0.03	0.04	± 0.03
Dead grass	27.2	± 1.09	19.7	± 1.15	8.4	± 2.51
Nettle	14.4	± 1.34	9.9	± 1.42	3.5	± 1.13
Bramble	4.9	± 0.50	3.9	± 0.81	1.1	± 0.37
No of gaps	1.85	± 0.18	1.13	± 0.17	0.05	± 0.03

* = standard error

Boundaries with annually cut sides. These were very similar to biennially trimmed field boundaries except that they were significantly taller.

Boundaries grazed regularly. Significantly less dead grass, nettle and bramble occurred at the base of these boundaries than for any other type, and earth banks were lower than for all boundaries apart from unmanaged ones.

Headlands

The mean brood size for grey partridges on blocks of fields with sprayed and unsprayed headlands (from 1 January) are given in Table 5 for 1983 to 1985 on the Hampshire study area, and for 1984 and 1985 on the farms in the eastern counties. In all these situations grey partridge brood size was significantly larger where headlands were left unsprayed. Furthermore, as illustrated in Figure 1, breeding density on the Hampshire study area has risen rapidly since experiments began, an increase that has been significantly greater than that observed in other areas of Hampshire and Wiltshire where headlands were fully sprayed.

TABLE 5

Grey partridge brood sizes on blocks of cereal fields with headlands sprayed and unsprayed (from 1 January) in Hampshire 1983 to 1985, and East Anglia 1984 to 1985.

Year	Study area	Mean (± S.E.) brood size Sprayed headlands	Unsprayed headlands	P
1983	Hampshire	4.7 ± 0.5	8.4 ± 0.4	< 0.01
1984	Hampshire	7.4 ± 0.8	10.0 ± 0.6	< 0.01
1985	Hampshire	3.3 ± 1.1	6.2 ± 1.2	< 0.05
1984	East Anglia	4.7 ± 0.3	7.8 ± 0.6	< 0.001
1985	East Anglia	2.7 ± 0.4	4.0 ± 0.7	< 0.05

In 1985 some field headlands were left unsprayed from 1 October, in other words from sowing through until harvest. Table 6 shows the effect of this on grey partridge brood size. From this one year the results suggest that leaving headlands unsprayed from 1 October has no greater benefit than leaving headlands unsprayed from 1 January.

FIGURE 1 Grey partridge breeding densities from 1982 to 1985, on the Manydown Estate (filled stars) and on National Game Census estates in Hampshire and Wiltshire (unfilled stars).

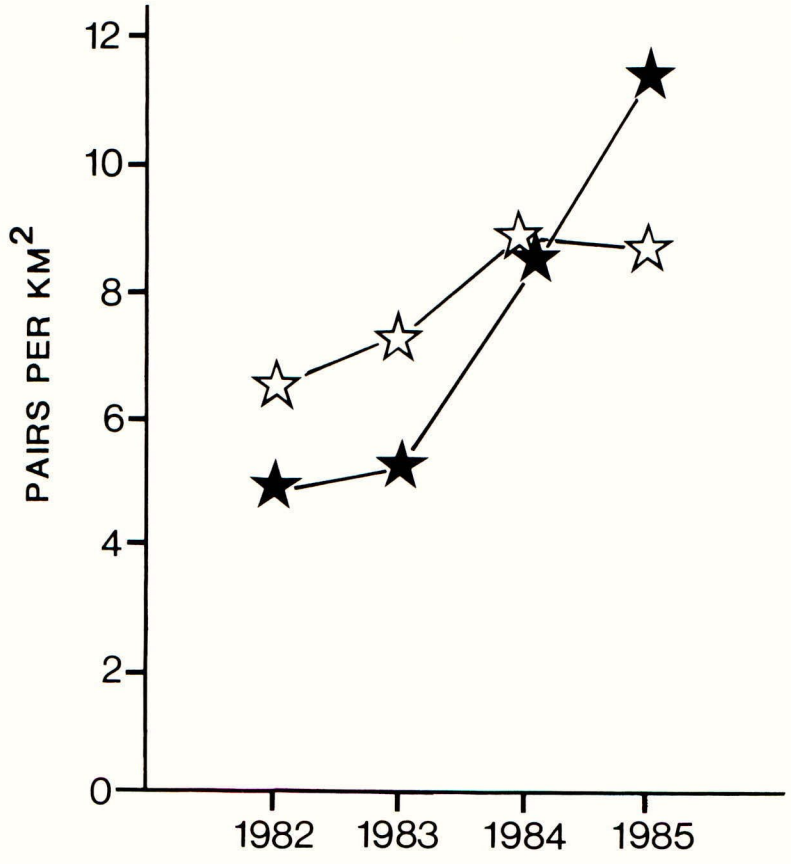

TABLE 6

Grey partridge brood sizes on fields with sprayed headlands, unsprayed headlands from 1 January, and unsprayed headlands from 1 October, on the Hampshire study area in 1985.

Headland	Mean brood size (± SE)
Sprayed	3.3 ± 1.1
Unsprayed from 1 January	6.2 ± 1.2
Unsprayed from 1 October	5.4 ± 0.8

Table 7 presents mean brood sizes for pheasants on the same study areas. It shows that pheasant brood sizes were also significantly higher where headlands were left unsprayed from 1 January.

TABLE 7

Pheasant brood sizes on blocks of cereal fields with headlands sprayed and unsprayed (from 1 January) in Hampshire, and East Anglia, 1984 to 1985.

Year	Study area	Mean (± SE) brood size: Sprayed headlands	Unsprayed headlands	P
1984	Hampshire	3.2 ± 0.5	6.9 ± 0.5	< 0.001
1985	Hampshire	3.0 ± 1.0	4.6 ± 0.6	< 0.05
1985	East Anglia	2.6 ± 0.3	3.7 ± 0.4	< 0.01

Data for weed abundance, insect densities, butterfly numbers and further details of gamebird chick survival are given elsewhere (Sotherton et al 1985, Rands and Sotherton 1986, Rands 1985, 1986b).

DISCUSSION

In this paper we have reviewed the methods by which field boundaries and field headlands can be managed for the benefit of wild gamebirds. It is clear that the biennially trimming of hedgerows and other field boundary types creates optimum ground vegetation characteristics for nesting partridges. Similarly, this method of management is associated with the presence of high earth banks at the base of the field boundary, which is another habitat characteristic beneficial to game. Cereal field headlands left unsprayed from 1 January are clearly a good foraging habitat for grey partridge and pheasant chicks and are significantly better than sprayed headlands.

The characteristics of field boundaries that make them suitable for partridges also appear to be advantageous for other forms of farmland wildlife. We have shown elsewhere (Sotherton and Rands 1986) that various

types of field boundary are important for overwintering polyphagous predators. It would appear that the presence of a grassy bank, and to a lesser extent a clipped thorn hedgerow, encourages high numbers of insect predators in a field boundary in winter as well as providing an acceptable nesting site for partridges the following spring. The possibilities of benefit to other farmland wildlife groups from hedgerow management for partridges may also occur. However, we can only speculate on these until we have researched what components of a field boundary are important to which groups, and why!

The important feature that makes a field boundary of greatest use to wildlife and creates minimum problems for farmers appears to be the presence of a perennial flora at the base of the hedge/fence. This is where gamebirds nest and insect predators of crop pests spend the winter. However, it is not immediately apparent what factors are responsible for the maintenance of this perennial flora. Factors such as aspect and shading, bank height, and agronomic practices in adjacent fields, may all play some role in its maintenance.

In contrast, it is easier to identify reasons why field boundaries have become less useful to game and wildlife, and in many cases even a direct problem to the farmer, following the loss of this perennial hedgerow flora as a result of various agricultural practices. These include improper disposal of straw by burning, deliberate spraying of hedge bottoms with broad-spectrum herbicides, the drift of herbicides or fertilisers into hedgerow bottoms, and over-grazing by livestock.

The benefits of having some degree of pesticide exclusion from the headlands of cereal fields have now been proved over three seasons, and on many study farms throughout Britain. Currently, the quantification of benefits to wildlife has expanded beyond game. Work to assess the benefits of pesticide manipulation on cereal field headlands now covers research into wild flowers, songbirds, insectivorous mammals and butterflies.

In 1984 and 1985, butterflies were recorded from mid-May to harvest from census transects carried out on farmland near Basingstoke, in Hampshire, during which equivalent lengths of cereal field headlands were walked that had either been sprayed as normal, or had all pesticides omitted from 1 January onwards. The transects were carried out on headlands of fields containing the same crop, adjacent to similar field boundary types and of the same aspect.

In 1984, a total of 82 butterflies per kilometre of sprayed headland transect were recorded, whereas 242 butterflies were seen per kilometre of unsprayed headland. In 1985, 165 butterflies per kilometre were recorded in sprayed headlands compared to 331 in unsprayed headlands (Dover 1986).

Although the benefits to butterflies are consistent between years, more research is needed to discover the mechanisms underlying these observations, and what longer-term effects we are producing (if any) on populations of individual species.

Until the costs of the proposed management techniques have been quantified satisfactorily in terms of yield loss (both in quality and quantity) and harvesting difficulty, and until we have a clearer

definition of the terms "unsprayed" and "headland", this work must still be considered as being in an experimental stage and no recommendations will be made. However, we believe that these restraints will be overcome in the near future, and that unsprayed headlands will form a satisfactory basis for game and wildlife conservation on arable farmland.

REFERENCES

Dover, J. W. (1986). The benefits of unsprayed headlands: butterflies on farmland. Annual Review of the Game Conservancy 17, 65-68.

Rands, M. R. W. (1982) The effect of habitat quality on the population ecology of partridges. Unpublished D.Phil. thesis, University of Oxford.

Rands, M. R. W. (1985) Pesticide use on cereals and the survival of grey partridge chicks: a field experiment. Journal of Applied Ecology 22, 49-54.

Rands, M. R. W. (1986a) Effect of hedgerow characteristics on partridge breeding densities. Journal of Applied Ecology 23, 479-487.

Rands, M. R. W. (1986b) The survival of gamebird chicks in relation to pesticide use on cereals. Ibis 128, 57-64.

Rands, M. R. W.; Sotherton, N. W. (1986) Pesticide use on cereal crops and changes in the abundance of butterflies on arable farmland. Biological Conservation, 36, 71-82.

Rands, M. R. W. (In press) Recruitment of grey and red-legged partridges (Perdix perdix and Alectoris rufa) in relation to population density and habitat. Journal of Zoology.

Sotherton, N. W.; Rands, M. R. W.; Moreby, S. J. (1985) Comparison of herbicide treated and untreated headlands on the survival of game and wildlife. Proceedings 1985 British Crop Protection Conference - Weeds 3, 991-998.

Sotherton, N. W.; Rands, M. R. W. (1986) The environmental interest of field margins to game and other wildlife: a game conservancy view. This volume.

MANAGEMENT FOR CONSERVATION OF WILDLIFE - FWAG EXPERIENCES

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FWAG (Farming and Wildlife Advisory Group) advisers are asked many questions on hedgerow management, and in the majority of cases, the advice given is based on educated conjecture, rather than drawn from scientific research. There has been very little work carried out on the kind of questions we are asked (which is probably why we are asked them), so I will try to outline the common problems raised and the type of advice offered, which will highlight the areas in which further research is needed.

Questions about hedgerow management may crop up as part of a general farm conservation plan or may be concerned specifically with restoration of poorly managed hedges. Poorly managed hedges fall into two categories - those suffering from neglect and which have got out of control, and those which have been overmanaged in the past and are becoming exhausted.

Advice on neglected hedges is usually to coppice or lay, to bring them back into management. Both of these are quite drastic, especially with coppicing, when all the above-ground material is removed. Nevertheless, I would submit that the effects on the long-term structure of the hedge are far more satisfactory than if it is suddenly cut to four feet with a mechanical flail. There is a problem of cost with coppicing or laying, although in Wiltshire there are a number of hedgelayers operating at a reasonable charge and I tend to find that the economics of the work are not as unfavourable as many people think. The problem with laying neglected hedges, though, is that they are unlikely to be stock-proof, whereas properly managed hedges which have been regularly laid can provide a very good barrier against stock.

On coppicing, I have reservations both about its immediate effect on wildlife and also on the speed of recovery of populations, as well as implications for the landscape and public relations. In some parts of the country, notably arable areas, coppicing is carried out on a regular rotation, say every 15 years. Whilst birds and other mobile forms of wildlife can probably adapt to this management, I wonder whether, for example, small mammal or mollusc populations may not be gradually eroded by this process and eventually lost - another question for the researchers. Once we know a little more about coppicing, we might benefit from the development of machinery to do the work, if we feel it could be used as a regular management tool in arable areas.

Overmanaged hedges present a completely different problem, and in the arable areas of the country I would suggest that they present a far greater problem than the removal of hedges.

Farmers are very much conditioned to an annual cycle of activities, and every year at a certain time, they tend to cut their hedges whether necessary or not. There is also a good deal of conditioning towards tidymindedness, so that an untrimmed hedge is considered bad farming, and in some tenancies, it is actually a condition of tenure that hedges should be cut every year.

In arable areas in particular, but also where stock have been allowed to graze too tightly against the hedge, regular annual cutting can be a great drain on the resources of the plants. There may also be pressure due to close ploughing, spray-drift, scorching from burning, or from weed infestation, so that each year the amount of regrowth is less and the plants lose vigour. The bottom of the hedge becomes thin, while the top becomes stubby and flat-topped, and its habitat and visual qualities are greatly reduced. It is only a short step from this stage to remove the hedge altogether, probably with little objection because the value of the hedge has long been lost.

This is a very depressing state of affairs and one that concerns us a good deal. I recommend leaving the hedge for a few years in order to allow the exhausted plants to put on some new root growth, and then to coppice. This again is remedial work, and much more research and re-education is needed to prevent hedges getting into this condition. A reliable method of establishing shrubs in gaps in an existing hedgerow would also be welcome. At present, we use our best tree and shrub planting techniques and hope for the best, but the conditions in which we are planting the young shrubs are very hostile to their establishment.

With the general conservation management of ordinary farm hedges our aims are normally to achieve a variety of types of habitat and to fit in with the farming pattern. We like to see thick, stock-proof hedges, as these have considerable agricultural and landscape value, and if the hedge has a positive function its future is on a much firmer foundation than one which has become redundant as a barrier. An impenetrable hedge also provides safe nesting sites for small birds and warm overwintering roosts for invertebrates. We hope, however, that the management allows some scope for flowering and fruiting because of the great food value of these features, but apart from suggesting a longer rotation to achieve this, we would generally prescribe a continuation of the existing management. (A question for the plant physiologists: What is the effect on a tight, stock-proof hedge of 2-yearly or 3-yearly instead of annual cutting? Also, how can we control elder (Sambucus nigra) in hedgerows where farmers might otherwise adopt this rotation, but are not prepared to due to its presence?)

As a rule of thumb on hedge management over the whole of a farm, I would suggest that hedges running on an east-west axis are kept relatively low and free of trees, as this will limit their effect on the adjacent crop to the north, whilst a wider verge and hedge bottom should be encouraged, particularly on the southern side, where the microclimate will favour invertebrates and game birds. Perhaps the farm track could run along this side of the hedge to make a significant buffer from cultivation activities.

Hedges running on a north-south axis can be allowed to get much higher, and hedgerow trees can be encouraged more easily. That brings me on to another question - which trees should be planted in hedgerows? I tend to favour ash (Fraxinus excelsior) as it is late in leaf and casts only a light shade on surrounding crops and hedgerow plants, particularly where regular ploughing on both sides is going to prevent roots encroaching too much into the field, but again more information would be welcome.

I have spoken mostly about hedgerow management, but the field margin at the bottom of the hedge is also a most valuable habitat for wildlife. We welcome the research being carried out, but I wonder whether further work on the whole subject of field margin and headland management could be undertaken. Many of us have come across farmers who have created very wide verges, 15 metres or more across, and this may be a technique which could be applied further, particularly if a set-aside policy is ever introduced. A margin this wide can be fenced with flexi-netting and stocked with sheep or managed for hay or silage. It means that there is no headland to the arable crop, with the attendant problems of compaction, and no legal obligation to plough before burning. It can provide a useful communication route to get about the farm as well as having significant wildlife and game advantages. More work on this technique would be needed before it was likely to be taken up widely, and a shift in Government policy could help tremendously.

On the subject of hedge bottom flora, following on from what the (now disbanded) Weed Research Organisation (WRO), and Long Ashton Research Station (LARS), have demonstrated, I have a problem particularly related to new hedges. De facto, these are planted into bare ground, and chemical weed control may be carried out for several years, in accordance with present day tree planting techniques, to help the shrubs get established without too much weed competition. At some stage, however, this weed control will be relaxed, and we need to influence the type of vegetation which will colonise the hedge bottom. We are trying to encourage farmers in Wiltshire to experiment with low maintenance grass mixtures, of fescues and bents, either sown at the same time as the hedge is planted, or some years later when weed control is withdrawn. Further work on this problem would put this ad hoc advice onto a firmer footing and help to make hedgerow planting a more attractive proposition. Cheaper and more practical forms of rabbit protection for newly planted hedges would also be welcome.

I have tried to outline the main subjects of interest which occupy FWAG advisers, although I am sure my colleagues in other counties could add to these. I have also I think pointed out the dearth of research on the subject which is quite understandable but which I hope can be made up. We welcome the excellent work being carried out by the Game Conservancy, the WRO and LARS, the British Trust for Ornithology, the Institute of Terrestrial Ecology, and other research organisations, and support them wholeheartedly in their aims. In a modest way in my county FWAG in Wiltshire we have for some years now been experimenting with a variety of hedgerow treatments, and have just embarked on a totally new project in which we are monitoring the effects of different treatments of hedges at a farm at Dauntsey. Records are being kept of wild flowers, fruits, birds, small mammals, butterflies and some diptera, as well as carrying out time and motion studies and costings of operations, and trying to assess the relative merits of the hedges resulting from the different forms of management. There are numerous modest experiments like this being carried out, but they tend to be on a shoe-string budget and in our case are very much dependent on the goodwill of the team of amateur naturalists who have become involved. We would like to think such experiments could be taken up on a larger scale, in the context of a range of cropping patterns, soil types and hedge conditions, and carried out on a rather more scientific basis.

In the meantime we continue to offer advice based on the best information available at the present. We hope that in doing so we can arrest the decline in the state of our hedgerows and field margins, reduce the temptation to remove them, and give practical information on the creation of new ones where appropriate.

MEASURES TAKEN TO PRESERVE ARABLE WEEDS AND THEIR ASSOCIATED COMMUNITIES IN CENTRAL EUROPE

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INTRODUCTION

During the course of the last 5 to 10 years, most countries in Europe have gradually come to realize that weeds growing on arable land are just as worthy of protection as other, perhaps more spectacular, plant and animal groups. The reasons for this increased interest, as with the protection of individual species and conservation in general, encompass not only ecological and ethical aspects and those relating to the history of civilization, but also economic and psycho-social aspects. To demonstrate a very simple ecological relationship, a single plant species serves very often as host plant and food for at least ten species of various small organisms. In turn, many other creatures such as carabid beetles and spiders right through to partridge, quail and pheasant are dependent on these organisms for their survival.

The decimation of arable weeds, whose colourful display of flowers was typical of the agricultural landscape for centuries, has proceeded extremely rapidly over the last 25 to 30 years. This is a direct result of modern intensive farming practices. On the whole, the reasons for this decimation can be attributed to five factors:

- the increased purity of cereal seed;
- the abandonment of specialized cultures such as flax;
- the widespread use of mineral fertilizers;
- intensive soil management;
- the use of herbicides;

Most experts are of the opinion that the liberal application of herbicides has contributed more to the decimation of plant and animal life in cereal fields than the other four factors put together.

MODEL PROJECT 1978-1981 "PROTECTION OF RARE AND ENDANGERED ARABLE WEEDS AND ASSOCIATED COMMUNITIES ON UNSPRAYED FIELD MARGINS"

From 1978 to 1981, the German Ministry of Agriculture in Bonn supported our research group in a study to examine whether or not it was possible to combine agricultural use and conservation aspects in one and the same field. We were primarily concerned with whether the accompanying wild flora in cereal fields could survive on two to three-metre wide unsprayed field margins. Twenty interested farmers made a total of fifteen kilometres, and later twenty kilometres, of unsprayed margins in their cereal fields available. In return, they were compensated for the loss of income due to the smaller harvest.

The success of the project, especially on the calcareous soils of the Eifel Mountains but also on the soils of the Lower Rhine area, which is a particularly intensively farmed area near Bonn, was so obvious that, in 1982, various states in the Federal Republic began providing financial support to protect and restore the plant and animal life of the cereal fields in their respective areas.

The initial scepticism with which the project was greeted from various farmers and institutions was soon allayed. Those farmers who supported us in the early days are still participating today, nine years later. Furthermore, the combined efforts of conservation groups and farmers have received such a positive response by the general public that, in 1984, the concept of unsprayed cereal field margins was supported by all the major farming federations in the Federal Republic.

MEASURES TAKEN TO PRESERVE ARABLE WEEDS FROM 1984-1986

In 1984, unsprayed cereal field margins were supported from public funds in the following states in the Federal Republic: North-Rhine Westfalia, Rhineland Palatinate, Lower Saxony, Baden-Württemberg and Bavaria. Similar projects were carried out by various conservation bodies and sporting groups.

In Switzerland, the Swiss Conservation Group, with donations from the charity "Action Cornflower," supported a project on unsprayed margins in nearly all its provinces from 1983-84. Similar projects have been carried out on a smaller scale in Austria. We have no knowledge though of similar activities from other countries on the European mainland. We were therefore all the more pleased, when, in 1985, we learned from the Game Conservancy that they had been carrying out investigations into unsprayed cereal field headlands in southern England since 1982.

In 1985, the total length of unsprayed field margins in the cereal fields in the Federal Republic amounted to about 500 kilometres. The bulk of this was concentrated in North-Rhine Westfalia (with about 200 kilometres) and Bavaria (with about 80 kilometres).

In 1986, all states in the Federal Republic will be participating in this project and will increase the length of unsprayed margins in cereal fields to about 2000 kilometres.

These projects are being backed by the various states, in some cases with quite considerable sums of money. For instance North-Rhine Westfalia will be making about £27,000 (DM100,000) available, and the state Hessen roughly £80,000 (DM300,000). This means that in the next five years, the total length of unsprayed field margins could probably rise to about 5000 kilometres.

The amount of compensation the farmers receive varies between about two and three pence a square metre. On some soils, such as poor quality sandy soils or high-productive clay soils, the amount of fertilizer is reduced, too. The width of the field margins ranges from two to five metres in accordance with spraying procedures and the local situation in general.

Apart from margins there are some cases where whole cereal fields remain unsprayed. These though are mainly small fields which are difficult to cultivate.

One must mention the efforts of several agricultural open-air museums in Europe which are interested in preserving arable weeds as part of their displays on agricultural heritage, and to keep the relevant species in culture. This has been the case at the Rhineland Open-Air Museum at Kommern, near Bonn since 1980.

Similar goals are pursued by the so-called "Arable Weed Reserves" which can be found in the state Baden-Württemberg at Münsingen (since 1970) and Oberböhringen (since 1982), and also more recently in the GDR near Luckau, Gleina, Diedorf and Gerswald. In the GDR, the work-group "Conservation of Arable Weeds" has been formed as part of the Biological Society of this country.

We would be very pleased, if similar projects were more widespread in Britain and all European countries.

A SELECTION OF THE LITERATURE AVAILABLE

Nezadal, W. (1980) Naturschutz für Unkräuter? Zur Gefährdung der Ackerunkräuter in Bayern. Schriftenreihe Naturschutz u. Landschaftspflege 12, S. 17-27.

Potts, G. R. (1985) Herbicides and the decline of the partridge: an international perspective. Proceedings 1985 British Crop Protection Conference - Weeds 3, 983-990

Rohrer, N. (1982) "Un-Kraut" in Feld und Acker. Sondernummer 1, Schweizer Bund für Naturschutz (SBN), 25 Seiten.

Schlenker, G.; Schill, G. (1979) Das Feldflora-Reservat auf dem Beutenlay bei Münsingen. Mitteilungen d. Vereins f. Forstl. Standortskunde u. Forstpflanzenzüchtung H. 27, S. 55-59

Schumacher, W. (1980) Schutz und Erhaltung gefährdeter Ackerwild kräuter durch Integration von landwirtschaftlicher Nutzung und Naturschutz. Natur und Landschaft 55, S. 447-452.

--- (1980) Flora und Vegetation der Äcker, Raine und Ruderalplätze. Deutscher Naturschutzring, 20 Seiten.

--- (1981) Artenschutz für Kalkackerunkräuter. Zeitschrift Pflanzenkrankheiten u. Pflanzenschutz Sonderheft IX, S. 95-100.

--- (1983) Gefährdete Ackerwildkräuter können auf ungespritzten Feldrändern erhalten werden - Dreijährige Modelluntersuchung liefert Beweis. LÖLF-Mitteilungen, Heft 1, S. 14-21.

--- (1984) Über die Neubegründung von Ruderalgesellschaften im Rheinischen Freilichtmuseum in Kommern. Schriftenreihe Heft 3 der Stiftung zum Schutze gefährdeter Pflanzen: Dörfliche Vegetation im Freilichtmuseum, S. 11-20.

Sotherton, N. W.; Rands, M. R. W.; Moreby, S. J. (1985) Comparison of herbicide treated and untreated headlands on the survival of game and wildlife. Proceedings 1985 British Crop Protection Conference - Weeds 3, 991-998.

Sukopp, H. (1984) Die Bedeutung der Freilichtmuseen für den Arten- und Biotopschutz. The significance of open-air musuem for the protection of species and biotopes. Schriftenreihe Heft 3 der Stiftung zum Schutz gefährdeter Pflanzen: Dörfliche Vegetation im Freilichtmuseum, S. 34-48.

3.
Discussion

Chairman: Mr E. S. CARTER

DISCUSSION

Discussion was conducted in four lively sessions, following each group of talks. Rather than report contributions in the order they were made, the questions, answers and comments have been assembled here under a number of general headings.

AGRICULTURAL PROBLEMS

Pursuing Dr Marshall's talk about weed distributions in cereal fields, Mr Shrubb asked whether the data were obtained before or after the use of herbicides, and expressed doubt as to whether the picture obtained from studying a treated field would be relevant. Dr Marshall confirmed that the distributions were assessed in spring and summer - after spraying - but pointed out that the information was relevant to the succeeding crop rather than the current one. He added that data on the occurrence of viable buried seed had revealed a similar picture. Mr Bond surmised that the figures serve to demonstrate the relative resistance of weed species to herbicides. Mr Roughton argued that since some farmers do not use herbicides on headlands, the most relevant information would be that concerning the spread of weeds into the centres of unsprayed fields.

Dr Davis queried whether plant species of such different growth habits as field pansy (Viola arvensis), cleavers (Galium aparine) and weed grasses could be compared in terms of their frequency within quadrats. Dr Marshall clarified the methods used to obtain his data, involving ten 0.25 m^2 quadrats, at distances of 0, 3 and 50 m from the field edge; this gave an objective measure of species' presence or absence, but did not indicate the plant's competitive effect.

Miss Osborn asked whether couch grass (Elymus repens) spreads significantly into the crop by seed, as well as vegetatively. Mr Roebuck replied that rhizomes are the major method of spread, but in field centres there may be some occurring by seed propagation.

Mr Sim suggested that weed problems in headlands might arise not only from the close proximity of potential weeds in the hedgerow bottom, but might also accrue from inefficient cultivation and straw disposal on headlands, or be encouraged by reduced competition with the poorer headland crop. He wondered whether these factors had been separated in studies of weeds. Mr Roebuck agreed that there are many factors involved (eg tractor damage), some of which were addressed by Mr Fielder's paper.

Referring to the links between hedge structure and adjoining weed or aphid problems demonstrated by Dr Smith, Mr Spink asked if any similar investigations had been carried out on the design of shelterbelts. Dr Smith replied that some information on pests had been reported, and the beneficial effects of shelterbelts on pollinating insects and fruit yields in orchard crops were well known. He pointed out that it is possible to predict where aphids would first alight in a field, by measuring windspeed and the porosity and height of the hedge. Mr Spink wondered if shelterbelts could be regarded as generally beneficial. Dr Smith felt that much depended on the crop; there could be disadvantages from shading. Some work had been done on the effects of planting a belt of willows to encourage pollinating bees.

Dr Perring asked if awned canary-grass Phalaris paradoxa was an important weed, and wondered if it were a relic of cultivation, or whether it spreads 'naturally'. Mr Roebuck responded by saying that the species constitutes a local problem in the East Midlands, where it is confined to 3 - 4% of fields of winter wheat, generally on heavy soils. He felt that it was probably introduced through seed contamination, and was easily spread, although effective control methods were available. It was mainly confined to headlands, and did not yet appear to be a weed of economic importance.

Following Mr Bond's paper, Dr Marshall expressed doubts about the use of mecoprop (CMPP) to control seedling cleavers in the hedge bottom. He pointed out that pot experiments had revealed mecoprop to have effects on many hedge bottom species, including some grasses. The chemical is therefore unselective, and is probably unsuitable for this use. Mr Bond replied that the suggestion was to spray in mid-winter, when cleavers are apparent in the hedge but other perennial plants are dormant. However, he agreed that there was an urgent need for research on selective herbicides. Mr Roebuck added a comment on the control of major grass weeds (eg blackgrass (Alopecurus myosuroides), wild oats (Avena fatua) and brome grasses (Bromus spp,)), which was straightforward, since a selective herbicide treatment such as triallate followed by isoproturon would leave a useful number of flowering plants on the headland to satisfy the needs of gamebirds. Because of its great effect on crop yield, cleavers demand a more potent herbicide; he felt that fluroxypyr offered suitable control of cleavers, and would leave a number of flowering plants. Mr Bond commented that the degree of control obtained in one year by fluroxypyr treatment permitted a 2 - 3 year regime of rotational spraying.

CONSERVATION PRIORITIES

Dr Marshall asked if there were any plant species occurring solely in hedgerows, that might be threatened nationally by hedge losses. Dr Hooper replied that the only species in the UK to be confined to hedges is the Plymouth Pear (Pyrus cordata); its status is well known and it is scheduled for protection under the Wildlife and Countryside Act 1981. Nevertheless, some 25 to 30 species, mostly among the Rosaceae, were locally dependent on hedges. With these exceptions, the hedge may not be a vital habitat for general plant conservation.

Dr Marshall continued by outlining the frequent elimination of desirable perennial ground cover in hedge bottoms by the use of herbicides. With much current interest in re-creating suitable vegetation at the hedge base, he sought Dr Hooper's views on how this might best be achieved. Dr Hooper agreed with the wisdom of encouraging perennial plants at the base of the hedge, at the expense of annuals, many of which are weeds. He felt that the creation of a grass strip might be a useful approach, even though it would require regular management. Plants such as blackthorn (Prunus spinosa) have a high rate of colonisation into grass strips. Mr Klinner asked if there were any consensus about the optimum width of grass strip to benefit fauna and flora, bearing in mind the need to manage field margins by mechanical means. Dr Hooper said that there could be no consensus, because different species were favoured by different widths. Dr O'Connor made the point that for birds, other features - notably the volume of a hedge - may be more important than its width.

Dr Smith commented that the height of grass at the base of hedgerows is important for some butterflies, and wished to know whether it was also critical for other groups of insects. Dr Webb explained that the example he had given was the result of work on grazed downland; there was no direct information from field margins.

Dr Brown identified the rabbit as an important element of the field margin fauna, both because of its pest status, and for its role in maintaining short grass barrier strips. He referred to recent research suggesting that the abundance and diversity of weeds can be directly related to rabbit grazing pressure in experimental fields, and asked what the effects of field margin management were likely to be on rabbits and other mammals. Mr Meyer responded by explaining that the Wildlife and Storage Biology Discipline of ADAS had for the past four years been undertaking a national survey of small mammal numbers in hedgerows. This had the long-term objective of relating population densities to hedgerow habitat composition and the agricultural use of adjoining land. Mr Christensen reported that initial results from one study site indicated that plant species diversity did not seem to increase small mammal density. Dr Macdonald confirmed that there were as yet no firm answers for other mammals.

Dr Davis suggested that fertilizers are likely to have an important effect on the plants of hedgerows, and therefore on the insects, birds and other wildlife, and wondered what evidence there was to support this opinion. Mr Christensen commented that plant structure is altered very quickly once fertilizer applications are stopped, while Dr Sotherton added the view that any effects on insect populations would certainly work through vegetation changes.

Miss Marston questioned Dr O'Connor about the features that favour birds in hedges, pointing out the dangers of offering generalised advice towards producing an 'ideal' hedge. She suggested that of the 30 - 40 species of birds whose densities in farmland correlate with the presence of hedges, many would be more dependent on other habitats such as woodland. Perhaps the objectives of hedgerow management should be modified to take particular account of those species more narrowly dependent on hedges. In reply, Dr O'Connor reaffirmed that there can be no 'ideal' hedge, since the optimal requirements for each species are different. However, the combined preferences shown by many species reveal a structural average that can realistically form a management objective for farmers looking for general wildlife benefits. In addition, he stressed that the importance of hedges to birds is chiefly a result of the large numbers they harbour, rather than the presence of particular unique species. With woodland cover steadily diminishing, a substantial proportion of the total populations of common species that otherwise prefer woods, may now be supported in field hedges. He felt that the issue is one of environmental quality - the presence of common songbirds being highly valued by farmers and the general public - rather than a problem of conservation.

GAME INTERESTS

Prompted by Dr Rands' talk on gamebirds, Mr Shrubb asked whether the greater density of insect food in headlands was due to the proximity of the hedgerow, or to small differences in management practices at the edge

of the crop. Dr Rands replied that there are probably more herbs beside the hedge to start with, but any factors that affect weed density, including differences in management, would also have an influence on insect numbers. Mr Shrubb continued, asking if insects were affected directly by the fact that headlands are less likely to be burnt than the rest of fields; Dr Rands said that no work had been done on this point, but that it would not affect comparisons of sprayed and unsprayed fields.

MANAGEMENT PRACTICES AND COMPROMISES

Pursuing a point made in Miss Osborn's paper, Mr Roughton stressed that farmers' tendencies to be 'over-tidy' should be countered; grass verges, for example, should be left until mid-July or August to encourage a range of wild flowers, and ditches on fenland farms without hedges should be treated similarly. He proposed that a cheap solution for an 'over-managed' hedge is to stop trimming it altogether; by giving seedlings in gaps a chance to grow, a hedge can often repair itself. Miss Osborn agreed that in the initial stages of restoration, hedges should be left alone, but pointed out that in some areas such as Wiltshire, hawthorn will not regenerate naturally, so that active management is necessary later.

After Dr Rands' paper describing the benefits to gamebirds of leaving headlands unsprayed, Dr Feare asked what effects this had on crop yields. Dr Rands explained that this aspect had been monitored from the start of the Cereals and Gamebirds Research Project in 1983. This had shown that headlands - whether sprayed or not - produce lower yields than the main crop, but unsprayed plots had given a significantly greater reduction in only one out of three years. Dr Boatman added that the reductions of yield were still being quantified. The value for gamebirds of leaving headlands unsprayed was not dependent on preserving the most pernicious weeds (eg cleavers and weed grasses), and work was in progress to develop selective control measures for these species while allowing most broadleaved herbs to survive. The penalties in reduced yield should then be slight - probably in the range of 0 - 20% loss.

Dr Brown wished for further information on the increases of butterfly numbers recorded in unsprayed headlands, wondering if that was a result of providing more habitat, or was due to a redistribution of individual insects. The latter effect might be detrimental, by attracting butterflies to areas where they would be at risk from spraying and other management practices. Dr Rands replied that probably both mechanisms were involved. It was thought that the extra food supply in unsprayed field margins could increase butterflies' egg-laying rates, and hence reproductive success; this is now being investigated.

Dr Smith wondered if the need for dead grass to provide partridge nest-sites could be met by spot treatments of parts of hedges with herbicide. Dr Rands thought that mowing would be a preferable course of action, since some desirable grasses would be lost by spraying.

Miss Tetley asked if any work was underway to identify the best species to encourage or introduce as a grass strip, to meet the joint requirements of wildlife value, easy management, and a barrier to the spread of weeds. Dr Hooper mentioned studies in Bavaria, Holland, and the UK (at the Game Conservancy and by ITE at Monks Wood Experimental

Station). Certain cultivars now available as sports turf were being tested; in particular, 'Westerwolds' is useful for quick establishment, and provided it is cut to prevent seed set, dies out in favour of other species such as fescues, bents and wild white clover.

Mr Klinner reported that a new design of grain harvester was being developed at NIAE. It strips grain from crops without cutting, and performs satisfactorily in the presence of weeds, even where the crop is laid. Collection of the sieve efflux is a possibility that could reduce the spread of weeds, and an important advantage of the system was that the straw - which is left standing - could be incorporated by ploughing or discing without the need to chop it first. Dr Boatman stated that in a survey of farmer subscribers to the Cereals and Gamebirds Research Project about leaving headlands unsprayed, respondents expressed greater concern over harvesting problems connected with weed contamination than over losses of yield. These new techniques could be of great benefit in overcoming such difficulties.

Mr Oliver-Bellasis commented that the planting of new hedges on to chemically-cleared bare ground is a problem unless rabbits can be excluded. An alternative is to create a bank (by turning over several furrows) and plant the hedge into grass cover on the top, where, although growth might be slower, young plants will be protected, and beneficial insects favoured.

Mr Hayward commented that trimming hedges annually carried advantages in controlling growth, avoiding drastic damage to hedge plants, and minimising the debris to be collected and disposed of. Miss Osborn responded that the effects of frequent cutting depend heavily on the size of flail cutter used, and the care taken by the operator. Although hedges that were in poor condition owing to exhaustion, scorching, spray drift, close cultivation, and so on were often damaged by heavy cutting, careful annual trimming need not have any detrimental effects. It may even encourage a denser, more stock-proof growth of twigs.

In response to a comment about the apparent conflict over suitable hedge profiles for game and for other wildlife, Dr Rands protested that the Game Conservancy was not opposed to 'A-shaped hedges', but only against the shading of grass at the base, giving poorer nest-sites for game. He maintained that in order to present a united front in giving advice, there was a need to know the hedge-shape requirements of different species; this had not yet been established even for well-studied groups such as songbirds.

Mr Measures pointed out that ditches, which are the principal element of field boundaries in some regions, had not been considered by any of the speakers, although they might be equally as important as hedges. Mr Carter likened a ditch to an 'inverted hedge', and Dr Greaves agreed that aquatic elements should certainly be included in the prescription for a good field margin; some relevant work was in progress at Long Ashton Research Station.

Mr Hayward suggested that sowing tramlines into a crop could be a major means of reducing over-treatment by sprayers and fertilizer spreaders, though recognising that it would still leave problems of spray drift.

LANDSCAPE

Mr Taylor expressed disappointment at the omission of a broader concern for the landscape and the countryside at large in many talks and comments. He cited Dr O'Connor's and Mr Bond's papers as exceptions that demonstrated a wide underlying recognition of the importance of human values in countryside conservation. Overt priorities given to landscape had been diminished, he maintained, by the feeling that they were based on less objective criteria than the scientific principles involved in arguments for wildlife conservation or agricultural issues. However, Mr Taylor suggested that the concentration of research on particular species was just as subjective as the approach of landscape conservationists.

ADVICE AND THE PROMOTION OF GOOD MANAGEMENT

Several speakers recognised the fact that since different species have different requirements, there can be no single 'ideal' way to manage the field margin, and expressed concern over the danger of encouraging standardised hedgerows across the countryside. Miss Osborn proposed that each hedgerow should be assessed for its potential, and management should then be designed to maximise that potential. Though general, unspecific advice might be helpful, the aim should be to encourage diversity, both within farms and across the whole countryside. Dr O'Connor echoed this view, referring to evidence that the largest and most diverse communities of winter birds coincide with areas of mixed farming, where the diversity of management is greatest.

Despite the lack of a straightforward prescription for a 'good' field margin, Mr Hayward, Mr Fielder and others pointed to the urgent need for advisory guidelines. Dr Bunyan suggested that for practical purposes, a single comprehensive advisory package, produced at a reasonable cost, was necessary. General agricultural advisors required clarification of those aspects where field margins could be managed in different ways for different purposes. The advice offered to farmers who are interested in making a contribution to the environmental value of their farms, but have no specific objectives in mind, should be consistent, and without too great a complexity. Mr Oliver-Bellasis felt that an effective approach might be to produce a compendium of harmful practices, in order to prevent further damage while allowing time for good practices to emerge. Dr Smith suggested that separate packages for each part of the country might be developed, to take account of regional differences in wildlife, landscape and farming practice. Dr O'Connor confirmed that the British Trust for Ornithology's data revealed considerable regional variations in farmland bird populations: from east to west, with farmland in the east supporting a broader spectrum of breeding species; and from north to south, with farms in the north having fewer individuals, irrespective of habitat.

Dr Potts pointed out that even if the benefits of management changes such as leaving headlands unsprayed were accepted, there would remain a need to make these practices fashionable. He referred to the impressive initiative in the Federal Republic of Germany that Professor Schumacher had described, and wondered how money might be raised for a similar purpose in the UK. Dr Perring felt that a campaign for improved field margin management would command considerable public appeal, and attract funds, as had a recent effort concerning roadside verges. Mr Taylor

mentioned the existing mechanisms by which grants from the Countryside Commission might be obtained for this purpose.

Dr Jones commented that although they may be of value to conservation, many hedges now fulfil no agricultural function. Farmers are under increasing financial pressure and must be convinced of the value of their hedges if suitable management is to be achieved.

Prompted by Professor Schumacher's talk, Miss Tetley asked how the FDR authorities had arrived at a compensation figure of 2 - 3p/m^2 for not spraying or fertilizing crop headlands. Professor Schumacher replied that it was calculated by assuming a reduction of 30% from a grain yield of 5 tonnes/hectare; experimental sites were selected on the criteria that the density of crops was suitable (densities yielding 7 tonnes/hectare were considered too high), that wild flower populations conformed with requirements, and that fertilizer application was reduced. If weed problems developed too far, hand-spraying of weed patches was accepted. Dr Boatman stated that the reduction of yield due to leaving headlands unsprayed would generally be less in the UK; Professor Schumacher explained that the figure had originally been estimated from work at an agricultural research station, but had since been confirmed in farm trials.

Mr Measures reported that the BCPC Weeds Committee intended to focus attention on field margins by including a question on the use of herbicides and their role in the establishment of new hedges and farm plantations, in the 1986 'Review of Herbicide Usage'.

Dr Perring suggested that the RSNC would be willing to join with others in 1987 to consider an extension of their 1986 'Wild Flower Week' to cover the management of field margins.

CONCLUSION

Mr Carter summed up the final discussion session by emphasising that management of field margins is the farmer's choice; he is most likely to be amenable to advice if offered sound practical reasons for the action advocated. Thus the agricultural function of hedges is of great importance, and the implications of any regime for the practicalities of farming must be identified, as well as the benefits to game or wildlife.

Mr Carter agreed that there should be a move away from the notion of a standardised ideal 'national hedge', but felt that the variety of interests involved in giving advice would ensure that an appropriate diversity was maintained. He proposed that a simple code of guidance was needed, either based on a black list of bad practices that should be avoided, or on positive advice about basic concepts, elaborated when possible by local priorities.

Finally, he stressed that much more fundamental knowledge was needed. Research in several areas should be continued and expanded to speed the production of a comprehensive advisory package, which would certainly be welcomed by all concerned with the sensible management of field margins.